Matteo Filippi
Department of Economics, University of Zurich
Schönberggasse 1, 8001 Zürich, Switzerland
matteo.filippi@econ.uzh.ch

14 September 2026

Prof. Emily Breza, Prof. Arun Chandrasekhar, and Prof. Davide Viviano
Workshop on Development Economics and Networks for Early-Career Researchers
National Bureau of Economic Research
1050 Massachusetts Avenue, Cambridge, MA 02138

Dear Professors Breza, Chandrasekhar, and Viviano,

I am writing to apply to the Workshop on Development Economics and Networks for Early-Career Researchers, to be held in Cambridge on December 5, 2026. I am a fifth-year PhD candidate in Economics at the University of Zurich, supervised by Lorenzo Casaburi and David Hémous. During the spring of 2026 I was a visiting PhD student in the Economics Department at Columbia University, hosted by Eric Verhoogen.

The paper I would present is "In Search of Demand Engines: Evidence from South Africa's Automotive Industrial Policy." It studies how a policy-induced demand shock at the downstream assembly stage of the South African automotive supply chain propagates to upstream component producers, and why that propagation stalls.

In this single PDF I enclose, in the order requested:

(i) this cover letter;

(ii) my curriculum vitae, including a list of all completed PhD courses;

(iii) a one-page statement of motivation and current research interests;

(iv) the working paper described above.

Should my application be shortlisted, the following faculty member has agreed to provide a recommendation:

Prof. Lorenzo Casaburi
Department of Economics, University of Zurich
lorenzo.casaburi@econ.uzh.ch

Thank you for considering my application. I would be glad to provide any further material on request.

Sincerely,

Matteo Filippi
PhD Candidate in Economics, University of Zurich

Matteo Filippi — Curriculum Vitae

Email: matteo.filippi@econ.uzh.ch Address: Schönberggasse 1, 8001 Zürich

EDUCATION

Columbia University (Economics Department) — **New York, USA**
Visiting Ph.D student — *Jan 2026 - June 2026*
Academic Host: Eric Verhoogen

University of Zurich (ZGSE) — **Zurich, Switzerland**
Ph.D in Economics — *Aug 2022 - current*
Supervisors: Lorenzo Casaburi, David Hemous

Collegio Carlo Alberto (CCA) — **Turin, Italy**
Master in Economics (Allievi Honors Program) — *Oct 2018 - Mar 2021*
Supervisor: Giovanni Mastrobuoni, Final Grade: *Distinction*

Università degli Studi di Torino (Unito) — **Turin, Italy**
M.Sc. (Laurea Magistrale) in Economics — *Oct 2018 - Mar 2021*
Supervisor: Giovanni Mastrobuoni, Final Grade: 110/110 cum laude

Università degli Studi di Firenze (Unifi) — **Florence, Italy**
B.Sc. (Laurea Triennale) in Economia e Commercio — *Oct 2015 - Oct 2018*
Supervisor: Alessandro Petretto, Final Grade: 110/110 cum laude

Liceo Classico "Michelangiolo" — **Florence, Italy**
Diploma (high school with emphasis on humanities) — *Sep 2010 - Jun 2015*
Final Grade: 100/100

PREVIOUS AND CURRENT EMPLOYMENT

University of Zurich, Economics Department — **Zurich, Switzerland**
PhD student — *Aug 2022 - Aug 2027*
Supervisors: Lorenzo Casaburi, David Hemous

Bank of Italy, Economics and Statistics Division — **Rome, Italy**
Graduate Research Intern — *Jan 2023 / Jan 2024 / Jun 2024*

University of Turin (Unito), Economics Department — **Turin, Italy**
Research fellow, Artificial Intelligence for Museums (AI4MS) project — *Jun 2021 - Aug 2022*

European Central Bank (ECB), Directorate General Statistics (DG-S) — **Frankfurt, Germany**
Traineeship, Analytical Credit and Master Data Division — *Oct 2020 - May 2021*

TEACHING AND STUDENTS SUPERVISION

Teaching Experience

University of Zurich (Bachelor) — **Prof. Dina Pomeranz**
Global Policy Analysis: Poverty, Development, Growth — *Spring 2024, 2025*

University of Zurich (Master) — **Prof. Lorenzo Casaburi**
Global Poverty and Economic Development — *Fall 2024, 2025*

Thesis Supervision

- Valentin Matteo Meister (Master)
- Simon Kappeler (Master)
- Samira Benli (Master)
- Minyang Bai (Master)
- Cristina Sabrina Ruth Maria Spiegelburg (Master)

LIST OF COMPLETED PHD COURSES

- Short Course on Advanced Topics in Growth and Development Economics
- Short Course on Bunching Methods: Theory and Applications
- Evaluating Social Impact with Field Experiments
- Graduate Lab in the Field Experiments I and II
- Graduate Empirical Industrial Organization
- Graduate Development Economics
- Graduate Labor Economics
- Graduate Behavioral Economics
- Econometrics for Research Students
- Macroeconomics for Research Students
- Microeconomics for Research Students
- Graduate Introductory Math Course

PRESENTATIONS AND CONFERENCES (INCL. SCHEDULED)

- Sep 2026: German Institute of Global and Area Studies (GIGA), Hamburg
- Jun 2026: Unlocking South Africa's Export Performance Conference (ERSA), Pretoria
- June 2026: Nordic Conference in Development Economics, Vaxjo, Sweden
- May 2026: South African Administrative Data Workshop, University College Dublin, Dublin
- Feb 2026: Columbia Development Economics Colloquium, New York
- Feb 2026: World Bank/STEG/IGC Industrial Policy for Africa Conference, Nairobi
- Feb 2026: Trade Researchers' Workshop (ERSA), Pretoria
- Dec 2025: Collegio Carlo Alberto Alumni Workshop (CCA), Turin

RESEARCH GRANTS

- Oct 2025: STEG 8th PhD Research Grant (GBP 15'000), CEPR
- Jul 2025: Full Project Grant (CHF 25'000), Swiss-Re Excellence Foundation
- Jul 2025: Exploratory Research Grant (CHF 7500), URPP
- Jun 2025: "Unlocking South Africa's Export Performance" (ZAR 100'000), ERSA
- Jan 2025: Travel Grant (CHF 2'490), Swiss-Re Excellence Foundation
- Sep 2024: Director's Grant (CHF 1'500), UZH
- Jul 2024: Travel Grant (CHF 1'790), Swiss-Re Excellence Foundation

AWARDS AND FELLOWSHIPS

- Jul 2026: 6th-Year Academic Fellowship, UZH
- Sep 2025: UBS Center Scholarship, UBS
- Apr 2022: Bonaldo Stringher Scholarship (Particolarmente meritevole), Bank of Italy
- Apr 2022: Marco Fanno Scholarship (winner), Unicredit Foundation
- Mar 2021: Best Master's thesis in Economics, University of Turin
- Jun 2019, 2020: Summer school scholarship, Collegio Carlo Alberto
- Oct 2019: Best-performing student in Economics (1st prize), University of Florence
- Sep 2016, 2017, 2018: Merit-based scholarship, University of Florence

SPECIAL SKILLS

Programming Language	Python
Statistical software	Stata, Eviews
GIS sofware	ArcGIS, QGIS
DBMS	SQL

ACADEMIC SERVICE

- 2024-2025: UZH Development Lunch (main organizer)
- 2019-2020: Monitoring and Re-Examination Commission (University of Turin, Unito)

ADDITIONAL CERTIFICATIONS

- Sep 2024: "Welfare Implications of Trade and Growth: from Theory to Measurement" (Gerzensee)
- May 2024: "Causal Inference Workshop on Difference-in-Differences" (CUNEF Universidad)
- Jul 2021: Graduate Record Examination (GRE), Quant score 167/170.
- Jul 2021: IELTS Academic, Overall band 8 – level C1.
- Jul 2021: "Complex Network Analysis: Tools for Economic Development" (BGSE)
- Jul 2019: "Dynamic and non-linear panel data models" (BGSE)
- 2014: First Certificate of English, level B2

VOLUNTARY ACTIVITIES

- 2023-2024: Volunteer for Graduate Applications International Network (GAIN).
- 2020: Private graduate-level macroeconomics tutorship for 1st year students.
- 2014 - 2016: Volunteer at "Tommasino Bacciotti" Foundation, Florence.

Statement of Motivation and Research Interests

Matteo Filippi — University of Zurich

I am a fifth-year PhD candidate in Economics at the University of Zurich, supervised by Lorenzo Casaburi and David Hémous, and a 2026 visiting student at Columbia University hosted by Eric Verhoogen. My research focuses on industrial development and structural change, drawing both from contemporary poor countries and historical settings in advanced economies. Methodologically, I like to combine theoretical insights with modern empirical methods.

My prospective job market paper, "In Search of Demand Engines: Evidence from South Africa's Automotive Industrial Policy," uses South Africa's industrial policy as a case study to examine how production linkages between firms determine whether growth in one part of an economy transmits to the rest of it, and the reasons behind this (lack of) propagation. In 2013, South Africa replaced a conventional export-promotion incentives with the Automotive Production and Development Programme, a new system rewarding local value addition through import duty rebates on complementary input and output products. I show theoretically that the reform may be interpreted as a large shock to the input sourcing decisions of a handful of very large multinational assemblers, operating downstream along the domestic supply chain and exporting a large share of their sales. Using administrative, VAT, customs, corporate tax, and payroll records from the South African Revenue Service (SARS), together with vehicle-level and component-firm survey data, I trace what happens as that shock travels upstream. In line with the policy objectives, downstream assemblers increased local value addition (by roughly 75 percent) and grew in scale, mostly through demand for domestic inputs. In upstream segments, the policy jointly led to large inflows of new entrants in component manufacturing, together with a scale expansion for incumbent component producers. However, the transmission looks incomplete in an informative way. Component producers' imported input expenditure rose by more than 300 percent by the end of the sample period, and heterogeneity analysis reveals that the ability to scale up was confined to firms with pre-existing access to foreign inputs. Overall, it looks like the quality requirements imposed by the downstream exporting firms act as a friction in the upstream propagation of the shock, and proximity to the demand source is not sufficient if a supplier cannot meet its specifications.

More specifically, in order to capture exposure to the policy-induced demand shock, I use a variety of empirical strategies including an exposure design combining StatSA input-output tables (an inherently network object) with the geographic distribution and production capacity of assembly plants in South Africa. However, the network I observe is only sectoral and spatial rather than dyadic. This is where I hope the workshop would help me most, by gaining from the workshop's lectures and from discussion with researchers who work on exactly these problems, and I would welcome being pushed on whether my current design can be defended, sharpened, or replaced. I am also drawn to this workshop by its format. As my paper has been presented mostly to trade and industrial policy audiences, I've had so far very little exposure to researchers whose primary lens is network structure, and I expect this interaction to be potentially very helpful for improving the framing or the quality of the analysis. Being in a room of early-career researchers working on empirical networks in developing countries, with senior researchers present, is the most efficient way I can think of to close that gap.

In Search of Demand Engines: Evidence from South Africa's Automotive Industrial Policy *

Matteo Filippi†

September 14, 2026

Abstract

The use of export-led industrial policy is widespread across many poor countries, yet its effects on domestic supply chains are debated, with benefits often accruing to large multinational enterprises (MNEs). This paper investigates whether and how alternative models of industrial policy can promote deeper domestic industrialization, without undermining export performance. Focusing on South Africa's 2013 Automotive Production and Development Program (APDP), I study a shift from export incentives to a novel system rewarding local value addition through import duty rebates on complementary input and output products. I first develop a simple framework of firms' input sourcing decisions, showing that the APDP incentives introduce a kink in the firm's input sourcing problem between local and foreign inputs, with implications for both the intensive and extensive margins of input demand. I then empirically study these predictions using a rich combination of administrative, survey and commercial data from South Africa. The results indicate that, in line with the policy objectives, downstream MNE assemblers significantly increased local value addition and grew in scale, mostly through demand for domestic inputs. In upstream segments, the policy jointly led to growth of incumbent component producers and large inflows of new entrants in the market, together with a large increase in demand for imported inputs. To explain the latter finding, I first document increased sales at the assembly stage, largely driven by the introduction of new and more advanced models for export. Moreover, additional results on component producers show that the ability to scale up is limited to firms with baseline access to foreign inputs; among these, I also find that greater policy exposure is associated with several dimensions of firm upgrading, although these effects are concentrated among multinational producers. Overall, the results are consistent with a process of localization where demand from large domestic MNEs is able to sustain domestic firms' growth, but access to (high-quality) imported inputs is necessary to meet MNEs quality standards. These findings provide one of the first empirical assessments of localization-led industrial policy and shed light on the role of MNEs as engines of demand in developing economies.

Keywords: Industrial Policy; Localization; Global Value Chains; Multinational Enterprises; Automotive Sector; Export Performance
JEL Codes: O25; L62; F23; F14; O14; O55

*I am grateful to Pol Antras, Ariel Burstein, Lorenzo Casaburi, Gordon Hanson, David Hemous, Ronak Jain, Kristina Manysheva, Sebastian Otero, Michael Peters, Dina Pomeranz, Tommaso Porzio, Tristan Reed, Alireza Tahbaz-Salehi, Eric Verhoogen, and David Yaganizawa-Drott for insightful comments that significantly improved the paper. I also personally thank seminar participants at Collegio Carlo Alberto Alumni Workshop, ERSA Trade Researchers' Workshop, World Bank/STEG/IGC Industrial Policy for Africa Conference, Columbia Development Economics Colloquium, UCD South African Administrative Data Workshop, Nordic Conference in Development Economics, ERSA "Unlocking South Africa's Export Performance" Conference, and the German Institute of Global and Area Studies for useful comments and suggestions. I finally personally thank Michael Kilumelume for answering many questions on the NT-SDF administrative data, Sandra Sitoe and Joseph Gozoya for remote code execution at the NT-SDF, Donald McKay for sharing the official tariff data, and Dylan Jessup for outstanding consultancy service. This work was supported by the Swiss Re Excellence Foundation, Structural Transformation and Economic Growth (STEG-CEPR, grant 4532) and Economic Research Southern Africa (ERSA). All errors are my own.

†University of Zurich. Email: matteo.filippi@econ.uzh.ch

1 Introduction

Industrial policy is back on government agendas (OECD, 2026) and, although traditionally met with skepticism by many economists, a growing body of recent work seeks to understand its implications for economic growth (Itskhoki and Moll, 2019; Liu, 2019; Bartelme et al., 2024). Yet, the empirical evidence remains limited and concentrated in high-income settings - historically more active users of industrial policy (Juhász et al., 2024) - offering poor guidance for industrial policy design in low- and middle-income countries (LMICs). This gap is particularly consequential because, despite the historical prominence of industrial policy in advanced economies, developing countries are now the heaviest users across a wide range of industries and policy tools (World Bank, 2026)[1].

Motivated by this lack of evidence, the starting point of this paper is the observation that a prevalent form of industrial policy in LMICs has centered on promoting exports. This strategy - motivated by fixed production costs and the importance of market size for economies of scale (Murphy et al., 1989) - was pioneered by the Asian Tigers and later adopted by countries such as Vietnam, Mexico, China, and more recently, South Africa. The case for export-led growth remains compelling, supported by recent research linking larger market size to productivity gains in emerging markets (Walker et al., 2024; Goldberg and Reed, 2023). However, critics highlight its vulnerabilities, primarily stressing a tendency to disproportionately benefit large exporting multinational enterprises (MNEs), which often rely on imported inputs and engage less with local suppliers (Javorcik, 2004; Pavlinek, 2016; Barnes, Black and Monaco, 2021; Garetto et al., 2025). Importantly, this pattern has been well documented across a variety of settings, including Mexico, East Asia and South Africa [2]. The result is a form of enclave industrialization - high export volumes by a narrow set of firms coexisting with relatively underdeveloped domestic value chains - that limits the potential for economy-wide productivity spillovers and structural transformation (Hirshman, 1958; Gallagher and Zarsky, 2007), leaving open the question of how industrial policy can be harnessed to promote value chain depth in LMICs.

To make progress on this question, I study whether and how alternative forms of industrial policy can promote deeper domestic industrialization, without undermining export performance, focusing in particular on the automotive sector in South Africa. This industry provides the ideal setting to study this question, not only because of the relevance of the automotive sector in global manufacturing and industrial promotion strategies[3], but also because the country precisely transitioned in 2013 from an export-oriented to a localization-oriented program, the Automotive Production Development Program (APDP). Broadly defined, localizazion-oriented industrial policy may be understood as a strategy i)

[1] For instance, in World Bank (2026), total business subsidies among upper-middle-income economies are shown to average 4.2 percent of GDP (the highest on record). Similarly, middle-income economies have higher average import tariffs and more dispersion of tariffs across individual products compared to high-income economies, interpreted as evidence of stronger targeted protection of certain industries. A review of the latest national development plans across 183 economies finds that low-income economies target growth in 13 industries on average, more than twice the number in high-income economies.

[2] Mexico is perhaps the most well-studied case in economics: the maquiladora assembly plants along Mexico's northern border, despite generating substantial export volumes and attracting significant foreign investment, developed famously thin backward linkages to Mexican suppliers, with most intermediate inputs sourced from abroad rather than domestically. Similar dynamics have been observed in export processing zones across East Asia, where foreign-invested assembly operations achieved impressive export growth while remaining largely decoupled from local supplier networks.

building on a previous export-orientation phase, aimed at attracting large MNE firms operating at large scale, and ii) incentivizing MNEs' demand for domestic inputs, indirectly promoting local suppliers (TIPS, 2023). Thus, the core policy change lies in shifting the source of demand from foreign markets to large multinational enterprises (MNEs) operating domestically, potentially creating scale economies for upstream component producers. This mechanism of firm upgrading is supported by recent studies linking demand shocks from MNEs to sizable productivity gains (Alfaro-Urena et al., 2022; Masso and Vahter, 2023); yet, the extent of MNEs' integration with local suppliers remains limited, and how to unlock the gains from increased domestic input sourcing is still an open question (Garetto et al., 2025). This paper proposes localization-based industrial policy as a potential tool towards this end.

To begin with, I develop a stylized model of the South African automotive supply chain which provides testable predictions for the empirical analysis, clarifies the mechanisms through which the incentives operate, and helps guiding the heterogeneity analysis. In the model, while a fixed number of final producers operate under constant returns to scale and combine labor with domestic and imported inputs to produce a final good (car), a large number of component producers operate in the upstream segment under increasing returns and free entry to provide the domestic input. At baseline (with no industrial policy), due to increasing returns, each individual component firm would like to expand indefinitely, but its equilibrium size is determined by the size of the demand for domestic components by downstream assemblers. I next introduce the APDP-style incentives at the final assembly stage, which introduce a kink in the firm's input sourcing problem between domestic and foreign inputs. The key insight is that, when some complementarity between local and imported inputs exists, the location of the optimal solution depends critically on the firm's pre-policy foreign input intensity, a feature I exploit in my heterogeneity analysis. This also highlights the key potential channels of firm adjustment: for heavy importers (the large MNE assemblers that are the primary policy target) rebates can increase demand for domestic (and foreign) inputs through an income effect, by operating as an inframarginal tax reduction on the firm's cost constraint; for intermediate importers, the same instruments induce substitution between foreign and domestic inputs in anticipation of the higher cost associated to the former; finally, for light importers, all duty credits operate on the marginal units, firms remain in the duty free region, and demand for imported inputs rise. In any case, the incentives lower the final assemblers' marginal cost and increase their scale of operation; taking into account this equilibrium effect on the final good market, the model can generate an increase in scale and entry of component producers, irrespective of the specific regime, providing directly testable predictions for the empirical analysis.

In the empirical part of the paper, I next test these predictions using quasi-experimental methods commonly used in the new generation of research on industrial policy (Juhász et al., 2024) combined with a rich combination of data sources from South Africa. The primary source is administrative micro-data from the South African Revenue Service (SARS), hosted at the National Treasury Secure Data Facility (NT-SDF) in Pretoria, covering the period 2007/08–2019/20. The key datasets are: i) the Value Added Tax

[3]Many developing and emerging economies have sought to establish a domestic automotive industry through various policy instruments, including incentives for direct investments (e.g., Brazil, Mexico, Turkey, and Thailand), support for local companies (e.g., Malaysia), investment in research and development (e.g., Turkey and Brazil), and facilitating joint ventures between multinational corporations and local businesses (notably in China).

(VAT) records, crucially distinguishing firm-level purchases and sales by domestic and foreign source, ii) transaction-level customs data, crucially including a unique flag identifying whether specific import transactions used industrial policy duty rebates; I complement these sources with Corporate Income Tax (CIT) records and IRP5 payroll data. Given the limited number of treated units among downstream MNE assemblers, and a single treated unit when collapsing the data at the sector level to study entry and exit, my main strategy adopts the Synthetic Difference-in-Differences (SDID) estimator of Arkhangelsky et al. (2021), which relaxes the requirement for a large number of treated units, allowing me to seamlessly adopt the same estimator for firm-level and sector-level specifications; inference for event studies relies on a sector-level clustered bootstrap procedure adapted from Athey et al. (2024). In addition to the administrative sources, I also incorporate alternative commercial data sources allowing for closer inspection of the adjustment margins, both at the final assembly and the component manufacturing stages. For final assembly, I first use data on the universe of vehicle sales in South Africa, including domestically manufactured, exported and imported vehicles, from Lightstone SA, the primary officially approved supplier of vehicle data from the National Association of Automobile Manufacturers of South Africa (NAAMSA). Importantly, these data cover both manufacturers and retailers, a key feature I exploit in my empirical analysis, together with detailed information on vehicle attributes and models. My empirical strategy here consists of standard diff-in-diff specifications at the vehicle type-level (e.g. BMW 1-Series), with treatment status determined by manufacturing vs retailing status and defined at the brand or firm level. For component manufacturing, I employ panel data from the South African Automotive Benchmarking Club (SAABC), an industry association of South African automotive component manufacturers, containing information on the onwership status (local vs MNE), the tier of operation, the type of manufacturing activity, and a rich set of outcomes directly related to firm upgrading (Verhoogen, 2023). Here, I exploit variation within the component sector in the exposure to the downstream demand shock based on the content of a specific set of materials (so called standard materials) which are rewarded in the calculation of local value added; I next embed this measure in a continuous-exposure design estimated through a standard diff in diff specification[4]. Finally, in order to get at sector-level aggregate effects and to tackle potential threats to identification, I employ sector-level survey sources from Statistics South Africa (StatSA), the Department of Trade, Industry and Competition (DTIC) and international trade data from the OECD's Trade in Value Added database. Given the aggregate nature of these data sources, I use a Synthetic Control (SC) or Synthetic Diff in Diff (SDID) estimator exploiting cross-sectoral and time variation, a standard approach in similar settings (Abadie and Gardeazabal, 2003; Abadie et al., 2010; Abadie, 2021); in the TIVA data, I also exploit variation across sector-countries to estimate triple difference specifications.

To set the stage for the empirical results, I start by documenting three empirical facts for the pre-APDP period in South Africa. First, using data from the StatSA Manufacturing Utilization of Production

[4]To get at this measure, I first exploit detailed information on the type of firm-level manufacturing activity, and use input-output tables obtained from Statistics South Africa to build an index of the average content of these materials in the firm-level output; next, I interact this index with a measure of the local demand shock, as proxied by the production capacity of the assembly plants located in the same province. I obtain data on assembly plant production capacity through Marklines, an international data provider for the automotive sector.

Capacity (MUCP), I provide direct evidence on the role of demand in automotive: between 2010 and 2015, on average 20% of total production capacity was under-utilized, with figures peaking at 40% during the pandemic; breaking down the underlying reasons for this under-utilization, I find that between 60 and 80% is explained by insufficient demand. Second, using input-output data from StatSA, I document that, despite automotive in South Africa has strong technological potential for generating upstream spillovers, either directly or indirectly, the domestic value added generated along the entire value chain was among the smallest in 2013, with approximately 40% of value added generated abroad. Third, I microfound this result using the VAT administrative data, and find that the light-vehicle and medium-heavy-vehicle manufacturers registered as industrial policy users in 2013, despite being very large firms across a wide range of outcomes, were among the smallest *relative* users of domestic inputs, corresponding respectively to the 2.93 and 4.34 percentiles of the entire manufacturing distribution. This result suggests that, despite being potentially suitable to sustain firm growth in upstream segments, these firms were also relying little on domestic inputs, leaving scope for a potential increase in local sourcing that the APDP was intended to promote.

Motivated by these facts, I move to the main results. I find that among downstream MNE assemblers, both light and medium-heavy vehicle manufacturers substantially increased local value added and domestic input expenditure - by approximately 75% and 25% respectively - and expanded in overall scale by the end of the sample period, with total revenues and total input expenditure jointly increasing[5]. Among upstream component manufacturers, the results first indicate substantial firm entry (approximately 200 new entrants per year at the peak, roughly double the pre-policy level), with no corresponding increase in exit, suggesting that the program created additional demand rather than displacing incumbents. Most of the new entrants (around 60%) are fully-domestic firms, they are mostly genuine new firms (more than 80% of them also enter in the balance-sheet data after 2013) and look like legit firms when compared to entrants in untargeted manufacturing sectors, across a wide range of outcomes. However, using sector-level difference-in-difference specifications comparing the average productivity of new entrants in automotive versus other untargeted manufacturing, I find that the average entrant in targeted industries is about 60% less productive; tracking the life cycle of the new entrants, I also find that new entrants in automotive generate consistently smaller total value added, but are not different across other domains. Second, results on incumbent producers show a pattern of scale expansion, with total revenues increasing by around 50% and driven primarily by domestic sales, accompanied by a striking increase in imported input use, with expenditure on imported inputs rising by more than 300% over the sample period. This pattern is consistent with a localization process where increasing domestic sourcing at the assembly stage together with binding downstream quality requirements for exports operate as a friction in the further upstream transmission of the policy, making access to higher-quality imported inputs a necessary requirement to meet MNE assemblers' specifications.

To find evidence for this type of mechanism, I perform three different exercises. First, I consider heterogeneity of my main results by pre-policy foreign input intensity, both at the assembly and compo-

[5]A revenue decomposition reveals that light manufacturers upgraded primarily through the export channel, consistent with their global orientation, while medium-heavy manufacturers expanded through domestic sales; however on net the first effect dominates.

nent manufacturing stages. The results on assemblers indicate that the effects are largely concentrated on above-median relative users of foreign inputs, consistent with the heterogenous effects predicted by my framework. At the component stage, consistent with my hypothesis, I also find that the increase in scale is largely concentrated in firms with above-median baseline access to foreign inputs. Second, I use data from Lightstone and show that the policy induced manufacturers to increase their export orientation (export sales increase at double speed than domestic sales), and that an important margin of adjustmnent is the introduction of new and more advanced models for the export market, plausibly requiring relative more imports for manufacturing. Third, to investigate potential margins of firm upgrading, I use the SAABC data and show that firms more exposed to the downstream policy-induced shock increase their sales by 20% more for a 1 standard-deviation higher exposure; moreover, they also use relative more materials and labor, are more likely to export, and become more efficient as proxied by overhead expenses[6]. However, this upgrading effects are largely concentrated in multinational component producers. This evidence is consistent with quality demand by downstream car assemblers - and the resulting need to access international inputs - operating as a friction in the further transmission of industrial policy, consistent with a rich body of work showing that imported inputs tend to be of better quality than locally sourced inputs.

I also directly address potential threats to identification using data from Marklines, a leading commercial provider of automotive data across the globe, and the OECD TIVA database. First, I show that the results are inconsistent with a decline in international competitive pressure on South African automotive producers, which might otherwise explain the assemblers' increase in sales. Second, I provide evidence against a general international demand shock for automotive products, that could have generated the observed increases in automotive sales even in the absence of any policy intervention.

Finally, to get at aggregate sector-level effects, I use sectoral data sources. First, I confirm that subsidies and incentives increased sharply in both the vehicle and component sectors following 2013. Sales data from the MPS and output and value added data from the DTIC confirm a roughly 40% increase in real automotive sales and 20% increase in real output and value added. Export performance improved substantially, both in absolute and relative terms as a share of output. Using data from TIVA, I also document large increases in the domestic value added embodied in exports. Taken together, the results indicate that although localization and global integration need not be competing objectives, growing through exports may operate as a major obstacle in the transmission of demand shocks to upstream segments if quality requirements operate as a binding constraint.

Related Literature. This paper contributes to ongoing debates on demand-constrained industrialization in developing economies and the potential role for targeted industrial policies. On the theoretical front, recent work has emphasized the stage-dependent nature of optimal industrial policy in the development process (Itskhoki and Moll, 2019), the case for subsidizing upstream sectors in the presence of production network frictions (Liu, 2019), and the connection between sector-level economies of scale and aggregate welfare gains (Bartelme et al., 2024). However, compared to the recent theoretical progress,

[6]This evidence also attenuates concerns of pure trans-shipping happening in response to the policy.

the empirical evidence is much more limited and largely concentrated in high-income countries[7], with only a few recent papers exploring LMIC contexts: Rotemberg (2019) analyzes direct and indirect effects of small-firm subsidies in India; Lane (2022) studies directed credit and trade protection for the heavy industry in South Korea; and Kalouptsidi (2018) investigates industrial subsidies in China's shipbuilding sector. Relative to this literature, the present project examines a conceptually novel industrial policy intervention - one that shifts the focus from traditional export promotion to localization incentives, potentially re-directing input demand by large downstream producers from foreign to domestic firms. This type of industrial policy specifically takes into account the demand-side constraints to industrial development faced by many LMICs and exploits the presence of large MNEs operating domestically as an engine of demand for upstream producers.

Second, this project relates to a well-established literature on the impact of multinational enterprises (MNEs) on domestic economies, with a particular focus on backward linkages - the case in which MNE affiliates source inputs from local suppliers. The findings in this literature tend to be mixed (Javorcik, 2004; Giroud et al., 2012; Newman et al., 2015; Kee, 2015; Masso and Vahter, 2022; Carballo et al., 2023; Amiti et al., 2023), although the most recent research finds that suppliers to a MNE can experience dramatic effects on productivity growth (Alfaro-Urena et al, 2022). However, MNE affiliates are often heavy users of imported inputs, limiting the extent to which domestic firms can reap these potential productivity benefits; at the same time, the reasons behind MNEs' limited engagement with local suppliers - and the extent to which industrial policy can address this gap - remain poorly understood (Garetto et al., 2025). This paper addresses this question by investigating whether and how localization-oriented industrial policy interventions can unlock these upstream productivity spillovers.

Finally, this paper connects to a substantial literature on trade and firms' access to intermediate inputs. A consistent finding in this body of work is that imported inputs are typically of higher quality and imperfect substitutes for domestic ones, leading to significant productivity gains (Amiti and Konings, 2007; Topalova and Khandelwal, 2011; Halpern et al., 2015; Kugler and Verhoogen, 2009) and improved export performance (Bas, 2012; Manova and Zhang, 2012). Relative to this body of work, I provide two main contributions. At the assembly stage, I focus on a setting where complementarities in production between imported and domestic inputs can be exploited in the design of industrial policy; to the extent that some form of complementarity between foreign and domestic inputs exists, I show that an industrial policy program linking import duty rebates to local value added can indeed *increase* domestic input sourcing and generate demand effects for upstream component producers. At the component stage, my findings confirm the crucial role of imported intermediates already highlighted in the existing literature, although through a different channel: I show that access to foreign inputs might be an important determinant of who is able to leverage the gains from increased downstream local sourcing, resulting in various forms of firm upgrading (Verhoogen, 2023).

[7]Notable studies have examined the effects of R&D subsidies (Bronzini and Iachini, 2014; Howell, 2017), investment incentives (Criscuolo et al., 2019), and regional development programs (Busso et al., 2013; Kline and Moretti, 2014).

2 Institutional Background

2.1 Some Rationale for Targeting the Automotive Sector

Accounting for approximately 15% of global GDP (Barnes and Meadows, 2008), the automotive sector is one of the largest manufacturing sectors worldwide, often seen as a key driver of domestic industrialization and growth (Barnes et al., 2017; Barnes, Black and Monaco, 2021)[8]. As a consequence, many emerging economies have sought to establish a domestic automotive industry through various policy instruments, including incentives for direct investments (e.g., Brazil, Mexico, Turkey, and Thailand), support for indigenous firms creation (e.g., the Proton and Perodua projects in Malaysia), investment in R&D (e.g., Turkey and Brazil), and facilitating joint ventures between multinational corporations and local businesses, most notably in China (Wuttke, 2021). Although the rationale for targeting the automotive sector is rarely stated explicitly, possible explanations include:

1. ***Within-industry spillovers***. Many countries aim at promoting the growth of domestic automotive components industries, with positive effects on job creation and technological capability through spillovers from MNE assemblies (Humprey, 2003). This process is eased by the large value added and distinct number of components embodied in a vehicles, generating demand for a wide set of automotive component manufacturers (Black, 2002; Barnes and Black, 2013).[9]

2. ***Cross-industry spillovers***. The industry has strong linkages to other upstream and downstream industries. On the input side, it largely sources from industries such as aluminium, chemicals, electronics, leather and textiles, plastics, steel, machinery and equipment, service industries such as engineering, logistics, tooling and others such as financial, wholesale, retail and advertising (Davies, 2010). On the output side, it displays strong linkages to employment-intensive activities such as motor trade (the service industry involved in sales, distribution, maintenance and operation of motor vehicles) and the transportation service sector (Flatters, 2006). This feature creates strong potential for upwards and downwards spillovers across industries.

2.2 Industrial Policy Evolution in South Africa

2.2.1 Import substitution (Until 1995)

The South African automotive industry has a long tradition, with initial production originating from the indigenous steel industry in the 1920s (Kaplan, 1977). Over the 20th century, the sector developed under high levels of protection, which included prohibitive tariffs of more than 100% and local content requirements (Black, 2001; Adams 2007, Flatters, 2006)[10]; this attracted a large number of foreign

[8] OICA estimates that approximately 8.8 million (primarily skilled) jobs are directly linked to the automotive manufacturing sector worldwide, with a total of approximately 50 million people that earn their living from all kinds of vehicles, trucks, buses and coaches (OICA, 2010).

[9] In South Africa, Black and Bhanisi (2006) report that each vehicle contains on average 10 000 components.

[10] A series of local content programmes were introduced in 1961, with the main objective to save foreign exchange rather than to rationalize production (Black 2001). Until 1989, local content was defined by weight (Black, 2002; Barnes, Kaplinsky and Morris, 2004), which led to the emergence of a low-volume component industry oriented towards the production of heavy components such as body pressings (Black, 2001).

companies establishing new assembly plants (Barnes and Black, 2013) and joint ventures with local firms (Barnes, Black and Monaco, 2021)[11]. Although production volumes increased, especially in the phase 1950-1980 when sales increased tenfold (Black, 2001), the automotive industry remained inefficient and highly inward-oriented (Barnes et al, 2014), with minimal exports (Barnes, Black and Monaco, 2021) and poor-quality outdated products (Bronkhorst, Steyn and Stiglingh, 2013). This process was exacerbated by the excessive proliferation of makes and models assembled in low volumes (Black, 2001), in turn forcing component manufacturers to inefficiently produce at levels well below world standards (Barnes and Black, 2013; Barnes et al, 2017). This was especially true in supply-chain segments requiring high-cost and model-specific tooling and machinery, a common feature in the automotive industry (Sturgeon et al., 2008)[12]. In parallel, imports were minimal, with South African assembly plants kept isolated from the global production networks of the parent companies except as markets for completely knocked down (CKD) packs of imported parts (Black, 2001). In an effort to make the industry increasingly exposed to international competition, partial liberalization took place in 1989 in the component sector, but tariffs remained prohibitive on built-up vehicles at 115% (Barnes and Black, 2013) and levels of foreign ownership remained low, both among vehicle manufacturers and component producers (Barnes et al, 2017)[13]. Overall, the industry was very inefficient and could not have competed either domestically or internationally in the face of immediate further trade liberalization (Flatters, 2009).

2.2.2 The Motor Industry Development Program (MIDP) (1995-2012)

In order to expose the industry to more competition, while at the same time promoting larger scale and better rationalization in domestic production (Flatters, 2006; Davies, 2010; Strydom, 2014), in 1995 South Africa approved the Motor Industry Development Program (MIDP)[14]. The MIDP consisted primarily of a rapid reduction in import tariffs on vehicles and components, coupled with a drop of the previous local content requirements and new incentives in the form of import duty rebates linked to exports (Bronkhorst et al., 2013)[15]. In particular, the MIDP comprised four main policy instruments:

1. **Duty Phase Down**: a gradual reduction in nominal import tariffs on both completely built-up (CBU) vehicles and completely knocked-down (CKD) components, from 65% and 49% in 1995 to 25% and 20% in 2012, respectively. Figures E.1 and E.2 show the evolution of import tariffs on CBU and CKD as mandated by the MIDP and the resulting effective protection; the rate of decline was steeper than required by the GATT (Barnes and Black, 2013).

[11] Worldwide, the automotive industry was an important pillar in import substitution programmes, especially in larger countries (Humphrey et al., 1998). Similar experiences were observed in emerging economies such as India and Brazil.

[12] Because of low production volumes and the resulting complexity, firms built expertise in logistics, materials flow, machine changeovers, and production scheduling - vary far from the cost-minimization focus of world-scale plants (Black, 2002).

[13] In addition, the definition of local content changed from weight to value (Barnes, Kaplinsky and Morris, 2004) and vehicle producers could meet part of their local content requirements by exporting (Black, 2001), reducing actual local content in domestically-produced vehicles to a minimum of 50% (Black, 2002). Exports rose rapidly from negligible volumes in the mid-1980s to R2,245 million in 1994, but scale remained suboptimal and production costs high (Barnes and Black, 2013).

[14] Originally planned until 2003, the MIDP was subjected to two reviews, in 1999 and in 2002. The first review extended the programme to 2007, whilst the second extended it to 2012 but on a phasing down basis.

[15] Many developing countries opt to offer fiscal incentives, mostly because they cannot afford outright financial grants. This was also the strategy chosen by South Africa to support its own automotive sector (Kaggwa, Pouris and Steyn, 2007).

2. **Import-Export Complementation (IEC) Scheme**: a scheme allowing exporters of vehicles and/or components to earn Import Rebate Credit Certificates (IRCCs), usable against tariffs on vehicles and/or components[16]. The key objective was to generate higher production volumes, which would help assemblers to compete in the domestic market against imports (Black, 2002) and component producers to lower input costs into the assembly industry (Barnes and Black, 2013). This is the MIDP's main policy instrument.
3. **Duty Free Allowance (DFA)**: a scheme allowing assemblers selling vehicles for the local market to earn a 27% duty rebate, usable against import duties on components and - if any credit remained - on vehicles (left panel in Figure E.3). The rationale behind the DFA was to push manufacturers to locally produce more vehicles for the domestic market, in parallel importing components and complementary vehicles duty-free to compete in other segments (Strydom, 2014).
4. **Productive Asset Allowance (PAA)**: a new scheme introduced in 2000 and allowing firms making qualifying investments in productive assets to import vehicles duty free. The incentive size was 20% of the investment value, to be used at 4% per year. The key objective was to support capital upgrading in state-of-the-art assets, helping automotive plants to meet higher production volumes (Black, 2002; Jennings, 2008); the PAA was phased out in 2009 (right panel of Figure E.3).

The MIDP is widely regarded as a major success of South Africa's post-apartheid industrial policy (Flatters, 2005) and one of the most significant interventions since 1994, given its powerful incentive structure and the importance of the industry it targeted. Overall, this policy can be understood as a scale-enhancing strategy addressing the problem of a limited domestic and regional market (Barnes and Kaplinsky, 2000; Barnes, Kaplinisky and Morris, 2004; Black, 2009), by rewarding volumes of production for the local and export market, coupled with a complementary incentive to make investments in support of production volumes. However, despite significant exports growth, the MIDP is believed to have contributed little to value chain depth (Strydom, 2014), leading to a major policy revision.

Additional Information. For additional information on the MIDP, the reader is referred to the Section E. Section E.1.1 provides additional information on the declining tariff rates over the period, the effective rates of protection, and the resulting incentive sizes. Section E.1.2 discusses channels of firm upgrading. Section E.1.3 provides additional information on the Productive Asset Allowance (PAA). Section E.1.4 extensively discusses the evolution of the industry under the MIDP phase 1995-2012.

2.2.3 The Automotive Production Development Program (APDP)

Already in 2008, the need for strengthening the automotive value chain with increased levels of local content and job creation was clearly identified as the major objective in the transition to the APDP (Adams, 2007; Barnes and Black, 2008; Strydom, 2014). Still in 2013, the levels of localization were small,

[16]Some attempt to incentivize local sourcing were already in place under the MIDP, as the value of the IRCCs was formally computed as a percentage of the local content value embodied in exports (middle panel in Figure E.3). However, local content is different then local value added (the focus of the APDP); moreover, it was inclusive of raw materials. As a consequence, many assemblers and component manufacturers specialized in the export of peripheral components (catalytic converters, leather seats) rich in local raw materials, but carrying litte value added (Flatters, 2005; Black, 2009; Barnes and Black, 2013).

largely due to the industry operating below minimum efficient scale (Barnes and Black, 2013; Strydom, 2014). As such, the long-term objective identified by the Department of Trade and Industry (DTI) was to increase vehicle production to 1.2 million vehicles per year by 2020, simultaneously deepening the local components manufacturing industry. To this end, the government introduced the Automotive Production and Development Program (APDP) in 2013, consisting of three main policy instruments:

1. **Stabilized Import Tariffs**: the tariff phase down under the MIDP ceased in 2012; from 2013 onwards the tariffs remained stable under the APDP, at 25% on CBU light motor vehicles and 20% on CKD components (SAABC, 2008). Figure E.1 shows the tariff evolution between 1995 and 2020.
2. **Production Incentive (PI)**: a scheme linking local value added in production to duty-free imports of vehicles and/or components, open to light-vehicle assemblers, medium-heavy-vehicle assemblers and component manufacturers. Specifically, according to the official APDP rules, the content of specific domestic raw materials (so-called standard materials) embodied in locally-sourced inputs is not fully deducted, but rather contributes to the definition of local value added according to a so-called Standard Value Added (SVA) percentage; to get to the final incentive, a so-called Production Incentive (PI) factor is applied (Figure E.4). Through a system of cross-declarations, the program therefore tracks the value added generated along the entire domestic value chain. This is the main APDP's policy instrument.
3. **Volume Assembly Allowance (VAA)**: a scheme rewarding firms' sales (irrespective of the market) through import duty rebates on components and - if any credit remained - on vehicles, for a certain percentage of sales. Only assemblers with sufficient production capacity qualify for this incentive (Figure E.5). Higher volumes of production achieved through the VAA were expected to indirectly push for higher local content on an economic basis (Adams, 2007; Davies, 2008).

The APDP can be understood as an attempt to promote higher value chain depth, by: i) maintaining/increasing volumes of production (through the VAA), thereby reinforcing scale economies; ii) because imported inputs are fully netted out in the local value added definition, producers have an extensive-margin incentive to expand production through domestic inputs; second, because the incentive depends in turn on the local content of these local inputs, there is an intensive-margin incentive to source from domestic suppliers with higher local content (Deloitte and Touche, 2009; Strydom, 2014), a feature I exploit in Section 8. This process would result in faster growth of the local component industry, not only at a 1st tier level but also at the 2nd and 3rd tier (Strydom, 2014; Barnes, Black, and Monaco, 2021)[17]. In line with this logic, using a survey administered to component manufacturers, Strydom (2014) reports that most producers expected the APDP to promote higher volumes of local production, a rise in quality and productivity, larger local investment, and higher local content of motor vehicles and components.

Policy Uncertainty and Anticipation. Although the general APDP objectives were already defined in 2008, and it was made clear that reasonable support for the industry would be maintained until 2020 (DTI, 2010), the specific forms and levels of support were not clarified until the actual implementation

[17]As a by-product of higher domestic value addition, the APDP was also expected to have positive spin-offs for employment creation (Pitot, 2011) and to promote training and mentoring of employees, entrepreneurial skill and modern technology adoption (Strydom, 2014).

in 2013. While the original aim was to publish the details of the APDP regulations during the first quarter of 2011/12 (DTI, 2011), Bronkhorst et al. (2013) report that, still in the third quarter of 2012/13, the final APDP regulations had yet to be published. As a consequence, the new programme left many key stakeholders with a cloud of uncertainty (Bronkhorst et al., 2013; Strydom, 2014), with the largest element of uncertainty being represented by the exact mechanism of the PI and what could be regarded as "value-added" (Bronkhorst et al., 2013, Strydom, 2014)[18]. Due to this uncertainty before the actual implementation phase, assemblers could not risk making strategic plans and only started deploying their APDP-aligned supply chain strategies after 2013, once the official rules were released (Bronkhorst et al., 2013; Strydom, 2014)[19]. For this reason, I expect little evidence of anticipation effects.

Additional Information. For additional information on the APDP, the reader is referred to the Section E. Here, I first provide additional intuition on the rationale and basic mechanics of the APDP; next, Sections E.2.1 and E.2.2 provide additional information on the PI and the VAA, respectively. Section E.2.3 discusses another policy instrument replacing the MIDP's PAA (the Automotive Investment Scheme), which however was introduced well before 2013 and is thus outside the scope of this paper.

3 A Theoretical Framework

This section presents a stylized model of the South African automotive value chain allowing for the introduction of APDP-style incentives. The main purposes are: (i) clarify the mechanisms through which duty rebates affect firms' input sourcing, (ii) derive testable predictions, and (iii) guide the heterogeneity analysis. The framework is deliberately simple, yet able to characterize margins of adjustment.

In particular, I consider an economy where a small fixed number of assemblers operate under constant returns combining labor with a domestic and a foreign input. These inputs are complements in production, capturing the key idea that assemblers might need access to foreign specialized intermediates which are not domestically manufactured, providing a rationale for the import duty rebates. The domestic input is produced by a larger number of component producers, operating under increasing returns and free entry. Due to decreasing average production costs, these firms would like to grow indefinitely, but their size in the no-policy benchmark is constrained by the size of the domestic demand for components. I next introduce in the model APDP-style incentives, either in the form of the VAA or PI (see Section 2), and derive equilibrium predictions for output levels and component demand at the final assembly stage, together with output levels and entry at the component stage.

I begin by lying down the assembler's problem; I next show how the APDP-style incentives can be modeled and characterize optimal input sourcing. Last, I provide the main testable implications and discuss how they map to the empirical analysis. All derivations are omitted and reported in Section A.

[18] As the PI was intended to assist local component production (Bronkhorst et al., 2013), an industry observer commented that much of the success of the MIDP would depend on the finalized definition of the PI (Pitot, 2012).

[19] Despite all the uncertainty, in their survey to APDP stakeholder Bronkhorst et al. (2013) find that the majority (58%) of participating stakeholders were of the opinion that the APDP would contribute towards increasing the local content of motor vehicles.

3.1 The assembler's problem

At the assembly stage, I consider a single-product firm choosing labor L, a locally sourced input x_1 and an imported input x_2 to produce output q. The production technology is Cobb-Douglas

$$q = Ax_1^{\alpha(1-\gamma)}x_2^{(1-\alpha)(1-\gamma)}L^{\gamma}, \qquad 0<\alpha<1, \qquad 0<\gamma<1 \tag{1}$$

where $A>0$ is firm's TFP. The firm is competitive on output and input markets: the output price is p, while the status-quo input prices are p_1 for the domestic input and $p_2(1+t_2)$ for the imported input, where t_2 denotes the ad valorem import duty. While all prices are taken as given by the firm, p and p_1 will be determined in equilibrium, while p_2 is fully exogenous.
In the no-policy benchmark, the firm problem consists in choosing the optimal combination of inputs to maximize output for given total production cost k, that is

$$\max_{x_1,x_2,L} Ax_1^{\alpha(1-\gamma)}x_2^{(1-\alpha)(1-\gamma)}L^{\gamma} \quad \text{s.t.} \quad p_1x_1+p_2(1+t_2)x_2+wL\leq k. \tag{2}$$

3.2 Industrial policy incentives as duty-free import allowances

The APDP instruments considered here can be interpreted as allowing a firm to import a subset of x_2 duty-free, subject to a policy-specific limit. This generates a *kinked* marginal price schedule for imported inputs. I separately consider the VAA and the PI below.
Vehicle Assembly Allowance (VAA): Under the VAA, the firm can use a fraction ϕ of its *revenues* to import inputs duty-free. Up to the point where duty-free imports are exhausted, that is until $p_2x_2<\phi pq$, the marginal price of x_2 equals the world price p_2; once duty-free capacity is exceeded, the marginal price jumps to $p_2(1+t_2)$. I denote this marginal price by $p_2^m(x_2,q)$ to emphasize that this is a *marginal* price, in turn depending on the output and import volumes. Formally,

$$p_2^m(x_2,q)=\begin{cases} p_2, & \text{if } x_2\leq \dfrac{\phi pq}{p_2} \quad (\textit{duty-free region}),\\ p_2(1+t_2), & \text{if } x_2>\dfrac{\phi pq}{p_2} \quad (\textit{duty region}). \end{cases} \tag{3}$$

As a consequence, the firm solves

$$\max_{x_1,x_2,L} Ax_1^{\alpha(1-\gamma)}x_2^{(1-\alpha)(1-\gamma)}L^{\gamma} \quad \text{s.t.} \quad p_1x_1+p_2x_2+p_2t_2\max\left\{x_2-\tfrac{\phi pq}{p_2},0\right\}+wL\leq k, \tag{4}$$

which makes explicit the kink in the cost constraint. In particular, the firm only pays import duties on the share of imports exceeding the policy threshold $\frac{\phi pq}{p_2}$, if any.
Production Incentive (PI): Under the PI, the firm can use a fraction ψ of its *local value added* to import inputs duty-free. In this stylized representation, local value added is $pq-p_2x_2$, so the duty-free allowance shrinks mechanically as imported input use rises. Similarly to before, up to the point where duty-free imports are exhausted, that is until $p_2x_2<\psi(pq-p_2x_2)$, $p_2^m(x_2,q)=p_2$ so the marginal price of x_2

equals the world price p_2; once duty-free capacity is exceeded, the marginal price jumps to $p_2(1+t_2)$. The marginal price schedule is

$$p_2^m(x_2,q)=\begin{cases} p_2, & \text{if } x_2 \leq \dfrac{\psi pq}{p_2(1+\psi)} \quad (\textit{duty-free region}), \\ p_2(1+t_2), & \text{if } x_2 > \dfrac{\psi pq}{p_2(1+\psi)} \quad (\textit{duty region}). \end{cases} \tag{5}$$

By comparing Equation (3) to Equation (5), it is clear that providing import duty rebates through local value added (rather than revenues) shrinks the maximum amount of duty-free imports by directly penalizing imported inputs. The corresponding kinked-constraint problem is

$$\max_{x_1,x_2,L} \; Ax_1^{\alpha(1-\gamma)}x_2^{(1-\alpha)(1-\gamma)}L^{\gamma} \quad \text{s.t.} \quad p_1x_1+p_2x_2+p_2t_2\max\left\{x_2-\tfrac{\psi pq}{p_2(1+\psi)},0\right\}+wL\leq k. \tag{6}$$

where again the kink in the cost constraint is made explicit. In particular, the firm only pays import duties on the share of import exceeding the policy threshold $\frac{\psi pq}{p_2(1+\psi)}$, if any.

3.3 Duty-free regions under constant returns to scale

In Section A, I show that, under constant returns to scale, the shape of the duty-free region can be expressed only in terms of the *relative input intensity* x_2/x_1. In particular,

$$\frac{x_2}{x_1} \leq r_2^{\text{kink}} = \left[\frac{\phi pA}{p_2}\left(\frac{p_1\gamma}{w\beta_1}\right)^{\gamma}\right]^{\frac{1}{1-\beta_2}} \quad (\textit{VAA}), \qquad \frac{x_2}{x_1} \leq r_2^{\text{kink}} = \left[\frac{\psi pA}{(1+\psi)p_2}\left(\frac{p_1\gamma}{w\beta_1}\right)^{\gamma}\right]^{\frac{1}{1-\beta_2}} \quad (\textit{PI}) \tag{7}$$

The comparative statics are immediate: (i) a higher output price p expands the duty-free region (by expanding revenues and/or value added); (ii) a higher imported-input price p_2 shrinks it (by inducing a faster depletion of the maximum duty-free imports); (iii) larger policy intensities ϕ and ψ expand it, although the PI expands it less strongly because the allowance is penalized by imported input use through local value added (the $1+\psi$ term); (iv) the effect of α is ambiguous, reflecting the interaction between the relative contribution of x_2 to costs vs the policy-induced incentives.

Graphical Intuition: Figure 1 shows graphically the resulting kinked isocost, either under the VAA (Figure 1a) or the PI (Figure 1b). In both cases, the yellow solid line denotes the status quo isocost with no industrial policy, while the green solid line represents the kinked isocost generated by each industrial policy instrument. The dark-shaded area denotes the duty-free region, while the light-shaded area is the duty payment region; the boundary is represented by a straight line with slope given by Equation (7). In the duty-free region, the import duty rebates generate a decrease in the relative price of imports, for given price of the local input. In line with the discussion above, the size of the duty-free region is smaller under the PI than under the VAA. In the duty-payment region, while the relative price of imports is unchanged compared to the status quo, the isocost shifts outwards, indicating an income effect. The income effect is generated by the rebate on each unit of imported input until x_2^{kink}, and therefore equals $t_2p_2x_2^{kink}$. The shape of the new isocost implies three qualitatively distinct potential solutions: (i) an

interior solution in the duty-free region (relative-price channel), (ii) a kink solution with the optimum at the kink[20], and (iii) an interior solution in the duty region (income-effect channel). The next section formally states the optimal sorting into each of these regimes; the results hold both for the VAA and the PI, with each policy instrument having its own specific definition of r_2^{kink}.

3.4 Characterization of optimal input sourcing

Let the pre-policy cost-minimizing (equivalently, output-maximizing) input ratio be $r_2^{pre} = \frac{x_2^{\text{pre}}}{x_1^{\text{pre}}} = \frac{1-\alpha}{\alpha}\frac{p_1}{p_2(1+t_2)}$. The post-policy optimal input mix depends on this pre-policy foreign-input intensity.

Proposition: optimal sorting into policy regimes. The optimal sorting into policy regimes is:

- Interior solution, no duty payment: If $r_2^{pre} < \frac{r_2^{kink}}{(1+t_2)}$, then the firm locates in the duty-free region and $r_2^{\text{post}} = \frac{x_2^{\text{post}}}{x_1^{\text{post}}} = \frac{1-\alpha}{\alpha}\frac{p_1}{p_2}$. This is the solution for low levels of foreign input intensity.
- Kink solution, no duty payment: If $\frac{r_2^{kink}}{1+t_2} \leq r_2^{pre} < r_2^{kink}$ then the firm chooses the kink point and $r_2^{\text{post}} = \frac{x_2^{\text{post}}}{x_1^{\text{post}}} = \frac{x_2^{\text{kink}}}{x_1^{\text{kink}}}$. This is the solution for intermediate levels of foreign input intensity.
- Interior solution, with duty payment: If $r_2^{pre} \geq r_2^{kink}$ then the firm remains in the duty region and $r_2^{\text{post}} = \frac{x_2^{\text{post}}}{x_1^{\text{post}}} = \frac{1-\alpha}{\alpha}\frac{p_1}{p_2(1+t_2)}$. This is the solution for high levels of foreign input intensity.

3.5 Equilibrium predictions and motivation for the empirics

In Section A, I next embed these policy instruments into the full model with upstream component producers. These firms are symmetric, operate under increasing returns and have some form of market power over their output. The component producers also compete against each other according to Cournot competition. The model is partial-equilibrium and delivers equilibrium values for 5 key endogenous variables: final good price p, final good output volume q, domestic input price p_1, domestic input volume q^u, number of domestic component producers N^u.

In Section A, I first show that in all policy regimes, the aggregate demand for components can be written as $X_1(p_1) = \psi^{(j)} p_1^{-\xi}$ where $\xi = 1 + \beta_1(\eta - 1), j \in \{\text{duty}, \text{duty-free}, \text{kink}\}$. In particular, the elasticity of aggregate demand for domestic components is always ξ no matter the regime; the policy regime only affects the demand shifter $\psi^{(j)}, j \in \{\text{duty}, \text{duty-free}, \text{kink}\}$. Taking into account the optimal sorting of firms into regimes, I can then rank the the size of the demand shifters, and find that firms sorting into the duty regime have the highest pre-post increase in domestic input sourcing, followed by firms sorting into the kink regime, and finally by firms choosing the duty-free regime. This monotone ranking implies that firms with higher foreign input intensity at baseline should also be the firms displaying the largest increase in local sourcing; I use this prediction to guide my heterogeneity analysis.

Finally, I consider the new equilibrium of the model arising from the introduction of the incentives. I first characterize the regularity conditions needed to ensure existence, uniqueness and stability of the equilibrium, with different requirements depending on the elasticity of the final demand. Under these

[20] In the kink solution, the firm chooses inputs such that the duty-free allowance binds exactly, placing the optimum at the nondifferentiability of the effective isocost.

conditions, I show the new equilibrium results in: i) increase in scale of downstream assemblers, ii) increased domestic input sourcing by assemblers, irrespective of the elasticity of final demand, iii) increased entry of component producers iv) increase in scale of component producers. The key economic mechanism is that, with some form of competition between component producers, larger demand for intermediates translates into entry, which depresses markups and cause an increase in scale needed to lower the average cost of production and break-even in the face of increased competition from new entrants. In the following, I use data from South Africa to test these predictions.

4 Data

4.1 Administrative data

As my main data source, I employ rich administrative data from the South African Revenue Service (SARS) made available to researchers through the National Treasury Secure Data Facility (NT-SDF) based in Pretoria, South Africa. Specifically, I make use of four datasets covering the period 2007/2008 to 2019/2020: i) Corporate Income Tax (CIT) firm-level data, ii) IRP5 payroll firm-level data, iii) Value-Added Tax (VAT) firm-level data, iv) Transaction-level customs data. In the context of the NT-SDF, a firm is defined as a CIT-registered entity that filed an IT14 and/or ITR14 tax form, and each unique CIT reference number is uniquely assigned to an entity and may be traced over time, enabling an analysis of firm entry and exit. Moreover, all four datasets may be linked together via SARS-provided link tables, mapping CIT tax reference numbers to IRP5, VAT and customs identifiers. I now introduce each dataset more in detail below.

1. ***CIT firm-level panel.*** The CIT firm-level panel represents the backbone of the NT-SDF data. Sourced from IT14 and, after 4 May 2013, ITR14 tax returns, it contains typical firm characteristics, income statement and balance sheet information, including industry and province, capital, liabilities, equity, income, expenditure, and debit and credit tax adjustments[21]. Fields are harmonized across the two forms, and only the latest revision per firm-year is kept, with ITR14 taking precedence over IT14. In terms of coverage, because the CIT universe includes dormant companies, share block companies and body corporates, only 44–46% of firms have non-missing and non-zero sales.

2. ***IRP5 firm-level panel.*** Built from individual employee tax certificates (IRP5 and IT3(a)) filed by PAYE-registered entities, the data are next aggregated to the firm level. Importantly, one CIT entity can map to many PAYE numbers but not the reverse, with the consequence that the data fields represent the number of jobs and not individuals (a worker at two branches of the same firm is counted twice)[22]. Unfortunately, no wage or income variables are carried over from the IRP5 tax certificates, and only 21–24% of CIT firms have any IRP5 match, with matched firms distributed around a higher sales mean.

[21] While the IT14 asked all firms the same questions, the ITR14 varies by firm size — micro and small firms file a simplified return, medium and large an extended one.

[22] Twelve employment measures are provided: three definitions (all forms; forms with positive 3601 income; forms with positive employment income), each unweighted and weighted, across two matching approaches: the "total periods set" (periods worked ÷ total periods in year) and the "dates set" (actual employment start/end dates). Weighted measures run roughly 72–79% of unweighted.

3. ***VAT firm-level panel***. This dataset is constructed from VAT returns filed by VAT-registered vendors. Registration is compulsory only above R1 million in taxable supplies over any 12 months, which produces visible bunching just below that threshold. The forms are submitted at varying frequencies (monthly through annual) and aggregated to an annual figure before the VAT identifier is linked to a CIT reference number. Besides input and output VAT paid and payable, the data record firm-level purchases and sales, distinguishing between local and foreign suppliers and customers; this is particularly important to study the effectiveness of the localization incentives at various stages of the supply chain. I use this dataset to construct my main outcomes in terms of domestic input sourcing and (local) value added.

4. ***Customs transaction-level data***. This dataset contains import and export records for entities holding a customs reference number. Each transaction records the Rand value, origin/destination, quantity and unit, and HS product codes. Importantly for my purposes, the dataset also contains a unique MIDP-APDP flag identifying whether specific import transactions made use of duty rebates under the MIDP and/or the APDP, distinguishing between products entering under rebate items 317.03/317.04 (for light motor vehicles producers), 317.07 (for medium-heavy motor vehicle producers) and 317.06 (for automotive component producers). This allows to identify users of industrial policy and to quantify the take-up of the industrial policy incentives. When compared to the entire set of firms in the CIT, customs-linked firms are vastly larger than non-customs firms.

4.2 Commercial data sources

In order to shed light on the mechanisms of firm responses, both at the final assembly and component manufacturing stages, and to mitigate potential identification concerns, I complement the administrative data with additional sources obtained form commercial providers.

1. **Lightstone SA data**. First, I use data on vehicle sales provided by Lighstone SA, the primary licensed data provider from the National Association of Automobile Manufacturers of South Africa (NAAMSA)[23]. The data cover the universe of vehicle sales, including domestic and export sales, imports, and re-exports, and include information on a wide array of vehicle attributes[24]. Over the entire period 2008-2024, I observe approximately 3.83 million pure domestic sales, 5.47 million exports, 4.95 million imports, and 174k re-exports. I use this source to detect potential production changes at the assembly stage, both in terms of value and composition. I provide more information on this data in Section 8.

2. ***SAABC data***. Next, to study potential channels of firm upgrading in relatively more exposed component producers, I use data from the South African Automotive Benchmarking Club (SAABC), a privately-funded and non-profit industry association established in 1997 to promote the improvement

[23]NAAMSA is the leading South African automotive trade association already established in 1935 to represent South Africa' manufacturing OEMs, retailing OEMs, and heavy commercial OEMs. It supports its members by engaging with government and policy makers, by facilitating closer business relationships between buyers and suppliers, and by providing automotive technical expertise and market intelligence services.

[24]As an example, the Lightstone SA data report information on the model, make, manufacturer, model-year, destination market, suggested retail price, engine size, kw and hp, fuel, drive and gear type, gross vehicle mass and fuel injection type.

of the domestic automotive sector[25]. The SAABC administers an annual benchmarking survey to its members that is composed of 6 sections: i) company profile and economic performance, ii) supplier linkages, iii) customer linkages, iv) operational performance, v) human resource development, vi) product development capacity. Participation is voluntary. In Table C.2 I provide a complete overview of the available indicators and the corresponding definitions.

3. ***Marklines data***. Finally, I use automotive data from Marklines, a leading industry data provider with global coverage of automotive production and sales. From their data portal, I use two main data sources: i) vehicle production volumes (in units) across 68 countries, with information on the model, manufacturer and country; as this data is only available at an aggregate level for South Africa until 2017, I use it to study production responses by South African competitors in Section 9; ii) geographic location and production capacity of assembly plants worldwide, which I use to compute measures of exposure to the downstream demand shock in Section 8.

4.3 Sector-level survey data

Finally, to investigate the aggregate consequences of the APDP introduction, I use a rich combination of survey sources produced by Statistics South Africa (StatSA) and disseminated at the sector level. Importantly, most of these data sources use industry classifications that distinguish between final vehicle producers and component manufacturers, allowing to study what stages of the value chain are most responsive the the policy. These include:

1. ***Annual Financial Statistics (AFS, StatSA)***. An annual enterprise survey collecting financial information from the formal business sector, excluding agriculture, financial intermediation, insurance and pension funding, government and education. The sampling frame uses a double stratification of firms in the statistical business register by predominant activity (primary stratum, from SIC) and by size (secondary stratum, using turnover as the size measure). The largest size group is fully enumerated, accounting for roughly 42% of the total sample; for medium and smal enterprises, samples are drawn randomly within each size-group-by-industry cell. The AFS 2024 sample was 12,492 enterprises.

2. ***Quarterly Employment Survey (QES, StatSA)***. An establishment-based quarterly survey of enterprises in the formal non-agricultural business sector. It is one of South Africa's two official employment sources, the other being the household-based QLFS. The sample frame consists of roughly 20,000 VAT-registered private and public enterprises, drawn from the SARS VAT register. Inclusion requires VAT registration with annual turnover above R300,000. It contains 8 SIC5 major sectoral divisions, and each enterprise is assigned to the industry reflecting its predominant activity.

3. ***Manufacturing Production and Sales (MPS, StatSA)***. A monthly enterprise-based survey of the manufacturing industry producing the value of manufacturing sales (at current prices) and a volume

[25]The services offered by the SAABC to its members include: i) a customer survey, to learn about how customers compare the firm's performance against expectations and competitors; ii) a financial snapshot, aimed at estimating labour, capital, materials, energy and multi-factor productivity against industry peers; iii) maturity assessment, to compare the firms' operations and culture to best practice and industry peers; iv) manufacturing meetups, to learn about best practice at other firms through monthly webinars and in-person study tours.

index of manufacturing production. The sampling units are enterprises derived from the SARS VAT- and income-tax business registers. The sampling design consists of a stratified random sampling procedure of about 3k enterprises drawn from a population of about 27k manufacturing enterprises, with strata combining sectoral SIC information with size class. While firms in the largest-size group are completely enumerated, simple random sampling applies to the other groups.

4. ***TIVA, OECD***. Finally, I use cross-country sectoral data from the OECD Trade in Value Added (TIVA) database. TiVA uses the OECD Inter-Country Input-Output (ICIO) tables to construct indicators tracking the origins of value added in exports, imports and final demand across origin and destination countries. In the current version, the data span 44 industries and 76 national economies, including South Africa. I use this source to capture aggregate shifts in the local content of exports driven by the APDP, and to address residual identification concerns.

5 Descriptive Evidence

5.1 Demand-side constraints, sectoral linkages, firm size and input demand

Capacity Utilization and Demand-Side Constraints. I begin by presenting descriptive evidence on demand-side constraints using the Manufacturing Utilization of Production Capacity (MUPC), a quarterly survey collected by Statistics South Africa (StatSA). The MUPC provides historical information on capacity under-utilization and the underlying reasons, with the primary purpose to assess the extent to which manufacturing firms face capacity constraints (StatSA, 2025). The survey covers large enterprises (annual turnover greater than R100 million) primarily engaged in manufacturing, with a sample of about 980 enterprises, selected without probability sampling. Although collected at the firm level, the data are released only at the sectoral level[26]. The results are reported in Figure 2, where I separately plot raw time trends of production capacity utilization in the entire manufacturing sector and the automotive industry for the period 2004-2025. Figure 2a shows that, on average, around 20% of total manufacturing capacity was underutilized between 2010 and 2015, peaking at about 40% during the COVID-19 pandemic. Breaking down the sources of under-utilization reveals that insufficient demand is the dominant factor, accounting for roughly 60% of under-utilization between 2010 and 2020, although its relative importance declines slightly in later years. In contrast, shortages of raw materials contribute far less (consistently below 20%), and labour-related constraints (skilled and semi/unskilled) are even smaller contributors. Importantly, Figure 2b indicates that while overall capacity utilization in automotive is comparable to the manufacturing average, insufficient demand plays an even more prominent role here, often contributing about 80% to under-utilization. In Figure B.1 I also present disaggregated results by 2-digit industry, and find that automotive tends to be among the sectors with the largest under-utilization share. Even more strikingly, I find that many sectors commonly believed to be upstream relative to automotive (basic iron and steel, metal products, non-metallic mineral products, leather) are characterized by even larger shares of under-utilization reaching up to 30%, again driven by

[26]The aggregation from firm-level to sector-level statistics relies on enterprise-level weights based on total sales as a share of sectoral sales. The final series are also seasonally adjusted using the X-12 Seasonal Adjustment Programme.

insufficient demand. Overall, although demand is a key constraint across manufacturing as a whole, it appears to be especially binding in the automotive industry; moreover, the data provide some rationale for targeting automotive as a relatively downstream industry relying on demand-dependent upstream sectors. I elaborate on this last point below.

Sectoral Linkages. As a next step, in order to better understand how automotive is positioned relative to other upstream and downstream sectors, I use industry-level input-output tables from Statistics South Africa (StatSA) for 2013, the year of the APDP introduction. Starting from the underlying industry-by-product/product-by-industry Supply and Use Tables (SUTs), StatSA first aggregates these to 50 industries and 50 products using CPC Version 2 and the South African SIC 5th edition, respectively [27]; it then converts this aggregated SUT into a symmetric industry-by-industry table recording measures of the value of inputs supplied by industry i and used as intermediate inputs by industry j[28]. The final I-O table contains 50 sectors for the entire South African economy, with individual I-O industries often combining several SIC5 codes [29]. I use the 2013 I-O table to construct industry-level measures of direct and total (direct and indirect) requirements and total (direct and indirect) value added, capturing respectively the total amount of inputs directly required to produce one unit of output for final demand in industry j, the total amount of inputs through all upstream production rounds to support one unit of final demand in industry j, and the total value added generated in all upstream production rounds to support one unit of final demand in industry j. As the Stats SA I-O tables do not distinguish between domestic and imported inputs, I present two alternative versions of the results, one using the original I-O entries and another adjusting them by the domestic value-added share. The results are reported in Figure 3. In particular, Figure 3a shows that, not correcting for the domestic value added share, the automotive sector has the third largest direct requirement coefficient, and the largest total (direct and indirect) requirement coefficient among the 50 industries in the input-output table. However, in Figure 3b I correct for the domestic share, and show that despite the sector remains among the largest in terms of total requirements, the domestic value added generated along the entire value chain is the second smallest among the 50 sectors, with approximately 40% of value added generated abroad. I interpret the results are implying that, despite from a technological standpoint the automotive sector in positioned very downstream in the value chain, potentially generating spillovers to upstream industries, it also generated little domestic value added at the onset of the APDP, further motivating the policy focus on domestic value added generation. In the next paragraph, I microfound this finding by looking at the pre-policy input sourcing behavior of users of the MIDP and APDP in the VAT administrative data.

Firm size and input sourcing behaviour. In order to find empirical evidence justifying the introduction of local value added-based incentives, and to document a potential role for industrial policy users as

[27] The aggregation is necessary because there are considerably more industries than products, so several SIC industries have to be combined to establish a sufficiently close mapping between the industry and product classifications. Stats SA describes the resulting 50-by-50 mapping as the most reliable feasible correspondence between SIC and CPC.

[28] The aggreagation operates under a fixed industry-output structure assumption (Model C): each industry is assumed to have a characteristic output structure despite potentially producing several different products. This allocation assumption is what permits product flows in the SUT to be translated into flows from one industry to another.

[29] For automotive, the I-O sector I32 corresponds to SIC 381–387, combining motor vehicles, vehicle bodies and trailers, parts and accessories together with locomotives, aircraft and spacecraft, ships and boats, and other transport equipment.

sources of demand for smaller, generally upstream firms, I also provide some descriptive evidence on the baseline size and input demand behaviour of MIDP and APDP users, relative to the general distribution of manufacturing firms. To this end, I use data for manufacturing firms in the pre-policy year (2012) and show the distribution of a range of outcomes together with the mean outcome for 3 separate sets of Industrial Policy users: light assemblers (12 firms), medium-heavy assemblers (32 firms), and component producers (70 firms). Firms are classified as Industrial Policy Users if they are ever observed using the rebate codes associated with the MIDP (pre-2013) or the APDP (post-2013). For readability purposes, all outcomes excluding shares are winsorized at 1% and 99% levels, and monetary values are expressed in million rands. The results are reported in Figure 4, where each graph also reports the percentile associated with the three groups in the unwinsorized raw data. I find that the users of the MIDP and APDP are unambiguously large across a wide range of outcomes: for instance, they are consistently located above the 99 manufacturing percentile for gross sales, cost of sales, employment and total labor cost. The same patterns hold when looking at sources of revenues and inputs, especially at the assembly stage, with figures close or above the 99 manufacturing percentile. However, an important finding is that, when expressed in terms of shares, these firms are also among the *smallest* users of domestic inputs: Figure 4l shows that light assemblers, medium-heavy assemblers and component producers registered under the MIDP/APDP correspond on average to the 2.93, 4.34 and 5.84 percentiles of the corresponding manufacturing distribution, respectively. This result indicates that, despite these firms are large in absolute terms and thus potentially suitable to sustain firm growth in upstream segments, they also relied relatively little on domestic inputs, leaving substantial scope for the increase in local sourcing that the APDP was designed to promote.

5.2 Summary Statistics: The South African Automotive Value Chain

Assembly: patterns of specialization. Using the Lightstone SA data, I discuss here general patterns of the data consistent with increasing returns in assembly and models' specialization; I next present summary statistics below. In the raw data, among the distinct models locally manufactured and sold for the domestic market, 82.2% are also exported; similarly, among the distinct models locally manufactured and exported, 67.6% are also sold for the domestic market. On the contrary, *none* of the locally manufactured models is imported (either for the local market or for re-export), and *none* of the imported models is locally manufactured. The large overlap between the domestic and foreign markets in production is consistent with assemblers' pursuit of scale economies through specialization of a common set of models for both markets. At the same time, the imperfect overlap suggests room for specialization to accommodate consumers' taste; indeed, I show below that, once sales volume is taken into account, exports and domestic sales have important differences in terms of observable vehicle characteristics. At the same time, the perfect substitution between imports and domestic production is consistent with increasing returns in assembly and international specialization in models production,

as in Krugman (1981)[30]. This is an important piece of evidence motivating demand for import duty rebates on foreign-manufactured models, an important feature of both the MIDP and APDP.

Assembly: summary statistics. Table 1 presents sales-weighted model-level summary statistics for models locally manufactured and sold (column 1), locally manufactured and exported (column 2), manufactured abroad and imported (column 3), manufactured abroad and re-exported (column 4). The results indicate that while imported models are mostly concentrated in the passenger vehicles category (about 88.5%), large shares of the domestic production also cover light commercial vehicles (particularly for domestic sales: 49.3%), and to a lesser extent medium-heavy vehicles and extra heavy vehicles (particularly for the domestic market: 4.2% and 4.9%, respectively). This finding reflects the diversified South African automotive production, inclusive of light and medium-heavy assemblers, which are however mostly inward oriented, with export shares very close to zero; indeed, exports are mostly concentrated in passenger vehicles and light commercial vehicles (64% and 35.3% of the total). Because of the different composition of vehicles, locally produced and sold models tend to have larger mass than exported and imported vehicles (more than 3 times and almost 2 times larger, respectively) and larger engine sizes. Importantly, models for export have the largest retail price, with a price premium of around 50% compared to both locally sold and imported models. This is likely explained by different vehicle characteristics: for instance, while locally manufactured models for the domestic market and imported models tend to favor non-all wheels (not-AWD) drive types and manual gear types, vehicle for exports mostly use all wheels (AWD) drives and are more likely to have an automatic gear installed. By the same token, they also tend to have lower emission rates and larger power (as measured by average KW and HP). Overall, these patterns are indicative of specialization based on destination markets' characteristics; I provide more evidence consistent with this in Section D.1.

Component Industry. In order to better understand the composition of the South African automotive industry, I also extract additional data from the National Association of Automotive Component and Allied Manufacturers (NAACAM). NAACAM represents approximately 150 large manufacturing brands, with over 80% of its members supplying the local assemblers (for car assembly operations as well as for aftermarket needs) and to the independent aftermarket; the rest are Tier 2 and Tier 3 firms and direct exporters. In particular, the website reports the full list of NAACAM members, including information on employment, export status, economic activity, geography and automotive tier where the firm operates. Table 2 presents summary statistics; I notice upfront that the statistics may be skewed toward larger exporting firms, which are more likely to be formal NAACAM members. Indeed, most members are largely involved in export activities, with export shares ranging between 75% for producers on tier 2 and 3 and 90% for firms also operating on tier 1. Firm size differs systematically across tiers: tier 1 firms are considerably larger, employing on average about 450 workers, compared to roughly 100 employees among firms in tiers 2 and 3. The nature of production varies as well: tier 1 firms focus

[30] I also find that, among the imported models, about 60% of them are also re-exported to other countries, with more than 99% of these re-exports concentrated in African countries (Namibia, Botswana, Swaziland, Zimbabwe, Mauritius, Mozambique, Zambia, Lesotho, Malawi, Kenya, Tanzania, Seychelles and Uganda). This fact is consistent with South African assemblers operating as major distributors of imported models to other regional economies.

primarily on manufacturing Original Equipment (OE) components for multinational enterprises (MNEs) and the aftermarket; by contrast, firms in tiers 2 and 3 diversify into accessories, replacement parts, and allied products supplied to MNEs and other industries. Geographically, at least three major clusters of component producers emerge, located in the Eastern Cape, Gauteng, and KwaZulu-Natal. I present more information on component producers from the SAABC data in Table C.1 and Section D.1 and more granular geographic information below.

Geographical Patterns. Finally, I examine the geographic distribution of the automotive industry in South Africa using granular data from Spatial Tax Data, a new project that draws on administrative tax records to generate spatial insights on the South African economy. in Figure 5, I show the geographical distribution of the automotive plants in South Africa in tax year 2014, the earliest year available, roughly coinciding with the start of the APDP[31]. In total, I identify approximately 2'000 establishments, located in at least four different geographical clusters. Among these, the by-far largest hub is the one located in the area of Johannesburg and including the local municipalities of Johannesburg, Tshwane and Ekurhuleni, with approximately 700 establishments, equivalent to about 35% of the total. Other major clusters include the eThekwini local municipality with Durban (South-East), the cluster of Cape Town (South-West) and the Nelson Mandela Bay area with Port Elizabeth (South), containing respectively other 150-200 establishments each. Smaller concentrations appear in Emfuleni, Madibeng, and Buffalo City. Overall, it appears that the industry is dominated by four geographical clusters, sufficiently spread across space, with a dominant hub around Johannesburg and three additional clusters of broadly comparable size. I provide more results on the geography of the automotive industry in Figure B.4.

6 Empirical Strategy

Throughout the paper, depending on the nature of the specific data source at hand, I use a variety of different empirical strategies, all falling under the umbrella of difference-in-differences style approaches (standard diff-in-diff, matching, synthetic control and synthetic diff-in-diff, exposure designs). In particular, when working with the NT-SDF administrative data (my main data source), I mostly rely on synthetic diff-in-diff; I briefly explain and motivate this approach below. I refer the reader to Section 8 for the alternative approaches I adopt when working with the Lightstone SA, SAABC and Marklines data.

Synthetic Diff-in-Diff (SDID). At the firm-level, a key empirical challenge is the limited number of treated units, particularly among downstream light-vehicle manufacturers, of which only eight were active in South Africa in 2013; this limitation is less severe for component manufacturers[32]. Moreover, as already shown in Section 5, these firms tend to be much larger then the average manufacturing firm along a wide range of outcomes, making it unlikely that raw data entries may represent a good control group. Lastly, when studying effects on firm entry and exit at the industry level, given that only

[31] The figure uses a two-digit industry classification encompassing the following three-digit industries: (i) manufacture of motor vehicles; (ii) manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers; and (iii) manufacture of parts and accessories for motor vehicles.

[32] Depending on the specific sectoral definition, there were about 300-500 component manufacturers in South Africa at the onset of the APDP (2013).

automotive is specifically targeted by the APDP, this results in an empirical design with only 1 treated unit. Given this context, my empirical strategy builds on recent advances in the literature and adopts the Synthetic Difference-in-Differences (SDID) approach developed by Arkhangelsky et al. (2021). This approach can be understood as the individual-level data analogue of SC, a standard approach commonly used to evaluate aggregate interventions affecting a small number of large units (Abadie and Gardeazabal, 20003; Abadie et al., 2010) and now widely used in similar settings (Abadie, 2021). In my setting, SDID has many advantages over standard diff-in-diff: (i) it relaxes the need for a large number of treated units, which is a requirement in traditional difference-in-differences designs; (ii) it provides a data driven approach to estimate cross-sectional weights while also accommodating unit-level fixed effects, allowing for level differences between treated and control units; iii) it may also be implemented with a single treatment unit (Arkhangelsky et al., 2021), thus allowing to seamlessly move from firm-level to sector-level specifications. Formally, the estimating equation is

$$(\hat{\tau}^{sdid}, \hat{\mu}, \hat{\alpha}, \hat{\beta}) = \arg\min_{\tau,\mu,\alpha,\beta} \left\{ \sum_{i=1}^{N} \sum_{t=1}^{T} (Y_{it} - \mu - \alpha_i - \beta_t - W_{it}\tau)^2 \hat{\omega}_i^{sdid} \hat{\lambda}_t^{sdid} \right\} \tag{8}$$

where Y_{it} denotes a typical outcome, μ is a constant, α_i are individual fixed effects, β_t are time fixed effects, and W_{it} is an indicator for treated units in the post-treatment period. In particular, when studying effects on assemblers, W_{it} is a simple dummy equal to 1 for downstream car producers, either of light vehicles, medium-heavy vehicles or combined; when studying effects on component producers, my main specification consists of an ITT approach with W_{it} equal to 1 for all firms classified as component producers in the pre-treatment year. Compared to a standard diff-in-diff approach, SDID also uses cross-sectional weights $\hat{\omega}_i^{sdid}$ and time weights λ_t. The average treatment effect is given by τ; I also provide event-study estimates of dynamic effects. For inference, I rely on the asymptotic normality of the ATT estimator as established by Arkhangelsky et al. (2021); event-study confidence intervals are constructed using a sector-level clustered bootstrap procedure adapted from Athey et al. (2024) where I re-sample entire control sectors with replacement. Importantly, all my data sources contain a variety of potential control sectors, allowing me to test for robustness to changes in the composition of the donor pool; moreover, most of the available data provide a sufficiently long pre- and post-treatment period - an essential condition for the credibility of the SC method (Abadie, 2021), which I can use to backdate the treatment period.

7 Results

I begin the discussion of my results from the firm-level administrative data from the NT-SDF. To set the stage for the empirical results, I first show simple statistics on policy take-up from the transaction-level customs data, showing that indeed there is demand for industrial policy duty rebates. Next, I describe the composition of my main estimation sample and show results on local value added - the main policy objective -, defined as the difference between total revenues and expenditure on imported inputs; for completeness, I also show effects on total value added. Next, I look at revenues and input expenditure

separately, breaking them down by source (revenues from local sales and exports, expenditure on local and imported inputs); these results allow to inspect potential sources of increased value added. All these results are presented separately for downstream light and medium-heavy MNE assemblers and upstream component manufacturers. Finally, I collapse these data at the sector-level to study entry, exit and selection of new entrants in targeted industries. Motivated by the large effects, I next turn to sector-level sources to get at the aggregate consequences on a variety of other outcomes, taking into account the changing composition of the industry.

7.1 Incumbent Firms: Main Results

Industrial Policy Take-up. To show that there's demand for the ADPD incentives, and to better understand the sources of these incentives, I first analyze the import duty rebates of downstream assemblers in the NT-SDF customs data. I focus here on light-vehicle assemblers, which use different codes under the MIDP and the APDP, allowing to distinguish the source of the rebates. The results are reported in Figure 6. In particular, Figure 6a shows that, starting from 2013, these firms import a substantial amount of components under the VAA instrument, on average 42 billions ZAR per year, equivalent to about 2.4 billion USD at current exchange rates; however not all these imports are necessarily duty-free[33]. Light-vehicle assemblers also import a large amount of products using rebates granted by the PI: Figure 6b shows trends disaggregated by production source, indicating that on average MNE assemblers import products worth 114 million USD per year. Most of these rebates originate from the production of light motor vehicles (LVE), although the contribution of automotive components (ACO) is not negligible. Overall, these results indicate substantial take-up of APDP incentives, motivating further analysis of how rebates are generated through firms' input-sourcing decisions.

Sample Description. The main analysis uses a balanced panel of manufacturing firms observed in every year from 2007 to 2019 (corresponding to tax years 2008–2020). Depending on the outcome, the estimation sample includes roughly 230,000 firm-year observations and about 18,000 firms. For vehicle manufacturers, treatment status is determined by observing whether a firm was ever registered as a vehicle manufacturer; in line with numbers on vehicle manufacturers provided in business reports, treatment status is concentrated among a small set of firms: 8 treated light-vehicle producers and 25–30 treated medium/heavy-vehicle producers. Instead, the component-manufacturer analysis includes approximately 150–160 treated firms; here, the treatment eligibility is determined by whether a firm is classified as a component manufacturer in the year of the APDP (or the year before). For all sets of firms, my baseline specification covers 53 three-digit manufacturing industries and excludes firms operating in the same two-digit manufacturing sector as the treated automotive firms, motivated by potential within-industry spillovers. In each producer-specific analysis, I also drop treated firms outside the group of interest: for example, when estimating effects for light-vehicle producers, I exclude medium/heavy-vehicle producers and component manufacturers.

[33] The final amount of duties paid on these imports is calculated on a separate custom form submitted only quarterly to the South African Revenue Service (SARS) and taking into account the VAA and PI incentives for the corresponding quarter. Data request for this separate form is currently pending.

Results on Vehicle Manufacturers. The results for light-vehicle and medium-heavy-vehicle manufacturers are shown in Figures 7 and 8, respectively. The first key finding is that both kind of assemblers increased their local value added (Figures 7a and 8a), the effect being particularly strong for light motor vehicle manufacturers, amounting to about $+75\%$ by the end of the sample period, compared to about $+25\%$ for medium-heavy vehicle manufacturers. I find no sustained effect on overall value added, even though I observe short-lived effects for light vehicle producers that fade away by the end of 2019 (Figures 7b and 8b). The second key result is that both light and medium-heavy vehicle manufacturers increased both total revenues and total input expenditure, with effects in the order of $65-70\%$ for the former (Figures 7c and 7d) and $20-25\%$ for the latter (Figures 8c and 8d) by the end of the sample period. Because revenues and input expenditures increase jointly, with similar changes both in levels and in relative terms, the evidence is consistent with a key prediction from Section 3, that is an increase in scale for ex-ante heavy importing firms. The next results look at the sources of this increase in scale. On the revenue side, Figures 7e and 7f show that light motor vehicle manufacturers mostly upgraded through the export channel, while medium-heavy manufacturers mostly increased domestic sales (Figures 8e and 8f); this result is consistent with light vehicle manufacturers being large exporters, while medium-heavy producers are mostly oriented to the local market, in line with the evidence shown in Figures B.2 and B.3. However, on the input side, the key result is that both types of producers substantially increase their demand for domestic inputs (Figures 7g and 8g), with effects particularly strong for the former ($+70\%$ by the end of the sample period, as opposed to $+35\%$). The effects on the demand for imported inputs are less clear-cut, mostly due to some data issue whereby this variable is always reported as zero in the early years; nevertheless, I can exclude crowding out of the imported inputs, suggesting at least some weak complementarity between local and imported inputs. The increased local input sourcing by downstream MNE assemblers motivates further analysis of the upstream component industry.

Results on Component Manufacturers. Next, I turn to effects on component manufacturers in Figure 9. Here, while I find no effects on local value added and overall value added (Figures 9a and 9b), I find again evidence in favor of an increase in scale, with total revenues and total input expenditure jointly increasing by similar sizes. Consistently with the previous findings on increased demand for local inputs by light and medium-heavy assemblers, Figure 9e shows that most of the increase in revenues comes from local sales of components to domestic downstream firms ($+50\%$ by the end of the sample period), while the effects on exports are generally smaller and only materialize at the very end of the sample period. The final key result concerns the input sourcing behavior by component manufacturers: while I find null effect on domestic input sourcing, I find strong evidence in favor of increased demand for imported inputs (Figures 9g and 9h), with expenditure on imported inputs increasing by more than 3 times compared to the pre-policy year. Consistently, Figure 9j shows clear and persistent negative effects on the share of local inputs demanded by component manufacturers ($-7p.p$ by the end of the sample period), while the effects on the share of local output is generally smaller. The results are consistent with a process of localization in which demand by downstream large MNE firms may sustain growth for upstream producers, but access to imported (better-quality) inputs is necessary to comply with MNEs' quality standards. Finally, a comparison of the magnitudes of the estimates shows that the increase

in vehicle producers' demand for local inputs is substantially larger than the increase in component manufacturers' revenues from local sales, consistent with vehicle producers sourcing from a broader set of suppliers. This motivates studying entry (and exit) as additional margins of firm response, which I do in the next section.

Robustness. The baseline results use a balanced panel of firms observed in every year from 2007 to 2019. Because the analysis window is defined relative to the policy year (2013), changing the range of years around 2013 alters the composition of the balanced sample: shorter windows generally include more firms. I therefore assess robustness to alternative window definitions by shifting the start of the sample to 2008 or 2009 instead of 2007. The results are fully robust to these alternative sample definitions. Second, because the main results for vehicle producers rely on a small number of treated firms, one concern is that the estimates may be driven by a single large firm. To evaluate this possibility, I run a robustness check that winsorizes the largest treated firm's outcome at the level of the second-largest treated firm, year by year. If a single firm were driving the results, this adjustment should change the estimates, both qualitatively and quantitatively; instead, the findings remain essentially unchanged, indicating that the results are plausibly not driven by one outlier firm. Finally, the baseline results uses a sample of manufacturing firms and computes standard errors using a bootstrap procedure clustered at the sector level. Due to a change in the tax form used by firms to submit their returns to the South African Revenue Agency (SARS) in 2013, the baseline results use a new sector variable introduced in the new tax form, commonly believed to be the most reliable one. However, as 2013 is also the policy year, one concern might be that this sample selection endogenously selects firms switching sectors as a result of the policy. Therefore, I also test for robustness to using the same sector classification but as reported for 2012, due to firms revising or submitting their tax forms late[34]. Again, the results are robust to the use of this alternative sector definition.

7.2 Extensive Margin: Entry and Exit

7.2.1 Entry and Exit: Main results

Motivated by the previous evidence on local input sourcing, I also study firm entry (and exit) as possible direct consequences of increased demand by large MNE customers, estimating 3-digit sector-level regressions using the number of entrants and exiters as outcomes. I restrict the sample to manufacturing sectors, and in my preferred specification I also exclude all sub-sectors in the same 2-digit industry as the automotive sector; the results are robust to the inclusion of all manufacturing. The results are reported in Figure 10. Figure 10a shows entry effects using the number of entrants in the motor vehicle manufacturing (SIC5 381) and parts and accessories manufacturing (SIC5 383) combined. The results indicate that already two years after the program's start, about 190 new firms enter, equivalent to an effect size of 100% compared to control. The effect sizes further grow over time, reaching a plateau in 2017 and 2018 (200 new entrants per year), and starting to vanish only in 2019. Figures 10b and 10c

[34] The new tax form came into effect about 1 year after the end of the tax year 2012. As most firms submit their declarations at least one year after the end of the corresponding tax year, this means that a large fraction of firms is supposed to have used the new sector variable already for tax year 2012.

further separate the number of entrants by industry (SIC5 381 and 383) and shows that these effects hold in both segments of the market with remarkably similar relative magnitudes: for instance, I find that in both cases there are about 2-times more new entrants in 2019 compared to the pre-policy year, relative to control sectors. When comparing these results to the effects on firm exit, I do not find comparatively large effects (Figures 10d to 10f). Overall, the results are consistent with increased local sourcing from large downstream MNEs enabling more upstream firms to operate at a profit, with limited evidence of displacement, confirming another key prediction from Section 3. This suggests that baseline demand size was the real barrier to entry, and that downstream demand is now large enough to sustain a larger pool of upstream suppliers.

7.2.2 Characterizing new entrants

In light of the strong results on firm entry, here I attempt to better characterize new entrants in targeted sectors and compare them to entrants in other untargeted manufacturing industries. I characterize these entrants across four main domains: timing of entry, foreign-domestic ownership status, reporting completeness, and life-cycle growth. Each of these exercises addresses potential concerns that I separately explain below.

Foreign-domestic ownership status. A first potential concern is that, as a result of the shifted focus from export sales to local value added, the vast majority of new entrants might be represented by foreign firms entering South Africa with the purpose of generating domestic value added. If so, the benefits in terms of local firm creation might be limited. Therefore, I start by classifying the new VAT entrants according to their foreign-domestic ownership status, resorting to the various indicators reported in the CIT data and introduced by Kilumelume, Reynolds and Ebrahim (2021). The results are reported in Figure 11 and show that, no matter their specific industry, very few new VAT entrants (typically close to or less than 1%) in targeted sectors can be classified as foreign firms in the form of branches or subsidiaries; however, a non-trivial share close to 40% of the new entrants may be classified as associates, implying some form of connection with foreign parent companies [35]. At the same time, very few of these firms can be classified as a South African parent of a foreign firm, either in the form of a South African MNE or a foreign-connected firm, suggesting that these new entrants are almost exclusively inward oriented and not engaged in international firm acquisitions [36]. Importantly, the results for targeted sectors look very similar to the corresponding figures for untargeted manufacturing, both when restring to the post-2013 period (Figure 11a) and when extending the set of VAT entrants to the entire period 2008-2020 (Figure 11a), attenuating potential concerns that the policy only attracts foreign firms now attempting to generate value added in South Africa. in Figure B.5 I also show that very similar patterns apply when restricting attention to recent CIT entrants, defined either as VAT entrants who only entered CIT after 2013 (Figure B.5a), or as VAT entrants who entered CIT at most one year before VAT (Figure B.5b).

[35] A branch is an office or division of a foreign firms; a subsidiary is a company whose parent is a majority holder of more than 50% of its shares; an associate is a company whose parent possesses a minority stake in the ownership of the company.

[36] A South African MNE is a South African firm with more than 50% of the shares of a foreign firm; a foreign-connected firm is a South African firm with more than 10% of the shares of a foreign firm.

Entry timing. A second potential concern is that, due to the shifted focus from export value to local value addition, already existing firms might have started complying with VAT requirements in order to claim value added generation; if so, entry in the VAT firm panel (VATFP) might capture better reporting compliance rather than business creation. At the same time, VAT reporting is subject to a specific threshold requirement, implying that effects on entry might be capturing not only new business creation but also growth of existing firms. To shed light on these concerns, in Figure 12 I first show that most of the new entrants in targeted sectors post-2013 also entered the CIT firm panel (CITFP) after 2013 (Figure 12a), with shares slightly different across sectors but in all cases very close to 80%. In Figure 12b, I also show that more than half of these new entrants take at most 1 year after entry in CIT to also enter VAT. To get a better sense of the distribution of timing between entry in CIT and VAT, in Figure 13 I plot the distribution of the difference between the first year of reporting in the VAT firm panel (VATFP) and the CIT firm panel (CITFP) and separately show results for firms in motor vehicle manufacturing (Figure 13a), bodies, trailers and semi-trailers manufacturing (Figure 13b), parts and accessories manufacturing (Figure 13c), and the entire set of manufacturing firms for comparison (Figure 13d). I find that the likelihood of VAT reporting decreases monotonically in the year difference, implying that younger firms are more likely to enter, with very similar patterns for targeted sectors when compared to the general distribution of manufacturing. Overall, these results suggest that the bulk of entry is not driven by old firms strategically submitting VAT forms to claim value addition, or by old firms crossing the threshold size for VAT reporting.

Do the new entrants look like legit firms?. A further potential concern is that the shift in the incentive-generation mechanism from export value to domestic value addition may have encouraged the creation of shell firms in South Africa acting purely as trans-shipment intermediaries between foreign input suppliers and downstream assemblers. Although formally appearing as domestic suppliers of inputs used in local assembly, such firms would in practice do little more than import and resell foreign intermediates, thereby artificially inflating measured domestic sourcing and circumventing the intended local value-addition mechanism of the policy. While difficult to identify, it is conceivable that this kind of firm would appear different across a range of observables from regular firms, for instance by under-reporting to avoid mandatory size-dependent reporting requirements, or by over-reporting to minimize the probability of a tax inspection. To shed light on this, in Figure 14 I focus again on the post-2013 entrants in the VAT firm panel (VATFP) and plot the share of firms reporting a positive value, zero value or missing value across a range of outcomes. I separately show results for the three 3-digit targeted sectors (motor vehicle manufacturing; bodies, trailers and semi-trailers manufacturing; parts and accessories manufacturing) and the other manufacturing industries. The results show that most of the new entrants report positive outcomes for sales and cost of sales (Figures 14a and 14b), employment (Figure 14c), VAT output and input tax (Figures 14d and 14e), and taxable income (Figure 14f). Moreover, the results appear very similar when comparing across the three targeted sectors, and when comparing these to other manufacturing industries, making it unlikely that pure trans-shipment of imported intermediates is able to explain the bulk of the effects on entry documented in Section 7.

7.2.3 Selection on entry

A final concern is that, by increasing demand for domestically sourced inputs and effectively lowering the bar for operating in the domestic market, the reform might have induced the entry of relatively less productive and less efficient firms. In this case, the expansion of the domestic supplier base could have come at the cost of a deterioration in the average quality and/or productivity of component producers. To verify whether this is the case, I proceed in two steps. First, I study selection at entry through sector-level specifications comparing the average entrant in targeted sectors to the average entrant in other untargeted manufacturing. Second, I descriptively look at the life cycle of the new entrants and compare their age profile to the one of other untargeted manufacturing industries.

Selection on entry: methodology. To examine whether the reform altered selection into targeted automotive industries, I implement a two-step procedure aimed at producing measures of sector-level average productivity of new entrants. In the first step, I construct a measure of firm-level productivity by estimating production functions separately for each 3-digit manufacturing industry using observations up to tax year 2013 (the pre-policy period). Specifically, I estimate a revenue production function using the standard Olley-Pakes approach (Olley and Pakes, 1996), which compared to the Levinsohn and Petrin (2003) methodology has the advantage of using investment has the proxy variable, thus delivering estimated elasticities for the (domestic and imported) materials in production. I treat labor and expenditures on local and imported non-capital materials as freely adjustable inputs, capital as the state variable, and expenditures on local and imported capital goods as proxies for investment capturing the unobserved productivity shock. For firm i in industry s and year t, productivity is then recovered from the estimated input elasticities as

$$A_{ist} = \exp\{\log Y_{ist} - \hat{\beta}_s^L \log L_{ist} - \hat{\beta}_s^{MD} \log M_{ist}^D - \hat{\beta}_s^{MI} \log M_{ist}^I - \hat{\beta}_s^K \log K_{ist}\} \tag{9}$$

where A_{ist}, Y_{ist}, L_{ist}, M_{ist}^D, M_{ist}^I and K_{ist} denote respectively productivity (in levels), revenues, labor (in expenditure terms or units), expenditure on domestic inputs, expenditure on imported inputs, and capital. The coefficients $\hat{\beta}_s^L$, $\hat{\beta}_s^{MD}$, $\hat{\beta}_s^{MI}$ and $\hat{\beta}_s^K$ denote the estimated revenue elasticities with respect to labor, domestic materials, imported materials and capital, and the subscript s makes it explicit that the estimation is implemented industry by industry. In the second step, I use the VAT firm panel (VATFP) to identify each firm's year of entry and restrict attention to productivity in this first year, thereby focusing on the productivity composition of successive entry cohorts rather than on entrants' subsequent productivity growth. To avoid the influence of large outliers, I winsorize entrants' productivity at 95% level and collapse the data into 3-digit industry-by-entry-year cells, constructing both unweighted and revenue-weighted average productivity measures. I then estimate an event-study diff-in-diff specification at the sector level of the form:

$$log\bar{A}_{st} = \alpha_s + \lambda_t + \sum_{\tau \neq 2012} \beta_\tau \left(\text{Targeted}_s \times \mathbb{1}\{t = \tau\} \right) + \varepsilon_{st} \tag{10}$$

where $\bar{A}_{st}$ denotes average productivity among firms entering industry s in year t, α_s and λ_t are three-

digit industry and entry-year fixed effects, and 2012 is the omitted reference year. For completeness, I also study selection on other observable outcomes (employment, materials expenditure) which do not require a first estimation step as for productivity. In the baseline specification, treated industries are motor-vehicle manufacturing (SIC5 381) and automotive parts and accessories (SIC5 383), while the comparison group consists of manufacturing industries outside the broader 2-digit transport-equipment sector, due to potential spillover concerns. The standard errors are clustered at the three-digit industry level. The resulting coefficients β_τ capture whether, following the reform, firms entering targeted automotive industries became systematically more or less productive at entry relative to contemporaneous entrants in untargeted manufacturing industries.

Selection on entry: results. The results on selection on productivity are reported in Figure 15, where Figure 15a focuses on the unweighted-average case, while Figure 15b reports results for sales-weighted average productivity. I find clean evidence of negative selection: relative to the counterfactual productivity profile of successive cohorts of entrants in other untargeted manufacturing, the average entrant in targeted industries is about 63% less productive already in the 1st year of the full APDP deployment (2014), with point estimates remaining remarkably similar over time until 2020 (Figure 15a). However, the results look different when weighting by VAT sales: in Figure 15b I find that, if anything, the average entrant in automotive is about 1.73 times more productive in the 1st year of the policy (2013), with point estimates rapidly going to zero over time and becoming not significant at conventional levels. This result suggests that few large and very productive firms may have entered in 2013 as a result of the APDP, but this positive selection is only temporary and quickly fades away. Indeed, going back to Figure 15a, the results indicate a precise zero effect for 2013, likely the result of the entry of a large number of small less productive firms and few larger and more productive firms. Overall, the results are consistent with negative selection on the average firm, coupled with the short-lived entry of few large champions. I don't find clear evidence of selection on other observable outcomes.

Life-cycle growth. Next, I turn to comparing the life cycle of the average new entrant in targeted sectors to the average entrant in untargeted manufacturing industries, focusing again on all post-2013 entrants in the VAT firm panel (VATFP). The results are shown in Figures 16 and 17. Using data from the CIT firm panel (CITFP) and IRP5 firm panel (IRP5FP), I first find that new entrants in automotive look similar to untargeted manufacturing along a range of outcomes including measures of capital (property, plant and equipment, Figure 16c) and labor (total labor cost, Figure 16d; wages inclusive of medical and pension items, Figure 16e; employment, Figure 16f). The same also applies to measures of firm size (gross sales and cost of sales, Figures 16a and 16b), with the exception that firms classified as motor vehicle manufacturing (therefore closer to the assembly operations) look larger relative to the average entrant in bodies and trailers manufacturing, parts and components manufacturing, and untargeted manufacturing. I confirm this pattern in Figure 17, where I also study VAT outcomes and find that the average entrant in motor vehicle manufacturing has larger revenues, input expenditure and also local value added, the key policy objective (Figures 17a, 17c and 17e), while firms in other automotive do not appear different from the average entrant in untargeted manufacturing. Interestingly, and consistent with the overall policy architecture, firms in automotive industries are more inward oriented, both on

the output side (especially as age progresses, Figure 17b) and on the input side (Figure 17d). However, the key result is that the average entrant in all targeted industries show smaller value added compared to untargeted ones (Figure 17f). This last result is in line with the negative selection on productivity at entry reported in the previous section and confirm that the new entrant in automotive is *both* less productive at entry and over the entire life cycle, pointing to potential efficiency losses associated with the policy.

7.3 Sector-Level Results

In this section, I next move to sector-level data sources, with the main objective of getting at aggregate sector-level effects, while taking into account the changing composition of the targeted sectors, as previously documented.

Incentive Size. I first use sectoral data on government's subsidies and incentives from the Annual Financial Statistics (AFS) to confirm increased levels of government support in targeted sectors. For brevity, I combine the results for motor vehicle and component manufacturing, and show the results in Figure 18. I find that the introduction of the APDP was accompanied by a notable increase in the size of incentives by approximately 1.5 times already 2 years after the policy change, relative to control sectors; the effect sizes get smaller but still close to 1 in later years, suggesting that on average targeted sectors received roughly double the amount of support received under the MIDP pre-2013 (Figure 18a). Although the effects in Figure 18a are estimated using the full set of sectors available in the data, Figure 18b shows that the results are robust to restricting the sample to manufacturing sectors, either broadly or narrowly defined. Similarly, Figure 18c shows that the results hold when changing the composition of the donor pool, either by excluding the top-5 directly or indirectly backward and forward linked sectors to automotive, or by excluding non-exporting sectors or keeping only large exporting sectors. In Figure 18d, I also perform leave-one-out estimation where I iteratively exclude control sectors and show that the results do not depend heavily on the inclusion of any particular control unit. Finally, Figure 18e reports placebo inference where I iteratively re-assign the treatment status to control units and re-estimate the model; the one-sided p-value (close to 0.18) is suggestive of increased government support, but not significant at conventional significance levels.

Aggregate Sector-level Effects. Having confirmed increased levels of support in targeted sectors, in Figure 19 I describe additional results shedding light on the aggregate policy effects. I begin by using data from the Manufacturing Production and Sales (MPS) to document aggregate effects on automotive sales (Figure 19a), which respond on impact already in 2013 and then continuously grow over the post-policy period, reaching effect sizes of approximately $+60\%$ by 2019. Next, I use data from the Quarterly Employment Survey (QES) and find very similar patterns for labor earnings, although the effect size is generally smaller, reaching a plateau at about $+30\%$ already in 2017 (Figure 19b). Importantly, this result is not simply driven by a scale expansion: when decomposing the effect in earning per employee and employment levels (Figures 19c and 19d), I find that the former account for about two thirds of the increase in total labor remuneration until approximately 2018, when employment effects start accelerating, peaking at $+15\%$ by the end of the sample period. Next, I investigate effects on measures

of real value added and real output, arguably the ultimate outcomes of interest for any industrial policy evaluation. Using data from the Department of Trade, Industry and Competition (DTIC), I find that the APDP likely resulted in aggregate positive effects on both margins (Figures 19e and 19f) with similar effect sizes of about 20%. I notice upfront that output shows some evidence of a 1-year anticipation, which is consistent with the immediate response of sales in 2013, already documented in Figure 19a; below, I investigate more in detail the robustness of the results to backdating the treatment date. To support the idea that these results are driven by true production responses, I also study effects on various measures of inventories from the Annual Financial Statistics (AFS), and show large effects on closing values of raw materials (Figure 19i) and especially work-in-progress (Figure 19j), while the effects are smaller for finished goods (Figure 19k), consistent with the increase in sales. I also document positive effects on aggregate staff training expenditure (Figure 19l), which tends to accelerate around 2017, when employment effects also materialize; taken together, the result suggests increased staff hiring as a result of newly acquired labor skills. Consistent with the increase in domestic input sourcing, Figure 19g also shows large immediate effects on expenditure on subcontractors, which doubles already in 2013 and gradually slows down over the sample period, suggesting higher levels of engagement with domestic firms. Finally, I investigate aggregate responses of trade outcomes, again using data from the DTIC. I find large export responses in the bulk of $+30/40\%$, both in absolute terms and as a share of output (Figures 19m and 19n), which are consistent with the increase in scale documented in Section 7; imports also increase, both in absolute terms and as a share of domestic demand, but mostly towards the end of the sample period (Figures 19o and 19p). Taken together, these findings point to increases in scale driven by an intensification of real production activity, skilled employment expansion, better integration with domestic firms, and larger export orientation.

Robustness. In this section, I make sure the results are robust to a variety of alternative specifications. In Figure B.6 I test for the results' sensitivity to the exclusion of particular control units (leave-one-out), and show that the results one obtains are almost indistinguishable from each other. This suggests that the main estimates from Figure 19 are not driven by high cross-sectional weights on any particular control sector. In Figure B.7 I perform placebo inference by iteratively re-assigning the treatment status to each control unit, and show that for a large number of outcomes the results look like outliers in the resulting treatment effect distribution. Figure B.8 considers alternative donor pools of control sectors by excluding top-5 directly or indirectly backward and forward linked sectors to automotive, or by excluding non-exporting sector or only including large exporters. For most outcomes, the results are remarkably similar across definitions of the donor pool. The only important difference concerns employment effects (Figure B.8d), which if anything get larger when only including in the sample large exporting sectors as controls. When the underlying data source contains sectors beyond manufacturing, I show in Figure B.9 that the results are very similar when keeping all sectors or restricting the sample to manufacturing, either narrowly or broadly defined. Finally, I test for robustness to backdating the treatment date, and make sure that the effect size remains similar to the baseline in Figure 19. While for some outcomes the coefficients for the period between the new treatment date and the effective one remain small and non-significant (sales, labor earnings, imports and most importantly value added, Figures B.10a, B.10b,

B.10g and B.10i), for others I find some evidence of a 1-year anticipation, most notably in real output, exports and employment Figures B.10d, B.10e, B.10g and B.10j). Nonetheless, I argue that this result is largely consistent with the sales response that I find on impact, requiring some form of pre-adjustment to the supply expansion. Additionally, the effect sizes remain very similar for different choices of the back-dated placebo treatment date, and also very similar to the baseline effect sizes in Figure 19. Overall, I confirm that the results hold across a wide range of alternative specifications and placebo tests.

8 Mechanism

In this section, I shed light on the mechanisms of adjustment to the policy, distinguishing between the final assembly and the component manufacturing stages. To this end, I proceed in three steps. First, I consider heterogeneity in firm responses by levels of baseline foreign-domestic input intensity, using the VATVP data already used in Section 7. Second, I make use of the Lightstone SA data, covering the universe of new vehicle sales in South Africa for the domestic and export markets, to shed light on changes in production at the assembly stage. Third, I exploit the detailed information on the type of production activity, ownership status and tier of operation contained in the SAABC data to study whether and where component producers upgrade in response to the policy. I describe the data more in detail and present the econometric specifications and results below.

8.1 Heterogeneity by baseline foreign-domestic input intensity

In this section, I consider heterogeneity of the main results reported in Section 7 distinguishing between downstream MNE assemblers and component producers. In order to guide this heterogeneity exercise, I first exploit the testable predictions of the model introduced in Section 3, showing that the policy can be interpreted as introducing three different regimes in the assembler's input sourcing problem based on the pre-policy foreign-domestic input ratio. More specifically, the model shows that the input and output response should be monotonically increasing in the baseline foreign-input intensity, providing a directly testable prediction for the empirical analysis. Given the limited number of assemblers in the data, I combine together light and medium-heavy producers and create two equally-sized groups based on the median pre-2013 average expenditure share on domestic inputs. Regarding component producers, the model in Section 3 is too parsimonious to generate predictions for heterogeneity. However, a large empirical literature has documented the gains from importing intermediates and established that imported inputs often tend to be better quality and imperfect substitutes for domestic ones, providing some ground for testing for heterogeneity along the same dimension. Baseline access to imported inputs might be especially important for component producers as their output directly feed into vehicle assembly by large exporting MNEs, making quality standards a crucial requirement. I return to this point and provide some evidence for this type of mechanism in Section 8.2.

Results. The results are reported in Figures 20 and 21. Consistent with the theoretical predictions, Figures 20a and 20b show that the overall output and input response is driven by assemblers with

below-median expenditure share on domestic inputs, in other words relatively large users of foreign intermediates. On the flip side, I find a precisely estimated null effect for assemblers with above median domestic expenditure share. In Figures 20c and 20d I also show that the same set of firms drives the response of domestic input expenditure, resulting in increased local value added. Interestingly, in Figure 20c I also find some evidence of a smaller response by above-median firms; this is not inconsistent with the model, which only predicts a larger response by below median firms, and also limits concerns of the main findings being driven by a very limited set of firms. Next, in Figure 21 I turn to component producers. Here I find again that the responses documented in Section 7 are driven by firms with small relative use of domestic inputs. First, both revenues and input expenditure rises are concentrated in below-median firms (Figures 21a and 21c), and most of the increase in revenues is explained by sales to domestic firms (Figure 21b). Second, the very rapid increase in foreign input expenditure documented in Section 7 is again driven by below-median firms (Figure 21d), in other words firms with baseline relatively large use of foreign inputs; on the contrary, the response by firms with little access to foreign inputs at baseline is very close to zero. These findings points to very stark interpretation of the results as an intensive margin response: only firms with access to foreign inputs are able to scale up their imports and leverage the downstream demand shock through larger domestic sales. Access to foreign markets, and in particular to foreign intermediates, emerges as a crucial determinant of whether domestic firms are able to leverage the policy-induced demand shock from downstream assembly firms.

8.2 Final assembly

Although Section 7 already showed robust responses by the MNE assemblers in terms of local value added and domestic input sourcing (the key policy targets), those results mostly focused on the input side of the assembly stage firms. However, another margin of value added expansion simply operates through larger sales value, and it is therefore plausible to also expect firms adjustment on the output side, both in terms of destination markets and type of assembly operations. Changes along these margins may also shed light on changes in input requirements and thus responses by component producers.

Data. To make progress, I use vehicle sales data from Lighstone SA, the primary licensed automotive data provider from the National Association of Automobile Manufacturers of South Africa (NAAMSA)[37]. The data cover the universe of vehicle sales in South Africa, including domestic and export sales, imports, and re-exports. The raw data come at the vehicle model-level (e.g. 116i Hatch 3-dr MY07), with information on the vehicle type (e.g. BMW 1-Series), automotive make (e.g. BMW) and manufacturer (e.g. BMW GROUP). Roughly speaking, manufacturers, makes, types and models can be understood as the automotive group, brand, vehicle class and specific model, respectively. In the raw data, I observe 19'134 distinct models belonging to 941 vehicle types, 90 makes, and 55 manufacturers. Additionally, for each model I observe a wide array of vehicle attributes: market, model-year, suggested retail price,

[37]NAAMSA is the leading South African automotive trade association already established in 1935 to represent South Africa' manufacturing OEMs, retailing OEMs, and heavy commercial OEMs. It supports its members by engaging with government and policy makers, by facilitating closer business relationships between buyers and suppliers, and by providing automotive technical expertise and market intelligence services.

engine size, KW and HP, fuel type, fuel injection type, drive type, gear type, gross vehicle mass (GVM), ECE consumption and ECE emissions. Each of these features only change at the model level, and there is no variation within a given model. Finally, using information on the vehicle source (local vs import), the distribution channel, and the (export) country, I organize the data into 4 mutually exclusive categories: cars with local origin sold locally (pure domestic), cars with local origin sold abroad (exports), cars with foreign origin sold locally (imports), cars with foreign origin sold abroad (re-exports)[38]. Over the entire period 2008-2024, I observe approximately 3.83 million pure domestic sales, 5.47 million exports, 4.95 million imports, and 174k re-exports. I use this categorization in the sections below.

Econometric Specification. In order to study changes in assemblers' production in response to the policy, I exploit variation across automotive groups, makes and vehicles types in manufacturing vs retailing status. Since both the MIDP and APDP explicitly targeted manufacturing firms, retailers provide a natural candidate control group for the analysis; I address potential threats to identification below. My main specification consists of a difference-in-difference model estimated at the vehicle type level. The choice of this level of aggregation is motivated first of all by the relatively large number of vehicle types observed in the data: after restricting to the period before 2020, I observe 793 types in total, among which 419 (52.83%) have both pre-2013 and post-2013 data. Moreover, vehicle types nest variation in vehicle characteristics through the different models belonging to each type; as a consequence, this allows to study effects on sales for different categories of vehicles, and thus to detect changes in the composition of locally manufactured models. I proceed by creating a weakly balanced sample where each vehicle type is observed in all years between its first and last period with non-zero sales; for years in-between this range, I impute missing sales with zeros. I next estimate a model of the following form:

$$y_{imgt} = \alpha_i + \lambda_t + \sum_{k \neq -1} \beta_k (\text{Manufacturer}_{i/m/g} \times \mathbb{1}\{t - 2013 = k\}) + \varepsilon_{imgt} \tag{11}$$

where i denotes a vehicle type, m a make, g a group, and t time. The outcome variable y_{imgt} is sales (number of vehicles), either as an aggregate or disaggregated for different destination markets (local, export) or for different categories of models. Due to the count nature of the outcome variable and the presence of zeros, I estimate the model through Poisson Pseudo Maximum Likelihood (PPML), which solves the problem of inconsistent OLS estimation with log outcomes in the presence of heteroskedasticity (Silva and Tenreyro, 2006), and allows for zero outcomes, thus jointly estimating effects at the intensive and extensive margins. I adopt the implementation of Correia et al. (2019), which allows for fast estimation in the presence of high dimensional fixed effects (HDFE). The terms α_i and λ_t indicate unit (type) and time fixed effects, and all coefficients β_k are estimated relative to 2012, the pre-treatment year. The treatment indicator $\text{Manufacturer}_{i/m/g}$ is determined by manufacturing vs retailing status, measured over the entire sample period 2008-2019. I present results from alternative specifications where the treatment status is defined at different nested levels of aggregation (type, make, and group)

[38]The dataset distinguishes between vehicles with local and import origin, and between vehicles distributed through alternative channels: export, dealerships, government, single orders, and rentals. While the detail regarding distribution through dealerships, government, single orders and rentals only cover SACU countries (South Africa, Namibia, Lesotho, Swaziland and Botswana), the exports channel works as the residual category covering all non-SACU countries.

and cluster standard errors at the corresponding level. The final sample consists of 793 types, 83 makes and 50 groups, of which 145, 31 and 25 belong to the treatment group, respectively.

Main Results. The first key result is that overall sales strongly increase post-policy for manufacturing firms. The point estimates reported in Figure 22 show flat pre-trends, followed by an upwards-sloping trajectory that stabilizes 4 years after the policy. The estimated effects are large: for instance, using a point estimate of 0.65 (where the coefficients stabilize), the effect size corresponds to a 91.5% increase relative to the pre-policy year (Figure 22a)[39]. Decomposing the increase in sales by exports and local sales, Figures 22b and 22c show that, although both increased, the effects is particularly strong for exports, with point estimates continuously growing through the sample period and reaching the size of $+170\%$ by the end of 2019[40], while domestic sales jump on impact but stabilize relatively quickly at around $+50\%$[41]. Exploiting the nested structure of models within vehicle types, I next decompose the effects in intensive-margin effects (sales per model), and extensive-margin effects (total number of models sold, and number of new models sold). I find that the results are driven by a combination of intensive and extensive margin adjustments. First, overall sales per model increase continuously as a result of the APDP (Figure 22d), reaching an effect size of about $+100\%$ by 2018-2019 [42], with export and domestic sales contributing approximately equally (Figures 22e and 22f), although export sales per model slow down approximately 3 years after the APDP. This last result is likely explained by extensive margin adjustments: Figures 22g and 22h show that, despite no clear effect of the total number of models sold (and the number of models sold for the local market), the number of exported models clearly responds on impact, with effects accelerating towards the end of the sample period and reaching $+122\%$ by 2018-2019 (Figure 22i) [43]. A final check consists of whether this extensive margin response comes from entirely new manufactured models, which has implications for upstream effects on component producers. The results strongly confirm this hypothesis: while the estimated effects on the number of new models is perhaps positive but imprecisely estimated for overall and domestic sales (Figures 22j and 22k), the effects for exports are more precise, larger in magnitude, and increasing over time (Figure 22l). Thus, compared to the pre-policy period, manufacturing firms keep expanding the model pool with new models for export, which, as shown in Table 1, are typically associated with export premiums and different vehicle characteristics. By the end of 2019, the effect sizes points to the sales of new models being triple of their 2012 counterpart. For completeness, Table 3 also reports Average Treatment Effects on the Treated (ATT) on the same set of outcomes. The results indicate large and significant sales growth ($+55\%$) mostly driven by exports, with similar intensive margin effects across domestic and foreign sales ($+27-33\%$), but extensive margin effects (number of models and number of new models) concentrated in export sales ($+36\%$ and $+45\%$ respectively).

Threats to Identification. In this section, I address three main identification concerns that might arise from the previous section. First, manufacturing vs retailing is an endogenous decision, and a

[39] Computed as $(e^{0.65}-1)*100\%$.
[40] Computed as $(e^{1}-1)*100\%$.
[41] Computed as $(e^{0.4}-1)*100\%$.
[42] Computed as $(e^{0.7}-1)*100\%$.
[43] Computed as $(e^{0.8}-1)*100\%$.

potential concern might be selection into treatment as a result of the policy change. However, a closer look at the data mitigates this type of concern: among the manufacturing groups/makes in the post treatment period (after 2013), only two joined the manufacturing group in the post-APDP period [44]; in other words, even if the group of manufacturers is likely selected and potentially different from pure retailers, this selection likely remained constant within the sample period, and thus cannot explain the diverging trends that I only observe after the policy change. Nonetheless, in robustness checks I make sure that the results hold when excluding the two manufacturers who only joined in the post period. Second, I take into account that my baseline specification with treatment status defined at the vehicle-type level does not consider that some control vehicle types (which are defined as those never observed to be manufactured in South Africa) might belong to manufacturing makes or groups, which would invalidate the standard SUTVA assumption underlying my difference-in-difference identification. To address this point, I re-estimate specifications at the vehicle-type level with treatment status defined at higher levels of aggregation (make or group), and cluster standard errors at the corresponding level. A final concern is that, because the APDP allowed manufacturers to rebate import duties on finished vehicles, this could again indirectly affect the group of retailers and introduce spillovers between the treatment and control group. I first notice that, since this aspect of the policy did not change between the MIPD and APDP, to the extent that the size of these spillovers did not change across policies, this would not necessarily undermine the validity of the approach. Nonetheless, I also address this concern more directly through measures of similarity in the product space across manufacturers, makes and types, by keeping in the regression only control units most dissimilar to treated units. The idea is that, due to larger differences in the typical product characteristics, these units should be facing less competition from treated manufacturers, and should thus be less subject to the potential negative spillovers originating from rebates on finished cars. Comparing the size of the effects between the baseline specification and the new specification provides an indirect test for the presence and size of spillovers. I discuss the construction of these similarity measures more in detail in Appendix Section ***.

Alternative Specifications and Robustness. The results from the exclusion of the two firms who only joined as manufacturers post-2013 (FAW TRUCKS and IVECO, results not reported for brevity) are virtually unchanged when compared to the baseline results, both in terms of size and significance. This is consistent with the limited number of new joiners and their limited market share (only 0.34% of the total after-2013 vehicle sales). Next, I discuss the results when defining the treatment status at higher levels of aggregation. The results are presented in Figures B.11 and B.12. The results are consistent with the key result from the previous section: overall sales strongly increase (Figures B.11a and B.12a), with larger effects on exports compared to domestic sales. Indeed, Figures B.11c and B.12c confirm that the effect on export sales is large and in all cases in the bulk of $+170\%$ by the end of 2019; at the same time, the results confirm more muted responses by domestic sales (Figures B.11b and B.12b), especially in the specification with manufacturer-level treatment. Perhaps the biggest difference concerns the results on the intensive margin (sales per model) for the domestic market (Figures B.11e and B.12e),

[44] While IVECO was already operating as a retailer before 2013 and became a manufacturer in 2017, FAW TRUCKS entered the market as a manufacturer in 2013.

which appear more muted with make-level treatment, and vanish with group-level treatment; on the contrary, intensive margin results for exports are large, significant and comparable in magnitude to the previous ones (Figures B.11f and B.12f). Finally, I find again that extensive margin results (total number of models, and new models) only come from export sales (Figures B.11i, B.11l, B.12i and B.12l), with limited effects on domestic sales (Figures B.11h, B.11k, B.12h and B.12k). Overall, the results strongly point towards growth through exports, which has implications for component producers, as discussed in the next section. Finally, I address the third and last identification concern related to the potential presence of spillovers due to import duty rebates on finished vehicles. In my preferred specification, I only use pre-2013 model characteristics in the construction of the measure, and exclude brand information as it tends to reduce variability[45]. I next use this measure to exclude from the sample control units (types, makes or groups) above the median similarity. I present the results in Figure 23 and Figures B.13 and B.14, where the treatment assignment and the cross-similarity measure are defined at the type, make and group levels respectively. The results broadly confirm the previous results: large sales increase mostly concentrated in export sales (particularly with type and manufacturer-level treatment, while the difference is more muted with make-level treatment) and extensive margin effects mostly driven by exports. More importantly, for most outcomes the effect sizes are very similar to the baseline specification in Figure 22 and Figures B.11 and B.12, suggesting that the size of the spillovers from manufacturers to retailers is likely to be small.

Heterogeneity by Vehicle Characteristics. As a final step, I test whether the sale increase documented in the previous section tends to reward specific vehicle characteristics. Provided that more advanced types of vehicle disproportionally benefit from larger sales, this implies changes in input requirements, with direct implications for input demand by MNE assemblers across domestic vs foreign suppliers. Operationally, I exploit the rich set of vehicle attributes available in data, and for each of them I categorize values in advanced/large and basic/small attribute values. Table C.3 summarizes the categorization of vehicle attributes I employ in my analysis. I next estimate the same specification as in Equation (11), but splitting sales into four mutually-exclusive categories: sales with advanced/large attribute and with basic/small attribute, either for the domestic or the export market.
Figure 24 shows results with treatment status defined at the vehicle type level. The first key result is that the sales increase is concentrated in vehicles with price premiums (above median price) for the export market (Figure 24a); I cannot reject zero effects for the other sales categories. Next, in line with the descriptive evidence reported in Table 1, I find that the increase in sales in concentrated in models with characteristics commonly associated with car quality: above-median mass (Figure 24b) and power as measured by KW and HP (Figures 24c and 24d), and more advanced fuel injection and drive types (Figures 24e and 24f). I also find sales to be concentrated in vehicles with below-median engine sizes and emissions, as measured by ECE consumption (Figures 24g and 24h); combined with the previous evidence, the results indicate that assemblers' production plans responded to the APDP by favoring overall more efficient models (larger vehicle mass and engine power with smaller engine sizes and emissions). I

[45]The results are very similar when using the entire set of models between 2008 and 2019 and when also using brand information in the construction of the measure.

don't find strong evidence of asymmetric effects in terms of gear types (Figure 24i). For completeness, I also report results with treatment status defined at the make and group level (Figures B.15 and B.16). The results are consistent with the ones reported above, the only difference being less heterogeneity in terms of engine size and ECE consumption, with more similar responses across attributes and destination markets. However, it remains true that sales are concentrated in models with larger prices, mass and power, and more advanced injection and drive types; this pattern is particularly visible for exports and, to a lesser extent, for domestic sales.

8.3 Component Manufacturing

The results are consistent with a localization process in which downstream assemblers' higher demand for domestic inputs increases the scale of production of upstream component producers, while further upstream transmission through component manufacturing is dampened by access to international sourcing options. As shown in the previous section, this input response by component producers is likely explained by changes in market orientation at the assembly stage, which tends to disproportionally favor exports over domestic sales. To the extent that production for export tends to be concentrated in models of higher quality and better specifications, as it is also shown above, a natural prediction would be an increase in the share of imported inputs. In this section, I use the SAABC data on component producers to study how suppliers respond to this demand shock, what type of firms is most responsive (purely local vs multinationals) and whether the policy is accompanied by firm upgrading.

Econometric Specification. In order to study production responses by component producers, I exploit a particular feature of the APDP, rewarding a set of specific materials in the calculation of local value added (the key policy target by downstream assemblers). Specifically, each unit of domestic input sourced by a APDP participant contributes to local value added based on the content of aluminium, brass, leather, platinum group metals, stainless steel and steel (so-called standard materials); at the moment of purchasing any domestic input, an APDP participant is required to obtain a certificate from its supplier, documenting the content of these materials in each unit of purchased inputs. Thus, the policy indirectly incentives input sourcing from relatively intense users of these materials; I exploit this feature together with detailed information on production activity in the SAABC data to construct a firm-level measure of exposure to the downstream demand shock; I then embed this measure in an exposure design exploiting heterogeneity *within* component producers to study production responses. Specifically, I define:

$$\text{Exposure}_i = \sum_o w_i \mathbb{1}\{i \text{ in same province as } o\} \Delta\text{Demand}_o \tag{12}$$

where i denotes a component producer. The term w_i captures the intensity of standard-materials usage by component producer i, and it is constructed by linking the SAABC production activities and standard materials to sectors in input-output tables provided by StatSA. Figure B.17a shows the standard materials content score at the production activity-level, distinguishing between direct and indirect requirements,

and Appendix *** contains more information on the construction of this index. ΔDemand_o denotes assembly plant's o production capacity, proxying for the potential demand shock originating from assembly plant o. For this purpose, I use MarkLines assembly plant data on locations and production capacity; Figure B.17b shows the plants' geographical distribution, together with information on production capacity and start year. In words, Exposure_i weights the production capacity of each assembly plant o located in same province as i through the firm-specific output content of standard materials. Figures B.17c and B.17d show the distribution of the standardized final index, based on direct and total (direct + indirect) requirements, respectively. I next estimate a regression of the following form:

$$y_{it} = \alpha_i + \lambda_t + \sum_{k \neq -1} \beta_k (\text{Exposure}_i \times \mathbb{1}\{t - 2014 = k\}) + \gamma_{p,t} + \gamma_{t,t} + \varepsilon_{it} \tag{13}$$

where α_i and λ_t denote firm (unit) and time fixed effects. The coefficients of interest β_k are estimated relative to 2013. In alternative specifications, I also include either province-time fixed effects $\gamma_{p,t}$, which take care of province-specific shocks by identifying β_k only through within-region variation, or tier-time fixed effects $\gamma_{p,t}$ (tier 1: direct suppliers to downstream MNEs, tier 2/3: indirect suppliers), which test for propagation across tiers. Again, I estimate the model through Poisson Pseudo Maximum Likelihood (PPML), allowing for zeros, and cluster standard errors at the firm level.

First-Stage Results. I first validate the exposure design through effects on first-stage outcomes, showing that indeed higher exposure as defined in Equation (12) predicts larger downstream demand. The results are presented in Figure 25. First, firms more exposed to the downstream demand shocks increase their manufacturing sales relatively more compared to less-exposed firms (Figure 25a). The point estimates indicate flat pre-trends, suggesting that the demand shock only materializes post-APDP, when the incentives for local sourcing from intense users of standard materials become active. The effect size is also meaningful: a one standard deviation increase in exposure increases manufacturing sales by $25-30\%$, with point estimates increasing over time in the post-period and stabilizing 3-4 years after the policy. Second, the increase in sales goes hand in hand with meaningful adjustments on the input side: expenditure on materials (Figure 25b) and expenditure on labour (Figure 25d). The effect size is stronger for labour, with point estimates rising quickly post-policy and stabilizing at $+40-50\%$, while the effects on materials are smaller but very similar to sales, both in magnitude ($25-30\%$) and shape. The stark input response by more exposed firms also rules out potential concerns of pure trans-shipping of imported inputs operated by newly established component producers; I provide additional evidence on this below. Finally, more-exposed firms are also more likely to increase their expenditure on materials from domestic suppliers (Figure 25c): although less precisely estimated, the results indicate that a one standard deviation increase in exposure leads to approximately $+40\%$ materials from domestic suppliers already 2 years post policy, with effects slowing down over time, possibly due to less-exposed firms catching up. In robustness exercises, I also show that these effects are robust to the inclusion of tier fixed effects, suggesting that the effects are not limited to direct MNE suppliers.

Firms' Adjustment to Downstream Demand. Having established first-stage responses by more

exposed firms, I next investigate potential frictions in the process of adjustment to the downstream demand shock. Figure 26 shows the results. I first find evidence of initial capacity constraints on the production side: more exposed firms are more likely to increase their average number of operating shifts per day, with large effects in the bulk of $+80-100\%$ already two years after the policy (Figure 26a), and to increase their overtime rate (Figure 26b), even though the effects are smaller and more imprecisely estimated. Second, I find evidence of technological constraints: more exposed firms are more likely to lose production time due to machine changeovers (Figure 26c), machine breakdowns (Figure 26d) and tooling breakdowns (Figure 26g), with effect sizes approximately equal to $+20\%$, $+20-30\%$, and $+15-20\%$ respectively. Among these effects, only the first is precisely estimated, but the others are of similar size and qualitatively consistent with the same interpretation. I don't find strong evidence of larger time waste due to materials unavailability, either external or internal (Figures 26e and 26f). Finally, I find clean evidence that, despite these initial adjustment constraints, production quality did not drop: Figure 26h shows no effect on customer return rates, with point estimates never significant and close to zero. Overall, the results indicate that, despite some initial challenges, more exposed firms were able to cope with the increased demand originating from downstream assemblers.

Firm Upgrading. I nest investigate various channels of potential firms upgrading in response to the downstream demand shock. Figure 27 shows the results. Consistent with the presence of larger demand from downstream firms, I first find strong evidence of reduced lead times with respect to domestic customers (Figure 27a). The results are large and long-lasting, stabilizing at approximately -60% 3 years after the policy. Second, I find strong evidence of efficiency improvements as measured by overhead expenses, which quickly drop post-2013 with effect sizes in the bulk of $-30/40\%$ for a one standard deviation increase in exposure. This effect is particularly notable given the increase in the scale of operations (sales and input expenditure) previously documented: in other words, more exposed firms save on overheads *despite* the overall increase in scale. Third, I find that more exposed firms are also more likely to export, with the share of finished goods exports doubling already one year after the policy change (Figure 27c), and slowing down later relative to less-exposed firms. Therefore, larger demand induces improvements on key performance metrics. On the employment side, I find that more exposed firms respond on impact by expanding their training expenditure per employee (Figure 27d), consistent with the previous evidence on the existence of adjustment constraints. The point estimate suggests increasing training intensity, peaking at $+50\%$ four years after the policy, and slowing down later on. Importantly, this is the time horizon where I also find evidence of increases in full-time employment, peaking at $+20\%$ in 2019 (Figure 27e), and reductions in labour turnover (Figure 27f), suggesting that larger training eventually allows firm to expand their workforce by retaining their best employees. Finally, I find direct evidence of improvements in production efficiency, as measured by the internal scrape rate (Figure 27g): although the effects are not precisely estimated, the point estimates suggest continuous improvements over the sample period, peaking at -40% in 2017-2018. As a final set of outcomes, I also study value added and operating profits as the ultimate downstream outcomes and find some evidence of improvements, although imprecisely estimated (Figures 27h and 27i). For completeness, Figure B.18 shows that I don't find strong evidence of changes in customer and supplier OTIF reliability, internal

reject and rework rates, management turnover, and value added per employee (although, as shown above, both value added and employment likely increased).

Robustness. In this section, I test for robustness of the previous results to the inclusion of additional fixed effects. A first concern is that, given the relatively small number of assembly plants as shown in Figure B.17b, the previous results could be driven by a single plant with large production capacity. Alternatively, given that most assembly plants are geographically clustered, the results could be driven by province-specific shocks affecting all component producers in a given production cluster. In order to address this concerns, I extend the baseline specification with the inclusion of province-year fixed effects. Given that my exposure measure as defined in Equation (12) varies at the firm level, the event-study coefficients are now estimated only using variation across firms within provinces. Figure B.19 shows that all the effects hold and that, if anything, the results are quantitatively larger than those in the previous section. A second concern might be that the results are only concentrated in a handful of direct suppliers to downstream MNE assemblers, leaving firms in upstream segments almost unaffected. To address this concern, I extend Equation (12) with the inclusion of tier-year fixed effects; the event-study coefficients are now identified only through variation across firms within suppliers' tiers. Figure B.20 shows the results, which are again robust to this alternative specification.

Heterogeneity by Ownership Status. As a last step, I use direct information available in the data concerning the firm-specific ownership status (domestic, multinational) to explore heterogeneity in the previous results. Figure 28 shows that virtually all the previously documented effects (with the exclusion of domestic customer lead times) are concentrated in multinational component firms. Specifically, while multinationals expand sales, expenditure on labor and materials (including materials from domestic suppliers), exports, value added and employment, while also cutting down on overheads, very few of these effects materialize for purely domestic firms. Consistent with the idea of multinationals being granted export opportunities by large downstream customers, the effects are largest for exports, which increase by more than 4 times on impact, and stay consistently above $+200\%$ over the sample period. Equally importantly, the demand for domestic inputs also increase markedly, with point estimates very close to $+100\%$ on impact and decreasing slightly later on. Overall, the results are fully concentrated in multinational component producers, suggesting that access to international sourcing opportunities might operate as a crucial requirement for leveraging the policy-induced demand shock, in line with my previous results and discussion.

9 Threats to Identification

Finally, in this section I present additional evidence addressing residual identification concerns. First, in Section 9.1, I show that the results are inconsistent with a decline in international competitive pressure on South African automotive producers, which might otherwise explain the increase in sales documented in Section 8. Second, in Section 9.2, I provide evidence against a general international demand shock for automotive products, that could have generated the observed increases in automotive production even in the absence of any industrial policy intervention.

9.1 Slowdown of International Competition

In the presence of a general slowdown of the international competitive pressure on South African producers, a difference-in-difference analysis might incorrectly interpret any observed diverging trends as the result of the introduction of the APDP. To address this concern, I use data on automotive production from Marklines, a leading automotive industry portal with global coverage of automotive production and sales. Unfortunately, Marklines only contains aggregate data for South Africa until 2017, preventing a brand-level or group-level analysis as in Section 8. Nonetheless, I first use the aggregate data for South Africa to show direct evidence of increased production volumes, and then turn to an analysis of the production responses by the main South African competitors around the APDP years.

Increased Production Volumes. Figure 29a shows the aggregate time series evolution of the South African automotive production by vehicle category (passenger cars, light commercial vehicles, buses, special-purpose vehicles, SUVs and trucks) using data from Marklines. The results indicate a clear response of passenger cars production in the years immediately following 2013. Comparing the data point at the end of the sample period (2019) to the 2013 baseline, the results indicate a 30% increase in annual vehicle production. Despite this result could be just driven by general favorable economic conditions, I provide evidence suggesting this is unlikely to be the case. First, as I show below, this period saw a strong intensification of competition from China, if anything operating against increased production volumes in South Africa. Second, in Figure 29b I relate the passenger cars production in South Africa to world production. The results clearly indicate a downwards trend until 2013, with a decrease from about 0.8% of world production in 2002 to less than 0.5% in 2013, followed by a change in slope and a positive trend after 2013. By the end of 2019, the share of South Africa's passenger cars production had increased by about 0.2pp, a 40% increase compared to the 2013 baseline. I also formally test for the presence of a structural break with unknown date usign a variety of methods (supremum, average and exponential Wald and likelihood ratio tests, p-values reported in Figure 29b), and find strong evidence supporting the presence of a structural break.

International Competitors I next use the Marklines data to inspect production responses by the main South African international competitors around the APDP years. To implement the analysis, I first construct a panel dataset at the level of brand by country-of-production, and restrict the sample period to 2009-2019, to avoid interference from the 2008 financial crisis and the 2020 Covid 19 trade disruption. The final sample contains 796 brands belonging to 69 different automotive groups and producing across 44 different countries. I next estimate specifications of the following form:

$$y_{b,c,t} = \alpha_b + \alpha_c + \alpha_t + \sum_{k \neq -1} \beta_k (\text{Competitor}_c \times \mathbb{1}\{t - 2013 = k\}) + \gamma_{b/g,t} + \varepsilon_{b,c,t} \tag{14}$$

where b, c and t denote brands, countries-of-production and time periods (respectively), $y_{b,c,t}$ is automotive production (measured in vehicle units), and α_b, α_c and α_t are brand, country of production and time fixed effects. While α_b and α_c capture the effect of time-invariant characteristics only changing at the brand and country level, α_t captures the effect of general shocks common to all brands and

countries. $Competitor_c$ is a dummy variable only varying at the country-of-production level and equal to 1 for competitors countries, defined in various ways as explained below. The coefficients of interest are β_k, capturing changes in automotive production of South African competitors relative to non-competitors, using 2012 as the baseline year. Finally, in alternative specifications I also include either group-year or brand-year fixed effects $\gamma_{b/g,t}$, which capture the effect of time-varying group/brand specific shocks. I always cluster standard errors at the country-of-production level.

Results. The results, reported in Figure 30, indicate a slowdown of production in traditional automotive countries (Europe, US, Japan and Korea) of approximately 20% in both total and passenger cars production, relative to other countries (Figures 30a and 30e). However, this finding is most likely explained by a relative acceleration of production in China: Figures 30b and 30f show indeed larger production volumes both in total vehicles and passenger cars, of similar magnitude to the relative slowdown previously documented. To understand the implications for production in South Africa, I next use UN Comtrade data for 2013 to identify two sets of potential competitor countries: i) large exporters of automotive products to South Africa, ii) large exporters of automotive products to the top-3 export markets for South Africa. In both cases, I distinguish between top-5 competitors (which did not include China at the moment of the APDP introduction), and top-10 countries (which instead include China already in 2013)[46]. The results are shown in Figures 30c and 30d for total production and in Figures 30g and 30h for passenger cars. I find some evidence of a relative slowdown of top-5 competitors, which tends to be faster for large export markets rather than for the South African market. However, this result is again most likely explained by pure reshuffling in favor of China: when I perform the same analysis for top-10 competitors in Figures 30g and 30h, I find no evidence of a slowdown in international competition. If anything, these countries together increase their production relatively faster then other non-competitor countries, even though the positive estimates are generally not significant at conventional levels. Importantly, the positive estimates in the immediate aftermath of the APDP introduction cannot explain the change in slope and the increase in the South African share of automotive world production documented in Figure 29b. To make sure the results truly capture country-specific trends in production rather than idiosyncratic shocks for specific brands or automotive groups, I also test for robustness to the inclusion of group-year and brand-year fixed effects in Figures B.21 and B.22, and find very similar results. Taken together, the results documented in Section 7 are unlikely to be driven by a slowdown of the international competitive pressure on South African producers.

9.2 International Demand Shocks for Automotive

A second potential concern is that the results shown in Sections 7 and 8 could simply be driven by an international demand shock for automotive products, which would sustain sales' expansion through export growth. To address this concern, I use cross-country sectoral data from the OECD Trade in Value

[46]The top-5 exporting countries of automotive products to South Africa in 2013 are Germany, USA, Japan, Korea and India; top-10 countries also include UK, China, France, Thailand and Italy. The top-5 exporting countries of automotive products to the top-3 export markets for South Africa in 2013 are Canada, Mexico, Japan, Germany and Korea; top-10 countries also include China, UK, Italy, France and Spain.

Added (TiVA) database. TiVA uses the OECD Inter-Country Input-Output (ICIO) tables to construct indicators tracking the origins of value added in exports, imports and final demand across origin and destination countries. This proves to be useful for two reasons. First, given the focus of the APDP on local value addition, I use the TiVA indicators to directly test for aggregate sectoral effects on the domestic value added content of South African trade flows. Second, I exploit the cross-country dimension of the data to implement triple-difference specifications to residualize the main effects for South Africa using a variety of comparable economies, and show that the results are unlikely to be explained by a general demand shock for automotive products in the years immediately following the APDP.

Econometric Specification. To implement the above-mentioned specifications, I construct a panel dataset from TiVA at the country-sector level, spanning 44 industries and 76 national economies. For the main effects on South African trade flows, I first estimate a simple SDID specification of Equation (8), which allows to recover the treatment effect for South Africa for time k, denoted as β_k^{SA}, as

$$\beta_k^{SA} = (y_{auto,k}^{SA} - \sum_{i \neq \text{auto}} \hat{\omega}_i^{sdid} y_{i,k}^{SA}) - \sum_{t=1}^{T^{pre}} \hat{\lambda}_t^{sdid} (y_{auto,t}^{SA} - \sum_{i \neq \text{auto}} \hat{\omega}_i^{sdid} y_{i,t}^{SA}) \tag{15}$$

where $y_{i,k}^{SA}$ is the typical outcome for industry i in South Africa, $\hat{\omega}_i^{sdid}$ are the synthetic difference-in-difference weights, and $\hat{\lambda}_t^{sdid}$ are the time weights. Equation (15) shows that all effects for the auto industry are computed by first relating this industry's outcome to a weighted average of other industries in the same period (1st difference), and then relating the result to a weighted average of differences between the auto industry and the synthetic control in the pre-treatment period (2nd difference), with time weights given by $\hat{\lambda}_t^{sdid}$.

For the triple difference specifications, I first identify different candidate sets of economies comparable to South Africa, denoted as C^{SA}: BRICS countries, other African countries, South-East Asia, and South America. For each of these groups, I separately estimate coefficients of the form of Equation (15) for South Africa and each country in C^{SA}, and then compute the triple difference coefficient for time k as

$$\beta_k^{SA,triple} = \beta_k^{SA} - \sum_{j \in C^{SA}} \frac{\beta_k^j}{|C^{SA}|} \tag{16}$$

where $|\cdot|$ denotes a set's cardinality. I compute standard errors through a country-by-country sector-level clustered bootstrap procedure, where at each iteration I re-sample control sectors with replacement and re-compute the main estimand using equation Equation (16).

DiD Results. The main DiD results are reported in Figure 31. Figures 31a and 31b show that both domestic and foreign content embodied in exports increased as a result of the policy. The effects are large: by the end of the sample period, the domestic and foreign VA embodied in exports increase by 145% and 187%, relative to the baseline 2013 levels. The contemporaneous increase in domestic and foreign value added is consistent with the increased domestic input sourcing by downstream MNE assemblers and the increased reliance on foreign inputs by upstream component producers, as reported in Section 7. Figure 31c also shows that the latter effects appears to dominate, resulting in aggregate increases in the

share of foreign value added relative to domestic. Moreover, the fact that both margins jointly increased is suggestive of complementarities in production between domestic and foreign content, in line with the theoretical framework lied down in Section 3, and of overall increased scale of production, as shown in Section 9.1. Indeed, I confirm the latter by studying overall sectoral export responses in Figure 31d, and find evidence of large increases in automotive export values of approximately $+162.5\%$ relative to 2013. Figure B.23 decomposes the increase in exports and value added embodied in exports by source (direct, indirect and re-imported value added, exports of final products, intermediates and re-exported intermediates) and shows that the effects are evenly distributed across sources of exports (Figures B.23a to B.23c) and sources of value added (Figures B.23d to B.23f).

Triple Diff Results. Finally, Figure 32 also reports the results of the triple-difference specifications. I find that the results from Figure 31 hold no matter the specific group of countries used to residualize the main DiD estimate, both in terms of magnitude and significance. In Figure B.24 I also perform the same exercise on the sources of exports (Figures B.24a to B.24c) and value added embodied in exports (Figures B.24d to B.24f) and still find very similar results to the ones reported in Figure B.23, no matter how the group of comparable economies C^{SA} is defined. Overall, the results make it unlikely that a general international demand shock for automotive products are driving the results, in the absence of comparable responses by a wide array of comparable countries.

10 Conclusion

This paper evaluates South Africa's 2013 APDP, an industrial policy shift from export support to localization incentives rewarding domestic value addition through duty rebates on complementary inputs and output products. I first show theoretically that, when some complementarity between domestic and foreign inputs exists, these incentives generate a kink in downstream assemblers' sourcing problem, generating increased demand for domestic inputs, with larger effects for ex-ante relatively more intense users of foreign intermediates. Moreover, in equilibrium the policy might result in increased scale of production, both at the assembly and component manufacturing stages, together with larger entry of component producers. Using administrative, commercial, and survey data, the empirical results indicate that downstream MNE assemblers substantially increased local sourcing. In upstream component manufacturing, the policy jointly led to large inflows of new entrants and increased scale of incumbent producers, but this expansion is accompanied by a sharp increase in imported input use. Consistent with binding quality constraints imposed by downstream MNE assemblers, I also show that: i) the scale increase is concentrated in component producers with ex-ante large access to foreign intermediates, ii) most effects on firm upgrading are concentrated in multinational component firms, iii) at the assembly stage, the policy results in increased sales of new and more advanced models, mostly for exports. The policy also resulted in aggregate improvements in real sales, value added and output, together with increased export orientation. Taken together, the findings provide rare evidence from an African setting that localization and global integration need not be competing objectives.

References

Abadie, Alberto. 2021. Using Synthetic Controls: Feasibility, Data Requirements, and Methodological Aspects. *Journal of Economic Literature*, **59**(2), 391–425.

Abadie, Alberto, & Gardeazabal, Javier. 2003. The Economic Costs of Conflict: A Case Study of the Basque Country. *American Economic Review*, **93**(1), 113–132.

Abadie, Alberto, Diamond, Alexis, & and, Jens Hainmueller. 2010. Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program. *Journal of the American Statistical Association*, **105**(490), 493–505.

Alfaro-Ureña, Alonso, Manelici, Isabela, & Vasquez, Jose P. 2022. The Effects of Joining Multinational Supply Chains: New Evidence from Firm-to-Firm Linkages*. *The Quarterly Journal of Economics*, **137**(3), 1495–1552.

Amiti, Mary, & Konings, Jozef. 2007. Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia. *American Economic Review*, **97**(5), 1611–1638.

Amiti, Mary, Duprez, Cédric, Konings, Jozef, & Van Reenen, John. 2024. FDI and superstar spillovers: Evidence from firm-to-firm transactions. *Journal of International Economics*, **152**, 103972.

Arkhangelsky, Dmitry, Athey, Susan, Hirshberg, David A., Imbens, Guido W., & Wager, Stefan. 2021. Synthetic Difference-in-Differences. *American Economic Review*, **111**(12), 4088–4118.

Barnes, Justin, & Black, Anthony. 2014 (05). The Motor Industry Development Programme 1995-2012: What have we learned?

Bartelme, Dominick, Costinot, Arnaud, Donaldson, Dave, & Rodríguez-Clare, Andrés. 2025. The Textbook Case for Industrial Policy: Theory Meets Data. *Journal of Political Economy*, **133**(5), 1527–1573.

Bas, Maria.

Black, Anthony. 2001. The Export 'Success' of the Motor Industry Development Programme and the Implications for Trade and Industrial Policy. 01.

Bustos, Paula. 2011. Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms. *American Economic Review*, **101**(1), 304–40.

Carballo, Jerónimo, de Artiñano, Ignacio Marra, Ottaviano, Gianmarco I.P., & Martincus, Christian Volpe. 2021. Linkages with Multinationals: The Effects on Domestic Firms' Exports. *Working paper*.

Clarke, Damian, Pailañir, Daniel, Athey, Susan, & Imbens, Guido. 2024. On synthetic difference-in-differences and related estimation methods in Stata. *The Stata Journal*, **24**(4), 557–598.

Fernandes, Ana Margarida, & Reed, Tristan. 2026. Industrial Policy for Development: Approaches in the 21st Century. *Policy Research Reports. Washington, DC: World Bank*.

Fieler, Ana Cecília, Eslava, Marcela, & Xu, Daniel Yi. 2018. Trade, Quality Upgrading, and Input Linkages: Theory and Evidence from Colombia. *American Economic Review*, **108**(1), 109–46.

Flatters, Frank. 2005. The economics of the MIDP and the South African Motor Industry. 01.

Flatters, Frank. 2006. Trade and Poverty in South Africa: Motor Industry Case Study. 01.

Garetto, Stefania, Pavcnik, Nina, Ramondo, Natalia, Alviarez, Vanessa, Fan, Jingting, Pandalai-Nayar, Nitya, Limodio, Nicola, Manelici, Isabela, Morales, Nicolas, Dardati, Evangelina, Garcia-Lembergman, Ezequiel, Gu, Grace, Hale, Galina, Hemous, David, Martin, Ralf, Farrokhi, Farid, Pellegrina, Heitor, Vezina, Pierre Louis, Boudreau, Laura, & Vasquez, Jose. 2025. Foreign Direct Investment and Development. *VoxDevLit*, **13**(1).

Giroud, Axèle, Jindra, Björn, & Marek, Philipp. 2012. Heterogeneous FDI in Transition Economies – A Novel Approach to Assess the Developmental Impact of Backward Linkages. *World Development*, **40**(11), 2206–2220.

Goldberg, Pinelopi, & Reed, Tristan. 2023. Presidential Address: Demand-Side Constraints in Development. The Role of Market Size, Trade, and (In)Equality. *Econometrica*, **91**(6), 1915–1950.

Goldsmith-Pinkham, Paul, Sorkin, Isaac, & Swift, Henry. 2020. Bartik Instruments: What, When, Why, and How. *American Economic Review*, **110**(8), 2586–2624.

Halpern, László, Koren, Miklós, & Szeidl, Adam. 2015. Imported Inputs and Productivity. *American Economic Review*, **105**(12), 3660–3703.

Itskhoki, Oleg, & Moll, Benjamin. 2019. Optimal Development Policies With Financial Frictions. *Econometrica*, **87**(1), 139–173.

Juhász, Réka, Lane, Nathan J, & Rodrik, Dani. 2023 (August). *The New Economics of Industrial Policy*. Working Paper 31538. National Bureau of Economic Research.

Kalouptsidi, Myrto. 2017. Detection and Impact of Industrial Subsidies: The Case of Chinese Shipbuilding. *The Review of Economic Studies*, **85**(2), 1111–1158.

Kee, Hiau Looi. 2015. Local intermediate inputs and the shared supplier spillovers of foreign direct investment. *Journal of Development Economics*, **112**, 56–71.

Kugler, Maurice, & Verhoogen, Eric. 2009. Plants and Imported Inputs: New Facts and an Interpretation. *American Economic Review*, **99**(2), 501–07.

Kugler, Maurice, & Verhoogen, Eric. 2011. Prices, Plant Size, and Product Quality. *The Review of Economic Studies*, **79**(1), 307–339.

Lane, Nathan. 2025. Manufacturing Revolutions: Industrial Policy and Industrialization in South Korea*. *The Quarterly Journal of Economics*, 05, qjaf025.

Liu, Ernest. 2019. Industrial Policies in Production Networks*. *The Quarterly Journal of Economics*, **134**(4), 1883–1948.

Manova, Kalina, & Zhang, Zhiwei. 2012. Export Prices Across Firms and Destinations*. *The Quarterly Journal of Economics*, **127**(1), 379–436.

Masso, Jaan, & Vahter, Priit. 2023. Joining and exiting the value chain of foreign multinationals and performance of their local suppliers: evidence from interfirm transaction data. *Industrial and Corporate Change*, **32**(4), 848–875.

Melitz, Marc J. 2003. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*, **71**(6), 1695–1725.

Murphy, Kevin M., Shleifer, Andrei, & Vishny, Robert. 1989. Income Distribution, Market Size, and Industrialization*. *The Quarterly Journal of Economics*, **104**(3), 537–564.

Newman, Carol, Rand, John, Talbot, Theodore, & Tarp, Finn. 2015. Technology transfers, foreign investment and productivity spillovers. *European Economic Review*, **76**, 168–187.

OECD. 2026. Industrial Policy Handbook: From Strategy Design to Implementation. *OECD Publishing, Paris*.

Rotemberg, Martin. 2019. Equilibrium Effects of Firm Subsidies. *American Economic Review*, **109**(10), 3475–3513.

Smarzynska Javorcik, Beata. 2004. Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers Through Backward Linkages. *American Economic Review*, **94**(3), 605–627.

Topalova, Petia, & Khandelwal, Amit. 2011. Trade Liberalization and Firm Productivity: The Case of India. *The Review of Economics and Statistics*, **93**(3), 995–1009.

Verhoogen, Eric. 2023. Firm-Level Upgrading in Developing Countries. *Journal of Economic Literature*, **61**(4), 1410–64.

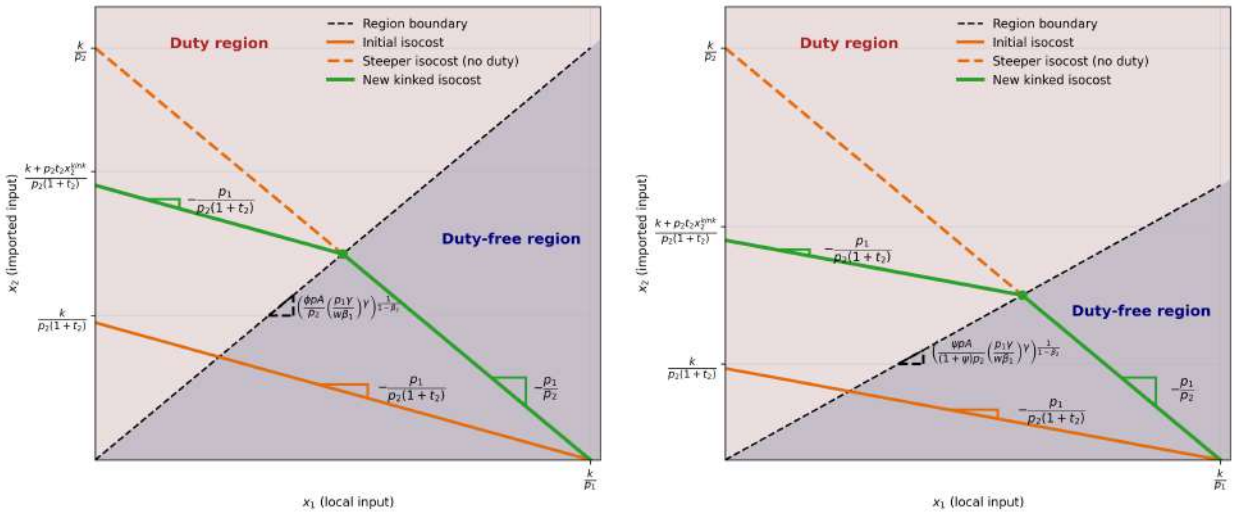
Verhoogen, Eric A. 2008. Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector*. *The Quarterly Journal of Economics*, **123**(2), 489–530.

Walker, Michael W., Shah, Nachiket, Miguel, Edward, Egger, Dennis, Soliman, Felix Samy, & Graff, Tilman. 2024 (Oct). *Slack and Economic Development*. NBER Working Papers. National Bureau of Economic Research, Inc.

Figures

FIGURE 1: THE KINKED OPTIMIZATION PROBLEMS UNDER INDUSTRIAL POLICY INCENTIVES

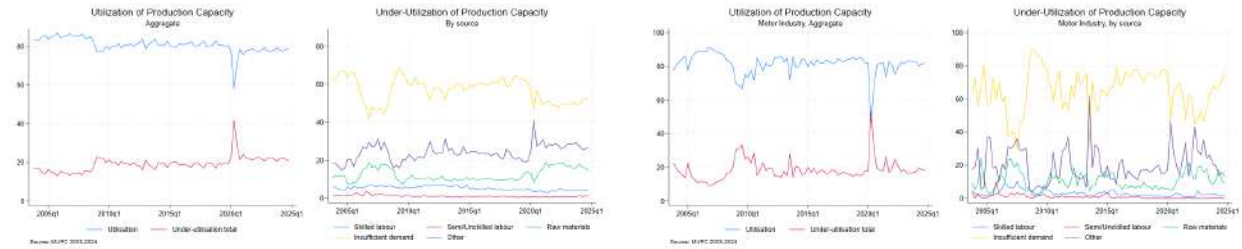
(A) VOLUME ASSEMBLY ALLOWANCE (VAA) (B) PRODUCTION INCENTIVE (PI)



Notes: The figures show the pre-policy isocost (solid yellow line) and the kinked post-policy isocost (solid green line), together with the duty region (light-shaded area) and the duty-free region (dark-shaded area). The boundary between the two regions is a straight line with slope given by Equation (7). Panel a) refers to the Volume Assembly Allowance (VAA), panel b) to the Production Incentive (PI).

FIGURE 2: MANUFACTURING UTILIZATION OF PRODUCTION CAPACITY (MUPC)

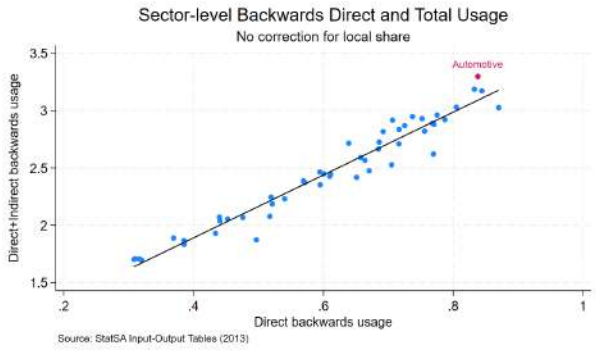
(A) AGGREGATE MANUFACTURING (B) AUTOMOTIVE



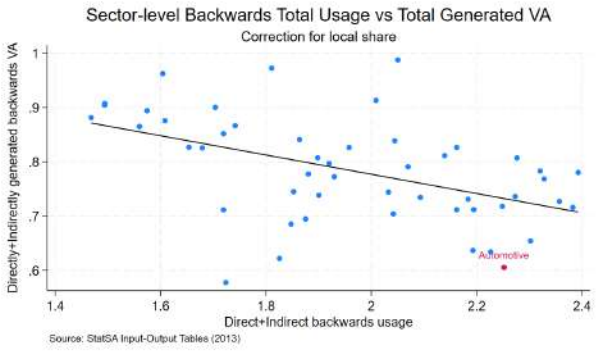
Notes: Each graph above shows on the left the time trends for the utilization of production capacity (in percentage points), on the right graph the disaggregation of the under-utilization time series by source (skilled labour, semi/unskilled labour, raw materials, insufficient demand, other). Panel A) refers to aggregate manufacturing, panel B) to automotive. Data source: StatSA Manufacturing Utilization of Production Capacity (MUPC).

FIGURE 3: SECTORAL LINKAGES - STATSA INPUT-OUTPUT TABLE (2013)

(A) DIRECT VS TOTAL REQUIREMENTS (NO CORRECTION FOR LOCAL SHARE)



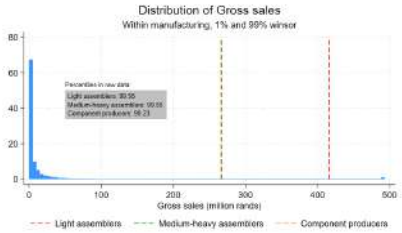
(B) TOTAL REQUIREMENTS VS TOTAL VALUE ADDED (CORRECTION FOR LOCAL SHARE)



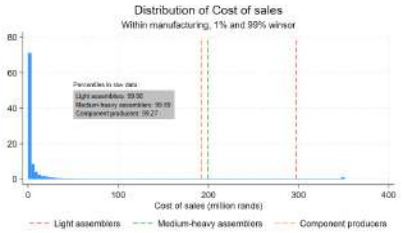
Notes: The graph on the left shows the industry-level direct requirements coefficient on the x axis and the total (direct and indirect) requirements coefficient on the y axis; the graph uses raw entries from the input-output tables not corrected for the domestic value added share. The graph on the right shows the industry-level total (direct and indirect) requirements coefficient on the x axis and the total value added (direct and indirect) coefficient on the y axis; the graph corrects the entries from the input-output tables for the domestic value added share. Data source: StatSA input-output tables (2013).

Figure 4: Manufacturing Distribution vs Industrial Policy Users

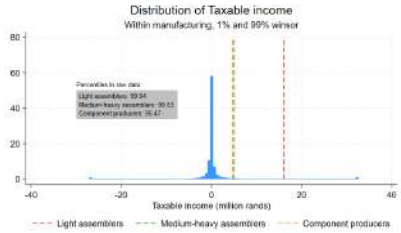
(A) Sales



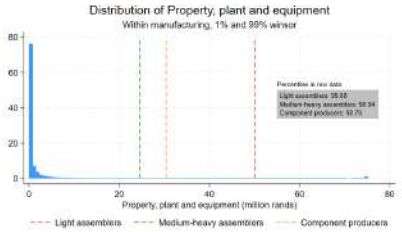
(B) Cost of Sales



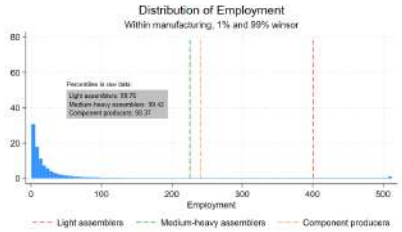
(C) Taxable Income



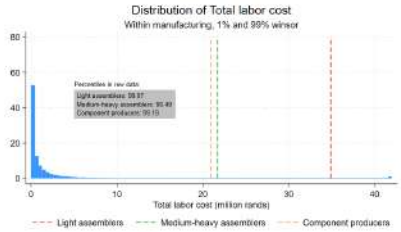
(D) Property, Plant and Equipment



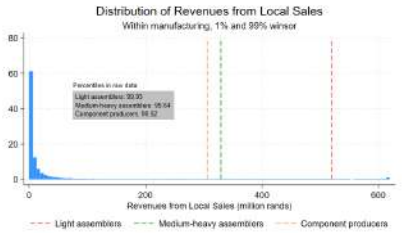
(E) Employment



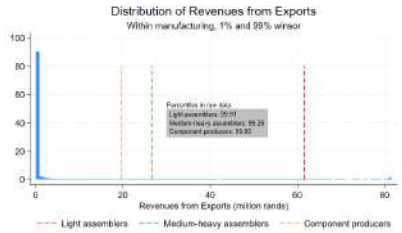
(F) Total labor cost



(G) Revenues from domestic sales



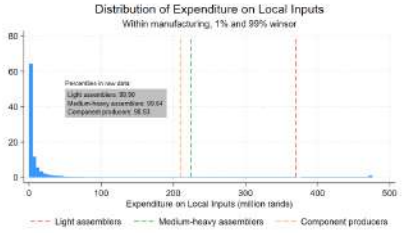
(H) Revenues from export sales



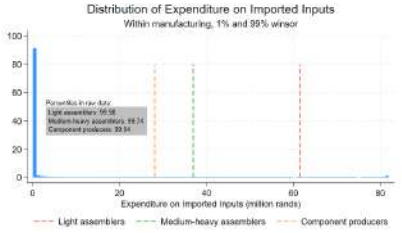
(I) Revenue share from export sales



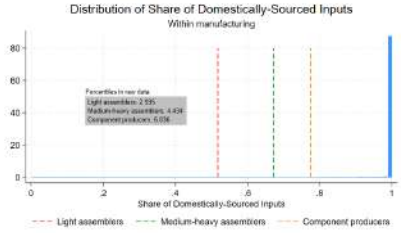
(J) Expenditure on domestic inputs



(K) Expenditure on imported inputs

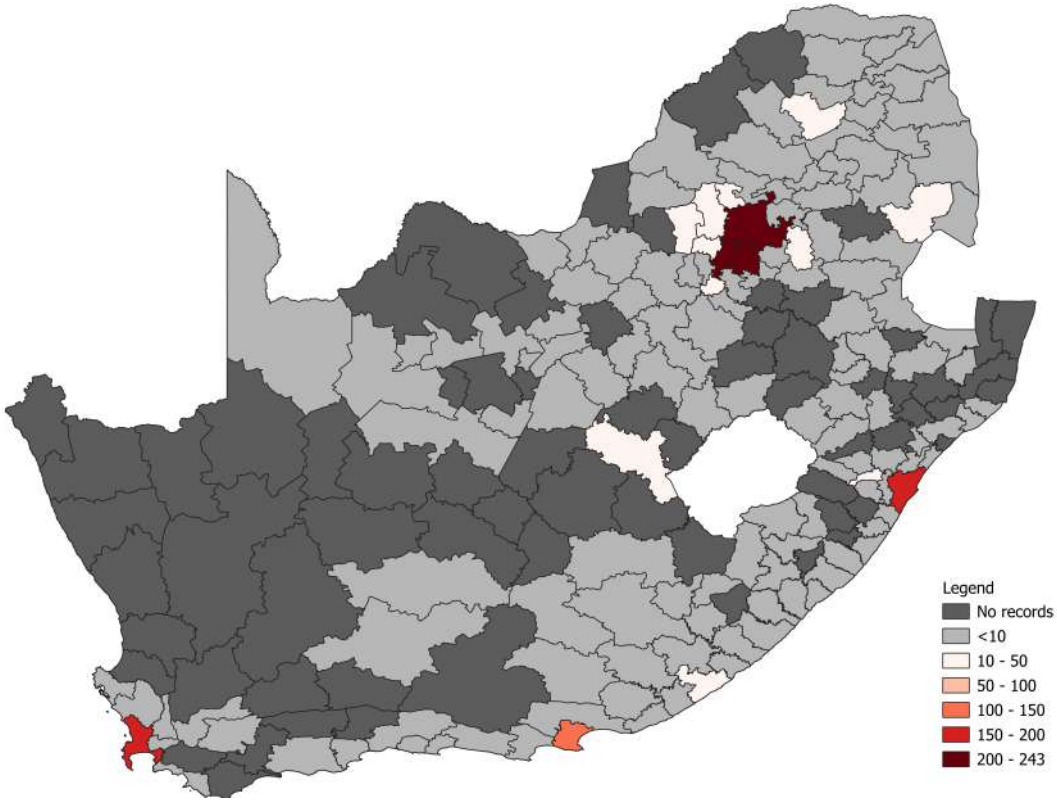


(L) Expenditure share on domestic inputs



Notes: Each graph shows an outcome's distribution for manufacturing firms in taxyear 2012 together with the mean outcome for 3 separate sets of Industrial Policy users: light assemblers (12 firms), medium-heavy assemblers (32 firms), and component producers (70 firms). Firms are classified as Industrial Policy Users if they are ever observed using the rebate codes associate with the MIDP (pre-2013) or the APDP (post-2013). For readability purposes, all outcomes excluding shares are winsorized at 1% and 99% levels. The gray box in each graph also reports the percentile associated with the three groups in the unwinsorized raw data. Monetary values are expressed in million Rands. Data source: CIT and IRP5 Firm Panels.

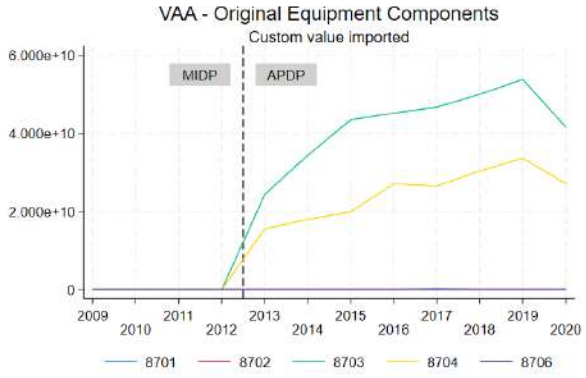
Figure 5: Automotive Establishments



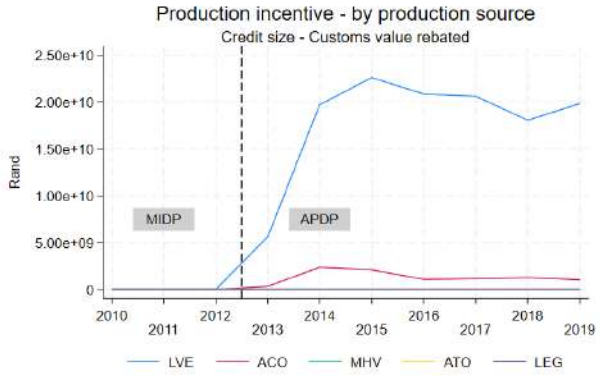
Notes: The figure shows the geographic distribution of automotive establishments across South Africa in the 2014 tax year, using data from the Spatial Tax Data project. Establishments are identified using a two-digit industry classification, which encompasses the following three-digit industries: (i) manufacture of motor vehicles; (ii) manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers; and (iii) manufacture of parts and accessories for motor vehicles. Black areas indicate municipalities with no records in the administrative data (zeros), while gray areas indicate municipalities with a positive count but fewer than 10 records; in these cases, the Spatial Tax Data project masks the exact number for confidentiality reasons. Data Source: Spatial Tax Data.

Figure 6: APDP Take-up - Value of imports using APDP duty rebates

(a) Volume Assembly Allowance



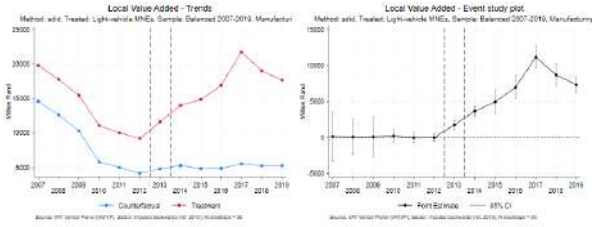
(b) Production Incentive



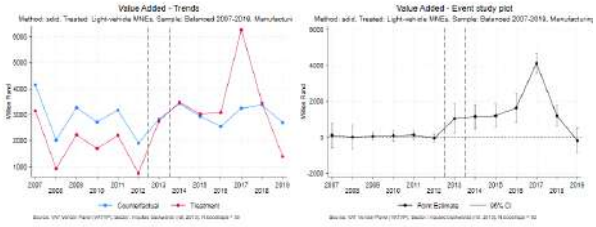
Notes: The figures above show take-up of the Volume Assembly Allowance (VAA, on the left) and the Production Incentive (PI, on the right) by South African light-vehicle assemblers using the NT-SDF administrative data. The left graph is disaggregated by usage (product imported using the rebate), the right graph is disaggregated by production source. All amounts are measured in South African rands. Data source: NT-SDF transaction-level customs data.

FIGURE 7: NT-SDF DATA: MAIN RESULTS ON LIGHT VEHICLE MANUFACTURERS

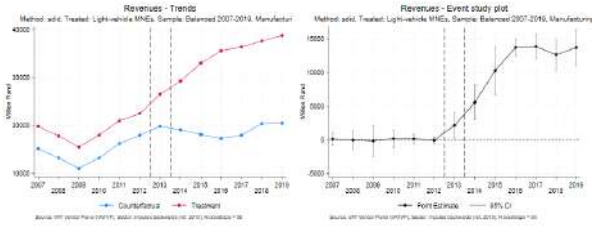
(A) LOCAL VALUE ADDED



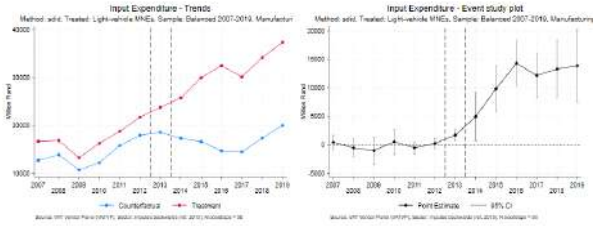
(B) VALUE ADDED



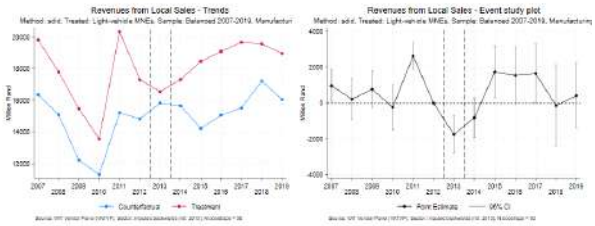
(C) TOTAL REVENUES



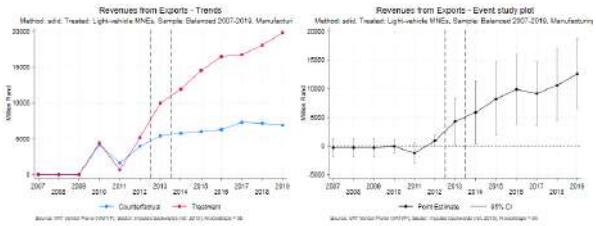
(D) TOTAL INPUT EXPENDITURE



(E) REVENUES FROM LOCAL SALES



(F) REVENUES FROM EXPORTS



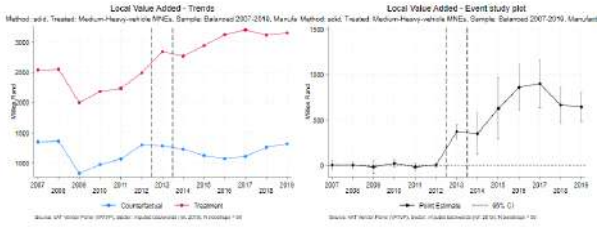
(G) EXPENDITURE ON LOCAL INPUTS



Notes: The figures show effects on VAT outcomes using the administrative data from the NT-SDF. Each graph above shows time trends for the raw treatment group and the synthetic control group (on the left) and the event-study estimates (on the right) using the synthetic difference-in-differences estimator developed in Arkhangelsky et al. (2021). The confidence intervals are generated through a sector-level clustered bootstrap procedure adapted from Athey et al. (2024) where I re-sample entire control sectors with replacement. The treatment group consists of light motor vehicle manufacturers. The underlying dataset is a firm-year panel restricted to manufacturing and always excluding medium-heavy assemblers, component producers, and all sub-sectors in the same 2-digit industry as the automotive sector. Data source: NT-SDF SARS data.

FIGURE 8: NT-SDF DATA: MAIN RESULTS ON MEDIUM-HEAVY VEHICLE MANUFACTURERS

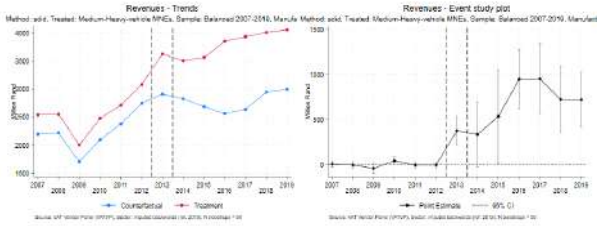
(A) LOCAL VALUE ADDED



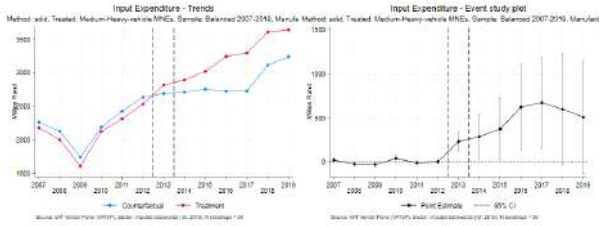
(B) VALUE ADDED



(C) TOTAL REVENUES



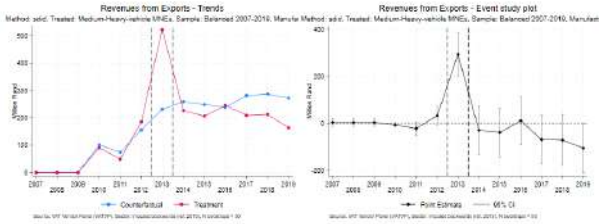
(D) TOTAL INPUT EXPENDITURE



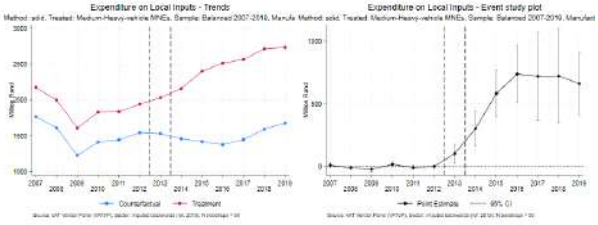
(E) REVENUES FROM LOCAL SALES



(F) REVENUES FROM EXPORTS



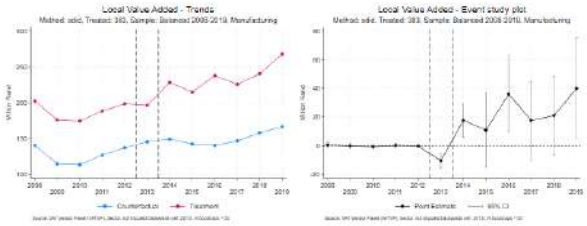
(G) EXPENDITURE ON LOCAL INPUTS



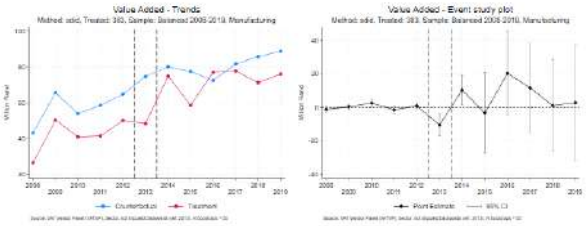
Notes: The figures show effects on VAT outcomes using the administrative data from the NT-SDF. Each graph above shows time trends for the raw treatment group and the synthetic control group (on the left) and the event-study estimates (on the right) using the synthetic difference-in-differences estimator developed in Arkhangelsky et al. (2021). The confidence intervals are generated through a sector-level clustered bootstrap procedure adapted from Athey et al. (2024) where I re-sample entire control sectors with replacement. The treatment group consists of medium-heavy motor vehicle manufacturers. The underlying dataset is a firm-year panel restricted to manufacturing and always excluding light assemblers, component producers, and all sub-sectors in the same 2-digit industry as the automotive sector. Data source: NT-SDF SARS data.

FIGURE 9: NT-SDF DATA: MAIN RESULTS ON COMPONENT MANUFACTURERS

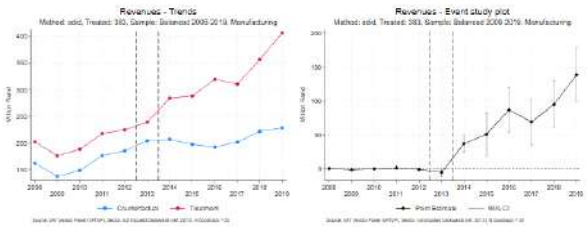
(A) LOCAL VALUE ADDED



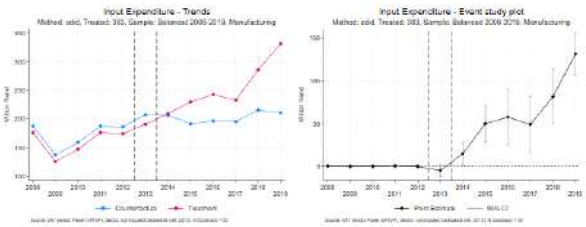
(B) VALUE ADDED



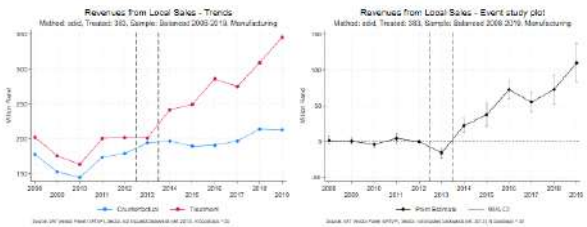
(C) TOTAL REVENUES



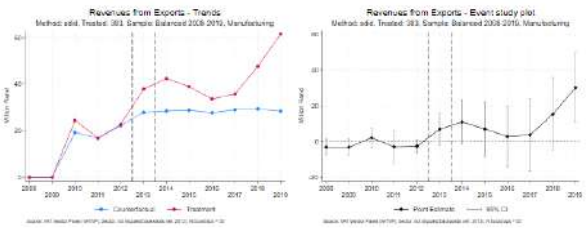
(D) TOTAL INPUT EXPENDITURE



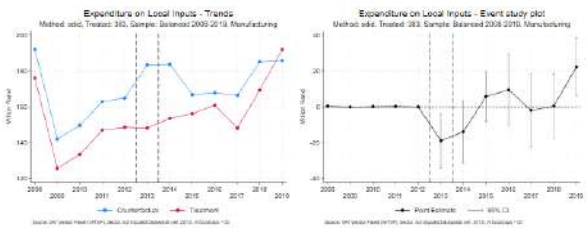
(E) REVENUES FROM LOCAL SALES



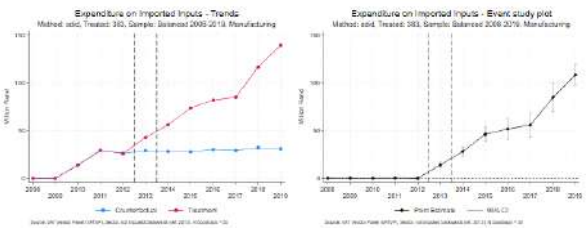
(F) REVENUES FROM EXPORTS



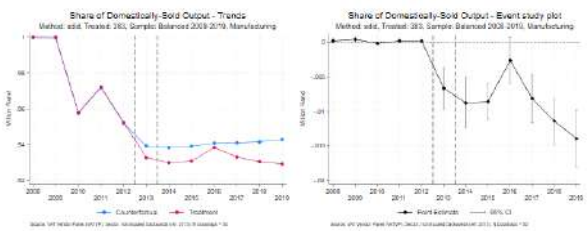
(G) EXPENDITURE ON LOCAL INPUTS



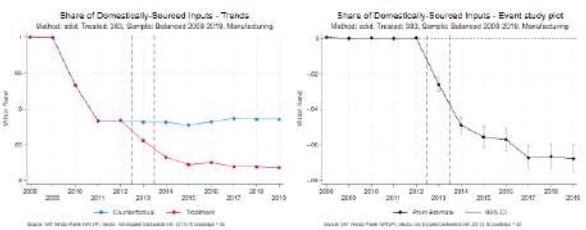
(H) EXPENDITURE ON IMPORTED INPUTS



(I) SHARE OF DOMESTICALLY-SOLD OUTPUT



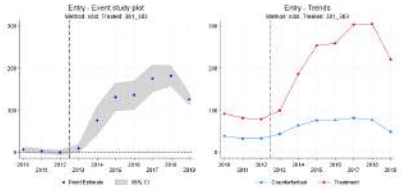
(J) SHARE OF DOMESTICALLY-SOURCED INPUTS



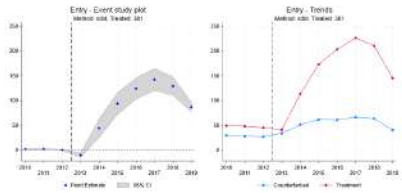
Notes: The figures show effects on VAT outcomes using the administrative data from the NT-SDF. Each graph above shows time trends for the raw treatment group and the synthetic control group (on the left) and the event-study estimates (on the right) using the synthetic difference-in-differences estimator developed in Arkhangelsky et al. (2021). The confidence intervals are generated through a sector-level clustered bootstrap procedure adapted from Athey et al. (2024) where I re-sample entire control sectors with replacement. The treatment group consists of component producers, defined as firms reporting SIC5 sector 383 in the pre-policy year. The underlying dataset is a firm-year panel restricted to manufacturing and always excluding light assemblers, medium-heavy assemblers, and all sub-sectors in the same 2-digit industry as the automotive sector. Data source: NT-SDF SARS data.

Figure 10: NT-SDF data: Entry and Exit

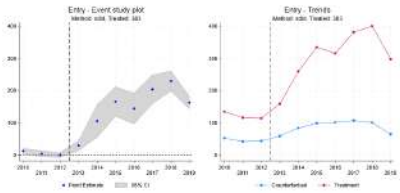
(A) Entry: Automotive Combined



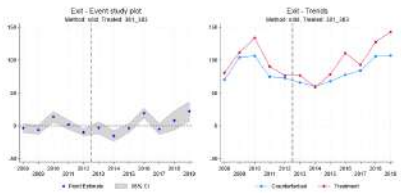
(B) Entry: Motor Vehicle Manufacturing



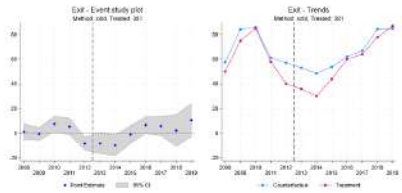
(C) Entry: Component Manufacturing



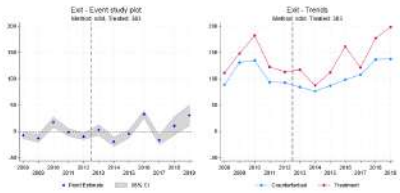
(D) Exit: Automotive Combined



(E) Exit: Motor Vehicle Manufacturing



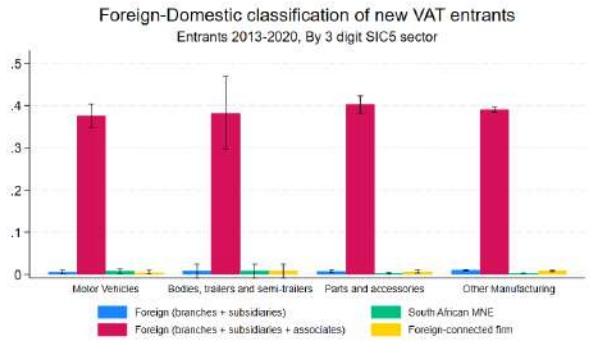
(F) Exit: Component Manufacturing



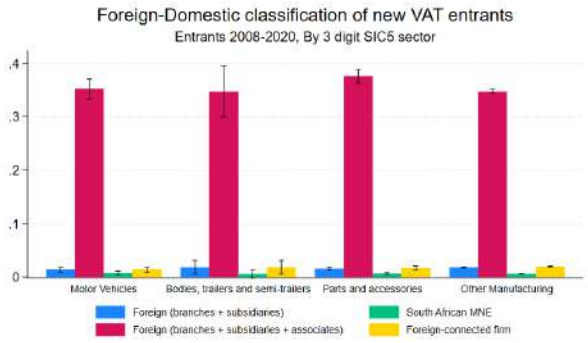
Notes: The figures show effects on firm entry and exit using the administrative data from the NT-SDF. Each graph above shows time trends for the raw treatment group and the synthetic control group (on the right) and the event-study estimates (on the left) using the synthetic difference-in-differences estimator developed in Arkhangelsky et al. (2021). The confidence intervals are generated through a sector-level clustered bootstrap procedure adapted from Athey et al. (2024) where I re-sample entire control sectors with replacement. Panels A) and D) consider as treated entrants/exiters in SIC5 industries 381 (manufacture of motor vehicles) and 383 (manufacture of parts and accessories for motor vehicles and their engines); panels B) and E) consider as treated only entrants/exiters in SIC5 industry 381 (and exclude industry 383 from the estimation sample); panels C) and F) consider as treated only entrants/exiters in SIC5 industry 383 (and exclude industry 381 from the estimation sample). The underlying dataset is a sector-year panel dataset at the 3-digit level restricted to manufacturing and always excluding all sub-sectors in the same 2-digit industry as the automotive sector. Data source: NT-SDF SARS data.

Figure 11: New entrants: foreign-domestic classification

(A) Post-policy period only (2013-2020)



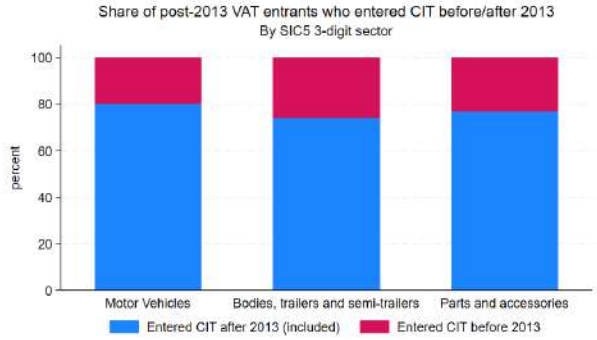
(B) All periods (2008-2020)



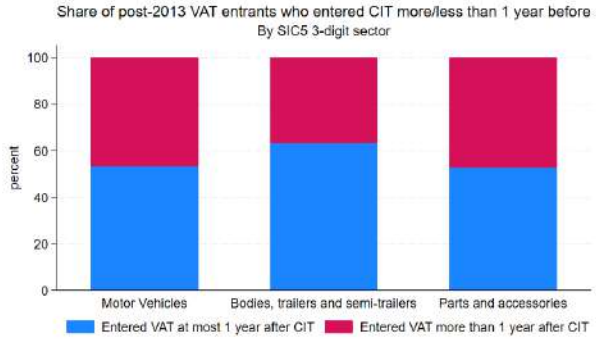
Notes: The graphs above show the share of new entrants classified as foreign firms in three targeted sectors (motor vehicle manufacturing; bodies, trailer and semi-trailers manufacturing; parts and accessories manufacturing) and compares them to other manufacturing untargeted sectors. Branch: office or division of a foreign firms; subsidiary: company whose parent is a majority holder of more than 50% of its shares; associate: company whose parent possesses a minority stake in the ownership of the company; South African MNE: South African firm with more than 50% of the shares of a foreign firm; foreign-connected firm: South African firm with more than 10% of the shares of a foreign firm. The foreign-domestic classification follows Kilumelume, Reynolds and Ebrahim (2021). Data source: VATVP and CITFP panel.

Figure 12: New entrants: timing of entry I

(A) Share that entered CIT before/after 2013



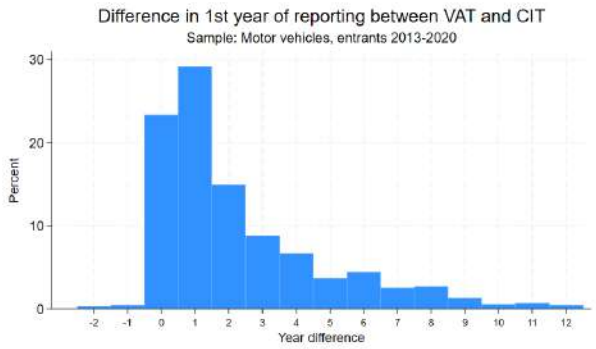
(B) Share that entered CIT at most 1/more than 1 year before entering VAT



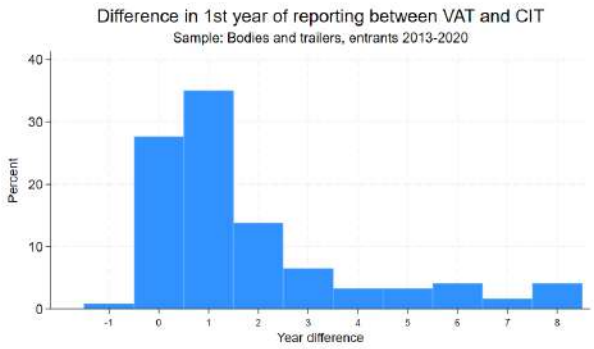
Notes: The graphs above show the share of post-2013 new entrants in the VAT firm panel (VATFP) who entered the CIT firm panel (CITFP) before and after 2013 (panel A), and the share of new entrants in the VAT firm panel (VATFP) who entered the CIT firm panel (CITFP) at most 1 year before or more than 1 year before entering VAT (panel B). Both panels distinguish between firms in motor vehicle manufacturing (SIC5 code 381), bodies, trailers and semi-trailers manufacturing (SIC5 code 382), automotive parts and components manufacturing (SIC5 code 383). Data source: VATFP and CITFP panel.

Figure 13: New entrants: timing of entry II

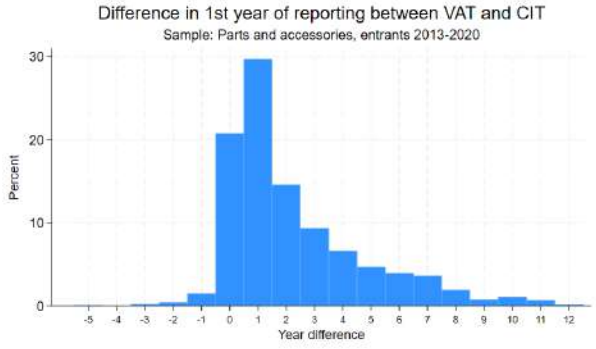
(A) Motor vehicle manufacturing



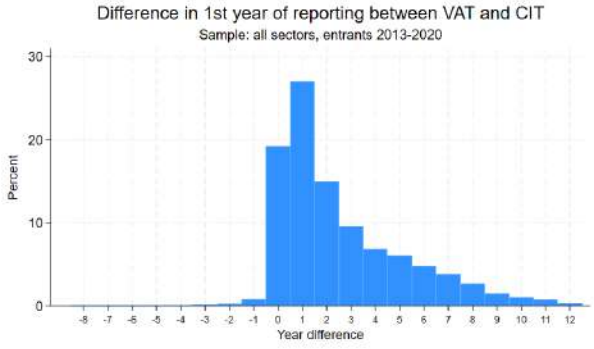
(B) Bodies, trailers and semi-trailers



(C) Parts and accessories



(D) All manufacturing



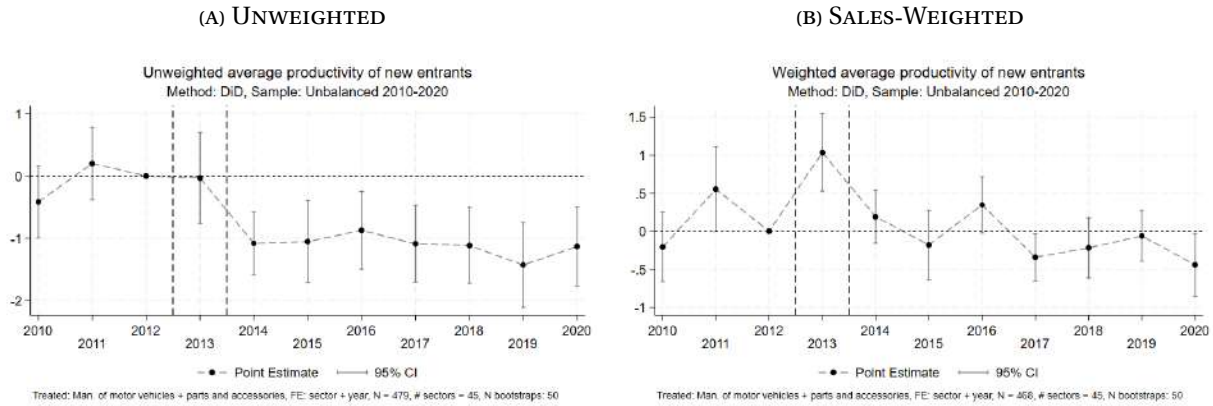
Notes: The graphs above show the distribution of the difference between the year of entry in the VAT firm panel (VATFP) and the year of entry in the CIT firm panel (CITFP). Panel A) is restricted to firms in motor vehicle manufacturing (SIC5 code 381), panel B) to firms in bodies, trailers and semi-trailers manufacturing (SIC5 code 382), panel C) to firms in automotive parts and components manufacturing (SIC5 code 383). Panel D) uses the entire sample of firms in manufacturing. Data source: VATFP and CITFP panel.

Figure 14: New entrants: do they look like legit firms?



Notes: The graphs above show the share of the post-2013 new entrants in the VAT firm panel (VATFP) reporting a non-zero value, zero value or missing value across a range of outcomes. The outcomes considered are: gross sales (panel A), cost of sales (panel B), employment (panel C), VAT input tax (panel D), VAT output tax (panel E), taxable income (panel E). Each panel separately plots results for firms in motor vehicle manufacturing (SIC5 code 381), bodies, trailers and semi-trailers manufacturing (SIC5 code 382), automotive parts and components manufacturing (SIC5 code 383), and firms in other manufacturing. Data source: VATFP panel, CITFP panel, IRP5FP panel.

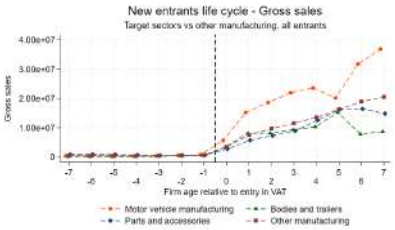
Figure 15: New entrants: Selection at Entry



Notes: The graphs above show results on selection at entry estimated through sector-level specifications comparing the average productivity at entry in targeted automotive sectors to other untargeted manufacturing. Productivity is recovered in a first step through a revenue production function estimation adopting the methodology of Olley and Pakes (1996) estimated industry by industry using observations up to tax year 2013 (the pre-policy period). Labor and expenditure on local and imported non-capital materials are treated as freely adjustable inputs, capital as the state variable, and expenditures on local and imported capital goods as proxies for investment capturing the unobserved productivity shock. Productivity is then recovered using Equation (9). In the second step, I identify each firm's year of entry, winsorize entrants' productivity at 95% level and collapse the data into 3-digit industry-by-entry-year cells, constructing both unweighted and revenue-weighted average productivity measures. I then estimate an event-study specification at the sector level of the form of Equation (10). Treated industries are motor-vehicle manufacturing (SIC5 381) and automotive parts and accessories (SIC5 383), the comparison group consists of manufacturing industries outside the broader 2-digit transport-equipment sector. The standard errors are computed using a sector-level clustered bootstrap procedure re-sampling entire control sectors with replacement. Data source: VATVP, CITFP and IRP5 panel.

Figure 16: New entrants: life cycle I

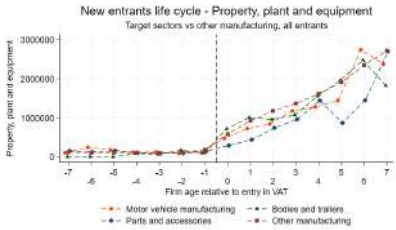
(A) Gross sales



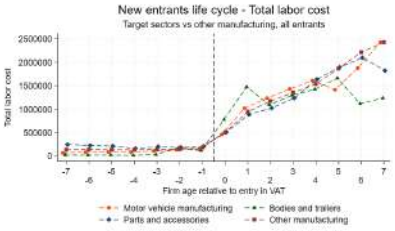
(B) Cost of Sales



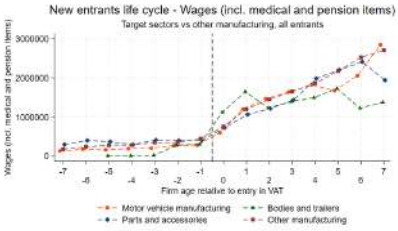
(C) Property, Plant and Equipment



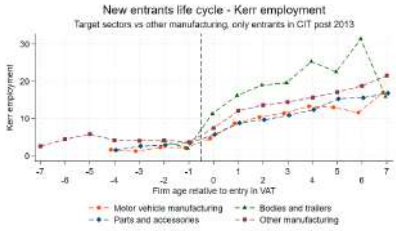
(D) Labor cost



(E) Wages (inclusive of medical and pension items)



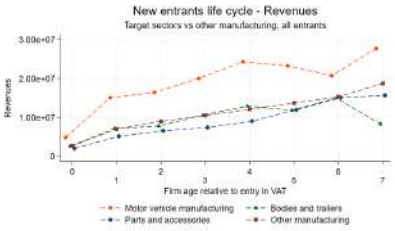
(F) Employment (Kerr def.)



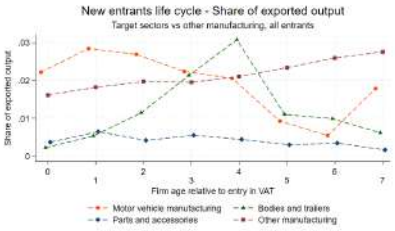
Notes: The graphs above show the life-cycle evolution of a range of economic outcomes for post-2013 new entrants in the VAT firm panel (VATFP), using data from the CIT firm panel (CITFP) and the IRP5 firm panel (IRP5FP). The outcomes considered are: gross sales (panel A), cost of sales (panel B), property, plant and equipment (panel C), labor cost (panel D), wages (inclusive of medical and pension items) (panel E), employment (Kerr definition) (panel F). Each panel separately plots results for firms in motor vehicle manufacturing (SIC5 code 381), bodies, trailers and semi-trailers manufacturing (SIC5 code 382), automotive parts and components manufacturing (SIC5 code 383), and firms in other manufacturing. Data source: CITFP dataset, IRP5FP dataset.

Figure 17: New entrants: life cycle II

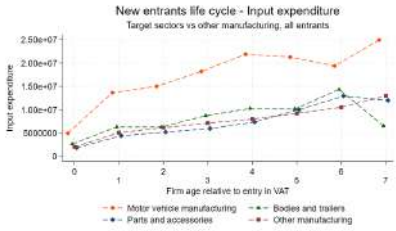
(A) VAT revenues



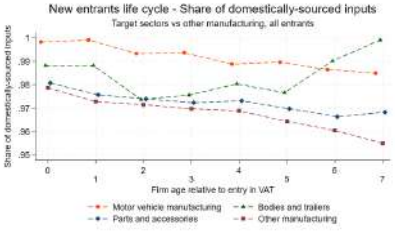
(B) Share of export revenues



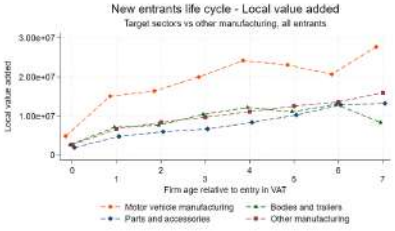
(C) Input expenditure



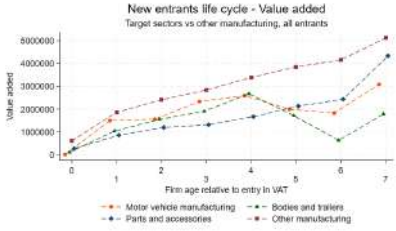
(D) Share of domestic input expenditure



(E) Local value added

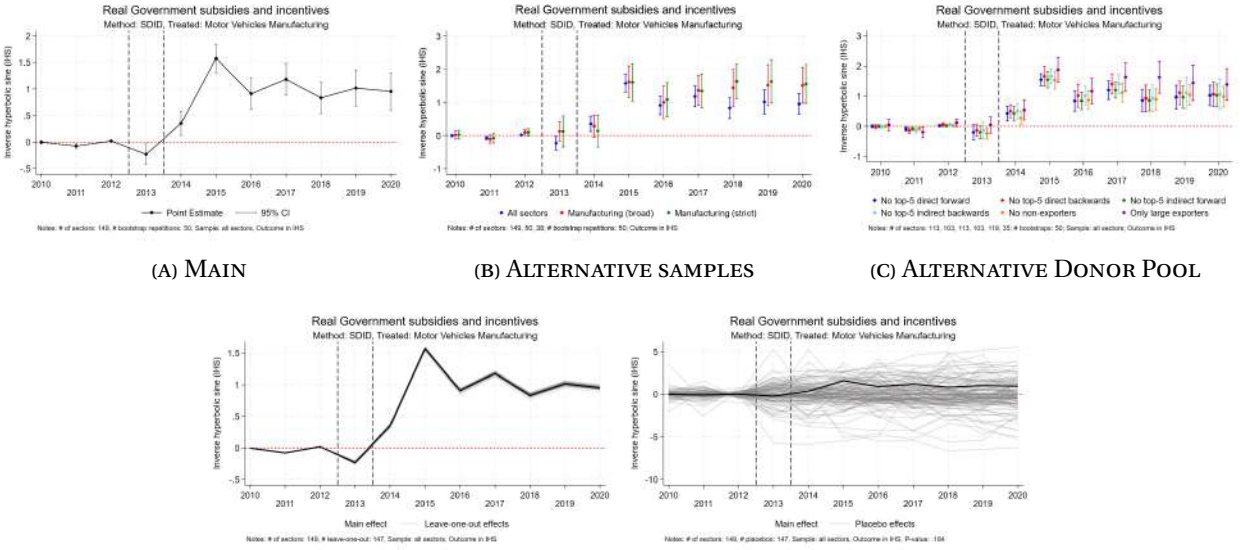


(F) Total value added



Notes: The graphs above show the life-cycle evolution of a range of economic outcomes for post-2013 new entrants in the VAT firm panel (VATFP), using data from the same dataset. The outcomes considered are: VAT revenues (panel A), share of export revenues (panel B), input expenditure (panel C), share of domestic input expenditure (panel D), local value added (panel E), total value added (panel F). Each panel separately plots results for firms in motor vehicle manufacturing (SIC5 code 381), bodies, trailers and semi-trailers manufacturing (SIC5 code 382), automotive parts and components manufacturing (SIC5 code 383), and firms in other manufacturing. Data source: VATFP dataset.

FIGURE 18: AGGREGATE SECTOR-LEVEL DATA - SUBSIDIES AND INCENTIVES

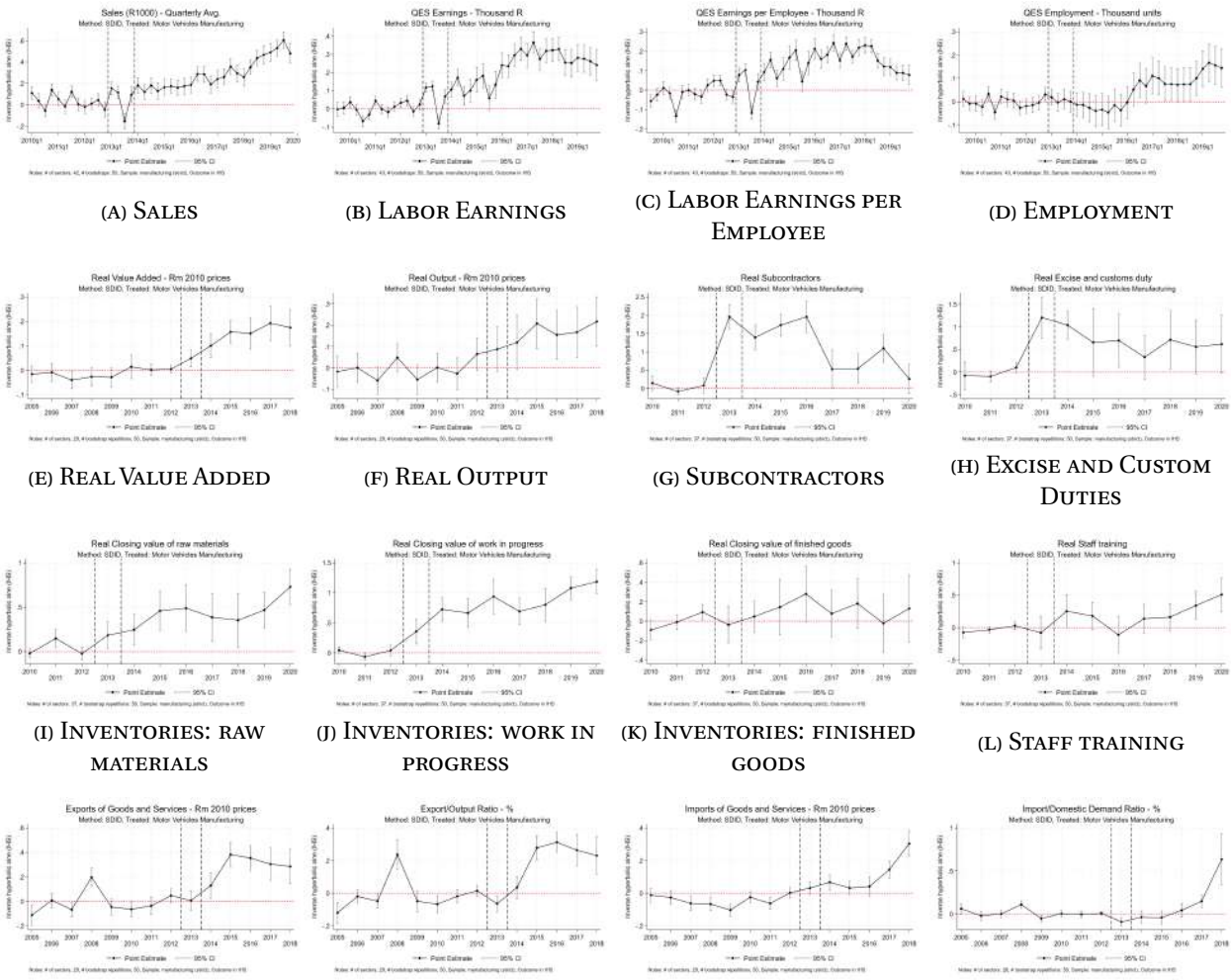


(A) MAIN (B) ALTERNATIVE SAMPLES (C) ALTERNATIVE DONOR POOL

(D) LEAVE-ONE-OUT (E) SPACE PLACEBO

Notes: Panel A shows event-study coefficients and 95% confidence intervals from Equation (8). Panel B does the same, but using alternative samples for estimation (all sectors, manufacturing sectors (broad), manufacturing sectors (strict)). Panel C does the same, but using alternative sets of potential donor sectors as controls (exclusion of top-5 direct forward links, direct backward links, indirect forward links, indirect backward links, non-exporting sectors, and inclusion of only large exporting sectors). Panel D performs leave-one-out estimation by excluding one control sector at a time. Panel D performs space placebo inference by iteratively re-assigning the treatment status to any control sector. The regression is estimated via synthetic difference in difference (Arkhangelsky et al., 2022). All regressions include sector and time fixed effects. All coefficients are estimated relative to a pre-treatment time-weighted average difference between treated and control sectors. The 95% confidence intervals are generated through a sector-level clustered bootstrap procedure adapted from Athey et al. (2024) where I re-sample entire control sectors with replacement. Data source: Annual Financial Statistics (AFS).

FIGURE 19: AGGREGATE SECTOR-LEVEL DATA - MAIN RESULTS



(A) SALES (B) LABOR EARNINGS (C) LABOR EARNINGS PER EMPLOYEE (D) EMPLOYMENT

(E) REAL VALUE ADDED (F) REAL OUTPUT (G) SUBCONTRACTORS (H) EXCISE AND CUSTOM DUTIES

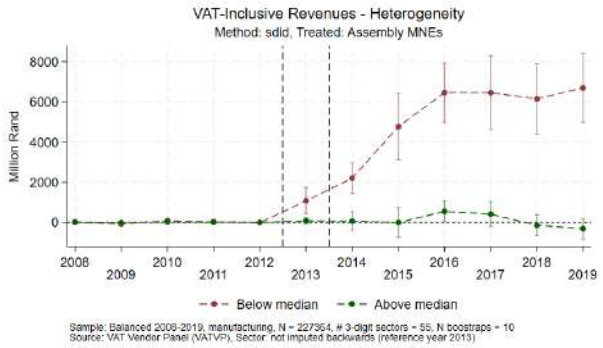
(I) INVENTORIES: RAW MATERIALS (J) INVENTORIES: WORK IN PROGRESS (K) INVENTORIES: FINISHED GOODS (L) STAFF TRAINING

(M) EXPORTS (N) EXPORT-OUTPUT RATIO (O) IMPORTS (P) IMPORTS-DOMESTIC DEMAND RATIO

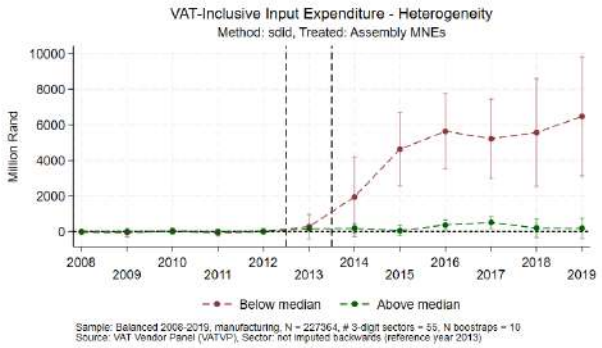
Notes: The graphs above show event-study coefficients and 95% confidence intervals from Equation (8). The regression is estimated via synthetic difference in difference (Arkhangelsky et al., 2022). All regressions include sector and time fixed effects. All coefficients are estimated relative to a pre-treatment time-weighted average difference between treated and control sectors. The 95% confidence intervals are generated through a sector-level clustered bootstrap procedure adapted from Athey et al. (2024) where I re-sample entire control sectors with replacement. Data source: Annual Financial Statistics (AFS).

FIGURE 20: ASSEMBLERS: HETEROGENEITY BY DOMESTIC INPUT EXPENDITURE SHARE

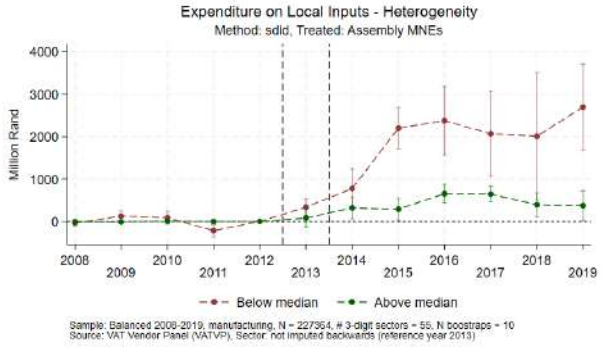
(A) VAT-INCLUSIVE REVENUES



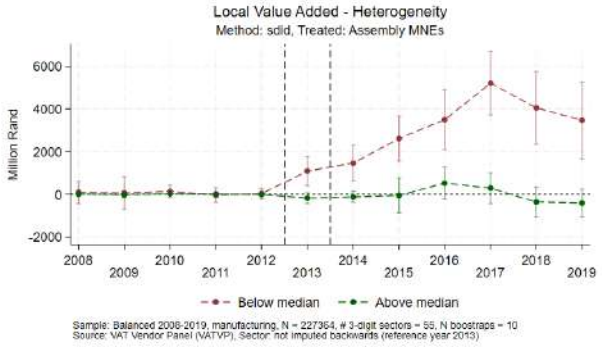
(B) VAT-INCLUSIVE INPUT EXPENDITURE



(C) DOMESTIC INPUT EXPENDITURE



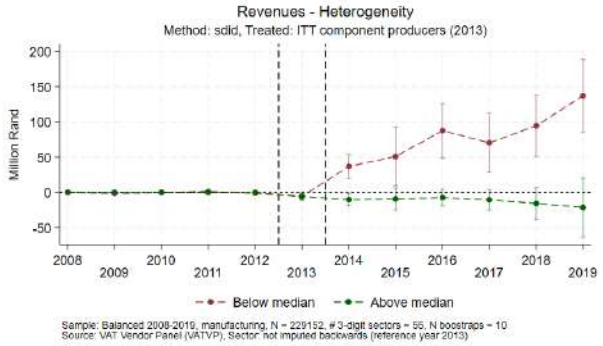
(D) LOCAL VALUE ADDED



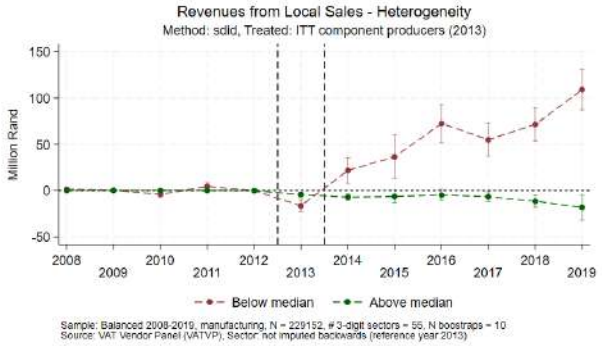
Notes: Each graph above shows event-study estimates using synthetic difference-in-differences following Arkhangelsky et al. (2021). The treatment group consists of all assembly manufacturers (both light-vehicle and medium-heavy vehicle producers); in each graph, I split the treatment group based on the pre-policy median expenditure share on domestic inputs. The sample is restricted to manufacturing sectors and excludes all sub-sectors in the same 2-digit industry as the automotive sector. The 95% confidence intervals are generated through a sector-level clustered bootstrap procedure adapted from Athey et al. (2024) where I re-sample entire control sectors with replacement. Data source: VATVP panel.

FIGURE 21: COMPONENT PRODUCERS: HETEROGENEITY BY DOMESTIC INPUT EXPENDITURE SHARE

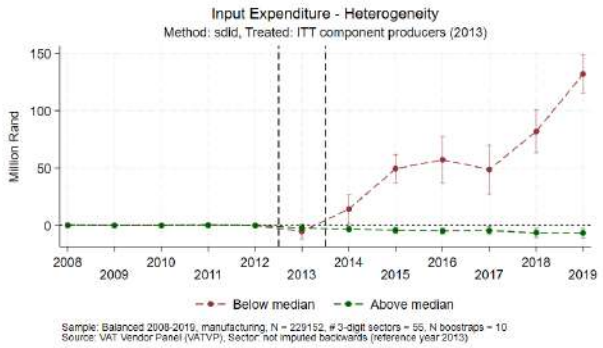
(A) REVENUES



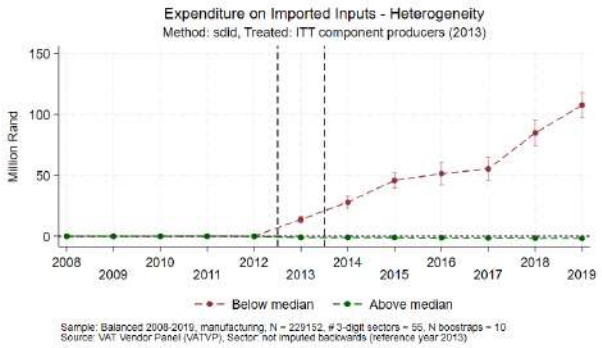
(B) REVENUES FROM DOMESTIC SALES



(C) INPUT EXPENDITURE

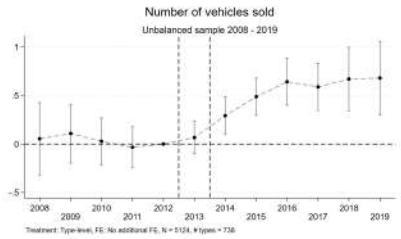


(D) EXPENDITURE ON IMPORTED INPUTS

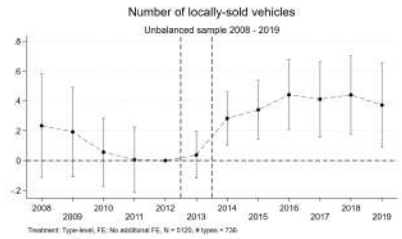


Notes: Each graph above shows event-study estimates using synthetic difference-in-differences following Arkhangelsky et al. (2021). The treatment group consists of all firms registered as component producers in the pre-policy year (ITT specification); in each graph, I split the treatment group based on the pre-policy median expenditure share on domestic inputs. The sample is restricted to manufacturing sectors and excludes all sub-sectors in the same 2-digit industry as the automotive sector. The 95% confidence intervals are generated through a sector-level clustered bootstrap procedure adapted from Athey et al. (2024) where I re-sample entire control sectors with replacement. Data source: VATVP panel.

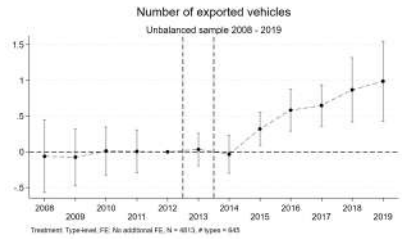
FIGURE 22: LIGHTSTONE SA - EFFECTS ON SALES BY DESTINATION MARKET - TYPE LEVEL TREATMENT



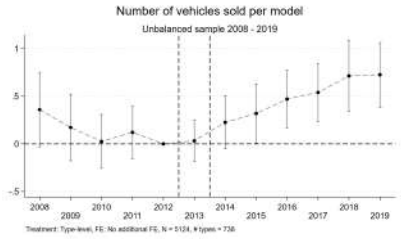
(A) NUMBER OF VEHICLE SOLD



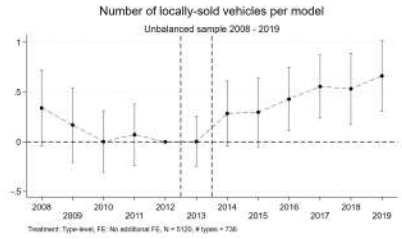
(B) NUMBER OF VEHICLE SOLD (LOCAL MARKET)



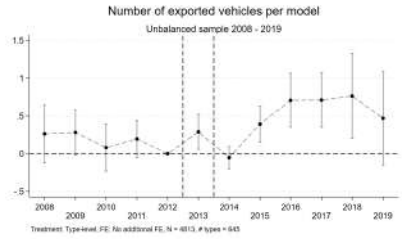
(C) NUMBER OF VEHICLE SOLD (EXPORT MARKET)



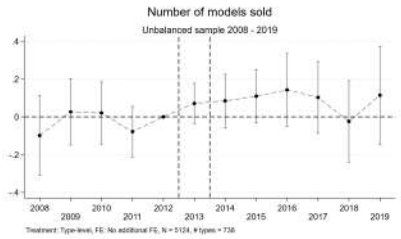
(D) NUMBER OF VEHICLES SOLD PER MODEL



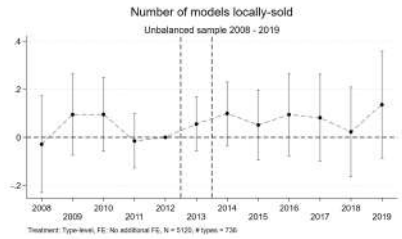
(E) NUMBER OF VEHICLES SOLD PER MODEL (LOCAL MARKET)



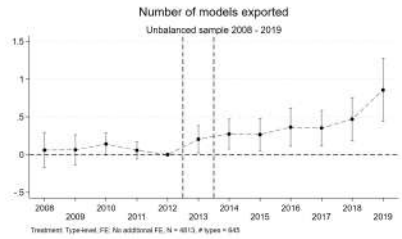
(F) NUMBER OF VEHICLES SOLD PER MODEL (EXPORT MARKET)



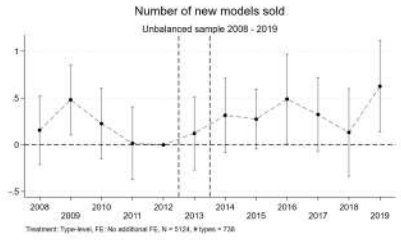
(G) NUMBER OF MODELS SOLD



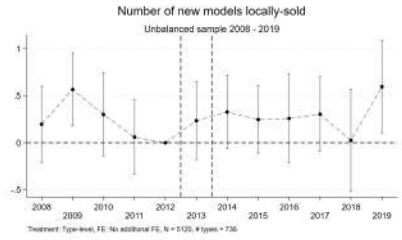
(H) NUMBER OF MODELS SOLD (LOCAL MARKET)



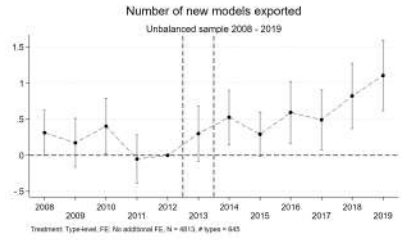
(I) NUMBER OF MODELS SOLD (EXPORT MARKET)



(J) NUMBER OF NEW MODELS SOLD



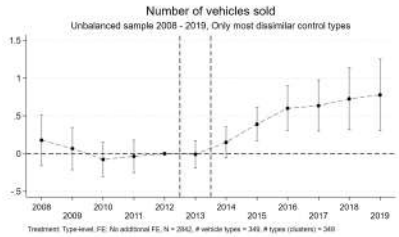
(K) NUMBER OF NEW MODELS SOLD (LOCAL MARKET)



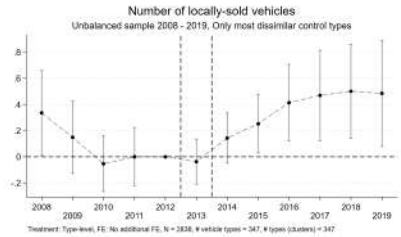
(L) NUMBER OF NEW MODELS SOLD (EXPORT MARKET)

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation Equation (11). Outcome variables are: number of vehicles (row 1), number of vehicles per model (row 2), number of models (row 3), number of new models (row 4). The columns consider different destination markets: all sales (column 1), local sales (column 2), export sales (column 3). The underlying dataset is a weakly-balanced panel at the vehicle type level, with imputed zero sales in years in-between the first and last year with non-zero reported sales. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (vehicle-type) fixed effects and time fixed effects. All event-study coefficients are estimated relative to 2012 (the pre-treatment year). The treatment indicator is determined by manufacturing vs retailing status, measured over the entire sample period 2008-2019, and defined at the vehicle type level. The standard errors are clustered at the level of treatment variation (vehicle type). Data source: Lightstone SA.

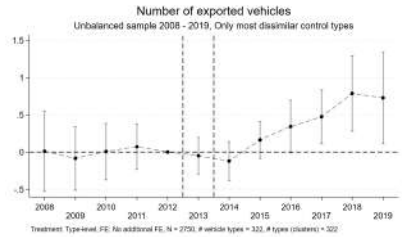
FIGURE 23: LIGHTSTONE SA - EFFECTS ON SALES BY DESTINATION MARKET - TYPE LEVEL TREATMENT - EXCLUDING CONTROL TYPES MOST SIMILAR IN THE PRODUCT SPACE TO TREATMENT TYPES



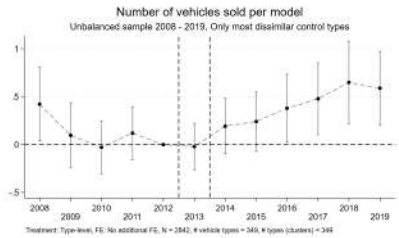
(A) NUMBER OF VEHICLE SOLD



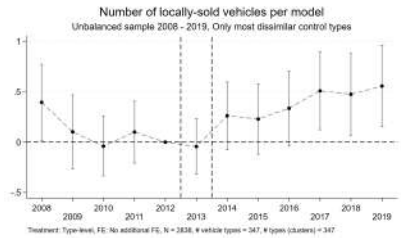
(B) NUMBER OF VEHICLE SOLD (LOCAL MARKET)



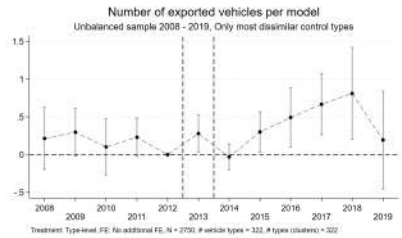
(C) NUMBER OF VEHICLE SOLD (EXPORT MARKET)



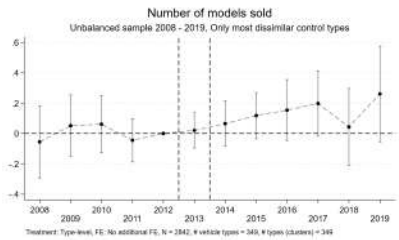
(D) NUMBER OF VEHICLES SOLD PER MODEL



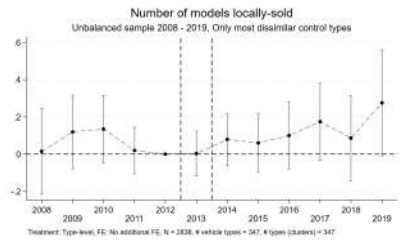
(E) NUMBER OF VEHICLES SOLD PER MODEL (LOCAL MARKET)



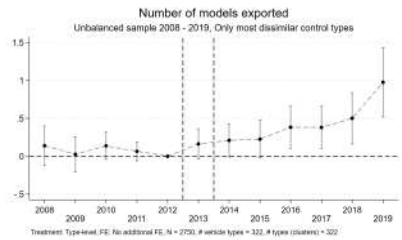
(F) NUMBER OF VEHICLES SOLD PER MODEL (EXPORT MARKET)



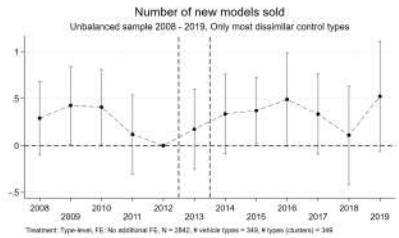
(G) NUMBER OF MODELS SOLD



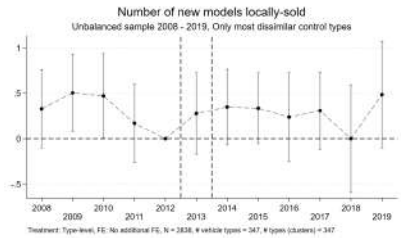
(H) NUMBER OF MODELS SOLD (LOCAL MARKET)



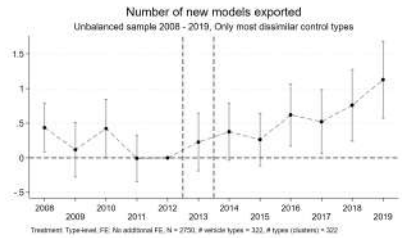
(I) NUMBER OF MODELS SOLD (EXPORT MARKET)



(J) NUMBER OF NEW MODELS SOLD



(K) NUMBER OF NEW MODELS SOLD (LOCAL MARKET)



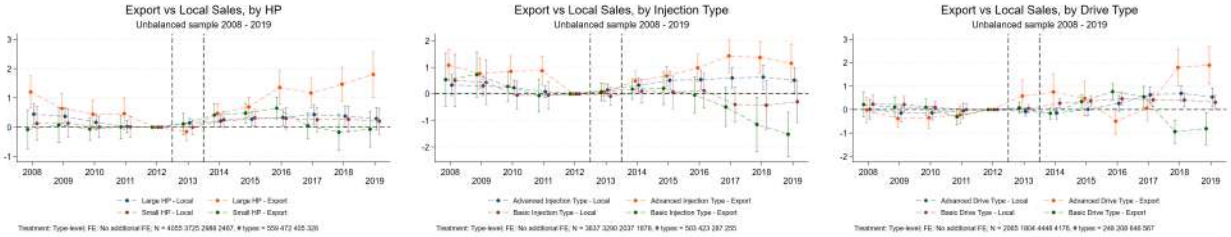
(L) NUMBER OF NEW MODELS SOLD (EXPORT MARKET)

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation Equation (11). The control group excludes vehicle types most similar (above median) in the product space to treatment types; the bilateral measure of similarity only uses information pre-2013 and excludes the brand in the construction of the measure. Outcome variables are: number of vehicles (row 1), number of vehicles per model (row 2), number of models (row 3), number of new models (row 4). The columns consider different destination markets: all sales (column 1), local sales (column 2), export sales (column 3). The underlying dataset is a weakly-balanced panel at the vehicle type level, with imputed zero sales in years in-between the first and last year with non-zero reported sales. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (vehicle-type) fixed effects and time fixed effects. All event-study coefficients are estimated relative to 2012 (the pre-treatment year). The treatment indicator is determined by manufacturing vs retailing status, measured over the entire sample period 2008-2019, and defined at the vehicle type level. The standard errors are clustered at the level of treatment variation (vehicle type). Data source: Lightstone SA.

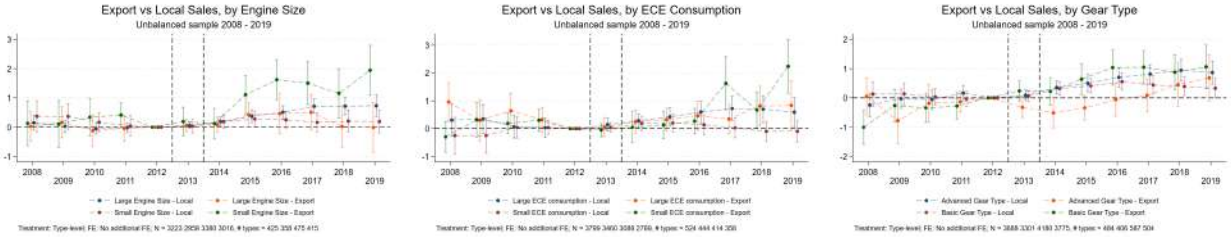
FIGURE 24: LIGHTSTONE SA - HETEROGENEOUS EFFECTS ON SALES BY VEHICLE CHARACTERISTICS AND DESTINATION MARKET - TYPE LEVEL TREATMENT



(A) BY RETAIL PRICE (B) BY GROSS VEHICLE MASS (C) BY KW



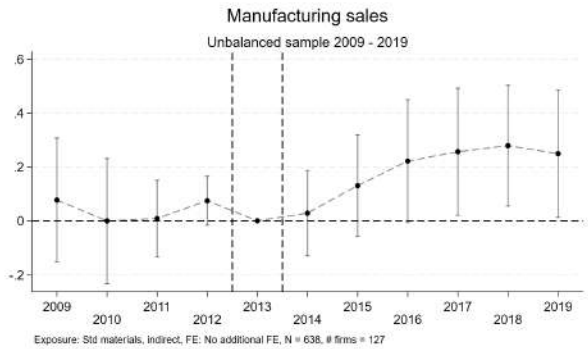
(D) BY HP (E) BY FUEL INJECTION TYPE (F) BY DRIVE TYPE



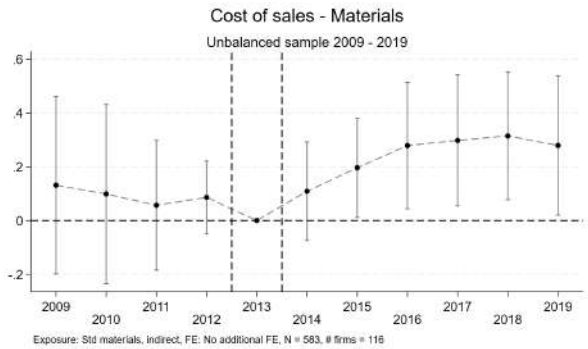
(G) BY ENGINE SIZE (H) BY ECE CONSUMPTION (I) BY GEAR TYPE

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation Equation (11). Outcome variables are: number of vehicles (row 1), number of vehicles per model (row 2), number of models (row 3), number of new models (row 4). The columns consider different destination markets: all sales (column 1), local sales (column 2), export sales (column 3). The underlying dataset is a weakly-balanced panel at the vehicle type level, with imputed zero sales in years in-between the first and last year with non-zero reported sales. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (vehicle-type) fixed effects and time fixed effects. All event-study coefficients are estimated relative to 2012 (the pre-treatment year). The treatment indicator is determined by manufacturing vs retailing status, measured over the entire sample period 2008-2019, and defined at the vehicle type level. The standard errors are clustered at the level of treatment variation (vehicle type). Data source: Lightstone SA.

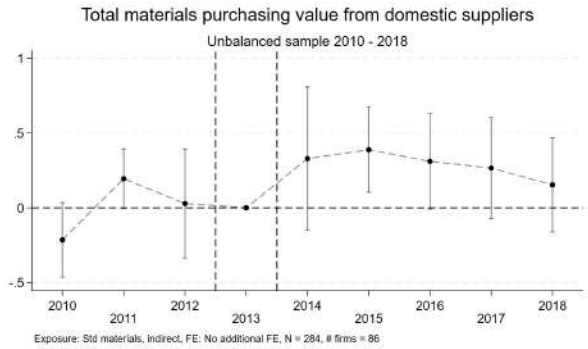
FIGURE 25: SAABC DATA - FIRST-STAGE REGRESSION RESULTS



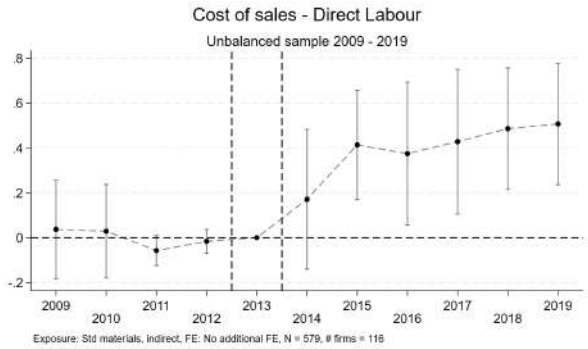
(A) MANUFACTURING SALES



(B) COST OF SALES - MATERIALS



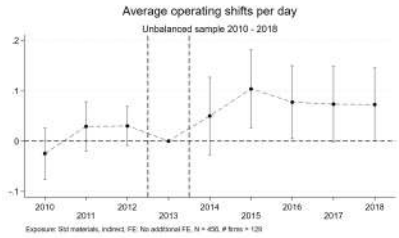
(C) COST OF SALES - MATERIALS (DOMESTIC SUPPLIERS)



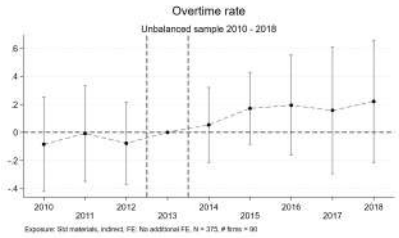
(D) COST OF SALES - LABOUR

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (13). Each point estimate plots the coefficient of the interaction between time fixed effects and a firm-specific time-invariant measure of exposure to the downstream demand shock, as defined in Equation (12). Outcome variables are: manufacturing sales (graph A), expenditure on materials (cost of sales) (graph B), expenditure on materials from domestic suppliers (graph C), expenditure on direct labour (cost of sales) (graph D). All outcomes are winsorized at 1% and 99% by year. The underlying dataset is a weakly-balanced panel at the firm level. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (firm) fixed effects and time fixed effects. All event-study coefficients are estimated relative to 2013, based on the results from Section 8. The standard errors are clustered at the firm level. Data source: South Africa Automotive Benchmarking Club (SAABC).

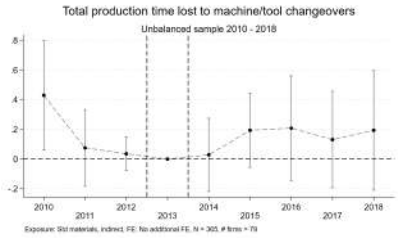
FIGURE 26: SAABC DATA - FIRM ADJUSTMENT TO DEMAND SHOCK



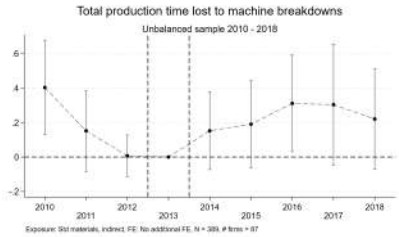
(A) AVERAGE SHIFTS PER DAY



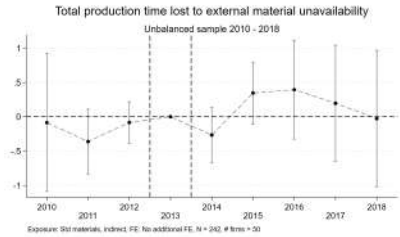
(B) OVERTIME RATE



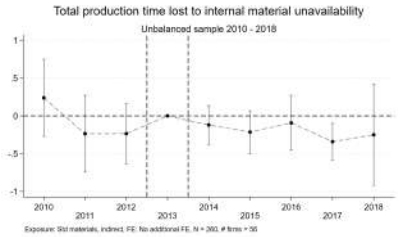
(C) PRODUCTION TIME LOST DUE TO MACHINE CHANGEOVER



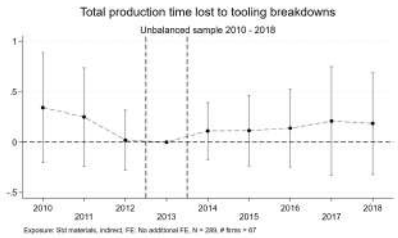
(D) PRODUCTION TIME LOST DUE TO MACHINE BREAKDOWN



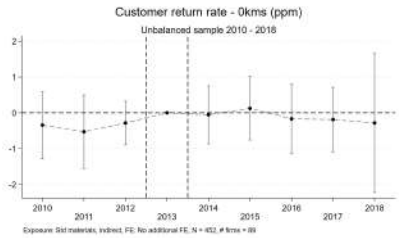
(E) PRODUCTION TIME LOST DUE TO EXTERNAL MATERIALS UNAVAILABILITY



(F) PRODUCTION TIME LOST DUE TO INTERNAL MATERIALS UNAVAILABILITY



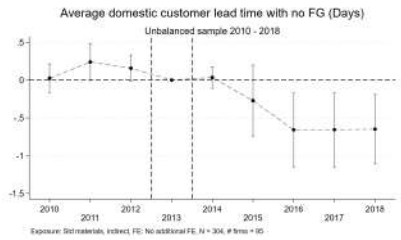
(G) PRODUCTION TIME LOST DUE TO TOOLING BREAKDOWN



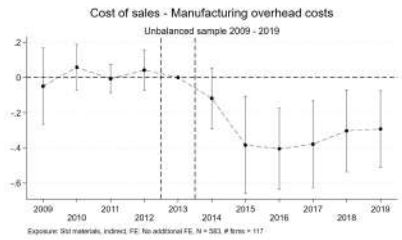
(H) CUSTOMER RETURN RATES

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (13). Each point estimate plots the coefficient of the interaction between time fixed effects and a firm-specific time-invariant measure of exposure to the downstream demand shock, as defined in Equation (12). Outcome variables are: average shifts per day (graph A), overtime rate (graph B), production time lost due to machine changeover (graph C), production time lost due to machine breakdowns (graph D), production time lost due to external materials unavailability (graph E), production time lost due to internal materials unavailability (graph F), production time lost due to tooling breakdowns (graph G), customer return rate (graph H). All outcomes are winsorized at 1% and 99% by year. The underlying dataset is a weakly-balanced panel at the firm level. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (firm) fixed effects and time fixed effects. All event-study coefficients are estimated relative to 2013, based on the results from Section 8. The standard errors are clustered at the firm level. Data source: South Africa Automotive Benchmarking Club (SAABC).

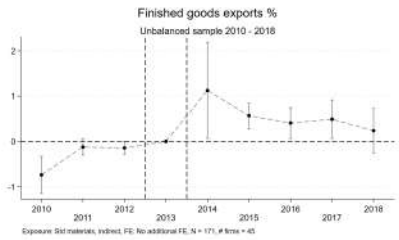
FIGURE 27: SAABC DATA - FIRM UPGRADING OUTCOMES I



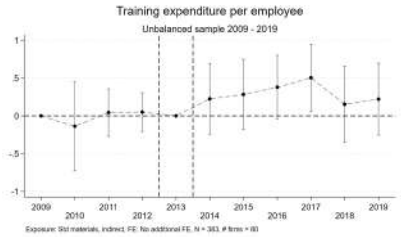
(A) AVERAGE DOMESTIC CUSTOMER LEAD TIME



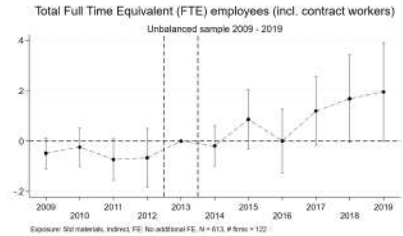
(B) COST OF SALES - MANUFACTURING OVERHEADS



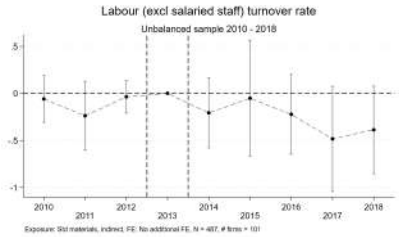
(C) FINISHED GOODS EXPORTS



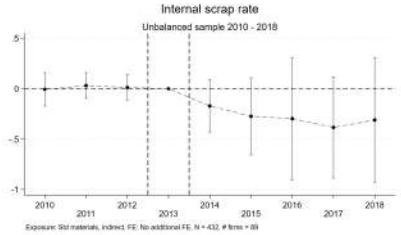
(D) TRAINING EXPENDITURE PER EMPLOYEE



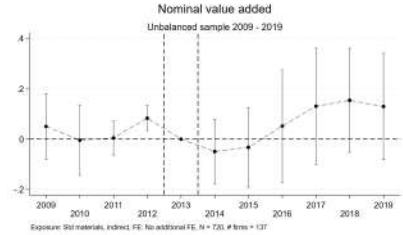
(E) FULL-TIME EMPLOYMENT



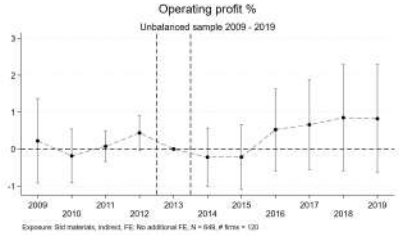
(F) LABOUR TURNOVER RATE



(G) INTERNAL SCRAP RATE



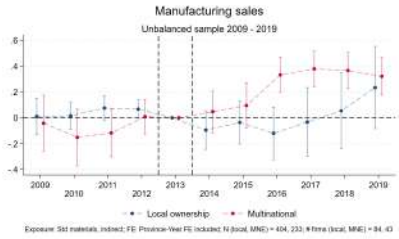
(H) NOMINAL VALUE ADDED



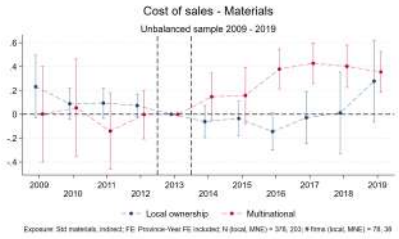
(I) OPERATING PROFIT

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (13). Each point estimate plots the coefficient of the interaction between time fixed effects and a firm-specific time-invariant measure of exposure to the downstream demand shock, as defined in Equation (12). Outcome variables are: average domestic customer lead time (graph A), manufacturing overheads (graph B), share of finished goods exports (graph C), training expenditure per employee (graph D), full-time equivalent employment (graph E), labour turnover rate (graph F), internal scrap rate (graph G), nominal value added (graph H), operating profit (graph I). All outcomes are winsorized at 1% and 99% by year. The underlying dataset is a weakly-balanced panel at the firm level. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (firm) fixed effects and time fixed effects. All event-study coefficients are estimated relative to 2013, based on the results from Section 8. The standard errors are clustered at the firm level. Data source: South Africa Automotive Benchmarking Club (SAABC).

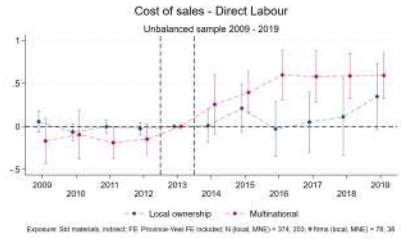
FIGURE 28: SAABC DATA - HETEROGENEITY BY OWNERSHIP STATUS



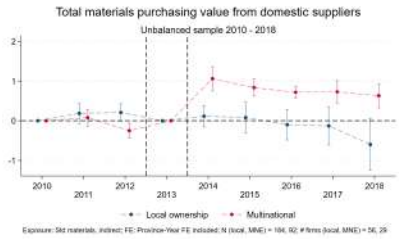
(A) MANUFACTURING SALES



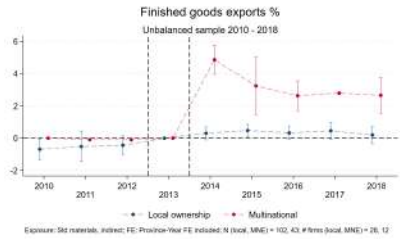
(B) COST OF SALES - MATERIALS



(C) COST OF SALES - LABOUR



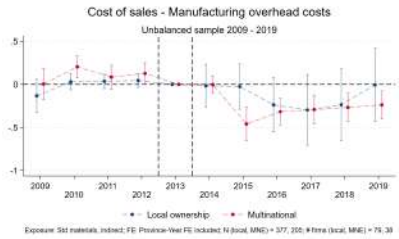
(D) COST OF SALES - MATERIALS (DOMESTIC SUPPLIERS)



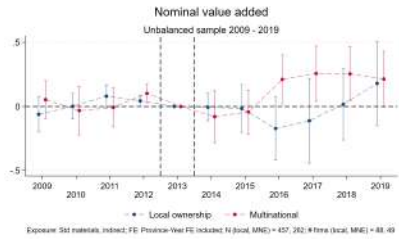
(E) FINISHED GOODS EXPORTS



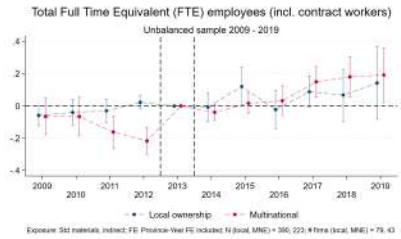
(F) AVERAGE DOMESTIC CUSTOMER LEAD TIME



(G) COST OF SALES - MANUFACTURING OVERHEADS



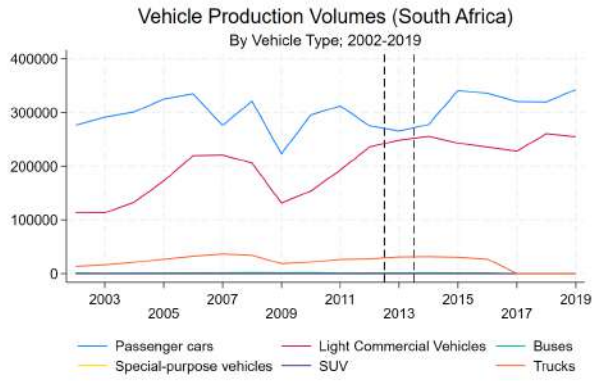
(H) NOMINAL VALUE ADDED



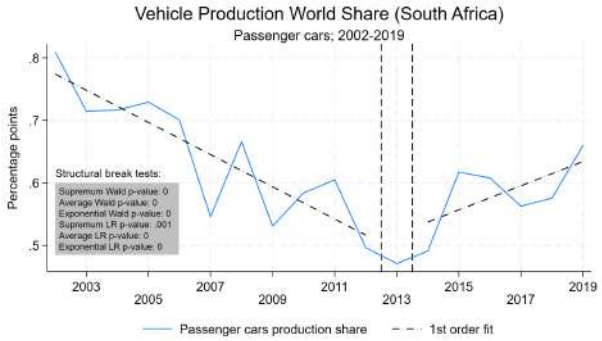
(I) FULL-TIME EMPLOYMENT

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (13), estimated separately for component producers with local and multinational ownership. Each point estimate plots the coefficient of the interaction between time fixed effects and a firm-specific time-invariant measure of exposure to the downstream demand shock, as defined in Equation (12). Outcome variables are: manufacturing sales (graph A), expenditure on materials (cost of sales) (graph B), expenditure on labour (cost of sales) (graph C), expenditure on materials from domestic suppliers (graph D), share of finished goods exports (graph E), average domestic customer lead time (graph F), manufacturing overheads (graph G), nominal value added (graph H), full-time employment (graph I). All outcomes are winsorized at 1% and 99% by year. The underlying dataset is a weakly-balanced panel at the firm level. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (firm) fixed effects and time fixed effects. All event-study coefficients are estimated relative to 2013, based on the results from Section 8. The standard errors are clustered at the firm level. Data source: South Africa Automotive Benchmarking Club (SAABC).

FIGURE 29: MARKLINES DATA - SOUTH AFRICA'S PRODUCTION RESPONSE



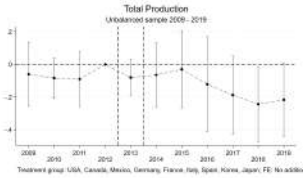
(A) SOUTH AFRICA'S PRODUCTION BY VEHICLE CATEGORY



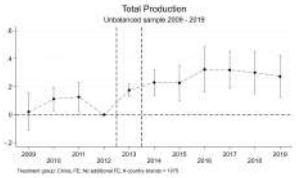
(B) SOUTH AFRICA'S WORLD PRODUCTION SHARE (PASSENGER VEHICLES)

Notes: The graphs above show descriptive evidence on the production response by South Africa around the APDP years. Graph A) plots the time series aggregate production volume for South Africa, distinguishing between: passenger cars, light commercial vehicles, buses, special-purpose vehicles, SUVs and trucks. Graph B) plots the volume of South African passenger cars as a share of world production; the graph also reports p-values for tests of structural break with unknown break date (supremum, average and exponential Wald and likelihood ratio). Data source: Marklines information platform.

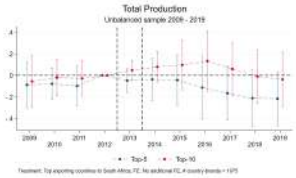
FIGURE 30: MARKLINES DATA - COMPETITORS PRODUCTION RESPONSE



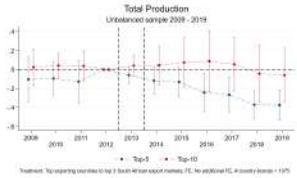
(A) TOTAL PRODUCTION: EUROPE-US-JAPAN-KOREA



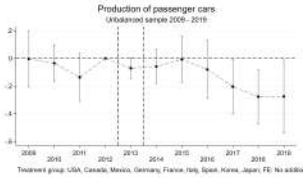
(B) TOTAL PRODUCTION: CHINA



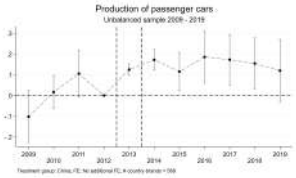
(C) TOTAL PRODUCTION: TOP EXPORTERS TO SA



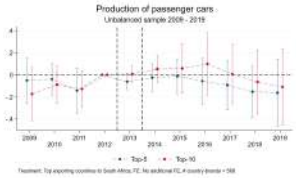
(D) TOTAL PRODUCTION: TOP EXPORTERS TO TOP-3 EXPORT MARKETS FOR SA



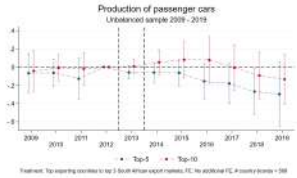
(E) PASSENGER CARS: EUROPE-US-JAPAN-KOREA



(F) PASSENGER CARS: CHINA



(G) PASSENGER CARS: TOP EXPORTERS TO SA

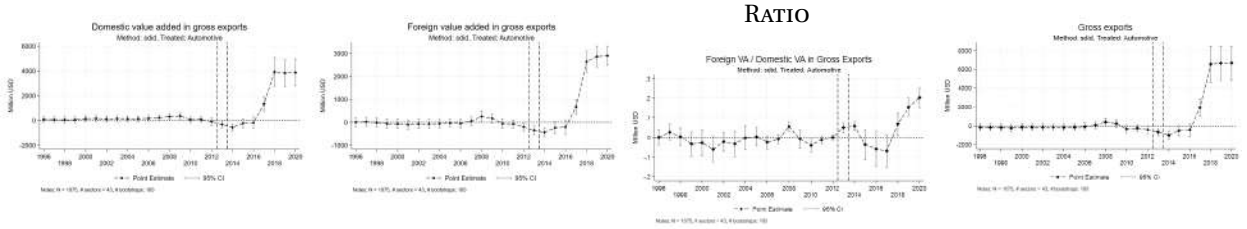


(H) PASSENGER CARS: TOP EXPORTERS TO TOP-3 EXPORT MARKETS FOR SA

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (14). Each point estimate plots the coefficient of the interaction between time fixed effects and a country-specific dummy for competitor countries. Outcome variables are total vehicle production (row 1) and production of passenger cars (row 2). The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include brand, country and time fixed effects. All event-study coefficients are estimated relative to 2012. The standard errors are clustered at the country-of-production level. Data source: Marklines information platform.

Figure 31: Domestic and Foreign Value Added Embodied in Gross Exports

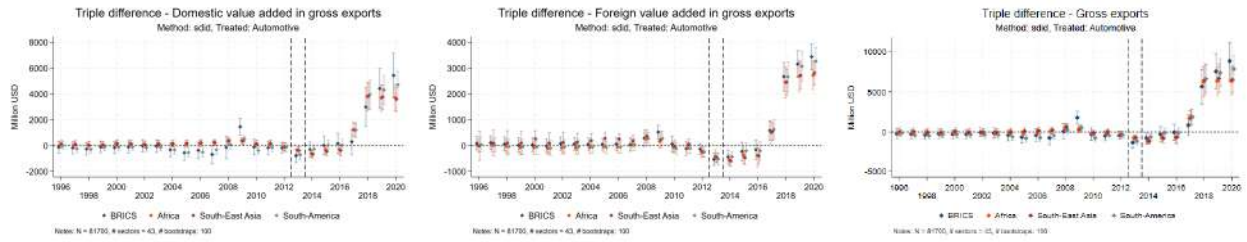
(A) Domestic Value Added (B) Foreign Value Added (C) Foreign-Domestic VA Ratio (D) Exports



Notes: The figures show effects on domestic value added (panel A), foreign value added (panel B), the ratio of foreign and domestic value added embodied in gross exports (panel C), and gross exports (panel D) using sector-level data from TIVA (OECD). Each graph shows event-study estimates using synthetic difference-in-differences (Arkhangelsky et al., 2021). Each coefficient is computed from Equation (15), confidence intervals are computed using a sector-level clustered bootstrap procedure where entire control sectors are re-sampled with replacement. The sample is a sector-level panel spanning 43 industries and excluding sub-sectors in the same 2-digit industry as automotive (manufacture of other transport equipment). Data source: OECD Trade in Value Added (TIVA) database.

Figure 32: Triple Diff: Domestic and Foreign Value Added Embodied in Gross Exports

(A) Domestic Value Added (B) Foreign Value Added (C) Exports



Notes: The figures show effects on domestic value added (panel A), foreign value added (panel B) and gross exports (panel C) embodied in gross exports using sector-level data from TIVA (OECD). Each graph shows event-study estimates using synthetic difference-in-differences (Arkhangelsky et al., 2021) and a country-sector triple difference specification. Each coefficient is computed from Equation (15) and Equation (16), confidence intervals are computed using a country-by-country sector-level clustered bootstrap procedure where entire control sectors are re-sampled with replacement. The sample is a sector-level panel spanning 43 industries and excluding sub-sectors in the same 2-digit industry as automotive (manufacture of other transport equipment). Data source: OECD Trade in Value Added (TIVA) database.

Tables

Table 1: Lighstone SA - Sales-weighted model-level summary statistics

	Vehicle Sale Type			
	Local source - Local sale	Local source - Foreign sale	Foreign source - Local sale	Foreign source - Foreign sale
	(1)	(2)	(3)	(4)
A. Customer Market				
Passenger	0.416	0.640	0.885	0.685
Light-commercial	0.493	0.353	0.095	0.270
Medium-Heavy commercial	0.042	0.003	0.014	0.031
Extra Heavy	0.049	0.004	0.007	0.014
B. Model-year, price and mass				
Model-year	2014.1	2015.1	2014.8	2014.2
Suggested retail price	25.405	36.722	23.809	28.278
Gross vehicle mass	3761.8	1021.7	2046.6	2615.5
C. Engine, power and emissions				
Engine size	2.616	2.102	1.813	2.341
KW	104.8	115.8	99.0	112.2
HP	142.5	157.4	134.7	152.6
ECE consumption	6.346	6.015	6.518	7.189
ECE emissions	154.0	148.8	155.4	176.5
D. Fuel type				
Diesel	0.487	0.427	0.217	0.370
Petrol	0.508	0.568	0.780	0.622
Other	0.004	0.004	0.004	0.007
E. Fuel injection type				
Direct	0.316	0.220	0.409	0.405
Indirect	0.241	0.013	0.380	0.258
Common rail	0.316	0.062	0.171	0.264
Other	0.032	0.001	0.018	0.009
F. Drive type				
AWD	0.105	0.397	0.137	0.332
Not-AWD	0.895	0.603	0.863	0.668
G. Gear type				
Automatic	0.255	0.451	0.379	0.379
Manual	0.745	0.549	0.621	0.621
N (distinct)	4,172	5,075	12,911	7,747
N (total sales)	3,828,008	5,474,833	4,946,786	174,345

Notes: The table reports sales-weighted summary statistics for South Africa's new vehicle sales, distinguishing between: vehicles with local origin and local destination (pure local sales, column 1), vehicles with local origin and foreign destination (exports, column 2), vehicles with foreign origin and local destination (imports, column 3), vehicles with foreign origin and foreign destination (re-exports, column 4). The table presents information on: vehicles' customer market share (panel A), model-year, suggested retail price, and gross vehicle mass (panel B), engine size, engine power and emissions (panel C), fuel type shares (panel D), fuel injection type shares (panel E), drive type shares (panel F), gear type shares (panel G). The price in panel B is expressed in thousand dollars at current exchange rates (June 2026). The category "Other fuel type" includes electric, plug-in hybrid, traditional hybrid and compressed natural gas. The category "Other fuel injection type" includes cases where fuel injection is not available or not provided. The category "Automatic gear type" includes automatic gear and CVT. The table also reports the distinct number of models and the total number of vehicles sold for each column category 1-4. Data source: Lightstone SA 2008-2024.

Table 2: NAACAM Component Manufacturers

	Automotive Tiers			
	Tier 1 only	Tier 1 + 2/3	Tier 2/3 only	All
	(1)	(2)	(3)	(4)
Export status and employment				
Export share	0.796	0.902	0.750	0.780
Number of employees	468.722	446.907	109.364	698.225
Economic Activity				
Manufacture/supply of OE components to MNEs only	0.329	0.446	0.167	0.291
Manufacture/supply of OE components + aftermarket/replacement	0.671	0.768	0.444	0.566
Manufacture of accessories and replacement	0.013	0.250	0.111	0.097
Allied products supplied to MNEs and other sectors	0.118	0.214	0.472	0.194
Support products to the motor industry	0.039	0.107	0.306	0.107
Service providers	0.013	0.054	0.000	0.148
Geography				
Eastern Cape	0.337	0.281	0.333	0.310
Gauteng	0.337	0.351	0.179	0.357
KwaZulu-Natal	0.217	0.298	0.256	0.225
Western Cape	0.060	0.070	0.179	0.080
N	83	57	39	213

Notes: The table reports summary statistics on the South African component manufacturing industry, distinguishing between producers only operating as tier 1 suppliers (column 1), both tier 1 and tier 2/3 suppliers (column 2), and tier 2/3 suppliers only (column 3); column 4 reports summary statistics for the entire sample. Data source: NAACAM member list as published on the NAACAM website.

Table 3: Lighstone SA - Average treatment effects on sales by destination market

	# Vehicles sold			# Vehicles sold per model			# Models sold			# New models sold		
	Total	Export	Domestic	Total	Export	Domestic	Total	Export	Domestic	Total	Export	Domestic
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	9.106	9.752	8.250	6.051	3.857	5.915	2.307	3.111	2.217	1.461	2.416	1.393
	(0.060)	(0.115)	(0.031)	(0.025)	(0.053)	(0.021)	(0.014)	(0.035)	(0.012)	(0.020)	(0.039)	(0.016)
Manufacturer*Post	0.439	0.437	0.230	0.249	0.285	0.239	0.112	0.311	0.048	0.161	0.372	0.076
	(0.143)	(0.182)	(0.109)	(0.126)	(0.133)	(0.127)	(0.069)	(0.101)	(0.066)	(0.127)	(0.134)	(0.116)
RMSE	0.546	0.667	0.497	0.635	0.773	0.625	0.425	0.557	0.425	1.002	0.845	1.011
Pseudo R2	0.929	0.947	0.910	0.829	0.828	0.823	0.544	0.769	0.502	0.420	0.639	0.397
# Clusters	738	645	736	738	645	736	738	645	736	738	645	736
Observations	5,124	4,813	5,120	5,124	4,813	5,120	5,124	4,813	5,120	5,124	4,813	5,120
Unit FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The table reports average treatment effects and complementary regression results from Equation (11). Outcome variables are: number of vehicles (columns 1-3), number of vehicles per model (columns 4-6), number of models (columns 7-9), number of new models (columns 10-12). Within each group, the first column considers the total outcome, while the second and third columns disaggregate each outcome by export and domestic sales. The underlying dataset is a weakly-balanced panel at the vehicle type level, with imputed zero sales in years in-between the first and last year with non-zero reported sales. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (vehicle-type) fixed effects and time fixed effects. The treatment indicator is determined by manufacturing vs retailing status, measured over the entire sample period 2008-2019, and defined at the vehicle type level. The standard errors are clustered at the level of treatment variation (vehicle type). Data source: Lightstone SA.

TABLE 4: LIGHSTONE SA - AVERAGE TREATMENT EFFECTS ON SALES BY DESTINATION MARKET

	# Vehicles sold			# Vehicles sold per model			# Models sold			# New models sold		
	Total	Export	Domestic	Total	Export	Domestic	Total	Export	Domestic	Total	Export	Domestic
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A. Type-level treatment												
Constant	9.106	9.752	8.250	6.051	3.857	5.915	2.307	3.111	2.217	1.461	2.416	1.393
	(0.060)	(0.115)	(0.031)	(0.025)	(0.053)	(0.021)	(0.014)	(0.035)	(0.012)	(0.020)	(0.039)	(0.016)
Manufacturer*Post	0.439	0.437	0.230	0.249	0.285	0.239	0.112	0.311	0.048	0.161	0.372	0.076
	(0.143)	(0.182)	(0.109)	(0.126)	(0.133)	(0.127)	(0.069)	(0.101)	(0.066)	(0.127)	(0.134)	(0.116)
RMSE	0.546	0.667	0.497	0.635	0.773	0.625	0.425	0.557	0.425	1.002	0.845	1.011
Pseudo R2	0.929	0.947	0.910	0.829	0.828	0.823	0.544	0.769	0.502	0.420	0.639	0.397
# Clusters	738	645	736	738	645	736	738	645	736	738	645	736
Observations	5,124	4,813	5,120	5,124	4,813	5,120	5,124	4,813	5,120	5,124	4,813	5,120
Unit FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
B. Make-level treatment												
Constant	9.068	9.705	8.215	6.086	3.878	5.945	2.275	3.078	2.186	1.404	2.356	1.342
	(0.074)	(0.124)	(0.062)	(0.053)	(0.078)	(0.048)	(0.033)	(0.055)	(0.032)	(0.065)	(0.063)	(0.062)
Manufacturer*Post	0.383	0.499	0.193	0.028	0.187	0.020	0.126	0.266	0.094	0.221	0.358	0.170
	(0.129)	(0.191)	(0.120)	(0.119)	(0.158)	(0.109)	(0.075)	(0.106)	(0.075)	(0.173)	(0.135)	(0.169)
RMSE	0.554	0.668	0.499	0.639	0.777	0.628	0.425	0.561	0.425	1.001	0.848	1.011
Pseudo R2	0.927	0.947	0.909	0.827	0.828	0.822	0.544	0.768	0.503	0.420	0.638	0.397
# Clusters	82	76	82	82	76	82	82	76	82	82	76	82
Observations	5,124	4,813	5,120	5,124	4,813	5,120	5,124	4,813	5,120	5,124	4,813	5,120
Unit FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
C. Group-level treatment												
Constant	9.114	9.743	8.262	6.108	3.912	5.963	2.311	3.128	2.224	1.438	2.403	1.380
	(0.091)	(0.149)	(0.083)	(0.064)	(0.084)	(0.061)	(0.050)	(0.063)	(0.049)	(0.109)	(0.076)	(0.103)
Manufacturer*Post	0.289	0.438	0.095	−0.019	0.112	−0.020	0.035	0.157	0.004	0.108	0.237	0.053
	(0.153)	(0.229)	(0.150)	(0.131)	(0.163)	(0.125)	(0.096)	(0.114)	(0.095)	(0.246)	(0.152)	(0.235)
RMSE	0.555	0.668	0.500	0.639	0.778	0.628	0.426	0.563	0.426	1.002	0.850	1.011
Pseudo R2	0.927	0.947	0.909	0.827	0.828	0.822	0.544	0.767	0.502	0.420	0.637	0.396
# Clusters	50	46	50	50	46	50	50	46	50	50	46	50
Observations	5,124	4,813	5,120	5,124	4,813	5,120	5,124	4,813	5,120	5,124	4,813	5,120
Unit FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The table reports average treatment effects and complementary regression results from Equation 11. Outcome variables are: number of vehicles (columns 1-3), number of vehicles per model (columns 4-6), number of models (columns 7-9), number of new models (columns 10-12). Within each group, the first column considers the total outcome, while the second and third columns disaggregate each outcome by export and domestic sales. The underlying dataset is a weakly-balanced panel at the vehicle type level, with imputed zero sales in years in-between the first and last year with non-zero reported sales. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (vehicle-type) fixed effects and time fixed effects. The treatment indicator is determined by manufacturing vs retailing status, measured over the entire sample period 2008-2019, and defined at the vehicle type level (panel A), make level (panel B), automotive group level (panel C). The standard errors are clustered at the level of treatment variation (vehicle type, make and group in panels A, B and C, respectively). Data source: Lightstone SA.

Supplemental Appendix

In Search of Demand Engines: Evidence from South Africa's Automotive Industrial Policy

Matteo Filippi

September 14, 2026

Table of Contents

A Theory Appendix . . . 1
A.1 Main results . . . 1
A.2 Auxiliary results . . . 15
B Appendix Figures . . . 21
C Appendix Tables . . . 41
D Appendix - Additional Results . . . 44
D.1 More Descriptive Evidence . . . 44
E Policy Appendix . . . 46
E.1 The Motor Industry Development Program (MIDP) . . . 46
E.1.1 MIDP: Declining Tariffs, Incentive Size and Effective Rates of Protection 46
E.1.2 MIDP: Channels for Firm Upgrading . . . 47
E.1.3 MIDP: The Productive Asset Allowance (PAA) . . . 49
E.1.4 MIDP: Industry Evolution (1995-2012) . . . 50
E.2 The Automotive Production Development Program (APDP) . . . 54
E.2.1 APDP: The Production Incentive (PI) . . . 55
E.2.2 APDP: The Volume Assembly Allowance (VAA) . . . 60
E.2.3 APDP: The Automotive Investment Scheme (AIS) . . . 63

A Theory Appendix

A.1 Main results

Problem Set-up

The firm maximizes output for given level of total expenditure K:

$$\max_{x_1,x_2,L} A x_1^{\alpha(1-\gamma)} x_2^{(1-\alpha)(1-\gamma)} L^{\gamma} \quad \text{s.t.} \quad p_1 x_1 + p_2 x_2 + p_2 t_2 \max\left\{x_2 - \frac{\psi p q}{(1+\psi)p_2}, 0\right\} + wL \leq K$$

where $q = A x_1^{\alpha(1-\gamma)} x_2^{(1-\alpha)(1-\gamma)} L^{\gamma}$ is output, w is the wage, ψ is the PI policy parameter. Due to CRS, denoting $\beta_1 = \alpha(1-\gamma)$ and $\beta_2 = (1-\alpha)(1-\gamma)$, we have $\beta_1 + \beta_2 + \gamma = 1$. The condition for the kink is $p_2 x_2 \leq \frac{\psi p q}{(1+\psi)}$ or $p_2 x_2 \leq \frac{\psi p A x_1^{\beta_1} x_2^{\beta_2} L^{\gamma}}{(1+\psi)}$. Dividing by x_1 and denoting $r_2 = \frac{x_2}{x_1}$ and $r_L = \frac{L}{x_1}$, we get

$$r_2 \leq \left[\frac{\psi p A}{(1+\psi)p_2}\right]^{\frac{1}{\beta_1+\gamma}} r_L^{\frac{\gamma}{\beta_1+\gamma}}$$

with the exponent $\frac{\gamma}{\beta_1+\gamma}$ positive but less than 1. Note that CRS in production is key to obtain a kink condition that only depends on input ratios r_2 and r_L.

Result 1. *The optimal r_L is identical across the 3 regimes (duty regime with internal solution, duty-free regime with internal solution, kink solution) and equal to $r_L^* = \frac{L}{x_1} = \frac{\gamma}{\beta_1}\frac{p_1}{w}$. The intuition is that the incentives only distort the marginal price of x_2 but never introduce a wedge between x_1 and w; as a result, the optimality condition for L relative to x_1 remains unaffected.*

Proof. A) With an internal solution in the duty-free area, the constraint is $p_1 x_1 + p_2 x_2 + wL \leq K$. The Lagrangian is $\mathcal{L} = A x_1^{\beta_1} x_2^{\beta_2} L^{\gamma} - \lambda[p_1 x_1 + p_2 x_2 + wL - K]$ and the FOCs with respect to x_1, x_2 and L are

$$\begin{aligned}
x_1) \quad & A\beta_1 x_1^{\beta_1-1} x_2^{\beta_2} L^{\gamma} - \lambda p_1 = 0 \Rightarrow \beta_1 \frac{q}{x_1} = \lambda p_1 \\
x_2) \quad & A\beta_2 x_2^{\beta_2-1} x_1^{\beta_1} L^{\gamma} - \lambda p_2 = 0 \Rightarrow \beta_2 \frac{q}{x_2} = \lambda p_2 \\
L) \quad & A\gamma L^{\gamma-1} x_1^{\beta_1} x_2^{\beta_2} - \lambda w = 0 \Rightarrow \gamma \frac{q}{L} = \lambda w
\end{aligned}$$

Dividing foc for x_1 by foc for L: $\frac{\beta_1 \frac{q}{x_1}}{\gamma \frac{q}{L}} = \frac{\lambda p_1}{\lambda w} \Rightarrow \frac{L}{x_1} = \frac{p_1}{w}\frac{\gamma}{\beta_1} \Rightarrow \boxed{r_L^{(*)} = \frac{p_1}{w}\frac{\gamma}{\beta_1}}$

Dividing foc for x_1 by foc for x_2: $\frac{\beta_1 \frac{q}{x_1}}{\beta_2 \frac{q}{x_2}} = \frac{\lambda p_1}{\lambda p_2} \Rightarrow \frac{x_2}{x_1} = \frac{\beta_2}{\beta_1}\frac{p_1}{p_2} \Rightarrow \boxed{r_2^{(*)} = \frac{\beta_2}{\beta_1}\frac{p_1}{p_2}}$

B) With an internal solution in the duty area, the firm pays full duties on units above the kink but earns a rebate for each unit below the threshold $\frac{\psi p q}{(1+\psi)p_2}$. For each of these units, the rebate is equivalent to $p_2 t_2$, so the total rebate amounts to $\frac{\psi p q t_2}{(1+\psi)}$. The effective budget constraint is then $p_1 x_1 + p_2(1+t_2)x_2 -$

$\frac{\psi pqt_2}{(1+\psi)} + wL \leq K$. Using $q = Ax_1^{\beta_1}x_2^{\beta_2}L^{\gamma}$ we obtain the Lagrangian

$$\mathcal{L} = Ax_1^{\beta_1}x_2^{\beta_2}L^{\gamma} - \lambda\Big[p_1x_1 + p_2(1+t_2)x_2 - \frac{\psi pt_2 Ax_1^{\beta_1}x_2^{\beta_2}L^{\gamma}}{(1+\psi)} + wL - K\Big]$$

$$\Rightarrow \mathcal{L} = Ax_1^{\beta_1}x_2^{\beta_2}L^{\gamma}[1 + \underbrace{\frac{\lambda\psi pt_2}{(1+\psi)}}_{\text{scale effect}}] - \lambda\Big[p_1x_1 + p_2(1+t_2)x_2 + wL - K\Big]$$

Intuitively, for a firm choosing to exhaust the duty free endowment at the optimum, the cost savings per unit of output are going to be $\frac{\psi pt_2}{(1+\psi)}$. These costs savings are evaluated at λ, the shadow value of the budget constraint, measuring how much additional output the firm could produce if it had one more unit of budget to spend on inputs. I elaborate on this in Remark 4. Computing the FOCs with respect to x_1, x_2 and L, we obtain:

$$x_1)\ A\beta_1 x_1^{\beta_1-1}x_2^{\beta_2}L^{\gamma}(1 + \frac{\lambda\psi pt_2}{(1+\psi)}) - \lambda p_1 = 0 \Rightarrow \beta_1\tfrac{q}{x_1}(1 + \frac{\lambda\psi pt_2}{(1+\psi)}) = \lambda p_1$$

$$x_2)\ A\beta_2 x_2^{\beta_2-1}x_1^{\beta_1}L^{\gamma}(1 + \frac{\lambda\psi pt_2}{(1+\psi)}) - \lambda p_2(1+t_2) = 0 \Rightarrow \beta_2\tfrac{q}{x_2}(1 + \frac{\lambda\psi pt_2}{(1+\psi)}) = \lambda p_2(1+t_2)$$

$$L)\ A\gamma L^{\gamma-1}x_1^{\beta_1}x_2^{\beta_2}(1 + \frac{\lambda\psi pt_2}{(1+\psi)}) - \lambda w = 0 \Rightarrow \gamma\tfrac{q}{L}(1 + \frac{\lambda\psi pt_2}{(1+\psi)}) = \lambda w$$

Dividing foc for x_1 by foc for L: $\dfrac{\beta_1\frac{q}{x_1}}{\gamma\frac{q}{L}} = \dfrac{p_1}{w} \Rightarrow \boxed{r_L^{(*)} = \dfrac{p_1}{w}\dfrac{\gamma}{\beta_1}}$

Dividing foc for x_1 by foc for x_2: $\dfrac{\beta_1\frac{q}{x_1}}{\beta_2\frac{q}{x_2}} = \dfrac{p_1}{p_2(1+t_2)} \Rightarrow \boxed{r_2^{(*)} = \dfrac{\beta_2}{\beta_1}\dfrac{p_1}{p_2(1+t_2)}}$

C) At the kink, both the budget constraint (with no duty payment) and the kink condition hold simultaneously. The Lagrangian with 2 constraints is:

$$\mathcal{L} = Ax_1^{\beta_1}x_2^{\beta_2}L^{\gamma} - \lambda[p_1x_1 + p_2x_2 + wL - K] - \mu[p_2x_2 - \frac{\psi pAx_1^{\beta_1}x_2^{\beta_2}L^{\gamma}}{(1+\psi)}]$$

Computing the FOCs with respect to x_1, x_2 and L and rearranging we obtain:

$$x_1)\ \beta_1 x_1^{\beta_1-1}Ax_2^{\beta_2}L^{\gamma} - \lambda p_1 + \mu\tfrac{\psi p\beta_1 x_1^{\beta_1-1}Ax_2^{\beta_2}L^{\gamma}}{(1+\psi)} = 0 \quad \Rightarrow \quad \tfrac{\beta_1 q}{x_1}(1 + \tfrac{\mu\psi p}{(1+\psi)}) = \lambda p_1$$

$$x_2)\ \beta_2 x_2^{\beta_2-1}Ax_1^{\beta_1}L^{\gamma} - \lambda p_2 - \mu p_2 + \mu\tfrac{\psi p\beta_2 x_2^{\beta_2-1}Ax_1^{\beta_1}L^{\gamma}}{(1+\psi)} = 0 \quad \Rightarrow \quad \tfrac{\beta_2 q}{x_2}(1 + \tfrac{\mu\psi p}{(1+\psi)}) = p_2(\lambda+\mu)$$

$$L)\ \gamma L^{\gamma-1}Ax_1^{\beta_1}x_2^{\beta_2} - \lambda w + \mu\tfrac{\psi p\gamma L^{\gamma-1}Ax_1^{\beta_1}x_2^{\beta_2}}{(1+\psi)} = 0 \quad \Rightarrow \quad \tfrac{\gamma q}{L}(1 + \tfrac{\mu\psi p}{(1+\psi)}) = \lambda w$$

Dividing foc for x_1 by foc for L: $\dfrac{\beta_1\frac{q}{x_1}(1 + \frac{\mu\psi p}{(1+\psi)})}{\gamma\frac{q}{L}(1 + \frac{\mu\psi p}{(1+\psi)})} = \dfrac{\lambda p_1}{\lambda w} \Rightarrow \dfrac{L}{x_1} = \dfrac{p_1}{w}\dfrac{\gamma}{\beta_1} \Rightarrow \boxed{r_L^{(*)} = \dfrac{p_1}{w}\dfrac{\gamma}{\beta_1}}$

Dividing foc for x_1 by foc for x_2: $\dfrac{\beta_1 \frac{q}{x_1}(1+\frac{\mu\psi p}{(1+\psi)})}{\beta_2 \frac{q}{x_2}(1+\frac{\mu\psi p}{(1+\psi)})} = \dfrac{\lambda p_1}{(\lambda+\mu)p_2} \Rightarrow \boxed{r_2^{(*)} = \dfrac{\beta_2}{\beta_1}\dfrac{p_1}{p_2}\dfrac{\lambda}{\lambda+\mu}}$
which will be solved below in closed form. The results indicate that across all policy regimes A), B) and C), the optimal labor-domestic input ratio is $r_L^{(*)} = \dfrac{p_1}{w}\dfrac{\gamma}{\beta_1}$. □

Corollary 1. *Given the optimal* $r_L^* = \frac{L}{x_1} = \frac{\gamma}{\beta_1}\frac{p_1}{w}$*, which is pinned down independently of the policy regime, the kink reduces to a condition on the relative foreign input intensity. In particular it holds that*

$$r_2^{kink} = \Big[\frac{\psi p A}{(1+\psi)p_2}\Big(\frac{p_1\gamma}{w\beta_1}\Big)^{\gamma}\Big]^{\frac{1}{1-\beta_2}}$$

Proof. Using $L = r_L^* x_1$, we can substitute L in the kink condition $p_2 x_2 = \frac{\psi p A x_1^{\beta_1} x_2^{\beta_2} L^{\gamma}}{(1+\psi)}$ and obtain $p_2 x_2 = \frac{\psi p}{(1+\psi)} A x_1^{\beta_1} x_2^{\beta_2} (r_L^* x_1)^{\gamma} = \frac{\psi p}{(1+\psi)} A x_2^{\beta_2} r_L^{*\gamma} x_1^{\beta_1+\gamma} = \frac{\psi p}{(1+\psi)} A x_2^{\beta_2} r_L^{*\gamma} x_1^{1-\beta_2}$. Therefore $p_2 x_2^{1-\beta_2} = \frac{\psi p}{(1+\psi)} A x_1^{1-\beta_2} r_L^{*\gamma} \Rightarrow \Big(\frac{x_2}{x_1}\Big)^{1-\beta_2} = \frac{\psi p A}{(1+\psi)p_2}\Big(\frac{p_1}{w}\frac{\gamma}{\beta_1}\Big)^{\gamma} \Rightarrow r_2^{\text{kink}} = \Big[\frac{\psi p A}{(1+\psi)p_2}\Big(\frac{p_1}{w}\frac{\gamma}{\beta_1}\Big)^{\gamma}\Big]^{\frac{1}{1-\beta_2}}$.

Problem's Unidimensional Reformulation

The labor to domestic input ratio is constant across regimes: $r_L^* = \frac{\gamma}{\beta_1}\frac{p_1}{w}$. Output is $A x_1^{\beta_1} x_2^{\beta_2} L^{\gamma} = A r_2^{\beta_2} r_L^{*\gamma} x_1 = [A r_L^{*\gamma}] r_2^{\beta_2} x_1$. Using the budget in the duty-free and duty region, we can express x_1 as a function of r_2 to re-formulate the expression for output only in terms of r_2.

A) In the duty-free region, we have $p_1 x_1 + p_2 x_2 + wL = K$ or $p_1 x_1 + p_2 r_2 x_1 + w r_L^* x_1 = K \Rightarrow x_1(p_1 + p_2 r_2 + w r_L^*) = K$ or $x_1(\delta + p_2 r_2) = K$ with $\delta \equiv p_1 + w r_L^*$. Therefore $x_1 = \frac{K}{\delta + p_2 r_2}$ and output is

$$\boxed{Q^{\text{df}}(r_2) = \frac{\kappa r_2^{\beta_2}}{\delta + p_2 r_2}} \quad \text{with} \quad \boxed{\kappa = AK r_L^{*\gamma}}$$

The term δ can also be reformulated as $\delta = p_1 + w(\frac{\gamma}{\beta_1}\frac{p_1}{w}) = p_1(1+\frac{\gamma}{\beta_1}) = p_1\Big(\frac{\beta_1+\gamma}{\beta_1}\Big) \Rightarrow \boxed{\delta = \dfrac{p_1(1-\beta_2)}{\beta_1}}$.

B) In the duty region, the budget is $p_1 x_1 + p_2(1+t_2)x_2 + wL - \frac{\psi p t_2}{(1+\psi)} A x_1^{\beta_1} x_2^{\beta_2} L^{\gamma} = K$ or $p_1 x_1 + p_2(1+t_2) r_2 x_1 + w r_L^* x_1 - x_1 f(r_2) = K$ with $f(r_2) = \frac{\psi p t_2}{(1+\psi)} A (r_L^*)^{\gamma} r_2^{\beta_2}$. Rearranging, we obtain $x_1(p_1 + p_2(1+t_2)r_2 + w r_L^* - f(r_2)) = K \Rightarrow x_1(\delta + p_2(1+t_2)r_2 - f(r_2)) = K$ so that $x_1 = \frac{K}{\delta + p_2(1+t_2)r_2 - f(r_2)}$. Substituting in the expression for output, we obtain $[A r_L^{*\gamma}] r_2^{\beta_2} \frac{K}{\delta + p_2(1+t_2)r_2 - f(r_2)}$ so the final expression is

$$\boxed{Q^{\text{duty}}(r_2) = \frac{\kappa r_2^{\beta_2}}{\delta + p_2(1+t_2)r_2 - f(r_2)}} \quad \text{with} \quad \boxed{\kappa = AK r_L^{*\gamma}}$$

Again, δ can also be reformulated as $\delta = p_1 + w(\frac{\gamma}{\beta_1}\frac{p_1}{w}) = p_1(1+\frac{\gamma}{\beta_1}) = p_1\Big(\frac{\beta_1+\gamma}{\beta_1}\Big) \Rightarrow \boxed{\delta = \dfrac{p_1(1-\beta_2)}{\beta_1}}$.

Therefore, the firm problem can be formulated as $\max_{r_2 \geq 0} Q(r_2)$ where

$$Q(r_2) = \begin{cases} Q^{\text{df}}(r_2) & \text{if } r_2 \leq r_2^{\text{kink}} \\ Q^{\text{duty}}(r_2) & \text{if } r_2 > r_2^{\text{kink}} \end{cases}$$

The firm will optimally choose the level of the foreign input intensity taking into account that different values of r_2 might imply that the firm operates in the duty-free or duty region, thereby affecting the maximum attainable output.

Lemma 1 (Output behavior under the duty-free and duty regime)**.** *Let* $r_2^{df} = \frac{\beta_2}{\beta_1}\frac{p_1}{p_2}$ *and* $r_2^{duty} = \frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)}$.

1. $Q^{df}(r_2)$ *is strictly increasing on* $(0, r_2^{df})$*, strictly decreasing on* (r_2^{df}, ∞)*, and the unique unconstrained maximum is* r_2^{df}.
2. $Q^{duty}(r_2)$ *is strictly increasing on* $(0, r_2^{duty})$*, strictly decreasing on* (r_2^{duty}, ∞)*, and the unique unconstrained maximum is* r_2^{duty}.
3. $r_2^{duty} < r_2^{df}$.

Proof. 1. Consider $Q^{\text{df}}(r_2) = \frac{\kappa r_2^{\beta_2}}{\delta + p_2 r_2}$. Computing the derivative with respect to r_2, we obtain

$$\frac{\partial Q^{\text{df}}(r_2)}{\partial r_2} = \kappa\Big[\frac{\beta_2 r_2^{\beta_2-1}(\delta + p_2 r_2) - r_2^{\beta_2} p_2}{(\delta + p_2 r_2)^2}\Big] = \kappa r_2^{\beta_2-1}\Big[\frac{\beta_2(\delta + p_2 r_2) - r_2 p_2}{(\delta + p_2 r_2)^2}\Big] = \kappa r_2^{\beta_2-1}\Big[\frac{\beta_2\delta - r_2 p_2(1-\beta_2)}{(\delta + p_2 r_2)^2}\Big]$$

The derivative is positive for $\beta_2\delta > r_2 p_2(1-\beta_2)$ or $\beta_2 \frac{p_1(1-\beta_2)}{\beta_1} > r_2 p_2(1-\beta_2) \iff r_2 < \frac{\beta_2}{\beta_1}\frac{p_1}{p_2}$. Therfore, output in the duty-free region is maximized at $\frac{\beta_2}{\beta_1}\frac{p_1}{p_2} = r_2^{\text{df}}$.

2. Consider $Q^{\text{duty}}(r_2) = \frac{\kappa r_2^{\beta_2}}{\delta + p_2(1+t_2)r_2 - f(r_2)}$. Computing the derivative with respect to r_2, we obtain

$$\begin{aligned}
\frac{\partial Q^{\text{duty}}(r_2)}{\partial r_2} &= \frac{\kappa}{\big(\delta + p_2(1+t_2)r_2 - f(r_2)\big)^2}\Big[\beta_2 r_2^{\beta_2-1}(\delta + p_2(1+t_2)r_2 - f(r_2)) - r_2^{\beta_2}\big(p_2(1+t_2) - \tfrac{\psi p t_2}{(1+\psi)}A(r_L^*)^\gamma \beta_2 r_2^{\beta_2-1}\big)\Big] \\
&= \frac{\kappa r_2^{\beta_2-1}}{\big(\delta + p_2(1+t_2)r_2 - f(r_2)\big)^2}\Big[\beta_2(\delta + p_2(1+t_2)r_2 - f(r_2)) - r_2\big(p_2(1+t_2) - \tfrac{\psi p t_2}{(1+\psi)}A(r_L^*)^\gamma \beta_2 r_2^{\beta_2-1}\big)\Big] \\
&= \frac{\kappa r_2^{\beta_2-1}}{\big(\delta + p_2(1+t_2)r_2 - f(r_2)\big)^2}\Big[\beta_2\delta + \beta_2 p_2(1+t_2)r_2 - \beta_2 f(r_2) - r_2 p_2(1+t_2) + \beta_2 f(r_2)\Big]
\end{aligned}$$

The derivative is positive as long as $\beta_2\delta - r_2 p_2(1+t_2)(1-\beta_2) > 0 \iff \frac{p_1(1-\beta_2)\beta_2}{\beta_1} > r_2 p_2(1+t_2)(1-\beta_2) \iff r_2 < \frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)}$. Therefore, output in the duty region is maximized at $\frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)} = r_2^{\text{duty}}$.

3. Immediate as $t_2 > 0$.

Properties of Q at the kink

Lemma 2 (Continuity at r_2^{kink})**.** $Q^{df}(r_2^{kink}) = Q^{duty}(r_2^{kink})$*, i.e.* Q *is continuous at the kink point* r_2^{kink}.

Proof. From the kink condition $p_2 x_2 = \frac{\psi pq}{(1+\psi)}$, rewrite as $p_2 r_2 = \frac{\psi p}{(1+\psi)} A (r_2)^{\beta_2} (r_L)^{\gamma}$. Using $r_L = r_L^*$ and the fact that we are on the kink, we get $p_2 r_2^{\text{kink}} = \frac{\psi p}{(1+\psi)} A (r_2^{\text{kink}})^{\beta_2} (r_L^*)^{\gamma}$. Using the expression for $f(\cdot)$ from before, $f(r_2^{\text{kink}}) = \frac{\psi p}{(1+\psi)} t_2 A (r_2^{\text{kink}})^{\beta_2} (r_L^*)^{\gamma} = p_2 t_2 r_2^{\text{kink}}$. Now evaluate $Q^{\text{df}}(r_2^{\text{kink}})$ and $Q^{\text{duty}}(r_2^{\text{kink}})$:

$$Q^{\text{df}}(r_2^{\text{kink}}) = \frac{\kappa (r_2^{\text{kink}})^{\beta_2}}{\delta + p_2 r_2^{\text{kink}}}, \qquad Q^{\text{duty}}(r_2^{\text{kink}}) = \frac{\kappa (r_2^{\text{kink}})^{\beta_2}}{\delta + p_2 (1+t_2) r_2^{\text{kink}} - p_2 t_2 r_2^{\text{kink}}} = \frac{\kappa (r_2^{\text{kink}})^{\beta_2}}{\delta + p_2 r_2^{\text{kink}}}$$

As the two expressions equal each other, Q is continuous at r_2^{kink}.

Lemma 3 (Sign of the left and right derivatives at r_2^{kink})**.** *Consider $Q(r_2)$. It holds that:*

1. *The sign of the left derivative at r_2^{kink} is $\frac{\partial Q^{df}}{\partial r_2}\Big|_{r_2^{kink}} = \begin{cases} > 0 & \text{if } r_2^{pre} > \frac{r_2^{kink}}{(1+t_2)} \\ \leq 0 & \text{if } r_2^{pre} \leq \frac{r_2^{kink}}{(1+t_2)} \end{cases}$*
2. *The sign of the right derivative at r_2^{kink} is $\frac{\partial Q^{duty}}{\partial r_2}\Big|_{r_2^{kink}} = \begin{cases} > 0 & \text{if } r_2^{pre} > r_2^{kink} \\ \leq 0 & \text{if } r_2^{pre} \leq r_2^{kink} \end{cases}$*
3. *$\frac{\partial Q^{df}}{\partial r_2}\Big|_{r_2^{kink}} > \frac{\partial Q^{duty}}{\partial r_2}\Big|_{r_2^{kink}}$*

Proof. 1. Consider $Q^{\text{df}}(r_2) = \frac{\kappa r_2^{\beta_2}}{\delta + p_2 r_2}$. Differentiating with respect to r_2 and evaluating at r_2^{kink}, we obtain

$$\frac{\partial Q^{\text{df}}(r_2)}{\partial r_2}\Big|_{r_2^{\text{kink}}} = \underbrace{\frac{\kappa (r_2^{\text{kink}})^{\beta_2 - 1}}{(\delta + p_2 r_2^{\text{kink}})^2}}_{>0} (\beta_2 \delta - r_2^{\text{kink}} p_2 (\beta_1 + \gamma))$$

The sign only depends on $\beta_2 \delta - r_2^{\text{kink}} p_2 (\beta_1 + \gamma)$. Using the definition of δ:

$$\beta_2 \frac{p_1 (1-\beta_2)}{\beta_1} - p_2 (1-\beta_2) r_2^{\text{kink}} > 0 \iff \frac{\beta_2 p_1}{\beta_1} - p_2 r_2^{\text{kink}} > 0 \iff r_2^{\text{kink}} < \frac{\beta_2}{\beta_1} \frac{p_1}{p_2} \iff \frac{r_2^{\text{kink}}}{1+t_2} < r_2^{\text{pre}}$$
$$\beta_2 \frac{p_1 (1-\beta_2)}{\beta_1} - p_2 (1-\beta_2) r_2^{\text{kink}} \leq 0 \iff \frac{\beta_2 p_1}{\beta_1} - p_2 r_2^{\text{kink}} \leq 0 \iff r_2^{\text{kink}} \geq \frac{\beta_2}{\beta_1} \frac{p_1}{p_2} \iff \frac{r_2^{\text{kink}}}{1+t_2} \geq r_2^{\text{pre}}$$

2. Consider $Q^{\text{duty}}(r_2) = \frac{\kappa r_2^{\beta_2}}{\delta + p_2 (1+t_2) r_2 - f(r_2)}$. Differentiating with respect to r_2 and evaluating at r_2^{kink}, we obtain

$$\frac{\partial Q^{\text{duty}}(r_2)}{\partial r_2}\Big|_{r_2^{\text{kink}}} = \underbrace{\frac{\kappa r_2^{\beta_2 - 1}}{\left(\delta + p_2 (1+t_2) r_2 - f(r_2^{\text{kink}})\right)^2}}_{>0} (\beta_2 \delta - r_2^{\text{kink}} p_2 (1+t_2)(1-\beta_2))$$

The sign only depends on $\beta_2 \delta - r_2^{\text{kink}} p_2 (1+t_2)(1-\beta_2)$. Using the definition of δ:

$$\beta_2 \frac{p_1 (1-\beta_2)}{\beta_1} - r_2^{\text{kink}} p_2 (1+t_2)(1-\beta_2) > 0 \iff r_2^{\text{kink}} < \frac{\beta_2}{\beta_1} \frac{p_1}{p_2 (1+t_2)} \iff r_2^{\text{pre}} > r_2^{\text{kink}}$$
$$\beta_2 \frac{p_1 (1-\beta_2)}{\beta_1} - r_2^{\text{kink}} p_2 (1+t_2)(1-\beta_2) \leq 0 \iff r_2^{\text{kink}} \geq \frac{\beta_2}{\beta_1} \frac{p_1}{p_2 (1+t_2)} \iff r_2^{\text{pre}} \leq r_2^{\text{kink}}$$

3. Defining $D \equiv \delta + p_2 r_2^{\text{kink}}$ and $V = \kappa (r_2^{\text{kink}})^{\beta_2 - 1}$ we obtain from point 1):

$$\frac{\partial Q^{\text{df}}(r_2)}{\partial r_2}\Big|_{r_2^{\text{kink}}} = \frac{V}{D^2}(\beta_2 \delta - r_2^{\text{kink}} p_2 (\beta_1 + \gamma))$$

Before obtaining the right derivative, recall that $f(r_2) = \frac{\psi t_2 p}{(1+\psi)} A (r_L^*)^\gamma (r_2)^{\beta_2}$ so $f(r_2^{\text{kink}}) = \frac{\psi t_2 p}{(1+\psi)} A (r_L^*)^\gamma (r_2^{\text{kink}})^{\beta_2}$. From the kink condition $p_2 r_2^{\text{kink}} = \frac{\psi p}{(1+\psi)} A (r_2^{\text{kink}})^{\beta_2} (r_L^*)^\gamma$ we obtain $f(r_2^{\text{kink}}) = t_2 p_2 r_2^{\text{kink}}$. Moreover $f'(r_2) = \frac{\psi t_2 p}{(1+\psi)} A (r_L^*)^\gamma \beta_2 r_2^{\beta_2 - 1}$ so $f'(r_2^{\text{kink}}) = \frac{\psi t_2 p}{(1+\psi)} A (r_L^*)^\gamma \beta_2 (r_2^{\text{kink}})^{\beta_2 - 1}$. Substituting $\frac{\psi p}{(1+\psi)} A (r_L^*)^\gamma (r_2^{\text{kink}})^{\beta_2}$ from the kink condition: $f'(r_2^{\text{kink}}) = t_2 \beta_2 p_2 \frac{r_2^{\text{kink}}}{r_2^{\text{kink}}} \Rightarrow f'(r_2^{\text{kink}}) = \beta_2 t_2 p_2$.

$$Q^{\text{duty}}(r_2) = \frac{\kappa r_2^{\beta_2}}{\delta + p_2(1+t_2) r_2 - f(r_2)} = \frac{\kappa r_2^{\beta_2}}{g(r_2)} \qquad \text{where } g(r_2) = \delta + p_2(1+t_2) r_2 - f(r_2)$$

$$\frac{\partial Q^{\text{duty}}(r_2)}{\partial r_2} = \kappa \Big[\frac{\beta_2 r_2^{\beta_2 - 1} g(r_2) - r_2^{\beta_2} g'(r_2)}{(g(r_2))^2} \Big] = \kappa r_2^{\beta_2 - 1} \Big[\frac{\beta_2 g(r_2) - r_2 g'(r_2)}{(g(r_2))^2} \Big]$$

Using the expressions for $f(r_2^{\text{kink}})$ and $f'(r_2^{\text{kink}})$, note that

- $g(r_2^{\text{kink}}) = \delta + p_2(1+t_2) r_2^{\text{kink}} - f(r_2^{\text{kink}}) = \delta + p_2(1+t_2) r_2^{\text{kink}} - t_2 p_2 r_2^{\text{kink}} = \delta + p_2 r_2^{\text{kink}} = D$
- $g'(r_2^{\text{kink}}) = p_2(1+t_2) - f'(r_2^{\text{kink}}) = p_2(1+t_2) - \beta_2 t_2 p_2 = p_2(1 + t_2(1-\beta_2)) = p_2(1 + t_2(\beta_1 + \gamma))$

Then

$$\begin{aligned} \frac{\partial Q^{\text{duty}}(r_2)}{\partial r_2}\Big|_{r_2^{\text{kink}}} &= \overbrace{\frac{\kappa (r_2^{\text{kink}})^{\beta_2 - 1}}{D^2}}^{=V} \Big[\beta_2 D - r_2^{\text{kink}} p_2 (1 + t_2(\beta_1 + \gamma)) \Big] \\ &= \frac{V}{D^2} \Big[\beta_2 \delta - (\beta_1 + \gamma) [p_2 r_2^{\text{kink}}] (1 + t_2) \Big] \end{aligned}$$

Then

$$\frac{\partial Q^{\text{df}}}{\partial r_2}\Big|_{r_2^{\text{kink}}} - \frac{\partial Q^{\text{duty}}}{\partial r_2}\Big|_{r_2^{\text{kink}}} = \frac{V}{D^2} \Big[(\beta_1 + \gamma) p_2 r_2^{\text{kink}} (1+t_2) - (\beta_1 + \gamma) p_2 r_2^{\text{kink}} \Big] = \frac{V}{D^2} (\beta_1 + \gamma) p_2 r_2^{\text{kink}} t_2 > 0$$

□

Result 2 (Optimal sorting into policy regimes)**.** *Let* $r_2^{pre} = \frac{\beta_2}{\beta_1} \frac{p_1}{p_2(1+t_2)}$. *Then it results that:*

- *If* $\frac{r_2^{kink}}{1+t_2} < r_2^{pre} < r_2^{kink}$, *the firm optimally moves to the kink:* $r_2^{post} = r_2^{kink} = \Big[\frac{\psi p A}{(1+\psi) p_2} \Big(\frac{p_1 \gamma}{w \beta_1} \Big)^\gamma \Big]^{\frac{1}{1-\beta_2}}$
- *If* $r_2^{pre} \leq \frac{r_2^{kink}}{1+t_2}$, *the firm optimally operates in a duty-free regime:* $r_2^{post} = r_2^{df} = \frac{\beta_2}{\beta_1} \frac{p_1}{p_2}$
- *If* $r_2^{pre} \geq r_2^{kink}$, *the firm optimally operates in a duty regime:* $r_2^{post} = r_2^{duty} = \frac{\beta_2}{\beta_1} \frac{p_1}{p_2(1+t_2)}$

Proof.

1. Consider the range of r_2^{pre} s.t. $\frac{r_2^{\text{kink}}}{1+t_2} < r_2^{\text{pre}} < r_2^{\text{kink}}$. In this range we have $r_2^{\text{kink}} > r_2^{\text{pre}}$ and $r_2^{\text{kink}} < r_2^{\text{pre}}(1+t_2)$, so $r_2^{\text{pre}} < r_2^{\text{kink}} < r_2^{\text{pre}}(1+t_2)$. Since $r_2^{\text{kink}} < r_2^{\text{pre}}(1+t_2) = \frac{\beta_2}{\beta_1} \frac{p_1}{p_2} = r_2^{df}$, the kink falls to the left of the duty free peak r_2^{df}. Therefore, by Lemma 1, Q^{df} is still increasing at r_2^{kink} so the left derivative

must be strictly positive; moreover, still by Lemma 1, Q^{df} is increasing on $(0, \frac{\beta_2}{\beta_1}\frac{p_1}{p_2})$ so the derivative must be positive on the entire interval $(0, r_2^{\text{kink}})$. Additionally, since $r_2^{\text{kink}} > r_2^{\text{pre}} = \frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)} = r_2^{duty}$, the kink falls to the right of the duty peak r_2^{duty}. Therefore, by Lemma 1, Q^{duty} is already decreasing at r_2^{kink} and the right derivative must be strictly negative; moreover, still by Lemma 1, Q^{duty} is decreasing on $(\frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)}, \infty)$ so it is also decreasing on the entire interval $(r_2^{\text{kink}}, \infty)$. In summary, Q is strictly increasing up to r_2^{kink} and strictly decreasing after; the firm loses by moving in any direction from the kink, and r_2^{kink} must be the unique global optimum.

2. Consider the range of r_2^{pre} s.t. $r_2^{\text{pre}} \leq \frac{r_2^{\text{kink}}}{1+t_2}$, which is equivalent to $r_2^{\text{kink}} \geq (1+t_2) r_2^{\text{pre}} = \frac{\beta_2}{\beta_1}\frac{p_1}{p_2} = r_2^{\text{df}}$. Since $r_2^{\text{kink}} \geq r_2^{\text{df}}$, here the kink falls at or to the right of the duty free peak r_2^{df}, therefore by Lemma 1 Q^{df} is non increasing at r_2^{kink} and the left derivative at r_2^{kink} is ≤ 0. Moreover, by Lemma 3 part (iii) the right derivative is strictly less than the left derivative, which is weakly negative, so it must be strictly negative. As $r_2^{\text{kink}} \geq \frac{\beta_2}{\beta_1}\frac{p_1}{p_2} > \frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)} = r_2^{\text{duty}}$, r_2^{kink} is located to the right of the duty peak r_2^{duty}, therefore by Lemma 1 Q^{duty} is strictly decreasing on the entire duty segment $[r_2^{\text{kink}}, \infty)$. By Lemma 2, Q is continuous at r_2^{kink}, implying that Q can weakly increase by lowering r_2 and no point in $[r_2^{\text{kink}}, \infty)$ can be optimal. In the duty free segment, the unconstrained peak is reached at $\frac{\beta_2}{\beta_1}\frac{p_1}{p_2}$ and the r_2^{kink} is weakly above this level; then this global max is feasible and the global maximum is achieved at $\frac{\beta_2}{\beta_1}\frac{p_1}{p_2} = r_2^{\text{df}}$.

3. Consider the range $r_2^{\text{pre}} \geq r_2^{\text{kink}}$, which means $r_2^{\text{kink}} \leq r_2^{\text{duty}} = \frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)} < \frac{\beta_2}{\beta_1}\frac{p_1}{p_2} = r_2^{\text{df}}$. Since $r_2^{\text{kink}} \leq r_2^{\text{duty}}$, the kink falls at or to the left of the duty peak; by Lemma 1 Q^{duty} is non-decreasing at r_2^{kink} and the right derivative is ≥ 0. By Lemma 3 part (iii) the left derivative is strictly greater than the right derivative, so it must be strictly positive. As by Lemma 1 Q^{df} is strictly increasing anywhere on $[0, r_2^{\text{df}})$ and $r_2^{\text{kink}} < r_2^{\text{df}}$, Q^{df} is strictly increasing on $[0, r_2^{\text{kink}}]$. By Lemma 2, Q is continuous at r_2^{kink}, implying that Q can weakly increase by increasing r_2 and no point in $[0, r_2^{\text{kink}}]$ can be the global optimum. On the duty segment, Q^{duty} achieves the unconstrained peak at $\frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)} = r_2^{\text{pre}}$ and r_2^{kink} is below this level; this implies that the unconstrained optimum is feasible and therefore the global optimum is $\frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)} = r_2^{\text{duty}}$. □

Comparison of the pre-post conditional input demands by regime

Using expressions from Result 5 in Section A.2, the conditional input demands (for given cost K) in the no policy benchmark are $x_1^{\text{pre}} = \frac{\beta_1 K}{p_1}$, $x_2^{\text{pre}} = \frac{\beta_2 K}{p_2(1+t_2)}$, $L^{\text{pre}} = \frac{\gamma K}{w}$.

A) Duty-free regime: from Result 2, a firm satisfying $r_2^{\text{pre}} \leq \frac{r_2^{\text{kink}}}{1+t_2}$ sorts into the duty-free regime, with post-policy conditional input demands $x_1^{\text{df}} = \frac{\beta_1 K}{p_1}$, $x_2^{\text{df}} = \frac{\beta_2 K}{p_2}$, $L^{\text{df}} = \frac{\gamma K}{w}$ (see Result 5 in Section A.2). The changes in demand relative to the no policy benchmark are

$$\frac{x_1^{\text{df}}}{x_1^{\text{pre}}} = 1, \qquad \frac{L^{\text{df}}}{L^{\text{pre}}} = 1, \qquad \frac{x_2^{\text{df}}}{x_2^{\text{pre}}} = 1 + t_2$$

Therefore, only demand for the imported input increases by a factor $(1+t_2)$, with the effect entirely driven by a relative price effect due to the custom duty rebate on x_2; in contrast, demand for the domestic input x_1 and L are unchanged. This is due to Cobb Douglas production function, resulting in an income

and substitution effects on L and x_1 perfectly offsetting each other.

B) Duty regime: from Result 2, a firm satisfying $r_2^{\text{pre}} \geq r_2^{\text{kink}}$ sorts into the duty regime, with post-policy conditional demands given by $x_1^{\text{duty}} = \frac{\beta_1 K^{\text{eff}}}{p_1}$, $x_2^{\text{duty}} = \frac{\beta_2 K^{\text{eff}}}{p_2(1+t_2)}$, $L^{\text{duty}} = \frac{\gamma K^{\text{eff}}}{w}$ where $K^{\text{eff}} = \frac{\beta_1 K}{p_1 - \beta_1 \Psi}$ is the effective budget and $\Psi = \frac{\psi p t_2}{(1+\psi)} A (r_2^{\text{pre}})^{\beta_2} (r_L^*)^{\gamma} > 0$ is the rebate per unit of x_1 (see Result 5 in Section A.2). The changes in demand relative to the no policy benchmark are

$$\frac{x_1^{\text{duty}}}{x_1^{\text{pre}}} = \frac{K^{\text{eff}}}{K}, \qquad \frac{x_2^{\text{duty}}}{x_2^{\text{pre}}} = \frac{K^{\text{eff}}}{K}, \qquad \frac{L^{\text{duty}}}{L^{\text{pre}}} = \frac{K^{\text{eff}}}{K}$$

Therefore, in the duty region, scale is enhanced by a factor $\frac{K^{\text{eff}}}{K} > 1$ while the input mix is unaffected. The reason is that the relative input prices remain unchanged, and only the effective budget shifts due to the infra-marginal units of x_2 up to the kink providing rebates Ψx_1. As a result, the firms receives an effective income boost expanding the affordable set of inputs uniformly.

C) Kink regime: from Result 2, a firm satisfying $\frac{r_2^{\text{kink}}}{1+t_2} < r_2^{\text{pre}} < r_2^{\text{kink}}$ sorts into the kink regime, with post-policy demands given by $x_1^{\text{kink}} = \frac{K}{D^{\text{kink}}}$, $x_2^{\text{kink}} = \frac{r_2^{\text{kink}} K}{D^{\text{kink}}}$, $L^{\text{kink}} = \frac{r_L^* K}{D^{\text{kink}}}$ where $D^{\text{kink}} = p_1 + p_2 r_2^{\text{kink}} + w r_L^*$ (see Result 5 in Section A.2). Define $\mu = \frac{x_1^{\text{kink}}}{x_1^{\text{pre}}} = \frac{p_1}{\beta_1 D^{\text{kink}}}$. Using the definition of r_L^*, we obtain $\frac{L^{\text{kink}}}{L^{\text{pre}}} = \frac{r_L^* K}{D^{\text{kink}}} \frac{w}{\gamma K} = \frac{p_1}{\beta_1 D^{\text{kink}}}$, therefore $\mu = \frac{x_1^{\text{kink}}}{x_1^{\text{pre}}} = \frac{L^{\text{kink}}}{L^{\text{pre}}}$. Using the definition of D^{kink}, it follows that $\mu > 1 \iff p_1 > \beta_1 p_1 + \beta_1 p_2 r_2^{\text{kink}} + \beta_1 w r_L^*$ where $r_L^* = \frac{\gamma}{\beta_1} \frac{p_1}{w} \Rightarrow \beta_1 w r_L^* = \gamma p_1$. Then $\mu > 1 \iff p_1 > p_1(\beta_1 + \gamma) + \beta_1 p_2 r_2^{\text{kink}} \iff p_1 > p_1(1-\beta_2) + \beta_1 p_2 r_2^{\text{kink}} \iff \beta_2 p_1 > \beta_1 p_2 r_2^{\text{kink}} \iff r_2^{\text{kink}} < \frac{\beta_2 p_1}{\beta_1 p_2} \iff \frac{r_2^{\text{kink}}}{(1+t_2)} < r_2^{\text{pre}}$ which holds for firms sorting in the kink regime. As a consequence, both labor and x_1 increase in the same proportion. Regarding x_2, define $\rho = \frac{r_2^{\text{kink}}}{r_2^{\text{pre}}} = \frac{x_2^{\text{kink}}/x_1^{\text{kink}}}{x_2^{\text{pre}}/x_1^{\text{pre}}} = \frac{x_2^{\text{kink}}}{x_1^{\text{kink}}} \frac{x_1^{\text{pre}}}{x_2^{\text{pre}}} = \frac{x_2^{\text{kink}}}{x_2^{\text{pre}}} \frac{x_1^{\text{pre}}}{x_1^{\text{kink}}}$, so $\frac{x_2^{\text{kink}}}{x_2^{\text{pre}}} = \mu\rho$. Notice that $\rho > 1 \iff r_2^{\text{kink}} > r_2^{\text{pre}}$ which holds for firms sorting in this range. As $\rho > 1$ and $\mu > 1$, we have $\frac{x_2^{\text{kink}}}{x_2^{\text{pre}}} = \mu\rho > \mu > 1$: the foreign input demand increases by a factor larger than μ, which results in an increase of the foreign input intensity. However, it can be shown that, due to the presence of the kink, the proportional increase in x_2 is smaller than under the unconstrained internal solution. Comparing the expressions for $\mu\rho$ and $(1+t_2)$, we obtain $\mu\rho = \frac{x_2^{\text{kink}}}{x_2^{\text{pre}}} = \frac{r_2^{\text{kink}} K}{D^{\text{kink}}} \frac{p_2(1+t_2)}{\beta_2 K} < (1+t_2) \iff p_2 r_2^{\text{kink}} < \beta_2 D^{\text{kink}} = \beta_2(p_1 + p_2 r_2^{\text{kink}} + w r_L^*) \iff (1-\beta_2) p_2 r_2^{\text{kink}} < \beta_2(p_1 + w r_L^*)$. Using $p_1 + w r_L^* = p_1 \left(\frac{\beta_1 + \gamma}{\beta_1} \right)$ we obtain $(\beta_1 + \gamma) p_2 r_2^{\text{kink}} < \beta_2 p_1 \frac{(\beta_1 + \gamma)}{\beta_1} \iff r_2^{\text{kink}} < \frac{\beta_2}{\beta_1} \frac{p_1}{p_2} \iff r_2^{\text{pre}} > \frac{r_2^{\text{kink}}}{1+t_2}$ which holds for firms sorting in the kink regime. Therefore, the key result is

$$1 < \mu < \rho\mu < 1 + t_2$$

Despite all inputs increase, and x_2 increases proportionally more than x_1 and L, the proportional increase in x_2 is smaller than in the duty-free regime. The reason is that the unconditional increase would push the firm in the duty region; in order to save on import duties, the firm reshuffles its input expenditure from x_2 to x_1 and L, which do not cause the firm to cross the threshold. This exactly captures the intuition that in order to avoid the penalty, the firm distorts the unconstrained input choices towards domestic inputs; as a result, x_2 increases by less than the unconditional choice would predict.

Model Solution

In the following, I lie down the solution of a version of the model with a small fixed number of competitive and symmetric final-good firms operating under constant returns to scale, and a larger number of symmetric component producers with market power over their output. The component producers operate under increasing returns and compete against each other according to Cournot competition. The model is partial-equilibrium and delivers equilibrium values for 5 key endogenous variables: final good price p, final good output volume q, domestic input price p_1, domestic input volume q^u, number of domestic component producers N^u. I start by writing down the equilibrium conditions of the model.

1. $\bar{N}^D q = \bar{D} p^{-\eta}$, $\eta > 0$ and $\eta \gtreqless 1$
2. $p = \dfrac{c^{(j)}(p_1)}{A}$, $j \in \{duty, duty\text{-}free, kink\}$
3. $x_1(p_1, q) = \dfrac{q}{A} K^{(j)}(p_1)$, $j \in \{duty, duty\text{-}free, kink\}$
4. $p_1\left(1 - \dfrac{1}{\xi N^u}\right) = \tilde{c}^u$
5. $(p_1 - \tilde{c}^u) q^u = f$ with $q^u = \dfrac{X^u}{N^u}$ and $X^u = \bar{N}^D x_1$

The first condition is market clearing on the final good market: $\bar{N}^D q$ is aggregate supply, $\bar{D} p^{-\eta}$ is demand for the final good. The second condition is the zero profit condition on the final good market, with the marginal cost of 1 unit of final good $\frac{c^{(j)}(p_1)}{A}$ depending on the policy regime. Condition three is the component demand, again depending on the policy regime through $K^{(j)}(p_1)$. The fourth condition is the Cournot FOC, with ξ the elasticity of X_1 (aggregate demand for components) and N^u the number of component producers. Finally, condition five is the zero profit condition / free-entry condition of component producers with equilibrium on component market; here X^u is aggregate supply, $\bar{N}^D x_1$ is aggregate demand for components, f and $\tilde{c}^u$ are the component producers' fixed and marginal cost.

Result 3. *In all policy regimes, the aggregate demand for components can be written as*

$$X_1(p_1) = \psi^{(j)} p_1^{-\xi} \quad \textit{where} \quad \xi = 1 + \beta_1(\eta - 1), \quad j \in \{duty, duty\text{-}free, kink\}$$

In particular, the elasticity of aggregate demand for domestic components is always ξ no matter the regime; the policy regime only affects the demand shifter $\psi^{(j)}$, $j \in \{duty, duty\text{-}free, kink\}$.

Proof.

A) In the no policy benchmark, from Result 6 in Section A.2 the assembler's component demand is $x_1^{\text{pre}}(p_1, q) = q \frac{\beta_1}{A} \frac{c^{\text{pre}}}{p_1}$ where $c^{\text{pre}} = \frac{p_1^{\beta_1}(p_2(1+t_2))^{\beta_2} w^\gamma}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^\gamma}$. Thus, we can write $x_1^{\text{pre}}(p_1, q) = q \frac{\beta_1}{A} p_1^{\beta_1 - 1} K_3$ where $K_3 = \frac{(p_2(1+t_2))^{\beta_2} w^\gamma}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^\gamma}$. From the zero profit condition (ii) we have $p = \frac{c^{\text{pre}}(p_1)}{A} = \frac{p_1^{\beta_1} K_3}{A}$. From (i): $q = \left(\frac{\bar{D}}{\bar{N}^D}\right) p^{-\eta} = \left(\frac{\bar{D}}{\bar{N}^D}\right)\left(\frac{A}{K_3}\right)^\eta p_1^{-\eta\beta_1}$. Substituting into $x_1^{\text{pre}}(p_1, q)$: $x_1^{\text{pre}}(p_1) = \frac{\beta_1}{A} p_1^{\beta_1 - 1} K_3 \left(\frac{\bar{D}}{\bar{N}^D}\right)\left(\frac{A}{K_3}\right)^\eta p_1^{-\eta\beta_1} =$

$\frac{\beta_1 \bar{D}}{\bar{N}^D} A^{\eta-1} K_3^{1-\eta} p_1^{\beta_1(1-\eta)-1}$. Aggregating across $\bar{N}^D$ assemblers:

$$X_1^{(\text{pre})}(p_1) = \bar{N}^D x_1^{\text{pre}}(p_1) = \psi^{\text{pre}} p_1^{-\xi} \quad \text{where} \quad \psi^{\text{pre}} = \beta_1 \bar{D} \Big(\frac{A}{K_3}\Big)^{\eta-1}, \quad \xi = 1-\beta_1(1-\eta) = 1+\beta_1(\eta-1)$$

B) In the duty-free regime, from Result 6 in Section A.2 the assembler's component demand is $x_1^{\text{df}}(p_1,q) = q\frac{\beta_1}{A}\frac{c^{\text{df}}}{p_1}$ where $c^{\text{df}} = \frac{p_1^{\beta_1} p_2^{\beta_2} w^\gamma}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^\gamma}$. Thus, we can write $x_1^{\text{df}}(p_1,q) = q\frac{\beta_1}{A}\frac{p_1^{\beta_1-1} p_2^{\beta_2} w^\gamma}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^\gamma} = q\frac{\beta_1}{A} p_1^{\beta_1-1} K_1$ where $K_1 = \frac{p_2^{\beta_2} w^\gamma}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^\gamma}$. From the zero profit condition (ii) we have $p = \frac{c^{\text{df}}(p_1)}{A} = \frac{p_1^{\beta_1} K_1}{A}$. From the final-good market clearing (i) we have: $q = \Big(\frac{\bar{D}}{\bar{N}^D}\Big) p^{-\eta} = \Big(\frac{\bar{D}}{\bar{N}^D}\Big)\Big(\frac{A}{K_1}\Big)^\eta p_1^{-\eta\beta_1}$. Substituting into $x_1^{\text{df}}(p_1,q)$: $x_1^{\text{df}}(p_1) = \frac{\beta_1}{A} p_1^{\beta_1-1} K_1 \Big(\frac{\bar{D}}{\bar{N}^D}\Big)\Big(\frac{A}{K_1}\Big)^\eta p_1^{-\eta\beta_1} = \frac{\beta_1 \bar{D}}{\bar{N}^D} A^{\eta-1} K_1^{1-\eta} p_1^{\beta_1(1-\eta)-1}$. Aggregating across $\bar{N}^D$ assemblers:

$$X_1^{\text{df}}(p_1) = \bar{N}^D x_1^{\text{df}}(p_1) = \psi^{\text{df}} p_1^{-\xi} \quad \text{where} \quad \psi^{\text{df}} = \beta_1 \bar{D} \Big(\frac{A}{K_1}\Big)^{\eta-1}, \quad \xi = 1-\beta_1(1-\eta) = 1+\beta_1(\eta-1)$$

C) In the duty regime, from Result 6 in Section A.2 the assembler's component demand is $x_1^{\text{duty}}(p_1,q) = q\frac{\beta_1}{A}\frac{c^{\text{duty}}}{p_1}$ where $c^{\text{duty}} = \frac{p_1^{\beta_1}(p_2(1+t_2))^{\beta_2} w^\gamma}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^\gamma}$. Thus, we can write $x_1^{\text{duty}}(p_1,q) = q\frac{\beta_1}{A} p_1^{\beta_1-1} K_3$ where $K_3 = \frac{(p_2(1+t_2))^{\beta_2} w^\gamma}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^\gamma}$. From the zero profit condition (ii) we have $p = \Big(\frac{c^{duty}(p_1)}{A} - \frac{\psi p t_2}{(1+\psi)}\Big)$ so $p(1+\frac{\psi t_2}{(1+\psi)}) = \frac{c^{duty}(p_1)}{A} \Rightarrow p = \frac{c^{duty}(p_1)}{A(1+\frac{\psi t_2}{(1+\psi)})} = \frac{p_1^{\beta_1} K_3}{A(1+\frac{\psi t_2}{(1+\psi)})}$. From (i): $q = \Big(\frac{\bar{D}}{\bar{N}^D}\Big) p^{-\eta} = \Big(\frac{\bar{D}}{\bar{N}^D}\Big)\Big(\frac{A}{K_3}\Big)^\eta (1+\frac{\psi t_2}{(1+\psi)})^\eta p_1^{-\eta\beta_1}$. Substituting into $x_1^{\text{duty}}(p_1,q)$: $x_1^{\text{duty}}(p_1) = \Big(\frac{\bar{D}}{\bar{N}^D}\Big)\Big(\frac{A}{K_3}\Big)^\eta (1+\frac{\psi t_2}{(1+\psi)})^\eta p_1^{-\eta\beta_1} \frac{\beta_1}{A} p_1^{\beta_1-1} K_3$ which equals $\frac{\beta_1 \bar{D}}{\bar{N}^D} A^{\eta-1} K_3^{1-\eta} p_1^{\beta_1(1-\eta)-1} (1+\frac{\psi t_2}{(1+\psi)})^\eta$. Aggregating across $\bar{N}^D$ assemblers:

$$X_1^{\text{duty}}(p_1) = \bar{N}^D x_1^{\text{duty}}(p_1) = \psi^{\text{duty}} p_1^{-\xi} \quad \text{where} \quad \psi^{\text{duty}} = \beta_1 \bar{D} \Big(\frac{A}{K_3}\Big)^{\eta-1} (1+\tfrac{\psi t_2}{(1+\psi)})^\eta, \xi = 1-\beta_1(1-\eta) = 1+\beta_1(\eta-1)$$

D) In the kink regime, recall the kink is $r_2^{\text{kink}} = \Big[\frac{\psi p A}{p_2(1+\psi)}\big(\frac{\gamma}{\beta_1}\frac{p_1}{w}\big)^\gamma\Big]^{\frac{1}{1-\beta_2}} = p^{\frac{1}{1-\beta_2}} p_1^{\frac{\gamma}{1-\beta_2}} \Omega$ where $\Omega = \Big[\frac{\psi A}{p_2(1+\psi)}\big(\frac{\gamma}{\beta_1 w}\big)^\gamma\Big]^{\frac{1}{1-\beta_2}}$. From Result 6 in Section A.2, the assembler's component demand is $x_1^{\text{kink}}(p_1,q) = q\Big(\frac{1}{A(r_2^{\text{kink}})^{\beta_2}(r_L^*)^\gamma}\Big) = \frac{q}{A} p^{-\frac{\beta_2}{1-\beta_2}} p_1^{-\frac{\gamma\beta_2}{1-\beta_2}} \Omega^{-\beta_2}\Big(\frac{\gamma}{\beta_1}\frac{p_1}{w}\Big)^{-\gamma} = \frac{q}{A}\frac{p^{-\frac{\beta_2}{1-\beta_2}} p_1^{-\frac{\gamma}{1-\beta_2}}}{\Lambda}$ where $\Lambda = \Omega^{\beta_2}\Big(\frac{\gamma}{\beta_1 w}\Big)^\gamma$; moreover, from Section A.2 the marginal cost is $\frac{c^{\text{kink}}(p_1)}{A} = \frac{1}{A}\frac{D^{\text{kink}}}{(r_2^{\text{kink}})^{\beta_2}(r_L^*)^\gamma}$ where $D^{\text{kink}} = p_1 + p_2 r_2^{\text{kink}} + w r_L^*$. The assembler zero profit condition gives $p = \frac{c^{\text{kink}}(p_1)}{A} \Rightarrow pA(r_2^{\text{kink}})^{\beta_2}(r_L^*)^\gamma = D^{\text{kink}}$. Using the expression for r_2^{kink}, $pA p^{\frac{\beta_2}{1-\beta_2}} p_1^{\frac{\gamma\beta_2}{1-\beta_2}} \Omega^{\beta_2}\Big(\frac{\gamma}{\beta_1}\frac{p_1}{w}\Big)^\gamma = p_1 + p_2 p^{\frac{1}{1-\beta_2}} p_1^{\frac{\gamma}{1-\beta_2}} \Omega + w\frac{\gamma}{\beta_1}\frac{p_1}{w} \Rightarrow A\Lambda p^{\frac{1}{1-\beta_2}} p_1^{\frac{\gamma}{1-\beta_2}} = p_1\frac{(1-\beta_2)}{\beta_1} + p_2\Omega p^{\frac{1}{1-\beta_2}} p_1^{\frac{\gamma}{1-\beta_2}} \Rightarrow p_1^{\frac{\gamma}{1-\beta_2}} p^{\frac{1}{1-\beta_2}}(A\Lambda - p_2\Omega) = \frac{p_1(1-\beta_2)}{\beta_1} \Rightarrow p^{\frac{1}{1-\beta_2}} = p_1^{\frac{\beta_1}{1-\beta_2}}\frac{(1-\beta_2)}{\beta_1}\frac{1}{(A\Lambda - p_2\Omega)} = p_1^{\frac{\beta_1}{1-\beta_2}}\Pi_2$ where $\Pi_2 = \frac{(1-\beta_2)}{\beta_1(A\Lambda - p_2\Omega)}$. As a result, $p = \Pi_2^{(1-\beta_2)} p_1^{\beta_1}$. From the final-good equilibrium condition (i): $q = \Big(\frac{\bar{D}}{\bar{N}^D}\Big) p^{-\eta} = \Big(\frac{\bar{D}}{\bar{N}^D}\Big)\Pi_2^{-\eta(1-\beta_2)} p_1^{-\eta\beta_1}$. Obtaining aggregate demand and using the expression for p and q, $X_1^{\text{kink}}(p_1) = \bar{N}^D x_1^{\text{kink}}(p_1) = \bar{N}^D \frac{1}{A\Lambda} p^{-\frac{\beta_2}{1-\beta_2}} p_1^{-\frac{\gamma}{1-\beta_2}} \cdot q = \frac{1}{A\Lambda}\bar{D}\Pi_2^{-\eta(1-\beta_2)-\beta_2} p_1^{-(\eta\beta_1 + \frac{\beta_1\beta_2+\gamma}{1-\beta_2})}$. It can be shown that $\eta\beta_1 + \frac{\beta_1\beta_2+\gamma}{1-\beta_2} = \xi$. Therefore, in the kink regime,

aggregate component demand has the form

$$X_1^{\text{kink}}(p_1) = \psi^{\text{kink}} p_1^{-\xi} \quad \text{where} \quad \psi^{\text{kink}} = \frac{1}{A\Lambda} \bar{D} \Pi_2^{-\eta(1-\beta_2)-\beta_2}, \quad \xi = 1 + \beta_1(\eta - 1)$$

Cournot–Free entry system

There are N^u symmetric component producers each choosing q^u to maximize profits taking other firms' output as given. The aggregate component supply is $X_1 = \sum_{i=1}^{N^u} q_i^u$. The inverse demand for components comes from $X_1 = \psi p_1^{-\xi} \Rightarrow p_1(X_1) = \left(\frac{\psi}{X_1}\right)^{\frac{1}{\xi}}$. Each firm maximizes $\Pi_i = p_1(X_1) q_i^u - \tilde{c}^u q_i^u - f$. The foc is $\frac{\partial p_1(X_1)}{\partial X_1} \frac{\partial X_1}{\partial q_i^u} q_i^u + p_1(X_1) - \tilde{c}^u = 0$ with $\frac{\partial p_1(X_1)}{\partial X_1} = \psi^{\frac{1}{\xi}} \left(-\frac{1}{\xi}\right) X_1^{-\frac{1}{\xi}-1} = -\frac{1}{\xi} \psi^{\frac{1}{\xi}} \frac{1}{X_1^{\frac{1}{\xi}}} \frac{1}{X_1} = -\frac{1}{\xi} \frac{p_1(X_1)}{X_1}$ and $\frac{\partial X_1}{\partial q_i^u} = 1$. Therefore we can rewrite the foc as $-\frac{1}{\xi} \frac{p_1(X_1)}{X_1} q_i^u + p_1(X_1) = \tilde{c}^u \Rightarrow p_1(X_1)\left(1 - \frac{q_i^u}{\xi X_1}\right) = \tilde{c}^u$. With symmetric firms, $q_i^u = q^u$ and $X_1 = N^u q^u$ so $\frac{q_i^u}{X_1} = \frac{1}{N^u} \Rightarrow p_1\left(1 - \frac{1}{\xi N^u}\right) = \tilde{c}^u$. Rearranging we get $\frac{p_1 - \tilde{c}^u}{p_1} = \frac{1}{\xi N^u} (\star)$; in addition, free entry implies that $(p_1 - \tilde{c}^u) q^u = f$ or $(p_1 - \tilde{c}^u) \frac{X_1}{N^u} = f (\star\star)$. Substituting the markup in free entry $\Rightarrow \frac{p_1}{\xi N^u} \frac{X_1}{N^u} = f \Rightarrow N^{u2} = \frac{p_1 X_1}{\xi f} = \frac{\psi p_1^{1-\xi}}{\xi f} \Rightarrow N^u = \sqrt{\frac{\psi p_1^{1-\xi}}{\xi f}}$. Substituting back in the Cournot foc we get the equilibrium condition for p_1:

$$\boxed{p_1 - \tilde{c}^u} = \frac{p_1}{\xi N^u} = \frac{p_1}{\xi} \sqrt{\frac{\xi f}{\psi p_1^{1-\xi}}} = p_1 \sqrt{\frac{f}{\psi \xi p_1^{1-\xi}}} = \sqrt{\frac{f}{\psi \xi}} p_1^{1 - \frac{1-\xi}{2}} = \boxed{\sqrt{\frac{f}{\xi \psi}} p_1^{\frac{1+\xi}{2}}} \tag{17}$$

where

$$\frac{1+\xi}{2} = \frac{1+1+\beta_1(\eta-1)}{2} = 1 + \frac{\beta_1(\eta-1)}{2} \Rightarrow \text{sgn}\left(\frac{1+\xi}{2}\right) = \begin{cases} \geq 1 & \text{if } \eta \geq 1 \\ < 1 & \text{if } \eta < 1 \end{cases}$$

Once p_1 is determined via Equation (17), N^u and q^u can be determined from $(\star)$ and $(\star\star)$: $\boxed{N^u = \frac{1}{\xi \mu}}$ where $\mu = \frac{p_1 - \tilde{c}^u}{p_1}$ is the proportional markup, while $\boxed{q^u = \frac{f}{p_1 - \tilde{c}^u}}$. In particular, notice that $\frac{\partial N^u}{\partial p_1} = \frac{1}{\xi} \frac{p_1 - \tilde{c}^u - p_1}{(p_1 - \tilde{c}^u)^2} = -\frac{1}{\xi} \frac{\tilde{c}^u}{(p_1 - \tilde{c}^u)^2} < 0$ and $\frac{\partial q^u}{\partial p_1} < 0$: both N^u and q^u are decreasing in p_1, so provided that a pro-competitive effect exists ($\psi \uparrow \Rightarrow p_1 \downarrow$, i.e. larger demand induces lower equilibrium component prices) we obtain that larger demand induces entry and an increase in scale in the component market.

Existence and uniqueness

From Equation (17), the Cournot model with free entry delivers the equilibrium condition

$$\boxed{F(p_1) = p_1 - \tilde{c}^u - \Theta p_1^{\frac{(1+\xi)}{2}} = 0} \qquad \text{with} \qquad \Theta = \sqrt{\frac{f}{\xi \psi}}$$

I now characterize when a solution exists and is unique depending on whether $\eta > 1, \eta = 1, \eta < 1$. Notice this is equivalent to $\xi > 1, \xi = 1, \xi < 1$. To begin with, consider $p_1 \in (0, +\infty)$ and notice $F(0) = -\tilde{c}^u < 0$ and $F'(p_1) = 1 - \Theta \frac{(1+\xi)}{2} p_1^{\frac{\xi-1}{2}}$.

Case $\eta < 1$**.** F starts negative at $p_1 = 0$. Moreover, $F'(p_1) > 0 \iff \Theta(\frac{1+\xi}{2}) p_1^{\frac{\xi-1}{2}} < 1 \iff p_1 > p_1^{\text{crit}} \equiv \left[(\frac{1+\xi}{2})\Theta\right]^{\frac{2}{1-\xi}} > 0$. So F decreases up to p_1^{crit} and increases afterwards; moreover, $\lim_{p_1 \to \infty} F(p_1) = \lim_{p_1 \to \infty} p_1(1 - \Theta p_1^{\frac{\xi-1}{2}}) - \tilde{c}^u = +\infty$ as $\frac{\xi-1}{2} < 0$, and $F(p_1)$ is continuous in p_1. By the intermediate value theorem, the function crosses 0 exactly once and for any f and ψ there exists a unique solution.

Case $\eta = 1$**.** F starts negative at $p_1 = 0$. Moreover, $F'(p_1) > 0 \iff (1 - \Theta) > 0 \iff \sqrt{\frac{f}{\xi\psi}} < 1 \iff f < \psi$. $F(p_1)$ is continuous and $\lim_{p_1 \to \infty} F(p_1) = \lim_{p_1 \to \infty} p_1(1 - \Theta) - \tilde{c}^u =$

$$\begin{cases} +\infty & \text{if } \Theta < 1 \\ -\tilde{c}^u & \text{if } \Theta = 1 \\ -\infty & \text{if } \Theta > 1 \end{cases}$$

If $(1 - \Theta) > 0$ i.e. $\Theta < 1$, the function F is strictly increasing and by the intermediate value theorem there is a unique solution in p_1. If $(1 - \Theta) \leq 0$ i.e. $\Theta \geq 1$, the function has non-positive slope and a solution does not exist. So for $\eta = 1$, a unique equilibrium exists if and only if $f < \psi$.

Case $\eta > 1$**.** F starts negative at $p_1 = 0$. Moreover, $F'(p_1) > 0 \iff \Theta(\frac{1+\xi}{2}) p_1^{\frac{\xi-1}{2}} < 1 \iff p_1 < p_1^{\text{crit}} \equiv \left[(\frac{1+\xi}{2})\Theta\right]^{-\frac{2}{\xi-1}} > 0$. F increases up to p_1^{crit} and decreases after, so the maximum value of F is $F(p_1^{\text{crit}}) = p_1^{\text{crit}} - \tilde{c}^u - \Theta(p_1^{\text{crit}})^{\frac{1+\xi}{2}}$. Notice that $\Theta(p_1^{\text{crit}})^{\frac{\xi-1}{2}} = \Theta \frac{2}{(1+\xi)\Theta} = \frac{2}{1+\xi}$ so $\Theta(p_1^{\text{crit}})^{\frac{1+\xi}{2}} = p_1^{\text{crit}}(\frac{2}{1+\xi}) \Rightarrow F(p_1^{\text{crit}}) = p_1^{\text{crit}}\left(1 - \frac{2}{1+\xi}\right) - \tilde{c}^u = p_1^{\text{crit}}\left(\frac{\xi-1}{1+\xi}\right) - \tilde{c}^u$. Given that F is continuous, existence requires $F(p_1^{\text{crit}}) \geq 0$ or $\left[(\frac{1+\xi}{2})\Theta\right]^{-\frac{2}{\xi-1}} \geq \frac{(1+\xi)\tilde{c}^u}{\xi-1}$. Solving for Θ: $\Theta \leq \frac{2}{(1+\xi)}\left[\frac{(\xi-1)}{(1+\xi)\tilde{c}^u}\right]^{\frac{\xi-1}{2}}$. Substituting $\Theta = \sqrt{\frac{f}{\xi\psi}}$ and solving for ψ: $\sqrt{\frac{f}{\xi\psi}} \leq \frac{2}{(1+\xi)}\left[\frac{\xi-1}{(1+\xi)\tilde{c}^u}\right]^{\frac{\xi-1}{2}} \Rightarrow \frac{f}{\xi\psi} \leq \left[\frac{2}{1+\xi}\right]^2 \left[\frac{\xi-1}{(1+\xi)\tilde{c}^u}\right]^{\xi-1} \Rightarrow \psi \geq \frac{f}{\xi}\left[\frac{(1+\xi)}{2}\right]^2 \left[\frac{(1+\xi)\tilde{c}^u}{\xi-1}\right]^{\xi-1} \equiv \psi_{\min}$ The minimum demand shifter depends linearly on f (larger fixed cost requires a larger market) and non linearly on $\tilde{c}^u$ (higher marginal cost requires larger demand). So if $\psi > \psi_{\min}$ there are 2 solutions, if $\psi = \psi_{\min}$ there is 1 solution, if $\psi < \psi_{\min}$ there is no solution.

Lemma 4. *The condition for stability equals the condition for the pro-competitive effect*

Proof*. The equilibrium price p_1^* solves $F(p_1, \psi) = p_1 - \tilde{c}^u - \sqrt{\frac{f}{\xi\psi}} p_1^{\frac{(1+\xi)}{2}} = 0$. By the implicit function theorem $\frac{\partial p_1^*}{\partial \psi} = -\frac{\partial F/\partial \psi}{\partial F/\partial p_1}$, where $p_1 - \tilde{c}^u = \sqrt{\frac{f}{\xi\psi}} p_1^{\frac{1+\xi}{2}}$. Computing the two derivatives:*

$$\frac{\partial F}{\partial \psi} = -\sqrt{\frac{f}{\xi}}\Big(-\frac{1}{2}\Big)\psi^{-\frac{3}{2}} p_1^{\frac{(1+\xi)}{2}} = \frac{1}{2\psi}\sqrt{\frac{f}{\xi\psi}} p_1^{\frac{1+\xi}{2}} = \frac{1}{2\psi}\underbrace{(p_1 - \tilde{c}^u)}_{>0} > 0$$

$$\frac{\partial F}{\partial p_1} = 1 - \sqrt{\frac{f}{\xi\psi}}\frac{(1+\xi)}{2} p_1^{\frac{\xi-1}{2}} = 1 - \frac{1+\xi}{2}\sqrt{\frac{f}{\xi\psi}}\frac{p_1^{\frac{1+\xi}{2}}}{p_1} = 1 - \frac{1+\xi}{2}\frac{(p_1 - \tilde{c}^u)}{p_1} = 1 - \Big(\frac{1+\xi}{2}\Big)\mu$$

Using $\mu = \frac{p_1 - \tilde{c}^u}{p_1}$, *we obtain* $\frac{\partial p_1^*}{\partial \psi} = -\frac{1}{2\psi}(p_1 - \tilde{c}^u)\frac{1}{1-\frac{1+\xi}{2}\mu}$ *so* $\frac{\partial p_1^*}{\partial \psi} < 0 \iff 1 - \frac{1+\xi}{2}\mu > 0 \iff \boxed{\mu < \frac{2}{1+\xi}}$. *From the equilibrium condition for* p_1, *we have* $p_1 - \tilde{c}^u = \sqrt{\frac{f}{\xi\psi}} p_1^{\frac{(1+\xi)}{2}}$. *The condition that the slope of the lhs is larger than the rhs is* $1 > \frac{(1+\xi)}{2} p_1^{\frac{\xi-1}{2}} \sqrt{\frac{f}{\xi\psi}} = \frac{(1+\xi)}{2}\frac{p_1 - \tilde{c}^u}{p_1} = \left(\frac{1+\xi}{2}\right)\mu \Rightarrow \boxed{\mu < \frac{2}{1+\xi}}$. *This is the condition for stability, which therefore equals the condition for the pro-competitive effect (*$\frac{\partial p_1^*}{\partial \psi} < 0$*).*

Discussion. This equivalence can be understood from the Cournot pricing $p_1(N^u) = \frac{\tilde{c}^u}{1 - 1/(\xi N^u)}$, which establishes a negative relationship between N^u and p_1, and the equilibrium condition $p_1 - \tilde{c}^u = \sqrt{\frac{f}{\xi\psi}} p_1^{\frac{1+\xi}{2}}$, where the left hand side is the markup and the right hand side is the breakeven markup. If we increase p_1^* by ε, now the lhs will be larger than the rhs so there are positive profits, generating entry ($N^u \uparrow$). To go back to the previous equilibrium, this entry must generate a reduction in price ($p_1 \downarrow$), so pro-competitiveness and stability are equivalent. Similarly if we decrease p_1^* by ε, now the markup is smaller than the break even point, generating exit ($N^u \downarrow$). To go back to p_1^*, p_1 must increase in response, attracting entry of new firms.

Result 4 (Conditions for validity of the stability/pro-competitiveness condition)**.** *The condition for stability / pro-competitiveness is automatically established for* $\boxed{\eta \leq 1}$. *The condition is not automatically established for* $\boxed{\eta > 1}$ *but this is equivalent to asking that* $N^u \geq 1$ *(there is at least 1 firm). Moreover, provided that 2 solutions exist, the smaller root is stable and pro-competitive, while the larger root is unstable and does not deliver the pro-competitive effect.*

Proof. With $\eta < 1$ we have $\frac{2}{1+\xi} > 1$, as $\mu < 1$ we have that $\mu < \frac{2}{1+\xi}$. With $\eta = 1$ we have $\frac{2}{1+\xi} = 1$, as $\mu < 1$ we have that $\mu < \frac{2}{1+\xi}$. With $\eta > 1$, from the Cournot foc we have $\mu = \frac{1}{\xi N^u}$ so the condition becomes $\frac{1}{\xi N^u} < \frac{2}{1+\xi} \iff \boxed{N^u > \frac{1+\xi}{2\xi}}$ where $\frac{1+\xi}{2\xi} < 1 \iff 1 + \xi < 2\xi \iff \xi > 1 \iff \eta > 1$. Therefore, stability with $\eta > 1$ requires observing at least 1 firm in equilibrium. The stability condition $\mu < \frac{2}{1+\xi}$ in terms of p_1 is $\frac{p_1 - \tilde{c}^u}{p_1} < \frac{2}{1+\xi} \iff p_1 - \tilde{c}^u < \frac{2p_1}{1+\xi} \iff p_1\left(\frac{1+\xi-2}{1+\xi}\right) < \tilde{c}^u \iff \boxed{p_1 < \frac{(1+\xi)\tilde{c}^u}{\xi - 1} = p_1^{\text{stab}}}$. This defines a threshold below which the equilibrium is stable and by Lemma 4 the pro-competitive effect holds; above this level, the equilibrium is unstable and by Lemma 4 the pro-competitive effect does not hold. The existence condition $F(p_1^{\text{crit}}) \geq 0$ with $p_1^{\text{crit}} = \left[\Theta\frac{1+\xi}{2}\right]^{\frac{2}{1-\xi}}$ gives $p_1^{\text{crit}}\left(\frac{\xi-1}{1+\xi}\right) - \tilde{c}^u \geq 0 \iff p_1^{\text{crit}} \geq \frac{\tilde{c}^u(1+\xi)}{\xi-1} = p_1^{\text{stab}}$. So provided a solution exists, we have $\boxed{p_1^{\text{crit}} \geq p_1^{\text{stab}}}$. This already implies that with 1 solution ($\psi = \psi_{\min}$), the solution is unstable and does not provide the pro-competitive effect. When 2 solutions exist ($\psi > \psi_{\min}$), we have $F(p_1^{\text{crit}}) > 0$ and so $\boxed{p_1^{\text{crit}} > p_1^{\text{stab}}}$; therefore, the larger solution is unstable and does not provide the pro-competitive effect. What remains to show is that $p_1^* \leq p_1^{\text{stab}}$, that is the lower root is stable.

Lemma 5. *At any equilibrium* p_1 *satisfying* $F(p_1) = 0$, $p_1 \leq p_1^{stab} \iff p_1 \leq p_1^{crit}$. *With 2 solutions, this implies that a solution is stable (*$p_1 < p_1^{stab}$*) only if it is the smallest root (*$p_1 < p_1^{crit}$*, i.e. to the left of the peak of* F*)*

Proof. Define $G(p_1) = p_1 - \tilde{c}^u - \frac{2p_1}{(1+\xi)}$. $G(p_1) < 0 \iff p_1(1-\frac{2}{1+\xi}) < \tilde{c}^u \iff p_1 < \tilde{c}^u \frac{(1+\xi)}{\xi-1} = p_1^{\text{stab}}$, so the stability condition is $G(p_1) < 0$. At an equilibrium we have $F(p_1) = 0$ or $p_1 - \tilde{c}^u = \Theta p_1^{\frac{1+\xi}{2}} \Rightarrow G(p_1) = \Theta p_1^{\frac{1+\xi}{2}} - \frac{2p_1}{1+\xi} = \frac{p_1}{1+\xi}\left[\Theta(1+\xi)p_1^{\frac{\xi-1}{2}} - 2\right]$ where $p_1^{\text{crit}} = \left[\frac{2}{(1+\xi)\Theta}\right]^{\frac{2}{\xi-1}} \Rightarrow \Theta(p_1^{\text{crit}})^{\frac{\xi-1}{2}}(1+\xi) = 2$, so $\Theta(1+\xi) = \frac{2}{(p_1^{\text{crit}})^{\frac{\xi-1}{2}}}$. Substituting in $G(p_1)$, we obtain $G(p_1) = \frac{2p_1}{1+\xi}\left[\left(\frac{p_1}{p_1^{\text{crit}}}\right)^{\frac{\xi-1}{2}} - 1\right]$ where $\frac{\xi-1}{2} > 0$, so $G(p_1) \gtrless 0 \iff p_1 \gtrless p_1^{\text{crit}} \iff p_1 \gtrless p_1^{\text{stab}}$. The result implies that for $\eta > 1$ with $\psi > \psi_{\min}$ (2 solutions), the lower root satisfying $p_1^* < p_1^{\text{crit}}$ also satisfies $p_1^* < p_1^{\text{stab}}$ (the solution is stable). As stability is equivalent to pro-competitiveness, the solution also delivers $\frac{\partial p_1^*}{\partial \psi} < 0$. □

Taking stock: with $\eta < 1$, a solution exists and is unique. The solution is stable and pro-competitive ($\partial p_1^*/\partial\psi < 0$). With $\eta = 1$, a solution exists and is unique provided that $f < \psi$. The solution is stable and pro-competitive ($\partial p_1^*/\partial\psi < 0$). With $\eta > 1$, a unique solution exists for $\psi = \psi_{\min}$; this solution is unstable and not pro-competitive; 2 solutions exist for $\psi > \psi_{\min}$, where the lower root is stable and pro-competitive while the larger root is unstable and not pro-competitive. The pro-competitive solution corresponds to an equilibrium with at least 1 firm, while the not pro-competitive solution corresponds to a degenerate case with less than 1 firm.

Discussion: Demand comparison across regimes

1. **Duty-free regime vs no policy benchmark:**

$$\frac{\psi^{df}}{\psi^{\text{pre}}} = \frac{K_3^{\eta-1}}{K_1^{\eta-1}} = \frac{K_3^{(\eta-1)}}{K_1^{(\eta-1)}} = (1+t_2)^{\beta_2(\eta-1)}$$

With $\eta > 1$, component demand rises even in the duty-free regime. With $\eta = 1$, component demand is unaffected. With $\eta < 1$, component demand decreases. This regime isolates the equilibrium response of demand for components through the equilibrium on the final-good market: the APDP lowers the marginal cost of production, which through the zero profit condition lowers p, thereby increasing the equilibrium q through final demand, which in turn raises demand for x_1. With unit elasticity, this increased demand perfectly compensates the substitution effect at the final assembly stage due to the import duty rebate, thus demand for components is unaffected. If the final demand elasticity is larger than 1, the effect of increased demand for components dominates substitution and demand for components increases; if final demand has elasticity less than 1, the substitution at the assembly stage dominates and demand for components shrinks.

2. **Duty regime vs no policy benchmark:**

$$\frac{\psi^{duty}}{\psi^{\text{pre}}} = (1+\tfrac{\psi t_2}{(1+\psi)})^{\eta} > 1 \quad \text{for any} \quad \eta \gtrless 1$$

In this regime, the APDP raises component demand by a factor $(1+\frac{\psi t_2}{(1+\psi)})^{\eta}$; here $\frac{\psi}{(1+\psi)}$ acts as an output subsidy that lowers the assembler's marginal cost and the effect is amplified through the elasticity of

demand by η-fold. Contrary to the duty-free regime, there is no substitution effect at the firm level as all the subsidies are infra-marginal. As $\psi^{duty} > \psi^{\text{pre}}$, due to pro-competitiveness the equilibrium price decreases compared to the pre policy. Moreover, the demand shifter ψ^{duty} is increasing in the policy parameter ψ, so higher ψ lowers p_1^{duty} and raises $N^{u(3)}$ and $q^{u(3)}$. The effect is larger in η, which amplifies the transmission of industrial policy upstream, and in t_2 as the infra-marginal income effect that the firm receives increases in the size of the duties rebated.

3. **Regime 2 vs no policy benchmark:** At the kink we have $p_2 r_2^{\text{kink}} = \psi p A (r_2^{\text{kink}})^{\beta_2}(r_L^*)^{\gamma} \Rightarrow pA(r_2^{\text{kink}})^{\beta_2}(r_L^*)^{\gamma} = \frac{p_2 r_2^{\text{kink}}}{\psi}$. From the assembler's zero profit $p = \frac{c^{\text{kink}}}{A}$ where $c^{\text{kink}} = \frac{D^{\text{kink}}}{(r_2^{\text{kink}})^{\beta_2}(r_L^*)^{\gamma}} \Rightarrow pA(r_2^{\text{kink}})^{\beta_2}(r_L^*)^{\gamma} = D^{\text{kink}}$. So $\frac{p_2 r_2^{\text{kink}}}{\psi} = D^{\text{kink}} = p_1 + p_2 r_2^{\text{kink}} + w r_L^* \Rightarrow p_2 r_2^{\text{kink}}\left(\frac{1-\psi}{\psi}\right) = p_1 + w r_L^*$ Using $w r_L^* = w\frac{\gamma}{\beta_1}\frac{p_1}{w} = \frac{\gamma}{\beta_1}p_1 \Rightarrow p_1 + w r_L^* = p_1\left(1+\frac{\gamma}{\beta_1}\right) = p_1\left(\frac{1-\beta_2}{\beta_1}\right)$. We obtain $r_2^{\text{kink}} = \frac{(1-\beta_2)}{\beta_1}\frac{p_1}{p_2}\frac{\psi}{(1-\psi)}$. Substituting into D^{kink}: $D^{\text{kink}} = p_1 + p_2\frac{1-\beta_2}{\beta_1}\frac{p_1}{p_2}\frac{\psi}{1-\psi} + \frac{\gamma}{\beta_1}p_1 = p_1\left[1+\frac{1-\beta_2}{\beta_1}\frac{\psi}{1-\psi}+\frac{\gamma}{\beta_1}\right] = \frac{p_1}{\beta_1}\left[\beta_1+\gamma+(1-\beta_2)\frac{\psi}{1-\psi}\right] = \frac{p_1}{\beta_1}(1-\beta_2)\left[1+\frac{\psi}{1-\psi}\right] = \frac{p_1(1-\beta_2)}{\beta_1}\left[\frac{1}{1-\psi}\right]$ and $(r_2^{\text{kink}})^{\beta_2}(r_L^*)^{\gamma} = \left[\frac{1-\beta_2}{\beta_1}\frac{p_1}{p_2}\frac{\psi}{1-\psi}\right]^{\beta_2}\left(\frac{\gamma}{\beta_1}\frac{p_1}{w}\right)^{\gamma} = B(\psi)p_1^{\beta_2+\gamma}$ so the conditional input demand is $x_1^{(2)} = q\left(\frac{1}{A(r_2^{\text{kink}})^{\beta_2}(r_L^*)^{\gamma}}\right) = \frac{q}{AB(\psi)p_1^{\beta_2+\gamma}}$. The assembler zero profit $pAB(\psi)p_1^{\beta_2+\gamma} = D^{\text{kink}} = \frac{(1-\beta_2)p_1}{(1-\psi)\beta_1} \Rightarrow p = \frac{(1-\beta_2)p_1^{\beta_1}}{(1-\psi)\beta_1 AB(\psi)}$. Using final demand $q = (\frac{\bar{D}}{\bar{N}^D})p^{-\eta}$ and then substituting into $x_1^{(2)}$, $\bar{N}^D x_1^{(2)}$: $X_1^{(2)} = \bar{N}^D x_1^{(2)} = \bar{N}^D\frac{1}{AB(\psi)p_1^{\beta_2+\gamma}}\left(\frac{\bar{D}}{\bar{N}^D}\right)\left[\frac{(1-\beta_2)}{(1-\psi)\beta_1 AB(\psi)}\right]^{-\eta}p_1^{-\eta\beta_1} = \bar{D}A^{\eta-1}\left[\frac{(1-\psi)\beta_1}{(1-\beta_2)}\right]^{\eta}B(\psi)^{\eta-1}p_1^{-\xi}$. We know the regime applies to $\frac{r_2^{\text{kink}}}{1+t_2} < r_2^{\text{pre}} < r_2^{\text{kink}}$ where $r_2^{\text{kink}} = \frac{1-\beta_2}{\beta_1}\frac{p_1}{p_2}\frac{\psi}{1-\psi}$, $r_2^{\text{pre}} = \frac{p_1}{p_2(1+t_2)}\frac{\beta_2}{\beta_1}$ so $\frac{r_2^{\text{kink}}}{r_2^{\text{pre}}} = \frac{1-\beta_2}{\beta_1}\frac{p_1}{p_2}\frac{\psi}{1-\psi}\frac{\beta_1 p_2(1+t_2)}{\beta_2 p_1} = \frac{(1-\beta_2)(1+t_2)\psi}{\beta_2(1-\psi)}$. At the boundary with regime 3 we have $\frac{r_2^{\text{kink}}}{r_2^{\text{pre}}} = 1 \Rightarrow \frac{(1-\beta_2)(1+t_2)\psi}{\beta_2(1-\psi)} = 1 \iff (1-\beta_2)(1+t_2)\psi = \beta_2(1-\psi) \iff \beta_2(1-\psi+(1+t_2)\psi) = (1+t_2)\psi \iff \beta_2(1+t_2\psi) = (1+t_2)\psi \iff \boxed{\beta_2 = \frac{(1+t_2)\psi}{(1+t_2\psi)}} \Rightarrow \beta_2 \geq \psi$. At the boundary with regime 1 we have $\frac{r_2^{\text{kink}}}{r_2^{\text{pre}}} = (1+t_2) \iff \frac{(1-\beta_2)(1+t_2)\psi}{\beta_2(1-\psi)} = (1+t_2) \iff (1-\beta_2)\psi = \beta_2(1-\psi) \iff \psi - \beta_2\psi = \beta_2 - \beta_2\psi \iff \boxed{\beta_2 = \psi}$. Now check the 2 boundaries:

$$\frac{\psi^2}{\psi^{\text{pre}}}\Big|_{\beta_2=\psi} = (1+t_2)^{\beta_2(\eta-1)} \geq 1 \text{ for } \eta \geq 1, \quad \text{equal to } \frac{\psi^1}{\psi^{\text{pre}}}$$

$$\frac{\psi^2}{\psi^{\text{pre}}}\Big|_{\beta_2=\frac{(1+t_2)\psi}{1+t_2\psi}} = (1+\psi t_2)^{\beta_2(\eta-1)}\left(\frac{1-\psi}{1-\beta_2}\right)^{E} = (1+\psi t_2)^{\eta} \geq 1, \quad \text{equal to } \frac{\psi^3}{\psi^{\text{pre}}}$$

A.2 Auxiliary results

Remark 1. *With the PI, the maximum amount of x_2 that may be imported duty free is $\frac{\psi pq}{(1+\psi)p_2}$, and for each of these the savings are $p_2 t_2$. Thus, increasing output by 1 unit always lets the firm increase the maximum amount of duty free x_2 by $\frac{\psi p}{(1+\psi)p_2}$ and to save an additional amount $\frac{\psi p}{(1+\psi)p_2}p_2 t_2$. Therefore $\frac{\psi p t_2}{(1+\psi)}$ is the marginal cost-saving effect of 1 additional unit of output for a firm exhausting the duty free imports under the PI. This is a feature of the proportional rule (the total rebate size is proportional to output) and not an implication of CRS. The same applies to the VAA, where the marginal cost-saving effect of 1 additional unit of output for a firm exhausting the duty free imports is given by $\psi p t_2$. This is larger than under the PI, given the direct penalty on imports embedded on the PI's local value added definition.*

Remark 2. *The PI links the kink position to local value added, which depends on q and hence on L. As a consequence, the optimal combination of x_1 and x_2 directly depends on labor, creating interdependence between x_1, x_2 and L at the optimum. This results in a failure of the standard 2-stage budgeting. The same applies to the VAA, where the kink position depends on revenues and thus L jointly with x_1 and x_2.*

Remark 3. *While with 2 inputs the ratio of x_2/x_1 is able to fully determine whether the firm is operating in a duty free or duty regime, with labor the applicable regime also depends on the relative labor intensity r_L. Intuitively, for given foreign input intensity, larger labor intensity increases production without affecting the size of the imports to be rebated, so higher labor intensity makes it more likely that a given foreign input intensity is duty free. Conversely, higher foreign input intensities require larger labor intensities to be duty free. However, I show in Result 1 that the optimal labor–domestic input ratio does not depend on the regime, so the kink can be expressed as a condition on r_2 only.*

Remark 4. *In the duty region (when the kink bites), $\frac{\lambda\psi pt_2}{(1+\psi)}$ is the value in units of output of the additional budget relaxation generated by producing 1 more unit of q. Producing more output earns more rebates ($\frac{\psi pt_2}{(1+\psi)}$ per unit) and each unit is worth λ in output terms. This scaling term multiplies the marginal products of all 3 inputs by the same factor, so in the duty region the PI (and the VAA) acts like a proportional output subsidy making all inputs more productive in equal proportions rather than an input-specific subsidy. This distinguishes the **income effect** in the duty region, where the policy raises the returns to production uniformly and expands scale without affecting relative input usage, and the **relative-price effect** in the duty free region, which distorts relative prices by lowering the price of the imported good.*

Result 5 (Conditional input demands for given cost K in the 3 regimes and in the no-policy benchmark)**.** *The conditional input demand functions in the no policy benchmark and in the three policy regimes (duty free, duty payment, kink) are:*

A) In the no policy benchmark, standard results for the maximization problem of the firm under Cobb-Douglas production deliver $\boxed{x_1^{pre}(K,p_1)=\frac{\beta_1 K}{p_1}, x_2^{pre}(K,p_2,t_2)=\frac{\beta_2 K}{p_2(1+t_2)}, L^{pre}(K,w)=\frac{\gamma K}{w}}$

B) With an internal solution in the duty free region, we have $\frac{x_2}{x_1}=\frac{\beta_2}{\beta_1}\frac{p_1}{p_2}$ and $\frac{L}{x_1}=\frac{\gamma}{\beta_1}\frac{p_1}{w}$, thus $x_2=\frac{\beta_2}{\beta_1}\frac{p_1}{p_2}x_1$ and $L=\frac{\gamma}{\beta_1}\frac{p_1}{w}x_1$. Substituting this expressions in the isocost $p_1x_1+p_2\frac{\beta_2}{\beta_1}\frac{p_1}{p_2}x_1+w\frac{\gamma}{\beta_1}\frac{p_1}{w}x_1=K$, we obtain $p_1x_1\left(1+\frac{\beta_2}{\beta_1}+\frac{\gamma}{\beta_1}\right)=K \Rightarrow p_1x_1\left(\frac{\beta_1+\beta_2+\gamma}{\beta_1}\right)=K$ with the expression in parenthesis equal to $\frac{1}{\beta_1}$. The conditional input demands are $\boxed{x_1^{pre}(K,p_1)=\frac{\beta_1 K}{p_1}, x_2^{pre}(K,p_2,t_2)=\frac{\beta_2 K}{p_2}, L^{pre}(K,w)=\frac{\gamma K}{w}}$*. I notice that, compared to the pre-policy regime, x_1 and L do not change, while x_2 increases due to a relative price decrease. The income and substitution effects that price change generates on x_1 and L perfectly offset each other, thus x_1 and L do not move.*

C) With an internal solution in the duty region, we have $\frac{x_2}{x_1}=\frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)}$ and $\frac{L}{x_1}=\frac{\gamma}{\beta_1}\frac{p_1}{w}$. Rewriting the isocost as $p_1x_1+p_2(1+t_2)x_2+wL-\frac{\psi pt_2}{(1+\psi)}Ax_1^{\beta_1}x_2^{\beta_2}L^{\gamma}=K$ and using $x_2=\frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)}x_1$ and $L=\frac{\gamma}{\beta_1}\frac{p_1}{w}x_1$, we obtain $p_1x_1+p_2(1+t_2)\frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)}x_1+w\frac{\gamma}{\beta_1}\frac{p_1}{w}x_1-\frac{\psi pt_2}{(1+\psi)}x_1A\left(\frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)}\right)^{\beta_2}\left(\frac{\gamma}{\beta_1}\frac{p_1}{w}\right)^{\gamma}=K$.

Then $p_1 x_1\left(1+\frac{\beta_2}{\beta_1}+\frac{\gamma}{\beta_1}\right)-\frac{\psi p t_2}{(1+\psi)}x_1 A\left(\frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)}\right)^{\beta_2}\left(\frac{\gamma}{\beta_1}\frac{p_1}{w}\right)^{\gamma}=K$. *Defining*

$$\boxed{\Psi=\frac{\psi p t_2}{(1+\psi)}A\Big(\frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)}\Big)^{\beta_2}\Big(\frac{\gamma}{\beta_1}\frac{p_1}{w}\Big)^{\gamma}}$$

we obtain $\frac{p_1 x_1}{\beta_1}-x_1\Psi=K\Rightarrow x_1\left(\frac{p_1-\beta_1\Psi}{\beta_1}\right)=K\Rightarrow \boxed{x_1=\frac{K\beta_1}{p_1-\beta_1\Psi}}$. Ψ *is* $\frac{\psi p t_2}{(1+\psi)}\frac{q}{x_1}$ *so this is the total rebate income per unit of* x_1. *I notice that the optimal level of* x_1 *increases compared to the duty free case, the more so when the elasticity of output to* x_1 *is larger, and when the rebate income per unit of* x_1 *increases. Notice that* $p_1>\beta_1\Psi$ *as from the budget constraint we have* $\frac{p_1x_1-x_1\beta_1\Psi}{\beta_1}=K>0\Rightarrow\frac{p_1x_1}{\beta_1}>x_1\Psi\Rightarrow p_1>\beta_1\Psi$*: as long as the firm has positive budget, the denominator is guaranteed to be positive. Simple inspection of* Ψ *shows that the expression increases in* ψ. *Regarding* t_2, *consider the derivative of* $\frac{t_2}{(1+t_2)^{\beta_2}}$ *with respect to* t_2*:*$\frac{(1+t_2)^{\beta_2}-t_2\beta_2(1+t_2)^{\beta_2-1}}{(1+t_2)^{2\beta_2}}=\frac{(1+t_2)^{\beta_2}}{(1+t_2)^{2\beta_2}}\left(1-\frac{t_2\beta_2}{1+t_2}\right)=\frac{1}{(1+t_2)^{\beta_2}}\frac{(1+t_2-t_2\beta_2)}{(1+t_2)}=\frac{1+t_2-t_2\beta_2}{(1+t_2)^{\beta_2+1}}$ *where* $1+t_2-t_2\beta_2=1+t_2(1-\beta_2)>0$. *Therefore, a larger policy parameter* ψ *and a larger duty rate on the imported input increases demand for the domestic input for given* K. *Rewriting and substituting in the expressions for* x_2 *and* L*:*

$$x_1^{pre}(K,p_1)=\frac{K\beta_1}{p_1-\beta_1\Psi}=\frac{K\beta_1}{p_1}\frac{p_1}{p_1-\beta_1\Psi}=\boxed{\frac{\beta_1K^{eff}}{p_1}}\quad \textit{where } K^{eff}=\frac{Kp_1}{p_1-\beta_1\Psi}$$

$$x_2^{pre}(K,p_2,t_2)=\frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)}\frac{K\beta_1}{p_1-\beta_1\Psi}=\frac{p_1}{p_1-\beta_1\Psi}\frac{\beta_2K}{p_2(1+t_2)}=\boxed{\frac{\beta_2K^{eff}}{p_2(1+t_2)}}$$

$$L^{pre}(K,w)=\frac{\gamma}{\beta_1}\frac{p_1}{w}\frac{K\beta_1}{p_1-\beta_1\Psi}=\frac{p_1}{p_1-\beta_1\Psi}\frac{\gamma K}{w}=\boxed{\frac{\gamma K^{eff}}{w}}$$

C) With a kink solution, we have that no duty is paid so $p_1x_1+p_2x_2+wL=K$ *or* $p_1x_1+p_2r_2^{kink}x_1+wr_L^*x_1=K$. *Then,* $x_1(p_1+p_2r_2^{kink}+wr_L^*)=K$ *so* $\boxed{x_1^{pre}(K,p_1)=\frac{K}{p_1+p_2r_2^{kink}+wr_L^*}}$ *where* $r_2^{kink}=\left[\frac{\psi pA}{(1+\psi)p_2}\left(\frac{p_1}{w}\frac{\gamma}{\beta_1}\right)^{\gamma}\right]^{\frac{1}{1-\beta_2}}$ *and* $r_L^*=\frac{\gamma}{\beta_1}\frac{p_1}{w}$. *Using the solution for* x_1, *we also obtain*

$$\boxed{x_2^{pre}(K,p_2,t_2)=r_2^{kink}\frac{K}{p_1+p_2r_2^{kink}+wr_L^*}}\qquad\boxed{L^{pre}(K,w)=r_L^*\frac{K}{p_1+p_2r_2^{kink}+wr_L^*}}$$

Here the firm bunches at the kink, no duty is paid and the effective budget remains K.

Discussion of the duty-region case. Relative to the no policy benchmark, all the 3 inputs increase by a common factor $K^{\text{eff}}/K>1$ due to an income effect: intra-marginal rebates relax the budget constraint without affecting relative prices, so all inputs expand proportionally and the ratios stay unaffected. A larger ψ means that a firm earns a larger rebate per unit of output, which relaxes the budget constraint and increases demand for all inputs proportionally. Conditional on the solution remaining in the duty region as ψ moves, this does not create any substitution effect because the rebate remains intramarginal.

A larger t_2 has 2 opposing effects on the rebate per unit of x_1, that is Ψ. First, a higher t_2 directly raises the rebate per unit of x_1 as each intramarginal unit of imports now saves more in tariff payments; this creates an income effect through higher savings. However, higher t_2 also decreases the output per unit of x_1 through r_2, which reduces the size of the rebates. These two effects can be understood by looking at $\Psi = \frac{\psi p t_2}{(1+\psi)}(r_2)^{\beta_2}(r_L)^{\gamma}$. While t_2 directly enters in the numerator of Ψ, a higher t_2 also means that the effective price of x_2 rises and $x_2^{\text{duty}} = \frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)}$ decreases, shrinking output per unit of x_1 and therefore the rebate base; with a lower rebate base, the budget decreases, which pushes for smaller input demands. Therefore both channels operate through an income effect and capture the relative role of the rebate rate vs rebate base. Mathematically, we can verify that the elasticity of output per unit of x_1 with respect to t_2 is negative but smaller than 1 in absolute value:

$$
\begin{aligned}
&Ax_1^{\beta_1}x_2^{\beta_2}L^{\gamma} \Rightarrow \frac{q}{x_1} = Ar_2^{\beta_2}r_L^{\gamma} = A\Big(\frac{\beta_2}{\beta_1}\frac{p_1}{p_2(1+t_2)}\Big)^{\beta_2} r_L^{\gamma} \equiv \tilde{q}(t_2)\\
&\frac{\partial \tilde{q}(t_2)}{\partial t_2} = Ar_L^{\gamma}\Big(\frac{\beta_2}{\beta_1}\frac{p_1}{p_2}\Big)^{\beta_2}\frac{(-\beta_2)}{(1+t_2)^{\beta_2+1}}\\
&\frac{\partial \tilde{q}(t_2)}{\partial t_2}\frac{t_2}{\tilde{q}(\cdot)} = Ar_L^{\gamma}\Big(\frac{\beta_2}{\beta_1}\frac{p_1}{p_2}\Big)^{\beta_2}\frac{(-\beta_2)}{(1+t_2)^{\beta_2+1}}t_2\frac{1}{A\Big(\frac{\beta_2}{\beta_1}\frac{p_1}{p_2}\Big)^{\beta_2}(1+t_2)^{-\beta_2}r_L^{\gamma}} = -\frac{\beta_2 t_2}{1+t_2}
\end{aligned}
$$

Therefore, when t_2 increases, the tax reduction dominates the reduction of the tax base, so the effective income and input demand grow through an income effect.

Lemma 6. *The slope of the ray from the origin in the (x_1,x_2) space intersecting the pre-policy budget $p_1x_1+p_2(1+t_2)x_2+wL=K$ at the x_1^{kink} level of x_1 is given by $\hat{r}_2 = \frac{r_2^{kink}}{1+t_2}$*

Proof. *We can rewrite the pre-policy budget as $p_1x_1+p_2(1+t_2)x_2+wr_L^*x_1=K$ or $x_1(p_1+wr_L^*)+p_2(1+t_2)x_2=K$. Using the expression for $x_1^{kink}=\frac{K}{p_1+p_2r_2^{kink}+wr_L^*}$ we obtain*

$$
x_2 = \Big[K - \frac{(p_1+wr_L^*)K}{p_1+p_2r_2^{kink}+wr_L^*}\Big]\frac{1}{p_2(1+t_2)} = \frac{Kr_2^{kink}}{(p_1+p_2r_2^{kink}+wr_L^*)(1+t_2)}
$$

Dividing x_2 by x_1^{kink} to get the slope: $\hat{r}_2 = \frac{Kr_2^{kink}}{(p_1+p_2r_2^{kink}+wr_L^*)(1+t_2)}\cdot\frac{(p_1+p_2r_2^{kink}+wr_L^*)}{K} \Rightarrow \boxed{\hat{r}_2 = \frac{r_2^{kink}}{1+t_2}}$ is the slope of the ray from the origin to the intersection of the pre-policy budget with $x_1 = x_1^{kink}$.

Result 6 (Cost functions and input demands in the 3 regimes and in the no-policy benchmark)**.** *The cost and input demand functions in the no policy benchmark and in the three policy regimes (duty free, duty payment, kink) are:*

A) In the no policy benchmark, we have $x_1^{pre} = \frac{\beta_1 K}{p_1}$, $x_2^{pre} = \frac{\beta_2 K}{p_2(1+t_2)}$, $L^{pre} = \frac{\gamma K}{w}$. The supply function is $Q(K) = A\Big(\frac{\beta_1 K}{p_1}\Big)^{\beta_1}\Big(\frac{\beta_2 K}{p_2(1+t_2)}\Big)^{\beta_2}\Big(\frac{\gamma K}{w}\Big)^{\gamma} = AK\frac{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^{\gamma}}{p_1^{\beta_1}(p_2(1+t_2))^{\beta_2}w^{\gamma}}$ so the cost function is

$$
C(q) = \frac{q}{A}\frac{p_1^{\beta_1}(p_2(1+t_2))^{\beta_2}w^{\gamma}}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^{\gamma}} = \frac{q}{A}c^{pre}(p_1) \quad \textit{where} \quad c^{pre}(p_1) = \frac{p_1^{\beta_1}\big[p_2(1+t_2)\big]^{\beta_2}w^{\gamma}}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^{\gamma}}
$$

Substituting K for $C(q)$, the resulting the input demands are

$$\boxed{x_1^{pre}(q) = q\Big(\frac{\beta_1}{p_1}\frac{c^{pre}(p_1)}{A}\Big)} \quad \boxed{x_2^{pre}(q) = q\Big(\frac{\beta_2}{p_2(1+t_2)}\frac{c^{pre}(p_1)}{A}\Big)} \quad \boxed{L^{pre}(q) = q\Big(\frac{\gamma}{w}\frac{c^{pre}(p_1)}{A}\Big)}$$

B) In the duty-free regime, the optimal input choices are $x_1^{df} = \frac{\beta_1 K}{p_1}$, $x_2^{df} = \frac{\beta_2 K}{p_2}$, $L^{df} = \frac{\gamma K}{w}$. Then the supply function is $Q(K) = A(\frac{\beta_1 K}{p_1})^{\beta_1}(\frac{\beta_2 K}{p_2})^{\beta_2}(\frac{\gamma K}{w})^{\gamma} = KA\frac{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^{\gamma}}{p_1^{\beta_1}p_2^{\beta_2}w^{\gamma}}$, so the cost function is:

$$C(q) = \frac{q}{A}\frac{p_1^{\beta_1}p_2^{\beta_2}w^{\gamma}}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^{\gamma}} = q\frac{c^{df}(p_1)}{A} \qquad \textit{with} \qquad c^{df}(p_1) = \frac{p_1^{\beta_1}p_2^{\beta_2}w^{\gamma}}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^{\gamma}}$$

Substituting K for $C(q)$, the resulting the input demands are

$$\boxed{x_1^{df}(q) = q\Big(\frac{\beta_1}{p_1}\frac{c^{df}(p_1)}{A}\Big)} \quad \boxed{x_2^{df}(q) = q\Big(\frac{\beta_2}{p_2}\frac{c^{df}(p_1)}{A}\Big)} \quad \boxed{L^{df}(q) = q\Big(\frac{\gamma}{w}\frac{c^{df}(p_1)}{A}\Big)}$$

C) In the duty regime, the optimal input choices are $x_1^{duty} = \frac{\beta_1 K^{eff}}{p_1}$, $x_2^{duty} = \frac{\beta_2 K^{eff}}{p_2(1+t_2)}$, $L^{duty} = \frac{\gamma K^{eff}}{w}$. Then the supply function is $Q(K) = A\Big(\frac{\beta_1 K^{eff}}{p_1}\Big)^{\beta_1}\Big(\frac{\beta_2 K^{eff}}{p_2(1+t_2)}\Big)^{\beta_2}\Big(\frac{\gamma K^{eff}}{w}\Big)^{\gamma} = AK^{eff}\frac{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^{\gamma}}{p_1^{\beta_1}(p_2(1+t_2))^{\beta_2}w^{\gamma}}$ with $K^{eff} = \frac{p_1 K}{p_1 - \beta_1\Psi}$. The resulting cost function is:

$$C(q) = q\frac{1}{A}\frac{p_1^{\beta_1}(p_2(1+t_2))^{\beta_2}w^{\gamma}}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^{\gamma}}\underbrace{\frac{p_1-\beta_1\Psi}{p_1}}_{<1} = q\frac{p_1-\beta_1\Psi}{p_1}\frac{c^{duty}(p_1)}{A} \textit{ where } c^{duty}(p_1) = \frac{p_1^{\beta_1}(p_2(1+t_2))^{\beta_2}w^{\gamma}}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^{\gamma}}$$

It can be shown that $\frac{p_1-\beta_1\Psi}{p_1}\frac{c^{duty}(p_1)}{A} = \frac{c^{duty}(p_1)}{A} - \frac{\psi pt_2}{(1+\psi)}$, so $C(q) = q\Big(\frac{c^{duty}(p_1)}{A} - \frac{\psi pt_2}{(1+\psi)}\Big)$. This shows that the marginal cost per unit of output decreases compared to the pre-policy level $c^{pre}(p_1)$ by $\frac{\psi pt_2}{(1+\psi)}$, which is the marginal cost savings per unit of output when the firm exhausts the duty free allowance. Substituting K for C(q), the input demand functions are:

$$x_1^{duty}(q) = \frac{\beta_1}{p_1}\frac{p_1 K}{p_1-\beta_1\Psi}\cdot\frac{1}{K} = \frac{\beta_1}{p_1}\frac{p_1}{p_1-\beta_1\Psi}\frac{q}{A}\frac{p_1^{\beta_1}(p_2(1+t_2))^{\beta_2}w^{\gamma}}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^{\gamma}}\frac{p_1-\beta_1\Psi}{p_1} = \boxed{q\Big(\frac{\beta_1}{p_1}\frac{c^{duty}(p_1)}{A}\Big)}$$

$$x_2^{duty}(q) = \frac{\beta_2}{p_2(1+t_2)}\frac{p_1}{p_1-\beta_1\Psi}\frac{q}{A}\frac{p_1^{\beta_1}(p_2(1+t_2))^{\beta_2}w^{\gamma}}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^{\gamma}}\frac{p_1-\beta_1\Psi}{p_1} = \boxed{q\Big(\frac{\beta_2}{p_2(1+t_2)}\frac{c^{duty}(p_1)}{A}\Big)}$$

$$L^{duty}(q) = \frac{\gamma}{w}\frac{p_1}{p_1-\beta_1\Psi}\frac{q}{A}\frac{p_1^{\beta_1}(p_2(1+t_2))^{\beta_2}w^{\gamma}}{\beta_1^{\beta_1}\beta_2^{\beta_2}\gamma^{\gamma}}\frac{p_1-\beta_1\Psi}{p_1} = \boxed{q\Big(\frac{\gamma}{w}\frac{c^{duty}(p_1)}{A}\Big)}$$

D) In the kink regime, we have $x_1^{kink} = \frac{K}{D^{kink}}$, $x_2^{kink} = \frac{r_2^{kink}K}{D^{kink}}$, $L^{kink} = \frac{r_L^{*}K}{D^{kink}}$ where $D^{kink} = p_1 + p_2 r_2^{kink} +$

wr_L^*. *Then the supply function is* $Q(K) = A\Big(\frac{K}{D^{kink}}\Big)^{\beta_1}\Big(\frac{r_2^{kink}K}{D^{kink}}\Big)^{\beta_2}\Big(\frac{r_L^*K}{D^{kink}}\Big)^{\gamma} = \frac{AK}{D^{kink}}(r_2^{kink})^{\beta_2}(r_L^*)^{\gamma}$ *and the resulting cost function is*

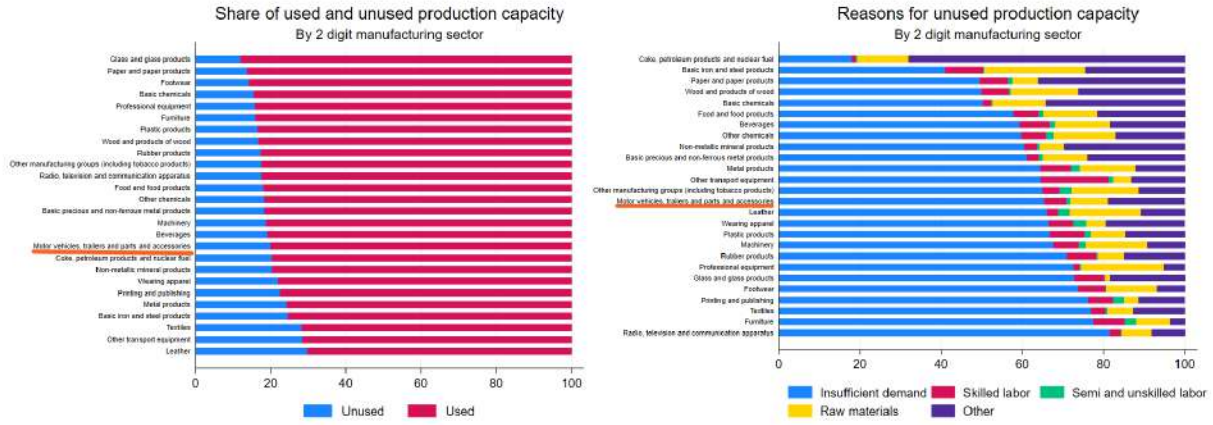
$$C(q) = \frac{q}{A}\frac{D^{kink}}{(r_2^{kink})^{\beta_2}(r_L^*)^{\gamma}} = q\frac{c^{kink}(p_1)}{A} \qquad \textit{where} \qquad c^{kink}(p_1) = \frac{D^{kink}}{(r_2^{kink})^{\beta_2}(r_L^*)^{\gamma}}$$

Substituting K for C(q), the resulting input demands are:

$$\boxed{x_1^{kink}(q) = q\Big(\frac{1}{A(r_2^{kink})^{\beta_2}(r_L^*)^{\gamma}}\Big)} \qquad \boxed{x_2^{kink}(q) = q\Big(\frac{r_2^{kink}}{A(r_2^{kink})^{\beta_2}(r_L^*)^{\gamma}}\Big)} \qquad \boxed{L^{kink}(q) = q\Big(\frac{r_L^*}{A(r_2^{kink})^{\beta_2}(r_L^*)^{\gamma}}\Big)}$$

B Appendix Figures

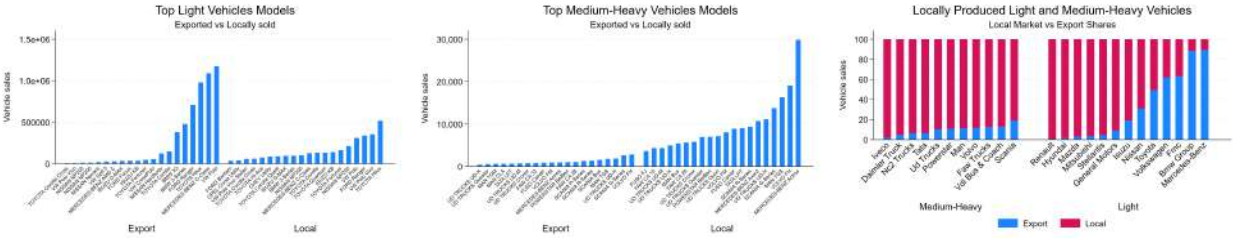
FIGURE B.1: MANUFACTURING UTILIZATION OF PRODUCTION CAPACITY (MUPC) BY 2-DIGIT INDUSTRY



Notes: Each graph above shows on the left the share of utilization of production capacity (in percentage points) by 2-digit industry, on the right graph the disaggregation of the under-utilization share by source (skilled labour, semi/unskilled labour, raw materials, insufficient demand, other). Data source: StatSA Manufacturing Utilization of Production Capacity (MUPC).

FIGURE B.2: MODEL SPECIALIZATION - LOCAL SALES VS EXPORTS

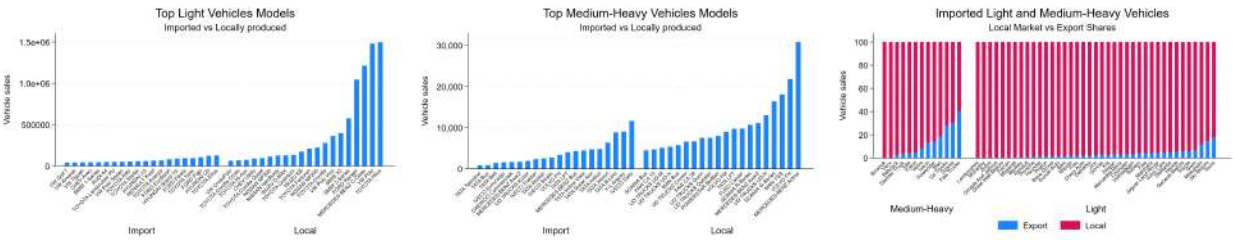
(A) LIGHT VEHICLES (B) MEDIUM-HEAVY VEHICLES (C) EXPORT SHARES



Notes: The figures above show the top 20 models sold by light motor vehicle manufacturers (left figure) and medium-heavy manufacturers (middle figure), distinguishing between exported models and models sold for the local market. The figure on the right shows the export share of medium-heavy vehicle producers (on the left) and light vehicle producers (on the right). The data refer to the entire period 2008-2024 and the bars refer to the entire vehicle count over this period. Data source: Lightstone SA 2008-2024.

FIGURE B.3: MODEL SPECIALIZATION - LOCAL PRODUCTION VS IMPORTS

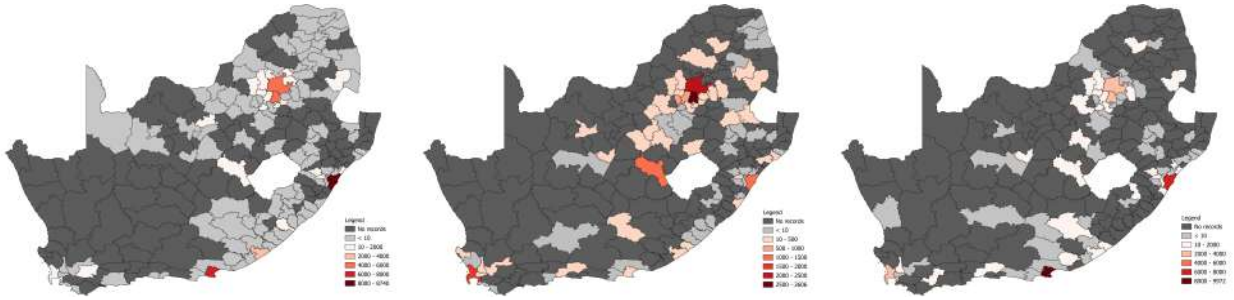
(A) LIGHT VEHICLES (B) MEDIUM-HEAVY VEHICLES (C) RE-EXPORT SHARES



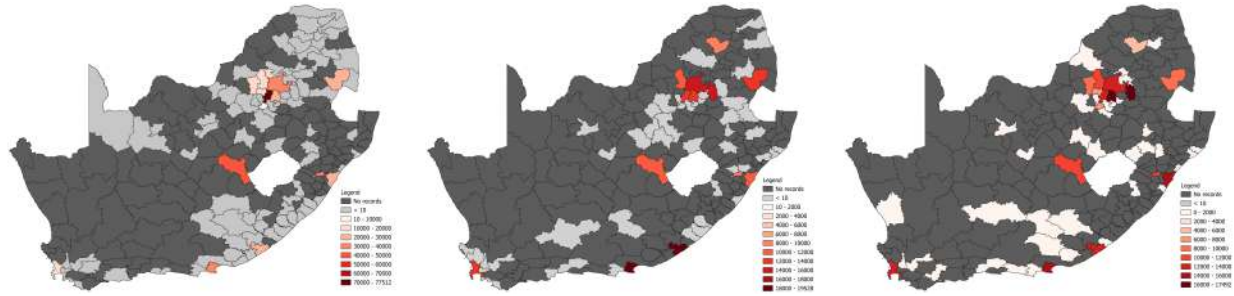
Notes: The figures above show the top 20 models sold by light motor vehicle manufacturers (left figure) and medium-heavy manufacturers (middle figure), distinguishing between imported models and locally-produced models. The figure on the right shows the re-export share of imported vehicles of medium-heavy vehicle producers (on the left) and light vehicle producers (on the right). The data refer to the entire period 2008-2024 and the bars refer to the entire vehicle count over this period. Data source: Lightstone SA 2008-2024.

Figure B.4: Automotive Full-Time Employment and Income

(A) Motor Vehicles (B) Bodies and Trailers (C) Parts and Accessories



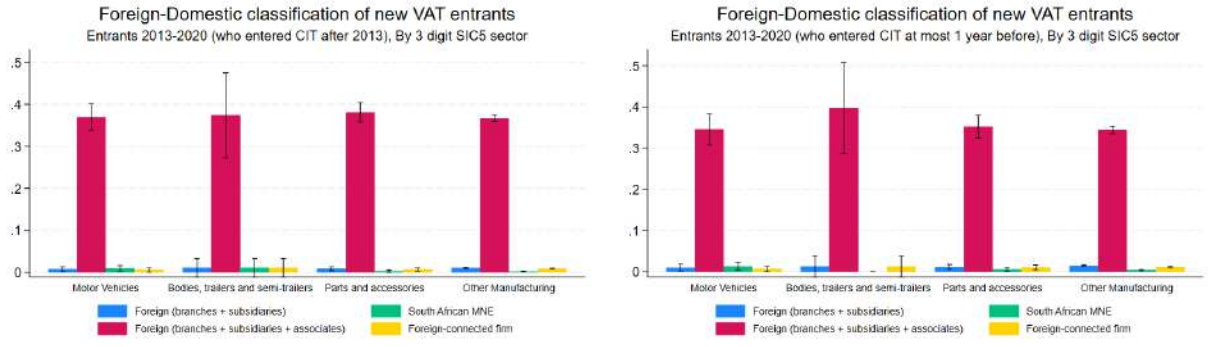
(D) Motor Vehicles (E) Bodies and Trailers (F) Parts and Accessories



Notes: The figures show the geographic distribution of automotive full-time employment (FTE) and (median) income across South Africa in the 2014 tax year, using data from the Spatial Tax Data project. Row 1 refers to FTE, row 2 to median income. The automotive industry is disaggregated in three 3-digit industries: (i) Manufacture of Motor Vehicles (column 1); (ii) Manufacture of Bodies (Coachwork) for Motor Vehicles; Manufacture of Trailers and Semi-Trailers (column 2); and (iii) Manufacture of Parts and Accessories for Motor Vehicles (column 3). Black areas indicate municipalities with no records in the administrative data (zeros), while gray areas indicate municipalities with a positive count but fewer than 10 records; in these cases, the Spatial Tax Data project masks the exact number for confidentiality reasons.

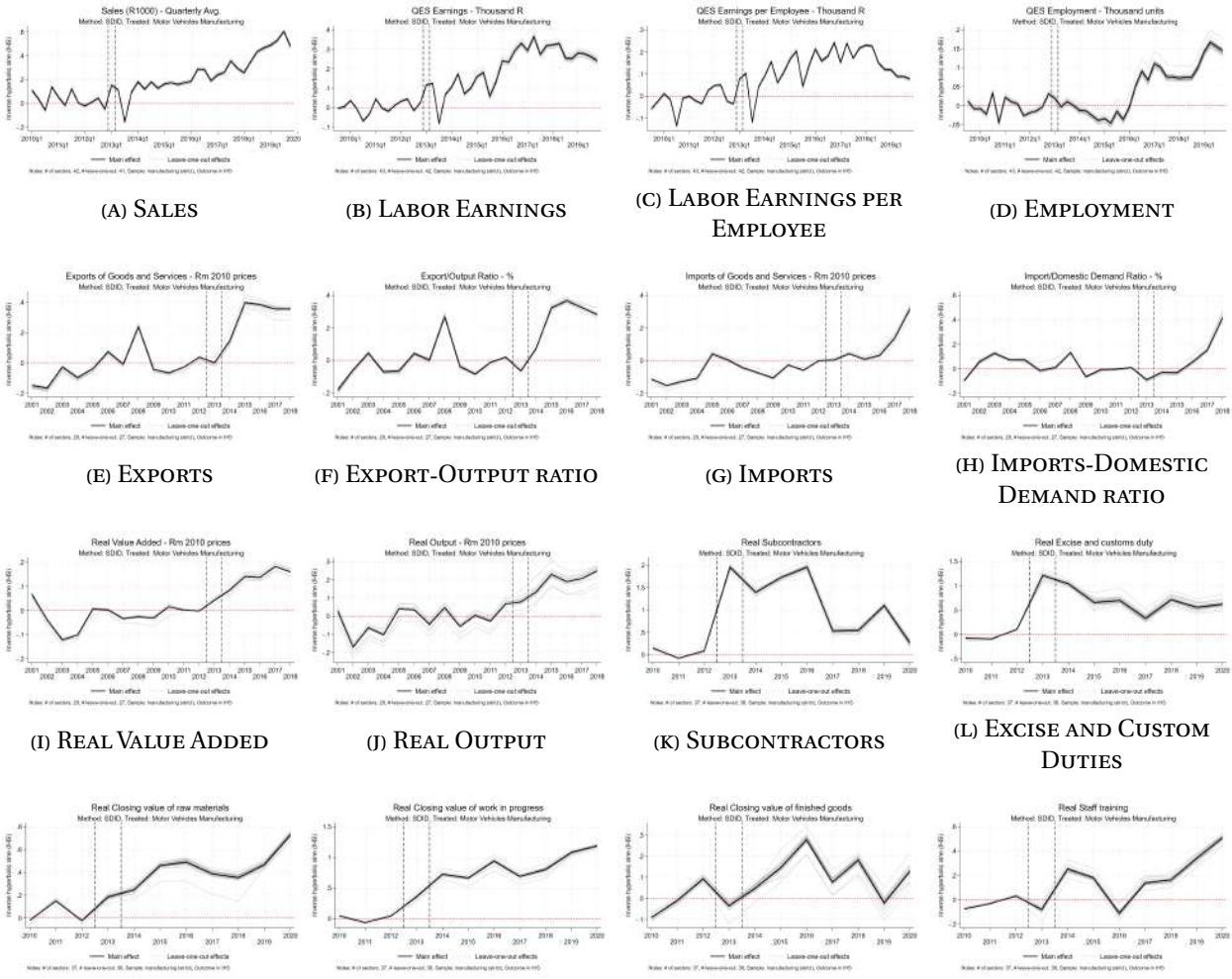
Figure B.5: New entrants: foreign-domestic classification

(A) Entered CIT after 2013 (B) Entered CIT at most 1 year before VAT



Notes: The graphs above show the share of new entrants classified as foreign firms in three targeted sectors (motor vehicle manufacturing; bodies, trailer and semi-trailers manufacturing; parts and accessories manufacturing) and compares them to other manufacturing untargeted sectors. Panel A) refers to post-2013 VAT entrants who also entered CIT after 2013; panel B) refers to post-2013 VAT entrants who entered CIT at most 1 year before entering VAT. Branch: office or division of a foreign firms; subsidiary: company whose parent is a majority holder of more than 50% of its shares; associate: company whose parent possesses a minority stake in the ownership of the company; South African MNE: South African firm with more than 50% of the shares of a foreign firm; foreign-connected firm: South African firm with more than 10% of the shares of a foreign firm. The foreign-domestic classification follows Kilumelume, Reynolds and Ebrahim (2021). Data source: VATVP and CITFP panel.

FIGURE B.6: AGGREGATE SECTOR-LEVEL DATA - LEAVE ONE OUT



(A) SALES (B) LABOR EARNINGS (C) LABOR EARNINGS PER EMPLOYEE (D) EMPLOYMENT

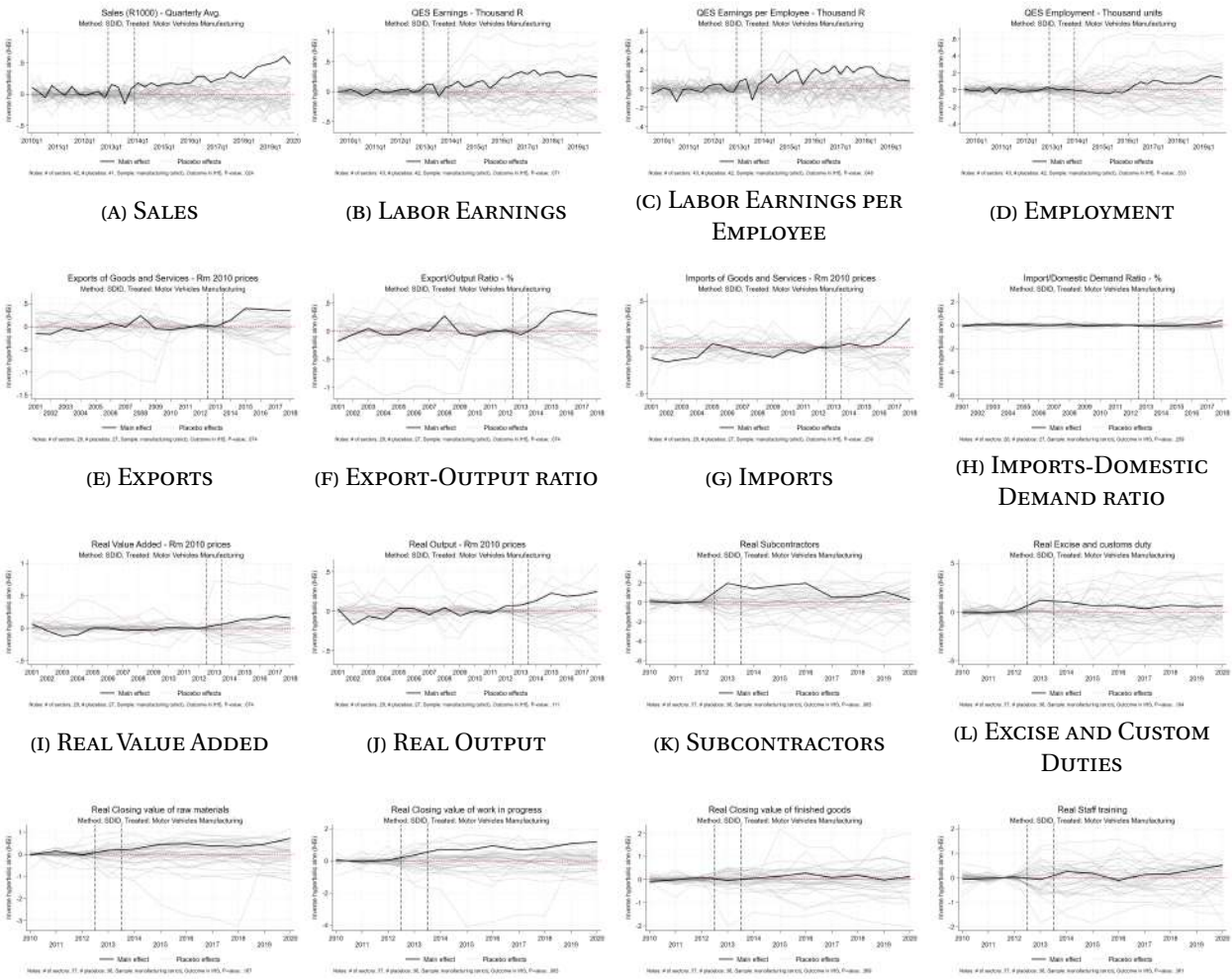
(E) EXPORTS (F) EXPORT-OUTPUT RATIO (G) IMPORTS (H) IMPORTS-DOMESTIC DEMAND RATIO

(I) REAL VALUE ADDED (J) REAL OUTPUT (K) SUBCONTRACTORS (L) EXCISE AND CUSTOM DUTIES

(M) INVENTORIES: RAW MATERIALS (N) INVENTORIES: WORK IN PROGRESS (O) INVENTORIES: FINISHED GOODS (P) STAFF TRAINING

Notes: The graphs above show event-study coefficients from Equation (8) where I iteratively exclude control sectors from the estimation sample, one at a time. The regression is estimated via synthetic difference in difference (Arkhangelsky et al., 2021). All regressions include sector and time fixed effects. All coefficients are estimated relative to a pre-treatment time-weighted average difference between treated and control sectors. Data source: Annual Financial Statistics (AFS).

FIGURE B.7: AGGREGATE SECTOR-LEVEL DATA - SPACE PLACEBO



(A) SALES (B) LABOR EARNINGS (C) LABOR EARNINGS PER EMPLOYEE (D) EMPLOYMENT

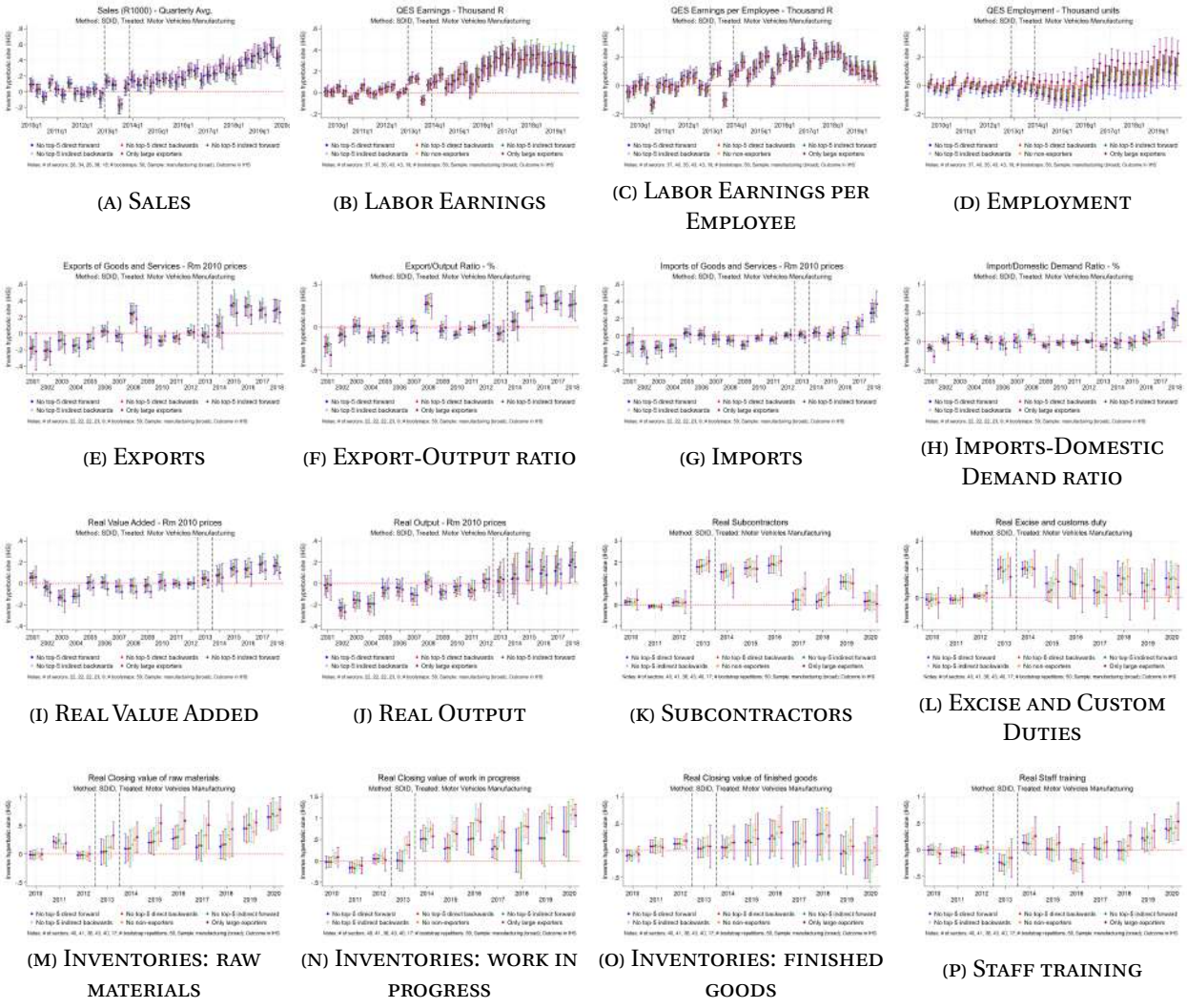
(E) EXPORTS (F) EXPORT-OUTPUT RATIO (G) IMPORTS (H) IMPORTS-DOMESTIC DEMAND RATIO

(I) REAL VALUE ADDED (J) REAL OUTPUT (K) SUBCONTRACTORS (L) EXCISE AND CUSTOM DUTIES

(M) INVENTORIES: RAW MATERIALS (N) INVENTORIES: WORK IN PROGRESS (O) INVENTORIES: FINISHED GOODS (P) STAFF TRAINING

Notes: The graphs above show event-study coefficients from Equation (8), obtained by iteratively re-assigning the treatment status to control sectors and re-estimating the model. The solid line represents the baseline estimates, the light gray lines represent the placebo estimates. The regression is estimated via synthetic difference in difference (Arkhangelsky et al., 2021). All regressions include sector and time fixed effects. All coefficients are estimated relative to a pre-treatment time-weighted average difference between treated and control sectors. Data source: Annual Financial Statistics (AFS).

FIGURE B.8: AGGREGATE SECTOR-LEVEL DATA - ALTERNATIVE DONOR POOL



(A) SALES (B) LABOR EARNINGS (C) LABOR EARNINGS PER EMPLOYEE (D) EMPLOYMENT

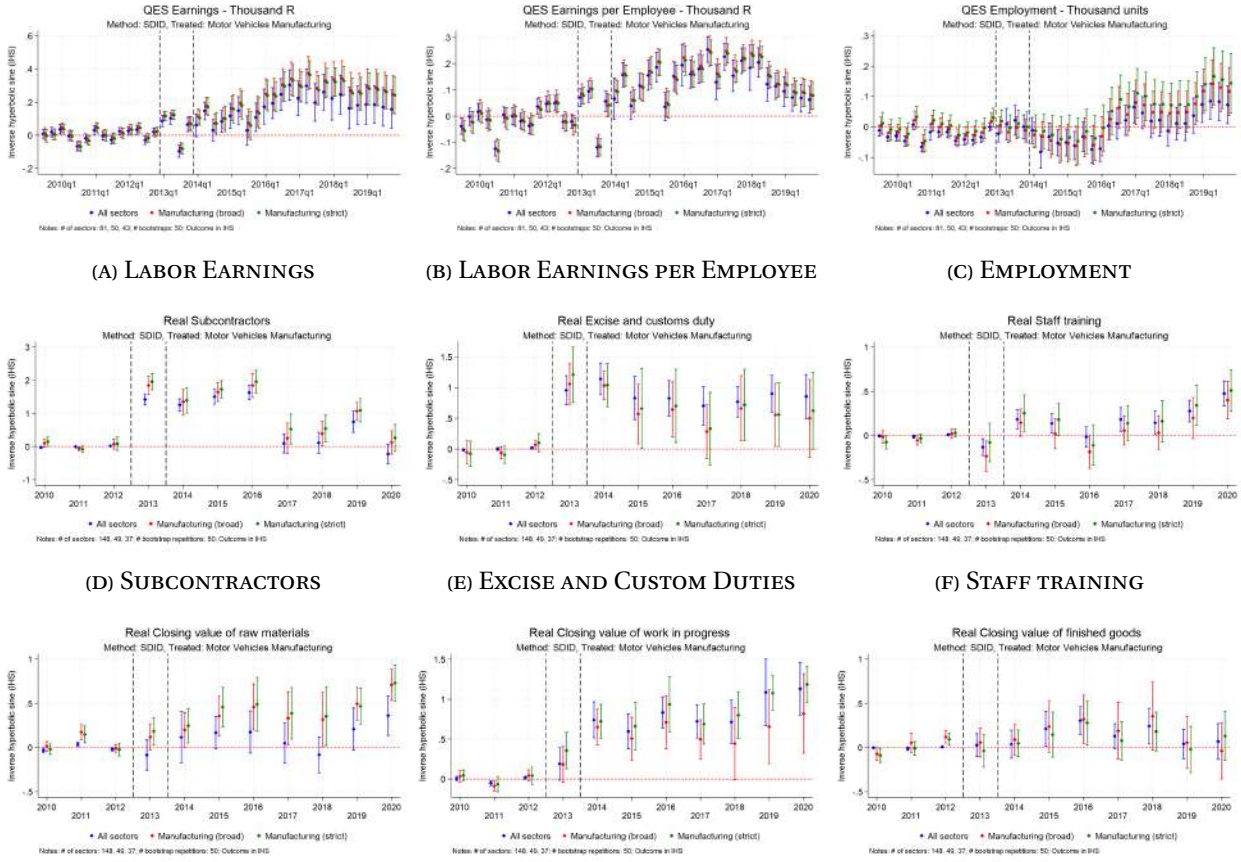
(E) EXPORTS (F) EXPORT-OUTPUT RATIO (G) IMPORTS (H) IMPORTS-DOMESTIC DEMAND RATIO

(I) REAL VALUE ADDED (J) REAL OUTPUT (K) SUBCONTRACTORS (L) EXCISE AND CUSTOM DUTIES

(M) INVENTORIES: RAW MATERIALS (N) INVENTORIES: WORK IN PROGRESS (O) INVENTORIES: FINISHED GOODS (P) STAFF TRAINING

Notes: The graphs above show event-study coefficients and 95% confidence intervals from Equation (8). In each graph, I provide alternative estimates by excluding top-5 directly or indirectly linked sectors, either backwards or forward, by excluding non-exporting sectors, or by retaining only large exporting sectors in the estimation sample. The regression is estimated via synthetic difference in difference (Arkhangelsky et al., 2021). All regressions include sector and time fixed effects. All coefficients are estimated relative to a pre-treatment time-weighted average difference between treated and control sectors. The confidence intervals are estimates through a sector-level clustered bootstrap procedure adapted from Athey et al. (2024), where I re-sample entire control sectors with replacement. Data source: Annual Financial Statistics (AFS).

FIGURE B.9: AGGREGATE SECTOR-LEVEL DATA - ALTERNATIVE SAMPLES



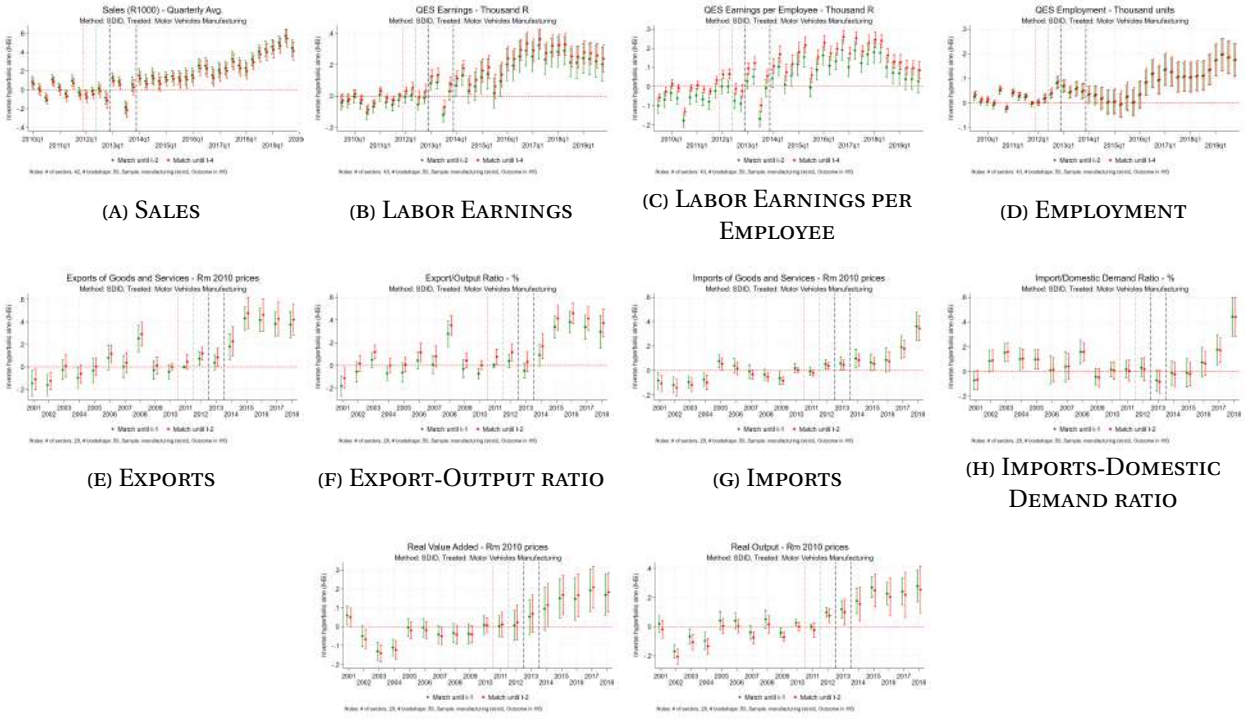
(A) LABOR EARNINGS (B) LABOR EARNINGS PER EMPLOYEE (C) EMPLOYMENT

(D) SUBCONTRACTORS (E) EXCISE AND CUSTOM DUTIES (F) STAFF TRAINING

(G) INVENTORIES: RAW MATERIALS (H) INVENTORIES: WORK IN PROGRESS (I) INVENTORIES: FINISHED GOODS

Notes: The graphs above show event-study coefficients and 95% confidence intervals from Equation (8). In each graph, I provide alternative estimates obtained through alternative estimation samples, either including all sectors or only including manufacturing sectors, either narrowly or broadly defined. The regression is estimated via synthetic difference in difference (Arkhangelsky et al., 2021). All regressions include sector and time fixed effects. All coefficients are estimated relative to a pre-treatment time-weighted average difference between treated and control sectors. The confidence intervals are estimates through a sector-level clustered bootstrap procedure adapted from Athey et al. (2024), where I re-sample entire control sectors with replacement. Data source: Annual Financial Statistics (AFS).

FIGURE B.10: AGGREGATE SECTOR-LEVEL DATA - TIME PLACEBO



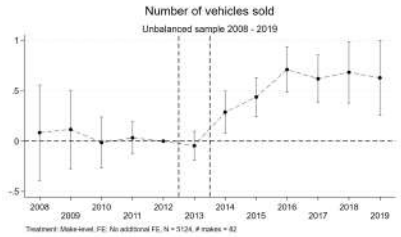
(A) SALES (B) LABOR EARNINGS (C) LABOR EARNINGS PER EMPLOYEE (D) EMPLOYMENT

(E) EXPORTS (F) EXPORT-OUTPUT RATIO (G) IMPORTS (H) IMPORTS-DOMESTIC DEMAND RATIO

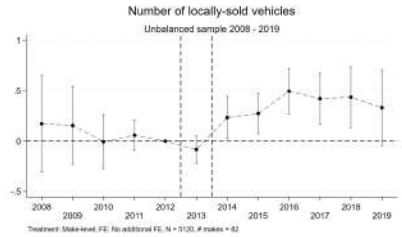
(I) REAL VALUE ADDED (J) REAL OUTPUT

Notes: The graphs above show event-study coefficients and 95% confidence intervals from Equation (8). In each graph, I provide alternative estimates by backdating by 1 or 2 years the true treatment date. The regression is estimated via synthetic difference in difference (Arkhangelsky et al., 2021). All regressions include sector and time fixed effects. All coefficients are estimated relative to a pre-treatment time-weighted average difference between treated and control sectors. The confidence intervals are estimates through a sector-level clustered bootstrap procedure adapted from Athey et al. (2024), where I re-sample entire control sectors with replacement. Data source: Annual Financial Statistics (AFS).

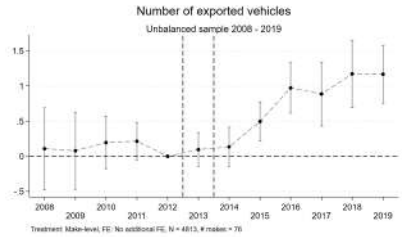
FIGURE B.11: LIGHTSTONE SA - EFFECTS ON SALES BY DESTINATION MARKET - MAKE LEVEL TREATMENT



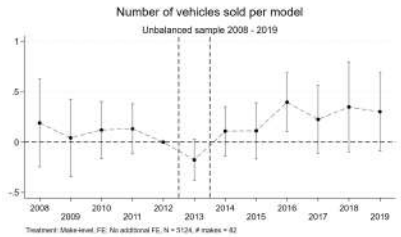
(A) NUMBER OF VEHICLE SOLD



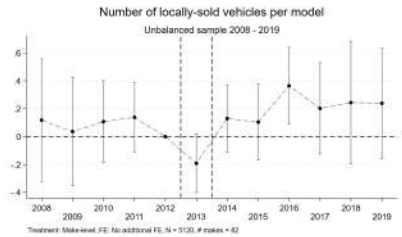
(B) NUMBER OF VEHICLE SOLD (LOCAL MARKET)



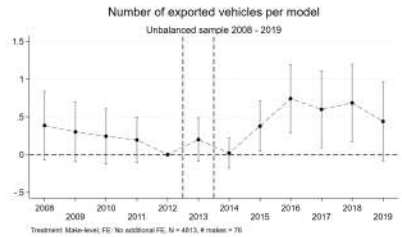
(C) NUMBER OF VEHICLE SOLD (EXPORT MARKET)



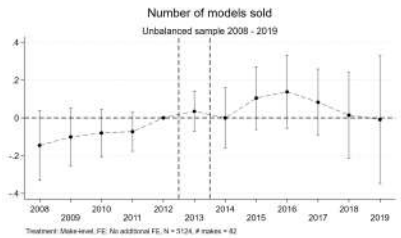
(D) NUMBER OF VEHICLES SOLD PER MODEL



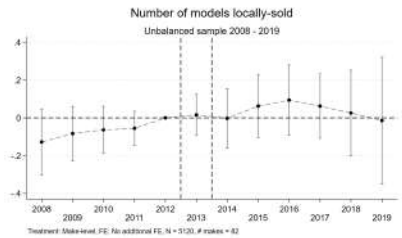
(E) NUMBER OF VEHICLES SOLD PER MODEL (LOCAL MARKET)



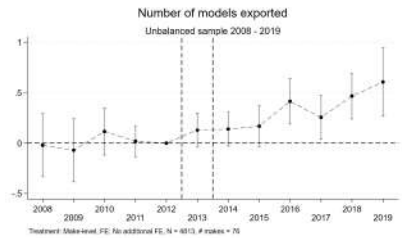
(F) NUMBER OF VEHICLES SOLD PER MODEL (EXPORT MARKET)



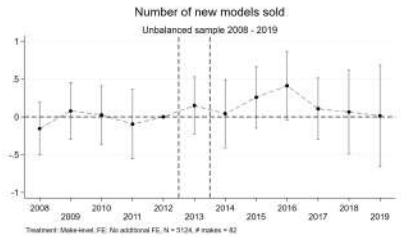
(G) NUMBER OF MODELS SOLD



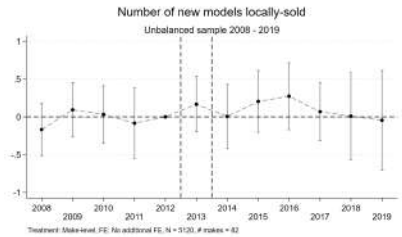
(H) NUMBER OF MODELS SOLD (LOCAL MARKET)



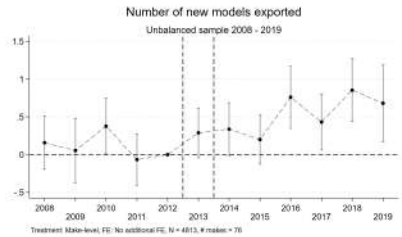
(I) NUMBER OF MODELS SOLD (EXPORT MARKET)



(J) NUMBER OF NEW MODELS SOLD



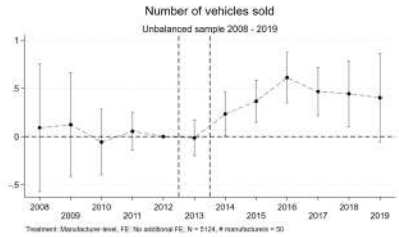
(K) NUMBER OF NEW MODELS SOLD (LOCAL MARKET)



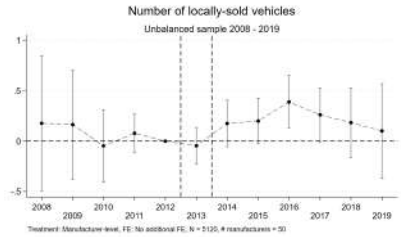
(L) NUMBER OF NEW MODELS SOLD (EXPORT MARKET)

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (11). Outcome variables are: number of vehicles (row 1), number of vehicles per model (row 2), number of models (row 3), number of new models (row 4). The columns consider different destination markets: all sales (column 1), local sales (column 2), export sales (column 3). The underlying dataset is a weakly-balanced panel at the vehicle type level, with imputed zero sales in years in-between the first and last year with non-zero reported sales. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (vehicle-type) fixed effects and time fixed effects. All event-study coefficients are estimated relative to 2012 (the pre-treatment year). The treatment indicator is determined by manufacturing vs retailing status, measured over the entire sample period 2008-2019, and defined at the automotive make level. The standard errors are clustered at the level of treatment variation (automotive make). Data source: Lightstone SA.

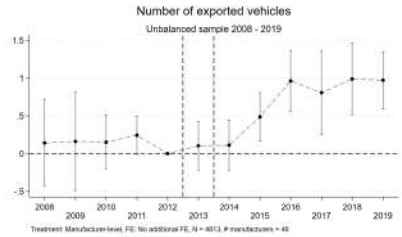
FIGURE B.12: LIGHTSTONE SA - EFFECTS ON SALES BY DESTINATION MARKET - GROUP LEVEL TREATMENT



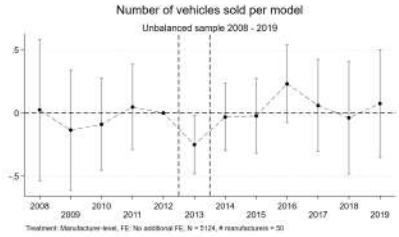
(A) NUMBER OF VEHICLE SOLD



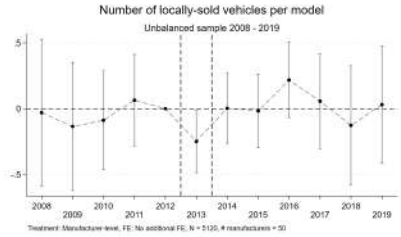
(B) NUMBER OF VEHICLE SOLD (LOCAL MARKET)



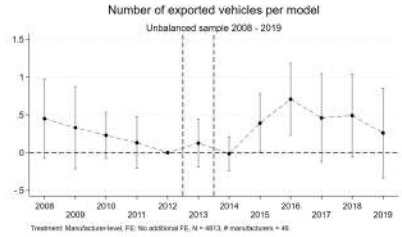
(C) NUMBER OF VEHICLE SOLD (EXPORT MARKET)



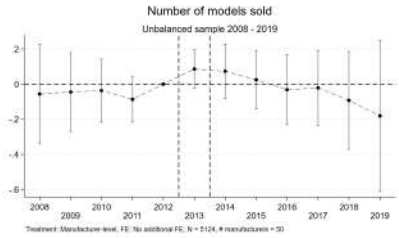
(D) NUMBER OF VEHICLES SOLD PER MODEL



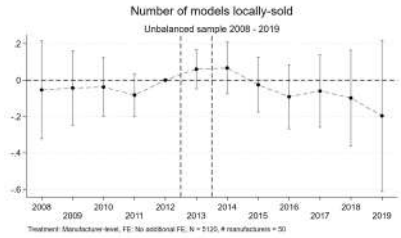
(E) NUMBER OF VEHICLES SOLD PER MODEL (LOCAL MARKET)



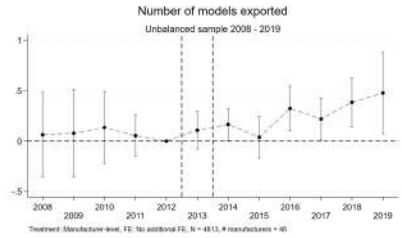
(F) NUMBER OF VEHICLES SOLD PER MODEL (EXPORT MARKET)



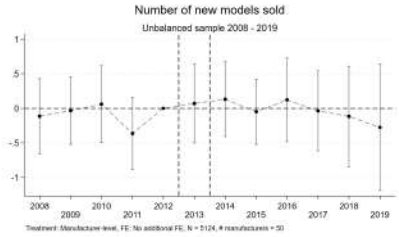
(G) NUMBER OF MODELS SOLD



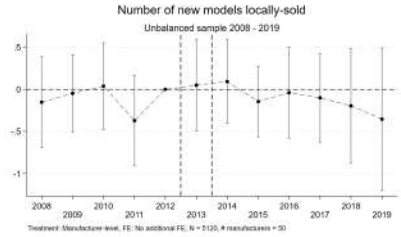
(H) NUMBER OF MODELS SOLD (LOCAL MARKET)



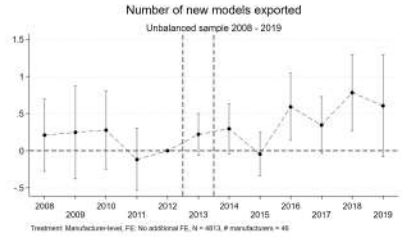
(I) NUMBER OF MODELS SOLD (EXPORT MARKET)



(J) NUMBER OF NEW MODELS SOLD



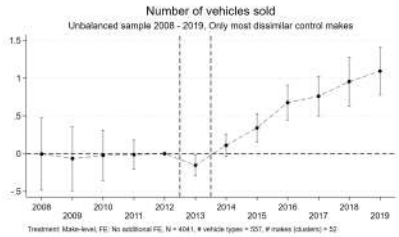
(K) NUMBER OF NEW MODELS SOLD (LOCAL MARKET)



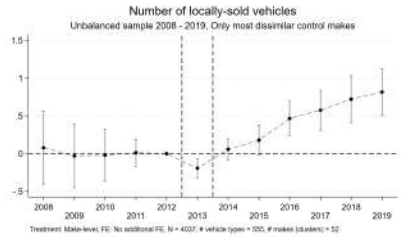
(L) NUMBER OF NEW MODELS SOLD (EXPORT MARKET)

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (11). Outcome variables are: number of vehicles (row 1), number of vehicles per model (row 2), number of models (row 3), number of new models (row 4). The columns consider different destination markets: all sales (column 1), local sales (column 2), export sales (column 3). The underlying dataset is a weakly-balanced panel at the vehicle type level, with imputed zero sales in years in-between the first and last year with non-zero reported sales. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (vehicle-type) fixed effects and time fixed effects. All event-study coefficients are estimated relative to 2012 (the pre-treatment year). The treatment indicator is determined by manufacturing vs retailing status, measured over the entire sample period 2008-2019, and defined at the automotive group level. The standard errors are clustered at the level of treatment variation (automotive group). Data source: Lightstone SA.

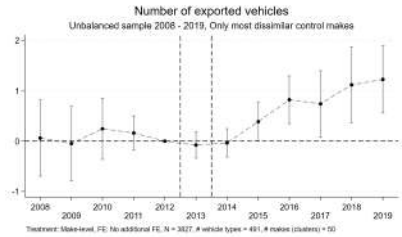
FIGURE B.13: LIGHTSTONE SA - EFFECTS ON SALES BY DESTINATION MARKET - MAKE LEVEL TREATMENT - EXCLUDING CONTROL MAKES MOST SIMILAR IN THE PRODUCT SPACE TO TREATMENT MAKES



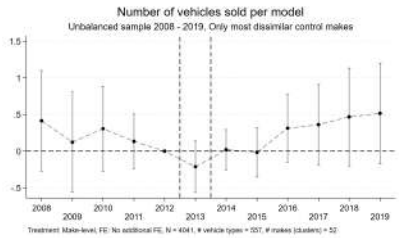
(A) NUMBER OF VEHICLE SOLD



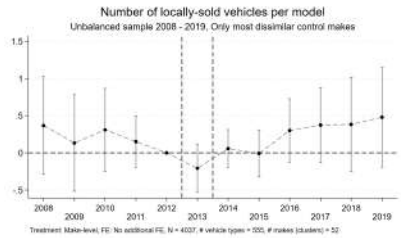
(B) NUMBER OF VEHICLE SOLD (LOCAL MARKET)



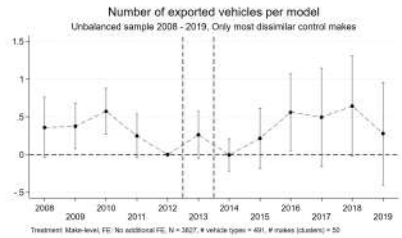
(C) NUMBER OF VEHICLE SOLD (EXPORT MARKET)



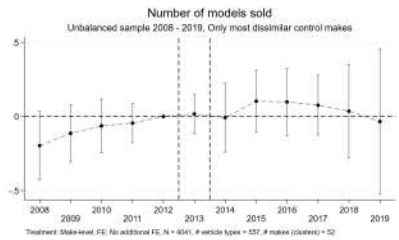
(D) NUMBER OF VEHICLES SOLD PER MODEL



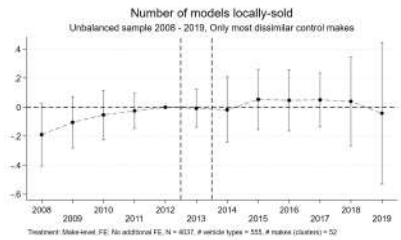
(E) NUMBER OF VEHICLES SOLD PER MODEL (LOCAL MARKET)



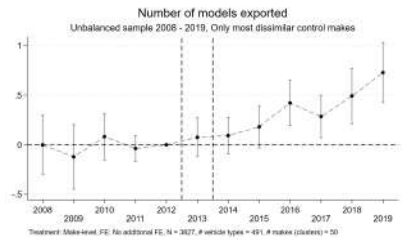
(F) NUMBER OF VEHICLES SOLD PER MODEL (EXPORT MARKET)



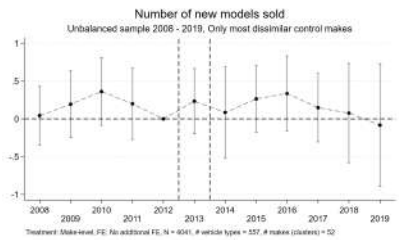
(G) NUMBER OF MODELS SOLD



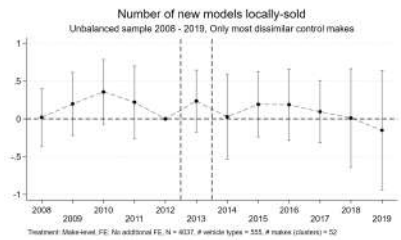
(H) NUMBER OF MODELS SOLD (LOCAL MARKET)



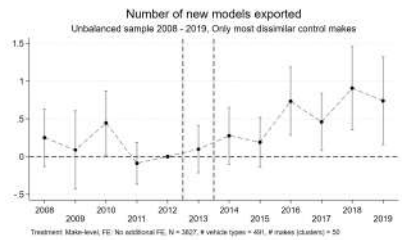
(I) NUMBER OF MODELS SOLD (EXPORT MARKET)



(J) NUMBER OF NEW MODELS SOLD



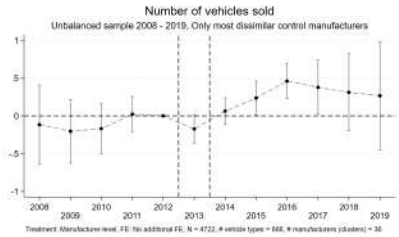
(K) NUMBER OF NEW MODELS SOLD (LOCAL MARKET)



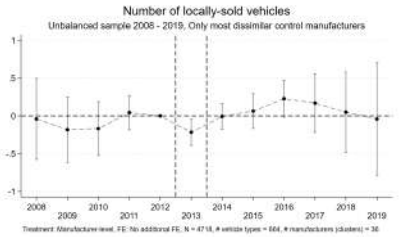
(L) NUMBER OF NEW MODELS SOLD (EXPORT MARKET)

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (11). The control group excludes vehicle makes most similar (above median) in the product space to treatment makes; the bilateral measure of similarity only uses information pre-2013 and excludes the brand in the construction of the measure. Outcome variables are: number of vehicles (row 1), number of vehicles per model (row 2), number of models (row 3), number of new models (row 4). The columns consider different destination markets: all sales (column 1), local sales (column 2), export sales (column 3). The underlying dataset is a weakly-balanced panel at the vehicle type level, with imputed zero sales in years in-between the first and last year with non-zero reported sales. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (vehicle-type) fixed effects and time fixed effects. All event-study coefficients are estimated relative to 2012 (the pre-treatment year). The treatment indicator is determined by manufacturing vs retailing status, measured over the entire sample period 2008-2019, and defined at the automotive make level. The standard errors are clustered at the level of treatment variation (automotive make). Data source: Lightstone SA.

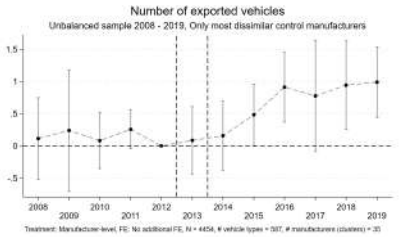
FIGURE B.14: LIGHTSTONE SA - EFFECTS ON SALES BY DESTINATION MARKET - GROUP LEVEL TREATMENT - EXCLUDING CONTROL GROUPS MOST SIMILAR IN THE PRODUCT SPACE TO TREATMENT GROUPS



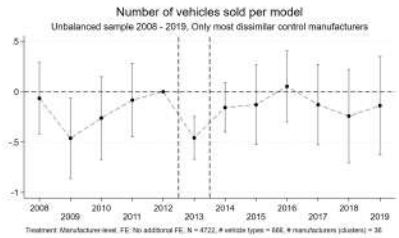
(A) NUMBER OF VEHICLE SOLD



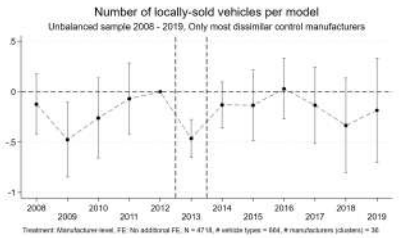
(B) NUMBER OF VEHICLE SOLD (LOCAL MARKET)



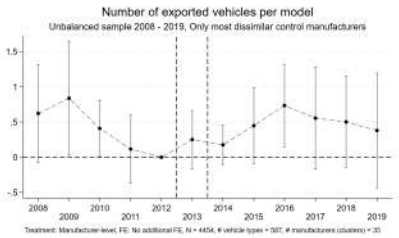
(C) NUMBER OF VEHICLE SOLD (EXPORT MARKET)



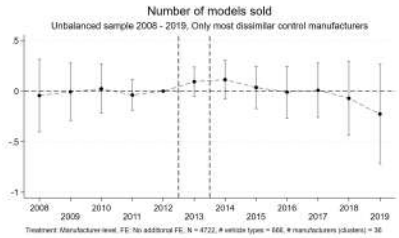
(D) NUMBER OF VEHICLES SOLD PER MODEL



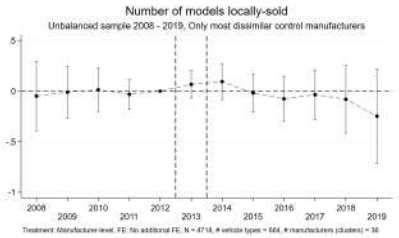
(E) NUMBER OF VEHICLES SOLD PER MODEL (LOCAL MARKET)



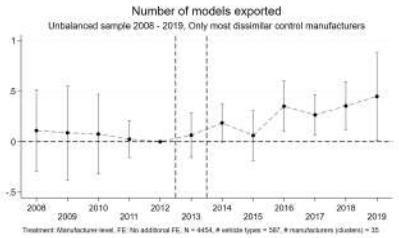
(F) NUMBER OF VEHICLES SOLD PER MODEL (EXPORT MARKET)



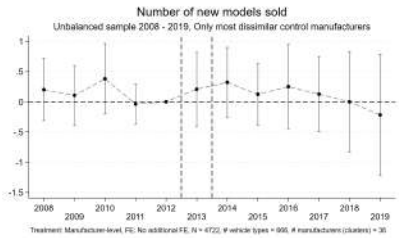
(G) NUMBER OF MODELS SOLD



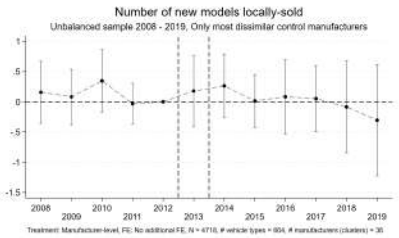
(H) NUMBER OF MODELS SOLD (LOCAL MARKET)



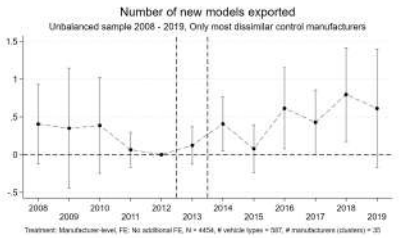
(I) NUMBER OF MODELS SOLD (EXPORT MARKET)



(J) NUMBER OF NEW MODELS SOLD



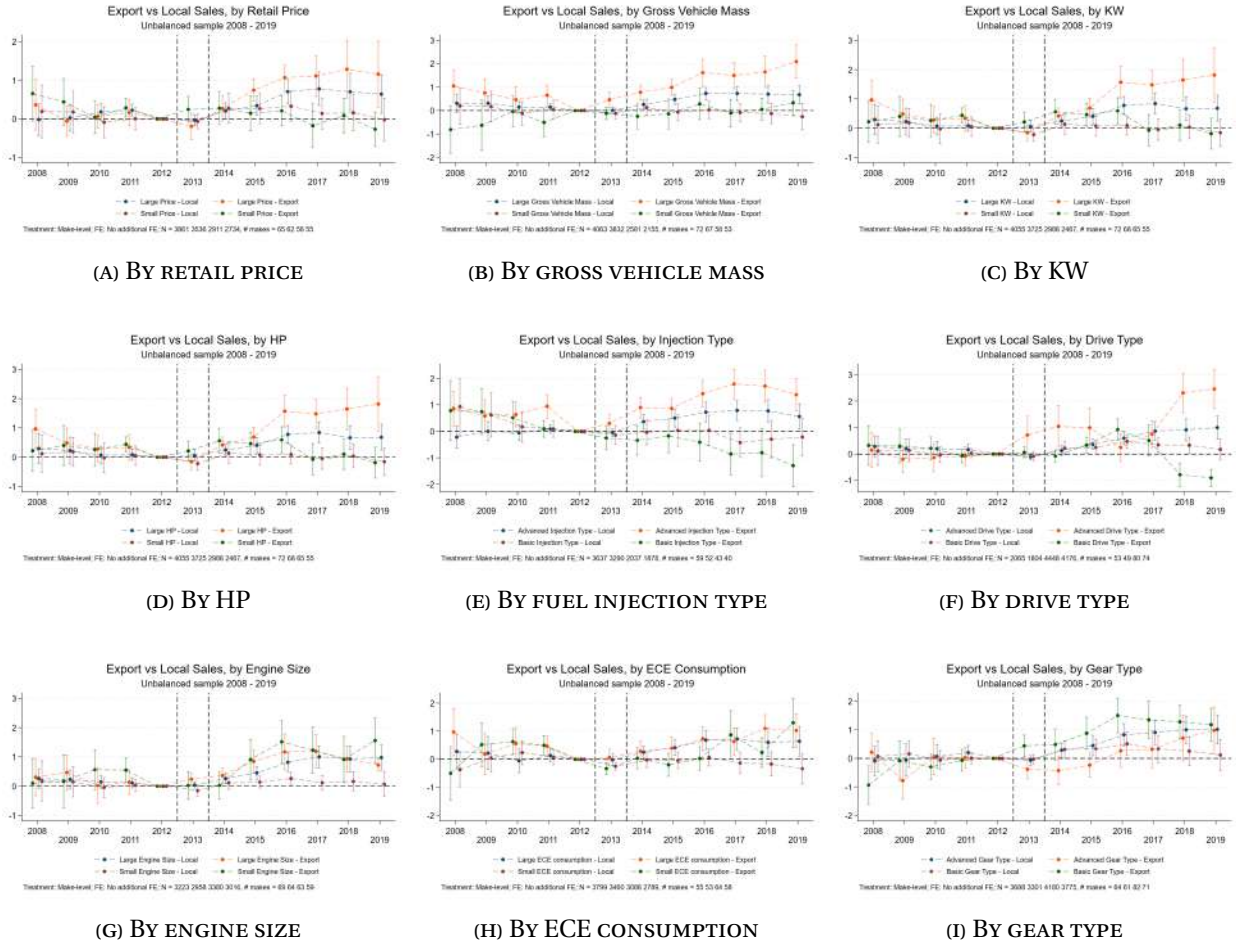
(K) NUMBER OF NEW MODELS SOLD (LOCAL MARKET)



(L) NUMBER OF NEW MODELS SOLD (EXPORT MARKET)

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (11). The control group excludes vehicle groups most similar (above median) in the product space to treatment groups; the bilateral measure of similarity only uses information pre-2013 and excludes the brand in the construction of the measure. Outcome variables are: number of vehicles (row 1), number of vehicles per model (row 2), number of models (row 3), number of new models (row 4). The columns consider different destination markets: all sales (column 1), local sales (column 2), export sales (column 3). The underlying dataset is a weakly-balanced panel at the vehicle type level, with imputed zero sales in years in-between the first and last year with non-zero reported sales. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (vehicle-type) fixed effects and time fixed effects. All event-study coefficients are estimated relative to 2012 (the pre-treatment year). The treatment indicator is determined by manufacturing vs retailing status, measured over the entire sample period 2008-2019, and defined at the automotive group level. The standard errors are clustered at the level of treatment variation (automotive group). Data source: Lightstone SA.

FIGURE B.15: LIGHTSTONE SA - HETEROGENEOUS EFFECTS ON SALES BY VEHICLE CHARACTERISTICS AND DESTINATION MARKET - MAKE LEVEL TREATMENT



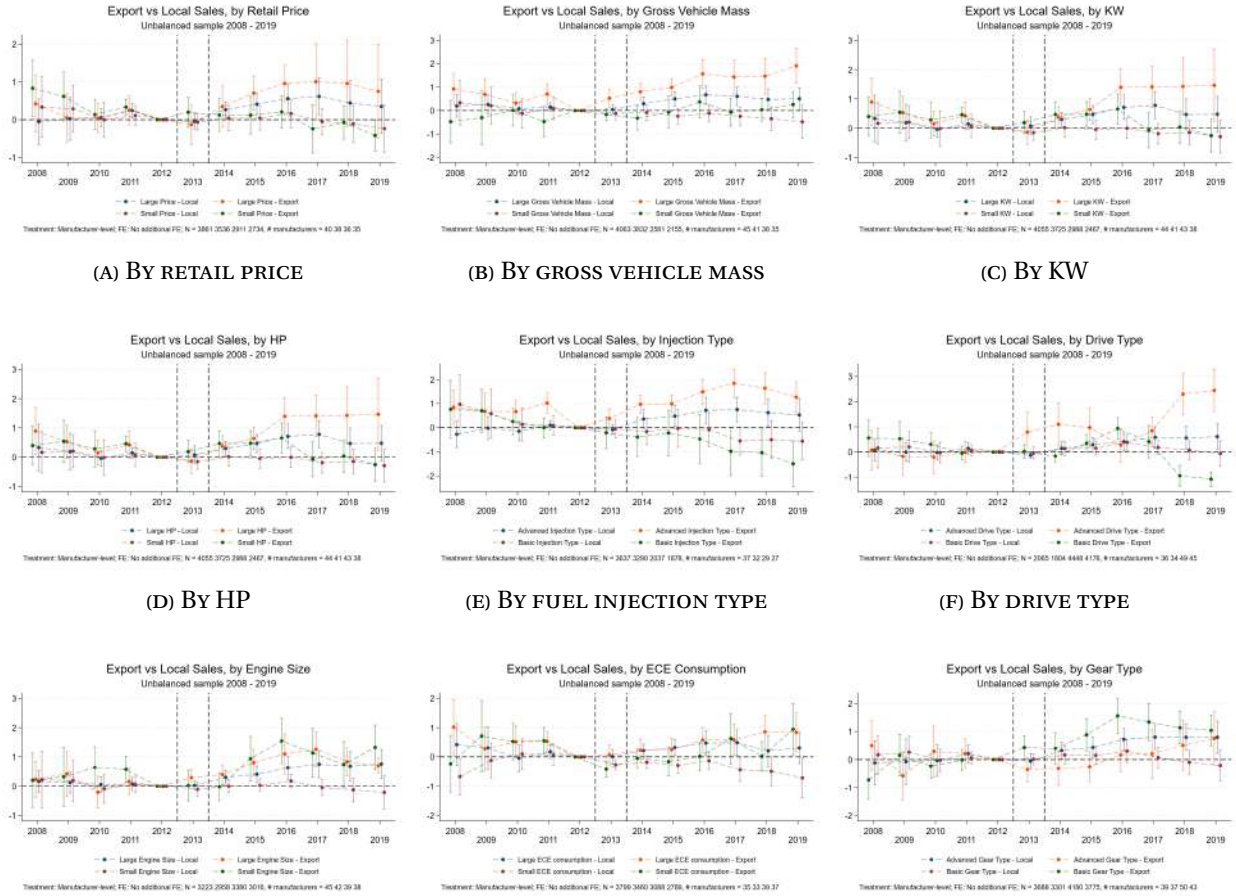
(A) BY RETAIL PRICE (B) BY GROSS VEHICLE MASS (C) BY KW

(D) BY HP (E) BY FUEL INJECTION TYPE (F) BY DRIVE TYPE

(G) BY ENGINE SIZE (H) BY ECE CONSUMPTION (I) BY GEAR TYPE

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (11). Outcome variables are: number of vehicles (row 1), number of vehicles per model (row 2), number of models (row 3), number of new models (row 4). The columns consider different destination markets: all sales (column 1), local sales (column 2), export sales (column 3). The underlying dataset is a weakly-balanced panel at the vehicle type level, with imputed zero sales in years in-between the first and last year with non-zero reported sales. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (vehicle-type) fixed effects and time fixed effects. All event-study coefficients are estimated relative to 2012 (the pre-treatment year). The treatment indicator is determined by manufacturing vs retailing status, measured over the entire sample period 2008-2019, and defined at the automotive make level. The standard errors are clustered at the level of treatment variation (automotive make). Data source: Lightstone SA.

FIGURE B.16: LIGHTSTONE SA - HETEROGENEOUS EFFECTS ON SALES BY VEHICLE CHARACTERISTICS AND DESTINATION MARKET - GROUP LEVEL TREATMENT



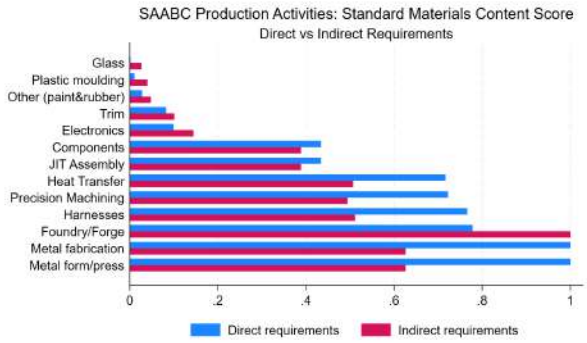
(A) BY RETAIL PRICE (B) BY GROSS VEHICLE MASS (C) BY KW

(D) BY HP (E) BY FUEL INJECTION TYPE (F) BY DRIVE TYPE

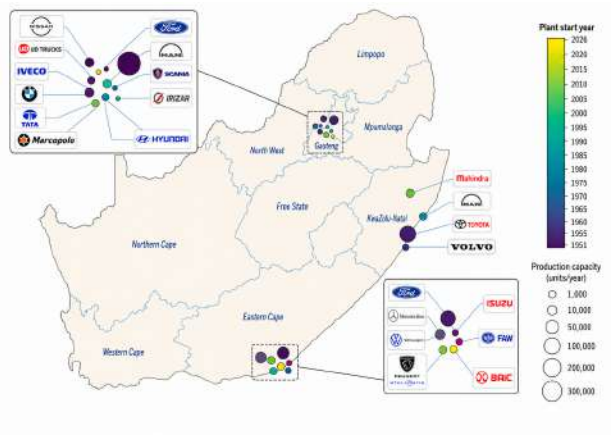
(G) BY ENGINE SIZE (H) BY ECE CONSUMPTION (I) BY GEAR TYPE

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (11). Outcome variables are: number of vehicles (row 1), number of vehicles per model (row 2), number of models (row 3), number of new models (row 4). The columns consider different destination markets: all sales (column 1), local sales (column 2), export sales (column 3). The underlying dataset is a weakly-balanced panel at the vehicle type level, with imputed zero sales in years in-between the first and last year with non-zero reported sales. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (vehicle-type) fixed effects and time fixed effects. All event-study coefficients are estimated relative to 2012 (the pre-treatment year). The treatment indicator is determined by manufacturing vs retailing status, measured over the entire sample period 2008-2019, and defined at the automotive group level. The standard errors are clustered at the level of treatment variation (automotive group). Data source: Lightstone SA.

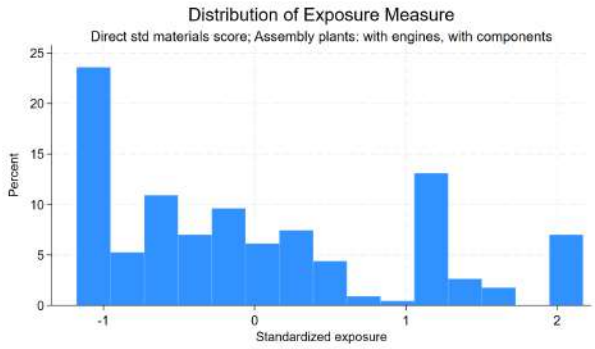
FIGURE B.17: SAABC EXPUSURE MEASURES



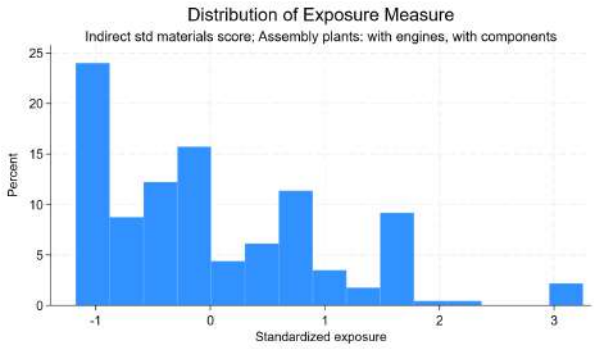
(A) PRODUCTION ACTIVITIES' STANDARD MATERIALS SCORE



(B) GEOGRAPHICAL DISTRIBUTION OF ASSEMBLY PLANTS



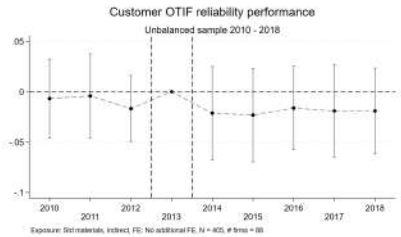
(C) DISTRIBUTION OF STANDARD. DIRECT EXPOSURE



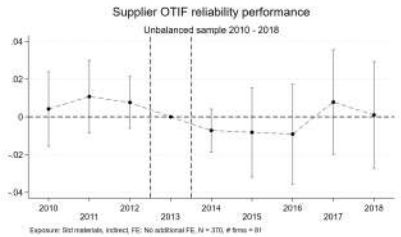
(D) DISTRIBUTION OF STANDARD. INDIRECT EXPOSURE

Notes: panel A) shows the standard material content score for each economic activity reported in the SAABC data, based either on direct or indirect requirements and constructed from StatSA input-output tables. Panel B) shows the geographical location and production capacity of the automotive assembly plants contained in the Marklines assembly plant database. Panels C) and D) show the distributions of the (standardized) direct and indirect exposure measures, respectively. Data source: SAABC and Marklines information platform.

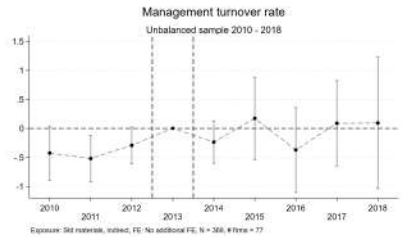
FIGURE B.18: SAABC DATA - FIRM UPGRADING OUTCOMES II



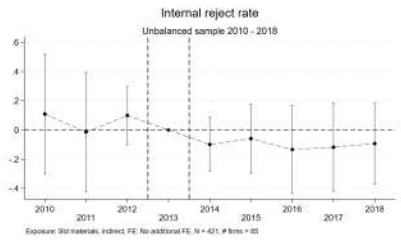
(A) CUSTOMER OTIF RELIABILITY



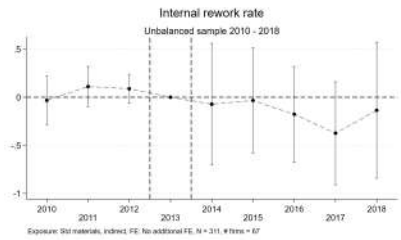
(B) SUPPLIER OTIF RELIABILITY



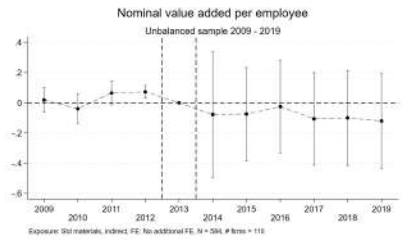
(C) MANAGEMENT TURNOVER RATE



(D) INTERNAL REJECT RATE



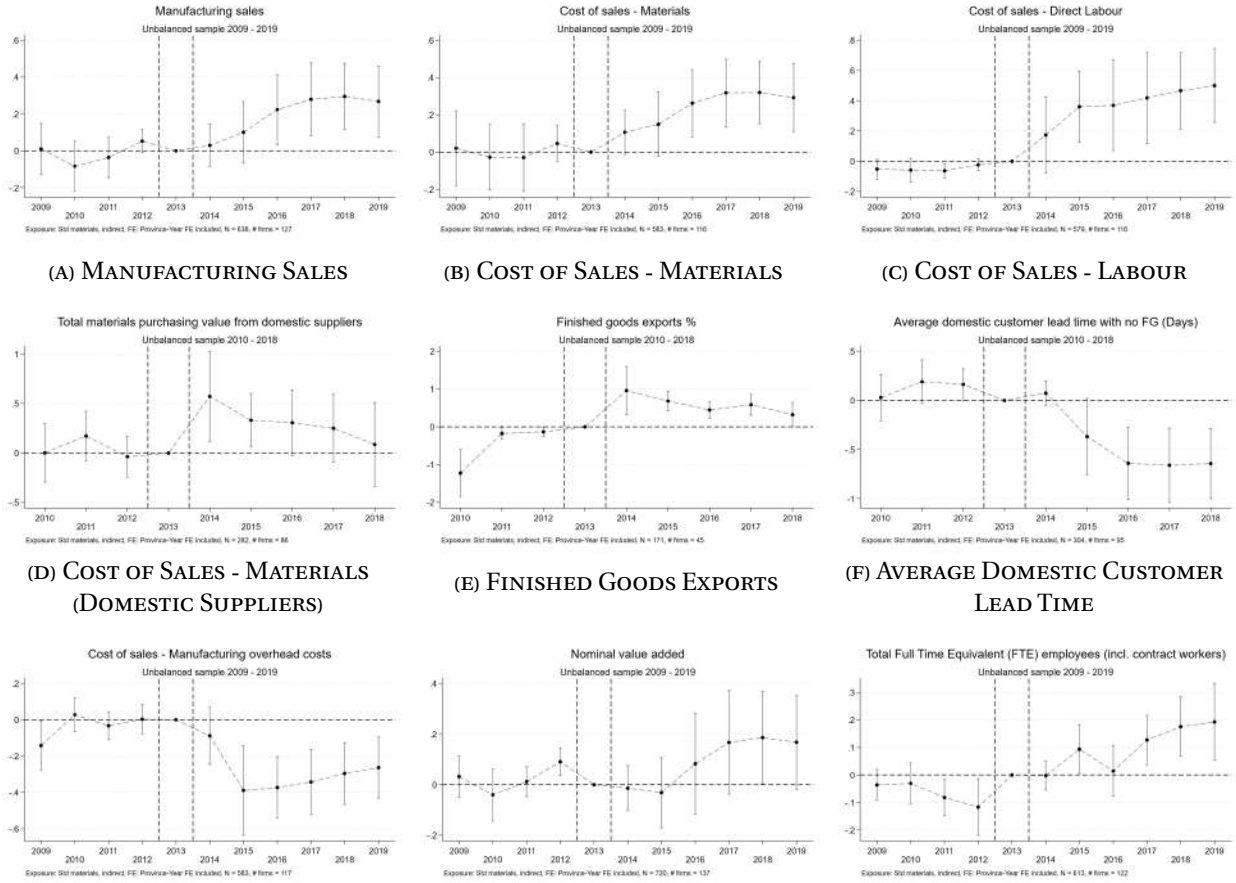
(E) INTERNAL REWORK RATE



(F) NOMINAL VALUE ADDED PER EMPLOYEE

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (13). Each point estimate plots the coefficient of the interaction between time fixed effects and a firm-specific time-invariant measure of exposure to the downstream demand shock, as defined in Equation (12). Outcome variables are: customer OTIF reliability performance (graph A), supplier OTIF reliability performance (graph B), management turnover rate (graph C), internal reject rate (graph D), internal rework rate (graph E), nominal value added per employee (graph F). All outcomes are winsorized at 1% and 99% by year. The underlying dataset is a weakly-balanced panel at the firm level. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (firm) fixed effects and time fixed effects. All event-study coefficients are estimated relative to 2013, based on the results from Section 8. The standard errors are clustered at the firm level. Data source: South Africa Automotive Benchmarking Club (SAABC).

FIGURE B.19: SAABC DATA - ROBUSTNESS: INCLUSION OF PROVINCE FIXED EFFECTS



(A) MANUFACTURING SALES

(B) COST OF SALES - MATERIALS

(C) COST OF SALES - LABOUR

(D) COST OF SALES - MATERIALS (DOMESTIC SUPPLIERS)

(E) FINISHED GOODS EXPORTS

(F) AVERAGE DOMESTIC CUSTOMER LEAD TIME

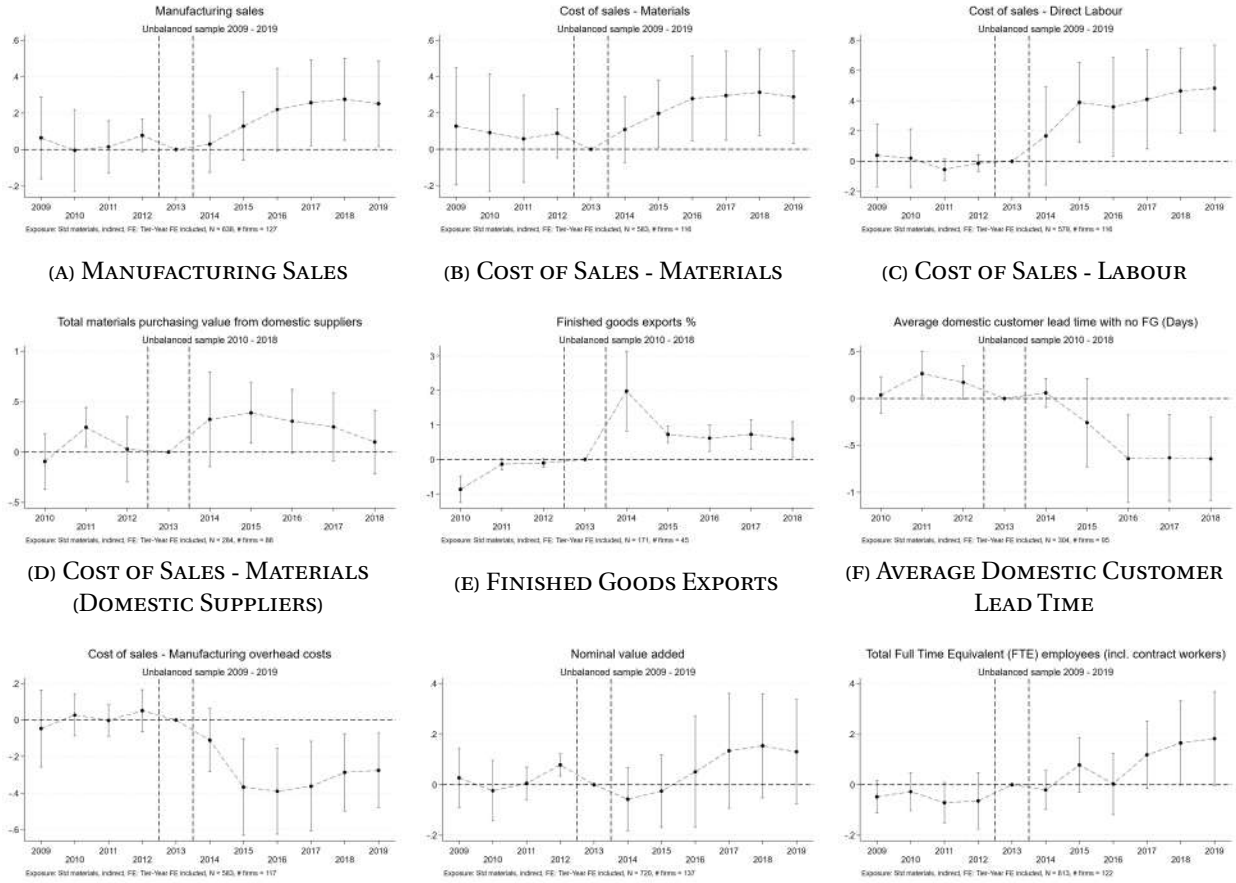
(G) COST OF SALES - MANUFACTURING OVERHEADS

(H) NOMINAL VALUE ADDED

(I) FULL-TIME EMPLOYMENT

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (13). Each point estimate plots the coefficient of the interaction between time fixed effects and a firm-specific time-invariant measure of exposure to the downstream demand shock, as defined in Equation (12). Outcome variables are: manufacturing sales (graph A), expenditure on materials (cost of sales) (graph B), expenditure on labour (cost of sales) (graph C), expenditure on materials from domestic suppliers (graph D), share of finished goods exports (graph E), average domestic customer lead time (graph F), manufacturing overheads (graph G), nominal value added (graph H), full-time employment (graph I). All outcomes are winsorized at 1% and 99% by year. The underlying dataset is a weakly-balanced panel at the firm level. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (firm) fixed effects, time fixed effects and province-year fixed effects. All event-study coefficients are estimated relative to 2013, based on the results from Section 8. The standard errors are clustered at the firm level. Data source: South Africa Automotive Benchmarking Club (SAABC).

FIGURE B.20: SAABC DATA - ROBUSTNESS: INCLUSION OF TIER FIXED EFFECTS



(A) MANUFACTURING SALES

(B) COST OF SALES - MATERIALS

(C) COST OF SALES - LABOUR

(D) COST OF SALES - MATERIALS (DOMESTIC SUPPLIERS)

(E) FINISHED GOODS EXPORTS

(F) AVERAGE DOMESTIC CUSTOMER LEAD TIME

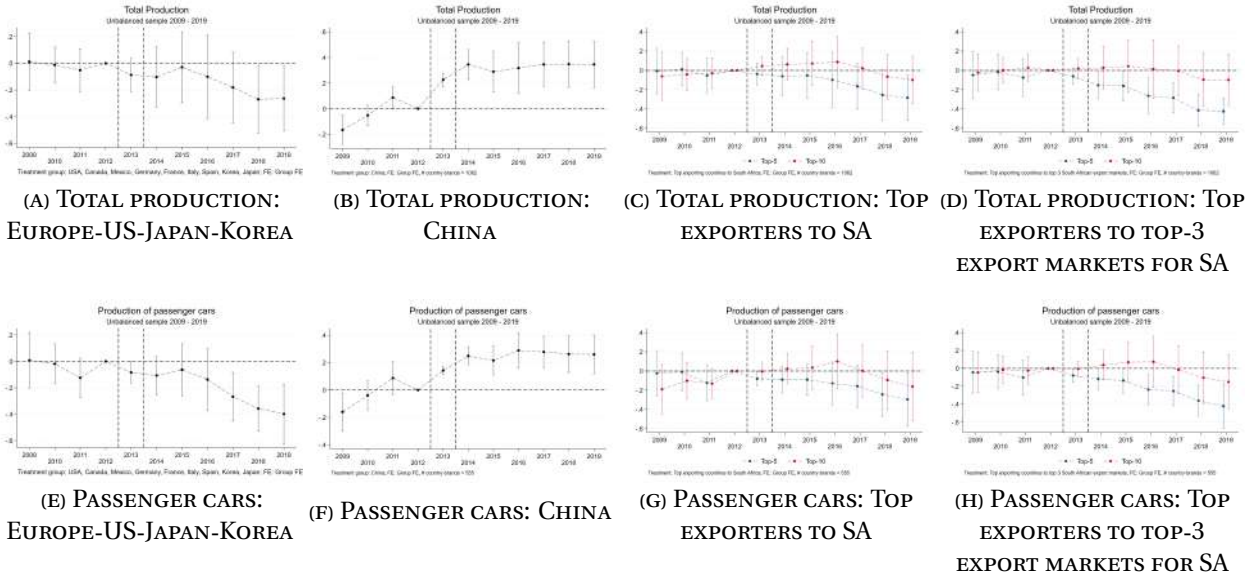
(G) COST OF SALES - MANUFACTURING OVERHEADS

(H) NOMINAL VALUE ADDED

(I) FULL-TIME EMPLOYMENT

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (13). Each point estimate plots the coefficient of the interaction between time fixed effects and a firm-specific time-invariant measure of exposure to the downstream demand shock, as defined in Equation (12). Outcome variables are: manufacturing sales (graph A), expenditure on materials (cost of sales) (graph B), expenditure on labour (cost of sales) (graph C), expenditure on materials from domestic suppliers (graph D), share of finished goods exports (graph E), average domestic customer lead time (graph F), manufacturing overheads (graph G), nominal value added (graph H), full-time employment (graph I). All outcomes are winsorized at 1% and 99% by year. The underlying dataset is a weakly-balanced panel at the firm level. The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include unit (firm) fixed effects, time fixed effects and tier-year fixed effects. All event-study coefficients are estimated relative to 2013, based on the results from Section 8. The standard errors are clustered at the firm level. Data source: South Africa Automotive Benchmarking Club (SAABC).

FIGURE B.21: MARKLINES DATA - COMPETITORS PRODUCTION RESPONSE - WITH GROUP-YEAR FE



(A) TOTAL PRODUCTION: EUROPE-US-JAPAN-KOREA

(B) TOTAL PRODUCTION: CHINA

(C) TOTAL PRODUCTION: TOP EXPORTERS TO SA

(D) TOTAL PRODUCTION: TOP EXPORTERS TO TOP-3 EXPORT MARKETS FOR SA

(E) PASSENGER CARS: EUROPE-US-JAPAN-KOREA

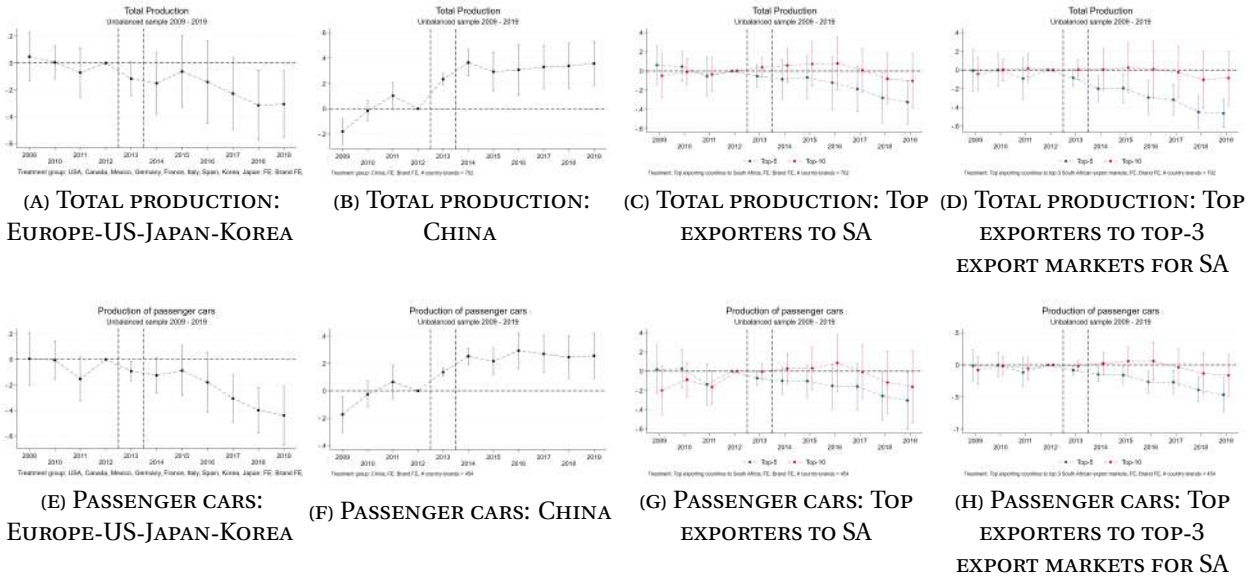
(F) PASSENGER CARS: CHINA

(G) PASSENGER CARS: TOP EXPORTERS TO SA

(H) PASSENGER CARS: TOP EXPORTERS TO TOP-3 EXPORT MARKETS FOR SA

Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (14). Each point estimate plots the coefficient of the interaction between time fixed effects and a country-specific dummy for competitor countries. Outcome variables are total vehicle production (row 1) and production of passenger cars (row 2). The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include brand, country and time fixed effects; in addition, these specifications include group-year fixed effects. All event-study coefficients are estimated relative to 2012. The standard errors are clustered at the country-of-production level. Data source: Marklines information platform.

FIGURE B.22: MARKLINES DATA - COMPETITORS PRODUCTION RESPONSE - WITH BRAND-YEAR FE



(A) TOTAL PRODUCTION: EUROPE-US-JAPAN-KOREA

(B) TOTAL PRODUCTION: CHINA

(C) TOTAL PRODUCTION: TOP EXPORTERS TO SA

(D) TOTAL PRODUCTION: TOP EXPORTERS TO TOP-3 EXPORT MARKETS FOR SA

(E) PASSENGER CARS: EUROPE-US-JAPAN-KOREA

(F) PASSENGER CARS: CHINA

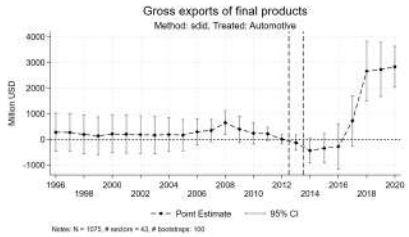
(G) PASSENGER CARS: TOP EXPORTERS TO SA

(H) PASSENGER CARS: TOP EXPORTERS TO TOP-3 EXPORT MARKETS FOR SA

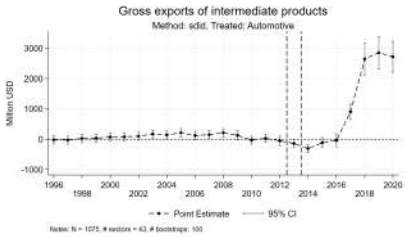
Notes: Each graph shows event-study coefficients and 95% confidence intervals from Equation (14). Each point estimate plots the coefficient of the interaction between time fixed effects and a country-specific dummy for competitor countries. Outcome variables are total vehicle production (row 1) and production of passenger cars (row 2). The regression is estimated via Poisson Pseudo Maximum Likelihood (PPML), adopting the implementation by Correia et al. (2019). All regressions include brand, country and time fixed effects; in addition, these specifications include brand-year fixed effects. All event-study coefficients are estimated relative to 2012. The standard errors are clustered at the country-of-production level. Data source: Marklines information platform.

FIGURE B.23: TIVA: DECOMPOSING VA IN EXPORTS AND EXPORTS GROWTH BY SOURCE

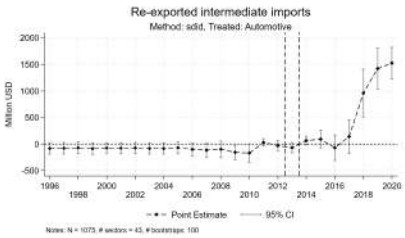
(A) FINAL PRODUCTS



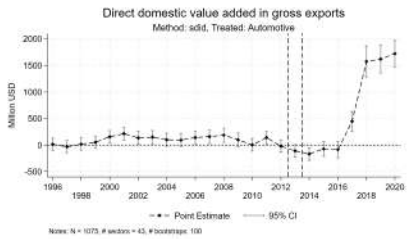
(B) INTERMEDIATE PRODUCTS



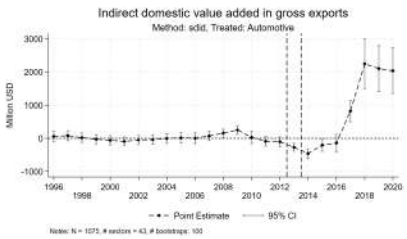
(C) RE-EXPORTED INTERMEDIATE PRODUCTS



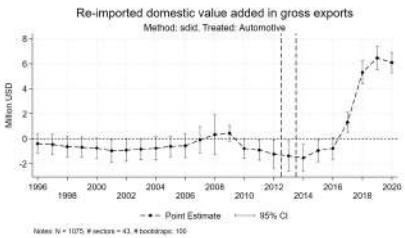
(D) DIRECT VA



(E) INDIRECT VA



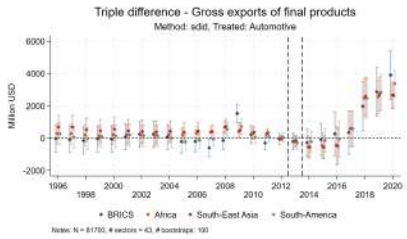
(F) RE-IMPORTED VA



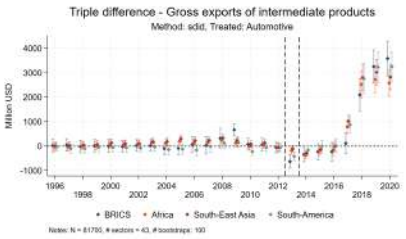
Notes: The figures show effects on: final product exports (panel A), intermediate product exports (panel B), re-exported intermediate product exports (panel C), direct domestic value added in exports (panel D), indirect domestic value added in exports (panel E) and the re-imported domestic value added in gross exports (panel F) using sector-level data from TIVA (OECD). Each graph shows event-study estimates using synthetic difference-in-differences (Arkhangelsky et al., 2021). Each coefficient is computed from Equation (15), confidence intervals are computed using a sector-level clustered bootstrap procedure where entire control sectors are re-sampled with replacement. The sample is a sector-level panel spanning 43 industries and excluding sub-sectors in the same 2-digit industry as automotive (manufacture of other transport equipment). Data source: OECD Trade in Value Added (TIVA) database.

FIGURE B.24: TRIPLE DIFF: DECOMPOSING VA IN EXPORTS AND EXPORTS GROWTH BY SOURCE

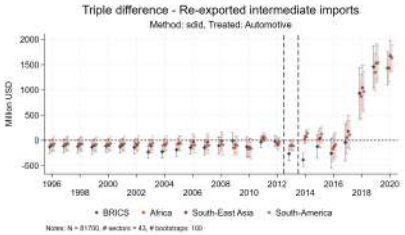
(A) FINAL PRODUCTS



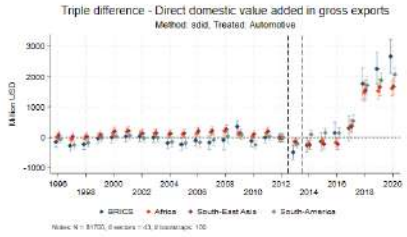
(B) INTERMEDIATE PRODUCTS



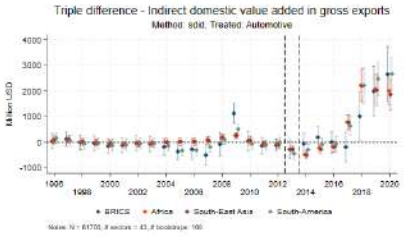
(C) RE-EXPORTED INTERMEDIATE PRODUCTS



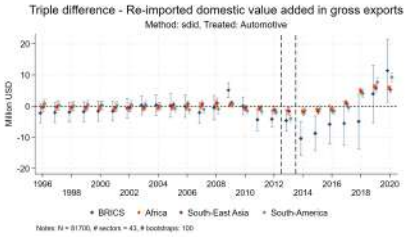
(D) DIRECT VA



(E) INDIRECT VA

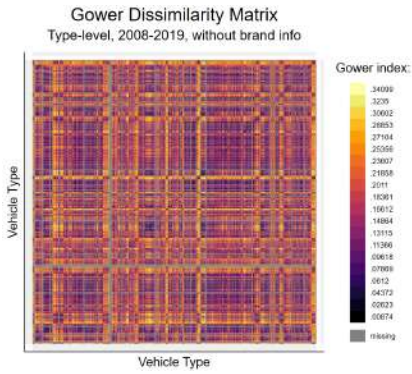


(F) RE-IMPORTED VA

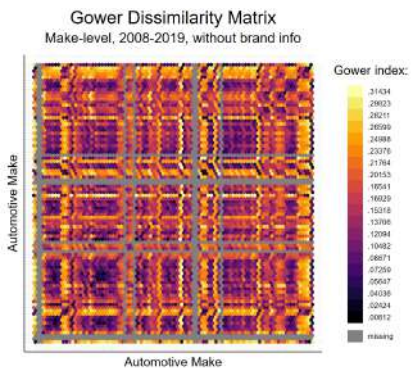


Notes: The figures show effects on: final product exports (panel A), intermediate product exports (panel B), re-exported intermediate product exports (panel C), direct domestic value added in exports (panel D), indirect domestic value added in exports (panel E) and the re-imported domestic value added in gross exports (panel F) using sector-level data from TIVA (OECD). Each graph shows event-study estimates using synthetic difference-in-differences (Arkhangelsky et al., 2021) and a country-sector triple difference specification. Each coefficient is computed from Equation (15) and Equation (16), confidence intervals are computed using a country-by-country sector-level clustered bootstrap procedure where entire control sectors are re-sampled with replacement. The sample is a sector-level panel spanning 43 industries and excluding sub-sectors in the same 2-digit industry as automotive (manufacture of other transport equipment). Data source: OECD Trade in Value Added (TIVA) database.

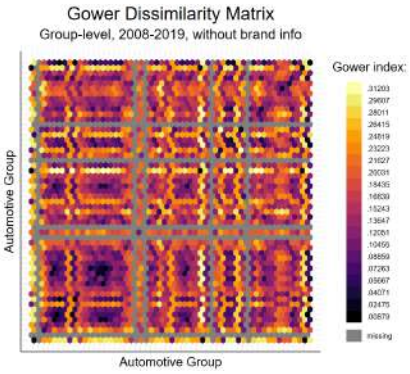
FIGURE B.25: LIGHTSTONE SA - GOWER DISSIMILARITY MATRIX



(A) VEHICLE TYPE LEVEL



(B) MAKE LEVEL



(C) GROUP LEVEL

Notes: Each graph shows the distribution of the bilateral Gower dissimilarity index defined at different levels of aggregation: vehicle type (graph A), automotive make (graph B), automotive group (graph C). In all graphs, the Gower indexes use all available vehicle attributes for the period 2008-2019 with the exclusion of brand. Each number results from a sales-weighted aggregation of underlying Gower dissimilarity indexes defined at the vehicle model level. In each graph, the missing entries are due to vehicle types, makes and groups not active in the period 2008-2019. Source: Lightstone SA.

C Appendix Tables

TABLE C.1: SAABC COMPONENT MANUFACTURERS

	Automotive Tiers and Ownership Status			
	Tier 1 - Local	Tier 1 - MNE	Tier 2/3 - Local	Tier 2/3 - MNE
	(1)	(2)	(3)	(4)
Economic Activity				
Metal forming/press	0.176	0.189	0.145	0.217
Metal casting & fabrication	0.206	0.149	0.368	0.174
Trim (interior/exterior)	0.176	0.135	0.158	0.348
Polymers, rubber, coatings & glass	0.191	0.135	0.145	0.043
Electrical & electronics	0.059	0.108	0.053	0.000
JIT / module assembly	0.059	0.149	0.026	0.043
Other components (unspecified)	0.132	0.135	0.105	0.174
Geography				
Eastern Cape	0.412	0.486	0.171	0.435
Gauteng	0.250	0.230	0.289	0.304
KwaZulu-Natal	0.338	0.203	0.474	0.217
Western Cape	0.000	0.081	0.039	0.043
N	68	74	76	23

Notes: The table reports summary statistics for South Africa's automotive component manufacturing industry, distinguishing firms by ownership and supplier tier: locally owned Tier 1 suppliers (column 1), multinational-owned Tier 1 suppliers (column 2), locally owned Tier 2/3 suppliers (column 3), and multinational-owned Tier 2/3 suppliers (column 4). Panel A summarizes firms' main component manufacturing activities, while Panel B reports their geographic distribution. Within each panel and column, entries are the share of firms in the corresponding category (rows), and shares sum to one within each panel. The data come from the South African Automotive Benchmarking Club (SAABC) dataset.

TABLE C.2: SAABC VARIABLES WITH QUESTIONNAIRE DEFINITIONS

Variable	Definition	Formula
Panel A. Company profile and economic performance		
Value added[1]	Sales net of material costs.	$\text{Sales} - \text{Material costs}$
Operating profit margin[2]	Gross profit is sales revenue less cost of goods sold. Operating profit is gross profit less marketing and administration costs, as a percentage of turnover.	$\frac{\text{Gross Profit} - (\text{Marketing} + \text{Admin. costs})}{\text{Turnover}}$
Materials[3]	Cost of materials that are an essential part of the manufactured product. Very low-value items that cannot be calculated per unit are treated as indirect materials and included in overheads.	—
Direct labour[3]	Labour used directly in manufacturing, including relevant contract workers.	—

Continued on next page

Table C.2 continued

Variable	Definition	Formula
Manufacturing overheads[3]	Production-associated indirect costs, including factory rent, machinery depreciation and maintenance, factory tools, utilities, indirect materials and indirect labour. Administration, office and sales/marketing costs are excluded.	—
Panel B. Linkages with suppliers		
Supplier delivery reliability[5]	Percentage of supplier deliveries received both on time and in full.	$\frac{\text{On-time and in-full supplier deliveries}}{\text{Total supplier deliveries}}$
Supplier quality performance / supplier return rate[6]	Parts returned to suppliers per million parts purchased. When unit values differ enough to distort the measure, rand values should replace physical units.	$\frac{\text{Units returned to suppliers}}{\text{Units purchased from suppliers}}$
Panel C. Customer linkages		
Customer delivery reliability[7]	Percentage of customer deliveries made both on time and in full.	$\frac{\text{On-time and in-full customer deliveries}}{\text{Total customer deliveries}}$
Panel D. Operational performance		
Internal reject rate[11]	Share of manufactured output rejected through inspections. If heterogeneous unit values would distort the rate, the value of rejected output should replace physical units.	$\frac{\text{Units rejected through inspection}}{\text{Total units manufactured}}$
Internal scrap rate[12]	Value of material scrapped during production as a percentage of material purchases.	$\frac{\text{Value of material scrapped}}{\text{Value of material purchases}}$
Internal rework rate[13]	Share of manufactured units reworked because of defects.	$\frac{\text{Units reworked because of defects}}{\text{Total units manufactured}}$
Customer return rate[14]	Customer returns per million units sold. If heterogeneous unit values would distort the rate, sales values should replace physical units.	$\frac{\text{Units returned by customers}}{\text{Total units sold}}$
Average throughput time[16]	Total elapsed time from the start to the end of production for the firm's five major products, including value-added time and non-value-added or idle time.	—
Production downtime due to internal material unavailability[19]	Downtime caused by an internal operation failing, for any reason, to deliver materials required at a later production stage.	—
Production downtime due to external material unavailability[20]	Downtime caused by external suppliers failing, for any reason, to deliver materials required for production.	—
Panel E. Human resource development		
Employee turnover rate: labour, salaried staff and management[22]	Dismissals and resignations relative to the average number of employees in the relevant category. Retrenchments are excluded. The labour measure includes medium- and long-term contract labour but excludes casual workers; the same formula is applied separately to staff and managers.	$\frac{\text{Dismissals and resignations in category}}{\text{Average employment in category}}$
Absenteeism rate[23]	Hours lost because employees were not at work relative to total hours available. Holiday leave is excluded; compassionate, sick and unpaid leave are included.	$\frac{\text{Hours lost through absence}}{\text{Total hours available}}$

Continued on next page

Table C.2 continued

Variable	Definition	Formula
Overtime rate[24]	Overtime man-hours relative to man-hours worked excluding overtime.	$\frac{\text{Overtime man-hours}}{\text{Man-hours worked excluding overtime}}$
Training expenditure as a percentage of remuneration[27]	Includes course-related costs and dedicated training-personnel costs. Excludes skills-levy payments, amounts claimed from SETA, lost production time, and travel and accommodation costs.	$\frac{\text{Total training expenditure}}{\text{Total remuneration (wages and salaries)}}$

Notes: The table reports variables' definitions from the South African Automotive Benchmarking Club (SAABC) questionnaire (2007). The questionnaire comprises six sections: Economic profile and performance, Linkages with suppliers, Linkages with customers, Operational performance, Human Resource Development issues, Product development capacity. If a firm does not measure the indicators requested, they are prompted to state DNM (do not measure) in the answer spaces allocated.

TABLE C.3: LIGHTSTONE SA - ADVANCED AND BASIC VEHICLE ATTRIBUTES

Vehicle Attribute	Advanced / Large	Basic / Small
Gear type	Auto; Continuously Variable Transmission (CVT)	Manual
Fuel type	Electric; Plug-in Hybrid; Traditional Hybrid; Compressed Natural Gas	Diesel; Petrol
Fuel injection type	Direct; Common Rail	Indirect
Drive type	4x4; 4x4L; 6x6; 8x8; AWD	4x2; 6x2; 6x4; 8x2; 8x4; 8x6; 10x4
ECE consumption	Above median (6.3)	Below median (6.3)
ECE emissions	Above median (149)	Below median (149)
Suggested retail price	Above median (335'200)	Below median (335'200)
Engine size	Above median (2)	Below median (2)
Gross Vehicle Mass (GVM)	Above median (1740)	Below median (1740)
KW	Above median (90)	Below median (90)
HP	Above median (122)	Below median (122)

Notes: The table reports the categorization of the Lightstone SA vehicle attributes in advanced/large and basic/small. The medians are computed over the entire period 2008-2024 using observations with non-missing attribute. Data source: Lightstone SA 2008-2024.

D Appendix - Additional Results

D.1 More Descriptive Evidence

Additional Evidence of Assembly Specialization. Using model-level data from LightStone SA, I present here additional descriptive evidence on model specialization, consistent with the pursuit of scale economies. In particular, Figure B.2 shows the 20 best-selling models, distinguishing between light vehicles (Figure B.2a) and medium-heavy vehicles (Figure B.2b), further distinguishing within each group between sales for the export and the local market. The results show that, although the precise ranking of models varies, the most exported vehicles tend to coincide with those that are also widely sold domestically, supporting the notion of model specialization. For example, among light vehicles, the Toyota Hilux, Toyota Corolla, VW Polo, Ford Ranger, and BMW 3-Series consistently appear both as best domestic sellers and top exports; similarly, among medium-heavy vehicles, models such as the Volvo FH, Scania G-Series, MAN TGS, and UD-Trucks UD-H dominate in both markets. This pattern holds despite differences in market orientation: light vehicle manufacturers such as Mercedes and BMW are heavily export-oriented (with export shares exceeding 80%), whereas medium-heavy producers remain primarily focused on the domestic market, with export shares consistently below 20% (Figure B.2c). These results stand in stark contrast to how domestically-produced models compare to imports. Figure B.3 shows again the 20 best-selling models, again distinguishing between light vehicles (Figure B.3a) and medium-heavy vehicles (Figure B.3b), but this time comparing imports to locally-produced models. The results indicate a clear substitution pattern: for instance, the 5 most-produced light models (Toyota Hilux, VW Polo, Mercedes C-Class, Ford Ranger, BMW C-Series) are never imported, substituted by complementary models (for instance, Toyota Etios and Yaris, Ford Figo and Fiesta); the same pattern holds for the most-produced heavy models (Mercedes Actros, Volvo FH, MAN TGS, Scania G-Series, UD Trucks UD-H). Again, the pattern holds regardless of the imports' final purpose: while medium-heavy producers tend to have larger re-export shares of their imports (reaching 40% in the case of Faw Trucks), the re-export share is always below 20% (and often below 10%) in the case of light motor producers (Figure B.3c).

Additional Evidence on Component Producers. I confirm and extend the findings on component manufacturers reported in Section 5 using data from the South African Automotive Benchmarking Club (SAABC). Besides information on geography and the tier of operation, these data also include information on the firm ownership status (local vs multinational) and the specific manufacturing activity for 241 automotive parts producers. Table C.1 shows summary statistics. The results indicate that, among firms operating in tiers 2 and 3, local firms tend to specialize in metal casting and fabrication, while multinational firms focus on trimming for interior and exterior parts. Among firms operating in tier 1, the range of manufacturing activities is broader and more equally distributed, including additional activities such as metal forming and press, manufacturing of polymers, rubber, coating and glass, manufacture of electric components, and just-in-time (JIT) module assembly. The geographic distribution from the NAACAM data is broadly confirmed in the SAABC data; I provide more granular information below.

Additional Geographical Patterns. I briefly describe here the distribution of full-time employment

and income across sub-sectors and space, using a three-digit industry classification corresponding to the automotive sub-sectors listed in Section 5. First, among the roughly 80,000 full-time employees in the automotive sector, manufacturing of vehicles and parts appear more labour-intensive than the bodies and trailers sub-segment, employing approximately 30,000–35,000 workers compared with about 12,000. Second, Figure B.4 maps the geographic distribution of employment in these sub-sectors. While all major clusters host activity in each segment, their specialization differs: Durban and Nelson Mandela Bay (Port Elizabeth) are more concentrated in motor vehicle and parts production, whereas Cape Town and Johannesburg are relatively more specialized in bodies and trailers (Figures B.4a to B.4c). Finally, I examine how these patterns translate into the spatial distribution of income generated in the sector. Median income in motor vehicle assembly is substantially higher than in bodies, trailers, and components - about 2.5 times larger on average across municipalities. The spatial distribution of income also highlights the leading role of the Johannesburg hub, which accounts for most income in vehicle assembly (with a smaller contribution from Mangaung/Bloemfontein). By contrast, income in bodies and parts is more geographically dispersed, with the main hubs contributing more evenly (Figures B.4d to B.4f).

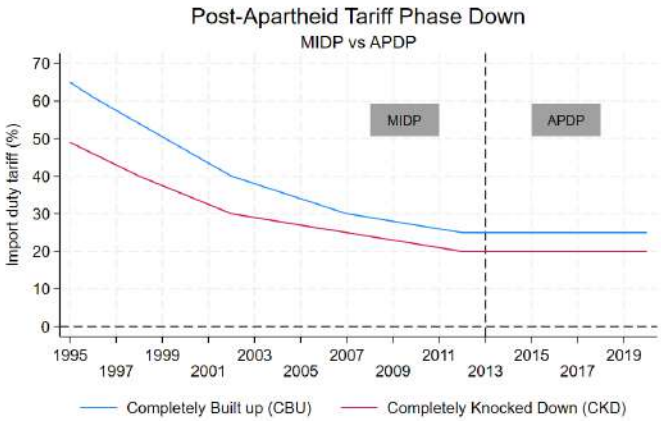
E Policy Appendix

E.1 The Motor Industry Development Program (MIDP)

This section provides additional information on the Motor Industry Development Program (MIDP), the industrial policy program active between 1995 and 2012. Section E.1.1 provides additional information on the declining tariff rates over the period, the effective rates of protection, and the resulting incentive sizes. Section E.1.2 discusses channels of firm upgrading during the MIDP phase. Section E.1.3 provides additional information on the Productive Asset Allowance (PAA). Section E.1.4 extensively discusses the evolution of the industry under the MIDP phase 1995-2012.

E.1.1 MIDP: Declining Tariffs, Incentive Size and Effective Rates of Protection

FIGURE E.1: TARIFF PHASE DOWN - MIDP VS APDP



Notes: The figure above shows the evolution of import tariffs on completely built up (CBU) vehicles and completely knocked down (CKD) components. Both the MIDP phase (1995-2013) and APDP phase (2013-2020) are shown. While one of the MIDP's pillars was a duty phase down, the APDP explicitly mandated tariff stability at the pre-APDP levels in 2012.

Declining Import Tariffs. One of the central pillars of the MIDP was a phased reduction in import duties on both completely built-up (CBU) vehicles and completely knocked down (CKD) components. Tariff rates, which initially stood at around 65% for CBUs and 50% for CKD components, were reduced relatively rapidly over the course of the programme, reaching 25% and 20%, respectively, by the end of the MIDP. These tariff rates have remained stable since then.

Effective Rates of Protection. Taking into account the declining import tariffs, Flatters (2005) computes the effective rate of protection (ERP) given to producers of vehicles and components under the MIDP. This is a measure of the percentage increase (or decrease) in domestic manufacturing costs made possible by tariffs and MIDP incentives, relative to what manufacturing costs would need to be in order to compete in the absence of any import duties and incentives. Figure E.2 displays the results. Figure E.2a shows the ERPs given to vehicles, distinguishing between those for the domestic market (thus earning the DFA) and those for the export market (thus earning IRCCs). The estimates are all based on the assumption that export IRCCs are used to import built-up vehicles (CBUs); moreover, the effective rate of protection

for domestic sales depends on the share of imported inputs in total production costs, and ERPs are shown for low (30 %), medium (50 %) and high (70 %) levels of import content. The key observation is that, despite generous incentives, the ERPs declined consistently during the MIDP, from about 75% to 25% in the case of export sales, and from as high as 175% to around 60% in the case of domestic sales. Similarly, Figure E.2b shows estimates of ERPs to OEM components exports (no incentives for local sales existed). As with vehicle exports, the ERP provided to components exports depends on whether IRCCs are used to import CBUs or CKDs, thus different lines are shown; moreover, from 1998 catalytic converters are subject to a different regime designed to eliminate the export subsidy for their precious metals component, so different lines are displayed. Again, the general message is that, despite generous assistance, the ERPs declined consistently during the MIDP from about 50-60% to around 10%.

Incentive size. Despite the decline in tariff rates, the size of the incentives provided by the MIDP is believed to be large. For instance, Flatters (2005) estimates that in 2002 and 2003 alone, the value of IRCCs exceeded R15 billion per year, an amount roughly equal to South Africa's total customs revenue collections and 50 percent higher than the national government's total annual expenditures on higher education; these amounts did not include the subsidies received in the form of duty free allowances (DFA) or productive asset allowance (PAA). Updated estimates revealed that over 2004 and 2005 another R475 million of duty credits were granted under the PAA program, of which about 410 million had already been utilized by 2006 (Flatters, 2006), and that yearly subsidies to producers were around R11-12 billion per year in 2009, totaling R100-120 billion between 1995 and 2007 (Flatters, 2009). Similarly, other observers have estimated that the average value of import rebates and investment incentives received from the MIDP amounted to as much as 8.4 % of sales in 2007 and 7.6 % in 2012 (Barnes and Black, 2008; Barnes et al., 2014). Overall, in 1996-2011 the average level of duty paid by vehicle manufacturers was only 0.6% of the total value of their imports of vehicles and components over the period (Duxbury, 2013; Barnes and Black, 2013; Barnes, Black and Monaco, 2021).

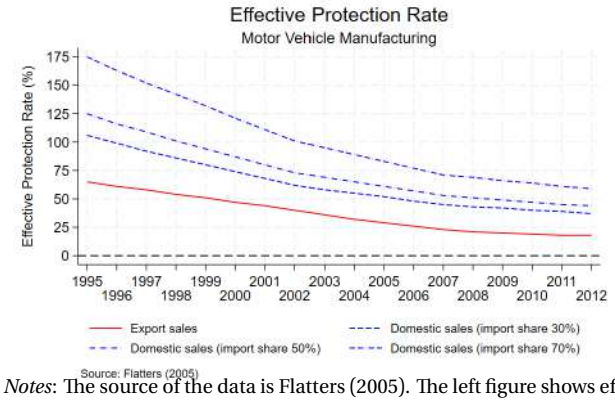
E.1.2 MIDP: Channels for Firm Upgrading

Exporting. A first channel for firm upgrading is exporting: for domestic companies to be able to export, they must produce worldclass automotive products at globally competitive prices. Thus, the system of rewards for export brought by the MIDP was supposed to indirectly motivate the domestic industry to attain economies of scale and efficient production means (Kaggwa, Steyn and Pouris, 2009).

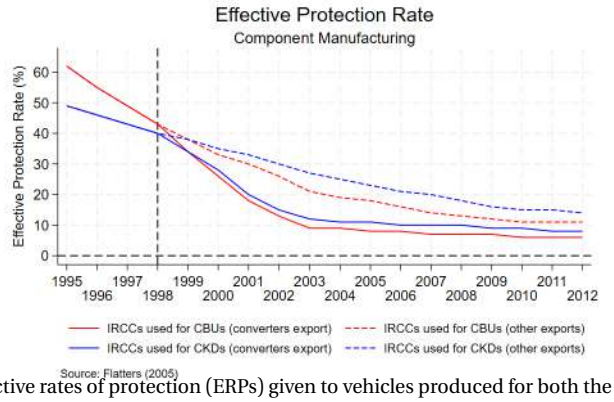
Declining Protection. Reductions in import tariffs brought by the MIDP introduced more competition and reduced the gap between South African and international prices (Flatters, 2006). On top of allowing for a wider range of makes and models, thus expanding consumers' choice (Barnes and Black, 2013; Strydom, 2014), this process was expected to force MNE assemblers to increase production as a way of reducing unit costs (Black, 2001), and component suppliers to adapt more efficient practices in order to meet cost pressures imposed by assemblers (SAABC, 2008; De Lange, 2010). However, critics highlight that import duties of more than 30% were still making car prices much higher than necessary, while allowing for continued profitable production of two obsolete models that had been discontinued in

FIGURE E.2: EFFECTIVE PROTECTION RATES

(A) VEHICLE MANUFACTURING



(B) COMPONENT MANUFACTURING



Notes: The source of the data is Flatters (2005). The left figure shows effective rates of protection (ERPs) given to vehicles produced for both the domestic and export market; the estimates are based on the assumption that export IRCCs are used to import built-up vehicles (CBUs). The ERP for domestic sales depends on the share of imported inputs in total production costs, and ERPs are shown for low (30 %), medium (50 %) and high (70 %) levels of import content. The right figure shows estimates of ERPs provided to components exports; from 1998, catalytic converters are subject to a different regime designed to eliminate the export subsidy for their precious metals component. As with vehicle exports, the effective protection provided to components exports depends on whether IRCCs are used to import CBUs or other components.

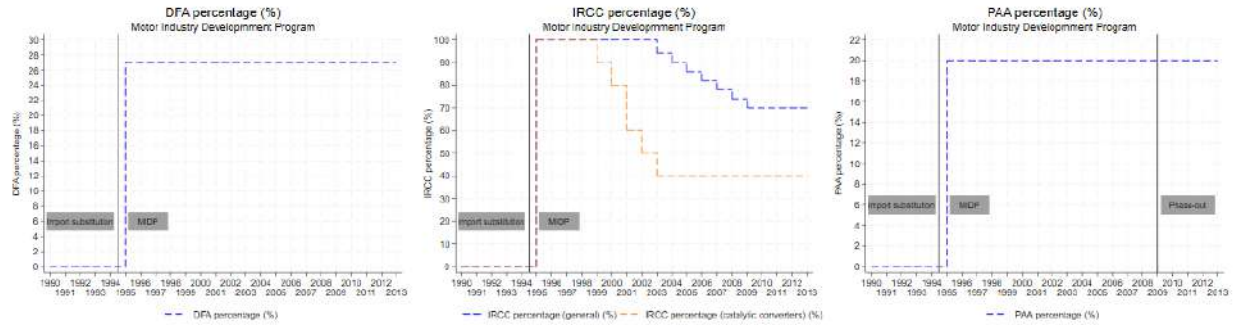
almost all of the rest of the world for decades (Flatters, 2006).

Dynamic Comparative Advantage. It has been argued that, in the absence of industrial policy, newly emerging industries after liberalization would reflect static rather than dynamic comparative advantage; this would leave the economy locked into the production and export of low-value goods, with limited prospects for upgrading (Davies, 2010). Consistent with this view, local observers justified the MIDP - particularly its import-export complementation schemes - through the lens of dynamic comparative advantage. Such dynamic effects are especially relevant in the automotive sector, where economies of scale are critical and a small number of multinational vehicle producers play a decisive role in determining the location of first-tier component suppliers (Gereffi, 1994; Black, 2001; Barnes, Kaplinsky and Morris, 2004; Barnes and Black, 2013).

Production Scale. However, the most fundamental channel for firm upgrading is believed to be the increased scale of production (Black, 2001; 2002; Barnes, Black and Monaco, 2021). Indeed, the automotive industry remains highly scale-intensive, with the consequence that a small domestic and regional market do not constitute a viable space for growth (Barnes and Black, 2013; Barnes et al., 2017). Although in a market with high effective rates of protection it may be economic for assemblers to build a wide range of models at below minimum efficient scale - driven by local market share considerations -, this raises costs and adds little value. Moreover, the implications for the component sector are highly adverse: the cost premium incurred by component makers for producing a wide range of products at low volume is considerable, and suppliers are severely disadvantaged by the decision of assemblers to increase product variety[47]. On the contrary, higher model volumes in the assembly industry are likely

[47]As an example, Black (2002) reports that minimum efficient scale for an engine plant is in excess of 200 000 units per year for a single basic make of engine, illustrating the problem encountered in raising local content in SA where the highest model volume is approximately 50 000 units. On the contrary, the Ford engine, which is exported in volumes of 240 000 per year, has attracted new investment in a range of local and foreign suppliers, reaching a local content level of 82%.

FIGURE E.3: MIDP PARAMETERS



Notes: The figure above shows the evolution of the key MIDP policy parameters between 1995 and 2012. The left panel is about the Duty Free Allowance (DFA) percentage, the middle panel is about the Import Rebate Credit Certificate (IRCC percentage), the right panel is about the Productive Asset Allowance (PAA) percentage. More details in the text.

to encourage investment in the component sector, resulting in a lower cost production structure and a more sustainable basis for automotive industry development (Black, 2001). The market-oriented incentives provided by the MIDP, either for the local or the export market, can therefore be understood as attempt to increase scale and to make localization economically viable.

E.1.3 MIDP: The Productive Asset Allowance (PAA)

Official information on the requirements and exact functioning of the PAA is very limited; in my discussion, I largely rely on Kaggwa, Pouris and Steyn (2007) and official documents when available.

Objective. After the MIDP inception, it was recognized that significant investments would be required to upgrade plants to meet higher volumes and quality requirements (Black, 2002). In support of the original MIDP, in 2000 the South African Government introduced a new investment incentive, the Productive Asset Allowance (PAA), to support investment in state-of-the-art productive assets. The main objective was to support production rationalization of light motor vehicles manufacturers by reducing the number of models produced locally, resulting in higher volumes per model and lower unit costs (Kaggwa, Pouris and Steyn, 2007). In turn, rationalization would also support the localization of original equipment components for fitment to these rationalized models and for export (DTI, 2005). By reducing average costs, the PAA was also supposed to indirectly support industry competitiveness.

Eligible entities and Investments. As a first pass, only manufacturers of light motor vehicles registered under the MIDP with the Department of Trade and Industry (DTI) were eligible for the PAA. New vehicle assemblers were subject to a minimum production of 20'000 units per annum per platform. Investment by component manufacturers might only qualify as long as the applicant was contracted to supply components to a manufacturer of light motor vehicles. Eligible investments include buildings (erected for the sole purpose of manufacturing light motor vehicles or components) and new or unused plant, machinery, tooling, jigs, dies and moulds, in-plant logistics, testing, design and production IT equipment and supporting software (SARS, 2012). In the case of component manufacturers, only investments

related to production for new models of platforms remaining after rationalization qualified.
Incentive size and Usage. The PAA may only be used to import light motor vehicles. The incentive size was 20% of the value of investments in productive assets, with the benefit spread over a period of 5 years at 4% per year (SARS, 2012). Certificates earned by component manufacturers must be sold to vehicle assemblers at a prescribed discount of 20% (Kaggwa, Pouris and Steyn, 2009). The PAA is non-tradable and mutually exclusive with any other investment incentive provided in the SACU region.
Application: To access the PAA, a 5-year business plan must be submitted, with two requirements: i) a clear statement of the planned rationalization process, ii) "a view to producing light motor vehicles or automotive components of sufficient quality, quantity and at competitive prices to supply to the common customs area and international markets" (SARS, 2012). Claims for the PAA could only be submitted after the approval of the project, supported by investment sites inspection by ITAC engineers and by an external auditor's unqualified report.
Some evidence. Kaggwa, Pouris and Steyn (2007) report that since the inception of the PAA, the number of model platforms for qualifying vehicle manufacturers has decreased from 31 platforms (with an average annual volume of 9500 units per platform) in 1996 to 18 platforms (with an average annual volume of 24 500 units per platform) in 2004.

E.1.4 MIDP: Industry Evolution (1995-2012)

In this section, I review the performance of the industry under the MIDP as described by local observers. I consider various measures of performance including rationalization in production, local content, employment, firm upgrading, imports and exports, investment and international integration.
Production Rationalization. Production rationalization and the reaping of scale economies were at the heart of the MIDP (Barnes, Kaplinsky and Morris, 2004; Barnes, Black and Monaco, 2021). Black (2001) reports that still in 1999 South Africa' assemblers produced as many as 36 different basic models, resulting in low average volumes per model[48]; this translated in cost premiums for component firms, forced to produce a wide range of products in low volumes and high unit costs - especially in terms of machinery amortization (Black, 2001, 2002)[49]. However, these problems could be obviated if assemblers achieved higher volumes, in particular if they became the sole global suppliers of a particular model; in parallel, component suppliers to domestic carmakers could achieve minimum efficient scale by exporting say half of their output (Black, 2002). Thus, the key idea of the MIDP was to provide incentives to rationalize production into a smaller range of products and achieve economies of scale through exports; to complement the domestic model mix, all other products would be imported (Flatters, 2005, 2006; Kaggwa, Steyn and Poursi, 2009). In fact, export development during the MIDP (see below) was usually accompanied by higher volumes and specialization: for example, the number of models of

[48] A senior Ford executive has refered to the unique complexity of their South African operations due to the large number of products produced in a single plant. Similarly, a logistics hub in Rosslyn serves several OEM manufacturers, whereas in other countries such hubs serve only one (Flatters, 2005).

[49] Some examples of products where costs were particularly high are body pressings, alternators, starter motors, electronic control units, exhaust systems, steering wheels and pistons.

light motor vehicles produced locally decreased from 42 model platforms in 1995 to 17 models in 2009 (NAAMSA, 2010)[50]. In turn, many component producers rationalized their product lines, assisted by the MIDP incentives to achieve scale economies by exporting (AIEC, 2011); consistent with this, survey data collected by Bronkhorst Steyn Stiglingh (2013) show that 56% of the participating stakeholders believed that the MIDP contributed to component affordability. However. in international standards the industry remained small, only contributing 0.66% to global vehicle production (NAAMSA, 2012); in addition, critics stress that continued import protection made it possible for the range of domestically produced vehicles to remain too large relative to the size of the domestic market, limiting the size of scale economies (Flatters, 2005).

Local content. Limited volumes of production at around 40-50'000 units per year do not justify the investments required to raise local content above a level of approximately 60% (Black, 2001, 2002); on the contrary, higher volumes in the region of 100'000 units per year would encourage higher local content and investments by first tier suppliers, with the resulting reduction in importing logistics costs enabling South African plants to compete without any support (Black, 2002). Despite greater economies of scale during the MIDP, with four vehicle models being manufactured in volumes greater than 40,000 units per year, production volumes remained low in international standards (Adams, 2007). As a consequence, very little change in local content and value adding was recorded from 1996 to 2010 (Black, 2001), even in relatively large-scale models (Black, 2009; Barnes et al, 2014), and local content lagged behind at levels often below 50% (Adams, 2007; Barnes and Black, 2013)[51]. It is then not surprising that despite significant foreign investment by first tier suppliers, these firms mostly operated as just-in-time sub-assemblers of imported components, with no manufacturing conversion process (Barnes and Black, 2013); the levels of integration in the domestic industry in terms of use of sub-components remained correspondingly low (Black, 2001). On top of this, perhaps unsurprisingly, less protection and no local content requirements made it easier to import sub-assemblies to reduce input costs and limit the problems of re-engineering, quality and supply complexity (Black, 2001; Black and Bhanisi, 2007). On balance, the local observers conclude that there was little change in local content since the introduction of the MIDP (Barnes and Black, 2013), and that most capabilities resided within large multinational firms, with only modest domestic spillovers (Barnes, Black and Monaco, 2021).

Employment: The response of employment has been at best limited (Black, 2002; Flatters, 2005), with total automotive employment *decreasing* from 104,100 in 1995 to 100,159 in 2012; job losses were particularly large (17%) in the first 5 years of the program (Flatters, 2009). The assembly sector accounts for most of this reduction, motivated by rationalization of production and outsourcing (Barnes and Black, 2013), while component manufacturers recorded a modest 6.8% increase in the period 1995-2012,

[50] BMW decided to specialize on the 3-Series car for the export market in North America, Australia, Europe and Japan, and displaced local production of the 5- and 7-Series with imports; Volkswagen sourced an increasing number of Golf 4 cars for the UK and European markets; Daimler-Chrysler focused its production on the C-Series Mercedes for Japan, the UK and Australia; Toyota began exporting its Toyota Corolla to Australia and New Zealand (Barnes, Kaplinsky and Morris, 2004).

[51] In 2008 and 2009, the average local content of vehicles assembled in South Africa was 35%, while the average local content of locally-produced components was between 70% and 80% (SAAW, 2009).

mostly driven the rapid growth in labour intensive export-led sub-sectors (Barnes and Black, 2013)[52]. Anyhow, for the entire duration of the MIDP the components industry remained a significant source of employment, providing jobs to more than double the number of employment opportunities catered for by assemblers (Pitot, 2012; Werbeloff, 2011). The most considerable employment creation was recorded in motor-trade (service industry involved in sales, distribution, maintenance and operation), which is more labour intensive and accounts for twice as many jobs as vehicle and components production together (Flatters, 2005); jobs in this sector tend to grow hand-in-hand with sales growth (Flatters, 2009). Overall, the focus on raw-material intensive component exports carrying little value addition is believed to have contributed to limited employment creation.

Firm Upgrading Starting from very low productivity at the onset of the MIDP, mostly due to low levels of automation and high complexity of the fragmented assembly lines[53], plant productivity is believed to have increased rapidly following the MIDP (Black, 2001; Barnes, Black and Monaco, 2021). Average quality also increased (Barnes and Kaplinsky, 2001), technology standards improved (Barnes, Black and Monaco, 2021), and a number of South African assemblers, such as Mercedes Benz and BMW, have been able to produce high quality defect-free vehicles for the export market (Barnes, Kaplinksy and Morris, 2004; Flatters, 2005), also receiving international awards (Black, 2002; Barnes and Black, 2013). A similar picture holds in the component sector, with substantial improvement in a number of metrics related to cost control and output quality (Barnes and Morris, 2008). In particular, the upper tier of component suppliers produces now a full range of components for the domestic and foreign market (Black, 2001), operating closely to the global frontier (Ballard and Barnes 2003).[54]. This process was favoured by the demand for quality by MNE buyers/assemblers, who actively sought out component suppliers able to meet the exacting standards of their own export-oriented assembly operations (Barnes, Kaplinksy and Morris, 2004; Barnes, Black and Monaco, 2021). Moreover, by encouraging initial investment, export incentives are believed to have increased learning, leading to a form of increasing returns (Black, 2002). However, despite substantial improvement, critics highlights the continued production of old-fashioned models for the local market, and performance standards still lagging that of the best international firms (Flatters, 2005).

Imports. Most local observers agree on the crucial role of the MIDP to promote the duty-free import of vehicles and components by exporting (Barnes and Black, 2013; Barnes, Black and Monaco, 2021). Overall, total imports of vehicles and components grew at a more rapid rate than policy makers expected, in nominal terms from R16.4 billion in 1995 to R 136.1 billion in 2012 (Flatters, 2005; Barnes, Black and Monaco, 2021). Interestingly, the overall share of automotive imports has not increased over the period, indicative of the rising share of imports in the South African economy as a whole (Barnes and Black, 2013). The growth in vehicle imports can be explained by the fact that, in partial contrast with

[52] A survey of component manufacturers by Black (2001) shows that already in 1995 component producers anticipated job creation in firms linked to the export market, and job separations in more traditional component segments ($n = 47$).

[53] Data collected by the International Motor Vehicle Programme based on detailed assembly plant surveys conducted in 1994 and 1996 showed that the average South African assembly plant compared poorly with those in other countries.

[54] Using data from the South Africa Automotive Benchmark Club (SAABC), Barnes and Morris (2008) show that over the period 1998-2012, registered component manufacturers lowered the inventory holding (operating days) by 58%, increased the customer return rate by 93%, and reduced the internal reject and scrap rates by 65.3% and 59.5% respectively

the rationalization objective, market share considerations dictate to maintain a full range of models for the local market (Black, 2002). As a result, as domestic production was rationalized into fewer production lines (Flatters, 2005, 2006), the share of vehicle imports grew rapidly, from about 2% in 1990 to 58.1% of total new vehicle sales in 2013 (AIEC, 2013), mostly focused on models not locally produced (Barnes and Black, 2013). Notably, the major share of vehicle imports was accounted for by domestic vehicle producers involved in large-scale export programmes (Barnes, Black and Monaco, 2021). In parallel, the IEC scheme also enabled assemblers to use import credits to source components as close to international prices, which led to a doubling of original equipment component (OEC) imports in real terms - from R107,000 to more than R200,000 per vehicle between 1996 and 2008 (Duxbury, 2013).
Exports. The MIDP is believed to have contributed to dramatic export improvement (Black, 2001, 2002; Barnes, Kaplinsky and Morris, 2004; Flatters, 2006; Adams, 2007), turning an initially inward-oriented industry into 'ultra-export oriented' (Barnes and Black, 2013). Starting at about R443 million at the end of the '80s, total automotive exports reached R86.9 billion by 2012, representing a real compound annual growth rate of 12.1%; the automotive export share also increased, from just 4% of total exports in 1995 to just over 12% in 2012 (Duxbury, 2013). Again, the import-export complementation scheme and the contemporaneous model rationalization are considered the most important factors behind this trend (Black, 2001; Kaggwa, Pouris and Steyn, 2007; Barnes and Black, 2013)[55]. In parallel, component exports increased even faster, but largely concentrated in raw material-intensive components (such as automotive leather and catalytic converters) carrying little value added and job creation, especially in the early years of the MIDP (Black, 2002; Flatters, 2005, 2009; Barnes, Kaplinsky and Morris, 2004)[56]. Indeed, as the import duty credits were linked to the full domestic content of exports (inclusive of raw materials), the MIDP is believed to have strongly incentivized the export of products with high raw material content and corresponding low 'automotive value added' (Barnes and Black, 2013). This outcome was the results of a conscious strategy followed by many assemblers, mostly consisting in the generation of import duty rebates through the export of high-value components (Black and Bhanisi, 2007). As a result, high value incentives were provided for disproportionately low employment and other economic benefits (Dewar, 2012); moreover, as these export categories typically involved light investments and low levels of integration into the domestic industry - both in terms of supply to domestic vehicles and use of subcomponents - this has also limited to extent to which domestic assemblers or the aftermarket could benefit from economies of scale (Black and Mitchell, 2002). The bulk of the component export expansion has not been realized by traditional component suppliers, but rather by a rapidly emerging group of mainly foreign firms with links to vehicle manufacturers (Black, 2001); similar trends have been observed in other countries experiencing rapid international integration and export expansion such as Brazil

[55]Other contributing factors have been low labour and management costs, cheap land and electricity (Black, 2002), coupled with limited growth of the domestic market and a weak rand over most of the MIDP phase (Barnes and Black, 2013)

[56]Catalytic converters consist of platinum and stainless steel and are raw material intensive; most of the value generated is attributable to their raw material content, rather than innovative processes that may result in increased employment opportunities (Bronkhorst Steyn Stiglingh, 2013). In 2001, catalytic converters alone amounted to nearly R9 billion or 48.4% of total component exports, equivalent to 10% of total world supply; still in 2012, catalytic converter exports alone amounted to R16.3 billion, equivalent to 44.3% of component exports. Leather seats further contributed for a large share - 12.9% of total component exports in 2001 (Black, 2002); over 1995-2012, South Africa supplied the bulk of BMW's global automotive leather requirements and was an important supplier to a number of other foreign vehicle manufacturers.

(Posthuma, 1995) and Argentina (Miozzo, 2000).

Investment. Although it was originally believed that higher levels of investment could be expected as a result of tariff reductions and higher competition (Barnes and Black, 2013), investment in fixed plants - both in vehicle and components assembly - lagged that of other emerging countries in early years, increasing only slightly from R3 billion to R4.5 billion (Black, 2001). The only exception was represented by first tier suppliers locating closer to exporting assembly plants, but many of these assembly operations involved limited local content (Barnes and Black, 2013). However, the introduction of the PAA in 2000 provided a new boost, attracting 31 applications worth R10.5 billion between 2000 and 2004 (DTI, 2004) and increasing total investment more than twofold (Kaggwa, Pouris and Steyn, 2007). A wide range of investments, including advanced production equipment and world-standard water-based paint plants, benefited from the PAA, and fixed investment in plant, machinery and tooling constituted more than 80% of the vehicle manufacturers' total annual investment between 1998 and 2004 (Kaggwa, Steyn and Pouris, 2007). However, investment was mostly concentrated in export-oriented, IRCC-generating activities (Flatters, 2005) with minimal investment in R&D, which accounted for less than 10% of total expenditure between 1998 and 2004 (Kaggwa, Pouris and Steyn, 2007).

International Integration. Access to international markets and export opportunities increasingly required local firms to establish strong links with global networks (Barnes and Kaplinsky, 2000; Barnes, 2013). This process took the form of increasing foreign ownership (Black, 2001): as opposed to the early 1990s, when most assemblers were under majority local ownership (Black, 2009), from 1994 the industry went through a period of rapid structural change with large direct investment by MNCs (Barnes, Black and Monaco, 2021), resulting in all assemblers (including Ford, Toyota, Nissan and General Motors) being now wholly or mainly owned by multinational firms (Black, 2001; NAACAM, 2009). There has also been growing foreign ownership in the component sector, with the majority of large component firms (over 500 employees) in the first two tiers being now foreign owned (Barnes and Black, 2013). Higher foreign ownership allowed vehicle producers to rely on multinational ties to secure major export contracts, while component manufacturers gained access to international networks through foreign partners (Barnes, Black and Monaco, 2021). As a by-product, this process is also believed to have promoted control, modernization, investment and plant upgrading (Black, 2001; Barnes and Black, 2013; Barnes, Black and Monaco, 2021).

E.2 The Automotive Production Development Program (APDP)

In 2005, the Department of Trade, Industry and Competition (DTI) initiated a comprehensive review of the Motor Industry Development Programme (MIDP) in order to assess its impact and recommend options to deal with identified gaps in terms of competitiveness. A Task Team involving the DTI, the National Treasury, the United Nations Industrial Development Organisation (UNIDO) and the Industrial Development Corporation (IDC), industry associations (National Association of Automobile Manufacturers of South Africa - NAAMSA - and the National Association of Automotive Component Manufacturers of South Africa - NAACAM) and independent experts worked on designing a new architecture for industry support in line with the new targets set for the industry.

Rationale. The logic of the APDP can be framed in terms of a dynamic complementarity between assembly volumes and localization. Because component production involves substantial fixed costs, relatively low assembly volumes (on the order of 40,000–50,000 vehicles per year) are generally only viable with low levels of local content (Black, 2001; 2002). By contrast, higher assembly volumes can generate scale economies and lower unit costs for component manufacturers, and are therefore a prerequisite for increasing the local content of domestically assembled vehicles (Davies, 2008; Barnes, Black and Monaco, 2021).[57] In this sense, the previous stage of industrial policy - the MIDP - can be interpreted as a step toward expanding volumes - a necessary but not sufficient condition for subsequently raising local content (Barnes, Kaplinksy and Morris, 2004). The APDP aimed to build on the larger volumes encouraged by the MIDP to drive *intensification*, i.e. deeper integration of domestic suppliers into the value chain through increased local value addition.

Why Automotive?. Although valid in any sector with strong scale economies, the possibility to foster this dynamic link is particularly promising in the automotive sector, where the interdependence between assemblers and auto parts manufacturers is strong, and increasing outsourcing to suppliers by MNE assemblies creates strong potential for higher value addition. In particular: i) suppliers are pushed towards upgrading, tailoring their products to the performance specifications of the specific assembly; ii) there is a tendency towards the supply of complete functions, with 1st tier suppliers responsible for the managements of 2nd tier suppliers and the assembly of parts into complete units; iii) with the increasing importance of just-in-time (JIT) production systems, the assembler has to invest in long-term relationships with suppliers and better quality at-source (Humphrey, 2003)[58].

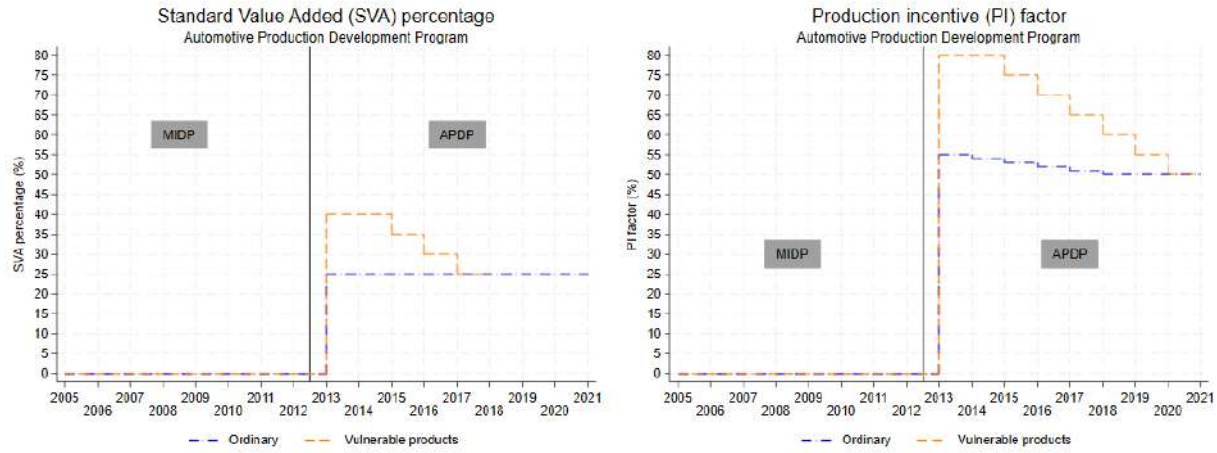
E.2.1 APDP: The Production Incentive (PI)

Purpose, Basic definition and Core Mechanics: The Production Incentive (PI) is a support measure for domestic automotive manufacturing that ties the value of customs-duty rebates to the amount of *local value added* embodied in eligible motor vehicles and automotive components. In practice, the PI is computed from a producer's sales value net of material inputs, with a key asymmetry in the treatment of inputs: *non-qualifying* inputs are deducted in full, whereas only a portion of *qualifying* materials is deducted. In particular, the qualifying materials are the **local** raw-material content embodied in **locally-sourced** materials; a system of declarations at each stage of the domestic supply chain keeps track of such content (see below). Therefore, while imported materials and components are treated as non-qualifying and reduce value added one-for-one, locally sourced inputs may contribute to qualifying materials to the extent that they embody qualifying content, so that part of their value is retained in the value-added base and increases the incentive size. This design generates two complementary localization incentives. First, because imported inputs are fully netted out, producers have an extensive-margin incentive to

[57] In his statement address to NAACAM members, David Powels identified the limited productivity of the supplier industry as the key constraint hindering growth: in his view, productivity had to improve dramatically from < 20 cars to > 30 cars per employee per year, supported by massive investment in training and skill development especially at the 2nd and 3rd tier.

[58] David Powels, in his address to Volkswagen employees, stated that suppliers need to move closer to the OEMs (customers) and the building of supplier parks is one such initiative. It allows for Just in time (JIT) delivery of parts, saving millions of rands in logistical spend, transport, packaging materials, handling and storage (Strydom, 2014).

FIGURE E.4: AUTOMOTIVE PRODUCTION DEVELOPMENT PROGRAM (APDP) - PRODUCTION INCENTIVE (PI)



Notes: The figures show the evolution of the Production Incentive (PI) parameters under the APDP phase (2013-2021). The graph on the left shows the Standard Value Added (SVA) percentage, determining which share of standard materials is retained in the calculation of local value added. The graph on the right shows the Production Incentive (PI) factor, converting local value added into duty rebates for finished vehicle and/or components. In both cases (SVA percentage and PI factor), the exact value depends on the vulnerability status of the product. More details in the text.

expand production through domestic inputs. Second, since producer's material declarations reflect the qualifying and non-qualifying content embodied in purchased inputs—including qualifying content generated at earlier domestic production stages—there is an intensive-margin incentive to source from domestic suppliers with higher local content. By raising the returns to production arrangements that increase domestic content along the value chain, the PI is intended to support localization and thereby contribute to positive employment spillovers.

Standard materials and the SVA percentage: In the PI regulation, the qualifying materials are called standard materials, defined as locally-beneficiated raw materials originating in the Southern African Customs Union (SACU) and processed to meet automotive specifications, consisting of: i) Aluminium; ii) Brass; iii) Leather; iv) Platinum group metal; v) Stainless steel; and vi) Steel. The Standard Value Added (SVA) percentage determines the share of these standard-materials that is retained as value added. Under the default localization rule, the SVA percentage is 25%; for *vulnerable products* (defined below), a higher SVA percentage applies: 40% for the period 1 January 2013 to 31 December 2014, after which it is reduced by 5 percentage points per annum from 1 January 2015 until it reaches 25%; the 25% rate applies from 1 January 2017 onwards. This higher retention rate increases the potential incentive size for eligible producers whose cost structure is intensive in standard materials. The left panel of Figure E.4 shows the full schedule for vulnerable and non-vulnerable products.

PI factor and PRCCs: The PI factor is the percentage scaling the value added base (computed as above) to arrive at the final incentive size; the certificate reporting the final incentive size is called Production Rebate Credit Certificate (PRCC). For claims in the period 1 January 2013 to 31 December 2013, the PI factor is 55%, and it is reduced by 1 percentage point per annum until it reaches 50%; the 50% rate applies from 1 January 2018 onwards. For vulnerable industries and products, the PI factor is 80%, and it is reduced by 5 percentage points per annum from 1 January 2015 until it reaches 50%; the 50% rate

applies from 1 January 2020 onwards. Relative to the default schedule, this higher PI factor provides a larger incentive size for producers of vulnerable products. The right panel of Figure E.4 shows the full schedule for vulnerable and non-vulnerable products.

Vulnerable products and related rules: Vulnerable industries/products include: i) Alloy wheels; ii) Aluminium products (engine and transmission components, heat exchangers and tubes therefor, suspension components, and heat shields); iii) Cast iron components (engine, axle, brake, transmission and related types of components); iv) Catalytic converters; v) Flexible couplings; vi) Leather interiors; vii) Machined brass components; and viii) Steel jacks. As a general rule, a vulnerable product loses its vulnerable status once it becomes an input into another product[59]. A further provision introduced in 2016 specifies that, where vulnerable products are combined into a higher-level assembly, the resulting final product (for which a vulnerable-product PRCC is claimed) retains vulnerable status provided that the vulnerable product(s) constitute the majority of the cost of the final product (e.g., an engine assembly). Finally, vulnerable products retain their vulnerability status even where the standard material used is imported; however, such imported standard material must be declared as non-standard material.

Eligibility and qualifying participants: Eligibility for the PI extends to three categories of South Africa–based producers that are registered with SARS as taxpayers: (i) light motor vehicle manufacturers[60]; (ii) automotive component manufacturers[61]; and (iii) automotive tooling manufacturers[62]. All products for which benefits are claimed must be *wholly manufactured in South Africa.* In addition, qualifying light motor vehicles must be manufactured in a *special licensed vehicle manufacturing warehouse* located in South Africa. Registered light motor vehicle manufacturers that do not qualify for the Vehicle Assembly Allowance (VAA) may nevertheless qualify for PRCC benefits. Component manufacturers must satisfy further conditions intended to ensure that they are meaningfully integrated into the OEM supply chain and that production constitutes genuine manufacturing activity in South Africa. First, they must demonstrate sufficient scale in supplying the local and/or international OEM supply chain. This can be satisfied by meeting at least one of the following thresholds (excluding tooling): (i) OEM supply-chain turnover of at least 25% of total automotive turnover; or (ii) at least R10 million per annum in OEM supply-chain invoicing. Evidence of supply-chain participation must include documentation such as a copy of a contract or a purchase order to supply a product to a manufacturer within the OEM supply chain[63]. Second, the manufacturer must demonstrate that production is substantively undertaken in South Africa (or within SACU, as specified by the rules). In particular, not less than 25% of the ex-factory selling price of the components at the time of sale must be represented by costs incurred in SACU, defined to

[59] For example, if a catalytic converter is incorporated into the domestic production of a specified light motor vehicle by a local OEM, only 25% of qualifying material is deemed to be automotive-specific in the downstream product.

[60] Light motor vehicles are defined with reference to specified tariff headings (`8701.20`, `87.02`, `87.03`, `87.04`, and `87.06`), subject to the applicable mass threshold, and include vehicles produced either with or without an engine and/or gearbox.

[61] Automotive component manufacturers are eligible where they produce components supplied into the light-vehicle or medium/heavy-vehicle value chain, including components supplied to production in South Africa or supplied for export.

[62] Automotive tooling manufacturers are eligible where they produce qualifying automotive tooling (e.g., dies for drawing or extruding metal; tools for pressing, stamping, or punching; work holders; assembly jigs and assembly lines; injection moulds; and moulding patterns), classified under tariff headings `8207.20`, `8207.30`, `8466.20`, `8479.89`, and `84.80`.

[63] When registering a component as an eligible product, the manufacturer must also provide identifying information on downstream application, including the names and addresses of the client(s) to whom the automotive components will be supplied, as well as the vehicle manufacturer and the vehicle model(s) into which the relevant product(s) are fitted.

include labour costs, the value of materials, and/or factory overhead expenses. To operationalise these requirements, component and tooling manufacturers must hold an *Eligible Production Certificate* (EPC) approved by ITAC; activities that consist only of packing or painting do not qualify as manufacturing for purposes of EPC approval[64].

Use of PRCCs: A PRCC may be used to reduce import duties on qualifying automotive imports. Eligible imports are limited to specific automotive products, namely (i) new right-hand-drive light motor vehicles and (ii) automotive components for light vehicles, which in turn may be original equipment components (OEC) destined for the production of new light vehicles or aftermarket/replacement components for used vehicles. A PRCC is valid for 12 months, with the validity period commencing on the first day of the quarter in which the PRCC claim was submitted to ITAC. Where a PRCC issued on the basis of component or tooling production, or on the basis of producing light motor vehicles without an engine and/or gearbox, is used to reduce duty on imports of light motor vehicles, the South African Revenue Service (SARS) discounts the value of the PRCC by 20 per cent[65].

Transferability of PRCCs: a PRCC may be traded, but not more than once after it is first issued. If a Letter of Authorisation is submitted with the original PRCC claim, ITAC issues the PRCC in the name of the authorised transferee. Thereafter, the PRCC may be transferred a further single time provided that the required documentation is submitted. In that case, SARS cancels the original certificate and issues a replacement certificate that is clearly marked *"Final Issue – Not Transferable"*; this final certificate is then forwarded to SARS. While a PRCC itself may be transferred subject to the above limits, the right to apply for a PRCC is not transferable.

Standard material declarations (SMDs): In practice, the system operates through *standard material declarations* (SMDs). An SMD is a certificate that records, for each specified output produced by each manufacturer in the supply chain, the standard and non-standard material content embodied in a single unit of that output[66]. For the producer at the most upstream stage of the supply chain (i.e., a standard-material producer or supplier, such as a steel producer), the SMD will typically report only the value of the relevant standard material, measured as the weighted-average selling price in the previous quarter. Where an upstream producer supplies locally produced standard material but also sources imported material that meets required technical specifications (treated as non-standard), the SMD should separately report the (weighted-average) locally manufactured standard material and the imported non-standard material[67]. More in general, each producer prepares a SMD for each unit of its output, deriving the standard material value (SMV) and non-standard material value (NSMV) from

[64] The scope of eligible components includes (i) components supplied directly into the assembly/OEM supply chain and (ii) replacement or service parts supplied into the aftermarket (e.g., sold to retailers). In both cases, the manufacturer-level requirements regarding OEM supply-chain participation and genuine manufacturing in South Africa apply.

[65] This provision implies a lower effective benefit when non-assemblers use PRCCs to offset duties on imports of complete vehicles, relative to using PRCCs for qualifying component imports.

[66] Each manufacturer prepares an SMD for the outputs sold during a given quarter, using its own financial information from the *previous* quarter. For operational purposes, the SMD for a specific quarter must be made available to users within 14 days from the start of the quarter to which it relates.

[67] By contrast, an upstream supplier that provides *only* non-standard (imported) material is not required to prepare an SMD; downstream users of those inputs simply record them as non-standard in their own SMD calculations.

SMDs received from its automotive suppliers[68]. For inputs purchased from non-automotive suppliers, as well as for imported inputs that are not accompanied by an SMD, the producer must declare the applicable SMV, non-standard material value, and imported material value directly in its own SMD.

Providing Accurate SMDs. Motor vehicle manufacturers, component manufacturers, and suppliers to the motor vehicle industry are required to obtain a SMD indicating the material/component values for each type of input received during a quarter. If no SMD is obtained, the entire weighted-average purchase price from the previous quarter must be treated as the *non-standard material value*; this reduces the implied value added that can be used in the calculation of PRCC-related benefits. However, the correctness of SMDs received from suppliers may be accepted as accurate by the user. Similarly, if incorrect information is supplied on an SMD certificate or its annexures, the document may be treated as null and void, in which case the purchase price of all items may be deemed as non-qualifying; again, this reduces the implied value added that can be used in the calculation of PRCCs.

Application, Validity and Scope: To obtain a PRCC, a producer must submit an application to the International Trade Administration Commission (ITAC). ITAC assesses the submission and, if satisfied, issues a PRCC specifying the production basis on which it was awarded: (i) specified motor vehicles; (ii) specified motor vehicles without an engine and/or gearbox; or (iii) automotive components and tooling. An application to ITAC may be filed only once the manufacturer has received full payment for the eligible products sold; for vehicles capitalized by an OEM, eligibility is determined by the date of capitalization. Completed PRCC applications must be lodged within 12 calendar months of the invoice date for the eligible products; once issued, a PRCC is valid for 12 months, with the validity period running from the first day of the quarter in which the claim was submitted to ITAC.

Verification, Enforcement and Record-keeping: All PRCC applications must be independently verified by a practising accountant and auditor; without an assurance report, the submission is deemed incomplete and the producer cannot access PRCC benefits. In addition, ITAC may verify any information submitted in a PRCC application and may, subject to conditions it determines, restrict the value of a PRCC. It may also instruct that a full investigation be conducted to test the accuracy of information supplied and request access to statutory books of account (as specified in the Companies Act or Close Corporations Act) as well as production records. To this end, applicants must retain original supporting documentation in an organized and readily accessible form for at least five years from the PRCC date. If the requested documentation is not provided within 30 days, ITAC treats the relevant sales as non-qualifying; if incorrect information was supplied, it may result in disqualification and forfeiture of benefits, together with repayment of any benefits already received[69]. ITAC retains discretion to amend, suspend, adjust, withdraw, or refuse to issue PRCCs, including where the applicant, a certificate holder,

[68] Certain items are excluded from both standard and non-standard material values. In particular, consumables that are not identifiable as integral or visible parts of the end product are excluded, as are petrol, distillate fuels, lubricating grease, and prepared lubricating oils used for the engine, gearbox, steering case, and drive-axle.

[69] Where ITAC detects anomalies, the adjustment mechanism depends on whether the PRCC has been used. If the certificate has not been used, ITAC reduces it by the over-declared amount and issues a replacement PRCC reflecting the corrected balance. If it has been used (fully or partially), or if the remaining balance is smaller than the required correction, SARS is informed so that over-utilised benefits can be recovered; alternatively, ITAC may permit the claimant to correct the overstatement through an adjustment to a future claim.

or a related party is the subject of a fraud investigation. Pending the outcome of civil, legal, or criminal proceedings, ITAC may withdraw a PRCC and deregister the participant. Applicants are also expected to ensure that duplicate submissions do not occur; where a PRCC has already been issued in respect of such sales, ITAC may trigger recovery of the associated benefits and penalties by SARS from the end user of the certificate, and determine exclusion from future participation in the APDP. Finally, submitting a claim before payment has been received results in cancellation of the PRCC and may lead to deregistration from the APDP.

Proof of payment requirements: A PRCC can only be claimed upon proof that the sale occurred and that payment was received; only one PRCC claim is permitted per tax invoice. For domestic sales, the applicant may apply only where payment was made through, and received via, a registered banking institution; the claimant must be able to provide a bank statement showing the payment received together with the debtor's remittance advice. For exports, the proceeds must be received as an inflow of foreign currency through a registered banking institution. Exporters may apply only once the foreign currency earnings have been repatriated and the auditor is willing to certify that repatriation. Upon request, the exporter must be able to provide (i) a bank statement showing the amount repatriated and (ii) a bank-issued advice indicating the repatriated amount and its conversion into South African rand.

Definition of Selling Price: For purposes of the PI calculation, the selling price is the price reflected on the final manufacturer's invoice, *exclusive* of VAT, ad valorem excise duty, the environmental levy, and any other charges that do not relate to manufacturing. In addition, specific non-manufacturing costs are excluded when calculating the relevant value for PRCC purposes. In particular: i) for exports: freight, insurance, distribution and destination expenditure, commissions and discounts, and warehousing costs are excluded; ii) for domestic sales: commissions and discounts are excluded. Where new vehicles are capitalized by an OEM as part of a "company fleet" and no invoice is issued, the capitalized amount is deemed to be the selling price.

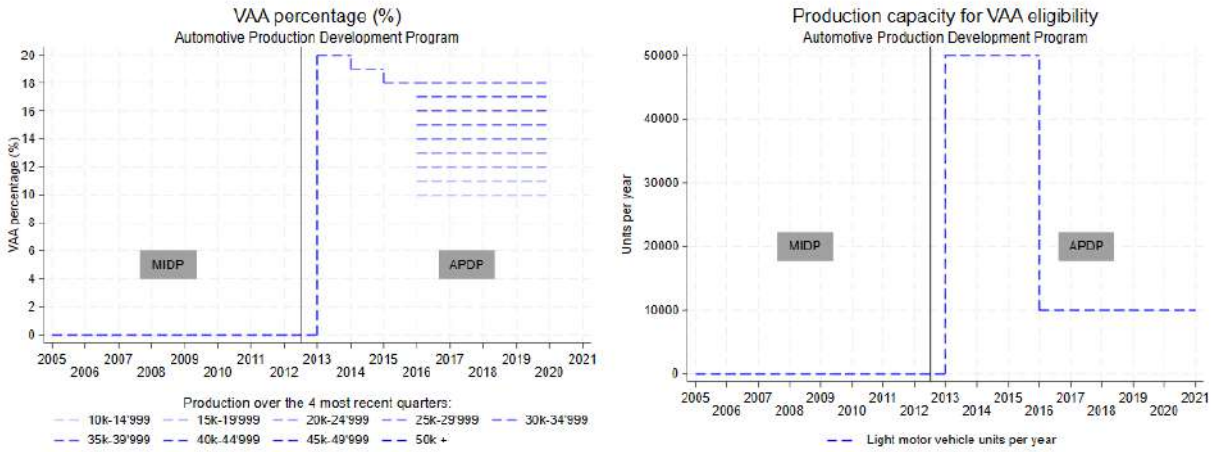
E.2.2 APDP: The Volume Assembly Allowance (VAA)

Basic Definition: The Volume Assembly Allowance (VAA) is an incentive available to qualifying light motor vehicle manufacturers and is calculated with reference to the value of vehicle sales. Only light motor vehicle manufacturers (OEMs) that are registered with ITAC and SARS and that manufacture light motor vehicles are eligible to claim VAA benefits[70].

VAA calculation: The VAA is based on the size of sales (value of output), determined by SARS as follows: for domestic sales, SARS uses the recommended retail list price (RRLP), which is the vehicle price as per the official manufacturer's price bulletin; for exports, SARS uses the free-on-board (FOB) value. SARS then applies a so-called company-specific percentage (CSP) provided by ITAC to convert this output value into a "net" price intended to reflect the amount accruing to the OEM (i.e., net of the dealer/retailer mark-up and marketing-related costs). A VAA percentage is subsequently applied to this net value to

[70] Light motor vehicles are defined with reference to tariff headings `8701.20`, `87.02`, `87.03`, `87.04`, and `87.06`, subject to the applicable mass threshold.

FIGURE E.5: AUTOMOTIVE PRODUCTION DEVELOPMENT PROGRAM (APDP) - VOLUME ASSEMBLY ALLOWANCE (VAA)



Notes: The figures above show the evolution of the Volume Assembly Allowance (VAA) parameters under the APDP phase (2013-2021). The graph on the left represents the VAA percentage, converting vehicle sales (irrespective of the market) into duty rebates for components; this value operates as a deduction on the customs tax base. From 2016, the VAA percentage depends on production volumes over the 4 most recent quarters. The graph on the right shows the production capacity needed to qualify for VAA incentives, in vehicle units per year. More details in the text.

compute the final incentive. The applicable VAA percentage varies over time. It was set at 20% in 2013, 19% in 2014, and 18% from 2015 onwards; from January 2016, the VAA percentage is a function of the OEM's production volume in the preceding four quarters, with the following schedule: i) 10% for 10,000 units or more but not more than 14,999 units; 11% for 15,000 units or more but not more than 19,999 units; 12% for 20,000 units or more but not more than 24,999 units; 13% for 25,000 units or more but not more than 29,999 units; 14% for 30,000 units or more but not more than 34,999 units; 15% for 35,000 units or more but not more than 39,999 units; 16% for 40,000 units or more but not more than 44,999 units; 17% for 45,000 units or more but not more than 49,999 units; 18% for 50,000 units or more. The left panel of Figure E.5 shows the full schedule.

Company-Specific Percentage (CSP): The CSP is a percentage calculated by ITAC and used by SARS in the determination of the VAA. Each OEM must determine a distinct CSP for each category of light motor vehicles[71], with separate CSPs for the domestic market and for exports. The CSP definition differs by market. For domestic sales, the CSP is the difference between the average RRLP and the average dealer's invoice price (the OEM selling price), expressed as a percentage of the RRLP, this difference corresponds to the mark-up allowed by the OEM. Both the RRLP and the invoice price must include all options fitted to the vehicle (e.g., metallic paint, radio, compact disc player, air conditioner, etc.). For exports, the CSP is the market-related expenditure expressed as a percentage of the dealer's invoice price (the OEM selling/invoice price); in this case, the mark-up category is considered to be 0%. All CSP applications must be verified by a practising accountant and auditor registered in terms of the Auditing Profession Act, 2005 (Act 26 of 2005). For administrative expediency, the CSP is computed using production values and statistics from the previous quarter.

[71] The categories are represented by the elighible product codes `8701.20`, 8702, 8703, 8704, 8706.

Eligibility. Eligibility for VAA benefits depends on both (i) registration as a motor vehicle manufacturer with ITAC and (ii) meeting minimum production requirements, assessed on a rolling basis. To verify these conditions, ITAC requires specific documentation, including an application form for registration as a new light motor vehicle manufacturer and an annual update form for existing registered manufacturers. As part of the registration process, OEMs must provide information on their planned localization of components. Prior to 1 January 2016, motor vehicle manufacturers with a plant capacity of at least 50,000 units per annum could apply to ITAC for registration as a specified motor vehicle manufacturer; additionally, the manufacturer would be eligible for VAA benefits only if a minimum production requirement of 50,000 units over the most recent four quarters was met[72]. From 1 January 2016, the minimum plant-capacity threshold for applying for registration was reduced to 10,000 units per annum; in addition, VAA eligibility requires meeting a corresponding rolling production threshold of at least 10,000 units over the most recent four quarters. The right panel of Figure E.5 shows the evolution of the production capacity required for VAA eligibility.

New entrants: New entrants must apply to ITAC for registration and, among other requirements, demonstrate sufficient production capacity. Under the regime applicable prior to 1 January 2016, the application had to indicate the capacity and ability to manufacture at least 12,500 vehicles per quarter (equivalently, 50,000 units per annum); from 1 January 2016, the corresponding capacity threshold for new entrants was reduced to 2,500 vehicles per quarter (i.e., 10,000 units per annum). The VAA treatment for new entrants is phased in. A new entrant receives VAA based on actual production during its first four quarters, irrespective of whether any minimum-volume threshold is met. VAA eligibility then becomes contingent on production volumes: in quarter 5, the entrant qualifies for VAA only if production exceeds 12,500 units (or 2,500 units from 1 January 2016); from quarter 6 onwards, VAA eligibility is assessed on the standard rolling basis, i.e., with reference to production in the most recent four quarters and the applicable minimum threshold (50,000 units until 1 January 2016 and 10,000 units from 1 January 2016). A further set of rules for new entrants was introduced from 1 January 2018. New entrants may elect whether to designate their first two quarters as "dead quarters" (see below). If the entrant elects to do so, it receives a 10% VAA during these two dead quarters, calculated on actual production; in the subsequent three quarters, the entrant receives VAA based on actual production, using a new-entrant sliding scale: 10% for 2,500 units or more but not more than 3,749 units; 11% for 3,750 units or more but not more than 4,999 units; 12% for 5,000 units or more but not more than 6,249 units; 13% for 6,250 units or more but not more than 7,499 units; 14% for 7,500 units or more but not more than 8,749 units; 15% for 8,750 units or more but not more than 9,999 units; 16% for 10,000 units or more but not more than 11,249 units; 17% for 11,250 units or more but not more than 12,499 units; 18% for 12,500 units or more; from quarter 6, the entrant transitions to the general regime, applying the rolling four-quarter rule and the standard VAA percentage schedule. Instead, if the entrant does not elect to use dead quarters, it receives VAA in quarters 1–3 based on actual production using the new-entrant sliding scale above, and

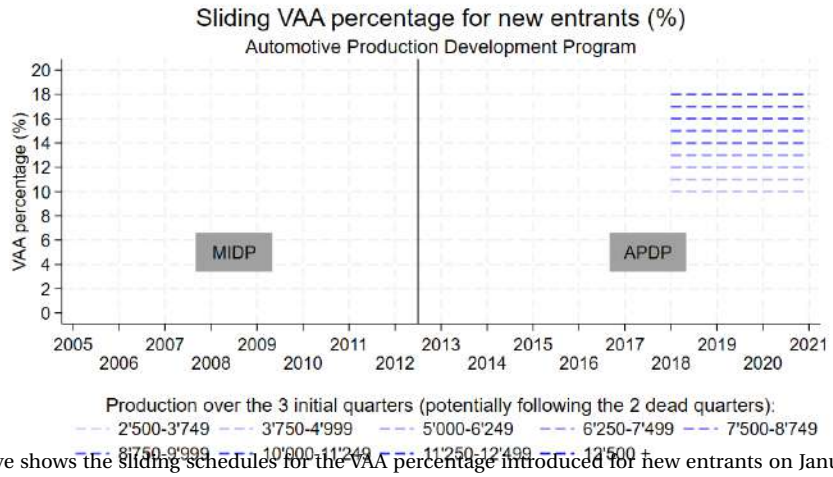
[72] Specific transitional provisions were applied in 2013 to ensure a smooth transition to the APDP. Specifically, no minimum production level was required in the first two quarters of 2013; a minimum production level of 12,500 units was required in the third quarter of 2013; and the full rolling four-quarter threshold of 50,000 units applied from the fourth quarter of 2013 onwards (measured over the most recent four quarters).

then transitions to the general regime from quarter 4 (i.e., the rolling four-quarter rule and the standard VAA schedule apply from that point onwards). Figure E.6 shows the full new-entrant sliding schedule.
Dead quarters: A registered light motor vehicle manufacturer that introduces a new model to replace an existing model in its manufacturing plant may apply to ITAC for two "dead quarters" in order to mitigate the impact of temporary production disruptions. During the two dead quarters, the manufacturer receives VAA based on actual production, without regard to minimum-volume thresholds. The VAA percentage applied during the dead-quarter period is the same as the percentage applicable in the quarter immediately preceding the dead quarters. In subsequent quarters, VAA eligibility and the applicable percentage are determined using production over the most recent four quarters excluding the two dead quarters (i.e., dead quarters do not enter the rolling production total). The application must be submitted to ITAC at least 90 days before the start of the proposed dead-quarter period and, where multiple models are produced, must describe the expected effect on total production volumes.
Use of the VAA and excess VAA: The VAA is not tradable or transferable, and no certificate is issued to evidence its value. In operational terms, the VAA is applied first to reduce customs-duty liability against (i) the customs-duty value of original equipment components (OECs) imported for the manufacture of new vehicles and (ii) the imported component values embodied in OECs received from any person within SACU. Where a balance remains after applying the VAA, PRCCs may then be used to further reduce the residual liability. If the VAA exceeds the liability in a given quarter, the surplus may be carried forward to subsequent quarters; alternatively, the excess VAA may (subject to prior written approval from the Commissioner for SARS) be used to rebate duties on imports of light motor vehicles. Where a manufacturer uses excess VAA in a quarter to rebate duties on fully built-up vehicles, SARS reduces the value of the VAA used for this purpose by 20%.
Compliance and verification: All CSP applications must be verified by a practising accountant and auditor, and an assurance report must accompany each application. OEMs are expected to reconcile all information used in the CSP calculation with their books of account, monthly management accounts, and audited annual financial statements, and to maintain the working papers necessary to substantiate the CSP. ITAC may at any time instruct that a full-scale investigation be conducted to verify any information relevant to the application. Furnishing incorrect information may lead to disqualification from the programme and forfeiture of benefits, together with a requirement to refund any benefits received to the Commissioner for SARS.

E.2.3 APDP: The Automotive Investment Scheme (AIS)

In 2009, the Automotive Investment Scheme (AIS) replaced the previous Productive Asset Allowance (PAA) as the main incentive for equipment upgrading, indirectly supporting increased production levels. Similarly to the previous PAA, the incentive was open to both vehicle assemblers and component manufacturers and equivalent to 20% of the project's qualifying investment in plant, machinery and building, but paid over a three-year period (Corbett et al., 2011). The main difference between the AIS and the PAA is that the incentive was now delivered as a cash grant (as opposed to an import duty rebate)

FIGURE E.6: AUTOMOTIVE PRODUCTION DEVELOPMENT PROGRAM (APDP) - NEW ENTRANTS (VAA)



Notes: The figure above shows the sliding schedules for the VAA percentage introduced for new entrants on January 1 2018. The graph represents the VAA percentage, which converts vehicle sales (irrespective of the market) into duty rebates for components; this value operates as a deduction on the customs tax base. More details in the text.

and administered by the Department of Trade, Industry and Competition (DTI), as opposed to the South African Revenue Service (SARS); moreover, the AIS included provisions for increased investment in research and development, while the MIDP did not provide similar support (DTI, 2010)[73]. Overall, it has been estimated that R1.8 billion in investment commitments were secured as a result of the AIS in the span of 2 years, mostly consisting of investments to facilitate increased production levels of light motor vehicles (Werbeloff, 2011); however, such investments appear not to directly address a broadening and deepening of the local components industry (Bronkhorst Steyn Stiglingh, 2013). In my analysis, I largely abstract from the AIS, given that its delivery as a cash grant makes it unobservable in my administrative data; moreover, since the AIS was introduced in 2009 - well before the major policy change of interest in 2013 -, it is unlikely that any firm-level adjustment observed under the APDP can be attributed to this incentive.

[73]As a result, in their survey of APDP stakeholders at the onset of 2013, Bronkhorst, Steyn and Stiglingh (2013) report that most of the respondents believed the APDP to result in increased research and development activities.