Trade Policy Is Real News: Theory and Evidence*

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Abstract
We evaluate the aggregate effects of news about future tariff reforms. In a quantitative model with forward-looking households and firms that make dynamic exporting decisions, we find that expectations of lower *future* tariffs temporarily decrease investment, hours worked, and output. Furthermore, canceling an expected decline in future tariffs raises investment and output in the short-run but substantially lowers medium-run growth. These effects are larger when the expected reform is bigger. Empirically, we find that countries with more trade growth after the General Agreement on Tariffs and Trade (GATT) rounds decreased investment and hours worked in the years leading to the tariff cuts, consistent with theory. We also identify a novel total factor productivity boost from these trade reforms that benefits the countries where trade grew the most.

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1 Introduction

Changes in trade policy are rarely a surprise. Politicians campaign on trade policy. And most trade reforms—the General Agreement on Tariffs and Trade (GATT) and free trade agreements (FTAs)—involve long negotiations. When successful, they are implemented with a lag and gradually. We argue that these features of trade reforms make them ideally suited to revisit an old question: How does news about future productivity or policy affect current economic activity? A key challenge in this long-running debate (Pigou, 1927; Keynes, 1936; Beaudry and Portier, 2014) has been to identify future changes in technology or policy. Future changes in trade policy are relatively easy to identify and are closely linked to productivity. Using cross-country evidence from major GATT reforms in the 20th century, we show that news about trade reforms is contractionary even as the implementation is expansionary.

Trade policy has a clear predictable component. As examples, consider the three large successful GATT rounds. Each round was preceded by five plus years of well-publicized negotiations, which concluded largely in the shadow of the impending expiration of the U.S. President's negotiating authority. Following each successful negotiation, changes in trade policy were implemented gradually according to a well-defined schedule, or phaseout. Since both the negotiations and the phaseouts were public knowledge, the future policy changes were clearly anticipated to some extent by households and firms. Other instances of changes in trade policy, including bilateral trade agreements, follow a similar pattern.[1] Because trade policy changes affect future productivity, income, and prices, news about them leads to a different aggregate response than if the changes are unanticipated.[2]

We start by studying the aggregate effects of past, present, and future changes in trade policy in a two-country heterogeneous firm dynamic general equilibrium model. The model nests the standard international real business cycle model (Backus et al., 1994) and the

[1] Unilateral policies are forward looking. Most dumping provisions are limited in duration by sunset clauses. Likewise, voluntarily export restraint agreements (VERs) have well-defined windows. For instance, the VERs on Japanese autos in 1981 were initially set to last three years and had a rising cap on imports.

[2] While we focus on phaseouts, phaseins of protection are also common and are key elements of the new U.S.-Mexico-Canada Agreement(USMCA), 2020; the Build America, Buy America Act (BABA), 2021; and the Inflation Reduction Act (IRA), 2022. The USMCA raised the regional value content by over 20 percent over three years, the BABA raised the domestic content requirement for federal purchases and funding over five years, and the IRA contained growing domestic content requirements for green energy credits.

heterogeneous firm model for trade policy analysis (Melitz, 2003; Alessandria and Choi, 2014; Alessandria et al., 2021b). Households make forward-looking decisions about consumption, investment, and labor supply, and heterogeneous firms, which pay sunk costs to begin producing or exporting, make forward-looking investments in entry and export status. Expectations of future changes in trade policy, and their effects on the aggregate economy, can therefore affect both households' and firms' current behavior. The sunk cost assumption also implies that changes in trade policy affect trade gradually as the share of firms exporting changes slowly. Thus, both past and future trade barriers matter for the current economy. The model also captures the composition of trade in consumption, investment, and material goods so that changes in tariffs—whether past, present, or future—induce substitution effects between goods. The interaction between trade dynamics and capital accumulation with capital-intensive trade leads to rich transitions that are absent in other models.

In the model, a permanent surprise decrease in tariffs increases trade and economic activity through standard efficiency channels. Because households have higher wages and goods prices are lower, they substitute toward consumption and away from leisure, increasing labor supply and gross domestic product (GDP). Even with balanced growth preferences, this substitution effect dominates the wealth effect. Because trade is intensive in capital goods, cheaper imports decrease the price of capital goods relative to consumption goods and firms invest more, which in turn increases the marginal product of labor and leads to an even larger boost in economic activity in the long-run.

By contrast, news of *future* reductions in tariffs decreases investment and hours worked initially, but still increases export participation. Households expect to be richer in the future, and the wealth effect induced by that expectation—work less, consume more—has no offsetting substitution effect until tariffs actually change. Households also optimize intertemporally by delaying investment in physical capital until tariffs fall and the price of capital is lower. Meanwhile, lower future tariffs increase the future value of being an exporter, so firms invest more in export market access and the number of exporters increases.

Our results suggest that the transition of the economy depends on whether the changes in tariffs are expected or unexpected. Consider, for example, a decreasing path of tariffs where agents either know the complete path at the beginning or are constantly surprised by

unanticipated reductions. Because the expectation of lower future tariffs decreases investment today, a gap between the investment response under the two cases forms immediately and persists for many periods as households continue to expect even lower capital prices in the future. GDP, consumption, and labor also differ along the transition.

The model also tells us what happens when expected changes in tariffs are unrealized. What should we have expected in the U.S. economy, for example, when the U.S. pulled out of the Trans-Pacific Partnership (TPP) after the agreement had been signed? Or when it withdrew from the negotiations of the Transatlantic Trade and Investment Partnership (TTIP)? If agents had expected these reforms to go through, our model predicts that U.S. households responded to news of these agreements by working and investing less, anticipating higher future wealth and lower costs of capital, while firms responded by investing in greater export market access. Canceling the agreement, then, decreased expected wealth and raised the future price of investment for households, leading to a sharp rebound in investment and hours worked, with some pull back in export capacity. In other words, canceling an agreement looks like an economic boom. Of course, this view is short-sighted, as the model predicts that by canceling the agreement, agents miss out on a longer period of growth induced by the reform.

Having sorted out the rich interactions between the dynamics of trade policy and the aggregate economy, in Section 5 we turn to the data for evidence concerning the aggregate predictions of the model for expected trade liberalizations. Specifically, we consider the dynamics of GDP, consumption, investment, and hours worked for countries in the Organisation for Economic Co-operation and Development (OECD) both before and after three major GATT round implementations. GATT rounds are useful because they are multilateral agreements that affect each member country's trade flows and the negotiation and phaseout periods are well documented. Furthermore, because the agreements include a large number of countries and are more subject to political rather than economic cycles, it seems reasonable that the timing of the agreements is exogenous to any one country's business cycle. The data exercise shows that countries with higher trade growth in the 10 years after GATT round implementation had lower GDP, hours, and investment and higher consumption in the years directly preceding implementation, consistent with our stylized model. Moreover,

we find a novel total factor productivity (TFP) boost in the countries where trade grew the most.

We relate these empirical findings to the predictions of an extension of our model to six asymmetric countries or country groups—U.S., E.U., U.K., Japan, Canada, and the rest of the world—and a range of business cycle and tariff shocks. We simulate this model incorporating the information structure, timing, and size of the three main GATT rounds. Specifically, we introduce global trade shocks that capture the three GATT rounds, with each round expected to succeed three years in advance. We apply the same econometric methods to the model as we do to the data and show that it lines up quite well with the data in terms of the contractionary effects of future trade reforms. By contrast, alternative information structures that abstract from news about future tariffs are inconsistent with the dynamics of GDP, hours, and the division of expenditures in advance and in the first few years of the trade reforms.

1.1 Relevant Literature

Our paper relates to several strands of the literature on business cycles and international trade. A large branch of this work focuses on the gradual expansion of trade following trade agreements. Baier and Bergstrand (2007) show that the full impact of FTAs on trade can take up to 10 to 15 years to be realized. Baier et al. (2014), Alessandria and Choi (2014), and Besedes et al. (2020) show that most of this delayed effect comes from the dynamics of the extensive margin of trade, consistent with models where exporting involves a durable investment in foreign market access. In addition, a large literature in international macroeconomics focuses on the slow adjustment of trade and the trade balance to movements in the terms of trade and the real exchange rate.[3] The model we develop captures both of these observations and therefore allows for the impacts of a trade liberalization to become stronger over time.

Several papers have examined the quantitative impact of changes in trade barriers or trade policy on business cycle fluctuations.[4] Crucini and Kahn (1996) show that the increases in

[3] See Ruhl et al. (2008), Rabanal and Rubio-Ramirez (2015), and Alessandria and Choi (2021).

[4] A very large literature studies the long-run effects of changes in trade barriers. See Irwin (2019) for a summary of this work.

tariffs during the Great Depression could have reduced economic activity in the U.S. by more than 2 percent per year from 1931 to 1935. Similarly, Perri and Quadrini (2002) find that the increases in tariffs in Italy reduced output by 7 to 10 percent in the 1930s, with the higher reductions depending on wage rigidities. The larger effects in Italy than in the U.S. can be attributed to Italy being more open and raising barriers by more. For a cross-section of small economies, Barattieri et al. (2021) document that temporary increases in tariffs are contractionary. Caldara et al. (2020) show that changes in trade policy uncertainty can be recessionary for the U.S. with most of the impact arising from a reduction in investment. They show these effects of trade policy uncertainty arise in a dynamic exporting model with nominal rigidities. Our focus is on future, permanent shocks for which nominal rigidities are unlikely to be important. Alessandria and Choi (2021) show that changes in inward and outward US trade barriers have had a large impact on the dynamics of the US trade balance since the 1980s. Here we consider a richer process of trade integration and a richer model of business cycle fluctuations. Alessandria and Mix (2018) build on our framework and study the contribution of shocks to past, current, and future inward and outward trade barriers to U.S. aggregate fluctuations over the period from 1965 to 2020.

Our paper also contributes to the literature that explores how news about future changes in policy or the aggregate economy can be a source of business cycle fluctuations. Most work in this spirit has considered predictable changes in either productivity or fiscal policy, with much debate about how to identify future changes in these variables.[5] There is little doubt that trade agreements (and disagreements) contain important predictable components and that changes in trade barriers will feed into productivity. We use generalized information about tariff phaseouts to discipline trade policy news in our model.

News about the future has been central in the analysis of open economy business cycles. Backus et al. (1994) show that spillovers in technology across countries can lead to very low international comovement. Aguiar and Gopinath (2007) show that the high volatility of consumption and the countercyclicality of the current account in emerging markets relative

[5]See, for example, Beaudry and Portier (2006), Jaimovich and Rebelo (2009), Mertens and Ravn (2010), Ramey (2011), Barsky and Sims (2012), Mertens and Ravn (2012), and Schmitt-Grohé and Uribe (2012). For a full survey of the literature, see Beaudry and Portier (2014). House and Shapiro (2006) show that the phasein of the Bush tax cut in 2001 may have contributed to slow economic growth and that the sunset in 2008 may have contributed to the contraction in 2008-09.

to industrialized countries can be explained if emerging economies are characterized by more persistent shocks to the growth rate of TFP. More recently, Colacito et al. (2018) identify news shocks about productivity from price-to-earnings ratios and show that the dynamics of borrowing and lending to these news shocks are quite different empirically. Perhaps closest in spirit to our paper is Arezki et al. (2017) which shows that in response to large oil discoveries there is a contractionary effect of news on economic activity. We find quite similar contractionary effects in response to future trade reforms.

In Section 2, we discuss frequently observed patterns of changes in trade and trade policy. In Section 3, we describe the model in detail and our calibration of parameters. In Section 4, we explore the impact of trade policy shocks on the aggregate economy. In Section 5, we validate the key predictions of the model on future changes in tariffs. Section 6 concludes.

2 Trade and Tariffs over Time

To set ideas, we discuss several key features of trade and trade policy. First, we show that trade grew dramatically but gradually from the mid-1960s to the mid-2010s. Second, we emphasize that this gradual growth reflects both gradual reductions in tariffs and gradual expansion in trade, particularly on the extensive margin. And, third, we argue that long periods of negotiation and agreed-upon phase-outs of trade restrictions are consistent with a large forward-looking component to trade policy.

Since the mid-1960s, global trade as a share of global GDP has almost tripled.[6] This growth has been much larger for some countries and when one adjusts for changes in the relative price of traded and non-traded goods. Figure 1 plots the path of average real trade flows (exports plus imports) as a share of GDP for the United States from 1960 to 2019. The U.S. trade share was about 9 percent in the mid-1960s and rose to almost 27 percent by 2019. This amount of trade growth is common in OECD countries, as shown by the median and interquartile range in the same figure. Owing to the size and location of the U.S., most countries started out more open than the U.S., but integration has largely grown in parallel, in part because of global efforts to reduce policy barriers.

[6]Using Penn World Tables 10.0 (PWT) data, we find that the share of trade rose from 9.2 percent of world GDP in 1967 to 26.2 percent in 2007.

While trade growth has varied across periods, the adjustment has been gradual overall. The gradual adjustment of the trade-to-GDP ratio over time arises from two well-known features of trade policy and trade: (1) The response of trade to changes in trade policy or trade costs is gradual, and (2) trade policy changes gradually.

As evidence of the gradual response of trade to changes in trade policy, Baier and Bergstrand (2007) show that a trade agreement triples bilateral trade but that this growth takes between 10 and 15 years. Baier et al. (2014) and Alessandria and Choi (2014) find that the adjustment of trade is more gradual at the extensive margin of products or firms. Jung (2012) and Besedes et al. (2020) confirm that trade expansion is delayed beyond the slow phaseouts in tariffs. Numerous product-level analyses confirm this gradual growth. For example, for the North American Free Trade Agreement (NAFTA), Khan and Khederlarian (2021) find that the trade response to a tariff change in eight years is nearly three times the effect on impact. We capture the gradual adjustment of trade in our model by assuming exporters face a relatively high cost to begin exporting and a smaller cost to continue exporting, as first proposed by Baldwin and Krugman (1989) and confirmed by numerous structural analyses of firm-level exporter dynamics.[7] This formulation of trade costs makes exporting a dynamic decision so that the extensive margin of trade adjusts both slowly in response to changes in trade policy or other aggregate shocks and in advance of future shocks.

The gradualness of tariff reforms is evident in the two panels of Figure 2. Both panels plots moments of the distribution of applied tariffs of U.S. imports from 1972 to 2022. The left panel plots the most-favored-nation (MFN) rate which falls gradually from 1979 to 1987 (owing to the phaseout from the Tokyo Round) and then again from 1994 to 1999 (owing to the phaseout from the Uruguay Round). There was a modest drift up for the highest tariffs between 2018 and 2020 that was largely unwound by 2022. Between GATT rounds, the tariff distribution is quite stable with small variation from specific tariffs and commercial policy. We also include a measure of the average tariff, measured by tariff revenue scaled by non-oil imports that allows us to go further back in time. This series understates tariff barriers as trade flows are lower on higher tariff goods, but it shows that the effect of tariff reforms in the 1960s was minimal until the implementation of the Kennedy Round, which

[7] See Das et al. (2007) and the survey article by Alessandria et al. (2021a).

lowered tariffs by about one-third from 1967 to 1972.

The declines in trade policy barriers have a large predictable component related to both the negotiation window and the gradual implementation of the reforms. Table 1 reports the years that GATT member countries were negotiating during the Kennedy (1964–67), Tokyo (1973–79), and Uruguay (1986–93) rounds and the years over which tariffs phased out (linearly) after an agreement was made. The table also gives the phaseout period for quotas in the Agreement on Textiles and Clothing (ATC) implemented in the Uruguay Round.[8] Negotiations were no shorter than three years, during which consumers and firms likely anticipated that trade costs would decline. Following an agreement, there was usually a short delay before implementation, and then tariffs phased out over no less than five years. The tariff phaseout schedule and implementation date were both known by consumers and firms even before implementation. Agents were able to fully anticipate the changes in policy in each year following the agreement.

The negotiation windows were largely dictated by U.S. trade policy as each round was preceded by a Trade Act that determined both the scale of the tariff cuts and the window of presidential negotiating authority. Each GATT round was concluded in close proximity to the lapsing of presidential authority. The final three columns note the month these agreements were signed, the start of presidential authority, and the lapsing month.

This pattern of long negotiation and extended phaseouts in global trade agreements is also a common feature of bilateral liberalizations. Indeed, Baier and Bergstrand (2007) emphasize that nearly all FTAs contain phaseouts of 10 years.[9] The bottom three rows of Table 1 report that the three largest U.S. bilateral trade agreement—the Canada–U.S. Free Trade Agreement (CUSFTA), NAFTA, and the Korea–U.S. Free Trade Agreement (KORUSFTA)—followed extended negotiation periods with long phaseouts of tariffs.[10]

The right panel of Figure 2 plots the moments of the tariff distribution on Canada over time. In theory, the distribution of tariffs should be the same as MFN rates until the

[8]The ATC itself was the last step in a series of short-run agreements on textiles and clothing that started in the early 1960s. The phaseout period was extended in the U.S. and E.U. with the imposition of safeguards in 2005.

[9]For example, the European Economic Community agreement of 1958 had a 10-year phaseout.

[10]The CUSFTA enacted in 1989 was the culmination of many discussions and followed up on the Auto Pact of 1965, which eliminated auto tariffs.

CUSFTA starts its phaseout in 1989.[11] Any differences arise from using applied rates, which are conditioned on the set of goods being traded. U.S. tariffs on Canada follow the pattern of MFN tariffs with gradual declines from 1979 to 1986 owing to the Tokyo Round. The implementation of the CUSFTA in 1989 brings tariffs down to zero for most goods by 1999.[12]

These phaseouts, combined with the long negotiations, highlight the predictable aspect of trade policy. The long negotiations also suggest that the outcome of these negotiations has an unpredictable aspect. Indeed, efforts at several large trade agreements since the formation of the World Trade Organization (WTO)—such as the Doha round, the TPP, and T-TIP—have ultimately failed. Sorting out the predictable and unpredictable components of trade policy is challenging, but consumers and firms are clearly not completely surprised by these policy changes and have an opportunity to adjust in anticipation of the future path of trade policy barriers.

3 Model

We study the short- and long-run effects of current and future changes in import tariffs in a variation of the multi-country general equilibrium model of Mix (2023).[13] This model extends the international real business cycle model of Backus et al. (1994) and Alessandria and Choi (2007) to include firm and exporter dynamics, intermediate inputs in production, and $I \geq 2$ countries. It also allows for trade to be intensive in capital and intermediate goods, which captures the industry structure of trade and influences the propagation of shocks. The entry margins and material inputs in production are necessary to capture the aggregate effects of changes in tariffs most accurately.[14] In what follows, we describe the behavior of each agent in the model in detail. We start with the intermediate goods producers

[11] Besedes et al. (2020) construct CUSFTA and NAFTA scheduled phaseouts at the Harmonized System (HS) 8-digit product level. With CUSFTA (NAFTA), only 5 (36) percent of goods were made duty free on impact, 35 (6.3) percent had a 5-year phaseout, 60 (55) percent had a 10-year phaseout and none (2.5) had a 15-year phaseout. Initial tariffs were higher for longer phaseouts, with the products with the longest phaseouts having tariff levels two to three times those of the products with immediate tariff cuts.

[12] That not all goods are brought in tariff free by the mid 2000s arises from either the imposition of temporary trade barriers or the ineligibility of some goods because of regional content requirements.

[13] We abstract from other forms of trade policy such as quantitative restrictions, export taxes, subsidies, and other forms of commercial policy.

[14] Atkeson and Burstein (2010) and Alessandria and Choi (2014) show that the transition following a change in tariffs or trade costs depends on having a firm entry decision and a firm or exporter lifecycle.

and then move to households and final goods producers.

3.1 Intermediate Goods Producers

Each of I regions (with the set of I regions denoted by $\mathcal{I}$) has a continuum of mass N_i monopolistically competitive locally owned firms that produce differentiated goods that can be used in the production of consumption, C, investment, X, or material inputs, M. These firms are created with a cost and survive across periods with probability n_s. We assume that firms have the same costs of production but differ in their costs to export to destination $j \in \mathcal{I}$, with these differences being a result of past export decisions and an idiosyncratic shock.

All firms in a region $i \in \mathcal{I}$ sell their goods domestically, but only some firms export to other regions owing to both fixed and variable export costs. Both of these trade costs are stochastic and depend on the past export status in each destination. In each period and for each potential foreign export destination, j, firms in region i draw an idiosyncratic fixed cost κ_j from a generalized Pareto distribution with cumulative distribution function

$$F_{e_j}(\kappa) = 1 - \left(1 + \frac{\upsilon\kappa}{f_{e_j}}\right)^{-\frac{1}{\upsilon}}$$

where e_j is the current export status of the firm to destination j, with $e_j = 1$ denoting an exporter; f_{e_j} is a scale parameter; and υ is a shape parameter. With $\upsilon < 1$, the expected value of the distribution is $f_{e_j}/(1-\upsilon)$. Paying the fixed cost in the current period allows the firm to export to destination j in the following period. To capture the high persistence of exporting, we assume the fixed cost draw depends on the current export status through the scale parameter f_{e_j}. Consistent with work on exporter dynamics (Das et al., 2007), we set $f_1 < f_0$ so that incumbent exporters draw lower fixed costs, on average, than new exporters. Thus, as in the data, current exporters are more likely to continue exporting to a destination than nonexporters are to begin exporting, holding all else equal.

Exports of goods from i to j are also subject to end-use-specific iceberg costs ξ_{Gij} where G is one of C, X, or M. Making these costs end-use specific allows the model to capture the composition of bilateral trade among consumption, investment, and material inputs. In

the model, end-use of the intermediate product is determined by the importer; production of these goods is identical at the intermediate level. To capture the tendency of new exporters to expand gradually in the export market (Ruhl and Willis, 2017), we follow Alessandria et al. (2021b) and allow iceberg costs to depend on the export history of the firm and a shock. Specifically, we assume there are two types of exporters, low-iceberg-cost exporters L and high-iceberg-cost exporters H. All new exporters are high-iceberg-cost exporters and face iceberg costs ξ_{GHij} where G represents a type of good. But if the firm continues to export in the next period, it becomes a low-iceberg-cost exporter and faces iceberg costs $\xi_{GLij} < \xi_{GHij}$ with probability $1 - \rho$. Neither cost state is absorbing, and we assume the transition matrix is symmetric so that low-cost exporters have the same probability, $1 - \rho$, of switching back to the high-cost state. This cost structure allows the model to capture important features of the exporter life cycle in the data—that incumbent exporters export more, on average, than new exporters, and that new exporters are more likely to exit than incumbent exporters. More relevant to our setting, this structure of fixed and variable costs is a parsimonious way of spreading the investments into market access over multiple years, making firms forward looking in their exporting decisions and creating the gradual trade response to current and past trade policies that we observe in the data.

We assume that inputs are freely adjustable within the period and that production of goods is constant returns to scale, so that decisions on inputs and production can be made independently for each destination j. Conditional on exporting to j in the current period, a firm chooses its end-use G prices p_{Gj}, as well as its inputs of labor l_j, capital k_j and materials m_j to maximize static profits received from exporting to j. In addition, the firm chooses its export status in the future e'_j to maximize its lifetime expected discounted profits. Let κ_j be the firm's fixed cost draw, and let $\xi_j \in \{\infty, L, H\}$ be the firm f's iceberg cost state, where $\xi_j = \infty$ corresponds to a nonexporter (in other words, a firm facing infinite iceberg costs). The cost state also reveals the export state, with $e_j = 1$ if $\xi_j \in \{L, H\}$ and $e_j = 0$ otherwise. The recursive maximization problem of a firm from country i with regard to its exporting

behavior to destination j in aggregate state S is

$$V_{ij}(\xi_j, \kappa_j; F_{i,e_j}, S) = \max_{e'_j, p_{Gj}, l_{ij}, k_{ij}, m_{ij}} e_j \left[\sum_G p_{Gj} G_{ij}(f) - W_i l_{ij} - R_i k_{ij} - P_{Mi} m_{ij} \right] - W_i e'_j \kappa_j + n_s \mathbb{E} D_i V_{ij}(\xi'_j, \kappa'_j; F_{i,e'_j}, S')$$

subject to the demand functions of final goods producers, which are standard in constant elasticity of substitution (CES) trade models and will be discussed in detail later, and the production function

$$\sum_G \xi_{G\xi_j ij} G_{ij}(f) = z_i (k_j^{\alpha} l_j^{1-\alpha})^{1-\alpha_m} m_j^{\alpha_m}$$

where

$$D_i = \beta \frac{U'_{C_i}}{U_{C_i}} \frac{P_{Ci}}{P'_{Ci}}$$

is the subjective discount factor, $G_{ij}(f)$ is the firm's exports of end-use goods G, P_{Mi} is the price of materials, z_i is the common total factor productivity among all firms in region i, α is capital's share of value added in production, and α_m is the material share in total production.

The static solution to the firm's problem is a set of inputs k_{ij}, l_{ij}, and m_{ij} and prices p_{Gj}. Optimal prices are the familiar constant markup over marginal costs

$$p_{Gj} = \frac{\theta}{\theta - 1} \xi_{G\xi_j ij} MC_i = \frac{\theta}{\theta - 1} \xi_{G\xi_j ij} \frac{1}{z_i} \left(\frac{P_{Mi}}{\alpha_m} \right)^{\alpha_m} \left[\frac{\left(\frac{R_i}{\alpha}\right)^{\alpha} \left(\frac{W_i}{1-\alpha}\right)^{1-\alpha}}{1 - \alpha_m} \right]^{1-\alpha_m}. \tag{1}$$

where θ is the elasticity of substitution across varieties from the same source, which enters the intermediate producer's problem through the demand functions described later.

3.1.1 Dynamic exporting decision

For convenience, let $V_{\xi}(\kappa) = V(\xi, \kappa \sim F_e)$ be the value of a firm of type $\xi \in \{H, L, \infty\}$ where $\xi = \infty$ denotes a nonexporter and we suppress the source, destination and aggregate state indicators. Naturally, $e = 1$ if $\xi \in \{H, L\}$, and $e = 0$ if $\xi = \infty$. The dynamic problem

of the firm of each type can be expressed as

$$\begin{aligned} V_\infty(\kappa) &= \max\{-W\kappa + n_s\mathbb{E}DV_H(\kappa'), n_s\mathbb{E}DV_\infty(\kappa')\}, \\ V_H(\kappa) &= \max\{-W\kappa + n_s\mathbb{E}D[(1-\rho)V_L(\kappa') + \rho V_H(\kappa')], n_s\mathbb{E}DV_\infty(\kappa')\}, \\ \text{and } V_L(\kappa) &= \max\{-W\kappa + n_s\mathbb{E}D[(1-\rho)V_H(\kappa') + \rho V_L(\kappa')], n_s\mathbb{E}DV_\infty(\kappa')\}. \end{aligned}$$

The solution to these maximization problems defines a threshold fixed cost for each type ξ κ^*_ξ such that a type ξ firm that draws that fixed cost is indifferent between exporting and not exporting:

$$W\kappa^*_\infty = n_s\mathbb{E}D[V_H(\kappa') - V_\infty(\kappa')], \tag{2}$$

$$W\kappa^*_H = n_s\mathbb{E}D[(1-\rho)(V_L(\kappa') - V_\infty(\kappa')) + \rho(V_H(\kappa') - V_\infty(\kappa')], \tag{3}$$

$$\text{and } W\kappa^*_L = n_s\mathbb{E}D[(1-\rho)(V_H(\kappa') - V_\infty(\kappa')) + \rho(V_L(\kappa') - V_\infty(\kappa')]. \tag{4}$$

Conditional on being in the same cost state and having the same current export status, firms make identical decisions over inputs, prices, and future export status. Thus, rather than needing to keep track of the export costs by destination of the distribution of firms across time, we need only to keep track of the mass of firms of each type across time. The fixed cost thresholds make that task relatively simple.

To solve for the right-hand side of equations 2–4, we take the expected difference between the value of exporters of each type and the value of non-exporters. To be specific, let $\pi^*(\xi)$ be the expected profits of a firm with export cost state ξ where $\pi^*(\infty) = 0$. Let $dV_\xi \equiv \mathbb{E}(V_\xi(\kappa) - V_\infty(\kappa))$. Using the threshold values above, we can write these terms dV_ξ, which show up in the threshold fixed cost equations, as

$$\begin{aligned} dV_H = \pi^*(H) &- W\left[\int_0^{\kappa^*_H} \kappa dF_1(\kappa) - \int_0^{\kappa^*_0} dF_0(\kappa)\right] \\ &+ n_s\mathbb{E}D\left[[\rho F_1(\kappa^*_H) - F_0(\kappa^*_\infty)]\, dV'_H + (1-\rho)F_1(\kappa^*_H)dV'_L\right] \\ dV_L = \pi^*(L) &- W\left[\int_0^{\kappa^*_L} \kappa dF_1(\kappa) - \int_0^{\kappa^*_\infty} dF_0(\kappa)\right] \\ &+ n_s\mathbb{E}D\left[[(1-\rho)F_1(\kappa^*_L) - F_0(\kappa^*_0)]\, dV'_H + \rho F_1(\kappa^*_L)dV'_L\right]. \end{aligned}$$

3.1.2 Free entry

Each period, fraction $1-n_s$ of intermediate goods producers exogenously exit the market. They are replaced endogenously by a potentially unbounded mass of firms, each of which must pay a fixed cost, f_e, denominated in domestic labor, to enter the market. If a firm enters, it may begin producing for the domestic market and drawing fixed costs to export to foreign markets the following period. Firms will continue to enter in region i until the cost of entry $W_i f_e$ is equal to the discounted expected lifetime profits:

$$W_i f_e = n_s \mathbb{E} D_i \left[V'_{dom,i} + \sum_{j \neq i} V'_{\infty,ij} \right],$$

where

$$V_{dom,i} = \pi_{ii} + n_s \mathbb{E} D'_i V'_{dom,i},$$

and π_{ii} is the optimal static profits from operating in the domestic region.

3.2 Households

Each country is assumed to have a continuum of identical and infinitely-lived households, which we describe with a representative household. The representative household in country i chooses how much to work, L_i, consume, C_i, invest in physical capital, X_i, and invest in a globally traded risk-free bond, B_i to maximize its expected discounted lifetime utility, subject to a budget constraint and a labor endowment $\bar{L}_i$. The recursive problem of the representative household in country i is

$$V^H(K_i, B_i, S) = \max_{C_i, L_i, X_i, B'_i} \frac{\left[C_i^{\mu}(\bar{L}_i - L_i)^{1-\mu}\right]^{1-\sigma} - 1}{1-\sigma} + \beta V^H(K'_i, B'_i, S')$$

subject to a budget constraint and the law of accumulation for the capital stock

$$P_{Ci}C_i + P_{Xi}X_i + P_{C1}QB'_i \leq W_i L_i + R_i K_i + P_{C1}B_i - P_{C1}\frac{\phi}{2}\left(\frac{B_i}{Y_i^N} - \frac{\bar{B}_i}{\bar{Y}_i^N}\right)^2 + \Pi_i + T_i$$

$$K'_i = (1-\delta)K_i + X_i \left[1 - \frac{\psi}{2}\left(\frac{X_i}{X_{i,-1}} - 1\right)^2\right]$$

where S is the aggregate state variable, which includes prices; K_i is the capital stock; P_{Ci} and P_{Xi} are the prices of consumption and investment goods, respectively; Q is the global price of the risk-free bond (denominated in the consumption good of country 1); W_i is the nominal wage awarded to labor; R_i is the rental rate that firms pay to borrow capital from the household; Π_i is the profits of intermediate goods firms returned to households; T_i is a lump sum transfer from tariff revenues; $1/\sigma$ is the intertemporal elasticity of substitution; μ determines the relative marginal utilities of consumption and labor in equilibrium; β is the discount rate; δ is the depreciation rate of capital; and ψ determines the magnitude of investment adjustment costs (a subscript of -1 denotes the value of a variable in the prevous period). For computational reasons, we include a small adjustment cost to risk-free portfolio adjustment, the strength of which is determined by ϕ and which is evaluated with respect to bond holdings as a fraction of nominal GDP Y^N. Our framework allows for any vector of steady state net foreign asset holdings $\bar{B}$.

3.3 Final Goods Producers

Final consumption goods, C_i, investment goods, X_i and material inputs, M_i, are produced using intermediate goods produced domestically and abroad. Final goods producers in each sector $G \in \{C, X, M\}$ choose the optimal mix of inputs to maximize static profits subject to prices P_{Gi}. The production technology for final good G is a nested CES:

$$G_i = \left[\sum_{j \in \mathcal{I}} \left[\int_{f \in \Omega_{ji}} G_{ji}(f)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}$$

where Ω_{ji} is the set of firms in source region j that export to region i, θ is the elasticity of substitution across varieties of a common source region, and $\gamma < \theta$ is the elasticity of substitution across varieties from different source regions.

The firm chooses inputs to maximize

$$\pi_{Gi} = \max P_{Gi} G_i - \sum_{j \in \mathcal{I}} \tau_{ji} \int_{f \in \Omega_{ji}} P_{Gji}(f) G_{ji}(f) df$$

subject to the production technology described above, with P_{Gi} being the Dixit-Stiglitz price

index:

$$P_{Gi} = \left[\sum_{j\in\mathcal{I}} (\tau_{ji} P_{Gji})^{1-\gamma}\right]^{\frac{1}{1-\gamma}} \qquad \text{where} \qquad P_{Gji}^{1-\theta} = \int_{f\in\Omega_{ji}} P_{Gji}(f)^{1-\theta} df.$$

Tariffs τ_{ji} are source-destination specific but do not differ by good-type.

3.4 Aggregation and Market Clearing

Because (i) inputs are freely adjustable, (ii) fixed cost draws are independently and identically distributed and depend only on a firm's previous export status, and (iii) destination-specific export decisions are independent, we can aggregate across individual firm decisions in each market to express the model using only aggregate variables. By doing so, we avoid the need to track distributions over time. Instead, we need to track only the number of firms in each market of each type.

Let $N_{i,t}$ represent the number of firms in country i at time t. Given the survival rate and the mass of entrants $N_{ei,t}$ in each period, the law of motion for the number of intermediate producers in the country is $N_{i,t} = n_s(N_{i,t-1} + N_{ei,t-1})$. Now, using the exporter fixed cost distributions F_{ei}, threshold fixed costs $\kappa^*_{\xi ij}$, and the probability of switching iceberg cost states ρ, we can define the law of motion for the number of high-iceberg cost exporters from country i exporting to country j:

$$\begin{aligned} N_{Hij,t} = {} & n_s \rho N_{Hij,t-1} F_{1i}(\kappa^*_{Hij,t-1}) + n_s(1-\rho) N_{Lij,t-1} F_{1i}(\kappa^*_{Lij,t-1}) \\ & + n_s(N_{i,t} - N_{Hij,t-1} - N_{Lij,t-1}) F_{0i}(\kappa^*_{0ij,t-1}). \end{aligned}$$

The first term on the right-hand side represents the number of high-cost exporters from the previous period that survived, drew a sufficiently low fixed cost to continue exporting in the current period, and did not change their cost state. The second term is the number of *low-cost* exporters from the previous period that survived, drew a sufficiently low fixed cost, and did change their cost state. The final term is the number of nonexporters to j from the previous period that survived and drew a sufficiently low fixed cost to begin exporting at time t. The law of motion for low-cost exporters is similar but excludes the final term as we

assume all new exporters begin in the high-cost state:

$$N_{Lij,t} = n_s \rho N_{Lij,t-1} F_{1i}(\kappa^*_{Lij,t-1}) + n_s(1-\rho) N_{Hij,t-1} F_{1i}(\kappa^*_{Hij,t-1}).$$

Conditional on cost-state ξ, firms choose the same quantities of labor $l_{\xi ij,t}$, capital $k_{\xi ij,t}$ and materials $m_{\xi ij,t}$ as inputs for production in any given period. Thus, the aggregate quantity of, say, capital demanded by firms for production, $K^p_{i,t}$, can be defined as

$$K^p_{i,t} = N_{i,t} k_{ii} + \sum_{i \neq j} N_{Hij,t} k_{Hij,t} + N_{Lij,t} k_{Lij,t},$$

where k_{ii} is the quantity of capital demanded by each firm for production in the domestic market. Definitions for production labor $L^p_{i,t}$ and materials $M^p_{i,t}$ are similar. In equilibrium, capital demanded for production must not exceed the current capital stock of households $K^p_{i,t} \leq K_{i,t}$. Similarly, materials demanded for production must not exceed the quantity of materials produced by final goods firms $M^p_{i,t} \leq M_{i,t}$.

The labor market has a similar restriction, except that labor demanded by firms includes both production labor L^p_t and labor to use for payment of exporting and entry fixed costs. Labor demanded for fixed costs in region i can be expressed as

$$L^{fc}_{i,t} = \Bigg[N_{ei} f_{ei} + \sum_{j \in J} N_{Hij} \int_0^{\kappa^*_{Hij}} \kappa dF_{1ij}(\kappa) + N_{Lij} \int_0^{\kappa^*_{Lij}} \kappa dF_{1ij}(\kappa) + (N_i - N_{Hij} - N_{Lij}) \int_0^{\kappa^*_{0ij}} \kappa dF_{0ij}(\kappa) \Bigg].$$

In equilibrium, we have the restriction that labor used in production or payment of fixed costs must not exceed the labor supplied by households in country i, $L^p_{i,t} + L^{fc}_{i,t} \leq L_{i,t}$.

Just as we have aggregated quantities, we can also aggregate prices across firms. Again, conditional on cost state, firms charge the same prices in foreign markets. Using the Dixit-Stiglitz price index, the aggregated price of the bundle of end-use goods being sold by country i to country j can be expressed as

$$P_{Gij} = \frac{\theta}{\theta - 1} MC_i \chi_{Gij}^{\frac{1}{1-\theta}}$$

where $\chi_{Gij} = \xi_{GHij}^{1-\theta} N_{Hij} + \xi_{GLij}^{1-\theta} N_{Lij}$. Finally, bonds are in zero net supply, $\sum_i B_i = 0$.

3.5 Initial Calibration

To explore the basic predictions of the model and set ideas, we start with two symmetric countries. Later, we extend our calibration to include several asymmetric countries to examine how these predictions fare in the data and to quantify the effects of trade policy expectations on aggregate dynamics.

Our calibration strategy is a simplification of Mix (2023), and many parameters are kept the same. We set $I = 2$, and normalize the labor endowment $\bar{L}$ and productivity z in each country to 1. A period is one year. We set the discount factor $\beta = 0.96$, the depreciation rate $\delta = 0.1$, and the intertemporal elasticity of substitution $\sigma = 1$, all common values in the literature.

The materials share in intermediate goods production, α_m, is chosen to deliver a gross-output-to-value-added ratio of 2. The survival rate of intermediate goods producers is set to n_s =0.98 to match the labor share of exiting firms in the data.

We take the elasticities of substitution between varieties of the same ($\theta = 6$) and different ($\gamma = 4$) countries from Mix (2023), with the latter chosen to match a short-run annual trade elasticity of 3. Together, γ and θ (along with calibrated exporter behavior, discussed below) imply a long-run elasticity of just over 6. We also use the same shape parameter $\upsilon = 0.65$ for the generalized Pareto distribution.

We set initial tariffs to 10 percent. Our main experiments will include an announced elimination of tariffs in 5 years and an anticipated 10-year linear phaseout of tariffs.

The parameters that remain to be calibrated include source-destination-good type-cost state-specific iceberg costs ξ_{GTij}, source-specific scale parameters for the generalized Pareto distribution f_{ei}, the source-specific probability of an exporter staying in the same cost state ρ_i, the relative preferences for consumption and labor μ, and the capital share of value added in intermediate production α. With our two-region symmetric model (so that the parameters are the same for each region), this list includes 11 parameters, 6 of which are iceberg costs. As in Mix (2023), we simplify the iceberg cost structure and impose the assumption that low-cost-state iceberg costs are proportional to high-cost-state iceberg costs $\xi_{GLij} = \zeta \xi_{GHij}$

with $\zeta < 1$. With this simplification, we reduce the parameters related to iceberg costs to 4 and the total parameters to be assigned to 9. We choose the parameters to jointly match the following moments in steady state:

1. Imports-to-GDP ratio = 0.15
2. Capital goods share of imports = 0.2
3. Material goods share of imports = 0.6
4. New exporter share of total exports = 0.05
5. Export share of exporters with five or less years of tenure = 0.4
6. Export participation rate = 0.45
7. Share of exporters that are new = 0.15
8. Frisch elasticity = 2
9. Labor share of value added = 0.66

These moments are largely rough approximations from the data. The import share of 15 percent, for example, roughly matches the U.S. import share in recent years. The split of imports between capital, material, and consumption goods is consistent with average bilateral flows data (Mix, 2023). Moments related to the importance of new exporters are approximations of average export churning statistics taken from the World Bank Exporter Dynamics Database, as described by Mix (2023) and Steinberg (2023).

While these parameters are calibrated jointly to match all moments, some parameters are more influenced by one or more moments. To summarize, the average level of iceberg costs is pinned down by the import share (1) while the good-specific differences are pinned down by the share of imports in capital and material goods (2 and 3). The ratio of low to high iceberg costs and the probability of shifting to the alternative cost state are pinned down by the export share of new exporters (4) and the speed with which new exporters grow, which is represented in the export share of exporters with five or less years of tenure (5). The average scale parameter is pinned down by the export participation rate (6), while their ratio is pinned down by the relative ease with which incumbent exporters continue to export, as illustrated in the share of exporters that are new (7). Finally, the relative preference for

consumption μ is pinned down by the Frisch elasticity (8) and α is pinned down by the capital share of value added (9). Table 2 reports all assigned parameters.

4 Model Results

With the model in hand, we now discuss the dynamic response of the model economy to innovations to future tariffs. The aggregate effects of unanticipated shocks to tariffs have been studied in the literature, and the aggregate response in our model to an unanticipated permanent tariff reform is qualitatively similar to that in existing models, though with some quantitative differences in aggregate transition paths.[15] Anticipated shocks, by contrast, have novel aggregate effects, as the wealth effect and substitution effect occur at different times, particularly when trade results from a firm-level dynamic decision. We now work through several cases in which the path of future tariffs differs or expectations of trade policy differ. In all cases we start from a steady state and solve for the transition following a change in tariffs with a particular path and information structure.

4.1 Sudden versus Phaseouts: Same Discounted Expected Tariff

Figure 3 shows the aggregate response—in log changes from our initial steady state—to two different paths of global tariffs with the same expected value at steady-state interest rates. First, we consider the effects of eliminating the 10 percent tariffs in 5 years, shown with the solid black lines. And, second, we consider a phase-out of the tariffs over 10 years. The long-run effects are the same—the domestic expenditure share falls 4.8 percentage points, GDP rises 4.5 percent and consumption rises 3.8 percent. The transition effects are different particularly in the first few years.

In general, when agents expect tariffs to fall in the future, investment, trade, labor, and GDP all fall on impact; an anticipated trade liberalization is recessionary in the short run. Consumption, by contrast, remains about unchanged. Lower future tariffs increase the present value of the household's lifetime wealth, so households would like to consume more, take more leisure, and save less. When tariffs decline, traded goods become cheaper and the

[15] Recall the work by Crucini and Kahn (1996), Perri and Quadrini (2002), Alessandria et al. (2013), and Alessandria and Choi (2021).

substitution effect makes consumption and investment more attractive than leisure so that the labor, investment, and consumption responses are positive in the long run.

On impact, for the case with a cut in future tariffs, employment falls almost 1 percent, investment falls close to 10 percent, and consumption falls slightly. These variables stay low, and decline further, until just before tariffs are set to fall. On impact, trade falls slightly owing to the decline in investment. After the first period, trade increases (the domestic expenditure share falls) as more firms invest in market access so that the stock of exporters rises. The increase in trade before the tariff reform—despite the decline in output—arises because the value of exporting depends on future tariffs, and the aggregate economy, so that the entry and exit thresholds shift to the right as firms are more willing to incur larger fixed export costs to participate in the foreign market.

In anticipation of the cut in tariffs in year 5, the economy begins to recover a bit. Then there is a large jump in all variables with the tariff cut and then continued expansion. Some variables overshoot their long-run levels. The continued growth in trade after the tariff falls are unique to the dynamic exporting model; a model with a static exporting decision (for example, where all firms export) implies an immediate adjustment in trade with no anticipated or delayed effects.

The overshooting of GDP, consumption, investment, and employment here is common to models with dynamic exporting and endogenous firm entry. At the beginning of the liberalization, the economy has too many firms and too few exporters compared with the new steady state. After some initial adjustment, the liberalization lowers the value of being a nonexporter, and because the probability of becoming an exporter is low, potential entrants stay out of the market and the number of firms in the economy falls. The labor that was used to create new varieties is shifted towards producing more goods, leading to elevated levels of investment and consumption. Over time, the number of firms reaches its new steady state, almost 3 percent below the initial steady state. The smaller stock of firms reduces the productive capacity at home and fewer goods can be produced, leading to the overshooting in investment and, to a lesser extent, consumption.

The dashed blue lines in Figure 3 show the aggregate response when the tariff is phased-out. In this case, we assume that at $t = 0$ there is a perfectly credible announcement that

tariffs will be eliminated starting at $t = 1$ according to a 10-year linear phaseout, similar to what we often see at the product level in the data. The announcement gives agents an opportunity to prepare optimally for both the initial and the continued decline in tariffs.

At the steady state interest rate, the change in the discounted expected tariff is the same in the phased-out case as in our original case. Thus, on impact, the wealth effects are the same and so we see that consumption responds the same as in our case of a five-year delay. Investment, labor, and GDP all fall in the initial periods; an anticipated trade liberalization is recessionary in the short run, although less so than in our original case. When tariffs decline, traded goods become cheaper and the substitution effect makes consumption and investment more attractive than leisure, so that the labor, investment, and consumption responses start growing, although it takes a few years for GDP to exceed its initial level. Thus, the initial recessionary impact is partly explained by the immediate wealth effect, which is offset only gradually by the substitution effect throughout the liberalization.

4.2 Alternative Expectations

To isolate the role of expectations and wealth effects, we now model a 10-year linear phaseout in tariffs with three alternative assumptions about expectations. Specifically, we consider cases where agents (1) anticipate the phaseout three years before the tariff begins to decline, (2) see the phaseout as a series of unanticipated permanent tariff shocks, or (3) see the phaseout as a series of unanticipated transitory tariff shocks so that agents always expect a complete reversion of tariffs to steady state in the next period. As we move from the first to the third case we are progressively reducing the wealth effect and find some significant differences in aggregate behavior (see Figure 4).

The initial phases of an anticipated future phaseout look much like our future sudden reform as the economy goes into a recession with low GDP, employment, and investment. When the phaseout begins the expansion is more modest and drawn out than in our future reform. This case leads to relatively large swings in employment (-1 percent to +2.5 percent) and investment (-10 percent to +25 percent).

When the tariff cuts are unanticipated, there are no movements until tariffs actually change. Unlike the case where the phaseout is anticipated, investment, labor, and trade do

not change until tariffs fall. In case (2), where each tariff decline is unanticipated and viewed as permanent, consumption and investment both increase in each period to take advantage of lower goods prices. Likewise, production labor rises as households substitute away from leisure to consumption. Because agents do not anticipate future cuts in tariffs, there is no intertemporal substituion in employment and investment, so both are higher initially than in case (1). Trade grows a bit more slowly in case (2), as exporters do not consider the future tariff reforms in their decisions.

In case (3), where the tariff declines are perceived to be purely transitory, agents see the low price of foreign goods as temporary, leading them to invest and work more in the current period. Furthermore, because any permanent wealth change from a one-period change in tariffs is small, there is no pull toward leisure, which dampens the response in labor when the tariff declines are viewed as permanent.

Case (3) yields very different long-run effects despite facing the same tariff path. Because tariffs are expected to revert to their steady state value, the share of firms exporting remains constant, which in turn leads to less trade growth. As trade inputs are used more intensively in investment, this muted response in trade leads to a much smaller expansion in investment and the economy.

4.3 Anticipation Horizons

We now explore how the timing of the future liberalization influences the transition path. In general, we find that the declines in consumption and employment on impact are quite similar. We also find that the longer the anticipatory period, the deeper the decline in economic activity until reforms begin.

Consider the same linear phaseout of tariffs discussed previously, but announced one, four, or eight years before implementation. Figure 5 shows the impulse response functions of macroeconomic variables for these three scenarios.

Regardless of the time horizon, the announcement of a trade liberalization is initially recessionary. In the cases of four- and eight-year anticipation, the recession gets somewhat worse over time, with a trough in output the year before tariffs actually begin to fall. The recession, as measured by the decline in GDP, is stronger at longer expectation horizons.

Consumption stays about the same in all cases on impact. After the initial boost, consumption declines with investment and labor until the liberalization actually begins. It declines furthest with eight years of anticipation, as this scenario involves the most depletion of the capital stock.

Despite decreases in economic activity, the number of exporters does not fall in advance of the actual tariff cuts with four years of anticipation, and it falls only slightly with eight years. Because firms are forward looking, they know that while exporting today might be unprofitable, the future value of being an exporter is high. If they receive a good fixed cost draw today and the liberalization is sufficiently close, they use it to begin exporting, recognizing that the likelihood of receiving another good shock after the liberalization is low. Once the liberalization begins, growth in the extensive margin of trade is even higher.

4.4 Trade Liberalization Delays and Cancellations

We now consider the effect of canceling or delaying a future reduction in tariffs. Tariff reductions are often canceled or delayed because of changes in a country's leadership, economic downturns, or other factors. For example, President Trump withdrew the U.S. from the TPP—a multilateral trade agreement that had already been signed—soon after his election. He also renegotiated other trade agreements. We show these types of increases in future tariffs are expansionary in the near-term.

Suppose that agents receive news today that a trade liberalization will begin in four years. The year before it starts, however, they receive news that the liberalization is either being (1) delayed an additional four years or (2) canceled.

Figure 6 compares the macroeconomic outcomes under these two scenarios with those under the baseline scenario, where the tariff reduction occurs as announced at $t = 0$. For the first three years, the responses in all variables are the exact same, with consumption, investment, labor, trade, and output falling. When the agreement is canceled, households' expected future wealth decreases, and leisure falls sharply (labor rises) as households make up for previous periods of intensive leisure. Household expectations about the future price of capital also increase, making investment today more attractive, especially as three years of delayed investment leave them with depleted capital stocks. Canceling a trade agreement

therefore yields a persistent increase in hours, output, investment, and trade *from the date of cancellation*. However, canceling an agreement also reduces the growth of GDP over the next 15 years when compared with the implied path where the liberalization occurs on time.

Delaying a trade agreement mitigates all of these effects compared with canceling the agreement. Labor, investment, output, and trade recover a little when the delay is announced, but they decrease again before the new expected liberalization date. Consumption decreases as the delay lowers the present value of consumers' wealth. Prolonged low investment serves to exacerbate the dip in consumption in the medium run.

4.5 Sensitivity to Model Assumptions

In this section, we analyze how several key assumptions about the composition of trade, exporter dynamics, preferences, openness, and country size affect the aggregate response to changes in trade policy.[16] Discussions frequently refer to the impulse responses in Figure 7, which include dynamics for the baseline model and all variations. Table 2 also includes the calibrated parameters for each alternative model.

Trade composition. In our baseline model, trade is more intensive in investment and materials than in consumption as in the data. We now consider an alternative where the composition of trade reflects the composition of the domestic economy by assuming $\xi_C = \xi_I = \xi_M$. This variation is denoted as "Equal" in the figures. In our baseline model, a liberalization in trade reduces the prices of investment (and materials) by more than the price of consumption, inducing larger swings in investment response than in the equal costs model. In anticipation of the decline in tariffs and lower future investment prices, investment falls about 1.7 percent in the equal-costs model, compared with 7.2 percent in the baseline model. Long-run investment in the equal costs model is about 4 percent higher than in the initial steady state, compared with 15 percent higher in the baseline model. Relatedly, long-run consumption and GDP are higher with capital-intensive trade, as the price of capital falls by more leading to higher long run capital stocks. Consumers also take a bit more leisure in the long run (not shown) when trade is intensive in capital as firms substitute toward capital and away from workers.

[16] In Appendix B, we also report sensitivity to the firm creation margin, the export decision, and the use of materials in production.

Exporter dynamics. We now show that the dynamic response of aggregates to a change in tariffs depends on the firm-level trade frictions. We eliminate the export and firm creation decisions in a variation we call "BKK." Without an export decision, we get a smaller long-run response in trade and the aggregate economy. Compared with a peak expansion in GDP of 5.5 percent in year 14 this model yields a peak response of 3.2 percent in the long run. The early stages of the trade reform are less recessionary, as there is less incentive to cut back on investment early on. The BKK model yields mostly a monotonic transition of GDP and consumption.

Preferences. Wealth effects on labor supply primarily determine the current response to changes in future trade policy. Recent cross-country evidence from Boppart and Krusell (2020) on employment with development is consistent with stronger wealth effects than in our benchmark preferences. Given that we are considering a global policy change, we revisit the effects with alternative preferences. Specifically, we adopt the preferences

$$U(C,L) = \frac{C^{1-\sigma}-1}{1-\sigma} - \frac{\mu L^{1+\frac{1}{\psi}}}{1+\frac{1}{\psi}}$$

from MaCurdy (1981), where $1/\sigma$ remains the intertemporal elasticity of substitution, ψ is the Frisch elasticity, and μ now represents the relative disutility of labor. We choose $\sigma = 1.7$ and $\psi = 0.5$, as in Heathcote et al. (2014), which roughly matches the strength of the income effect as calibrated in Boppart and Krusell (2020). With these stronger wealth effects on labor supply, labor supply drops on news of a future tariff decline and does not increase as much in the long-run. The decline in production labor, shown in Figure 7, is somewhat smaller than in the baseline model. But the decline in fixed-cost labor is much larger, which can be seen in the immediate decline in the number of firms. In the long run, there is less labor supplied in the economy with a stronger wealth effect.

Openness. We now show that the effects of tariff reforms increase with openness. In particular, we consider a phased-out reform for economies with half or twice the import share of our baseline calibration. We vary the trade share by changing the average iceberg cost. Figure 8 plots the transition path of the economy. The long-run effects of the reform are scaled up or down by the ratio of initial trade to our baseline. Likewise the contractionary

effects in the first couple of years of the reform are larger for more open economies.

Asymmetric countries. The effects of global reforms will be heterogeneous across countries. They will depend on the importance of trade and the size of the reform in each economy. We explore this heterogeneity by considering a version of the model with asymmetries in country size. Specifically, we introduce asymmetric TFP z: The big country has $z = 1.05$, and the small country has $z = 0.95$. Figure 9 shows the macroeconomic effects of a phased-in global tariff liberalization for each country. The size of the liberalization in terms of the change in tariffs is the same for each country, but, by construction, the small country has a larger trade-to-output share and thus trade grows by more. The benchmark model in the figures is our model with symmetric countries (with $z = 1$ for each).

While the trade-to-GDP ratio evolves very similarly for both countries, the macroeconomic effects along the transition are very different. Because the small country is more open, the same future decrease in tariffs translates to a bigger decrease in prices and a larger increase in wealth than for the large country. Accordingly, the small country consumes more and works less initially once the path of future tariffs is known. Investment drops by more on impact in the small country, partly because it is crowded out by consumption, but also because firms in the small country are expecting a bigger capital price reduction in the coming years than are firms in the large country. Over time, investment in the small country grows quickly, far outpacing the growth of investment in the big country.

Asymmetries in country size also lead to international capital flows. The last panel plots the ratio of exports to imports. It shows that the small country will borrow from the larger country for about 10 years and then will repay beyond that period. These dynamics can be attributed to the larger gains from the reform for the smaller country leading to a stronger incentive to bring consumption and investment forward than for the big country.

5 Aggregate Evidence from GATT Rounds

Having explained how future changes in trade policy affect the aggregate economy, we now study the aggregate responses in the data and relate them to the model. Specifically, we consider the aggregate dynamics of OECD countries to future reductions in tariffs from three large GATT round implementations. Because GATT rounds were negotiated for several

years, we assume that participating countries have some prior knowledge about the timing and expected impact of the round on aggregate trade. We construct a proxy for expected future trade growth and implement a method similar to that of Arezki et al. (2017) to find the impact of expected future trade on current aggregate variables. The analysis confirms that a larger trade effect following a GATT round corresponds to lower hours worked, GDP, and investment, as well as higher consumption, before implementation. We apply the same empirical approach to a six-country variation of our model and align it with the timing and size of GATT reforms in the data. The model yields a good fit to the data in the window around the reforms.

5.1 Empirics

We obtain data on real and nominal GDP, investment, consumption and trade from the OECD, and we obtain total hours and TFP data from the PWT.[17] We use only the 23 OECD countries that have continuous data since 1960 and end the analysis in 2008. This time frame covers three large GATT rounds: the Kennedy Round (implemented in 1968), the Tokyo Round (1980), and the Uruguay Round (1995). Each of these rounds was negotiated for at least 5 years, allowing member countries to anticipate the effects the agreements would have on the economy.

While it is reasonable that agents understood that each trade agreement was possible, to measure anticipation effects requires constructing a time varying estimate of the effects of these trade reforms for each country, a challenging task. Instead, we proxy the expected effects of each of the agreement on each country with a measure of realized future trade growth over the following ten years. This approach is similar to assuming agents have perfect foresight of the policy effects and is common in dynamic quantitative trade studies (Eaton et al., 2016; Reyes-Heroles et al., 2016; Caliendo et al., 2019; Sposi, 2022). More specifically, for each country we construct a variable with the following steps.

First, let $\lambda_t = \log(1 - \frac{EX_t + IM_t}{2GDP_t})$ measure openness to foreign trade, with an economy in autarky having $\lambda_t = 0$. Let λ_t^T be the trend component of λ_t using a Hodrick-Prescott (HP)

[17] Consumption is private consumption and government spending. Investment is the gross capital flows.

filter with smoothness parameter 6.25. The anticipated size of the agreement $\hat{\lambda}_t$ is

$$\hat{\lambda}_t = \frac{\sum_{s=t}^{t+10} \beta^{s-t} \Delta \lambda_s^T}{\sum_{s=t}^{t+10} \beta^{s-t}},$$

so that $\hat{\lambda}_t$ is the discounted 10-year growth rate of λ^T starting at year t. Figure 10 shows λ_t^T for the U.S. over the sample and $-\hat{\lambda}_t$ at all GATT round implementations. As the figure illustrates, $\hat{\lambda}_t$ is increasing (further from zero) in future trade growth and initial openness. Thus, the relation between initial openness and changes in trade costs that was explored in the model is captured in our empirical analysis.

Our integration measure is included in a panel regression,

$$y_{it} = \gamma y_{i,t-1} - \sum_{s=-5}^{10} \beta_s \hat{\lambda}_{i,t-s} GATT_{i,t-s} + \alpha Z_{i,t} + \alpha_i + \varepsilon_{it},$$

where y_{it} is a macroeconomic variable of interest; $GATT_{i,t}$ is an indicator variable equal to one if a GATT round is implemented at time t and country i is a GATT or World Trade Organization member at the time; α_i is a country-specific fixed effect; and $Z_{i,t}$ is a vector of control variables, including the real effective exchange rate, oil prices, the cyclical component of HP-filtered Group of Seven (G-7) total GDP, and a quadratic country-specific trend as appropriate. The cyclical component of G-7 GDP controls for the world business cycle, as we want to avoid potential endogeneity arising from selection effects in the timing of GATT rounds.

In this specification, the identification of the aggregate effect of changes in future trade growth comes from differences in the effect of GATT rounds on trade growth across countries and across time. We assume that households and firms in countries in which trade grows more after the GATT round accurately anticipate that growth some time during the GATT negotiations and before implementation. Although agents are unlikely to know exactly the future growth of trade, we believe that differences in this measure between countries and the GATT rounds are likely to be correlated with actual differences in expectations, making this measure a good proxy for expected growth.

We estimate the regression for logged hours, logged real GDP, the nominal investment

rate (in which we include net exports considering the capital-intensive nature of trade), the nominal consumption rate, logged TFP, and trade openness scaled by nominal GDP. Figure 11 shows the impulse responses and 90 percent confidence intervals—calculated using Driscoll-Kraay standard errors (Driscoll and Kraay, 1998)—assuming $\hat{\lambda}_t = 1$ percent, which is roughly the mean value across countries in the first year of GATT rounds.

For the average country, hours start falling 4 years before the agreement, bottom out down 1 percent, and then grow to about 1 percent above their initial level by year 10. GDP largely follows the path of hours in advance of the reform but then grows more strongly following the reform, rising 3 percentage points 10 years later. The gap between hours and GDP reflects a strong increase in TFP with the growth in trade.

The division of expenditures aligns well with our earlier points. Nominal consumption as a share of GDP rises about 0.4 percent and peaks two years before the reform starts. The model rationalizes these movements as a wealth effect with no offsetting substitution effect. Because workers knew that the tariff cuts would increase wealth and wages, they reduced labor supply and increased consumption in anticipation. Mirroring the consumption rate, the nominal investment rate (to which we add net exports) fell about 0.4 percent in anticipation of GATT tariff cuts and then began to rise after the cuts began.

While we control for the global cycle, there may still be selection effects in that countries in a recessionary part of the business cycle are granted more concessions to increase exports or make more concessions to increase imports. Going against this narrative, however, is the result that TFP is unaffected in the five years leading up to implementation. After implementation, by contrast, we see that TFP is positively affected by larger trade liberalizations, a force we do not account for explicitly in our baseline model.

The results support the basic predictions of our model—that investment and hours worked fall and consumption rises when agents expect future tariff cuts. Importantly, the effect is not the same for all countries. Rather, countries that had (and, we assume, expected) higher trade growth after the tariff cuts had larger decreases in investment and hours and a larger increase in consumption. These empirical results are robust to alternative measures of future trade growth and to other ways of controlling for the global business cycle. That said, we recognize that our empirical strategy is not as clean or well-identified as we would

like. In the next section, we discuss these difficulties and perform our empirical strategy on model-simulated data to see whether model and data results are quantitatively consistent.

5.2 Model Comparison to Empirical Work

We now relate our empirical results to the model's prediction when tariff changes are expected and when they are a surprise. We show that a six-country variation of our model generates aggregate responses that are consistent with the data when agents expect the trade reforms to be implemented in the future.

Though adopted from Arezki et al. (2017), our empirical method differs in three key ways. First, the timing of oil discoveries, and thus the timing of changes in expectations about future wealth, is well documented. While we know when negotiations began for GATT rounds, we do not know at what point economic agents changed their expectations about future tariffs. Second, the change in expected wealth is easier to measure with oil discoveries, as the quantity of oil discovered and the current price of oil are known. For GATT rounds, however, during the negotiation period, agents may often change their expectations about how large the agreement will be, and it is uncertain at what point expectations are clearly set. Furthermore, measuring the expected size of the agreement for each country is difficult because we do not know how it affects the likelihood of future agreements or whether it was already expected from past agreements. In our analysis, we have assumed that post-GATT round trade growth was known by agents, and we use variation in trade growth across countries to account for variation in expectations. Finally, oil discoveries are a country-specific event, while GATT rounds are essentially global. We try to control for possible global cyclicality surrounding trade agreements by including cyclical fluctuations in G-7 GDP in the regression. Crucially, we do the same thing with the model and the data.

With these differences in mind, we perform the same exercise in our model-simulated data to compare with our empirical results. In the model, we know when expectations change. We also know the expected size of the agreement, as the change in tariffs is announced beforehand. We find that the estimated impulse responses are strikingly similar to the data. We take this finding as evidence that our empirical method is indeed capturing anticipatory effects of future trade agreements.

We use a stochastic version of a six-region setup of our model (Mix, 2023) to simulate data for use in our empirical exercise.[18] We calibrate the model to include six major regions in the 1960s: the U.S., Japan, Great Britain, the rest of the EU, Canada (as a major trade partner with the U.S.), and a rest-of-world aggregate. In steady state, we match relative GDP and population for all these regions in 1962, as well as the composition of bilateral trade between regions in capital, intermediate, and consumer goods.[19] The calibration is discussed in more detail in Appendix C. In our calibration we chose parameters to be consistent with business cycle moments of OECD economies and not to match our empirical results.

We simulate the model by linearizing it around the calibrated steady state.[20] Instead of linear phase-outs, we allow for trend tariff shocks. Specifically, the path of tariffs is described by the following two equations:

$$\tau_t = \tau_{t-1} + \psi_{t-3}$$

$$\psi_t = 0.75\psi_{t-1} + \varepsilon_{\psi,t}$$

where ε_ψ is normally distributed with mean 0. A shock to ψ hits tariffs 3 years after it is observed by agents, giving agents a chance to react to future changes. Starting at $t+3$, tariffs fall by ψ_t. With no further shocks, tariffs fall an additional 0.75ψ in $t+4$, $0.75^2\psi$ in $t+5$, and so forth. The persistence of ψ is chosen to generate a fairly swift phase out, consistent with the five- to eight-year phaseouts of GATT rounds.

In our simulation, all regions are subject to contemporaneous TFP shocks and trend tariff shocks announced with a three-year lag, as described above. The TFP shocks have a global component z_c and an idiosyncratic component z_i. We choose the same standard deviation of the TFP shocks for all countries. The variance and persistence of the total TFP shock imply that the HP-filtered cyclical GDP of each country has a standard deviation of roughly 1.4 percent, consistent with the OECD countries in our data.[21] We simulate the model for 300 periods. To capture the timing of GATT rounds, we assume that global liberalizations

[18] Our model is solved in Dynare using a first order approximation.

[19] Data on GDP and population for these regions are obtained from the World Bank. Data on industry-level trade is obtained from the Atlas of Economic Complexity.

[20] The year to which we linearize around has very minor effects on the results.

[21] A table with business cycle moments in our simulation and the data can be found in Appendix A. We match the volatility of GDP, investment, and consumption quite well. Net exports, by contrast are less volatile than in the data.

are announced at period 200, period 212, and period 227. Notice that agents do not expect subsequent GATT rounds until they are announced. The time between these liberalizations coincides with the timing of the GATT rounds in the data (1968, 1980, and 1995). Initial tariffs are chosen to match the initial tariffs in Yi (2003). In the first round, the average reduction in tariffs across countries is 20 percent (e.g., from 15 percent to 12 percent), but with random variation across regions. In the second round, tariffs fall an additional 30 percent on average (e.g., from 12 percent to 8.4 percent). In the third round, tariffs fall, on average, 80 percent (e.g. from 8.4 percent to 1.7 percent). The increasingly large declines in tariffs reflects our finding in the data that the Uruguay Round had the largest effect on trade for most countries. We assume countries in the rest-of-world aggregate are not members of the trade organization for the first two rounds, and thus reduce their import tariffs only in the third round.

After each simulation, we take the periods between 199 and 248 and estimate the implied impulse responses for a country with $\tilde{\lambda} = 0.01$ using the same method we applied in the data. Our expected tariff shocks are calculated using discounted future trade growth after the liberalization, just as in the data. The lag structure on the expected trade cost shock begins 2 years before the announcement (5 years before implementation) and extends to 10 years after implementation. We control for the global cycle using the cyclical component of U.S. and E.U. total GDP. We perform 400 simulations and take the mean over all impulse responses at each horizon as our point estimate. We use a bootstrapping method to calculate standard deviations over this point estimate.

The estimated impulse responses and their 90 percent confidence intervals are found in Figure 11 in solid blue. For most variables, the point estimate from the model lies within the confidence interval of the data. Indeed, the anticipatory contraction in hours is even stronger in the data than in the model. All in all, our empirical method applied to the model produced impulse responses that mirror those of the data.

As a placebo test, we show that expectations play a key role by considering a case with no anticipation. Here we assume that agents do not expect tariff changes but take them to be permanent when they occur, and we undertake the same analysis. The results of this case are plotted in the line denoted "Surprise." This alternative set of expectations yields a

similar path of trade but does not generate any anticipatory effects in hours or GDP and, as such, is unable to match the path of hours or the consumption-to-GDP ratio in the data. Indeed, several variables are now outside the 90 percent confidence interval of the data in the pre-reform window. Table 3 shows the ratio of the root mean square error (RMSE) in the baseline model relative to this alternative model with surprise shocks to trade only. For all variables, the baseline model yields a lower RMSE, especially in the anticipatory period before implementation. The simple average ratio across all variables is about 0.7 in the anticipatory period and 0.9 over the entire horizon.

We have not targeted the dynamics of these macroeconomic variables, so our model is not a perfect fit with the data. The model does best with hours and GDP, although the effects on GDP by year 10 are two to three times as big as in the model owing to a productivity surge in the data, suggesting some additional benefits to trade integration outside our model.

5.3 TFP Dynamics

We now explore introducing TFP dynamics that are correlated with the trade movements into our model. We consider a case where agents understand these effects and one where they don't. While this allows TFP dynamics to be closer to the data, only the fit on hours in the pre-reform period is improved. There are also reasons to prefer the specification in which agents do not expect these future changes in tariffs.

To capture the observed boost in TFP, we include a spillover from trade to TFP. Specifically, we calculate domestic expenditure λ_{it} both in transition and in steady state (with steady state denoted $\bar{\lambda}_i$) in each country i and assume productivity at time t in country i is $z_{it}\Lambda_{it}$ where

$$\Lambda_{it} = \left(\frac{\prod_{s=0}^{4} \lambda_{it-s}^{\frac{1}{5}}}{\bar{\lambda}_i} \right)^{-\epsilon}.$$

The geometric average of current and past λ_{it} is used so that productivity does not pick up cyclical changes in the trade share arising from transitory TFP shocks. We denote ϵ as the elasticity of productivity to the changes in our moving geometric average of the trade share. We set $\epsilon = 1.3$ to be consistent with the transition in TFP in the data, where TFP in the model is measured as the Solow residual. The effect of this change on TFP is shown in the

bottom left panel of Figure 12, and the impulse responses for other variables after the TFP adjustment are shown in the other panels and labeled "TFP Adj."

In this simulation, we assume that agents understand the effects on TFP from trade, increasing the wealth effect from a liberalization episode. By matching the path of TFP, the model captures the long-run movements in GDP and hours. But it leads to worse outcomes in some other variables in the anticipatory period. With a larger wealth shock, anticipatory adjustments in hours, investment, and consumption are all larger, though the path for hours remains within the 90 percent confidence interval of the data.

The link between increased trade and productivity may not be so clear, as illustrated in the history of debates on trade policy (Irwin, 2019). We run an additional simulation where the economy's productivity benefits from the liberalization, but that benefit is viewed by agents as a residual shock to TFP. In other words, productivity evolves as $z_{it}\Lambda_{it}$ above, but agents believe productivity evolves as z_{it}, so that trade-induced boosts to productivity are unexpected. The aggregate results from this scenario are shown in Figure 12 as "TFP Unexp." Like our first TFP adjustment, this scenario better captures the long-run changes in hours and GDP. Because the boost to productivity is not anticipated in advance, however, the anticipatory effect on GDP, investment, and consumption are less extreme and more in line with the data, even if the movements in hours are a poorer fit.

6 Conclusion

We study the aggregate effects of changes in past, present, and future tariffs in the data and in a general equilibrium model with a dynamic exporting decision. Consistent with previous related empirical work on news on productivity (Barsky and Sims, 2012), income (Arezki et al., 2017), and taxes (Mertens and Ravn, 2012; House and Shapiro, 2006), we find that decreases in future tariffs lower current employment, investment, and GDP. Our model generates these effects through (1) a wealth effect on labor supply that is not offset by a substitution effect until tariffs actually change, and (2) intertemporal optimization of capital expenditures when trade is capital-intensive. Future decreases in tariffs also induce entry of firms into export markets as firms recognize that the future value of exporting is high. This result, as well as the slow response of trade to changes in tariffs, depends on the firm export

decision being dynamic and trade being intensive in capital goods and materials.

Our model-based analysis of the three large GATT rounds offers a novel approach to examining the link between trade and economic activity. It is made possible by having a many country dynamic stochastic model. Our approach can also be applied to study FTAs and unilateral liberalizations, where there is much disagreement on the benefits of reform (Irwin, 2019). We find that GATT rounds depressed economic activity in advance of the reforms by similar magnitudes to those predicted by our model. The main miss in our analysis is the persistent TFP surge that accompanied the trade growth in the countries where trade grew the most. This growth in TFP suggests there may be even larger gains to removing tariffs than suggested by our baseline model. The aggregate effects of this TFP growth suggests that agents did not fully anticipate these benefits either.

Our analysis suggests that trade policy could contribute to movements in GDP over the cycle. Most trade models have a limited role for trade to affect the level of economic activity, as they abstract from issues of labor supply, capital accumulation, trade dynamics, or trade barrier dynamics. Our model, extended to include the usual business cycle shocks, is well suited to estimate the importance of these trade policy-induced effects. We expect that there are periods when these changes in trade policy are relatively important for both business cycle fluctuations and fluctuations in trend growth. Importantly, these shocks to future trade policy may help us understand how changes to other policies or technologies affect the aggregate economy. While we have not addressed these questions here, in a follow-up paper, Alessandria and Mix (2018), we study the contributions of changes in trade barriers to U.S. aggregate fluctuations and extract an expected path of inward and outward U.S. trade policies.In a more integrated world with more trade disagreements these trade-induced business cycle fluctuations are likely to matter more. Indeed, they may have been important in the dynamics of the aggregate economy since the Great Recession, especially as U.S. and China trade relations have soured and continue to worsen.

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Tables

Name	Negotiation Period	Phaseout	Agreement	Authority Granted	Authority Lapsed
Kennedy Round	1964–1967	1968–1972	6/1967	10/1962	6/1967
Tokyo Round	1973–1979	1980–1986	4/1979	1/1975	1/1980
Uruguay Round	1986–1993	1995–1999	4/1994	8/1988	4/1994
Agreement on Textiles and Clothing	1986–1993	1995–2005	4/1994	8/1988	4/1994
CUSFTA	1986–1987	1989–1998	10/1987	10/1984	10/1987
NAFTA	1988–1993	1994–2008	12/1992	5/1991	5/1993
US Korea FTA	2006–2012	2012–2041*	6/2007	8/2002	6/2007

*The long phaseout window for KORUSFTA includes the extension of the U.S. import tariff on trucks from 2019.

Table 1: Tariff Phaseouts and Negotiations

Targeted Moments	
Moment	Description of source
Imports/GDP=0.15	$\approx$ imports to GDP ratio in the U.S.
$\text{Imports}_{Capital}$/Imports=0.2	$\approx$ average share of capital imports in bilateral flows
$\text{Imports}_{Materials}$/Imports=0.6	$\approx$ average share of intermediate imports in bilateral flows
Exports_{New}/Exports=0.05	$\approx$ new exporter share in World Bank Exporter Dynamics Database
$\text{Exports}_{Tenure\leq 5}$/Exports=0.4	Mexican export data (Mix, 2023)
Exporters/Firms=0.45	Mix (2023)
Exporters_{New}/Exporters	$\approx$ in EDD
Frisch elast.=2	Macro elasticity
WL/Value Added = 2/3	$\approx$ labor share in U.S.

Calibrated Parameters					
	Parameter	Baseline	Equal	BKK	MaCurdy
Households	$\bar{L}$	1	1	1	1
	β	0.96	0.96	0.96	0.96
	μ	0.41	0.41	0.41	215
	σ	1	1	1	1.7
	ψ	–	–	–	0.5
	δ	0.1	0.1	0.1	0.1
	ϕ	0.001	0.001	0.001	0.001
IG Firms	z	1	1	1	1
	ξ_{CH}	2.89	2.15	2.73	2.89
	ξ_{XH}	1.08	2.15	0.99	1.08
	ξ_{MH}	2.00	2.15	1.89	2.00
	ζ	0.69	0.69	–	0.69
	ρ	0.83	0.83	–	0.83
	f_1	0.02	0.02	0.00	0.02
	f_0	0.28	0.28	0.00	0.28
	v	0.65	0.65	0.45	0.65
	α	0.17	0.17	0.16	0.17
	α_m	0.6	0.6	0.6	0.6
	f_e	2.47	2.47	2.80	2.47
	n_s	0.98	0.98	0.98	0.98
FG Firms	τ	1.1	1.1	1.1	1.1
	θ	6	6	6	6
	γ	4	4	4	4
	α_G	1	1	1	1

Table 2: Moments and Calibrated Parameters: 2 Region Symmetric Model

Variable	RMSE ratio – Baseline relative to					
	Surprise		TFP Adj.		TFP Unexp.	
	Antic. period	Total	Antic. period	Total	Antic. period	Total
GDP	0.51	0.92	0.29	0.73	0.53	0.50
$Hours$	0.66	0.87	1.81	0.94	1.17	0.52
$(I + NX)/Y$	0.75	0.96	0.17	0.17	1.00	0.15
C/Y	0.77	0.87	0.19	0.24	0.87	0.26
Average	0.67	0.90	0.62	0.52	0.89	0.36

Table 3: Relative Root Mean Square Error in Baseline Relative to Other Models

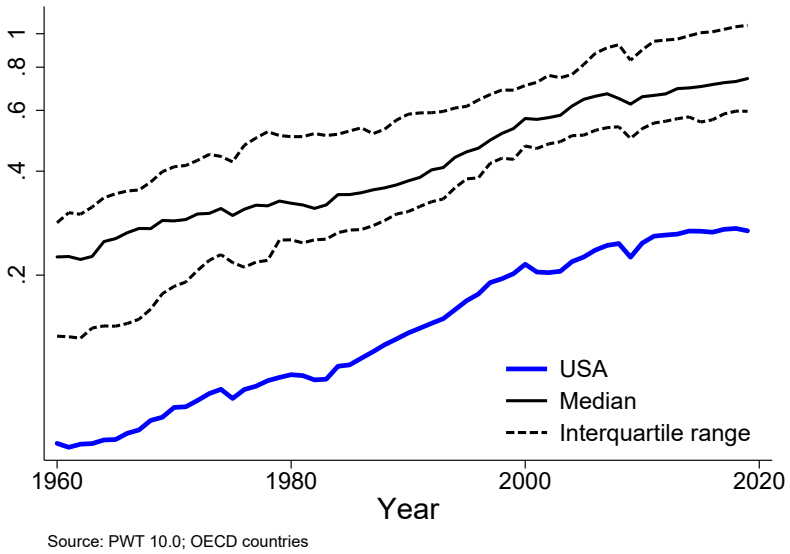


Figure 1: U.S. and OECD Trade to GDP—(EX + M)/Y

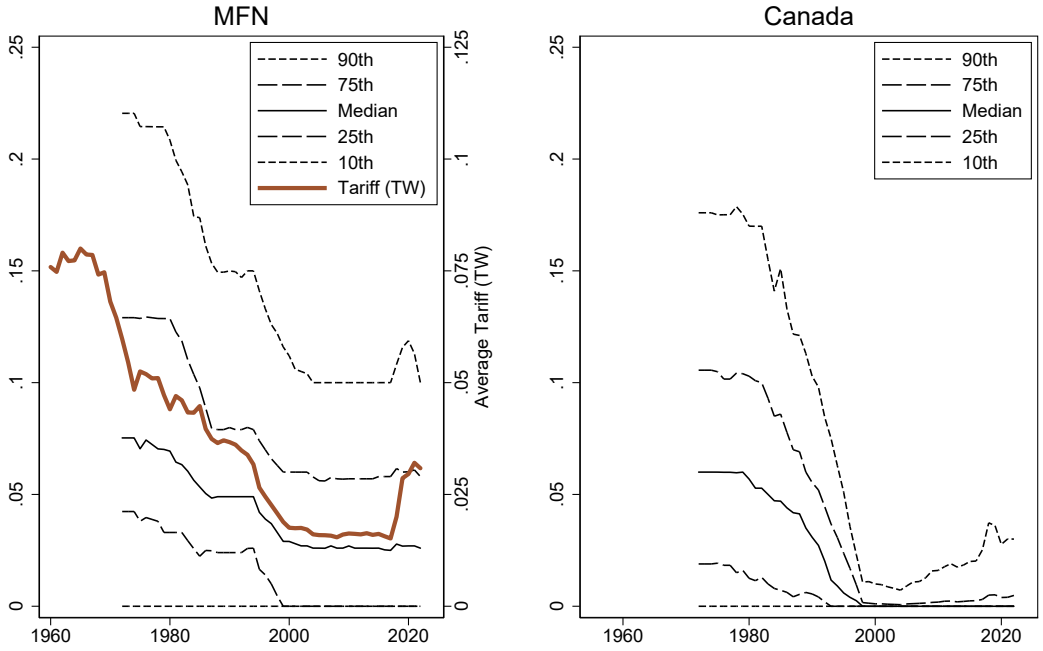


Figure 2: Distribution of U.S. Tariffs by Source

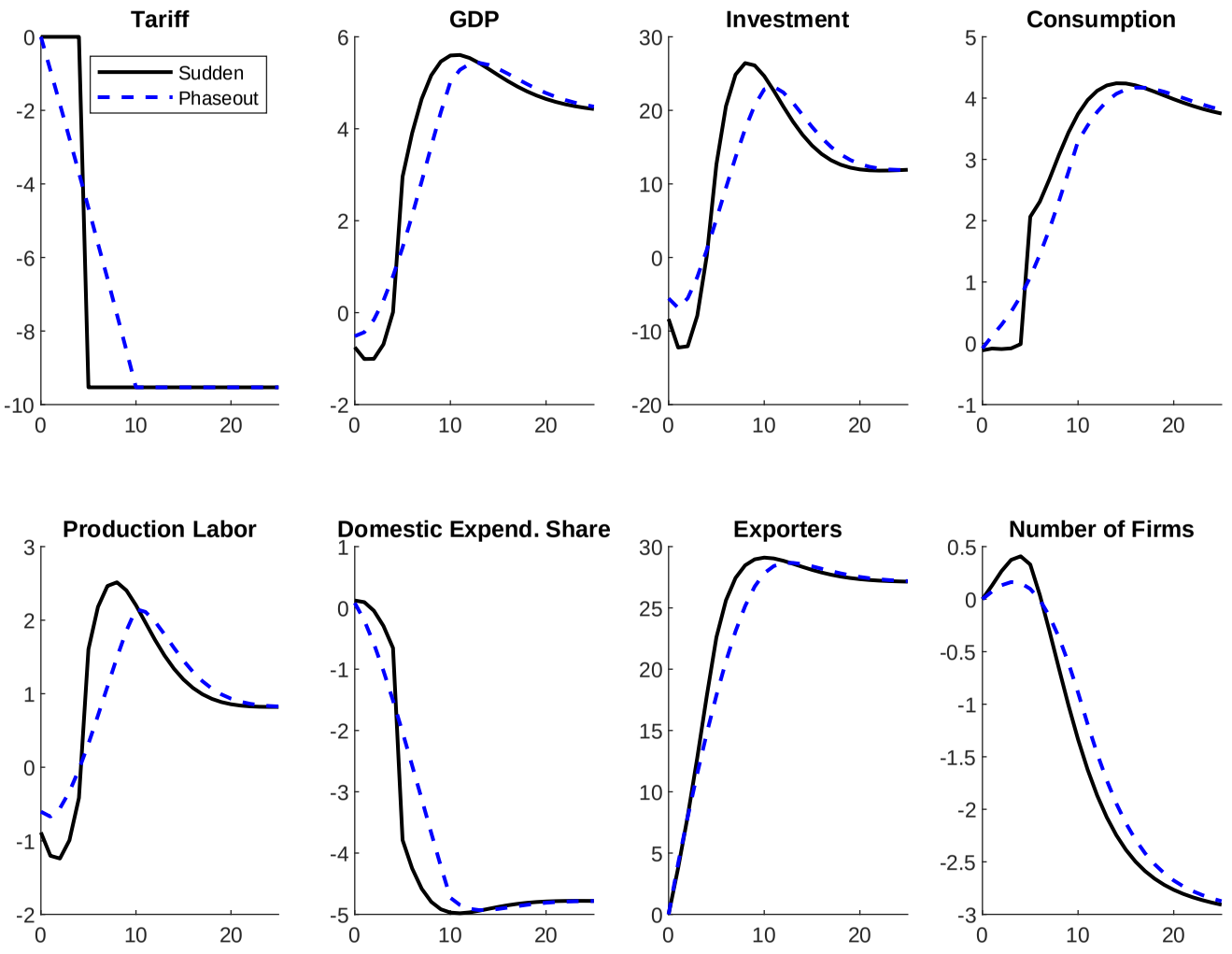


Figure 3: Impulse Response: Delayed Elimination versus Phase Out

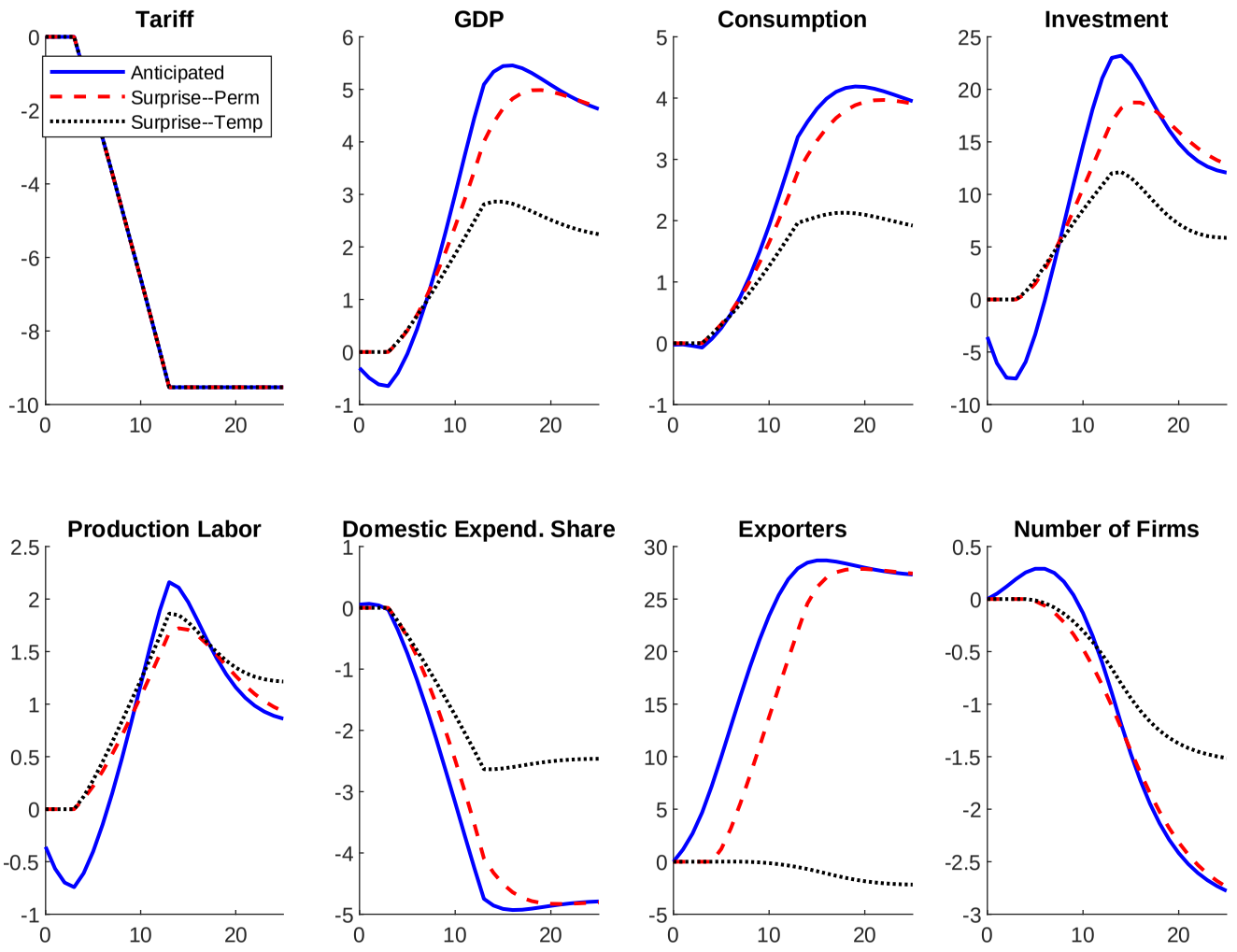


Figure 4: Phased Out Liberalization and Alternative Expectations

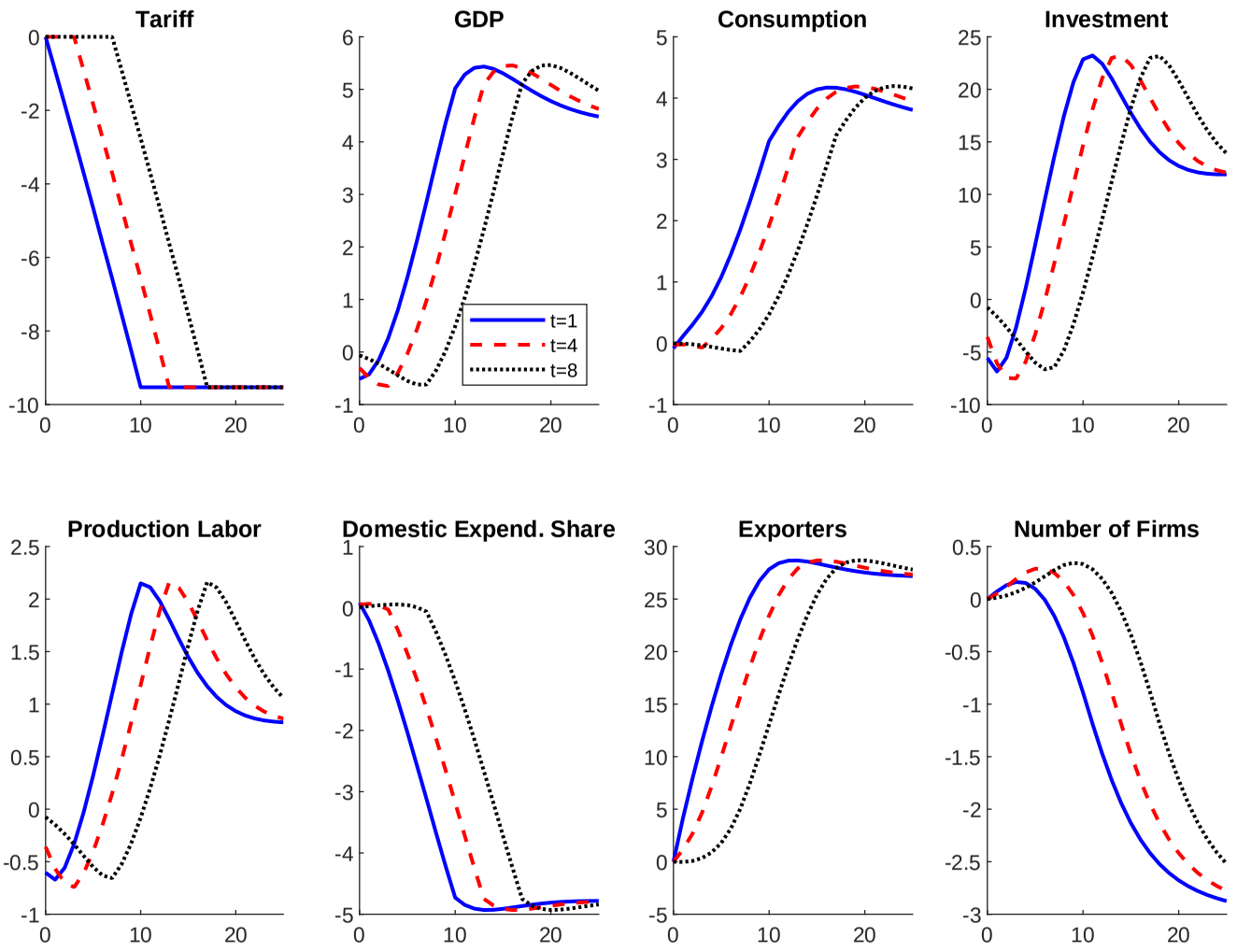


Figure 5: Future Phaseouts at Different Horizons

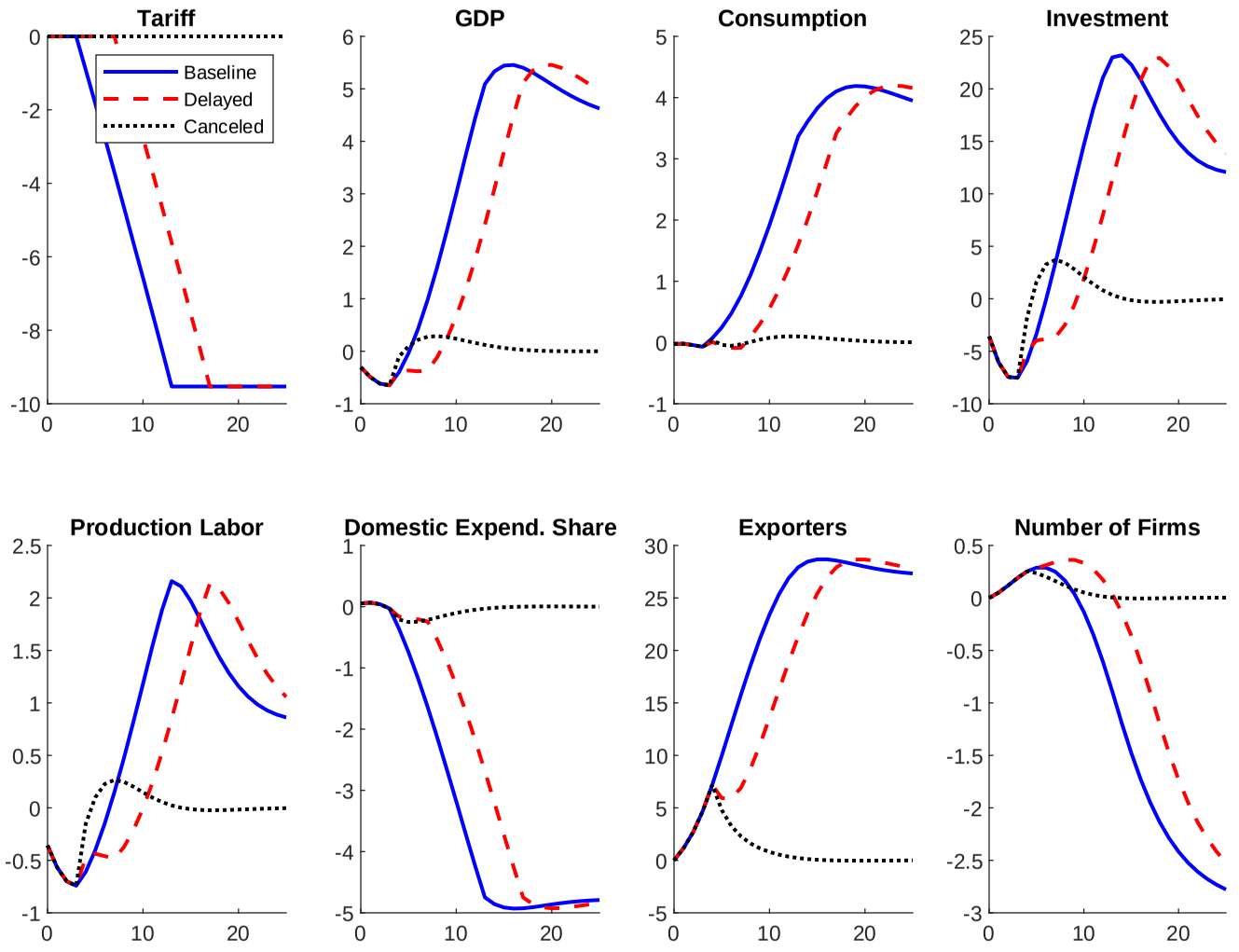


Figure 6: Canceled and Delayed Free Trade Agreements

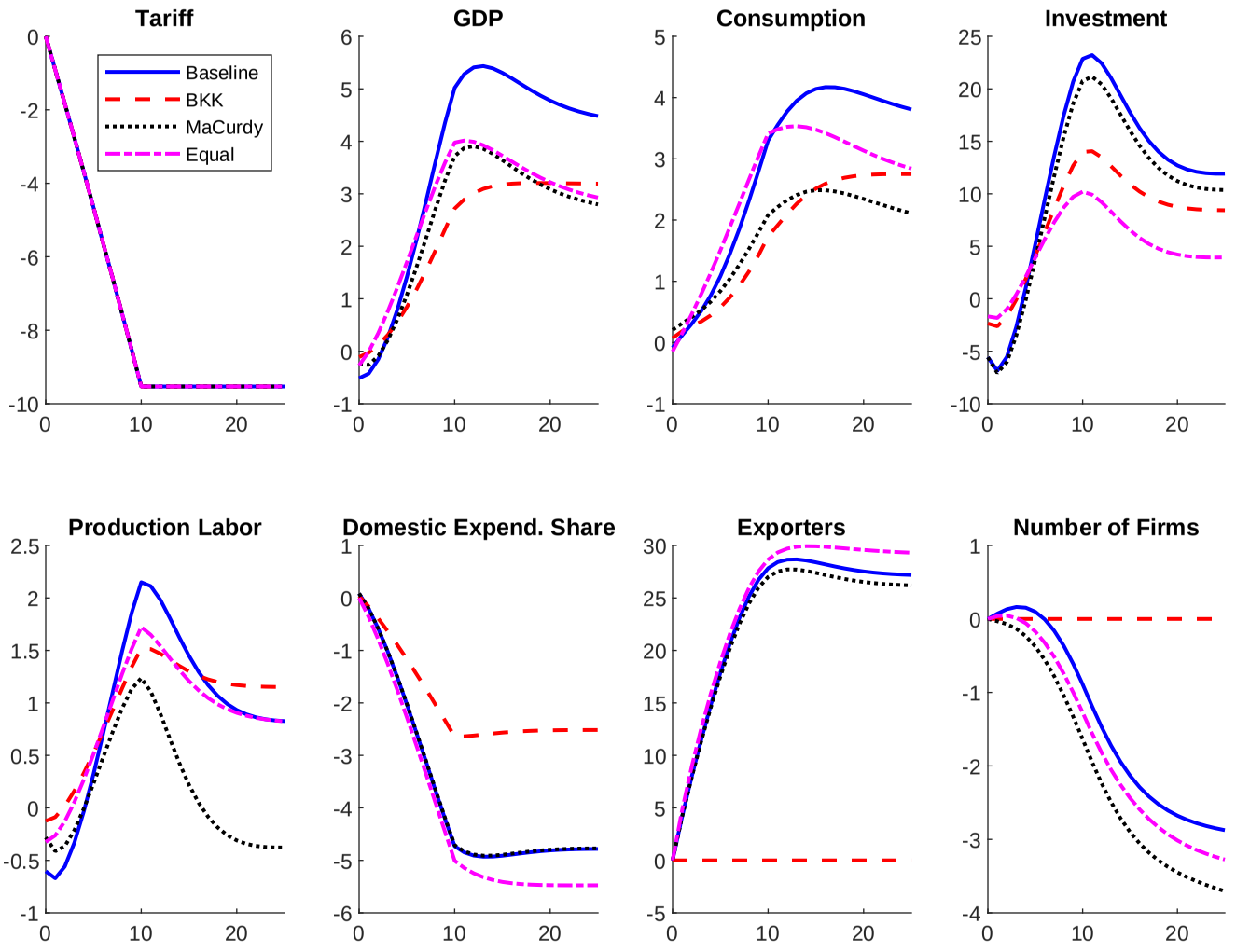


Figure 7: Sensitivity

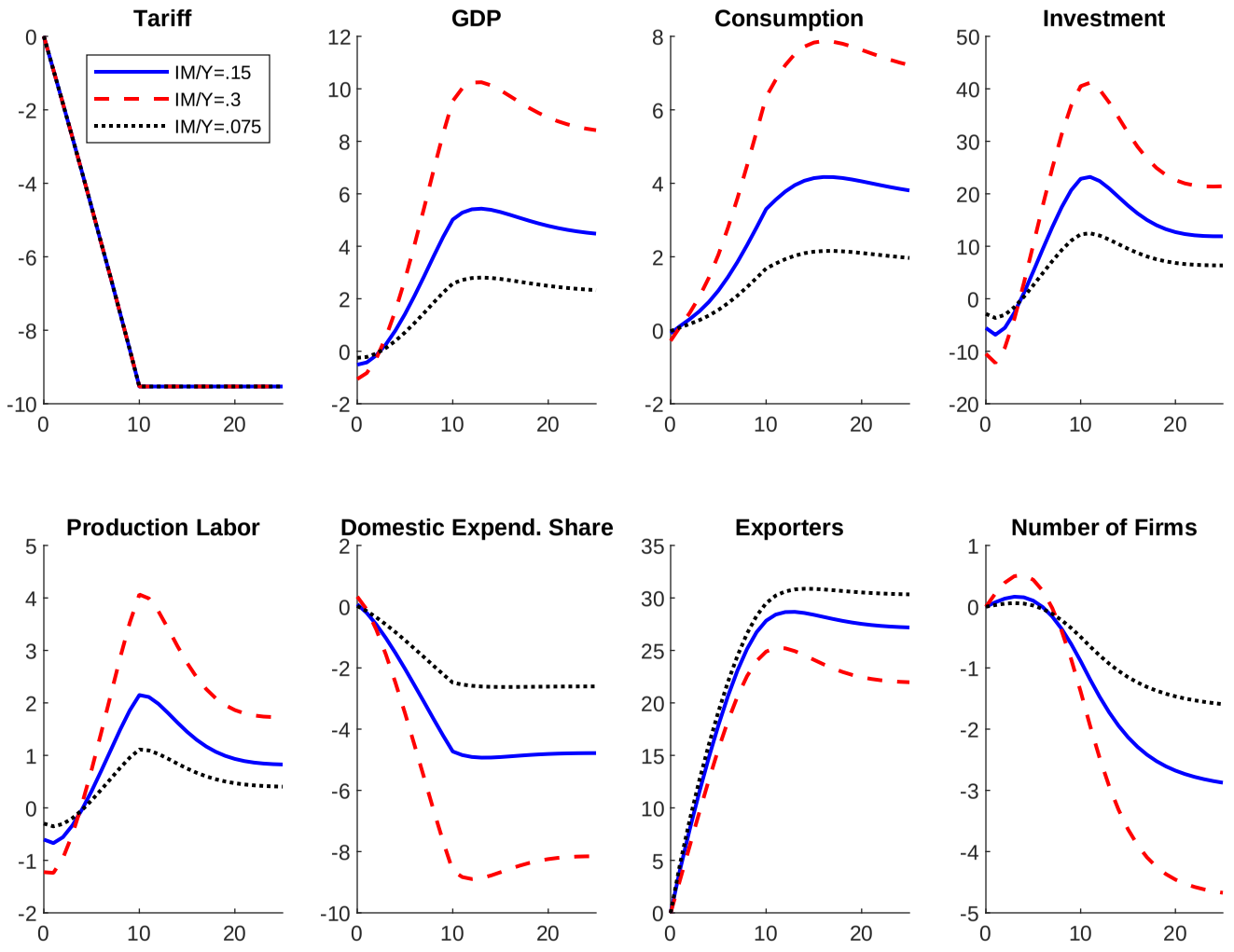


Figure 8: Sensitivity to Initial Irade Openness

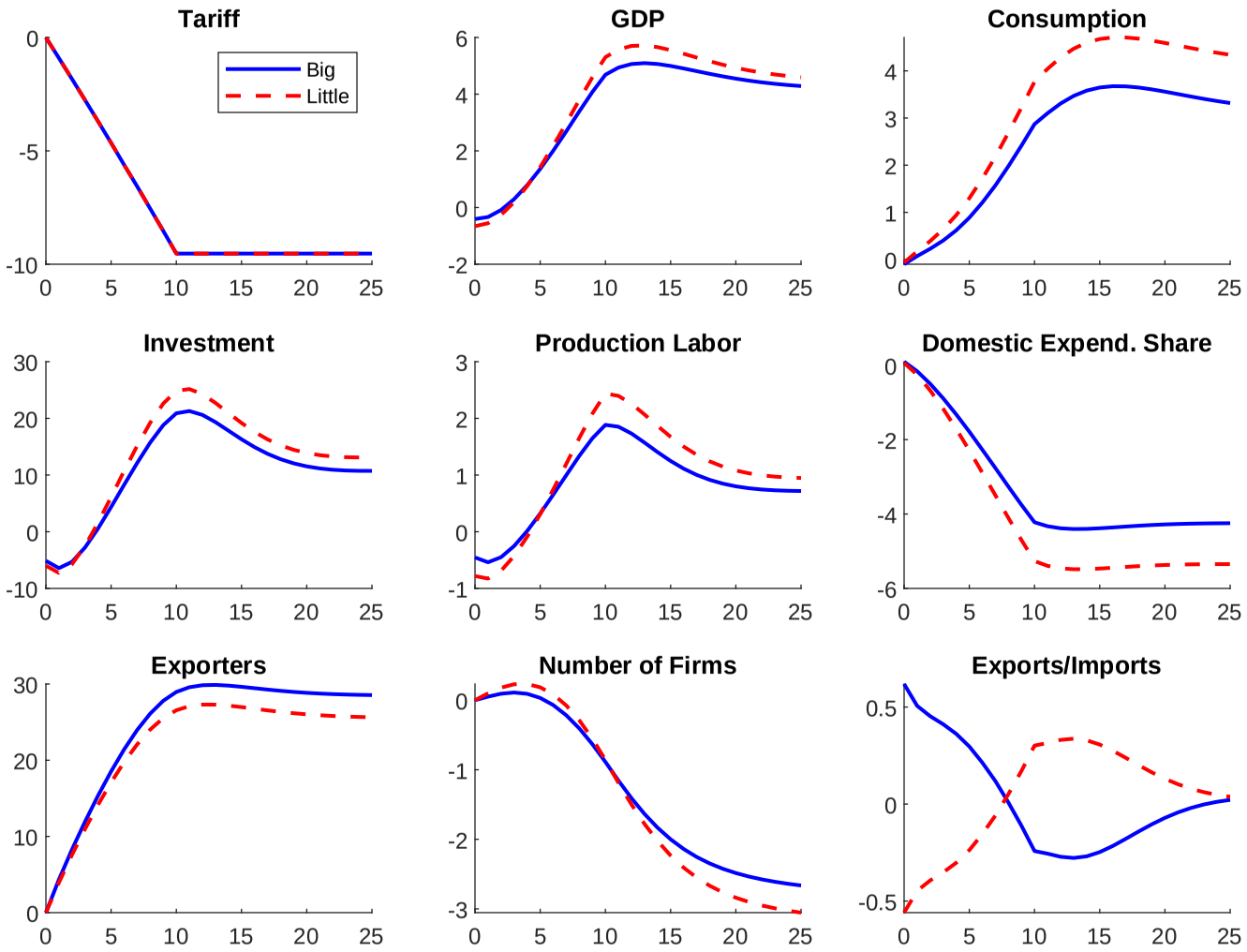


Figure 9: Sensitivity to Country Asymmetries

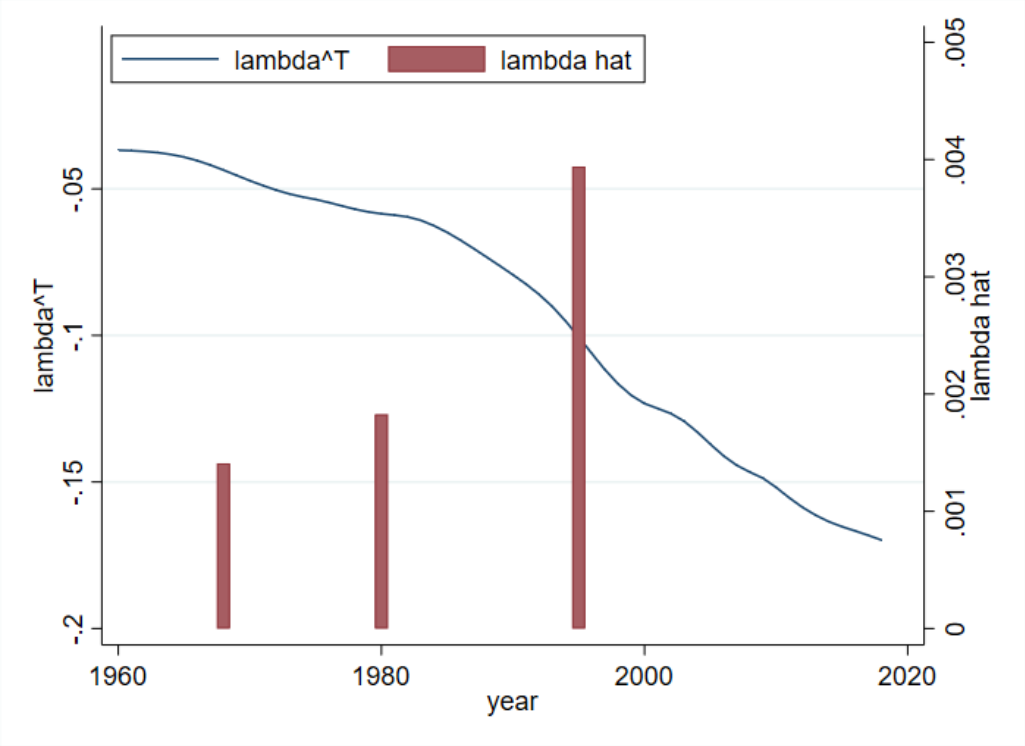


Figure 10: λ^T Path for the U.S.

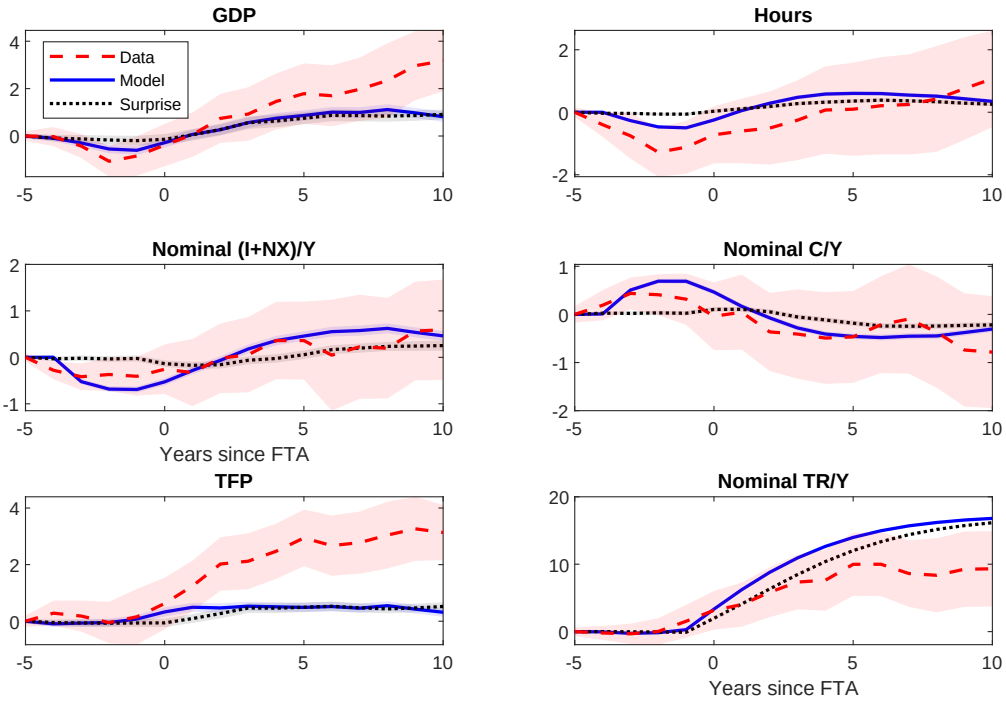


Figure 11: Aggregate Responses before and after GATT Liberalizations (with 90 percent confidence intervals)

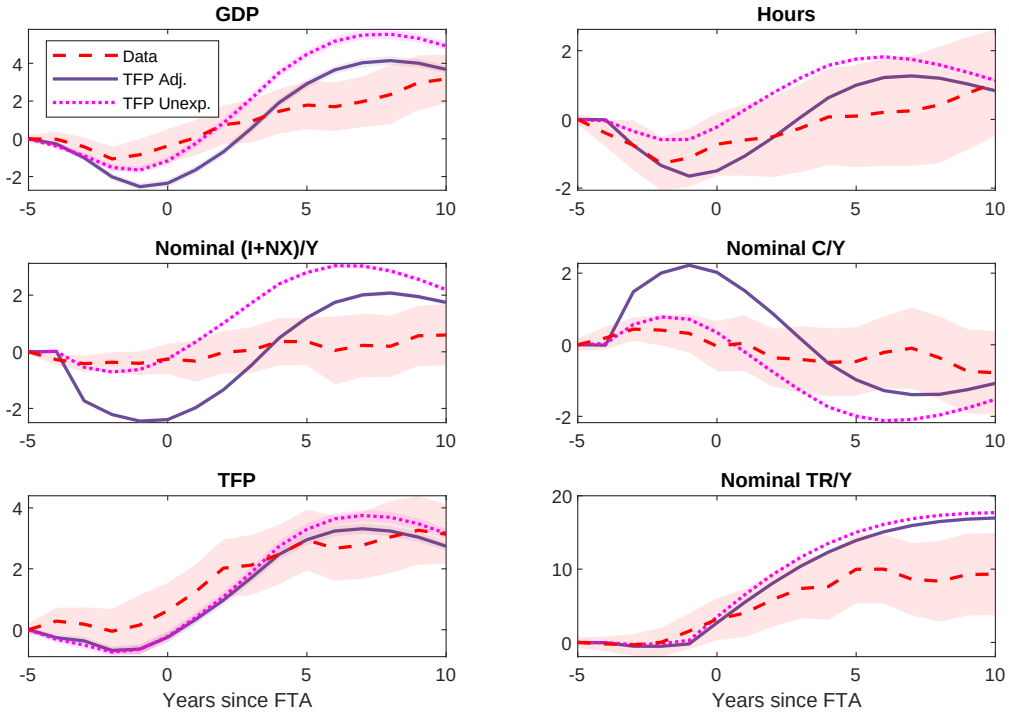


Figure 12: Aggregate Responses with TFP Adjustment (with 90 percent confidence intervals)

Appendix (For online publication)

The appendix contains three parts. In section A we review the data used in our empirical analysis. We also consider the sensitivity of our results to our controls and country coverage. In section B we review the effects of tariffs in some variations of our benchmark model with two countries. In section C we review the calibration of the six-country model we take to the data.

A Data Description and Sensitivity

We consider the following 23 OECD countries (or groups): Australia, Austria, Belgium (and Luxembourg), Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and the United States. Data for real consumption, investment, GDP, and trade are from the OECD and data on hours and TFP are from the Penn World Tables version 9 (Feenstra et al., 2015). The West Texas Intermediate spot price of crude oil (deflated by U.S. CPI) is our measure of global oil prices, obtained from the U.S. Energy Information Administration.

There is substantial variation across countries in the growth of trade following these three GATT rounds. Our measure of the size of a liberalization for each country, $\hat{\lambda}$, reflects this variation in trade growth, and it is the cross-sectional variation in the size of the liberalization across countries that we exploit. Figure A.1 plots the distribution of this measure across all countries and all three GATT rounds considered.

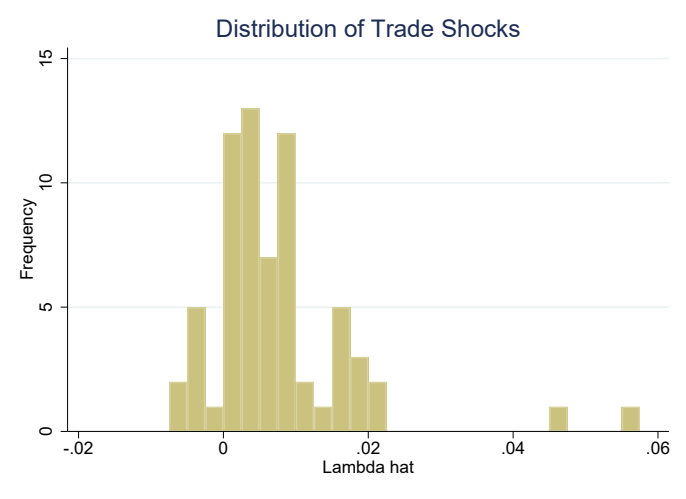


Figure A.1: $\hat{\lambda}$ for all countries in the year of a GATT round.

In total, these 23 countries represent 67 shocks in analysis.[22] On average, $\hat{\lambda} = 0.008$, and the standard deviation among all countries and rounds is 0.01. The outlying observations belong to Belgium/Luxembourg and Ireland in the Uruguay Round, and our results are robust to excluding these countries from the analysis.

Our baseline regression included controls for the cyclical component of G7 GDP, the broad real exchange rate of each country, and the oil price. In Table A.1, we report the estimated coefficients (and Driscoll-Kraay standard error) for these variables. Our key results regarding the response of aggregates to future and lagged trade shocks are unaffected by removing any of the control variables (see Figure A.2 for the impulse response function of hours with and without controls).

We base our estimates on the 23 OECD countries because these countries have high-quality data of sufficient length and were involved in each of the GATT rounds we consider. To check the applicability of these results more generally, we use national account Penn World Tables Data (version 10) for a larger set of countries. We still restrict the sample to include only countries with full data on aggregate variables from 1954 to 2011, which leaves us with a total of 63 countries. The impulse responses for GDP, hours, and nominal consumption and investment rates are shown in Figure A.3 below along with their 90% confidence intervals. Most importantly, the result that labor falls in anticipation for countries with larger expected

[22]Mexico did not join GATT until 1986 and therefore only have the trade shock from the Uruguay round.

Indep. Var.	Dependent Variable					
	$\ln(GDP)$	$\ln(hours)$	C/Y	I/Y	$(X-M)/Y$	$(X+M)/Y$
G7 GDP cycle	0.88***	0.58***	-0.37***	0.30***	-.20***	1.33***
	(0.14)	(0.13)	(0.10)	(0.06)	(0.05)	(0.30)
$\ln(RER)$	0.00	-0.01	0.02***	-0.002	-0.01	-0.03**
	(0.01)	(0.01)	(0.003)	(0.005)	(0.01)	(0.01)
P_{oil}/CPI_{US}	-.01***	-0.004*	0.003**	-0.005***	0.002*	0.02***
	(0.002)	(0.002)	(.001)	(0.001)	(0.001)	(0.01)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, standard errors in parentheses. $\ln(GDP)$ uses real GDP at constant prices while C/Y, I/Y, $(X-M)/Y$, and $(X+M)/Y$ are all measured with current prices.

Table A.1: Estimated Coefficients for Control Variables

trade growth holds true in this larger sample, which our model attributes to the wealth effect. Investment rates and consumption rates also move as predicted by our model and in line with our baseline results. GDP, by contrast, remains quite flat throughout the anticipatory and post-GATT periods. We suspect this result is related to larger productivity (TFP) effects of the liberalizations for the smaller countries included in this sample.

A.1 Model and Data Comparison

We plot the average tariff path (among the 400 simulations) for each region in our model in Figure A.4. Initial tariffs come from Yi (2003) where we give the ROW regions the average rest of world tariff in 1962. Thereafter, we assume tariffs fall by an average of 5% for the Kennedy Round, 7.5% for the Tokyo Round, and 20% for the Uruguay Round. The ROW region is assumed to only have the tariff decline in the Uruguay Round. Assuming alternative paths for tariffs makes very little difference for the final results.

Table A.2 reports some business cycle moments from the simulated six-country model and the OECD data used in our baseline regression. In both the model and data, we apply the HP-filter with a smoothing parameter of 6.25. The model does quite well in matching both the volatility of GDP and the volatility of its components. It is also consistent with the persistence of output and procyclicality of consumption and investment.

Now we take a closer look at the trade shocks in model and data. By construction, a 1% shock $\hat{\lambda}_i$ during a GATT round implies the same discounted average trade growth in both model and data. But, the growth may be weighted more toward the end or beginning of the

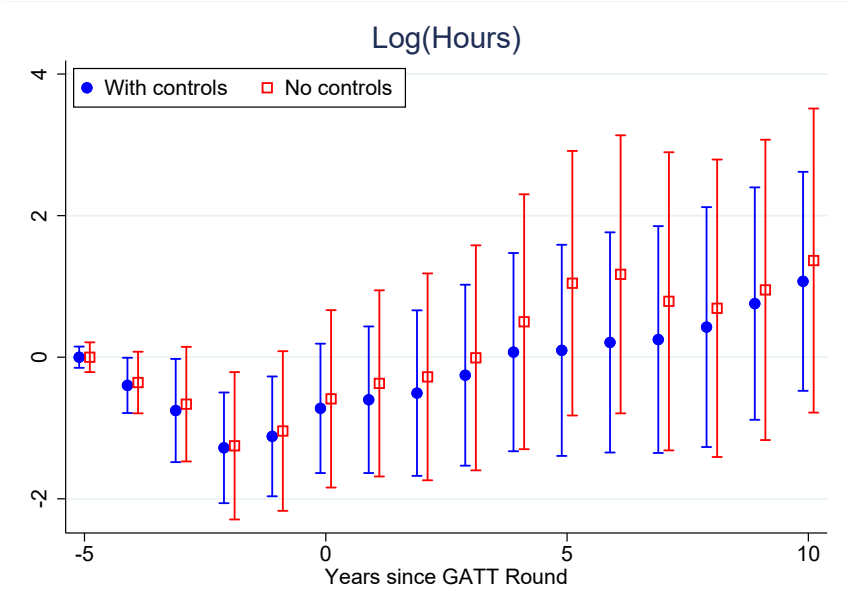


Figure A.2: IRF for log(Hours) with and without controls

Bars represent the 90% confidence interval around each point estimate in the IRF.

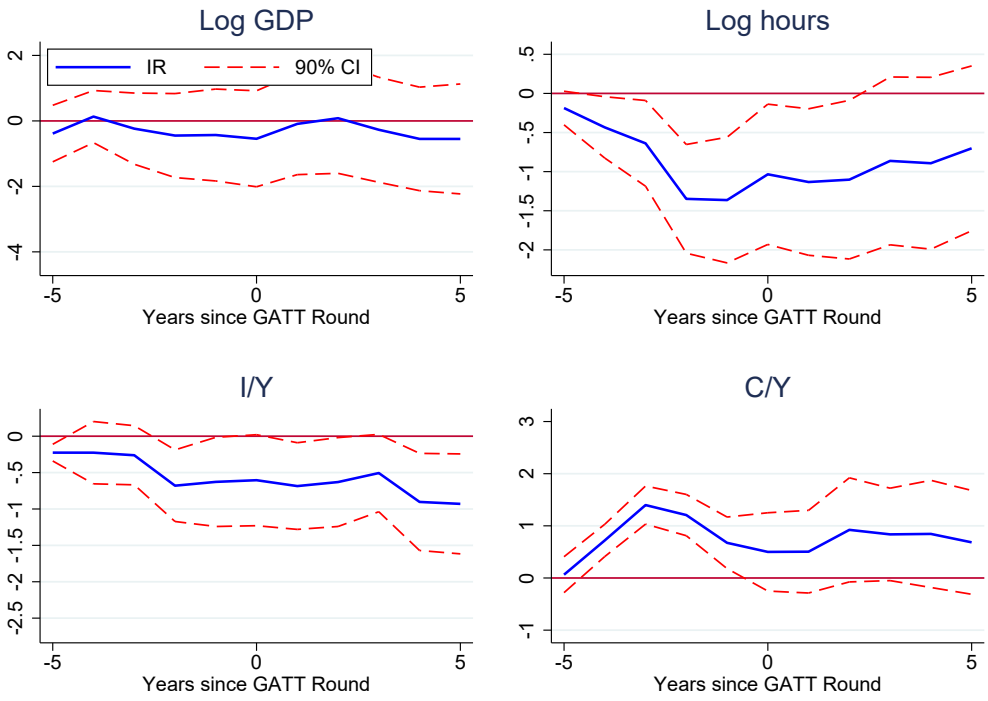


Figure A.3: Impulse responses using larger sample with PWT data

period, which could lead to different results for other aggregate quanitities (including the trade over output response). In what follows, we confirm that the median trade shock of 1%

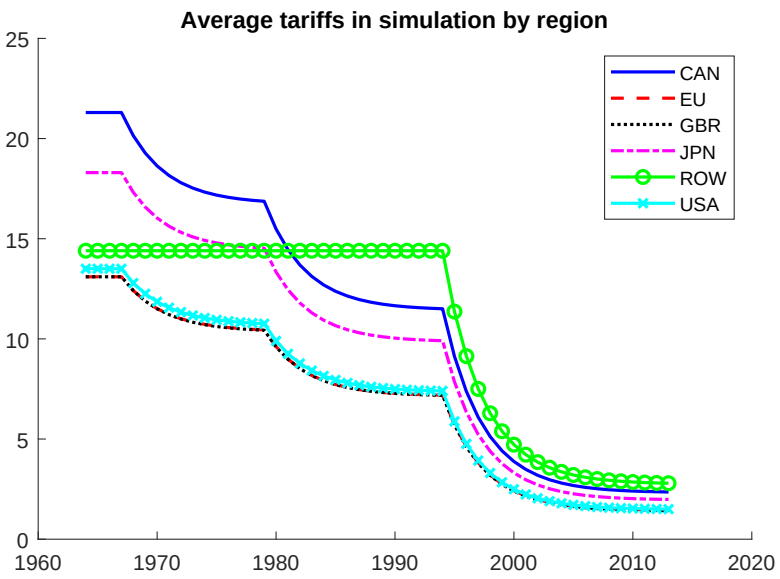


Figure A.4: Average Tariff Paths

implies a similar path for trade in both model and data, alleviating this concern.

Define an event as a GATT round during a period for which a country is a member of GATT. Let t_e be the first year of the GATT round enforcement and i be the country. The trade shock for this event is defined as

$$\hat{\lambda}_{i,t_e} = \frac{\sum_{s=t}^{t+10} \beta^{s-t} \Delta\lambda^T_{i,t_e+s}}{\sum_{s=t}^{t+10} \beta^{s-t}}.$$

The first thing we do is calculate the contribution of each period to the total trade shock in each event by dividing both sides by $\hat{\lambda}_{i,t_e}$:

$$1 = \frac{\sum_{s=t}^{t+10} \beta^{s-t} \Delta\lambda^T_{i,t_e+s}}{\hat{\lambda}_{i,t_e} \sum_{s=t}^{t+10} \beta^{s-t}} = \sum_{s=t}^{t+10} cont_{i,t_e+s}.$$

where $cont_{i,t_e+s}$ can be interpreted as the contribution of period $t_e + s$ to the event's trade shock for country i. Next, we take the median of these contributions across all events for each period s. We divide these median contributions by the sum across all $s = 1, ..., 10$ so that the sum across all contributions is equal to 1, and call this $\bar{cont}_{t+s}$. In words, this measure is the median contribution of a period to the trade shock for each GATT round event, regardless of size.

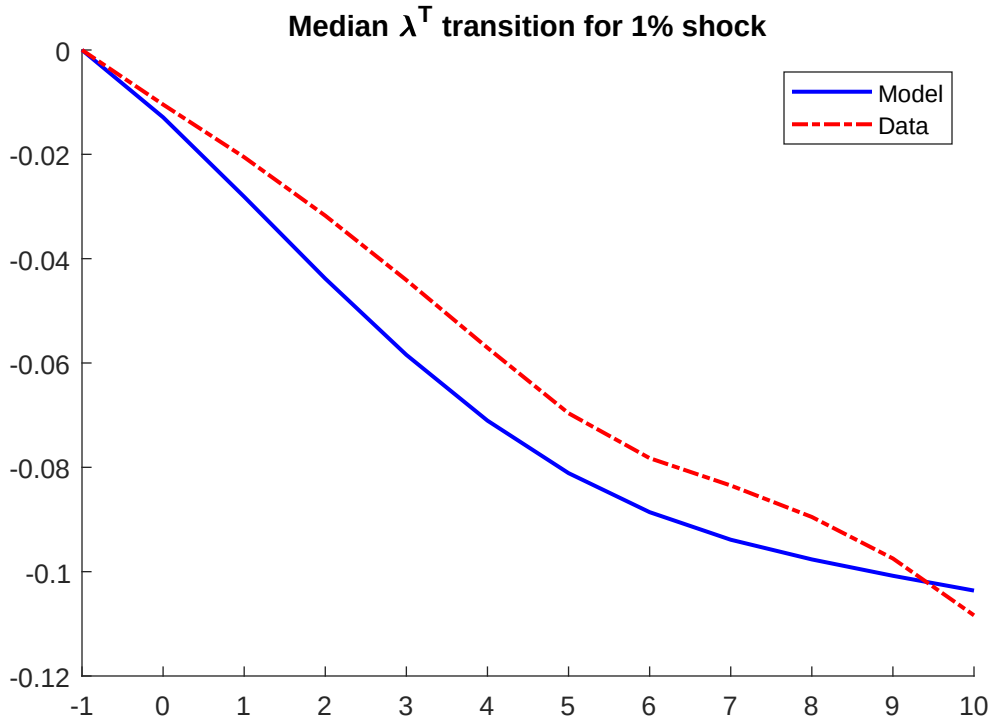


Figure A.5: Median path of λ^T in data and simulated data

Now, we use these contributions to find the median path for λ^T with a shock of size 1%. We will compare the two implied paths for model and data. We can calculate $\Delta\lambda^T$ for a shock size of 1% as

$$\Delta\lambda^T_{t+s} = \frac{.01\bar{cont}_{t+s}\sum_{s=t}^{t+10}\beta^{s-t}}{\beta^{s-t}}.$$

Using this measure, we plot the median transition path (from 0 at $t-1$) of λ^T for a 1% trade shock in data and simulated data in Figure A.5. The model's simulated data implies slightly faster growth in trade in the early years of the liberalization, while growth in the data seems to be more even across periods. The total growth in trade over the entire period is similar in model and data. Overall, we take trade shocks in model and data to imply similar paths for trade.

Moment	Data	Model
σ_y	1.4	1.4
σ_c/σ_y	0.8	0.7
σ_i/σ_y	3.1	3.1
$\sigma_{x/m}/\sigma_y$	2.9	2.0
$corr(y_t, y_{t-1})$	0.26	0.11
$corr(c, y)$	0.68	0.99
$corr(i, y)$	0.80	0.93

Note: GDP (y), consumption (c), and investment (i) are real. Exports over imports (x/m) is nominal.

Table A.2: Business Cycle Moments

B Additional Model Sensitivity

In this section, we report the sensitivity of the model to three modeling features: firm creation, an input–output structure, and an extensive margin of trade. Many analyses of the effects of trade policy abstract from these three margins and thus this offers a glimpse into the quantitative importance of these abstractions. Figures B.1 and B.2 plot transitions to tariff reforms in each case.

Fixed Entry. Making firm entry exogenous mitigates the contractionary short-run effects and amplifies the long-run effects on the aggregate economy. Specifically, we assume that a fixed mass of firms replaces exiting firms every period. Without a firm entry decision, the short-run contractionary effect on production labor with phased out tariffs is about 2/3 of the baseline while the long-run effect on consumption is 1.4 times larger.

Input–Output Structure. The importance of materials in production is determined by α_m, which we set to have a gross output to value added ratio of 2 in the model. To see the importance of materials for aggregate consequences, we reduce the parameter α_m to 0.15, which implies a gross output to value added ratio of about 1.14, so that most goods are directly used in final outputs rather than as materials in production of other goods. Previous work has found that the input–output structure can magnify the aggregate effect of trade. Our work is consistent with the previous work, as in the long run, the model with less-intensive use of materials in production exhibits lower consumption, investment, and output despite a similar transition in the domestic expenditure share.

Krugman. We calibrate the model so that virtually all firms export (99.8 percent) so the exporter margin is very inelastic. The response of trade to the tariff declines is much smaller than in the baseline model as there are no endogenous dynamics in the number of exporters to increase the trade elasticity over time. With all firms exporting, we get less of a boost to the economy coming from trade, but somewhat more of a boost coming from the increase in domestic firms, which reflects the increased value of exporting, as all entrants become exporters.

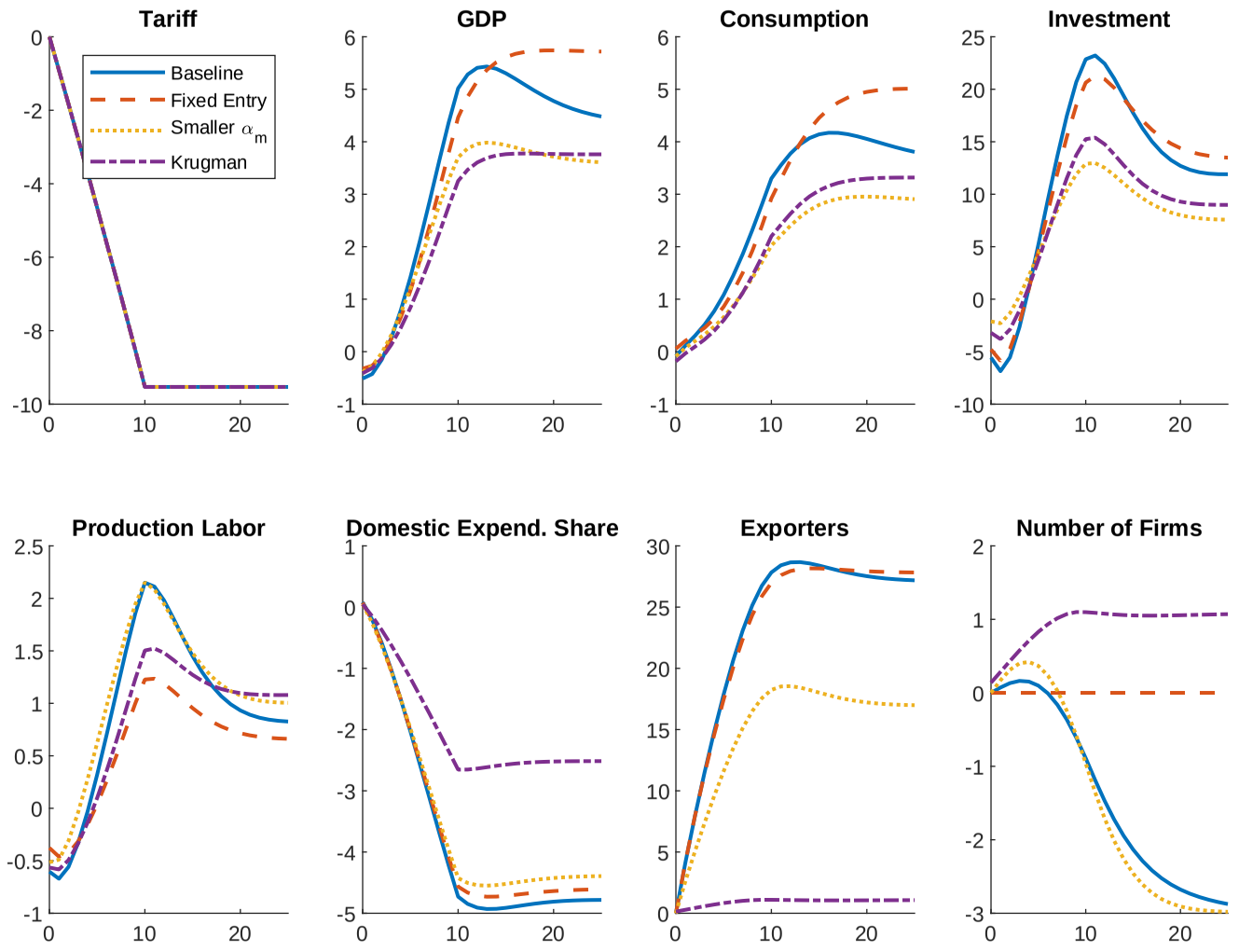


Figure B.1: Sensitivity: Phaseout

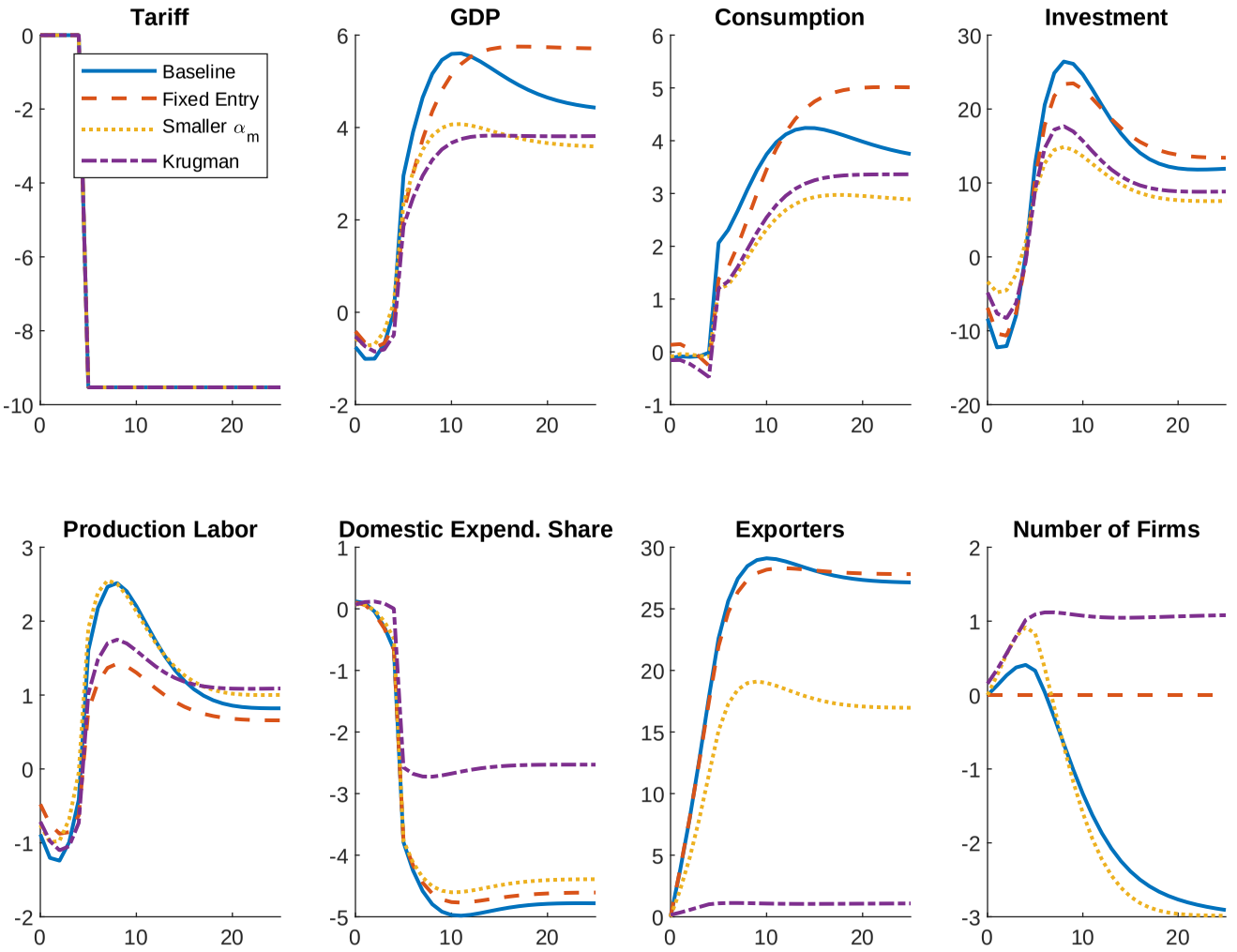


Figure B.2: Sensitivity: Future Tariff Cut

C Quantification of the 6-country model

We calibrate the 6-country model to match the state of the global economy in six regions in 1962: the U.S., Japan, Great Britain, the rest of the EU, Canada, and a rest of world aggregate (ROW). Data on GDP and population for these regions comes from the World Bank, and data on bilateral trade flows by product come from Harvard's Atlas of Economic Complexity. Trade data is originally for industries using the SITC Rev. 2 4-digit level classifications. We use a UN concordance to convert these bilateral trade flows to BEC primary end uses: consumption, capital, and intermediate goods. To properly account for the trade dependence of multi-country regions such as the EU and the ROW aggregate, we split the internal trade of these regions equally among all external regions in our calibration.

With data in hand, our calibration strategy follows the methodology described in Mix (2023). A description of each parameter and its calibrated value can be found in Table C.1 below. Most external parameters are kept the same as in the illustrative 2-country version of the model discussed in the paper. Country- and pair-specific parameters, by contrast, are chosen to match the relative size of each country in 1962, bilateral trade flows by BEC primary end use code in 1962, and average exporter churning statistics calculated from the World Bank Exporter Dynamics Database. In particular, we choose μ, α, f_e, f_{0i}, f_{1i}, ζ_i, ρ_i, z_i, ξ_{GHij}, and v to jointly match the following moments:

1. Bilateral imports as a fraction of GDP in 1962.
2. Share of capital goods imports from each region in 1962.
3. Share of material goods imports from each region in 1962.
4. Export churning (exports of new exporters/total exports) consistent with development in 1962.
5. Exporter churning (new exporters/total exporters) consistent with development in 1962.
6. Export share of exporters with 5 or less years of tenure=8.1·churning rate.
7. Export participation rate=0.10.
8. Average Frisch elasticity across regions=2.
9. Average labor share of value added across regions=0.66.

10. Number of firms equal to population in 1962 (normalization).

The churning statistics matched in the calibration help to determine the relative fixed costs paid by exporters and nonexporters (f_0 and f_1), the relative efficiency of incumbent exporters relative to new exporters (ζ), and how quickly new exporters become efficient exporters (ρ). Mix (2023) shows that average churning rates (both extensive churning and otherwise) are negatively correlated with GDP per capita in a region. We use the same estimates of the linear relationship reported in that paper to determine the targeted churning in each region of our model.

Table C.1: Calibrated Values for Model Parameters

Panel A: Externally calibrated parameters			
Param	Description	Value	Target
β	Discount factor	0.96	
δ	Capital depreciation rate	0.1	
σ	CRRA parameter	2	
γ	Armington elasticity	4	One-year trade elasticity = 3
θ	Elasticity of substitution between varieties	6	Markup = 20%
n_s	Firm survival rate	0.98	Surviving labor share
α_m	Share of materials in intermediate production	0.6	Gross output/value added = 2
$\bar{L}_i$	Labor endowment	varies	Population in i, $\bar{L}_{US} = 1$
ϕ	Adjustment cost on bonds	≈ 0	
ψ	Adjustment cost on investment	0.13	Relative volatility of investment in data
ρ_z	Persistence of TFP shocks	0.8	
σ_z	Standard dev. of TFP shocks	.0095	Volatility of GDP in data
ρ_ξ	Persistence of cost trend shock	0.75	
Panel B: Internally calibrated parameters			
μ	Relative preference C vs L	0.31	Average Frisch elasticity=2
f_e	Entry cost	1.89	Average $N_i = \bar{L}_i$
α	Capital share of value added	0.18	Average WL/VA =66%
f_{0i}	Fixed cost scale (nonexporters)	varies	Fraction exporters=0.10
f_{1i}	Fixed cost scale (exporters)	varies	export-weighted avg extensive churning (Mix, 2023)
ζ_i	Ratio ξ_{GLij}/ξ_{GHij}	varies	export-weighted avg churning (Mix, 2023)
ρ_i	Persistence of efficiency state	varies	avg share of exports by young exporters (Mix, 2023)
z_i	Productivity	varies	$\frac{GDP_i}{GDP_{US}}$, $z_{US} = 1$
ξ_{GHij}	Good-specific iceberg costs G	varies	End-use trade flows
v	Fixed cost shape parameter	1.54	Churning and export volume relationship

NOTES: The targets listed in Panel B are matched jointly by all parameters in Panel B.