Market Concentration and the Welfare Gains from Trade

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Abstract

Growing evidence shows that large firms have become more dominant in domestic markets across different countries. How does this increase in market concentration affect the welfare gains from trade and, thus, the incentives to maintain lower barriers? How does it interact with the role of foreign competition in disciplining domestic firms' markups? In this paper, I study how observed market structures and trade openness shape the welfare gains from trade using a sufficient statistic approach. I construct a general equilibrium model in which granular firms from different origins compete in domestic markets by selling products that are imperfect substitutes. I show that under both quantity and price competition, there exists a welfare-consistent concentration measure that captures the direct consumer welfare cost from markups due to granularity. On the producer side, I uncover a domestic aggregate markup from sales at home and abroad that determines domestic producers' aggregate profits. These results lead to two sufficient statistics measuring the consumer and producer gains from trade, together defining the total gains. I leverage these statistics to study the process of trade opening experienced by Chile at the turn of the century. I find that despite rising domestic concentration, the costs from markups declined as the economy opened, lowering the opportunity cost of reducing openness. These results highlight the importance of being equipped with statistics that consider the existing industry market structures when evaluating changes in trade exposure.

Keywords: Gains from Trade, Welfare, Market Concentration, Competition, Market Power, Oligopoly, Market Structure

JEL-Codes: F10, F12, F40, L13

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1 Introduction

A key theoretical gain from opening to international trade is the reduction in domestic firms' market power through heightened competition. In a world with increasingly concentrated markets and economies more exposed to foreign competition, this mechanism can be of high importance: closing the economy can return domestic markets to a growingly less competitive environment. In this paper, I construct a theoretical framework that delivers a connection between market concentration and the welfare gains from trade in the presence of granular firms via oligopolistic markups.

In recent years, the international trade literature has developed rich sufficient statistic approaches to measure different aspects of the gains from trade. The prime example is the formula developed by Arkolakis, Costinot and Rodriguez-Clare (2012)—the ACR formula—which collapses the aggregate gains from trade implied by the most used trade models into two statistics: the share of expenditure on domestic goods and the elasticity of import values with respect to variable trade costs—the trade elasticity. However, one of the key conditions for this result to hold with heterogeneous firms is that firms are small relative to the economy. In other words, individual firms are assumed to have no market power beyond monopolistic competition.

I build on that framework by introducing firms that can individually affect industry variables such as price and quantity indices. These so-called granular firms break a key necessary condition to arrive at the ACR formula: the share of profits in aggregate income becomes endogenous. I show how to exploit the structure of the CES demand system to overcome this issue and derive sufficient statistics for the changes in the distribution of markups and aggregate profits. In doing so, I am able to extend the current gold-standard statistic for the gains from trade to a world where large firms are dominant (c.f. Bernard et al., 2018). Centrally, the factor of correction that I introduce to deal with granularity only depends on domestic firms' market shares, making it a convenient statistic that can be easily computed with the same type of information needed for widely used market concentration measures such as the Herfindahl-Hirschman Index (HHI) and the Concentration Ratios (CR). This correction can be useful given recent macroeconomic discussions showing rising markups and concentration (e.g. De Loecker et al., 2020; Autor et al., 2020; Gutierrez and Philippon, 2017).

I derive two statistics to capture the two main features of market power: consumer costs from higher markups and producer gains from higher profits. In a general equilibrium setting, changes in market power first-orderly distort welfare through these two channels. First, it increases the price level due to higher aggregate markups. Such an increase depends on fundamentals that are often unobserved and difficult to estimate. I derive a function that only uses the firms' market shares in a

given market and, only if firms compete in prices, the elasticity of substitution across their varieties. Second, I derive a function to measure aggregate profits closely related to the level of misallocation in the economy. This measure is a function of widely employed concentration functions and can also be easily computed using firms' market shares. To be sure, versions of this result are well-known in the industrial organization literature (Syverson, 2019, Berry et al., 2019). My contribution is to embed it in an international trade framework and show how to implement it in a setting where domestic firms also export to foreign markets. Having these two measures can also be useful for international economists and macroeconomists studying market power.

To be sure, many papers have evaluated the pro-competitive gains from trade using different strategies. One of them has been to maintain the assumption of monopolistic competitive firms but abandon CES preferences for preferences yielding variable markups, firm heterogeneity or both (e.g. Neary, 2016; Feenstra and Weinstein, 2017; Arkolakis et al., 2019). In these papers, the usual goal is to get analytical expressions to perform comparative statistics and derive sufficient statistics. A different strategy has been to keep CES preferences but introduce granular firms to quantitatively estimate the gains from trade (e.g. Edmond, Midrigan and Xu, 2015). In this case, obtaining tractable analytical expressions becomes challenging. I show how to restore the ability to measure local welfare changes to this last setting using the aforementioned sufficient statistics, which summarize welfare costs arising from markups of firms from all exporting origins and welfare gains from domestic firms earning profits in all markets where they are active.

Have the gains from trade changed as globalization and market concentration increased across markets over the last decades? Answering this question is key to evaluating the opportunity cost of reducing trade openness, as some recent events may suggest. To do so, I apply this framework to measure welfare changes in a period of a steep increase in import penetration in Chile. Between 1998 and 2007, this country signed free trade agreements with the US, the EU and China, uniformly decreased the Most Favored Nation (MFN) tariff applied to all WTO members, and experienced an appreciation of its exchange rate, making the Chilean peso 50% more expensive in dollars in 2007 relative to 2003. Jointly, these events had a likely role in the increase in import penetration from 59% in 2000 to about 66% in 2007.

In contrast to what the usual market concentration indices show, I find that the welfare-consistent domestic concentration measure stayed the same throughout this period. This implies that the direct cost from oligopolistic domestic markups stayed the same in spite of an increase in the HHI and CR. The intuition is that, while these firms appeared more concentrated based on the allocation of expenditure on domestic goods alone, increased foreign competition forced them to

lower their markups overall. The horse-race between higher import penetration and higher domestic concentration resulted in the former dominating and generating lower consumer welfare gains from trade in 2007. In the end, the consumer welfare losses from a 10 log-point increase in the share of total domestic expenditure in domestic goods were 0.3 log points lower in 2007 vs 2003.

A key difference in the presence of granular firms is that profits are higher than under monopolistic competition when entry is limited. In other words, the producer gains from trade, in the form of higher markups, are positive compared to when firms are assumed to be in a continuum. From an aggregate perspective, changing trade conditions also modify the source of profits across sectors. In other words, sectors that are less affected by foreign competition are more likely to increase their share in aggregate profits. Therefore, the resulting producer gains indicator results from the interaction between industry profit shares and markup increases. I find that the local producer gains from closing the economy were relatively at the end of the period of trade opening, but that average industry markup went up for domestic firms. In the end, the aggregate welfare effect from closing the economy uniformly in 10 log points when considering both producer gains and consumer losses were slightly lower in 2007 vs 2003. The takeaway is that the aggregate local gains from trade depend on the domestic market structure, which at the same time depends on foreign competition. Therefore, the opportunity cost of closing the economy is likely to vary substantially across countries as the degree of firm granularity in economies increases.

My main contribution is providing a sufficient statistic for the gains from trade in the presence of granular firms. As mentioned above, Arkolakis, Costinot and Rodriguez-Clare (2012)—ACR—was foundational in showing that a family of trade models, ranging from those focusing on Ricardian comparative advantages to those with firm heterogeneity and monopolistic competition, all fell into a single sufficient statistic when the goal is evaluating the welfare gains from trade. In a subsequent paper, Arkolakis, Costinot, Donaldson and Rodriguez-Clare (2019)—ACDR—extended this framework to allow for a wide range of preference structures that yielded variable markups, including those delivering non-homothetic demand. In that setting, they maintained monopolistic competition and an ex-ante approach, which allowed them to correct the ACR statistic by a multiplicative factor that only depends on model parameters. Other papers also employed similar approaches to study the gains from trade from firm selection (Melitz and Redding, 2015), variety and markups in the context of monopolistic competition (Feenstra and Weinstein, 2017; Feenstra, 2018), with worker heterogeneity (Galle et al., 2022), and innovation (Impullitti et al., 2022), among others. My paper delivers a stylized formula to analyze the ex-post, short-run welfare gains in settings with high concentration. Moreover, this formula allows for decomposing welfare changes into producers'

and consumers' surplus changes, an analysis usually performed in the classic international trade literature that is standard in today's international trade undergraduate courses (e.g. Feenstra and Taylor, 2014).

My second contribution is to inform the literature studying sectoral and aggregate changes in market power in recent years by providing welfare-consistent concentration measures in open economies. Different papers have documented a rise in market power recently (e.g. De Loecker et al., 2020; Autor et al., 2020; Benkard et al., 2021), while others have cast doubts on the actual implication of the measures used for market power measurement (e.g. Rossi-Hansberg et al., 2021, Amiti and Heisse, 2024, Shapiro and Yurukoglu, 2024). I microfoundate a family of concentration measures by exploiting the convex relationship between markups and market shares when the latter account for the entire market, e.g. foreign exporters active in domestic markets. By doing so, my measures become most valuable in periods of changing trade conditions, given that domestic market concentration and markups alone cannot account for the entire state of competition.

Finally, I also contribute to understanding further the structure of trade and macroeconomics models with firm heterogeneity and granularity. These models feature complex interactions between firms, which makes working with them analytically challenging. They have been employed in quantitative settings to study international price deviations from relative purchasing power parity (Atkeson and Burstein, 2008), the gains from trade under misallocation (Edmond et al., 2016), the strength of firms' strategic complementarities in prices (Amiti et al., 2019), the role of granular firms in determining comparative advantages (Gaubert and Itskhoki, 2021), labor market power (Berger et al., 2022), the welfare costs of markups (Edmond et al., 2023), the interrelation between trade, innovation and markups (Cavenaile et al., 2023), how granularity modifies the trade gravity equation (Breinlich et al., 2023), the bargaining power between buyers and sellers (Alviarez et al., 2023), and macroeconomic fragility (Ferrari and Queirós, 2024), among others. To the best of my knowledge, I am the first to theoretically study the aggregation of firm-level markups in a unified way encompassing quantity and price competition. Doing so allows me to cast light on the model anatomy and its general equilibrium implications.

The rest of the paper is organized as follows. Section 2 presents the industry model with domestic and foreign granular firms, and shows how industry concentration and the CES price index are jointly determined in equilibrium, to then conclude by deriving the statistic for the consumer welfare gains from trade. Section 3 builds up a multi-sector, multi-country model to define the aggregate domestic markup and the producer welfare gains from trade. It ends by defining the local aggregate welfare gains from trade that extends ACR. Section 4 studies changes in trade exposure,

market concentration and the gains from trade in a period of trade opening in Chile. Section 5 concludes.

2 Industrial Concentration and Consumer Welfare

2.1 Industrial Framework

I focus on a generic market, i.e. industry-country, in which an exogenous number of firms $N_i = \sum_{i=1}^{I} N_{ji}$ from multiple origins indexed by i are active; i.e. can sell varieties without having to pay a fixed cost at this stage. I assume all N_{ji} are finite, and each firm is granular.

2.1.1 Consumers

Consumers have CES preferences over the different varieties ω of an industry good v, with elasticity of substitution σ. The industry quantity index is:

$$Q_i^v = \left[\sum_{j=1}^{J} \sum_{\omega \in \Omega_{ji}^v} q(\omega)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}},$$

where $q(\omega)$ is the ω-specific quantity.

For now, I assume consumer expenditure on good v, E_i^v, is exogenous. Expenditure on variety ω is $s_{ji}^v(\omega)E_i^v$, where $s_{ji}^v(\omega) = \frac{p_{ji}^v(\omega)^{1-\sigma}}{(P_i^v)^{1-\sigma}}$ is the expenditure share on ω, which I will refer to as the market share. P_i^v is the CES price index and will be one of the key objects to understand the relationship between consumer welfare and concentration. I will omit the superindex v for the rest of this section given that I focus on a single industry.

2.1.2 Firms

I assume there are N_{ji} firms from j active in country i. These firms have a draw $\{\varphi_1, \varphi_2, ..., \varphi_{N_{ji}}\}$ of productivities drawn from a continuous distribution $F(\varphi)$ with a lower bound φ_L. Each firm owns the blueprint of a variety, which means that $|\Omega_{ji}| = N_{ji}$. The fact that firms are active implies that they do not face fixed or sunk costs to produce at this stage.

Firms use only labor to produce, which can be hired at wage w. In order to export to country i, a firm in j has to ship τ_{ji} per unit of a product—i.e. there are iceberg trade costs. Therefore, a firm with productivity φ in country j has a marginal cost of $c_{ij}(\varphi) = w_j\tau_{ij}/\varphi$ to sell in i. Firms do not pay a trade cost to ship domestically (i.e. $\tau_{ii} = 1$). From now on, I will identify individual firms with their marginal costs, c.

2.1.3 Competition and Optimal Prices

Each variety's optimal price depends on firms' marginal costs c, and the type of competition $\mathscr{M}$, which can be quantity, price or monopolistic competition. Omitting the subindex and productivity index for simplicity here, we get:

$$p(c;\mathscr{M}) = c \times \bar{\mu} \times \varepsilon(c;\mathscr{M}), \tag{1}$$

where $\bar{\mu} \equiv \frac{\sigma}{\sigma-1}$ is a mark-up that does not generate misallocation across firms and $\varepsilon(c;\mathscr{M}) \geq 1$ is an *ad-valorem excess markup* that can arise from market power.

The optimal price dependence on the type of competition is due to the excess markup. Specifically, it takes the following functional forms for each type of competition:

$$\varepsilon(c;\mathscr{M}) = \begin{cases} 1 + \frac{s(c)}{1-s(c)} & \text{if } \mathscr{M} \text{ is quantity competition} \\ 1 + \frac{s(c)}{1-s(c)}\frac{1}{\sigma} & \text{if } \mathscr{M} \text{ is price competition} \\ 1 & \text{if } \mathscr{M} \text{ is monopolistic competition} \end{cases} \tag{2}$$

There are different aspects of the excess markup that are worth mentioning. The first one is that this formulation shows that monopolistic competition does not generate misallocation in this context. Secondly, both quantity and price competition make $\varepsilon(c;\mathscr{M})$ endogenous, as it depends on firms' market shares. Thirdly, the excess markup is parameter-free under quantity competition. Finally, we can think of both monopolistic and quantity competition as special cases of price competition when $\sigma \to 1$ and $\sigma \to \infty$, respectively.[1]

2.1.4 The Industry CES Price Index

Preferences are CES and therefore the welfare-relevant price index is the CES industry price index in importing country i. Exploiting the formulation above I get:

$$P_i(\mathscr{M}) \;=\; \left[\sum_{j=1}^{J}\sum_{c(\omega)\in\Omega_{ji}}\left[p^m(c)^{1-\sigma} \times \varepsilon(c;\mathscr{M})^{1-\sigma}\right]\right]^{\frac{1}{1-\sigma}}, \tag{3}$$

where $p^m(c) \equiv c \times \bar{\mu}$ is the efficient firm-specific price.

[1] Note that this is true for the excess markup only and not the complete markup which is a direct function of σ too.

Equation 3 explicitly shows that the industry price index in country i depends on the type of competition. For a given σ, the price index would be higher under quantity competition and lower under monopolistic competition, with price competition in the middle.

2.2 Consumer Welfare and Concentration

2.2.1 The Industry Excess Markup As a Concentration Measure

When firms compete in quantities and prices, the CES price index in equation 3 is endogenous, as it depends on the specific market structure $\{s(c)\}_{c=c_1,...c_{N_i}}$ through each $\varepsilon(c)$. In order to make progress in understanding the relationship between $P_i(\mathscr{M})$, the market structure, and competition, I log-differentiate equation 3 and write it as follows:

$$\hat{P}_i(\mathscr{M}) \quad = \quad \hat{P}_i^m(\{c\},\mathscr{M}) + \hat{\mathcal{C}}_i(\{s(c)\},\mathscr{M}), \tag{4}$$

where $\hat{P}_i^m(\{c\}) = \sum_{c(\omega)\in\Omega_{ji}} s(c)\hat{p}^m(c)$ is the log change in the CES price index that takes place due to changes in the efficient prices and $\hat{\mathcal{C}}_i(\{s(c)\},\mathscr{M}) \equiv \sum_{l=1}^{N_{ji}} s_{ji,l}\hat{\varepsilon_{ji,l}}(s(c_{j,l});\mathscr{M})$ is its log change due to changes in the industry ad-valorem excess markup. Given that the differentiation takes place around an initial equilibrium and preferences are CES, each firm-specific change is weighted by the initial market share.

Both terms defining the change in prices in Equation 4 depend on the type of competition but in different ways. In the case of $\hat{P}_i^m$, it only matters because it affects the market structure and thus the weights of individual firms. On the contrary, the market structure has a first-order effect on $\hat{\mathcal{C}}_i(\{s(c)\},\mathscr{M})$ because shares modify firms' markups. Therefore, this term is key to understanding how any change in market and policy conditions (e.g. import tariffs) first-orderly affects the price index and thus consumer welfare when we depart from monopolistic competition.

The fact that individual firms' excess markups and their weights are market shares suggests that the implicit function $\mathcal{C}$ is a function of market shares as well. I integrate $\hat{\mathcal{C}}_i(\{s(c)\},\mathscr{M})$ to get the anti-derivative, i.e. its explicit expression:[2]

[2]This is an application of the Fundamental Theorem of Calculus for Line Integrals. See the Appendix A.2 for the proof.

$$\mathcal{C}_i(\{s(c)\},\mathscr{M}) = \begin{cases} -\sum_{c(\omega)\in\Omega_{ji}}\left[\ln\left(1-s(c)\right)+s(c)\right] & \text{if } \mathscr{M} \text{ is quantity competition} \\ -\sum_{c(\omega)\in\Omega_{ji}}\left[\ln\left(1-s(c)\right)-\bar{\mu}\ln\left(1-s(c)\bar{\mu}^{-1}\right)\right] & \text{if } \mathscr{M} \text{ is price competition} \\ 0 & \text{if } \mathscr{M} \text{ is monopolistic competition.} \end{cases} \tag{5}$$

Since function $\mathcal{C}$ depends only on the excess markup, it inherits the same properties: (i) It is zero under monopolistic competition (given that it is in logs), (ii) it is endogenous, as it depends on market shares, (iii) it is parameter-free under quantity competition, and (iv) monopolistic and quantity competition are special cases of price competition since $\mathcal{C} \to 0$ and $\mathcal{C} \to \sum_{c(\omega)\in\Omega_{ji}}[-s(c) - \ln(1-s(c))]$ when $\sigma \to 1$ and $\sigma \to \infty$, respectively.

2.2.2 A Welfare-Consistent Concentration Measure

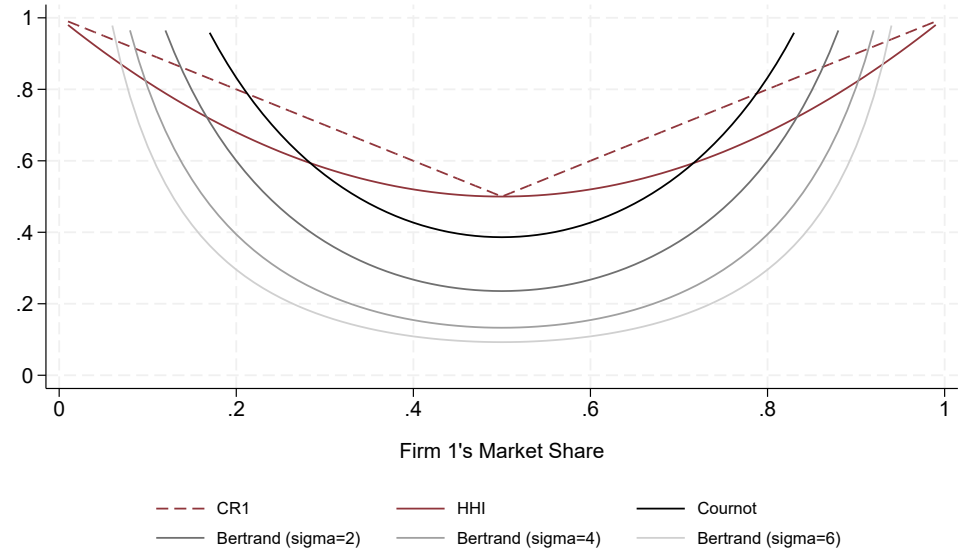
I argue that function $\mathcal{C}$ is a proper market concentration measure that has the desirable property of being welfare-relevant under oligopolistic competition.

Economists use a series of market concentration measures to understand how market conditions change over time that share the same property: they are weakly convex in firms' market shares. For instance, the Herfindahl-Hirschman Index (HHI) and the share of top N^T firms, often called Concentration Ratios ($CR(N^T)$, where N^T is the number of top firms considered).[3] Figure 1 illustrates HHI and $CR(1)$ in a market with two firms so I only need one market share s to represent these measures graphically.

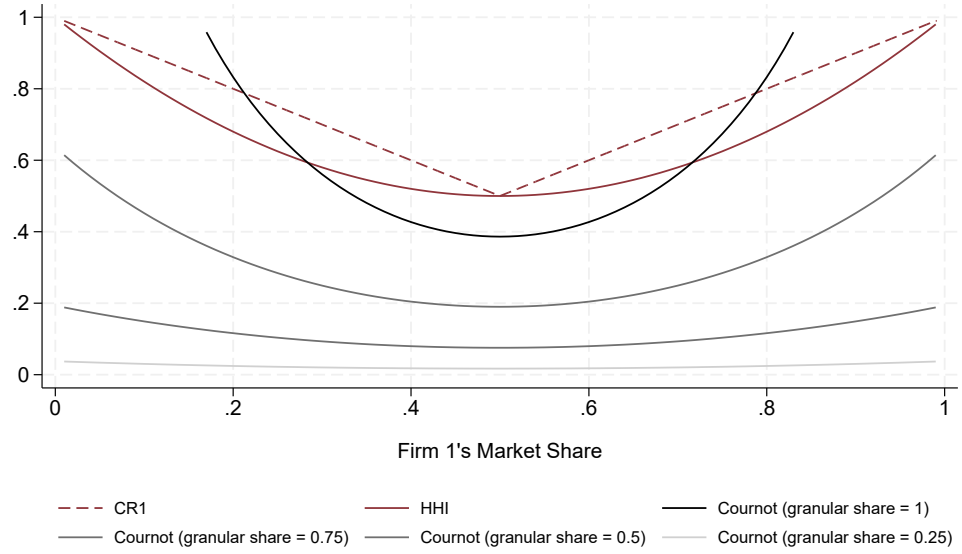
[3]For example, the US Census Bureau reports the HHI of the top 50 firms and the Concentration Ratio of 4, 8, 20 and 50 firms.

Figure 1: Concentration Measures with Two Firms.

(a) Different competition and σ



(b) Different Granular Shares



The function $\mathcal{C}$ shares the same property on top of proportionally capturing the direct increase in the CES price index due to firms' excess markups: it is (weakly) convex in market shares. Therefore, it can be interpreted as a welfare-consistent concentration measure. In Figure 1a, I include $\mathcal{C}$ under quantity competition and price competition.[4] In the last case, $\mathcal{C}$ is parametrized by σ, so I include it for different values of it. Note that as σ increases, the concentration measure shifts down, implying that the same market structure delivers lower excess markups. This is intuitive since a higher σ

[4] $\mathcal{C}$ is trivially zero under monopolistic competition.

implies higher substitutability across varieties and, therefore, more direct competition across firms. In addition, as σ approaches one, the concentration measure under price competition pointwise converges to the one under quantity competition.

2.2.3 Concentration with a Varying Oligopolistic Market Segment

It is relevant to explore how the concentration function changes when we only measure a segment of the market. This can arise under different scenarios. First, it may be that only a subset of firms in the market has oligopolistic power (e.g. are granular). In this case, only the share of granular firms matters since other firms would charge the efficient markup or no markup at all depending on the assumption. Second, we may want to measure only the concentration of a specific origin, such as domestic. This will be relevant for the welfare analysis.[5]

In Figure 1b, I show the concentration measure under a different share of granular firms in the case of quantity competition. As the granular share decreases, the concentration measure becomes less convex and shifts downwards, capturing the decrease in their excess markups and thus in their market power.

The fact that $\mathcal{C}$'s convexity varies depending on the segment of the market that is able to charge oligopolistic markups is an advantage of this measure over others such as the HHI as it can help to distinguish between efficient and inefficient concentration. Suppose that we are interested in the degree of market power of domestic firms during a period in which import penetration increased. Standard trade models with heterogeneous firms and endogenous markups would show that an increase in foreign competition can imply an increase in the HHI when only domestic firms are used to compute it. Instead, $\mathcal{C}$ would decrease because it uses the right market shares, i.e. the ones that account for foreign firms as well.[6]

Last but not least, the numerical evaluation of $\mathcal{C}$ has a direct interpretation by the lens of this model: it measures the first-order consumer welfare costs from oligopolistic behavior. In the absence of it, this function is equal to zero, as shown by Equation 5.

2.3 Endogenous Concentration Changes

The concentration measure $\mathcal{C}$ depends on the market structure and thus it is endogenous to market conditions as long as the relative price across firms' varieties depends on competition. In this section, I focus on analyzing changes in domestic concentration and derive an expression that

[5] This can be done given that $\mathcal{C}$ is additively separable across firms.

[6] We could compute the HHI using the right market shares as well but that would be against the common use of HHI and not deliver a welfare-consistent measure.

depends on the industry CES price index and the domestic absorption rate.[7]

Any change to trade costs affecting foreign firms can affect the relative price between domestic firms, given that firms face different perceived elasticities of demand. In models with granular firms in which consumers have love for variety from CES preferences, firms with higher productivity or producing varieties of higher perceived quality face a lower elasticity of demand and thus charge higher markups. When there is an increase in demand for domestic firms' varieties, these firms perceive it in the same way as an increase in productivity (or in quality), increasing markups further and to a greater extent the higher the starting point. As a result, the relative price of large vs small firms increases, reducing the relative demand of large firms' varieties and thus concentration.[8] This is captured by the following expression:

$$\frac{\hat{\mathcal{C}_{ii}}}{\lambda_{ii}} = \mathcal{E}^{\text{c}}_{ii} \times \left[- \frac{\hat{\lambda_{ii}}}{\sigma - 1} + \tilde{\Phi}^{\text{c}}_{ii} \hat{P}_i \right], \tag{6}$$

where $\frac{\hat{\mathcal{C}_{ii}}}{\lambda_{ii}}$ is domestic concentration normalized by the domestic absorption rate $\lambda_{ii} \equiv \frac{P_{ii}^{1-\sigma}}{P_i^{1-\sigma}}$, $\mathcal{E}^{\text{c}}_{ii} \equiv \frac{\partial \log e^{\mathcal{C}_{ii}}}{\partial \log P_i} < 0$ is the partial elasticity of concentration with respect to P_i and $\tilde{\Phi}^{\text{c}}_{ii} \equiv \frac{d \log e^{\mathcal{C}_{ii}}}{d \log P_i} \in (0, 1)$ is the concentration equilibrium response to P_i.[9]

The fact that $\mathcal{E}^{\text{c}}_{ii}$ is negative reflects that an increase in demand for domestic varieties reduces their elasticity of demand and thus raises their excess markups.

The term $\frac{\hat{\lambda_{ii}}}{\sigma - 1}$ captures the aggregate direct shift in market share from foreign to domestic varieties. Given that $\mathcal{C}_{ii}$ takes into account such share as well, this shift positively and directly affects domestic excess markups and thus the welfare-consistent concentration measure $\mathcal{C}_{ii}$ (i.e. $-\mathcal{E}^{\text{c}}_{ii} > 0$).[10]

The increase in $\mathcal{C}_{ii}$ is attenuated by the enhanced competition between domestic firms: a decrease in concentration due to the reallocation of domestic market shares also implies a lower demand for large firms' varieties and thus a lower relative price increase than without taking this equilibrium response into account. This is captured by $\tilde{\Phi}^{\text{c}}_{ii}$.

In conclusion, an increase in foreign firms' trade costs has two effects on domestic firms' aggregate excess markup: (i) it increases demand and thus domestic markups, and (ii) it increases domestic misallocation, attenuating the increase in markups. In this model, the first one dominates, implying that opening to trade can have pro-competitive welfare gains.

[7] The analysis holds for any market segment not affected directly by a common change in marginal costs.

[8] In other words, firm misallocation increases.

[9] See Appendix A.3 for the explicit expressions and the proof of equation 6.

[10] Note that we can write the market share $s(c) = \lambda_{ii} z(c)$, where $z(c) \equiv p(c)^{1-\sigma} / P_{ii}^{1-\sigma}$ is c's market share within the segment ii.

2.4 Consumer Welfare Gains from Trade

In this section, I derive the consumer welfare gains from trade using the domestic wage as a numeraire ($w_i = 1$) and assuming that the oligopolistic profits are thrown into the ocean. The last assumption implies that total demand is only determined by consumers who earn wages.[11]

2.4.1 The Change in the CES Price Index

In this setting, changes in consumer surplus are exclusively determined by changes in P_i. This implies that I can use the ACR strategy to derive changes in consumer welfare as the negative of changes in the CES price index:[12]

$$\hat{P}_i = \frac{\hat{\lambda_{ii}}}{\sigma - 1} + \frac{\hat{\mathcal{C}}_{ii}}{\lambda_{ii}}. \tag{7}$$

Equation 7 is the (ex-post) ACR-type welfare formula with heterogeneous firms and no entry corrected by changes in oligopolistic markups by the additive term $\frac{\hat{\mathcal{C}}_{ii}}{\lambda_{ii}}$. There is an important observation to be made: The change in domestic concentration normalized by the domestic absorption rate, $\frac{\hat{\mathcal{C}}_{ii}}{\lambda_{ii}}$, is sufficient to correct the ACR term due to changes in the excess markups of all firms, domestic and foreign. This is a convenient result for measurement, as I show later, and continues with the ACR tradition of using domestic statistics to derive gains from trade.

How does an increase in domestic concentration affect consumer welfare? As expected, a higher level of domestic markups implies a higher CES price index and thus lower consumer welfare, all else equal. Therefore, if an increase in trade costs causes domestic markups to increase, then consumer welfare decreases.

2.4.2 The Joint Determination of Changes in the Domestic Price Index and Concentration

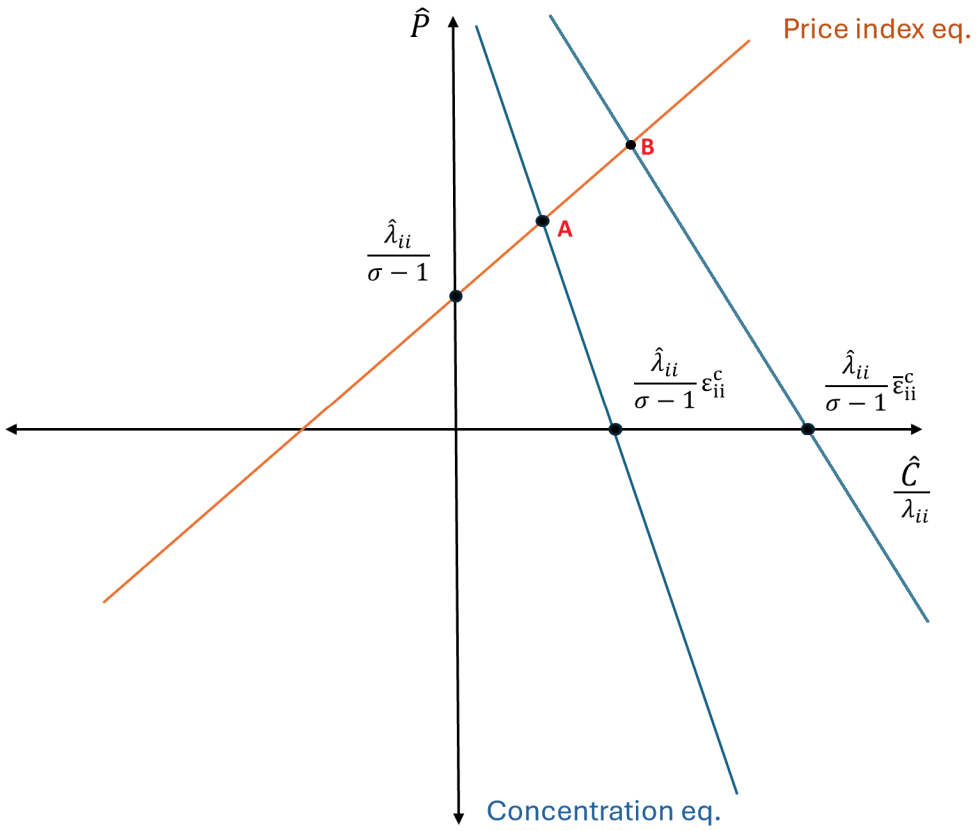
In order to derive changes in consumer welfare, $\hat{P}_i$, we have to solve the linear system of equations: The *Concentration Equation* (equation 6) and the *Price Index Equation* (equation 7). Figure 2 shows the log-change in P_i and $\mathcal{C}_{ii}$ that results from an increase in trade costs as captured by an increase in λ_{ii}).[13]

[11] I make this assumption to focus on consumer welfare in this specific industry, so it is for illustrative purposes only and will be relaxed later when analyzing profits.

[12] Proof in Appendix A.5.

[13] Trade costs do not enter directly because of not directly affecting P_i and $\mathcal{C}_{ii}$ in this formulation.

Figure 2: Price Index and Domestic Concentration Change with Increasing Trade Costs



In a model with monopolistic competition, we only need the price equation to determine the change in consumer welfare given that $\frac{\hat{\mathcal{C}}_{ii}}{\lambda_{ii}} = 0$, which delivers the known expression $\frac{\hat{\lambda_{ii}}}{\sigma-1}$. However, domestic markups and thus concentration also change under price or quantity competition. This can be observed by the right shift in the concentration equation. The joint equilibrium change in $\mathcal{C}_{ii}$ and P_{ii} is found at point A in Figure 2. Given that an increase in trade costs raises the domestic absorption rate, domestic markups increase due to a lower demand elasticity, amplifying the increase in P_{ii} and therefore consumer welfare losses. In the new equilibrium, the welfare-consistent concentration measure increases as expected.

Figure 2 also shows the equilibrium in the case of high concentration. When there is high concentration, the partial elasticity $\mathcal{E}_{ii}^{c}$ is also larger, so the *Concentration Equation* is shifted right. Therefore, the joint equilibrium in this case is at point B, which shows a greater increase in the price index due to a larger increase in markups.

2.4.3 A Granular-corrected Consumer Welfare Formula

We can analytically solve for $\hat{P}_i$ to compare the trade impact on consumer welfare against the case without granularity:

$$\hat{P}_i \quad = \quad \mathbf{g}_{ii}^{\text{cs}} \times \frac{\hat{\lambda}_{ii}}{\sigma - 1}, \tag{8}$$

with:

$$\mathbf{g}_{ii}^{\text{cs}} \quad \equiv \quad \frac{\text{Magnification from } \uparrow \text{ markups}}{\text{Attenuation from } \uparrow \text{ misallocation}} \equiv \frac{1 + \mathcal{E}_{ii}^{\text{c}}}{1 + \mathcal{E}_{ii}^{\text{c}} \tilde{\Phi}_{ii}^{\text{c}}} > 1.$$

The $\mathbf{g}_{ii}^{\text{cs}}$ factor augments the original ACR-type formula to account for changes in consumer surplus due to changes in markups. It arises because closing the economy magnifies the increase in the price index by increasing the market power of domestic firms and thus domestic markups. Closing the economy also generates misallocation across domestic firms that attenuates such effect. Factor $\mathbf{g}_{ii}^{\text{cs}}$ depends on the domestic market structure and the type of competition but does not depend on the market structure of the foreign segment of the market.

2.4.4 A Sufficient Statistic for the Consumer Welfare Gains from Trade under Granularity

In ACR, the welfare formula is understood as a sufficient statistic given that the change in absorption is observed and the denominator is the trade elasticity—a widely estimated parameter in the trade literature. Can we interpret equation 8 in a similar way?

This consumer welfare formula with granularity has three elements: $\hat{\lambda}_{ii}$, $\sigma - 1$ and $\mathbf{g}_{ii}^{\text{cs}}$. The first one can be assumed or observed in the data. For instance, what is the increase in the CES price index as a result of an increase in the domestic absorption rate of 10 log points?[14] The second element, $\sigma - 1$, would be the trade elasticity in this model if firms are close enough to competing in monopolistic competition—which defeats the purpose of this analysis. Therefore, getting $\sigma - 1$ would require either estimating it using the structure of the model or estimating the trade elasticity using only trade flows in which market power is unlikely.

The last element in $\mathbf{g}_{ii}^{\text{cs}}$ depends on the distribution of domestic market shares and σ. The latter can be obtained in the previous step, so what is needed is the set of domestic market shares. This information is the same as the one used by statistical agencies and economists to calculate other

[14] Note that this expression captures local and not global changes in consumer welfare.

concentration measures such as HHI (plus the share of domestic absorption), which makes it an object relatively simple to compute.

2.4.5 Discussion

The welfare formula in equation 8 is similar to others that use the structure of trade models, such as ACR and ACDR, but differs in a key aspect: it isolates the impact of trade on consumers alone. As a result, the granular factor $\mathbf{g}_{ii}^{cs}$ fully captures the pro-competitive gains from trade, i.e. it does not confound the impact of markups on consumer surplus with the potential market power rents of producers. Given this, it is logical that granularity enhances the consumer gains from trade given that increasing foreign competition disciplines domestic firms, reducing their markups.

In ACDR, the authors allow for variable markups that arise due to non-homothetic preferences. In their case, the welfare gains from trade are lower than with CES, as captured by a factor that can be lower or greater than one depending on the markup distribution's equilibrium response. They find empirically that the factor is lower than one by estimating the preference parameters predsent in the factor. In the case of oligopolistic competition, trade always decreases markups, causing the factor to be greater than one. Although this may seem more restrictive, the advantage is that it takes an ex-post approach, so it varies substantially depending on the specific market structure in which trade conditions change. Intuitively, the welfare impact of trade can be higher in a highly concentrated economy versus a more competitive one. In conclusion, this statistic can be implemented easily in concrete different examples and deliver different results.

3 Aggregate Gains from Trade in the Presence of Granular Firms

In this section, I take into account the impact of trade opening on income via the oligopolistic profits from excess markups. I consider an economy with a continuum of industries, each of them characterized as in the previous section. I assume consumers have Cobb-Douglas preferences over industries, where the expenditure share in industry v is α^v.

I assume that the domestic economy is a Small Open Economy (SOE). This implies that domestic granular firms do not make oligopolistic profits abroad as they face an exogenously given foreign import demand function.[15]

[15] I also assume there is no profit shifting.

3.1 Aggregate Income and Markup

Aggregate domestic income comes from labor income and profits made at home and abroad in all industries:

$$Y_i(\mathscr{M}) \quad = \quad L_i + \int [\Pi^v_{ii}(\mathscr{M}) + \sum_{j \neq i} \Pi^v_{ij}] dv, \tag{9}$$

where L_i is total labor, supplied inelastically, and I continue using domestic wages as the numeraire. Aggregate income depends on the type of competition via domestic profits only due to SOE assumption.

3.1.1 Aggregate Profits

Domestic firms make profits at home and abroad but, given the SOE assumption, only have oligopolistic market power in the former. Domestic profits in industry v can be expressed as follows:

$$\Pi^v_{ii}(\{s(c)\}, \mathscr{M}) = \frac{\lambda^v_{ii}(\{s(c)\}, \mathscr{M}) R^v_i}{\sigma} \times H^v_{ii}(\{s(c)\}, \mathscr{M}), \tag{10}$$

where R^v_{ii} is the industry revenue, and H^v_{ii} is the ad-valorem excess profits that directly originates from excess markups. Note that $\lambda^v_{ii}(\{s(c)\}, \mathscr{M})$ depends on the market structure and type of competition as well, given that it is a direct function of the domestic and industry CES price indices.

The ad-valorem excess profits have the following functional form depending on the type of competition:[16]

$$H^v_{ii}(\{s(c)\}, \mathscr{M}) = \begin{cases} 1 + (\sigma - 1)\lambda^v_{ii}(\{s(c)\}) HHI^v_{ii} & \text{if } \mathscr{M} \text{ is quantity competition} \\ 1 + \frac{(\sigma-1)\lambda^v_{ii}(\{s(c)\})}{\sigma-(\sigma-1)\lambda^v_{ii}(\{s(c)\})} \overline{HKI}^v_{ii} & \text{if } \mathscr{M} \text{ is price competition} \\ 1 & \text{if } \mathscr{M} \text{ is monopolistic competition,} \end{cases} \tag{11}$$

where $HHI^v_{ii} \equiv \sum_{c(\omega) \in \Omega_{ii}} z^2(c)$ is the Herfindahl-Hirschman Index computed using the within-domestic firms market shares $z(c) \equiv p(c)^{1-\sigma}/(P^v_{ii})^{1-\sigma}$ and $\overline{HKI}^v_{ii}$ is the weighted average Hannah-Kay Index over the discrete infinite number of degrees ($k = 2, 3, ...$), where an HKI of degree k is $HKI(k)^v_{ii} \equiv \sum_{c(\omega) \in \Omega_{ii}} z^k(c)$.[17][18]

[16] See Appendix A.6.1 for the proof.
[17] An intermediate step towards this analytical result can be found in Grassi (2018).
[18] Note that $HKI(2) = HHI$.

Equations 10 and 11 show that profits under quantity and price competition are functionally analogous to under monopolistic competition but augmented by an ad-valorem term.

3.1.2 Aggregate Excess Markup

Equation 10 is useful to characterize how profits change when market conditions change. However, it would be more useful to write income as a function of an aggregate markup to more conveniently derive the welfare function, including the producer surplus originating from market power rents. In other words, it is convenient to write income as follows:

$$Y_i = L_i \times \bar{\mu} \times \mathbf{m}_i(\{s^v(c)\}_{v \in V}, \mathscr{M}), \tag{12}$$

where $\mathbf{m}_i(\{s^v(c)\}_{v \in V}, \mathscr{M})$ is the aggregate excess markup computed over all industries in the economy.

Writing income as in 12 is convenient because I only need to analyze changes in the domestic excess markup in order to understand how trade costs affect producer surplus via protection. In Appendix A.6.2, I show that the aggregate excess markup takes the following functional form depending on the type of competition:[19]

$$\mathbf{m}(\{s^v(c)\}_{v \in V}, \mathscr{M}) = \begin{cases} 1 + \frac{\int \alpha^v r_{ii}^v \lambda_{ii}^v HHI_{ii}^v dv}{1 - \int \alpha^v r_{ii}^v \lambda_{ii}^v HHI_{ii}^v dv} & \text{if } \mathscr{M} \text{ is quantity competition} \\ 1 + \frac{\int \alpha^v \frac{r_{ii}^v \lambda_{ii}^v}{\sigma - (\sigma-1)\lambda_{ii}^v} \overline{HKI}_{ii}^v dv}{1 - \int \alpha^v \frac{r_{ii}^v \lambda_{ii}^v}{\sigma - (\sigma-1)\lambda_{ii}^v} \overline{HKI}_{ii}^v dv} & \text{if } \mathscr{M} \text{ is price competition} \\ 1 & \text{if } \mathscr{M} \text{ is monopolistic competition,} \end{cases} \tag{13}$$

where $r_{ii}^v \equiv R_{ii}/R_i$ is the share of revenue from domestic sales.

The aggregate markups in Equation 13 seem quite involved, but a careful inspection shows that it is the aggregate analogue to the firm-specific excess markup in Equation 2. These expressions also share the same properties: (i) monopolistic competition does not generate an excess markup, (ii) it is endogenous under both quantity and price competition, (iii) it is parameter-free under quantity competition (beyond the Cobb-Douglas elasticities), and (iv) quantity and monopolistic competition are special cases of price competition when $\sigma \to 1$ and $\sigma \to \infty$ respectively.[20]

[19] The proof uses trade balance and the market clear condition $E_i = Y_i$.

[20] I show this in Appendix A.6.2.

3.2 Endogenous Change in the Aggregate Markup

In this setting, trade opening affects aggregate income by reducing domestic markups. Therefore, domestic producers always prefer a closed economy. In reality, there are many other reasons why domestic producers may prefer an open economy, such as access to cheaper inputs or increasing productivity via scale. However, the focus of this paper is to analyze concentration and the pro-competitive gains from trade in depth.[21]

3.2.1 Aggregate Markup Determinants

In Equation 13, we can see that the aggregate excess markup directly depends on three domestic industry-specific endogenous objects: the industry absorption rate, λ_{ii}^{v}, the share of revenue from domestic sales, r_{ii}^{v}, and a concentration index (HHI_{ii}^{v} or $\overline{HKI}_{ii}^{v}$ depending on whether we assumed quantity or price competition respectively). An increase in the three of them increases industry profits, the former by lowering the elasticity of demand to all domestic firms as a whole and the latter by differentially lowering the elasticity of demand of large firms relative to small firms.

In order to understand how the aggregate markup reacts to competition, I express the change in the domestic concentration index as a function of the CES price index, as done in the case of the consumer welfare-consistent concentration measure. The resulting expression is as follows:

$$\hat{\mathbf{m}}_{ii} = \mathcal{E}_{ii}^{\mathrm{m}} \times \left[\frac{\overline{\hat{r_{ii}}}}{\sigma - 1} + \overline{(\varrho - 1)} \frac{\overline{\hat{\lambda_{ii}}}}{\sigma - 1} - \overline{\tilde{\Phi}_{ii}^{\mathrm{m}}} \overline{\hat{P}_i} \right], \tag{14}$$

where $\mathcal{E}_{ii}^{\mathrm{m}} \equiv \frac{\partial \log \mathbf{m}_{ii}}{\partial \log P_i} > 0$ is the partial elasticity of the aggregate markup with respect to $\overline{P_i}$, $\overline{\tilde{\Phi}_{ii}^{\mathrm{m}}} \in (0, 1)$ is the across-industry weighted average markup equilibrium response to $\overline{\hat{P}_i}$, where $\overline{\hat{P}_i}$ is the across-industry weighted average change in CES price indices (and the same for $\overline{\hat{r_{ii}}}$, $\overline{(\varrho - 1)}$ and $\overline{\hat{\lambda_{ii}}}$).[22] In all cases, industry weights account for the industry shares in total profits.[23]

Equation 14 is functionally identical to Equation 6, which captured the impact of competition and trade on the (normalized) consumer welfare-consistent concentration measure $\mathcal{C}$. The key difference is that objects $\mathcal{E}_{ii}^{\mathrm{m}}$ and $\overline{\tilde{\Phi}_{ii}^{\mathrm{m}}}$ differ in the firm-specific respective elasticities and the aggregation weights. When I analyzed the welfare-consistent concentration measure, I cared about how changes in markups affect consumers, and therefore it was important to use the aggregation associated with the CES ideal price index. In the case of the aggregate markup, the aggregation only implies adding

[21] In addition, the SOE assumption implies that domestic firms do not get oligopolistic profits in foreign countries—which may be another reason why domestic producers prefer an open economy.

[22] ϱ is the degree of the corresponding concentration index. In the case of quantity competition, the index is the HHI, so $\varrho = 2$. In the case of price competition, the index is a weighted average of the infinite series of HKI, with weights and, thus, the degree being endogenous (and greater than 2). See Appendix A.7 for details.

[23] See Appendix A.7 for the explicit expressions.

up individual firms' profits.

3.3 Producer Welfare Gains from Protection

Domestic firms gain if the economy closes to foreign competition because they can charge markups above monopolistic competition. Such gains depend on how much the domestic absorption rate and concentration change when trade costs raise. We know that $\hat{Y}_{ii} = \hat{\mathbf{m}}_{ii}$, so we can use Equation 14 to derive the producer gains and replace $\hat{P}_{ii}$ by the expression found in Section 2.

The following equation shows the changes in producer welfare as a function of the domestic absorption rate and the price index:

$$\hat{Y}_i = \int_v \big[\tilde{\alpha}^v \times \mathbf{g}_{ii}^{\text{ps},v} \times \frac{\hat{\lambda}_{ii}^v}{\sigma - 1}\big] dv, \tag{15}$$

with:

$$\mathbf{g}_{ii}^{\text{ps},v} \equiv \mathcal{E}_{ii}^{\text{m}} \Big[1 - \tilde{\Phi}_{ii}^{\text{m},v} \frac{1 + \mathcal{E}_{ii}^{\text{c},v}}{1 + \mathcal{E}_{ii}^{\text{c},v} \tilde{\Phi}_{ii}^{\text{c},v}}\Big],$$

where $\tilde{\alpha}^v$ is the industry-specific profit share. Note that we would have $\tilde{\alpha}_{ii}^v = \alpha^v$ if we were in a monopolistic competitive world, i.e. expenditure share equal to profit share. However, domestic firms may have differential market power across industries, introducing across-industry profit distortions.

Equation 16 directly captures how industry producer surplus increases when the economy closes. This effect is attenuated by misallocation as in the case of consumer surplus. In this case, this is captured by $\tilde{\Phi}_{ii}^{\text{m},v}$.

3.4 A Sufficient Statistic for the Welfare Gains from Trade under Oligopolistic Competition

The welfare gains from trade can be written as follows:

$$\hat{\mathbf{W}}_i = \hat{Y}_i - \hat{P}_i.$$

In Section 2, I derived the change in $\hat{P}_i^v$ at the industry level, which means that, given the Cobb-Douglas assumption, we have $\hat{P}_i = \int_v \alpha^v \hat{P}_i^v dv$. Using this expression, plus the formula for $\hat{Y}_i$ derived above, we get:

$$\hat{\mathbf{W}}_i = \int_v \mathcal{G}_{ii}^v \times \frac{\hat{\lambda}_{ii}^v}{\sigma - 1} dv \tag{16}$$

with:

$$\mathcal{G}_{ii}^v \equiv \tilde{\alpha}^v \mathbf{g}_{ii}^{\text{ps},v} - \alpha^v \mathbf{g}_{ii}^{\text{cs},v}.$$

This expression shows that welfare gains at a given point depend heavily on the interaction between the industry-specific openness and its contribution to producer and consumer surplus based on specific industrial market structures. For example, suppose the economy becomes 10 log points closer in all sectors and that the elasticity of substitution is 5 (so $\sigma - 1 = 4$). In this scenario, we would have that $\hat{\mathbf{W}}_i = 0.025 \times (\overline{\mathbf{g}_{ii}^{\text{ps}}} - \overline{\mathbf{g}_{ii}^{\text{cs}}})$.[24] If the across-sector average producer surplus is greater than the average consumer welfare, then such change would increase welfare. More generally, $\overline{\mathbf{g}_{ii}^{\text{ps}}}$ and $\overline{\mathbf{g}_{ii}^{\text{cs}}}$ can be interpreted as two indices capturing producer and consumer welfare changes under uniform changes in import penetration.

Finally, it is worth noting that this is a local result. In other words, it captures the first-order impact on welfare of small changes in trade opening. Given that this model involves markups that are highly nonlinear in market shares, this expression is unlikely to accurately capture global changes in welfare, e.g. going to autarky.

4 Trade Opening, Market Concentration and the Gains from Trade in Chile

In this section, I characterize the key trade and concentration statistics behind the sufficient statistics derived in the theory section and construct them for Chile between 1995 and 2007, a period of rapid increase in import penetration.

4.1 Data

There are two families of statistics that I need to compute the welfare formula. The first one is related to the individual domestic firm's market shares in the Chilean market. I use data from the Chilean Annual Manufacturing Survey ENIA (by its Spanish acronym to *Encuesta Nacional Industrial Anual*). This survey includes the 4-digit ISIC Revision 3.1 sector and revenue from

[24] $\overline{\mathbf{g}_{ii}^{\text{ps}}} = \int_v \tilde{\alpha}^v \mathbf{g}_{ii}^{\text{ps},v} dv$ and $\overline{\mathbf{g}_{ii}^{\text{cs}}} = \int_v \alpha^v \mathbf{g}_{ii}^{\text{cs},v} dv$.

domestic and foreign sales at the establishment level with a firm identifier. This allows me to construct market shares at the firm-level by defining a market as a 4-digit industry.[25] I also use this data to construct the industry domestic revenue shares.

I also employ import data to construct the domestic absorption rates, i.e. the sectoral share of domestic firms in domestic expenditure. I employ import data from COMTRADE at the same level of aggregation.

4.2 The Increase in Trade Exposure

The period leading to 2003 was very active for Chile regarding changes in trade exposure. A series of trade policy changes generated the conditions for an increase in import penetration: (i) China accessed the WTO in 2001, (ii) Chile signed two major trade agreements with the United States and the European Union in 2003, which were in force by January 2004, (iii) Chile also reduced its flat MFN tariff by 5 percentage points over the 1998-2003 period to reach a 6% uniform tariff in more than 95% of its tariff lines, and (iv) a period of currency depreciation reverted sharply, making importing cheaper. In addition to these changes, a free trade agreement with China came into force in 2006. My goal is not to identify the individual effect of these events described above on domestic trade exposure, but instead to provide a useful context for the increase in import penetration over this period.

4.2.1 Import Penetration

Import penetration is a key statistic for welfare in the context of oligopolistic competition given that its inverse enters directly into concentration and the standard ACR formula. I estimate the following equation to capture the changes in this variable.

$$\log \mathrm{IP}_t^v = \sum_{s \in S} \delta_s \times \mathbb{1}\{s = t\} + \theta^v + \nu_t^v, \tag{17}$$

where IP_t^v is import penetration in industry v and year t, θ^v is an industry fixed effect and ν_t^v is the error term. The omitted period is 1995.

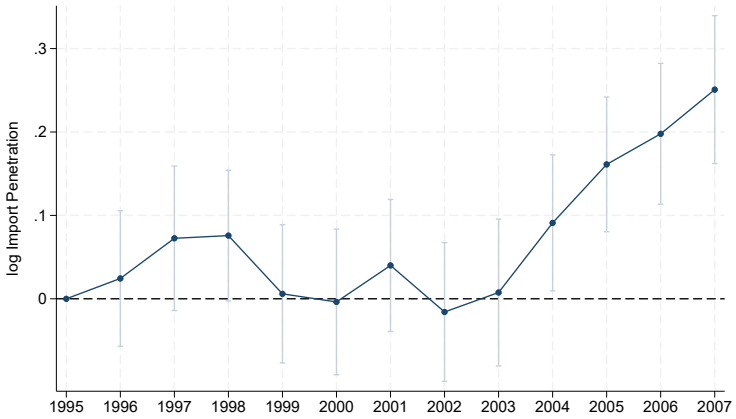
In Figure 3a, I plot coefficients from equation 17. Import penetration started increasing sharply after 2003, in coincidence with the trade opening events listed above. In 2007, it was about 20 log

[25] I do not employ sectors in the 23, and 27 to 29 divisions in the analysis, as they pertain exclusively to oil and mineral manufacturing.

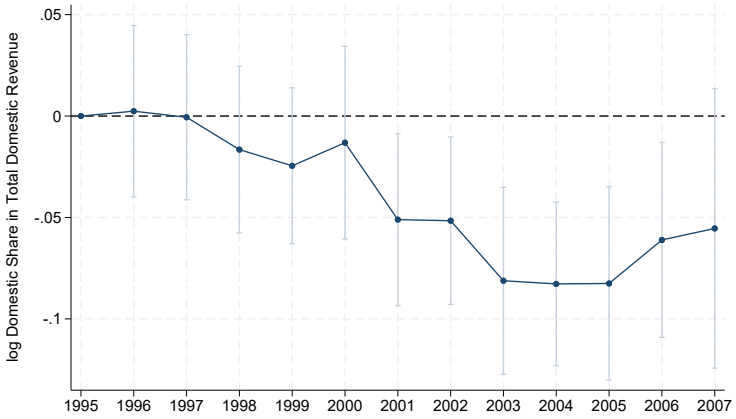
points higher than in the 1995-2003 period.[26].[27].

Figure 3: Trade Exposure Indicators. 1995-2007.

(a) Average Import Penetration over Time



(b) Average Domestic Share in Total Domestic Revenue



What does it imply for the welfare effect of domestic firms' market power under the lens of the model? Since the increase in import penetration is the inverse of a decrease in the domestic absorption rate, domestic firms lost market power at home over this period. When computing the sufficient statistics, this will be a downward force for the local consumer welfare gains from trade. The reason is that the disciplinary role of trade on domestic firms was more important at the beginning than at the end of the period given domestic markups convexity in market shares.

4.2.2 Industry Share of Domestic Sales in Total Domestic Revenue

During this period, Chilean firms increased the revenue derived from export markets. To see this, I estimate equation 17 but using instead the log of the domestic revenue share as a dependent

[26] Aggregate import penetration was about 59% in 1995 and ends up above 65% in 2007

[27] Import penetration from China increased faster and from earlier, reflecting possibly secular changes not associated with the events above. This is shown in Appendix Figure A1

variable. In Figure 3b, we can see a steady decline in the importance of domestic revenue of about 5 log points.[28] In this case, most of the decline took place before the above-mentioned changes in trade policy.

The decrease in the share of domestic sales in total revenue is a downward force on Chilean profits in my model, given the SOE assumption. Although this seems plausible in this case, it is expected to be a lower bound as a force pushing down aggregate profits, as Chile may operate as a large economy in some regional markets.

4.3 Domestic Market Concentration

Market concentration indices are often used to draw conclusions about the state of competition (e.g. Gutierrez and Phillipon, 2017). As discussed above, these indices cannot work as sufficient statistic because they (i) can confound increases in concentration that are actually caused by an increase in efficiency (i.e. lower misallocation), and (ii) employ sales shares of domestic firms only. Still, it is useful to compute and compare them to the existing evidence in other countries and the welfare-consistent concentration index. Moreover, the HHI, also partially determines the domestic aggregate markup by domestic firms in the context of the model, so it also has a microfounded interpretation.

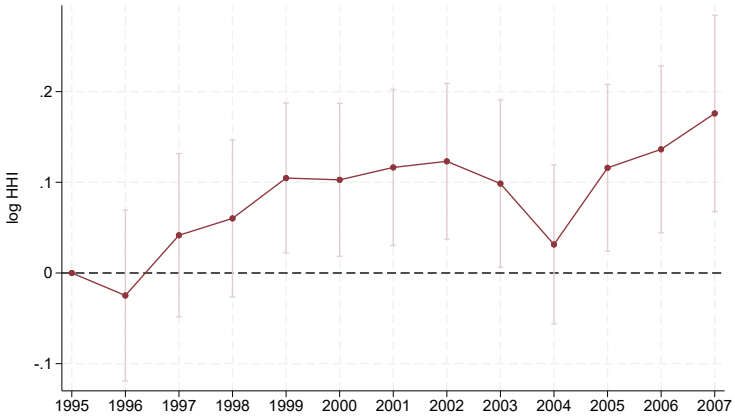
4.3.1 Usual Market Concentration Indices

In Figure A8, I plot the coefficients from estimating equation 17 for two commonly used concentration indices: The Herfindahl-Hirschman Index (HHI) and the market share of the top 4 firms ($CR(4)$). Regardless of the index used, this period saw an increase in domestic concentration in line with evidence for the US.

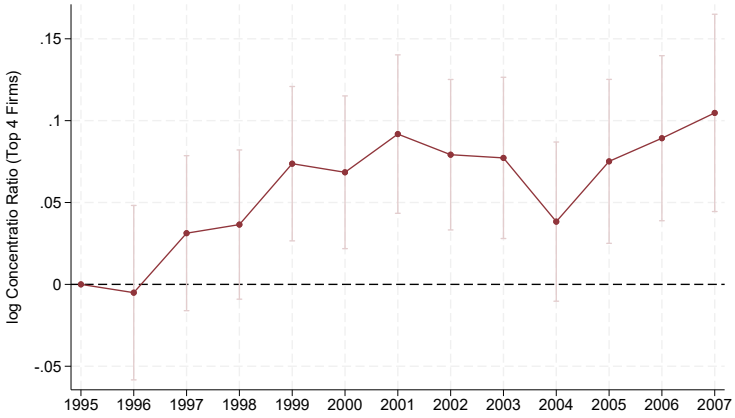
[28] The average industry share of domestic sales in total revenue went down from 87% to about 82% in 2007.

Figure 4: Domestic Market Concentration

(a) HHI



(b) Share of Top Four Firms



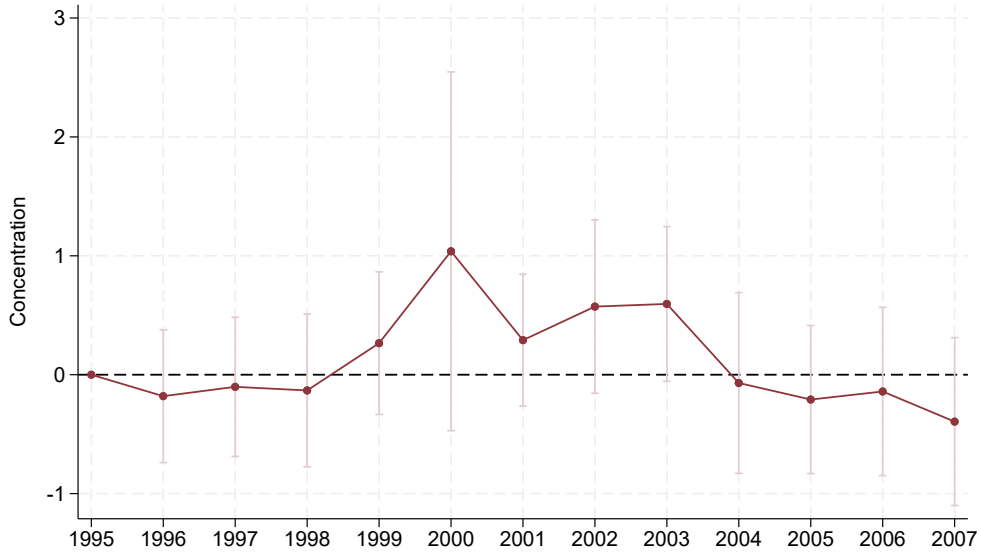
4.3.2 Welfare-Consistent Concentation Measure

I compute the welfare-consistent concentration measure $\mathcal{C}$ for each industry and year using the formula for quantity competition, which is parameter-free. In contrast to the concentration measures in the previous section, this statistic is microfounded by the model as it captures the first-order consumer welfare costs associated with the excess markup due to oligopolistic behaviour.

In Figure 5, I plot the coefficients from equation 17. The evaluation of index shows that there was not an increase in concentration that could be associated with an increase in market power. In fact, the index stayed the same throughout the period, indicating that the direct welfare costs from granularity did not change.[29]

[29] Assuming price competition shifts the function down, maintaining the over-time pattern.

Figure 5: Welfare-Consistent Concentration Measure. 1995-2007.



The evaluation of this index cannot be associated with the pro-competitive gains from trade as the latter is associated with changes in markups around the existing equilibrium. Below, I check the evolution of this result.

4.4 The Gains From Trade

In this section, I compute the local welfare gains from trade for each year. This indicator is useful because it captures the opportunity cost of marginally closing the economy. In the computations below, I assume quantity competition, although price competition delivers exactly the same qualitative predictions.

4.4.1 A Local Decrease in Trade Opening

My goal is to show that the opportunity cost of closing the economy is time-varying via the pro-competitive and profit gains from trade channels. To show this, I assume a uniform increase of 10 log points in the domestic absorption rate $\hat{\lambda}_{ii}^{v}$ and domestic revenue share $\hat{r}_{ii}^{v}$ in all industries. I also assume $\sigma = 5$, in line with previous estimates in the literature. These assumptions imply that the local change in the gains from trade at a time t is as follows:

$$\hat{\mathbf{W}}_{it} = \left\{ \underbrace{\sum_{v} \left[\tilde{\alpha}_{iit}^{v} \mathbf{g}_{iit}^{\text{ps},v} \right]}_{\text{Producer Gains}} - \underbrace{\sum_{v} \left[\alpha^{v} \mathbf{g}_{iit}^{\text{cs},v} \right]}_{\text{Consumer Losses}} \right\} \times 2.5. \tag{18}$$

4.4.2 Calibration

The ex-post approach employed to derive the statistics requires very few parameters. The most important one is the elasticity of substitution across varieties. As mentioned above, I assume the value of 5 as in Gaubert and Itskhoki (2021) given that they employ a similar setting with granular firms and a continuum of sectors. This delivers a trade elasticity of 4, which is within the common interval found in the literature (e.g. Fontagné et al., 2022), and a monopolistic competitive markup of 1.25, which is usually at the lower end in the empirical markup estimation literature (e.g. De Locker et al., 2020). It is worth recalling that this will be also the lower bound for markups in my framework.

I also need the Cobb-Douglas elasticities. I employ the sectoral sales from the ENIA and import values from COMTRADE to proxy for the sectoral total expenditure and use this information to compute sectoral expenditure shares. I compute the average shares using the 1995-1997 period—i.e. before the main trade opening events took place in my sample.

4.4.3 Industry Profit Weights

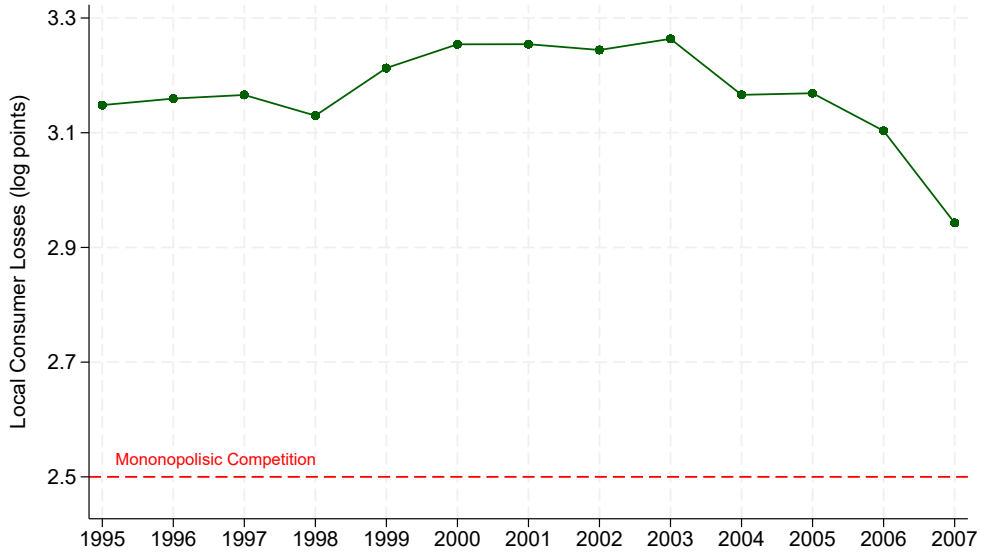
A key statistic for aggregation is the industry-specific profit weight $\tilde{\alpha}_{iit} \equiv \frac{\alpha^v r_{ii}^v \lambda_{ii}^v HHI_{ii}^v}{\sum_v \alpha^v r_{ii}^v \lambda_{ii}^v HHI_{ii}^v}$. These weights vary over time as the across-industry profit profile due to differential changes in competition. In Appendix Figure A4, I show the distribution of these weights along with their relation with the expenditure shares. The correlation between these two was 0.61 in 1995.

4.4.4 Consumer Welfare Gains From Trade

I graph the consumer component of the local gains from trade $\sum_v \left[\alpha_{iit}^v \mathbf{g}_{iit}^{\text{cs},v}\right] \times 2.5$ in Figure 6. In the 1995-2003 period, the consumer losses from closing the economy by 10 log points was about 3.2 log points. This is explained by a relatively closer economy in which domestic firms have more leeway to increase markups under lower foreign competition.[30] After 2003, consumer losses declined to about 2.9 log points in 2007, reflecting the increase in foreign competition and therefore a lower scope for domestic firms to increase markups. This implied a lower opportunity cost via the pro-competitive market from closing the economy, as domestic firms were more disciplined by competition in 2007 relative to before 2003.

[30] In fact, this index rose in the 1995-2003 period, reflecting the increase in domestic concentration without an increase in trade opening.

Figure 6: Consumer Losses from Closing the Economy (10 log points). 1995-2007.

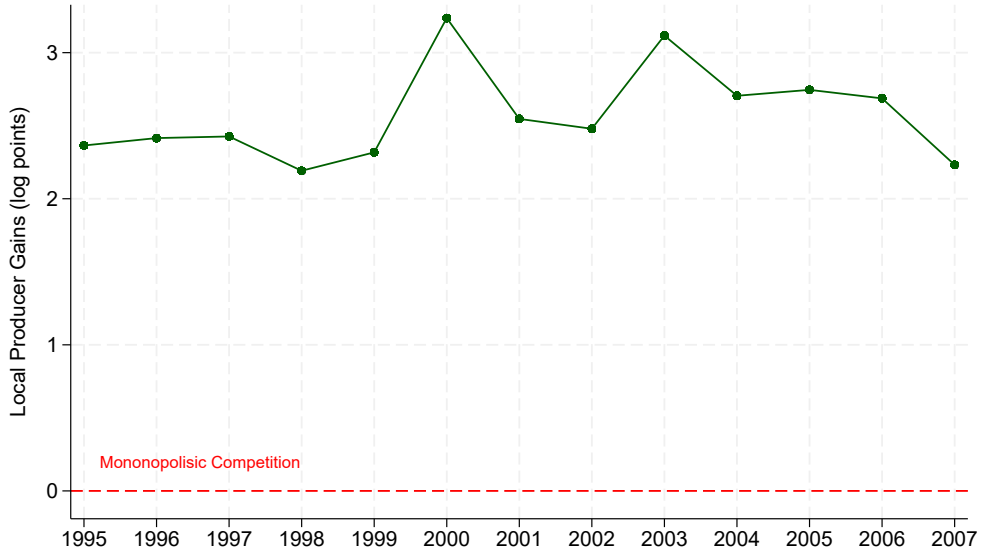


In Figure 6, I also added the consumer losses from closing the economy under monopolistic competition as a benchmark. Given that markups are constant in such a setting, the statistic collapses to the constant standard ACR. Including this indicator also helps in visualizing that under higher competition, losses from oligopolistic markups go down and tend to the monopolistic competitive benchmark.

4.4.5 Producer Welfare Gains From Trade

In Figure 7, I graph the producer component of the local gains from trade $\sum_v \left[\alpha^v_{iit}\mathbf{g}^{\text{cs},v}_{iit}\right] \times 2.5$. This term behaved differently over this period. In 1996-2003, it had substantial swings, being as low as 2.2 in 1998 and as high as 3.2 in 2000. Second, the statistic is virtually identical in 2007 to 1995. Note that the monopolistic competitive benchmark is zero in this case, as the profit share in income is constant in such a setting.

Figure 7: Producer Gains from Closing the Economy (10 log points). 1995-2007.



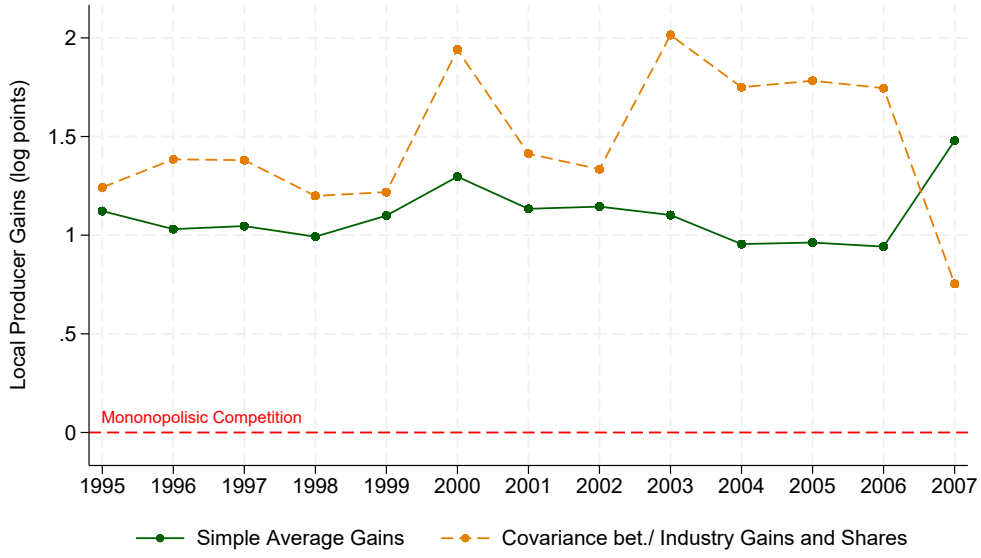
A key difference in this case is that the industry shares vary over time. Therefore, it is relevant to understand the evolution of the producer gains and the shares separately. To distinguish between these two, I employ the Olley-Pakes decomposition:

$$\mathcal{G}_{it}^{\text{ps}} = \overline{\mathbf{g}_{it}^{\text{ps}}} + COV_{it}(\tilde{\alpha}_{iit}^{v}, \mathbf{g}_{iit}^{\text{ps},v}), \tag{19}$$

where the first term is the simple average across sectors and the second one is the covariance between industry shares and producer gains. An increase in the covariance indicates a more concentrated pattern of specialization in sectors yielding higher profits.

In Figure 8, I show both terms from the decomposition in Equation 19. The simple average across industries was fairly constant in the entire period over time, except in 2007, when it jumped from 1 log point to 1.5. The covariance term increased over time from 1.25 to 1.7 in 2006, but then it collapsed in 2007 to 0.75. From this graph, it seems clear that 2007, the year in which China had full duty-free access to Chilean markets, strongly affected Chilean markets.

Figure 8: Decomposition of the Producer Gains from Closing the Economy (10 log points). 1995-2007.

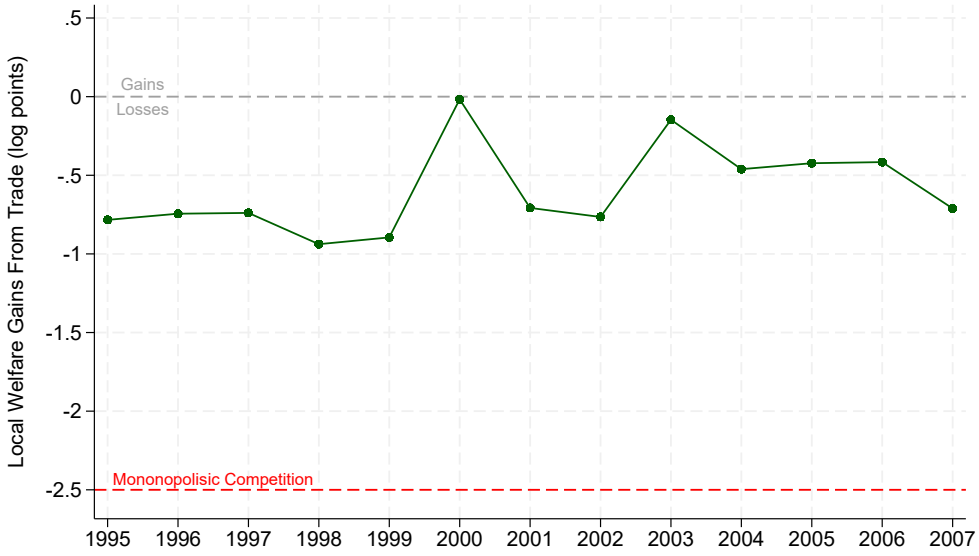


4.4.6 Aggregate Welfare Losses From Closing the Economy

What are the (local) aggregate welfare losses from closing the economy, and how did they evolve over time? In this section, I put together the consumer and producer statistics to compute Equation 18. In the monopolistic competitive case, such losses would be 2.5 log points given the assumptions, and it would only arise due to consumer losses through a higher domestic price index. Since there are no endogenous markups in such a case, the pro-competitive margin is zero and constant and there are no producer gains. With oligopolistic competition, markups (domestic and foreign) and profits are endogenous so this statistic changes over time and also has the potential to show aggregate welfare gains.

In Figure 9, I show the welfare statistic along with the monopolistic competitive benchmark and the gains-losses division. The average over the entire period was -0.6 log points—1.9 lower welfare losses than under monopolistic competition. This is not surprising given that domestic producers would benefit substantially in the short run from a closer economy via the profit channel. The statistic is never positive but gets close to it in 1998-2003, a period in which domestic concentration was already higher and the economy stayed relatively unchanged in terms of openness.

Figure 9: Local Welfare Losses from Closing the Economy (10 log points). 1995-2007.



In conclusion, the welfare gains from trade are variable and can differ substantially across periods when firms internalize the impact of their choices on industry aggregates. For this reason, it is important to consider the market structure conditions when a process of trade opening or closing takes place and how such market conditions would affect domestic consumers and producers differently. In a world with highly concentrated markets, the cost for consumers when the economy gets closed may be higher, given the higher possibility of increasing markups under weaker foreign competition for domestic firms. On the contrary, domestic producers may gain more in this situation. The aggregate effect depends on how the relative market power across sectors changes as the economy closes.

5 Conclusion

In this paper, I studied the role of market concentration in determining the welfare gains from trade in the presence of granular heterogeneous firms producing different varieties. I showed that this family of models gives rise to welfare-consistent concentration measures that (i) acknowledge the existence of foreign firms competing in domestic markets, and (ii) impose the right functional form from individual firms' perceived elasticities of demand. This allowed me to extend the canonical welfare formula of the gains from trade by including two factors of correction, capturing changes in consumer and producer surplus separately when trade conditions change.

I applied the statistics to study the case of Chile in the 1995-2007 period. During that time, Chile experienced an increase in import penetration and domestic market concentration, as measured by

standard indices. When I employ the microfounded welfare-consistent concentration index, I found that the cost from markups due to granularity stayed the same throughout this period. In terms of welfare, I find that the consumer gains from trade were lower in 2007 than before. This result is a consequence of the important role of foreign competition in disciplining domestic markups at lower rather than higher levels of trade opening. The welfare gains from trade when also considering changes in producers' surplus were fairly constant throughout the period and lower than under monopolistic competition, thanks to the offsetting effect of the increasing domestic profits in closer markets.

This paper provides a set of sufficient statistics that are useful to characterize the strength of market power in the context of granular economies and interrelated markets. Understanding the local welfare gains from trade is important to characterize the opportunity cost of a closing economy depending on the specific short-run market circumstances in which this process takes place. In this sense, these statistics can be useful for policy and academic work alike.

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Online Appendices

A Theoretical Results

A.1 Optimal Prices and Ad-valorem Excess Markups

Consumers have CES preferences $Q = \left[\sum_i^N \delta^{\frac{1}{\sigma}} q_i^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$.

N firms produce one variety each.

Firm i unit cost of producing q_i is c_i (so its productivity is $1/c_i$).

A.1.1 Quantity Competition

When firms compete in quantities, we need to take an extra step, which is to invert the demand function:

$$\begin{aligned} q_i &= \delta p_i^{-\sigma} P^{\sigma-1} \\ p_i &= \delta^{-1} q_i^{-\frac{1}{\sigma}} P^{\frac{\sigma-1}{\sigma}} \\ p_i &= \delta^{-1} q_i^{-\frac{1}{\sigma}} Q^{-\frac{\sigma-1}{\sigma}} \end{aligned}$$

where in the last step I used the CES expenditure function result ($Q \times P = 1$).

Therefore, each firm solves the following problem:

$$\begin{aligned} &\max_{q_i} (p_i - c_i) q_i \\ \text{s.t. } &p_i = \delta^{-1} q_i^{-\frac{1}{\sigma}} Q^{-\frac{\sigma-1}{\sigma}} \end{aligned}$$

The FOC is:

$$\begin{aligned} (p_i - c_i) + q_i p_i' &= 0 \\ p_i + q_i \delta^{-1} [-\frac{1}{\sigma} q_i^{-\frac{1}{\sigma}-1} Q^{-\frac{\sigma-1}{\sigma}}] - q_i \delta^{-1} \frac{\sigma-1}{\sigma} [q_i^{-\frac{2}{\sigma}} Q^{-2\frac{\sigma-1}{\sigma}}] &= c_i \\ p_i - p_i \frac{1}{\sigma} - \frac{\sigma-1}{\sigma} p_i q_i^{1-\frac{1}{\sigma}} Q^{-\frac{\sigma-1}{\sigma}} &= c_i \\ 1 - \frac{1}{\sigma} - \frac{\sigma-1}{\sigma} s_i &= \frac{1}{\mu_i^c} \\ \mu_i^c &= \frac{\sigma}{(\sigma-1)(1-s_i)} \end{aligned}$$

where I used that $\frac{q_i^{\frac{\sigma-1}{\sigma}}}{Q^{\frac{\sigma-1}{\sigma}}} = \frac{p_i^{1-\sigma}}{P^{1-\sigma}} = s_i$.

In this case, the excess markup is parameter-free as shown below:

$$\begin{aligned}\mu_i^c &= \bar{\mu}\left[\frac{\sigma}{(\sigma-1)(1-s_i)}\frac{\sigma-1}{\sigma}\right] \\ &= \bar{\mu}\left[\frac{1}{1-s_i}\right] \\ &= \bar{\mu}\left[1+\frac{s_i}{(1-s_i)}\right]\end{aligned}$$

Hence:

$$e^c = \frac{s_i}{(1-s_i)}$$

A.1.2 Price Competition

In price competition, firm i chooses their optimal price by solving the following problem:

$$\begin{aligned}&\max_{p_i}(p_i - c_i)q_i \\ &\text{s.t. } q_i = \delta p_i^{-\sigma} P^{\sigma-1}\end{aligned}$$

where $P = \left[\sum_i^N \delta p_i^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$ is the CES ideal price index, and we normalize total consumer expenditure to one.

The FOC is:

$$\begin{aligned}q_i + (p_i - c_i)q_i' &= 0 \\ \delta p_i^{-\sigma}P^{\sigma-1} + (p_i - c_i)\left[-\delta\sigma p_i^{-\sigma-1}P^{\sigma-1} + \delta(\sigma-1)p_i^{-2\sigma}P^{2(\sigma-1)}\right] &= 0 \\ 1 + (p_i - c_i)\left[-\sigma p_i^{-1} + (\sigma-1)p_i^{-\sigma}P^{\sigma-1}\right] &= 0 \\ 1 - \sigma(1-1/\mu_i^b) + (\sigma-1)(1-1/\mu_i^b)s_i &= 0 \\ 1 &= (1-1/\mu_i^b)(\sigma-(\sigma-1)s_i) \\ \frac{1}{\sigma-(\sigma-1)s_i} &= (1-1/\mu_i^b) \\ 1/\mu_i^b &= 1 - \frac{1}{\sigma-(\sigma-1)s_i} \\ \mu_i^b &= \frac{\sigma-(\sigma-1)s_i}{\sigma-(\sigma-1)s_i-1}\end{aligned}$$

In order to derive the excess markup, we use the definition of $\bar{\mu}$:

$$\begin{aligned}\mu_i^b &= \bar{\mu}\left[\frac{\sigma-(\sigma-1)s_i}{\sigma-(\sigma-1)s_i-1}\frac{\sigma-1}{\sigma}\right] \\ &= \bar{\mu}\left[\frac{\sigma-(\sigma-1)s_i}{(1-s_i)\sigma}\right] \\ &= \bar{\mu}\left[1+\frac{s_i}{\sigma(1-s_i)}\right]\end{aligned}$$

Therefore:

$$e^b = \frac{s_i}{\sigma(1-s_i)}$$

As mentioned, this excess markup depends on both the marker share and the elasticity of substitution.

A.2 Welfare-Consistent Concentration Measure

I prove this result in the case of quantity competition. Let's log differentiate the price index in the case of quantity competition:

$$\begin{aligned}d\log P_j^{1-\sigma} &= d\log\Big[\sum_{v\in\Omega_j}[c^v\times\bar{\mu}\times(1-s_j^v)^{-1}]^{1-\sigma}\Big] \\ &= \frac{1}{P_i^{1-\sigma}}\Big[\sum_{v\in\Omega_j}[c^v\times\bar{\mu}]^{1-\sigma}\times d(1-s_j^v)^{\sigma-1}\Big] \\ &= \frac{1}{P_j^{1-\sigma}}\Big[\sum_{v\in\Omega_j}[c^v\times\bar{\mu}\times(1-s_j^v)^{-1}]^{1-\sigma}(\sigma-1)d\log(1-s_j^v)\Big] \\ &= \frac{1}{P_j^{1-\sigma}}\Big[\sum_{v\in\Omega_j}[c^v\times\bar{\mu}\times(1-s_j^v)^{-1}]^{1-\sigma}\times\frac{1-\sigma}{1-s_j^v}ds_j^v\Big] \\ &= (1-\sigma)\Big[\sum_{v\in\Omega_i}\frac{s_j^v}{1-s_j^v}ds_j^v\Big],\end{aligned}$$

where in the last step I used CES, i.e. $s_j^v = [c^v\bar{\mu}(1-s_j^v)^{-1}]^{1-\sigma}/P_j^{1-\sigma}$.

Gradient Theorem (also known as the Fundamental Theorem of Calculus for Line Integrals):

If $\varphi : U \subseteq R^n \to R$ is a differentiable function and γ a differentiable curve in U which starts at a point p and ends at a point q, then:

$$\int_\gamma \nabla\varphi(\mathbf{s})\cdot d\mathbf{s} = \varphi(q)-\varphi(p)$$

where $\nabla\varphi(\mathbf{s})$ denotes the gradient vector field of φ.

If we think of φ as a function $\mathcal{C}(\mathbf{s})$, differentiable in market shares, and U as $[0,1]^n$, which is equivalent to $\log P_j$) but does not depend on marginal costs and other parameters, then we can apply this theorem:

$$
\begin{aligned}
\int_\gamma \nabla \mathcal{C}(\mathbf{s}) \cdot d\mathbf{s} &= \int_\gamma \sum_{v=1}^{n} \frac{s_{ij}^v}{1-s_{ij}^v} ds_{ij}^v \\
&= \sum_{v=1}^{n-1} \int_0^{\bar{s}_v} \frac{s_{ij}^v}{1-s_{ij}^v} ds_{ij}^v + \int_0^{1-\sum_{u=1}^{n-1}\bar{s}_u} \frac{s_{ij}^n}{1-s_{ij}^n} ds_{ij}^n \\
&= \sum_{v=1}^{n-1} \Big\{ \Big[-\bar{s}_v - \log(|1-\bar{s}_v|) \Big] - \Big[-0 - \log(|1-0|) \Big] \Big\} + \\
&+ \Big\{ \Big[-(1-\sum_{u=1}^{n-1}\bar{s}_u) - \log(|1-(1-\sum_{u=1}^{n-1}\bar{s}_u)|) \Big] - \Big[-0 - \log(|1-0|) \Big] \Big\} \\
&= \underbrace{\sum_{v=1}^{n} \Big[-\bar{s}_v - \log(|1-\bar{s}_v|) \Big]}_{\mathcal{C}(\bar{\mathbf{s}})} - \underbrace{\sum_{v=1}^{n} \Big[-0 - \log(|1-0|) \Big]}_{\mathcal{C}(0)=0}]
\end{aligned}
$$

where note that I defined γ as a curve mapping n to the $n-1$ dimensional simplex and I omitted the constant of integration.

Therefore, we get the expression that we needed:

$$
\mathcal{C}(\bar{\mathbf{s}}) = \sum_{v=1}^{n} \Big[-\bar{s}_v - \log(|1-\bar{s}_v|) \Big]
$$

In the case of price competition, it is the same procedure.

A.3 Concentration Equation

$$
\hat{\mathcal{C}_{ii}} = \sum_{l=1}^{N_{ii}} \frac{s_l}{1-s_l} ds_l
$$

The key to understanding counterfactual concentration when trade costs change is understanding how market shares change: which firms would grow and which firms would shrink?

We can re-write it as follows:

$$
\hat{\mathcal{C}_{ii}} = \sum_{l=1}^{N_{ii}} \frac{s_l^2}{1-s_l} \Big[\underbrace{\hat{p}_l^{1-\sigma} - \hat{P}_{ii}^{1-\sigma}}_{\substack{\text{Changes in domestic} \\ \text{market share } z_l}} + \underbrace{\hat{P}_{ii}^{1-\sigma} - \hat{P}_i^{1-\sigma}}_{\text{Changes in absorption } \lambda_{ii}} \Big]
$$

We know how to compute counterfactual absorption λ_{ii}, but we need the counterfactual distribution of domestic market shares, i.e. $z_l \equiv \frac{p_l^{1-\sigma}}{P_{ii}^{1-\sigma}}$ for each l.

Each individual price will react to a different level of competition as captured by P_i.

$$
\hat{p}_l = \frac{\psi_l}{1+\psi_l} \hat{P}_i,
$$

where $\psi_l \equiv (\sigma-1)\frac{s_l}{1-s_l}$ is what Amiti et al. (2019) call the "firm l own price markup elasticity".

ψ_l is increasing in the size of firms, so $\frac{\psi_l}{1+\psi_l} \in (0,1)$ is also increasing in the the size of firms.

Large firms prices are more elastic to changes in competition (as measured by changes in the CES price index).

We can write the domestic firm market share elasticity to the distribution of prices as follows:

$$\begin{aligned}
\hat{z}_l = \hat{p}_l^{1-\sigma} - \hat{P}_{ii}^{1-\sigma} &= \hat{p}_l^{1-\sigma} - \sum_{l=1}^{N_{ii}} z_l \hat{p}_l^{1-\sigma} \\
&= \frac{\psi_l}{1+\psi_l}\hat{P}_i^{1-\sigma} - \sum_{l=1}^{N_{ii}} z_l \frac{\psi_l}{1+\psi_l}\hat{P}_i^{1-\sigma} \\
&= (1-\sigma)\ \underbrace{\Big[\frac{\psi_l}{1+\psi_l} - \sum_{l=1}^{N_{ii}} z_l \frac{\psi_l}{1+\psi_l}\Big]}_{\substack{\text{Firm's l markup response relative} \\ \text{to aggregate market response}}}\ \hat{P}_i
\end{aligned}$$

The larger the firm, the more likely the response is greater than the average, e.g. an increase in P_i increases misallocation (reduces market shares of large firms and increases the one of small firms).

We can re-write the concentration function as follows:

$$\begin{aligned}
\hat{\mathcal{C}_{ii}} &= \sum_{l=1}^{N_{ii}} \frac{s_l^2}{1-s_l}\left\{(1-\sigma)\Big[\frac{\psi_l}{1+\psi_l} - \sum_{l=1}^{N_{ii}} z_l \frac{\psi_l}{1+\psi_l}\Big]\hat{P}_i + \hat{\lambda_{ii}}\right\} \\
&= -\mathcal{E}_{ii}^c \times \lambda_{ii} \times \left[\sum_{l=1}^{N_{ii}} [c_l - z_l]\frac{\psi_l}{1+\psi_l}\hat{P}_i + \frac{\hat{\lambda_{ii}}}{1-\sigma}\right] \\
&= -\mathcal{E}_{ii}^c \times \lambda_{ii} \times \left[\tilde{\Phi}_{ii}\hat{P}_i + \frac{\hat{\lambda_{ii}}}{1-\sigma}\right]
\end{aligned}$$

Where all the defined objects have a clear interpretation:

$\implies \mathcal{E}_{ii}^c \equiv \sum_{l=1}^{N_{ii}} z_l \frac{s_l}{1-s_l}(\sigma-1) > 0$ is the domestic industry's price index markup elasticity.

$\implies c_i \equiv z_l \frac{s_l}{1-s_l}(\sigma-1)/\mathcal{E}_{ii}^c$ is firm's l contribution to the price index markup elasticity.

$\implies \tilde{\Phi}_{ii} \equiv \Phi_{ii}^c - \Phi_{ii}^z \equiv \sum_{l=1}^{N_{ii}} [c_l - z_l]\frac{\psi_l}{1+\psi_l} \in (0,1)$ is captures misallocation (positive by proof).

Concentration (normalized to domestic size) depends on the CES industry price index and foreign competition changes, as captured by absorption:

$$\frac{\hat{\mathcal{C}_{ii}}}{\lambda_{ii}} = -\mathcal{E}_{ii}^c \tilde{\Phi}_{ii}\hat{P}_i + \mathcal{E}_{ii}^c \frac{\hat{\lambda_{ii}}}{\sigma-1}$$

An increase in the price index (less competition) reduces domestic concentration via misallocation.

An increase in absorption (less foreign competition) increases concentration by reallocating market shares relatively more to large firms.

A.4 Equilibrium Changes

Now, we can employ the following system of equations to understand how the CES price index would change when trade costs change, at the observed equilibrium concentration:

$$\textbf{Price Index Equation} \implies \hat{P}_i = \frac{\hat{\lambda_{ii}}}{\sigma - 1} + \frac{\hat{\mathcal{C}_{ii}}}{\lambda_{ii}}$$

$$\textbf{Concentration Equation} \implies \frac{\hat{\mathcal{C}_{ii}}}{\lambda_{ii}} = -\mathcal{E}^c_{ii}\tilde{\Phi}_{ii}\hat{P}_i + \mathcal{E}^c_{ii}\frac{\hat{\lambda_{ii}}}{\sigma - 1}$$

We can solve for the ACR-type formula with these two equations, getting:

$$\hat{P}_i = \left[\frac{1 + \mathcal{E}^c_{ii}}{1 + \mathcal{E}^c_{ii}\tilde{\Phi}_{ii}}\right] \times \frac{\hat{\lambda}_{ii}}{\sigma - 1}$$

Where $[\frac{1+\mathcal{E}^c_{ii}}{1+\mathcal{E}^c_{ii}\tilde{\Phi}_{ii}}] > 1$, i.e. when trade costs increase, domestic granular firms are able to charge higher markups due to lower competition.

A.5 Price Index Equation

Define $p^m(c) \equiv c \times \bar{\mu}$ as the price under monopolistic competition.

The CES industry price index can be written as follows:

$$P_i(\mathcal{M}) = \left[\sum_{j=1}^{J}\sum_{l=1}^{N_{ij}} p^m_{ij,l}(c_{i,l})^{1-\sigma}\varepsilon_{ij,l}(c_{i,l};\mathcal{M})^{1-\sigma}\right]^{\frac{1}{1-\sigma}},$$

where I index firms with l and keep explicitly the number of firms N_{ij} fixed.

Recall that firms i, l market share is sufficient to compute the wedge $\varepsilon_{ij,l}(c_{j,l};\mathcal{M})$ (plus σ if $\mathcal{M}$ is price competition).

The fact that market shares only enter into the wedge and not the first-best price is convenient.

Let's log differentiate $P_i(\mathcal{M})$ (indicated by the hats) and make explicit that ε depends on marginal costs via market shares:

$$\hat{P}_i(\mathcal{M}) = \hat{P}_j(\{c\}) + \hat{\mathcal{C}}_i(\{s(c)\},\mathcal{M}),$$

where $\hat{\mathcal{C}}_i(\{s(c)\},\mathcal{M}) \equiv \sum_{l=1}^{N_{ij}} s_{ij,l}d\varepsilon_{ij,l}(s(c_{i,l});\mathcal{M})$.

Changes in the family of functions $\mathcal{C}$ measure the first-order welfare costs of changes in the distribution of markup wedges.

A.5.1 ACR Strategy

Not being specific about the type of competition from now on for simplicity.

Assuming no changes in the distribution of marginal costs and the same number of firms, we have that under changes in trade costs:

$$\hat{P}_i = \lambda_{ii}\hat{w}_i + \lambda_{ji}\hat{w}_j + \hat{\mathcal{C}}_{ii} + \hat{\mathcal{C}}_{ji},$$

where I separated the concentration function $\hat{\mathcal{C}}_i$ into domestic and foreign, i.e. $\hat{\mathcal{C}}_i = \hat{\mathcal{C}}_{ii} + \hat{\mathcal{C}}_{ji}$, where e.g. $\hat{\mathcal{C}}_{ji}$ sums only firms from j in i.

Following strategy in ACR:

$$\hat{\lambda_{ji}} - \hat{\lambda_{ii}} = (1-\sigma)[\hat{w}_j - \hat{w}_i] + \frac{(1-\sigma)}{\lambda_{ji}}\hat{\mathcal{C}}_{ji} - \frac{(1-\sigma)}{\lambda_{ii}}\hat{\mathcal{C}}_{ii},$$

and thus $\hat{w}_j = \frac{1}{1-\sigma}[\hat{\lambda_{ji}} - \hat{\lambda_{ii}}] + \frac{1}{\lambda_{ii}}\hat{\mathcal{C}}_{ii} - \frac{1}{\lambda_{ji}}\hat{\mathcal{C}}_{ji}$.

Replacing $\hat{w}_j$ in $\hat{P}_i$ and using $\hat{w}_i = 0$, we get:

$$\begin{aligned}
\hat{P}_i &= \lambda_{ii}\Big[\frac{\hat{\lambda_{ii}} - \hat{\lambda_{ii}}}{1-\sigma} + \frac{1}{\lambda_{ii}}\hat{\mathcal{C}}_{ii} - \frac{1}{\lambda_{ii}}\hat{\mathcal{C}}_{ii}\Big] + \lambda_{ji}\Big[\frac{\hat{\lambda_{ji}} - \hat{\lambda_{ii}}}{1-\sigma} + \frac{1}{\lambda_{ii}}\hat{\mathcal{C}}_{ii} - \frac{1}{\lambda_{ji}}\hat{\mathcal{C}}_{ji}\Big] + \hat{\mathcal{C}}_{ii} + \hat{\mathcal{C}}_{ji} \\
&= \frac{\hat{\lambda_{ii}}}{\sigma - 1} + \frac{\hat{\mathcal{C}}_{ii}}{\lambda_{ii}}
\end{aligned}$$

The ACR term needs to be augmented by the domestic concentration only in the presence of granularity.

A.6 Aggregate Profits and Markup

A.6.1 Ad-valorem Excess Profits

Quantity Competition

$$
\begin{aligned}
\Pi &= \sum_{v=1}^{N} \pi_v \\
&= \sum_{v=1}^{N} (p_v - c_v) q_v \\
&= \sum_{v=1}^{N} (1 - c_v/p_v) q_v p_v \\
&= \sum_{v=1}^{N} \Big[1 - \frac{1}{\tilde{\mu}(1-s_v)^{-1}}\Big] r_v \\
&= \sum_{v=1}^{N} \Big[1 - \frac{(\sigma-1)(1-s_v)}{\sigma}\Big] r_v \\
&= \frac{R}{\sigma} \sum_{v=1}^{N} \Big[\sigma - (\sigma-1)(1-s_v)\Big] s_v \\
&= \frac{R}{\sigma} \sum_{v=1}^{N} \Big[1 + (\sigma-1) s_v\Big] s_v \\
&= \frac{\lambda R}{\sigma} \sum_{v=1}^{N} \Big[z_v + (\sigma-1)\lambda z_v\Big] \\
&= \frac{\lambda R}{\sigma} \Big[1 + \sum_{v=1}^{N} (\sigma-1)\lambda (z_i)^2\Big] \\
&= \frac{\lambda R}{\sigma} \Big[1 + (\sigma-1)\lambda HHI\Big]
\end{aligned}
$$

$$H_{ii} = 1 + (\sigma-1)\lambda_{ii} HHI_{ii}$$

Price Competition

$$
\begin{aligned}
\Pi &= \sum_{v=1}^{N} \pi_v \\
&= \sum_{v=1}^{N} (p_v - c_v) q_v \\
&= \sum_{v=1}^{N} (1 - c_v/p_v) q_v p_{vi} \\
&= \sum_{v=1}^{N} \Big[1 - \frac{c_v}{(\tilde{\mu} - s_v)(1 - s_v)^{-1} c_v} \Big] r_v \\
&= \sum_{v=1}^{N} \Big[1 - \frac{1 - s_v}{\tilde{\mu} - s_v} \Big] r_v \\
&= R \sum_{v=1}^{N} \Big[1 - \frac{(\sigma - 1)(1 - s_v)}{\sigma - s_v(\sigma - 1)} \Big] s_v \\
&= R \sum_{v=1}^{N} \frac{\sigma - s_v(\sigma - 1) - (\sigma - 1)(1 - s_v)}{\sigma - s_v(\sigma - 1)} s_v \\
&= R \sum_{v=1}^{N} \frac{s_v}{\sigma - s_v(\sigma - 1)} \\
&= \frac{R}{\sigma} \sum_{v=1}^{N} \frac{s_v}{1 - s_v \frac{\sigma - 1}{\sigma}}
\end{aligned}
$$

Now, let's work on the term in parenthesis:

$$
\begin{aligned}
\sum_{v=1}^{N} \frac{s_v}{1 - s_v \frac{\sigma-1}{\sigma}} &= \sum_{v=1}^{N} s_v \frac{1}{1 - s_v \frac{\sigma-1}{\sigma}} \\
&= \sum_{v=1}^{N} s_v \sum_{k=1}^{\infty} [s_v \frac{\sigma-1}{\sigma}]^{k-1} \\
&= \sum_{v=1}^{N} \sum_{k=1}^{\infty} s_v^k [\frac{\sigma-1}{\sigma}]^{k-1} \\
&= \sum_{k=1}^{\infty} \sum_{v=1}^{N} s_v^k [\frac{\sigma-1}{\sigma}]^{k-1} \\
&= \sum_{k=1}^{\infty} [\frac{\sigma-1}{\sigma}]^{k-1} \sum_{v=1}^{N} s_v^k \\
&= \sum_{k=1}^{\infty} [\frac{\sigma-1}{\sigma}]^{k-1} \sum_{v=1}^{N} \lambda^k z_v^k \\
&= \sum_{k=1}^{\infty} [\frac{\sigma-1}{\sigma}]^{k-1} \lambda^k \sum_{v=1}^{N} z_v^k \\
&= \lambda + \sum_{k=2}^{\infty} [\frac{\sigma-1}{\sigma}]^{k-1} \lambda^k \sum_{v=1}^{N} z_v^k \\
&= \lambda \Big[1 + \sum_{k=2}^{\infty} [\frac{\sigma-1}{\sigma}]^{k-1} \lambda^{k-1} \sum_{v=1}^{N} z_v^k \Big] \\
&= \lambda \Big[1 + \sum_{k=2}^{\infty} [\frac{\sigma-1}{\sigma} \lambda]^{k-1} HKI(k) \Big]
\end{aligned}
$$

where the third to last step follows from noting that $\sum_{v=1}^{N} z_v^k = 1$ and $[\frac{\sigma-1}{\sigma}]^{k-1} = 0$ when $k = 1$.

Note that $[\frac{\sigma-1}{\sigma}\lambda]^{k-1} \in (0, 1)$, so we can treat this term as weights to the different HKI degrees greater than 2 if we divide it by its sum.

$$
\begin{aligned}
\sum_{k=2}^{\infty} [\frac{\sigma-1}{\sigma}\lambda]^{k-1} &= \sum_{k=1}^{\infty} [\frac{\sigma-1}{\sigma}\lambda]^{k-1} - 1 \\
&= \frac{1}{1 - \frac{\sigma-1}{\sigma}\lambda} - 1 \\
&= \frac{\sigma}{\sigma - (\sigma-1)\lambda} - 1 \\
&= \frac{\sigma - (\sigma - (\sigma-1)\lambda)}{\sigma - (\sigma-1)\lambda} \\
&= \frac{(\sigma-1)\lambda}{\sigma - (\sigma-1)\lambda}
\end{aligned}
$$

So we use $\frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}$ as the denominator to define the k-specific weights $\iota_k \equiv [\frac{\sigma-1}{\sigma}\lambda]^{k-1} / \frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}$:

$$
\begin{aligned}
&= \lambda\Big[1+\sum_{k=2}^{\infty}[\frac{\sigma-1}{\sigma}\lambda]^{k-1}HKI(k)\Big] \\
&= \lambda\Big[1+\frac{\frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}}{\frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}}\sum_{k=2}^{\infty}[\frac{\sigma-1}{\sigma}\lambda]^{k-1}HKI(k)\Big] \\
&= \lambda\Big[1+\frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}\sum_{k=2}^{\infty}\iota_k HKI(k)\Big] \\
&= \lambda\Big[1+\frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}\overline{HKI}\Big]
\end{aligned}
$$

where $\overline{HKI} \equiv \sum_{k=2}^{\infty}\iota_k HKI(k)$ is the weighted average concentration index HKI over all the degrees (note that as $k \to \infty$, $HKI \to 0$, so the more weight on higher degrees, the lower the $\overline{HKI}$. Graphically, I can show that higher σ imply higher weight on higher degrees and $\sigma \to 1$ implies $\overline{HKI} \to HHI$, capturing the idea that quantity competition is a special case of price competition when $\sigma \to 1$.

We can come back to the original expression to have:

$$
\Pi = \frac{R}{\sigma}\sum_{v=1}^{N}\frac{s_v}{1-s_v\frac{\sigma-1}{\sigma}} = \frac{\lambda R}{\sigma}\Big[1+\frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}\overline{HKI}\Big]
$$

This implies that the following:

$$
H_{ii} = 1+\frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}\overline{HKI}
$$

A.6.2 Aggregate Markup

$$\begin{aligned}
Y_i &= L_i + \int_V [\Pi_{ii}^V + \Pi_{ij}^V] dV \\
&= L_i + \int_V [\frac{R_{ii}^V}{\sigma} H_{ii}^V + \frac{R_{ij}^V}{\sigma}] dV \\
&= L_i + \int_V [\frac{Y_i \alpha^V \lambda_{ii}^V}{\sigma} H_{ii}^V + \frac{Y_j \alpha^V \lambda_{ji}^V}{\sigma}] dV \\
&= L_i + \int_V \frac{Y_i \alpha^V \lambda_{ii}^V}{\sigma} H_{ii}^V dV + \int_V \frac{Y_j \alpha^V \lambda_{ji}^V}{\sigma} dV \\
&= L_i + \int_V \frac{Y_i \alpha^V \lambda_{ii}^V}{\sigma} H_{ii}^V dV + \int_V \frac{Y_i \alpha^V (1 - \lambda_{ii}^V)}{\sigma} dV \\
&= L_i + \frac{Y_i}{\sigma} \Big[\int_V \alpha^V \lambda_{ii}^V H_{ii}^V dV + \int_V \alpha^V (1 - \lambda_{ii}^V) dV \Big] \\
&= L_i + \frac{Y_i}{\sigma} \Big[1 + \int_V \alpha^V \lambda_{ii}^V (H_{ii}^V - 1) dV \Big] \\
&= L_i \times \frac{\sigma}{\sigma - 1 - \int_V \alpha^V \lambda_{ii}^V (H_{ii}^V - 1) dV}
\end{aligned}$$

Quantity Competition

$$\begin{aligned}
\mathbf{m}_{ii} &\equiv \frac{\sigma}{\sigma - 1 - \int_V \alpha^V \lambda_{ii}^V (H_{ii}^V - 1) dV} \\
&= \frac{\sigma}{\sigma - 1 - \int_V \alpha^V \lambda_{ii}^V (\sigma - 1) \lambda_{ii}^V HHI_{ii}^V dV} \\
&= \frac{\sigma}{(\sigma - 1)(1 - \int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV)} \\
&= \frac{\sigma}{\sigma - 1} \times [1 - \int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV]^{-1}
\end{aligned}$$

This aggregate excess markup can be computed as an ad-valorem term:

$$\mathbf{m}_{ii} = \frac{\sigma}{\sigma - 1} \times [1 + \frac{\int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV}{1 - \int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV}]$$

Price Competition

$$\begin{aligned}
\mathbf{m}_{ii} &\equiv \frac{\sigma}{\sigma - 1 - \int_V \alpha^V \lambda_{ii}^V (H_{ii}^V - 1) dV} \\
&= \frac{\sigma}{\sigma - 1 - \int_V \alpha^V \lambda_{ii}^V [\frac{(\sigma - 1)\lambda^V}{\sigma - (\sigma - 1)\lambda^V} \overline{HKI}^V] dV} \\
&= \frac{\sigma}{(\sigma - 1)(1 - \int_V \alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma - (\sigma - 1)\lambda^V} dV)} \\
&= \frac{\sigma}{\sigma - 1} \times [1 - \int_V \alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma - (\sigma - 1)\lambda^V} dV]^{-1}
\end{aligned}$$

This aggregate excess markup can be computed as an ad-valorem term:

$$\mathbf{m}_{ii} = \frac{\sigma}{\sigma-1} \times [1 + \frac{\int_V \alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V} dV}{1 - \int_V \alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V} dV}]$$

A.7 Equilibrium Aggregate Markup and Income Changes

A.7.1 Aggregate Markup Changes

Quantity Competition

$$\begin{aligned}
\hat{\mathbf{m}}_{ii} &= -(1 - \int_V \widehat{\alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V} dV) \\
&= \frac{1}{1 - \int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV} \Big[d \int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV \Big] \\
&= \frac{1}{1 - \int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV} \int_V \alpha^V d\Big[(\lambda_{ii}^V)^2 HHI_{ii}^V \Big] dV \\
&= \frac{1}{1 - \int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV} \int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V \Big[2\hat{\lambda}_{ii}^V + \widehat{HHI}_{ii}^V \Big] dV \\
&= \frac{1}{1 - \int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV} \Big[\int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V 2\hat{\lambda}_{ii}^V dV + \int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V \widehat{HHI}_{ii}^V dV \Big] \\
&= \frac{\int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV}{1 - \int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV} \Big[\int_V \frac{\alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V}{\int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV} 2\hat{\lambda}_{ii}^V dV + \int_V \frac{\alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V}{\int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV} \widehat{HHI}_{ii}^V dV \Big] \\
&= \frac{\int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV}{1 - \int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV} \Big[\int_V \frac{\alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V}{\int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV} 2\hat{\lambda}_{ii}^V dV \Big] + \\
&+ \frac{\int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV}{1 - \int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV} \Big[\int_V \frac{\alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V}{\int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV} \widehat{HHI}_{ii}^V dV \Big] \\
&= 2\theta_{ii}^Q \Big[\int_V \tilde{\alpha}^{q,V} \hat{\lambda}_{ii}^V dV \Big] + \theta_{ii}^Q \Big[\int_V \tilde{\alpha}^{q,V} \widehat{HHI}_{ii}^V dV \Big]
\end{aligned}$$

where $\tilde{\alpha}^{q,V} \equiv \frac{\alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V}{\int_V \alpha^V (\lambda_{ii}^V)^2 HHI_{ii}^V dV}$, is a modified sector share by the relative degree of domestic market power.

This expression means that we can use the computation for each sector to construct the local changes. These local changes will depend heavily on the initial state of competition across industries.

Deriving an expression for $\widehat{HHI}_{ii}$ is analogous to what I did for concentration on the consumer side. It implies using the firm-specific markup elasticity (that depends on shares) and then aggregating it based on the HHI function.

$$
\begin{aligned}
\widehat{HHI}_{ii} &= \frac{1}{HHI_{ii}} \sum_{v=1}^{N_{ii}} dz_v^2 \\
\widehat{HHI}_{ii} &= \frac{1}{HHI_{ii}} \sum_{v=1}^{N_{ii}} z_v^2 2\hat{z}_v \\
\widehat{HHI}_{ii} &= 2 \sum_{v=1}^{N_{ii}} h_v \hat{z}_v
\end{aligned}
$$

This expression depends on log changes in individual domestic market shares as $\mathcal{C}$.
In those results, we have $\hat{z_v} = (1-\sigma)[\frac{\psi_v}{1+\psi_v} - \sum_{v=1}^{N_{ii}} z_v \frac{\psi_v}{1+\psi_v}]\hat{P}_i$, so we can use this expression:

$$
\begin{aligned}
\widehat{HHI}_{ii} &= 2 \sum_{v=1}^{N_{ii}} h_v (1-\sigma)[\frac{\psi_v}{1+\psi_v} - \sum_{v=1}^{N_{ii}} z_v \frac{\psi_v}{1+\psi_v}]\hat{P}_i \\
&= 2(1-\sigma) \sum_{v=1}^{N_{ii}} h_v \frac{\psi_v}{1+\psi_v} \hat{P}_i - \sum_{v=1}^{N_{ii}} z_v \frac{\psi_v}{1+\psi_v} \hat{P}_i \\
&= 2(1-\sigma) \sum_{v=1}^{N_{ii}} [h_v - z_v] \frac{\psi_v}{1+\psi_v} \hat{P}_i \\
&= 2(1-\sigma) \tilde{\Phi}_{ii}^q \hat{P}_i
\end{aligned}
$$

Here we cannot use the aggregate price index for this expression as the weights in the markup use $\tilde{\alpha}$ rather than α. Therefore:

$$
\begin{aligned}
\hat{\mathbf{m}}_{ii} &= 2\theta_{ii}^Q \Big[\int_V \tilde{\alpha}^{q,V} \hat{\lambda}_{ii}^V dV \Big] + \theta_{ii}^Q \Big[\int_V \tilde{\alpha}^{q,V} \widehat{HHI}_{ii}^V dV \Big] \\
&= 2\theta_{ii}^Q \Big[\int_V \tilde{\alpha}^{q,V} \hat{\lambda}_{ii}^V dV \Big] + \theta_{ii}^Q \Big[\int_V \tilde{\alpha}^{q,V} 2(1-\sigma) \tilde{\Phi}_{ii}^{q,V} \hat{P}_i^V dV \Big] \\
&= 2\theta_{ii}^Q (1-\sigma) \Big[\int_V \tilde{\alpha}^{q,V} \frac{\hat{\lambda}_{ii}^V}{1-\sigma} dV \Big] + \Big[\int_V \tilde{\alpha}^{q,V} \tilde{\Phi}_{ii}^{q,V} \hat{P}_i^V dV \Big] \\
&= 2\theta_{ii}^Q (1-\sigma) \Big[\int_V \tilde{\alpha}^{q,V} [\frac{\hat{\lambda}_{ii}^V}{1-\sigma} + \tilde{\Phi}_{ii}^{q,V} \hat{P}_i^V] dV \Big]
\end{aligned}
$$

Price Competition Thanks to having the exact same formulation, we can follow the exact same strategy but also accounting for concentration degrees relative distortions:

$$
\begin{aligned}
\hat{\mathbf{m}}_{ii} &= -(1-\int_V \alpha^V (\lambda_{ii}^V)^2 \widehat{\frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V}} dV) \\
&= \frac{1}{1-\int_V \alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V} dV} \Big[d\int_V \alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V} dV \Big] \\
&= \frac{1}{1-\int_V \alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V} dV} \int_V \alpha^V d\Big[(\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V} \Big] dV \\
&= \frac{1}{1-\int_V \alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V} dV} \int_V \alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V} \Big[\frac{\widehat{(\lambda_{ii}^V)^2}}{\sigma-(\sigma-1)\lambda^V} + \widehat{\overline{HKI}^V} \Big] dV \\
&= \frac{\int_V \alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V} dV}{1-\int_V \alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V} dV} \int_V \frac{\alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V}}{\int_V \alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V} dV} \Big[\frac{\widehat{(\lambda_{ii}^V)^2}}{\sigma-(\sigma-1)\lambda^V} + \widehat{\overline{HKI}^V} \Big] dV \\
&= \frac{\int_V \alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V} dV}{1-\int_V \alpha^V (\lambda_{ii}^V)^2 \frac{\overline{HKI}^V}{\sigma-(\sigma-1)\lambda^V} dV} \int_V \tilde{\alpha}^{p,V} \Big[\frac{\widehat{(\lambda_{ii}^V)^2}}{\sigma-(\sigma-1)\lambda^V} + \widehat{\overline{HKI}^V} \Big] dV
\end{aligned}
$$

****

As before, we know how $\hat{\lambda}_{ii}$ changes with autarky, so we need $\widehat{\overline{HKI}_{ii}}$

Deriving an expression for $\widehat{\overline{HKI}_{ii}}$ is more involved now because weights depend on λ as well. First, let's re-write $\widehat{\overline{HKI}}$ as follows.

$$
\begin{aligned}
\overline{HKI}_{ii} &= \sum_{k=2}^{\infty} \frac{[\frac{\sigma-1}{\sigma}\lambda]^{k-1}}{\frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}} HKI(k) \\
&= \sum_{k=2}^{\infty} \frac{[\frac{\sigma-1}{\sigma}\lambda]^{k-1}}{\frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}} \sum_{v=1}^{N} z_v^k \\
&= \sum_{k=2}^{\infty} \sum_{v=1}^{N} \frac{[\frac{\sigma-1}{\sigma}\lambda]^{k-1}}{\frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}} z_v^k \\
&= \sum_{v=1}^{N} \sum_{k=2}^{\infty} \frac{[\frac{\sigma-1}{\sigma}\lambda]^{k-1}}{\frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}} z_v^k
\end{aligned}
$$

If we log-differentiate but keep λ constant (in the weights), we get:

$$
\begin{aligned}
\widehat{\overline{HKI}_{ii}}\big|_{\bar{\lambda}} &= \frac{1}{\overline{HKI}}\sum_{v=1}^{N}\sum_{k=2}^{\infty}\frac{[\frac{\sigma-1}{\sigma}\lambda]^{k-1}}{\frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}}kz_v^k\hat{z}_v \\
&= \frac{1}{\overline{HKI}}\sum_{k=2}^{\infty}\iota(k)k\sum_{v=1}^{N}z_v^k\hat{z}_v \\
&= \frac{1}{\overline{HKI}}\left[\iota(2)2\sum_{v=1}^{N}z_v^2\hat{z}_v+\iota(3)3\sum_{v=1}^{N}z_v^3\hat{z}_v+\iota(4)4\sum_{v=1}^{N}z_v^4\hat{z}_v+...\right] \\
&= \frac{1}{\overline{HKI}}\left[2HKI(2)\iota(2)\sum_{v=1}^{N}h_v(2)\hat{z}_v+3HKI(3)\iota(3)\sum_{v=1}^{N}h_v(3)\hat{z}_v+4HKI(4)\iota(4)\sum_{v=1}^{N}h_v(4)\hat{z}_v+...\right] \\
&= \sum_{v=1}^{N}\left[\frac{2\iota(2)HKI(2)}{\sum_{k=2}^{\infty}\iota(k)HKI(k)}h_v(2)+\frac{3\iota(3)HKI(3)}{\sum_{k=2}^{\infty}\iota(k)HKI(k)}h_v(3)+\frac{4\iota(4)HKI(4)}{\sum_{k=2}^{\infty}\iota(k)HKI(k)}h_v(4)+...\right]\hat{z}_v \\
&= \sum_{v=1}^{N}\left[2o(2)h_v(2)+3o(3)h_v(3)+4o(4)h_v(4)+...\right]\hat{z}_v \qquad o(k)\textbf{: contribution of } k \textbf{ degree to } \overline{HKI} \\
&= \sum_{v=1}^{N}\left[\sum_{k=2}^{\infty}ko(k)h_v(k)\right]\hat{z}_v
\end{aligned}
$$

My goal here is to get to an expression $\widehat{\overline{HKI}_{ii}} = \rho\sum_{v=1}^{N}\rho_v\hat{z}_v$ such that $\sum_{v=1}^{N}h_v = 1$ and $0 < \varrho < C < \infty$, i.e. ϱ is a finite bounded number. In the quantity case $\varrho = 2$.

$$
\begin{aligned}
\widehat{\overline{HKI}_{ii}}\big|_{\bar{\lambda}} &= \sum_{v=1}^{N}\left[\sum_{k=2}^{\infty}ko(k)h_v(k)\right]\hat{z}_v \\
&= \sum_{v=1}^{N}\left[\sum_{k=2}^{\infty}o(k)\times\Big[kh_v(k)\Big]\right]\hat{z}_v \qquad \textbf{Note that } \sum_{k=2}^{\infty}o(k)=1\textbf{, so it is a weighted average} \\
&= \sum_{v=1}^{N}\tilde{h}_v\hat{z}_v \qquad\qquad \tilde{h}_v \equiv \sum_{k=2}^{\infty}o(k)\times\Big[kh_v(k)\Big] \textbf{ is the weighted average} \\
&= \varrho\sum_{v=1}^{N}\rho_v\hat{z}_v \qquad\qquad \rho_v\textbf{: contribution of the } v \textbf{ firm to } \varrho
\end{aligned}
$$

It is worth noting the following of ϱ:

$$\begin{aligned}
\varrho &= \sum_{v=1}^{N}\sum_{k=2}^{\infty} o(k)kh_v(k) \\
&= \sum_{k=2}^{\infty} o(k)k\sum_{v=1}^{N} h_v(k) \\
&= \sum_{k=2}^{\infty} o(k)k\sum_{v=1}^{N} \frac{z_v^k}{HKI(k)} \\
&= \sum_{k=2}^{\infty} o(k)k
\end{aligned}$$

So closed form for $\widehat{\overline{HKI}_{ii}}\big|_{\bar{\lambda}}$ depends on ϱ is finite, i.e. that $\sum_{k=2}^{\infty} o(k)k$ converges. I conjecture this is true given that: $o(k) \in (0,1)$ for all k and goes to zero convexly as $k \to \infty$, whereas k goes to infinity linearly. This should be proven though.

I will also need that ρ_v is convex on z_v too to have as a result that the markup's own elasticity to prices is positive. For now, I will assume this is true.

Now, we need to know $\widehat{\overline{HKI}_{ii}}\big|_{\{\bar{z}_v\}_{v=1}^N}$ i.e. the log difference change due to changes in λ keeping the firms' market shares constant.

$$\begin{aligned}
\widehat{\overline{HKI}_{ii}}\big|_{\{\bar{z}_v\}_{v=1}^N} &= \frac{1}{\overline{HKI}}\sum_{k=2}^{\infty}\iota(k)HKI(k)\frac{\hat{\iota(k)}}{\hat{\lambda}}\hat{\lambda} \\
&= \sum_{k=2}^{\infty} o(k)\frac{\hat{\iota(k)}}{\hat{\lambda}}\hat{\lambda}
\end{aligned}$$

We need $\frac{\hat{\iota(k)}}{\hat{\lambda}}$, i.e. $\frac{d\log\iota(k)}{d\log\lambda}$, the elasticity of of the weights with respect to λ. Note that $\log\iota = (k-1)\log\frac{\sigma}{\sigma-1} + (k-1)\log\lambda + \log[\sigma-(\sigma-1)\lambda] - \log(\sigma-1) - \log\lambda$.

$$\frac{d\log\iota(k)}{d\log\lambda} = (k-2) - \frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}$$

We can replace this back:

$$\begin{aligned}
\widehat{\overline{HKI}_{ii}}\big|_{\{\bar{z}_v\}_{v=1}^N} &= \sum_{k=2}^{\infty} o(k)[(k-2) - \frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}]\hat{\lambda} \\
&+ \left[\Big[\sum_{k=2}^{\infty} o(k)k\Big] - [2 + \frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}]\right]\hat{\lambda} \qquad \textbf{I can the } \varrho \textbf{ definition and its finite assumptio} \\
&+ \left[\varrho - [2 + \frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}]\right]\hat{\lambda}
\end{aligned}$$

Then, we can use that $\widehat{\overline{HKI}_{ii}} = \widehat{\overline{HKI}_{ii}}\big|_{\bar{\lambda}} + \widehat{\overline{HKI}_{ii}}\big|_{\{\bar{z}_v\}_{v=1}^N} = \varrho\sum_{v=1}^{N}\rho_v\hat{z}_v + \left[\varrho - [2 + \frac{(\sigma-1)\lambda}{\sigma-(\sigma-1)\lambda}]\right]\hat{\lambda}$

****

$$
\begin{aligned}
&= \theta_{ii}^{P}\int_{V}\tilde{\alpha}^{p,V}\varrho_{ii}^{V}(1-\sigma)\Big[\frac{\hat{\lambda}_{ii}^{V}}{1-\sigma}+\tilde{\Phi}_{ii}^{p,V}\hat{P}_{i}\Big]dV\\
&= \varrho_{ii}\theta_{ii}^{P}(1-\sigma)\int_{V}\tilde{\alpha}^{p,V}\tilde{\varrho}_{ii}^{V}\Big[\frac{\hat{\lambda}_{ii}^{V}}{1-\sigma}+\tilde{\Phi}_{ii}^{p,V}\hat{P}_{i}\Big]dV
\end{aligned}
$$

where I defined objects analogous to the single sector case, but also needed to define $\varrho_{ii}\equiv\int_{V}\tilde{\alpha}^{p,V}\varrho_{ii}^{V}dV$ and $\tilde{\varrho}_{ii}^{V}\equiv\frac{\varrho_{ii}^{V}}{\int_{V}\tilde{\alpha}^{p,V}\varrho_{ii}^{V}dV}$.

A.7.2 Aggregate Income Changes

Quantity Competition

$$
\begin{aligned}
\hat{Y}_{i}=\hat{\mathbf{m}}_{ii} &= 2\theta_{ii}^{Q}(1-\sigma)\Big[\int_{V}\tilde{\alpha}^{q,V}[\frac{\hat{\lambda}_{ii}^{V}}{1-\sigma}+\tilde{\Phi}_{ii}^{q,V}\left[\frac{1+\mathcal{E}_{ii}^{c,V}}{1+\mathcal{E}_{ii}^{c,V}\tilde{\Phi}_{ii}^{c,V}}\right]\frac{\hat{\lambda}_{ii}^{V}}{\sigma-1}]dV\Big]\\
&= 2\theta_{ii}^{Q}(\sigma-1)\Big[\int_{V}\tilde{\alpha}^{q,V}[\frac{\hat{\lambda}_{ii}^{V}}{\sigma-1}-\tilde{\Phi}_{ii}^{q,V}\left[\frac{1+\mathcal{E}_{ii}^{c,V}}{1+\mathcal{E}_{ii}^{c,V}\tilde{\Phi}_{ii}^{c,V}}\right]\frac{\hat{\lambda}_{ii}^{V}}{\sigma-1}]dV\Big]\\
&= 2\theta_{ii}^{Q}(\sigma-1)\Big[\int_{V}\tilde{\alpha}^{q,V}[1-\tilde{\Phi}_{ii}^{q,V}\left[\frac{1+\mathcal{E}_{ii}^{c,V}}{1+\mathcal{E}_{ii}^{c,V}\tilde{\Phi}_{ii}^{c,V}}\right]]\frac{\hat{\lambda}_{ii}^{V}}{\sigma-1}dV\Big]
\end{aligned}
$$

As before, this expression is helpful, as it shows how aggregate profits depend on changes in absorption.

In this case, I will also add a different formulation employing an index of distortions:

$$
\begin{aligned}
\hat{Y}_{i} &= 2\theta_{ii}^{Q}(\sigma-1)\Big[\int_{V}\tilde{\alpha}^{q,V}[1-\tilde{\Phi}_{ii}^{q,V}\left[\frac{1+\mathcal{E}_{ii}^{c,V}}{1+\mathcal{E}_{ii}^{c,V}\tilde{\Phi}_{ii}^{c,V}}\right]]\frac{\hat{\lambda}_{ii}^{V}}{\sigma-1}dV\Big]\\
&= \Xi_{ii}^{Q}\int_{V}\xi_{ii}^{q}\frac{\hat{\lambda}_{ii}^{V}}{\sigma-1}dV
\end{aligned}
$$

where $\Xi_{ii}^{Q}\equiv 2\theta_{ii}^{Q}(\sigma-1)\Big[\int_{V}\tilde{\alpha}^{q,V}[1-\tilde{\Phi}_{ii}^{q,V}\left[\frac{1+\mathcal{E}_{ii}^{c,V}}{1+\mathcal{E}_{ii}^{c,V}\tilde{\Phi}_{ii}^{c,V}}\right]]dV\Big]$ and $\xi_{ii}^{q}\equiv 2\theta_{ii}^{Q}(\sigma-1)\Big[\tilde{\alpha}^{q,V}[1-\tilde{\Phi}_{ii}^{q,V}\left[\frac{1+\mathcal{E}_{ii}^{c,V}}{1+\mathcal{E}_{ii}^{c,V}\tilde{\Phi}_{ii}^{c,V}}\right]]\Big]/\Xi_{ii}^{Q}$.

Price Competition

$$
\begin{aligned}
\hat{Y}_{i}=\hat{\mathbf{m}}_{ii} &= \varrho_{ii}\theta_{ii}^{P}(1-\sigma)\Big[\int_{V}\tilde{\alpha}^{p,V}\tilde{\varrho}_{ii}^{V}[\frac{\hat{\lambda}_{ii}^{V}}{1-\sigma}+\tilde{\Phi}_{ii}^{p,V}\left[\frac{1+\mathcal{E}_{ii}^{c,V}}{1+\mathcal{E}_{ii}^{c,V}\tilde{\Phi}_{ii}^{c,V}}\right]\frac{\hat{\lambda}_{ii}^{V}}{\sigma-1}]dV\Big]\\
&= \varrho_{ii}\theta_{ii}^{P}(\sigma-1)\Big[\int_{V}\tilde{\alpha}^{p,V}\tilde{\varrho}_{ii}^{V}[1-\tilde{\Phi}_{ii}^{p,V}\left[\frac{1+\mathcal{E}_{ii}^{c,V}}{1+\mathcal{E}_{ii}^{c,V}\tilde{\Phi}_{ii}^{c,V}}\right]]\frac{\hat{\lambda}_{ii}^{V}}{\sigma-1}dV\Big]
\end{aligned}
$$

where I defined objects analogous to the single sector case, but also needed to define $\varrho_{ii}\equiv\int_{V}\tilde{\alpha}^{p,V}\varrho_{ii}^{V}dV$ and $\tilde{\varrho}_{ii}^{V}\equiv\frac{\varrho_{ii}^{V}}{\int_{V}\tilde{\alpha}^{p,V}\varrho_{ii}^{V}dV}$.

B Additional Empirical Results

Figure A1: Chinese Import Penetration. 1995-2007.

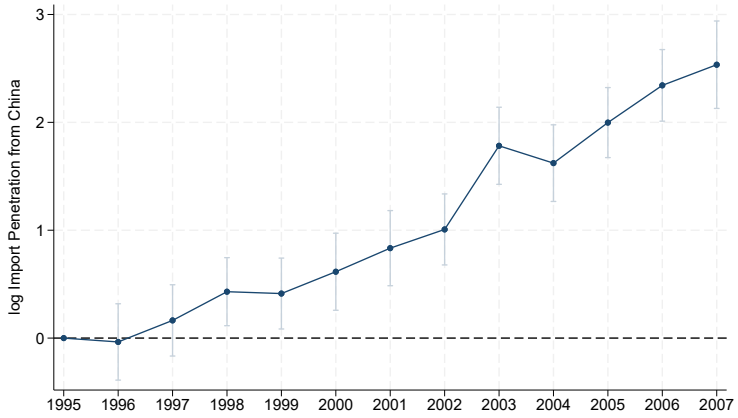


Figure A2: Sectoral Import Penetration. 1995 vs 2007.

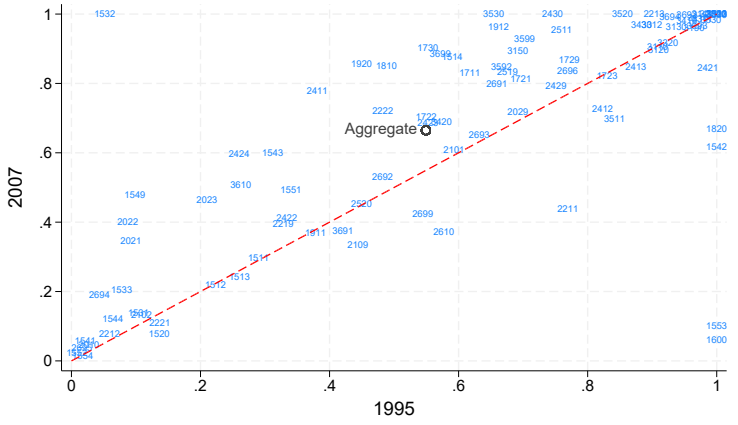


Figure A3: Sectoral Domestic Revenue Share. 1995 vs 2007.

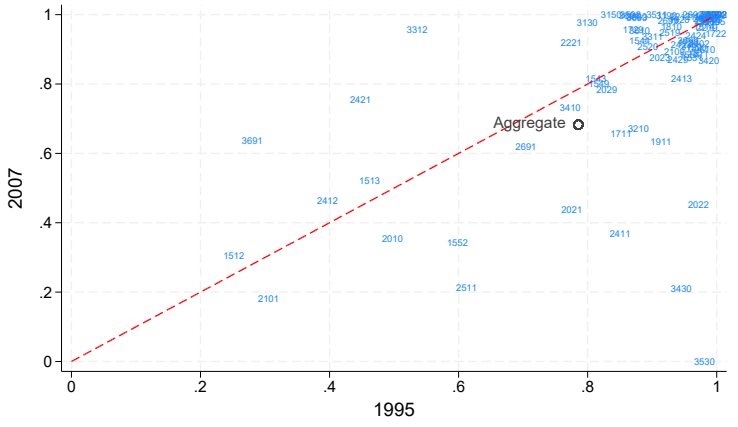


Figure A4: Profit and Expenditure Shares. 1995.

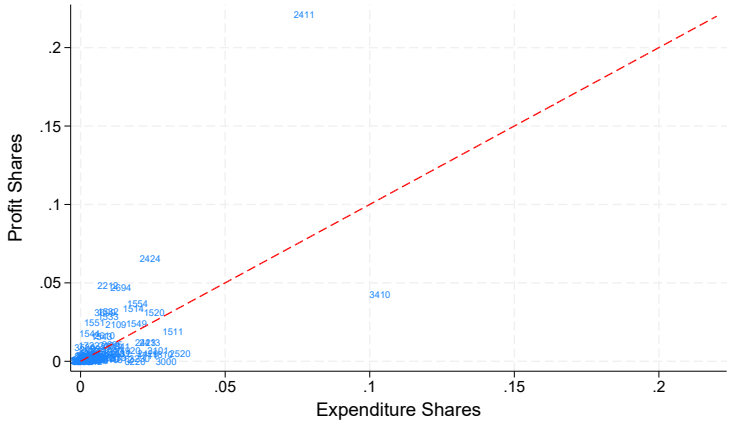
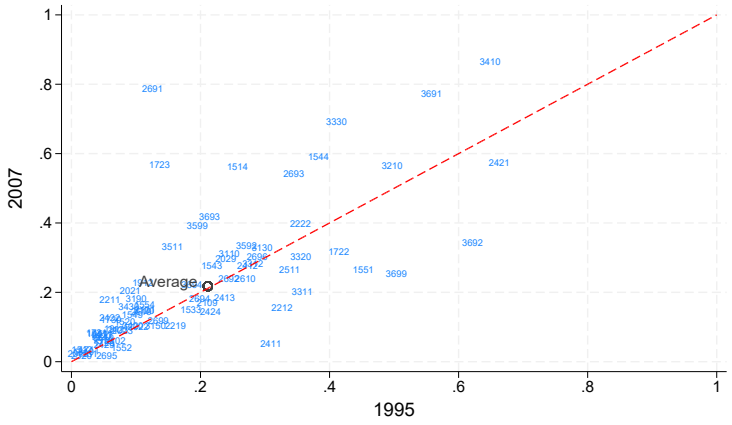


Figure A5: Sectoral Domestic Market Concentration.1995 vs 2007

(a) HHI



(b) Share of Top Four Firms

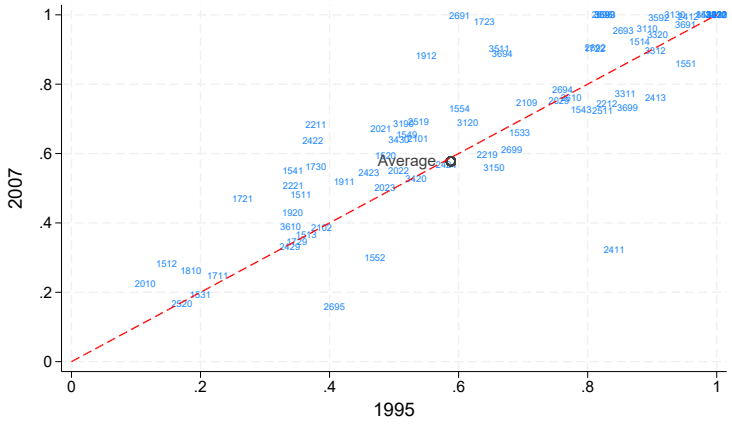


Figure A6: Welfare-Consistent Concentration Measure. Price Competition. 1995-2007.

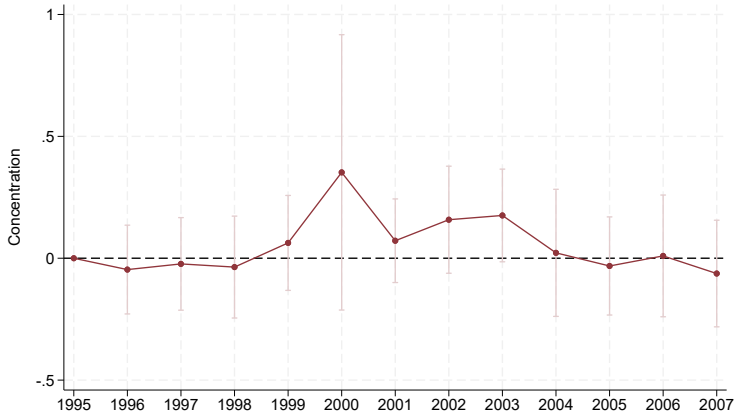


Figure A7: Welfare-Consistent Concentration Measure. 1995 vs 2007.

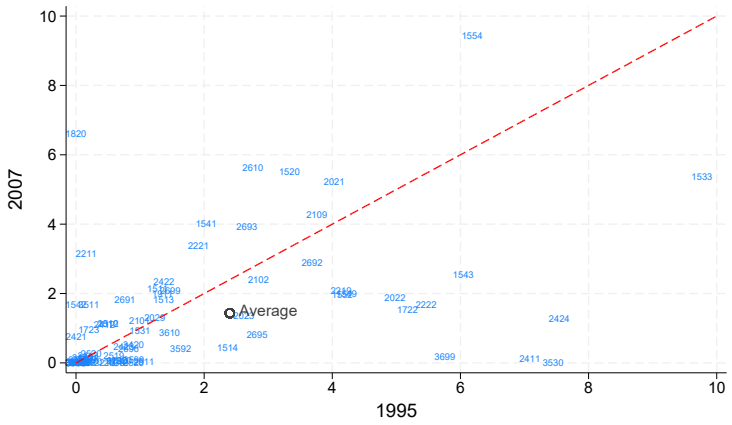
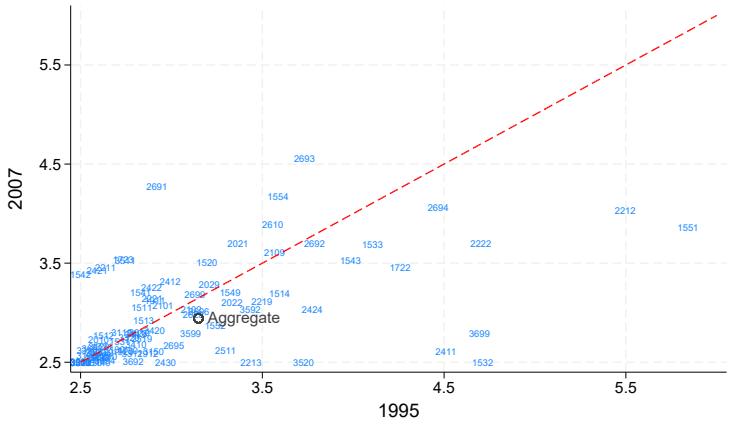


Figure A8: Sectoral Consumer Losses and Producer Gains from Closing the Economy (10 log points).1995 vs 2007

(a) Consumer Losses



(b) Producer Gains

