

GOVERNMENT POLICIES IN A GRANULAR GLOBAL ECONOMY*

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Abstract

We use the granular model of international trade developed in [Gaubert and Itskhoki \(2020\)](#) to study the rationale and implications of three types of government interventions typically targeted at large individual firms – antitrust, trade and industrial policies. We find that in antitrust regulation, governments face an incentive to be overly lenient in accepting mergers of large domestic firms. It substitutes for beggar-thy-neighbor trade policy in sectors with strong comparative advantage. In trade policy, targeting large individual foreign exporters rather than entire sectors is desirable from the point of national government, as doing so minimizes pass-through of the tariff into domestic consumer prices placing a greater portion of the burden on foreign producers. Finally, we show that subsidizing ‘national champions’ is generally suboptimal in closed economies as it leads to an excessive build-up of market power, but it may become unilaterally welfare improving in open economies. We contrast unilaterally optimal policies with the coordinated global optimal policy and emphasize the need for international policy cooperation in these domains.

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1 Introduction

Large firms shape national economies ([Gabaix \(2011\)](#)) and drive international trade even more so. Indeed, [Gaubert and Itskhoki \(2020\)](#) find that firm-level “granular” forces shape comparative advantage and trade patterns: they account for about 20% of sectoral variation in export intensity, and are more pronounced in highly export-intensive sectors. In this context, some very micro policy actions taken by governments, which concern only one or a couple of firms, end up having non trivial aggregate consequences. This is true in particular if they impact large exporters. One question that arises against this backdrop is: do governments see benefits in targeting individual firms rather than whole industries, when implementing various policies? Indeed, governments do take policy actions that are sometimes very narrow and appear tailor-made to target individual firms rather than industries. In particular, antitrust regulation, antidumping policies, and international sanctions all target large individual foreign firms.¹

In this paper, we study the rationale for and consequences of such “granular” policies. We are particularly interested in the impact such national policies may have in a global economy. To do so, we adopt the quantitative model of trade with granular firms developed and estimated in [Gaubert and Itskhoki \(2020\)](#). We use our model to study the general equilibrium implications of these policies in a granular open economy, both on the welfare of the home country and that of its trade partners. Across sectors, the model features classic Ricardian forces as in [Dornbusch, Fischer, and Samuelson](#); crucially, within sectors, it features a discrete (but potentially large) number of heterogeneous firms, who are oligopolistically competitive. The model is quantified to match patterns of domestic sales and exports of French manufacturing firms. In particular, the distribution of firm size is very skewed, so that some large firms have sectoral market shares well within the two digits even in sectors comprised of a large number of firms. We use this framework to characterize the qualitative and quantitative properties of various government interventions, as well as compute the optimal ones.

We first shed light on merger policy, by studying the potential merger of two domestic firms who are leaders in their sector. We find that the desirability of such a merger, from the perspective of the home government, depends crucially on how open the economy is. In general, mergers lead to some cost savings and productivity gains on the one hand; but they also lead to an increase in monopoly power, which reduces overall efficiency and also leads to a transfer of surplus from consumers to producers. In a relatively closed economy,

¹Recent examples of international antitrust regulations are the 2007 case of the European Commission (EC) against Microsoft Corporation and the 2017 fine imposed by the EC on Google. A very recent case of a granular trade war is [the 292% tariff](#) imposed by the US on a particular jet produced by the Canadian Bombardier. “Granular” tactics are particularly widespread in antidumping retaliation (see [Blonigen and Prusa 2008](#)) and international sanctions (as in the recent case of [the US against the Chinese ZTE](#)).

the efficiency loss due to an increase in monopoly power tend to make mergers undesirable. However, in a more open economy, mergers lead to a transfer of surplus to the merged home firm which is done, in part, at the expense of the foreign consumer surplus. Therefore, the more open the economy is, the more a given home merger is desirable, especially in sectors where home firms are export champions. Contrasting Home's attitude towards home mergers with Foreign's attitude towards the same merger reveals that this mechanism may lead to excessive leniency towards home mergers, at the expense of foreign trade partners. Finally, we compare unilateral optimal decisions in merger policies to the coordinated global planner's solution. Our estimated model suggests that the negative spillover effects on the Foreign country and aggregate welfare are significant quantitatively, and are particularly pronounced in the most granular and open sectors. This underlines the need for international cooperation over M&A policies to avoid excessive build-up of market power.

In a second exercise, we turn to trade policy. We are interested here in the incentives faced by governments to impose an import tariff on a single large foreign exporter, rather than imposing it to all firms in a given sector. Narrow trade restrictions and antidumping duties that target a narrow set of firms have indeed been regularly emphasized in the policy debate. While all unilateral import tariffs are welfare improving at home at the cost of the foreign (which we assume is passive and does not retaliate), the question we ask here is whether the breadth of tariff imposition matters, for revenue-equivalent tariffs. Specifically, we compare the welfare effects of imposing two different tariff schemes, a granular tariff and a sector-wide tariff, which raise the same revenue. We find that, in a granular world, a country prefers to impose an import tariff on the largest foreign exporter, rather than imposing a uniform tariff on all sectoral imports. This is particularly true in sectors where its trade partner enjoys a granular comparative advantage. The reason is that by taxing the largest foreign firm, a country takes advantage not only of the general-equilibrium terms-of-trade effect, operating via a reduction in the foreign wage rate, but also of the industry-level terms-of-trade improvement, due to a markup reduction by the large foreign firm.

Our last exercise is still work in progress. We study industrial policies that subsidize national champions. We show that they are generally suboptimal in closed economies due to excessive build-up of market power, yet become welfare improving, when used unilaterally, in open economies.

Related literature We contribute to the literature that studies the influence of large individual firms on macro aggregates (coined “granularity” in the macro literature), following [Gabaix \(2011\)](#). This literature typically focuses on the positive question of how much of aggregate fluctuations are driven by idiosyncratic productivity shocks (see e.g. [Acemoglu, Car-](#)

valho, Ozdaglar, and Tahbaz-Salehi 2012, Carvalho and Gabaix 2013, Carvalho and Grassi 2020, Grassi 2017) or how much of trade flows can be traced to firm-level shocks (see di Giovanni and Levchenko 2012, di Giovanni, Levchenko, and Méjean 2014, Gaubert and Itskhoki 2020). In contrast, we study the normative and policy implications of granularity.

Our study is related to the vast literature on trade policy and market structure, summarized in Helpman and Krugman (1989), Brander (1995) and Bagwell and Staiger (2004). In particular, early contributions that study profit-shifting motives for trade policy under oligopoly include Dixit (1984), Brander and Spencer (1984), Eaton and Grossman (1986). These papers focus on stylized models with homogeneous firms. A more recent literature explores how optimal trade policy is impacted by the presence of heterogeneous firms that self-select into exporting a la Melitz (2003) (see Demidova and Rodríguez-Clare (2013) Felbermayr, Jung, and Larch (2013), Bagwell and Lee (2020), Haaland and Venables (2016)). These analyses all rely on monopolistically competitive models and study a uniform tariff imposed on all firms. Costinot, Rodríguez-Clare, and Werning (2016) study non-uniform tariffs imposed on heterogeneous firms in a Melitz (2003) framework. They keep the focus on a setup with monopolistic competition with constant markups; in contrast, our quantitative analysis features strategic interactions between firms and endogenous markups. Our contribution to this literature is to study granular trade policy in a quantitative model of oligopolistic competition with many firms, which captures the salient features of the market structure of modern manufacturing industries.

We also contribute to the literature studying merger policy. In international trade, merger policy is often viewed as part of the toolkit that policymakers use to affect foreign market access (see e.g. Bagwell and Staiger (2004), Chapter 9), but systematic studies of merger policies in this context, reviewed in Breinlich, Nocke, and Schutz (2017), remain scarce. Early contributions, focusing typically on homogeneous firms, have expanded the study of merger from a closed economy context studied in IO to an open economy context (Barros and Cabral (1994), Head and Ries (1997)) and to considering merger and trade policy jointly (Horn and Levinsohn (2001), Richardson (1999), De Stefano and Rysman (2010)). Closer to our quantitative analysis, Breinlich, Nocke, and Schutz (2019) study, in a partial equilibrium setting, conditions under which a merger policy designed to minimize local consumer prices is too tough or too lenient from the viewpoint of the foreign country.

2 A Quantified Granular Model

In this section, we outline a granular model of international trade following [Gaubert and Itskhoki \(2020\)](#), as well as its quantification. We then discuss how the various policy experiments analyzed in subsequent sections are implemented in the model.

2.1 Theoretical Framework

We study a two-country multi-sector model, which combines a Ricardian [Dornbusch, Fischer, and Samuelson \(1977\)](#) model across sectors with the [Eaton, Kortum, and Sotelo \(2012\)](#) model of granular firms within each sector.² The two countries are Home and Foreign that represents the rest of the world. Households inelastically supply L and L^* units of labor, respectively at Home and in Foreign, with L/L^* measuring the relative size of the home country. We describe first the laissez-faire equilibrium in an economy without government policies.

Preferences There is a unit continuum of sectors $z \in [0, 1]$, with a *finite* number of product varieties $i \in \{1, \dots, K_z\}$ in each sector. The numbers of varieties offered in each country, K_z at home and K_z^* abroad, is endogenous, as described further below.

Households have Cobb-Douglas preferences over consumption in each sector, which is itself a CES aggregate of each product variety, that is:

$$Q = \exp \left\{ \int_0^1 \alpha_z \log Q_z dz \right\} \quad \text{with} \quad Q_z = \left[\sum_{i=1}^{K_z} q_{z,i}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad (1)$$

and $\int_0^1 \alpha_z dz = 1$. The parameter α_z measures expenditure shares on sector z and $\sigma > 1$ is the within-sector elasticity of substitution, common across sectors.

Using the properties of the CES demand aggregator, consumer expenditure on variety i in sector z in the home market is given by:

$$r_{z,i} \equiv p_{z,i} q_{z,i} = s_{z,i} \alpha_z Y \quad \text{with} \quad s_{z,i} \equiv \left(\frac{p_{z,i}}{P_z} \right)^{1-\sigma}, \quad (2)$$

where $p_{z,i}$ is the price of variety i in sector z , $P_z = \left[\sum_{i=1}^{K_z} p_{z,i}^{1-\sigma} \right]^{1/(1-\sigma)}$ is the sectoral price index, $s_{z,i}$ is the within-sector market share of the product variety, and Y is aggregate income (expenditure) at Home.

²The [Eaton, Kortum, and Sotelo \(2012\)](#) model is a granular version of the [Melitz \(2003\)](#) model, in its [Chaney \(2008\)](#) formulation. The model nests as special cases both the DFS-Melitz model, as firms become infinitesimal, as well as the Ricardian DFS model, as varieties of products become perfect substitutes and fixed costs tend to zero.

Production Each firm produces a distinct product variety using local labor as input. The technology has constant returns to scale:

$$y_{z,i} = \varphi_{z,i} \ell_{z,i},$$

where $\varphi_{z,i}$ denotes the productivity of the firm that produces product i in sector z . The output of the firm can be marketed domestically, as well as exported. Exports incur an iceberg trade cost $\tau \geq 1$. The marginal cost of supplying the home market is therefore constant and equal to:

$$c_{z,i} = \begin{cases} w/\varphi_{z,i}, & \text{for a home variety,} \\ \tau w^*/\varphi_{z,i}^*, & \text{for a foreign variety,} \end{cases} \quad (3)$$

where w and w^* are respectively the home and foreign wage rates. Symmetrically, the marginal cost of serving the foreign market is denoted $c_{z,i}^*$. In each market, we sort all potential sellers in increasing order of their marginal cost $c_{z,i}$ ($c_{z,i}^*$ in foreign, respectively). The index i therefore refers to the marginal cost ranking of a firm in a given market, so that the same firm is in general represented by different indexes in different markets.

To access a given market, firms have to pay a fixed cost F in units of labor of the destination country. The fixed cost is independent of the origin of the firm. As a result, the differential selection of domestic and foreign firms into the local market is driven only by iceberg trade costs, not by a differential fixed cost to access the market, to simplify equilibrium characterization.

Productivity draws We denote with M_z a potential (shadow) number of domestic products in sector z . M_z is the realization of a Poisson random variable with parameter \bar{M}_z . Each of the M_z potential entrants takes an *iid* productivity draw from a Pareto distribution with a shape parameter θ and lower bound $\underline{\varphi}_z$. Given this structure, the combined parameter:

$$T_z \equiv \bar{M}_z \cdot \underline{\varphi}_z^\theta \quad (4)$$

is a sufficient statistic that determines the expected productivity of a sector. Intuitively, a sector is more productive either if it has more potential entrants (\bar{M}_z) or if the average productivity of a potential entrant (proportional to $\underline{\varphi}_z$) is high. Symmetrically, foreign expected sectoral productivity in sector z is T_z^* , so that the ratio T_z/T_z^* determines the expected relative productivity of the two countries in sector z . It is a measure of the home's fundamental comparative advantage.

Market structure In a given market, entrants play an oligopolistic price setting game, following [Atkeson and Burstein \(2008\)](#). Firms are large in their own sectors, so that they inter-

nalize their influence on the sectoral price index P_z when they maximize profits. On the other hand, they are infinitesimal for the economy as a whole, hence take economy-wide aggregates (w, Y) as given.

We consider both a Bertrand and a Cournot oligopolistic setting.³ The Nash equilibrium in these oligopolistic games is a markup price setting rule:

$$p_{z,i} = \frac{\varepsilon_{z,i}}{\varepsilon_{z,i} - 1} \cdot c_{z,i}, \quad (5)$$

where

$$\varepsilon_{z,i} \equiv \varepsilon(s_{z,i}) = \begin{cases} \sigma(1 - s_{z,i}) + s_{z,i}, & \text{under Bertrand,} \\ [\sigma^{-1}(1 - s_{z,i}) + s_{z,i}]^{-1}, & \text{under Cournot,} \end{cases} \quad (6)$$

with the market share of the firm $s_{z,i}$ defined in (2), and $\varepsilon_{z,i} \in [1, \sigma]$ measuring the effective elasticity of residual demand for the product of the firm. Both Bertrand competition in prices and Cournot competition in quantities result in the same qualitative patterns: the elasticity of residual demand $\varepsilon_{z,i}$ decreasing in the firm's market share, so that in turn the markup $\mu_{z,i} \equiv \frac{p_{z,i}}{c_{z,i}} = \frac{\varepsilon_{z,i}}{\varepsilon_{z,i} - 1}$ increases with the firm's market share.

Given the set of entrants and their marginal costs $\{c_{z,i}\}_{i=1}^{K_z}$, the equilibrium, characterized by each firm's price and market share, is unique and has the property that prices $p_{z,i}$ increase with marginal costs $c_{z,i}$, while markups $\mu_{z,i}$ and market shares $s_{z,i}$ decrease with $c_{z,i}$. Finally, firms with higher market shares command higher profits. We turn next to solving for the endogenous set of entrants in each market.

Entry Firms enter a market if they make positive profit there, where profits from serving the home market (for instance) are given by:⁴

$$\Pi_{z,i} \equiv \Pi_z(s_{z,i}) = \frac{s_{z,i}}{\varepsilon(s_{z,i})} \alpha_z Y - wF, \quad (7)$$

where, given the markup pricing (5), elasticity $\varepsilon(s_{z,i})$ also equals the ratio of revenues $s_{z,i} \alpha_z Y$ to operating profits (before subtracting the fixed cost), and $\Pi_{z,i}$ monotonically increases in $s_{z,i}$.

The setup detailed above opens the possibility of multiplicity in entry patterns. In order

³Formally, in the case of Bertrand competition, for example, the profit maximization problem of firm i in the home market is to choose its price $p_{z,i}$ such that:

$$\Pi_{z,i} = \max_{p_{z,i}} \left\{ (p_{z,i} - c_{z,i}) \frac{p_{z,i}^{1-\sigma}}{\sum_{j=1}^{K_z} p_{z,j}^{1-\sigma}} \alpha_z Y - wF \right\},$$

taking as given the prices of its competitors $\{p_{z,j}\}_{j \neq i}$ and (w, Y) . Under Cournot, the firm instead takes the quantities of its competitors $\{q_{z,j}\}_{j \neq i}$ defined by (2) as given.

⁴Notice that due to linearity of the production function, each firm's profit maximization problem is separable across markets, and hence can be considered one market at a time.

to select a unique equilibrium, we consider a sequential entry game. Specifically, in each market separately, firms with lower marginal costs of serving the market move first and decide whether or not to enter. With this equilibrium selection, the entry game has a unique cutoff equilibrium, so that only firms with marginal costs below some cutoff enter the market.

General equilibrium is a vector of wage rates and incomes (w, w^*, Y, Y^*) , such that labor markets clear in both countries and aggregate incomes equal aggregate expenditures. In particular, in the home country

$$Y = wL + \Pi, \quad (8)$$

where Π are aggregate profits of all home firms distributed to home households:

$$\Pi = \int_0^1 \left[\sum_{i=1}^{K_z} \iota_{z,i} \Pi_z(s_{z,i}) + \sum_{i=1}^{K_z^*} (1 - \iota_{z,i}^*) \Pi_z^*(s_{z,i}^*) \right] dz, \quad (9)$$

with profit function $\Pi_z(s_{z,i})$ defined in (7); the indicator function $\iota_{z,i} \in \{0, 1\}$ is 1 if firm i is of local origin in the home market, while $\iota_{z,i}^*$ plays the same role for the foreign market.

Labor market clearing requires that the aggregate labor income wL equals the total expenditure of all firms on domestic labor:

$$wL = \int_0^1 \left[\alpha_z Y \sum_{i=1}^{K_z} \iota_{z,i} \frac{s_{z,i}}{\mu(s_{z,i})} + \alpha_z Y^* \sum_{i=1}^{K_z^*} (1 - \iota_{z,i}^*) \frac{s_{z,i}^*}{\mu(s_{z,i}^*)} + w F K_z \right] dz. \quad (10)$$

The three terms on the right-hand side of (10) respectively correspond to expenditure on domestic labor for (i) production for domestic market, (ii) production for foreign market, and (iii) entry of firms in the domestic market (irrespective of their origin). A parallel market clearing condition to (10) holds in the foreign country. We normalize $w = 1$ as numeraire.

Conditional on the sectoral equilibrium vectors $\mathbf{Z} \equiv \{K_z, \{s_{z,i}\}_{i=1}^{K_z}, K_z^*, \{s_{z,i}^*\}_{i=1}^{K_z^*}\}_{z \in [0,1]}$, the vector of general equilibrium quantities $\mathbf{X} \equiv (w, w^*, Y, Y^*)$ solves conditions (8)–(10) and their foreign counterparts.⁵ In turn, given the aggregate equilibrium vector \mathbf{X} , the solution to the entry and price-setting game in each country-sector yields the sectoral equilibrium vector \mathbf{Z} . The resulting fixed point (\mathbf{X}, \mathbf{Z}) is the equilibrium in the granular economy.

⁵One of the four aggregate equilibrium conditions is redundant by Walras Law, and is replaced by a numeraire normalization. Also note that in the closed economy conditions (8) and (10) are equivalent, and amount to $Y/w = \bar{\mu}[L - FK]$, where $K = \int_0^1 K_z dz$ is the total number of firms serving the home economy and $\bar{\mu} = [\int_0^1 \alpha_z \sum_{i=1}^{K_z} s_{z,i} / \mu(s_{z,i})]^{-1}$ is the (harmonic) average markup.

2.2 Key sectoral characteristics

In our analysis, we focus on two sector-level characteristics — a measure of the overall sectoral comparative advantage and its granular component, which reflects the contribution of idiosyncratic productivity draws of the large firms. The first is captured by the sectoral *home share* abroad:

$$\Lambda_z^* \equiv \frac{X_z}{\alpha_z Y^*} = \sum_{i=1}^{K_z^*} (1 - \iota_{z,i}^*) s_{z,i}^*, \quad (11)$$

where X_z is total home exports and $\alpha_z Y^*$ is total foreign absorption in sector z . Therefore, Λ_z^* equals the cumulative market share of all home firms serving the foreign market, capturing the export stance of home in sector z . It is a random variable that depends on market shares, and hence realized productivity draws, of the home firms in sector z in the foreign market. Conveniently, this statistics is an observable measure of the effective comparative advantage of home in sector z , irrespective of the source of this comparative advantage.

In our granular model, this sectoral outcome Λ_z^* is driven by two forces: an expected value based on sectoral characteristics and the contribution of idiosyncratic firm draws around this expected value. Specifically, the expectation of firms' productivities in the sector is formally pinned down by the fundamental comparative advantage of the sector, T_z/T_z^* . The *expected* home share abroad conditional on fundamental comparative advantage T_z/T_z^* is given by:

$$\mathbb{E}\{\Lambda_z^*\} = \frac{1}{1 + (\tau\omega)^\theta \cdot T_z^*/T_z}. \quad (12)$$

Across sectors, expectation of home share abroad is increasing in T_z/T_z^* , while in all sectors export shares increase with a reduction in the trade costs τ and relative wages $\omega \equiv w/w^*$.

In addition, because our model accounts for granularity, the home share Λ_z^* is also driven by the idiosyncratic realizations of firm productivities. To the extent that these realizations are variant and exhibit fat tails, they can feature strong outliers that affect realized sectoral productivity. As a result, the realized export stance of a country may differ markedly from its expected value, driven by a handful of firms with outsized productivity draws. We therefore decompose Λ_z^* into its expected value based on sectoral characteristics and the contribution of idiosyncratic firm draws around this expected value:

$$\Lambda_z^* = \mathbb{E}\{\Lambda_z^*\} + \Gamma_z^* \quad (13)$$

The statistic $\Gamma_z^* \equiv \Lambda_z^* - \mathbb{E}\{\Lambda_z^*\}$ is a *granular residual* that captures departures from the population mean, driven by outstanding firms, for the realized sectoral comparative advantage.

In what follows, we are interested in understanding how the economic consequences of various policies vary in the cross-section of sectors. In particular, we study the differential in-

Table 1: Estimated parameters

Parameter	Estimate	Std. error	Auxiliary variables	
σ	5	—	$\kappa = \frac{\theta}{\sigma-1}$	1.096
θ	4.382	0.195	w/w^*	1.130
τ	1.342	0.101	L^*/L	1.932
$F (\times 10^5)$	1.179	0.252	Y^*/Y	1.710
μ_T	0.095	0.150	Π/Y	0.180
σ_T	1.394	0.190		

centives faced by policy makers when designing policies for the export champions of a country at the sectoral level (high overall Λ_z^*) and at the individual firm level (high granular Γ_z^*). Note that the realizations of Γ_z^* and Λ_z^* are positively correlated across sectors, as Γ_z^* is one component of the overall comparative advantage, and in the estimated model it accounts for 20–30% of variation in Λ_z^* .

2.3 Model quantification

The model is estimated to match salient features of French firm-level data on domestic and export sales, and in particular their variation across 119 manufacturing industries, as discussed in detail in [Gaubert and Itskhoki \(2020\)](#). To quantify the model, we first parameterize the distribution of fundamental comparative advantage across sectors as:

$$\log(T_z/T_z^*) \sim \mathcal{N}(\mu_T, \sigma_T^2), \quad (14)$$

that is a log-normal distribution with parameters μ_T controlling the home’s absolute advantage and σ_T shaping the strength of the fundamental comparative advantage. With this parametrization, in order to quantify the model, we need to estimate the six parameters of the model, $\Theta \equiv (\sigma, \theta, \tau, F, \mu_T, \sigma_T)$, as well as calibrate the Cobb-Douglas shares α_z . We describe the estimation procedure and the moment fit in [Appendix C](#), and we report the estimated parameters in [Table 1](#), which we use as benchmark in our quantitative policy counterfactuals.

We point out a few features of the estimated parameters. First, $\kappa = \theta/(\sigma - 1)$ that controls the Pareto shape parameter of the sales distribution, and hence the strength of granular forces, is estimated to equal 1.096, corresponding to a somewhat *thinner* tail relative to Zipf’s law (see [Gabaix 2009](#)). We estimate μ_T to be positive, albeit small, implying an overall mild productivity advantage of French firms relative to their average foreign competitor, consistent with a French wage rate w which is 13% higher than that in a typical French trade partner w^* . The estimated value of $\sigma_T = 1.39$ is large, suggesting that a one standard deviation increase in fundamental comparative advantage across sectors corresponds to a four-fold increase in

the relative productivity T_z/T_z^* . We find that the iceberg trade costs are $\tau = 1.34$, broadly in line with the estimates in the literature (see [Anderson and van Wincoop 2004](#)).⁶ Finally, the model implies an aggregate share of profits in GDP (Π/Y) equal to 18%, broadly in line with the national income accounts.

3 Evaluating Granular Policies

A range of policies specifically target large firms. Our model is well suited to ask: what impact do these policies have on trade flows and welfare? Indeed, this question cannot be analyzed using standard “continuous” trade models where, even in the presence of heterogeneity, every firm is infinitesimal. In contrast, here, firms are granular and their response to policy can affect sectoral productivity and trade flows. In the rest of the paper, we explore in turn three policies: a merger between two large firms in a given sector of an open granular economy, a granular import tariff imposed on a single large foreign exporter, and an industrial policy aimed at subsidizing national champions. We outline here the general methodology we follow to compute and decompose the welfare effects of policies.

Welfare decomposition In our model, the welfare of a representative consumer at home is given by $\mathbb{W} = Y/P$, where Y is aggregate home income and $P = \exp \left\{ \int_0^1 \alpha_z \log P_z dz \right\}$ is the price index. In general, aggregate income can be decomposed as $Y = wL + \Pi + TR$, where wL is labor income, Π is aggregate profits defined in (9), and TR is government policy revenues distributed lump-sum to workers. Since labor is supplied inelastically and home wage is the numeraire, the log-change in home welfare in response to a policy can be expressed in all generality as follows:⁷

$$\hat{\mathbb{W}} \equiv d \log \frac{Y}{P} = \frac{d\Pi}{Y} + \frac{dTR}{Y} - \int_0^1 \alpha_z d \log P_z dz, \quad (15)$$

The three components in (15) correspond to the respective changes in the producer surplus, government revenues, and consumer surplus in general equilibrium.

We are interested in the general equilibrium impact of policies targeted at large firms, and in particular, in contrasting the effects they have in granular versus non-granular sectors. Given that the model features a continuum of sectors, a policy that impacts a sector in isolation

⁶The estimated model implies that France is about two times smaller than the rest of the world in terms of population. This is, of course, an abstraction of a two-country model with a common iceberg trade cost τ separating the two regions. The appropriate interpretation of L^*/L in the model is the relative size of the ROW, in which the individual countries are discounted by their economic distance to France (i.e., if countries trade little with France, their population weight is heavily discounted).

⁷Note that the change in the real wage is fully accounted for by the changes in the price level P since nominal wage $w = 1$ by our choice of the numeraire; otherwise, there would be an additional term $\frac{wL}{Y} d \log w$.

will have no aggregate effects. To go around this limitation, we study a given policy change in a positive measure of sectors Z that have similar levels of granularity and comparative advantage. The direct effect of a policy change in sector z is $\left[\frac{d\Pi_z + dTR_z}{\alpha_z Y} - d \log P_z\right] \alpha_z dz$ and has an order of magnitude $\alpha_z dz$. The general equilibrium impact of the policy on (w, w^*, Y, Y^*) is also of the order $\alpha_z dz$, which in turn affects every sector $z' \in [0, 1]$, and hence needs to be taken into account on par with the direct effect.

More concretely, we bin sectors into percentiles of granular residual Γ_z^* defined in (13) or into percentiles of realized export share Λ_z^* defined in (11). We then compute the corresponding welfare impact $\hat{W}_Z = d \log(Y/P)$ of the policy in bin Z , and report its *average* aggregate welfare effect, normalized by the size of set Z , given by:

$$\hat{W}_Z = \frac{1}{\int_{z \in Z} \alpha_z dz} \hat{W}_Z. \quad (16)$$

With this definition, in the limit as sets Z become tight around individual sectors z , the aggregate welfare change \hat{W} can be decomposed into sectoral contributions \hat{W}_z . In particular, consider a sectoral policy vector $\varsigma \equiv \{\varsigma_z\}_{z \in [0,1]}$, where ς_z characterizes policy implemented in sector z . We can then decompose the overall welfare impact of ς as a cross-sectional weighted-average of the GE welfare effects \hat{W}_z of the sectoral policies ς_z :

$$\hat{W} = \int_0^1 \alpha_z \hat{W}_z dz.$$

In this sense, by binning the sectors as in (16), we approximate the policy welfare contribution (derivative) of individual sectors, which is our measure of policy impact. We also consider the decomposition of the average welfare effects \hat{W}_Z into the contribution of changes in the consumer and producer surplus, according to (15). Given the linearity of the welfare function, the welfare impact $\hat{W}_z = 0.01$ is equivalent to a welfare effect of a 1% sectoral productivity improvement (or, equivalently, a 1% reduction in the sectoral price level holding income constant). These are units in which we report the welfare effects.

Welfare approximation To evaluate analytically the qualitative effects of policies, we consider a partial-equilibrium approximation, holding w and Y constant, with a given set of active firms K_z , that is also shutting down entry and exit. Typically both entry/exit and general equilibrium partially mute the aggregate response to policy changes without changing the direction of the overall effect, and therefore such approximation is useful for a qualitative assessment complemented with a full quantitative general equilibrium analysis. We set up this welfare approximation in a closed economy, and then show how to accommodate the open

economy and various specific policies considered below.

We consider a shock (e.g., a merger, industrial policy, or a tariff) which leads productivity $\varphi_{z,i}$ and/or markup $\mu_{z,i}$ to change for a subset of firms. We denote with $\hat{\varphi}_{z,i}$ the proportional change in productivity. The markup is endogenous and we write its proportional change as:

$$\hat{\mu}_{z,i} = \hat{\varepsilon}_{z,i} - \frac{\varkappa_{z,i}}{1 - \varkappa_{z,i}}(\hat{p}_{z,i} - \hat{P}_z), \quad (17)$$

where $\hat{\varepsilon}_{z,i}$ is an exogenous shifter (due to a change in the perceived demand elasticity $\varepsilon_{z,i}$, e.g. as a result of a merger), and the proportional change in the relative price, $\hat{p}_{z,i} - \hat{P}_z$, can be characterized as follows:

$$\hat{p}_{z,i} = \hat{\mu}_{z,i} + \hat{c}_{z,i} = (1 - \varkappa_{z,i})[\hat{\varepsilon}_{z,i} - \hat{\varphi}_{z,i}] + \varkappa_{z,i}\hat{P}_z, \quad (18)$$

Equation (18) is the log differential of (5), where $\hat{c}_{z,i} = -\hat{\varphi}_{z,i}$ since the wage rate w is held constant, and $\hat{\mu}_{z,i} \equiv d \log \frac{\varepsilon_{z,i}}{\varepsilon_{z,i}-1}$, which results in (17) since $\varepsilon_{z,i}$ is an increasing function of the market share $s_{z,i} = (p_{z,i}/P_z)^{1-\sigma}$.⁸ The coefficient $\varkappa_{z,i} \in (0, 1)$ is the strategic complementarity elasticity, which measures the response of the price to the sectoral price index P_z , and $1 - \varkappa_{z,i}$ is the cost pass-through elasticity (see [Amiti, Itskhoki, and Konings 2019](#)).

The log differential of the sectoral price index is given by:

$$\hat{P}_z = \sum_{i=1}^{K_z} s_{z,i} \hat{p}_{z,i} = \frac{1}{1 - \bar{\varkappa}_z} \sum_{i=1}^{K_z} s_{z,i} (1 - \varkappa_{z,i}) [\hat{\varepsilon}_{z,i} - \hat{\varphi}_{z,i}], \quad (19)$$

where the second equality substitutes in (18) and solves the fixed point for \hat{P}_z denoting with $\bar{\varkappa}_z \equiv \sum_{i=1}^{K_z} s_{z,i} \varkappa_{z,i}$. Note that $-\hat{P}_z$ captures the change in the consumer surplus, which declines if the weighted average of exogenous markup shifts net of productivity increases is positive, increasing the sectoral price level.

The producer surplus can be written in turn as:

$$\frac{d\Pi_z}{\alpha_z Y} = d \left[\sum_{i=1}^{K_z} s_{z,i} \left(1 - \frac{1}{\mu_{z,i}} \right) \right] = \sum_{i=1}^{K_z} \pi_{z,i} \hat{s}_{z,i} + \sum_{i=1}^{K_z} \frac{s_{z,i}}{\mu_{z,i}} \hat{\mu}_{z,i},$$

where $\pi_{z,i} \equiv \frac{\Pi_{z,i} + wF}{\alpha_z Y} = \frac{s_{z,i}}{\varepsilon_{z,i}}$, as follows from (7). By definition of market shares, $\sum_{i=1}^{K_z} s_{z,i} \hat{s}_{z,i} = 0$, and therefore $\sum_{i=1}^{K_z} \pi_{z,i} \hat{s}_{z,i}$ is a covariance term. Focusing on the first order effects, we have:

$$\frac{d\Pi_z}{\alpha_z Y} \approx \sum_{i=1}^{K_z} \frac{s_{z,i}}{\mu_{z,i}} \hat{\mu}_{z,i} = \sum_{i=1}^{K_z} \frac{s_{z,i}}{\mu_{z,i}} \left[\hat{\varphi}_{z,i} + (1 - \varkappa_{z,i})[\hat{\varepsilon}_{z,i} - \hat{\varphi}_{z,i}] + \varkappa_{z,i} \hat{P}_z \right], \quad (20)$$

⁸Note that the second equality in (18) uses (17) and solves the price-setting fixed point for $p_{z,i}$.

where we substituted in (17) and (18). That is, producers capture a portion of the surplus from increased productivity, as they pass-through the rest with lower prices to consumers, as well as benefit from increased markups. Note that the direct increase in markup is captured by $(1 - \kappa_{z,i})\hat{\varepsilon}_{z,i}$ for the firms directly affected by the shock, while $\kappa_{z,i}\hat{P}_z$ is the indirect markup effect from strategic complementarities experienced by every firm in the market.

Combining (19) and (20), we can write the change in the combined surplus (welfare) as:

$$\hat{W}_z = \frac{d\Pi_z}{\alpha_z Y} - \hat{P}_z = \sum_{i=1}^{K_z} \frac{s_{z,i}}{\mu_{z,i}} \hat{\varphi}_{z,i} - \frac{\bar{\mu}_z - 1}{\bar{\mu}_z} \hat{P}_z, \quad (21)$$

with \hat{P}_z given by (19) and $\bar{\mu}_z > 1$ measuring the average markup in the economy.⁹ Intuitively, (21) splits the overall change in welfare into the direct effect of the average productivity improvement (weighted by the cost shares $s_{z,i}/\mu_{z,i}$) and the redistributive effect from the movement in the price level in the presence of markup pricing $\bar{\mu}_z > 1$ (a wedge between consumer prices and producer costs resulting in a Harberger's triangle deadweight loss). Indeed, a change in \hat{P}_z has a non-zero welfare effect, as it redistributes surplus between consumers and producers, yet starting from an already distorted equilibrium. In an economy without markups ($\mu_{z,i} \equiv 1$), the overall welfare effect reduces to simply the average improvement in productivity, $\hat{W}_z = \sum_{i=1}^{K_z} s_{z,i} \hat{\varphi}_{z,i}$. This summarizes the approach we take to the welfare approximation that we use in the context of specific policies in an open economy below.

4 Mergers & Acquisitions and Antitrust

We are now ready to analyze quantitatively a series of policies typically targeted at large firms in the economy. An obvious example is antitrust policy that regulates mergers of firms with significant market power. Merger policy is often viewed as part of a toolkit that policymakers use to affect foreign market access (see e.g. [Bagwell and Staiger 2004](#), Chapter 9). Specifically, we analyze the consequences, on domestic and foreign welfare, of allowing two leading domestic firms in a given sector to merge. To shed light on international spillovers from merger policy in a granular open economy, we then discuss optimal merger policies, both unilaterally from the perspective of the host versus the foreign country, and from the point of view of a utilitarian global planner.

⁹Specifically, $\bar{\mu}_z = \left[\frac{\bar{\kappa}_z}{\bar{\mu}'_z} + \frac{1 - \bar{\kappa}_z}{\bar{\mu}''_z} \right]^{-1}$, where $\bar{\mu}'_z \equiv \frac{\sum_{i=1}^{K_z} s_{z,i} \kappa_{z,i}}{\sum_{i=1}^{K_z} \frac{s_{z,i}}{\mu_{z,i}} \kappa_{z,i}}$ and $\bar{\mu}''_z = \frac{\sum_{i=1}^{K_z} s_{z,i} (1 - \kappa_{z,i}) [\hat{\varepsilon}_{z,i} - \hat{\varphi}_{z,i}]}{\sum_{i=1}^{K_z} \frac{s_{z,i}}{\mu_{z,i}} (1 - \kappa_{z,i}) [\hat{\varepsilon}_{z,i} - \hat{\varphi}_{z,i}]}$.

4.1 Merger analysis: setup

We are particularly interested in the merger of *large* firms: under which conditions can they increase welfare at home? Since these large domestic firms are typically also large exporters (Melitz 2003), a merger of large domestic firms is likely to have nontrivial implications for the foreign country as well: does Foreign face an incentive to block the mergers of domestic superstar firms? How much does trade openness shape these considerations? We take a stab at these questions by simulating the hypothetical merger of the two top domestic firms in a series of sectors. We study quantitatively the welfare implications of such mergers, and study how they systematically vary with the level of comparative advantage and degree of granularity of the sectors we analyze.

We model mergers as follow. Typically, firms engage in merger and acquisition activities in order to realize cost synergies, to increase efficiency by transferring knowledge and best practices between entities, but also to increase their market power; when evaluating the desirability of such mergers, the policy maker typically trades-off such risk of an increase in market power in the economy against the efficiency benefits associated with the merger. We capture these channels in the following way. First, we assume that, upon merging, the merged entity continues to produce the two distinct product lines previously produced by the two separate firms, but that it now sets markups to maximize the total profit of the merged entity. As a consequence, the new firm's market power and markups increase.¹⁰

Second, we assume that the merger leads to efficiency gains, as it allows the merged entity to optimize both on fixed and variable costs. Specifically, we assume that the merged firm incurs only one fixed cost rather than two; we note however that this assumption is largely inconsequential quantitatively, as fixed costs are a very small fraction of revenues for the largest firms. We also allow the merger to generate productivity spillovers between the merged entities: the less-productive product may inherit some of the efficiency of the more productive one, with the strength of the spillover governed by the parameter $\varrho \in [0, 1]$. Specifically, the productivity of the post-merger product, $\varphi'_{z,2}$, is parameterized as:

$$\varphi'_{z,2} = \varrho \varphi_{z,1} + (1 - \varrho) \varphi_{z,2},$$

where $\varphi_{z,i}$ is the productivity of the pre-merger firm $i \in \{1, 2\}$.

Given this post-merger market structure and productivity distribution, we solve for the new entry game and price-setting equilibrium in each sector. To get at the full welfare effect of a merger, we simulate it for a positive measure of sectors $z \in Z$, and recompute the corresponding general equilibrium, as discussed in Section 3.

¹⁰Given CES demand, the optimal markups are the same for both products and depend on their cumulative market share $s'_{z,1} + s'_{z,2}$ in the new equilibrium, according to the same functional relationship as in (5) and (6).

In our baseline analysis, we consider an economy where $\tau = 1.34$, as estimated in Table 1 for France, and hence reflecting a fairly high level of trade openness typical of modern developed economies. Harder to calibrate is the value of the productivity spillover: we choose a value of $\varrho = 0.35$, that is a merger allows to close a third of the productivity gap between the first and the second product. With this value of the spillover parameter we can illustrate some of the most interesting policy trade-offs at play. We report the sensitivity of the analysis to alternative value of the merger spillovers below. The rest of the model parameters correspond to their benchmark values described in Table 1. We use Cournot competition for concreteness, and the results under Bertrand competition are qualitatively similar.

4.2 Welfare implications of a merger

The welfare consequences — at home and abroad — of merging the two top domestic firms in a given sector are considerably different across sectors, as we report in Figure 1. We split all sectors into deciles $z \in Z$ based on their domestic comparative advantage (Λ_z^* ; left panel) and its granular component (Γ_z^* ; right panel), and report the welfare impact \hat{W}_Z (defined in (16)), for Home and Foreign, from a merger of the top two home firms in each sector in these deciles.

For the bottom 80% of sectors, be it in terms of comparative advantage Λ_z^* or in terms of granularity Γ_z^* , both Home and Foreign benefit from these top mergers, due to the productivity spillover. In each case, welfare gains are more modest for Foreign than for Home, as market shares of the home firms are smaller in the foreign market due to trade costs. In stark contrast, in sectors with the strongest (top 20%) comparative advantage or level of granularity, welfare gains are considerably larger for Home and significantly negative for Foreign.

What are the mechanisms behind the starkly heterogeneous results of Figure 1? A merger has two effect on economic outcomes. First, it increases productivity due to the spillover ϱ , which results in lower consumer prices. However, it also increases market power and markups, which results in higher consumer prices and higher firm profits. This second effect has also an international distributive consequence in an open economy, as part of the reduction in foreign consumer surplus is redistributed towards increased home profits (producer surplus). This is one reason for differential welfare effects in the two countries from the same merger.

More specifically, in low- Λ_z^* or Γ_z^* sectors, the largest firms tend to account for relatively small market shares, and especially so in the foreign market. As a result, the market power increase from a merger is less important in such sectors, as in the model the markup is a convex function of the market share, consistent with the empirical evidence of decreasing cost pass-through with firm size (see [Amiti, Itskhoki, and Konings 2019](#)). As a result the positive productivity effect (which scales proportionally with market shares) dominates the relatively more modest increase in market power (which is convex in market shares). Furthermore,

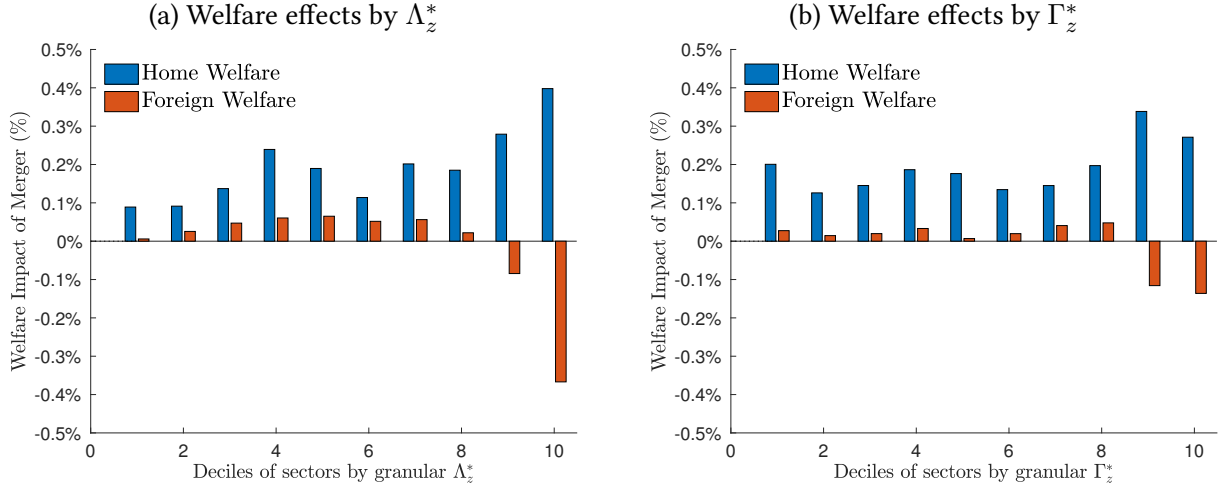


Figure 1: Welfare effects of mergers

Note: Welfare impact \hat{W}_Z , as defined in (16), at home and abroad, of a merger of the top two domestic firms, by deciles Z of sectors $z \in [0, 1]$ sorted by overall home comparative advantage Λ_z^* and its granular component Γ_z^* .

these net gains are felt more strongly at home, where the top two domestic firms have a more significant presence than abroad.

Matters are different in the top sectors in terms of both granularity and overall comparative advantage. In the foreign country, top domestic mergers now have significant negative welfare effects. The increased monopoly power of the top domestic firm destroys consumer surplus, and is not sufficiently compensated by productivity gains of the merged firm. When the increase in markups dominates the reduction in costs, foreign consumers lose surplus in view of increasing prices. The same effect plays out in the home market as well, and there is a decline in consumer surplus too, but, crucially, it is more than offset by the increase in the producer surplus of the merged domestic firms. Indeed, the merged entity increases profits both in the home and the foreign market. This is why mergers in an open economy have a “beggar-thy-neighbor” spillover effect on the trading partners. This suggests a rationale for governments in open countries to be overly lenient towards mergers, especially in more granular industries with strong comparative advantage, a topic we explore further below.

Overall, the welfare consequences of a top domestic merger are not trivial. In this baseline calibration, a merger between the top two firms in sectors with the strongest comparative advantage has the same welfare effect as a uniform 0.4% sectoral productivity increase at home and 0.35% sectoral productivity reduction abroad for every firm serving the market.

Of course, these numbers hinge importantly on the strength of the productivity spillover ρ . We report how these numbers are sensitive to the intensity of cost savings in the merger in the left panel of Figure 2, focusing on top 20% of sectors in terms of export share Λ_z^* . In short, increasing ρ increases welfare gains from merger, both for Home and Foreign, but it does so

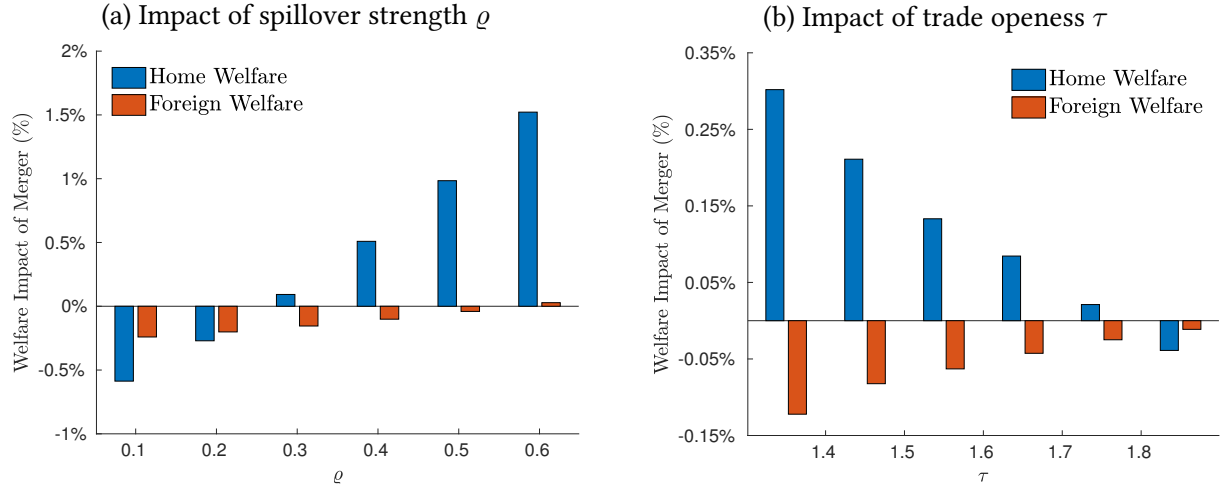


Figure 2: Impact of top mergers in high export intensity sectors: role of ρ and τ

Note: Welfare impact of mergers in top 20% sectors in terms of export intensity Λ_z^* . See notes to Figure 1.

much more strongly for Home, where the market shares of these firms are higher. If spillovers are limited, the mergers are particularly detrimental at home, as the dominant impact comes from the increased market power and markups of the combined entity. The effect is also negative abroad, but is less pronounced. In contrast, as productivity spillover growth larger, Home starts to benefit from mergers very strongly, while Foreign benefits much less and only when spillovers are very strong. The reason again is the transfer of foreign consumer surplus into the profits of domestic firms.

The level of trade openness, governed by iceberg trade cost τ , is also crucial to understand the results in Figure 1. At the current level of openness, or for even more open economies, the mergers we simulate in high export intensive sectors tend to be beneficial at home but detrimental abroad. In contrast, if we now study countries that are sufficiently closed (large τ), we see in the right panel of Figure 2 that the consumer loss at home will outweigh the producer gain, resulting in a net loss in domestic welfare, while effects on foreign welfare are still negative, yet very limited, because countries trade little. This highlights the essential role of trade openness for the welfare analysis of granular mergers. Domestic mergers are particularly contentious abroad if they happen in granular comparative advantage sectors, especially if countries have a strong trade relationship.

4.3 Optimal M&A policy

We have seen above that countries may be impacted quite differently by the mergers of large firms. In practice, large mergers of multinational firms may be evaluated by the antitrust authority of each country in which those firms operate, not only in the country that host

the headquarters of these firms. We therefore turn to examining the incentives and optimal policies of each country when examining merger proposals.

We call “merger policy” a simple binary policy option of whether or not to allow a merger. In order to cover all the cases of interest using a common notation, we index with λ the weight on the foreign welfare, $\hat{W}_z + \lambda \hat{W}_z^*$, where \hat{W}_z is the domestic welfare impact of a merger defined in (16) and \hat{W}_z^* is the corresponding welfare impact abroad. The case with $\lambda = 0$ captures the objective function of the Home government, $\lambda = \infty$ is the objective function of Foreign, and $\lambda \in [0, \infty]$ captures the objective of a global planner that puts a relative weight of λ on the rest of the world (vs Home).

We define a corresponding merger policy function, $m_\lambda(z)$. It is an indicator function defined over the set of sectors $z \in [0, 1]$, with $m_\lambda(z) = 1$ iff the merger of the top two Home firms in z is beneficial in equilibrium, that is:

$$m_\lambda(z) \equiv \mathbf{1}\{\hat{W}_z + \lambda \hat{W}_z^* > 0\}.$$

Note that $\lambda = L^*/L$ corresponds to a utilitarian global planner. Note that we focus on the merger of the Home firms only.¹¹ We study the differential properties of $m_\lambda(z)$ across objective functions parametrized by λ , tracing out the international spillover effects of domestic antitrust policy. We again focus on our baseline case with productivity spillover $\varrho = 0.35$.

Figure 3 plots a first broad summary of the results. Specifically, it shows the fraction of sectors where a merger is beneficial ($\int_0^1 m_\lambda(z) dz$), for Home, for Foreign and for a utilitarian global planner, $\lambda \in \{0, \infty, L^*/L\}$. These statistics change as a function of trade openness τ , ranging from a fully open economy to a very closed one. Interestingly, in an economy that is closed enough (high τ), the foreign country benefits from most domestic mergers, as their market power impact is very limit abroad.¹² In contrast, the home government blocks the majority of mergers when the economy is closed to international trade, as mergers in the closed economy have a particularly strong market power effect, as market shares are high due to lacking competition from foreign firms. As trade costs decline and home and foreign trade more with each other, the domestic government is more favorable towards the mergers, while they become increasing less welcome abroad. In particular, a utilitarian global planner would

¹¹We mostly do it for technical reasons, as it is computationally easier to focus on a single fixed point problem in terms of $m_\lambda(z)$ and world GE vector (w, w^*, Y, Y^*) , rather than simultaneously solving for a Nash equilibrium in both $m_0(z)$ at home and $m_\infty(z)$ abroad. However, such focus likely leads to little loss of generality in our analysis, as we anticipate the optimal M&A policy to be approximately a dominant strategy independently of the M&A policy abroad. We leave this conjecture for future quantitative evaluation. Another interpretation is that we focus on M&A in a large country, which trades with a continuum of small open economies, where M&A within each individual country is quantitatively inconsequential.

¹²Note the difference with Figure 2, where we focused on top-20% of sectors in terms of home export share, while in this analysis we look at merger policy across all sectors.

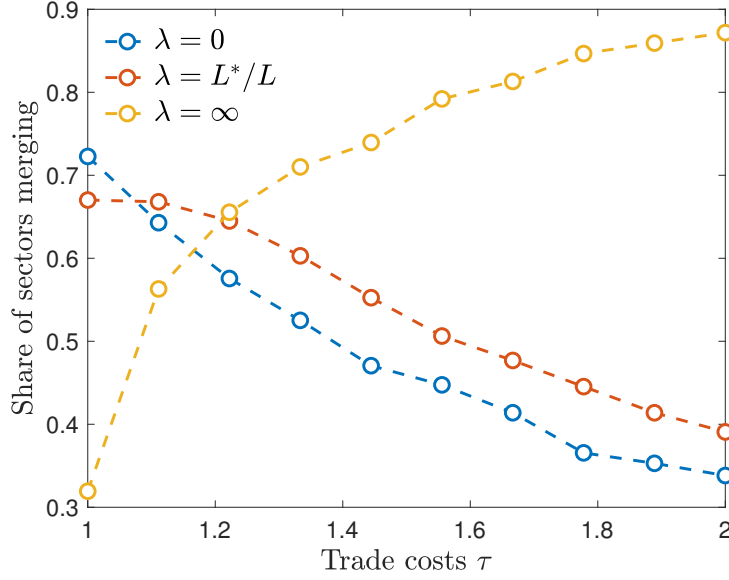


Figure 3: Optimal M&A policy depends on trade openness

Note: share of sectors where merger at the top leads to positive welfare effects — for the local government, the foreign government, and a utilitarian world planner, that is $\int_0^1 m_\lambda(z) dz$ for $\lambda \in \{0, \infty, L^*/L\}$.

approve fewer mergers than the domestic planner when economies are very open.

The summary statistics in Figure 3, however, hide dramatic heterogeneity in the subsets of sectors in which the various planners would see mergers with a favorable eye. This is the main source of international conflict of interest over the merger policy, which we illustrate in Figure 4. As above, we sort sectors into deciles of comparative advantage Λ_z^* in the left panel and deciles of granularity Γ_z^* in the right panel, and use the baseline value of trade costs $\tau = 1.34$. We combine together the bottom five deciles, as there is little variation across these lower deciles. We then plot the fractions of sectors within each bin for which the domestic ($\lambda = 0$) and foreign ($\lambda = \infty$) planners would favor a merger.

Two main insights emerge from the cross sectional analysis. The right panel indicates that both Home and Foreign dislike mergers in granular sectors, in relative terms. While they allow the majority of mergers in sectors without large granular firms, the home would only allow mergers in 2 out of 5 sectors and foreign in 1 out of 4 sectors in the top decile of granularity. The reason is the excessive market power that firms generally hold in such sectors, which is particularly costly for consumer surplus abroad without being compensated by any direct gains in the producer surplus.

The pattern in the left panel of Figure 3 is starkly different. From the perspective of home welfare, proportion of favorable mergers to a first approximation does not depend on sectoral comparative advantage: the home planner favors roughly 50–60% of mergers independently of Λ_z^* . In contrast, the foreign's approval of domestic mergers decreases sharply with home's

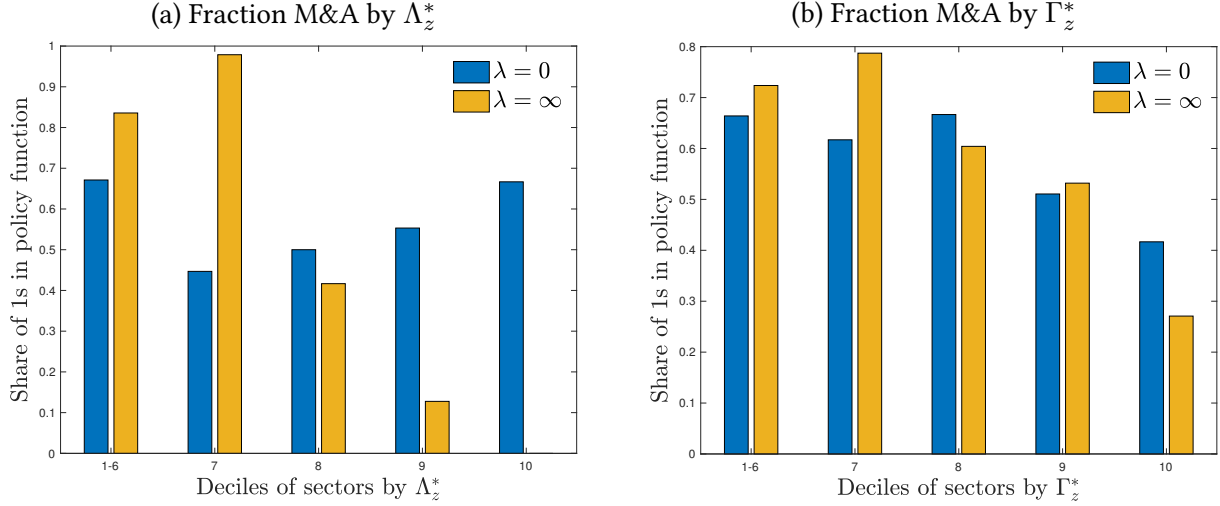


Figure 4: Optimal M&A policy across sectors

Note: Figure plots the fraction of sectors in which home mergers are welfare improving at home ($\lambda = 0$) and abroad ($\lambda = \infty$), by deciles of sectors in terms of home comparative advantage Λ_z^* and its granular component Γ_z^* . The bottom five deciles are binned together. Baseline parameters $\varrho = 0.35$ and $\tau = 1.34$.

comparative advantage — while the foreign favors most mergers in comparative disadvantage sectors, it would want to block *every* merger in the top decile of home comparative advantage.

This pattern is not surprising: as we discussed, home mergers in the comparative advantage sectors disproportionately hurt the foreign country due to the transfer of the consumer surplus. This, in turn, is the reason why home favors many mergers in high comparative advantage sectors. Nonetheless, such mergers can also be costly in the domestic economy due to their excessive concentration of market power, and this is the reason why the home planner would not favor all such mergers. Appendix Figure A1 illustrates these conflicting welfare effects — sectors with strong comparative advantage have both large consumer surplus losses at home, which are however offset by large producer surplus gains.

Overall, this analysis suggests an important role for international cooperation over M&A policies in open economies to avoid excessive build-up of market power. In the opposite case, each country will pursue excessive mergers, in particular in sectors with strong comparative advantage, resulting in Prisoner-dilemma-like equilibrium. Furthermore, the beggar-thy-neighbor distributional conflict makes some mergers unfavorable for foreign, even in situations when a unilateral global planner may favor them. This suggests that the home decision maker is typically too lenient to domestic mergers in comparative advantage sectors, while the foreign decision maker would try to always block such mergers, sometimes at the cost to multilateral efficiency.

Welfare approximation The general equilibrium quantitative effects discussed above can be conveniently illustrated using our partial equilibrium approximation introduced in (19)–(20) in Section 3. Since merger affects directly the productivity and markups of only the largest combined home firm, the direct consumer surplus effect is given by $\hat{P}_z = s_{z,1} \frac{1-\kappa_{z,1}}{1-\bar{\kappa}_z} [\hat{\varepsilon}_{z,1} - \hat{\varphi}_{z,1}]$, where $s_{z,1}$ corresponds to ex post market share of the merged firm, and $\hat{\varepsilon}_{z,1}$ and $\hat{\varphi}_{z,1}$ capture the markup and productivity shifts correspondingly. A parallel expression captures the change in the consumer surplus abroad, with $s_{z,1}^*$ and $\hat{\varepsilon}_{z,1}^*$ now capturing the combined market share and markup change in the foreign market. In general, due to trade costs, $s_{z,1}^* < s_{z,1}$, and thus we expect $\hat{\varepsilon}_{z,1} > \hat{\varepsilon}_{z,1}^*$, explaining both why welfare effects in Foreign are typically muted and less adverse in most sectors.

In most tradable granular sectors, however, the fall in Home’s consumer surplus is partially or fully compensated by the direct increase in the producer surplus of home firms serving both home and foreign markets, $\frac{d\Pi_z}{\alpha_z Y} \approx \frac{s_{z,1}}{\mu_{z,1}} [\kappa_{z,1} \hat{\varphi}_{z,1} + (1 - \kappa_{z,1}) \hat{\varepsilon}_{z,1}] + \frac{s_{z,1}^*}{\mu_{z,1}^*} [\kappa_{z,1}^* \hat{\varphi}_{z,1}^* + (1 - \kappa_{z,1}^*) \hat{\varepsilon}_{z,1}^*]$.¹³ The presence of this direct producer gain for home firms, absent for foreign firms, explains the international distributional conflict over domestic mergers between the home and the foreign government. This conflict is particularly pronounced when $s_{z,1}^*$ and $\hat{\varphi}_{z,1}^*$ is large in the foreign market, namely in sectors with pronounced domestic comparative advantage and granularity, provided the trade costs are low.

5 Granular Tariffs

Another aspect of government policies that may affect and target large firms is trade policy. In fact, trade policy is often so narrow that it appears tailor-made to target individual firms rather than industries. Such “granular” tactics are particularly widespread in antidumping retaliation (see [Blonigen and Prusa 2008](#)) and international sanctions (as in the recent case of [the US against the Chinese ZTE](#)). A recent example of such a granular trade war is [the 292% tariff](#) imposed by the US on a particular jet produced by the Canadian Bombardier.

Our quantified model is well-suited to analyze what are economic incentives faced by the Home government that could justify imposing such granular tariffs, rather than industry-wide ones, putting aside the legal ramifications of such decision. Specifically, we study two alternative tariff policies in an open granular economy. We contrast a *uniform* tariff $\bar{\zeta}_z$, levied on all imports in sector z , and a *granular* tariff $\hat{\zeta}_{z,1}$, levied exclusively on the largest foreign exporter in the same sector. For concreteness, we compare a 1% uniform tariff with a granular tariff $\hat{\zeta}_{z,1}$ that generates the same tariff revenue at the sectoral level.

¹³Recall that in addition there are second-round effects of markup adjustment by all firms, home and foreign, captured in (20) by $\kappa_{z,i} \hat{P}_z$.

Intuitively, a government may prefer a granular over a uniform tariff for two reasons. First, it might be more attractive in terms of domestic political economy, though perhaps more complex to impose legally. We leave aside these considerations in our analysis. Second, it might be a more effective policy at extracting surplus from foreign producers and improving the home country's terms of trade at a smaller expense in terms of the loss of consumer surplus at home. As we shall shortly see, this latter consideration is indeed the case in our granular model with oligopolistic competition.

General setup Consider firm-specific tariffs $\{\varsigma_{z,i}\}$ imposed by the home government on foreign firms i in sector z . In particular, if a foreign firm generates revenues $r_{z,i} = s_{z,i}\alpha_z Y$ in the home market, it needs to pay $\varsigma_{z,i}r_{z,i}$ to the home government, and takes home $(1 - \varsigma_{z,i})r_{z,i}$.

Then the foreign firm's profit maximization in the home market is:

$$\Pi_{z,i} = \max_{p_{z,i}} [(1 - \varsigma_{z,i})p_{z,i} - c_{z,i}] p_{z,i}^{-\sigma} \frac{\alpha_z Y}{\sum_{j=1}^{K_z} p_{z,j}^{1-\sigma}} - wF,$$

with the solution for prices and markups as if its costs were increased to $c'_{z,i} = c_{z,i}/(1 - \varsigma_{z,i})$, or equivalently productivity draw reduced to $\varphi'_{z,i} = \varphi_{z,i}(1 - \varsigma_{z,i})$. We denote the resulting market shares $\{s'_{z,i}\}$, and the resulting profits for foreign firms:

$$\Pi'_{z,i} = (1 - \varsigma_{z,i})\alpha_z Y \frac{s'_{z,i}}{\varepsilon(s'_{z,i})} - wF,$$

where $\varepsilon(s)$ is as before, defined in (6).¹⁴

The expenditure on foreign goods in the home market is still given by $s'_{z,i}\alpha_z Y$, and the foreign share is still $\Lambda'_z = \sum_{i=1}^{K_z} (1 - \iota'_{z,i})s'_{z,i}$. However now, the home government collects $TR_z = \alpha_z Y \sum_{i=1}^{K_z} (1 - \iota'_{z,i})\varsigma_{z,i}s'_{z,i}$, while the rest, $\Lambda'_z\alpha_z Y - TR_z$, is the revenue of foreign firms (total export revenue). We describe the resulting changes to the general equilibrium conditions in Appendix B.

The resulting change in the home welfare from the tariff policy $\{\varsigma_{z,i}\}$ is described by the general expression in (15), which allows to decompose the overall welfare effect into the tariff revenue, and changes in the consumer and producer surplus respectively. We again calculate the “welfare derivatives” \hat{W}_z , as described in (16), by studying the tariff policy in a subset of

¹⁴Note that a non-uniform tax creates a computational challenge for the entry game, as the effective condition for entry becomes $\alpha_z Y \frac{s'_{z,i}}{\varepsilon(s'_{z,i})} \geq \frac{wF}{1 - \varsigma_{z,i}}$, and ranking firms on $c'_{z,i}$ (and hence $s'_{z,i}$ does not guarantee monotonicity of $\Pi'_{z,i}$). We assume, however, that for a small enough $\varsigma_{z,i}$ (as is the case in our simulation), the approximation $F/(1 - \varsigma_{z,i}) \approx F$ is sufficiently accurate in the entry game. Indeed, recall that entry is a discrete zero-one decision, in which most entering firms are inframarginal, with $\Pi'_{z,i} \gg 0$ due to Zipf's law. An alternative interpretation is that local entry costs wF are deductible from taxable export revenues.

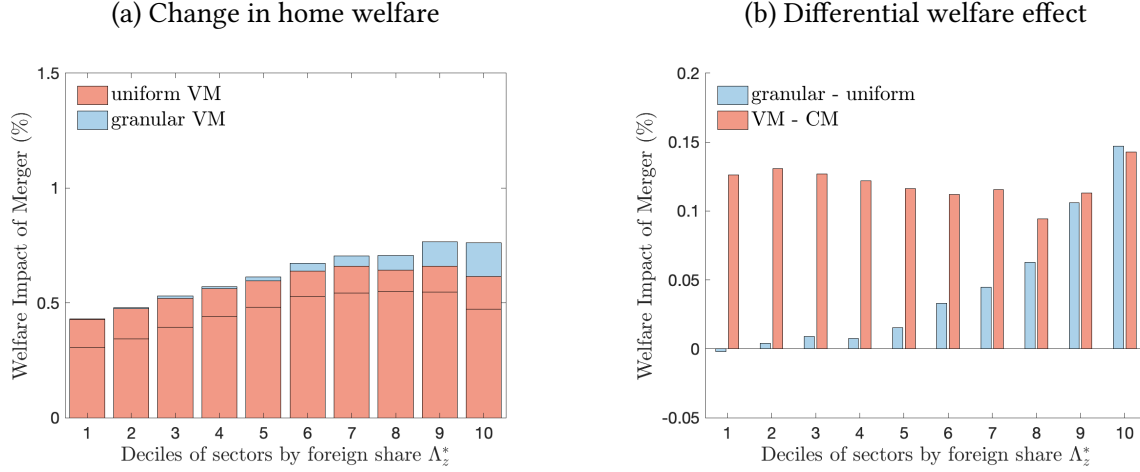


Figure 5: Granular tariff: welfare effect

Note: The welfare effect \hat{W}_Z of tariff policy by deciles of foreign comparative advantage Λ_z . The left panel plots \hat{W}_Z in the case of uniform tariff (red bars) and granular tariff (sum of red and blue bars) respectively, while the lines inside the red bars indicate the welfare effect in a counterfactual environment with constant markups. The right panel plots differential welfare effects of the uniform tariff over the counterfactual case with constant markups (red bars), as well as the differential welfare effect of the granular vs the uniform tariff (blue bars).

sectors with similar characteristics. This is necessary to appropriately capture the general equilibrium effects from the sectoral tariffs, which are of the same order of magnitude as the direct sectoral effect on the overall welfare.¹⁵

Results Using the general framework above, we now compare two alternative tariff policies: (a) a uniform tariff with $\varsigma_{z,i} = \bar{\varsigma}_z = 0.01$ for all foreign firms i selling in the home market in sector z ; and (b) a granular tariff $\hat{\varsigma}_{z,1}$ levied only on the largest foreign exporter to the home market in sector z , with the value of the tariff given by $\hat{\varsigma}_{z,1}s'_{z,1} = \bar{\varsigma}_z\bar{\Lambda}'_z$, that is the same as in case (a). We report here the results when competition takes the Cournot form, and the results for Bertrand competition are qualitatively similar, though quantitatively smaller as markups in that case are less variable. Figure 5 compares the domestic welfare effects of each policy, contrasting sectors with different comparative advantage of the foreign country, Λ_z .¹⁶ We find that imposing a granular tariff has clear welfare benefits from the point of view of Home, all the more as Foreign has a large penetration at home.

To understand the forces behind these results, we decompose these domestic welfare effects in Figure 6: namely, we report its three components, following equation (15) — tariff revenues,

¹⁵The direct effect is first order within the sector, but comes with a weight $\alpha_z dz$ in aggregation, while the indirect general equilibrium effect (on wages and price levels) is also of the order $\alpha_z dz$, via general equilibrium conditions. We implement the policy in a subset of sectors $z \in Z$ with cumulative expenditure weight $\int_{z \in Z} \alpha_z dz$, and scale the resulting welfare effect by $\int_{z \in Z} \alpha_z dz$, as in (16).

¹⁶Results are very similar when we group sectors by their level of Foreign granularity Γ_z .

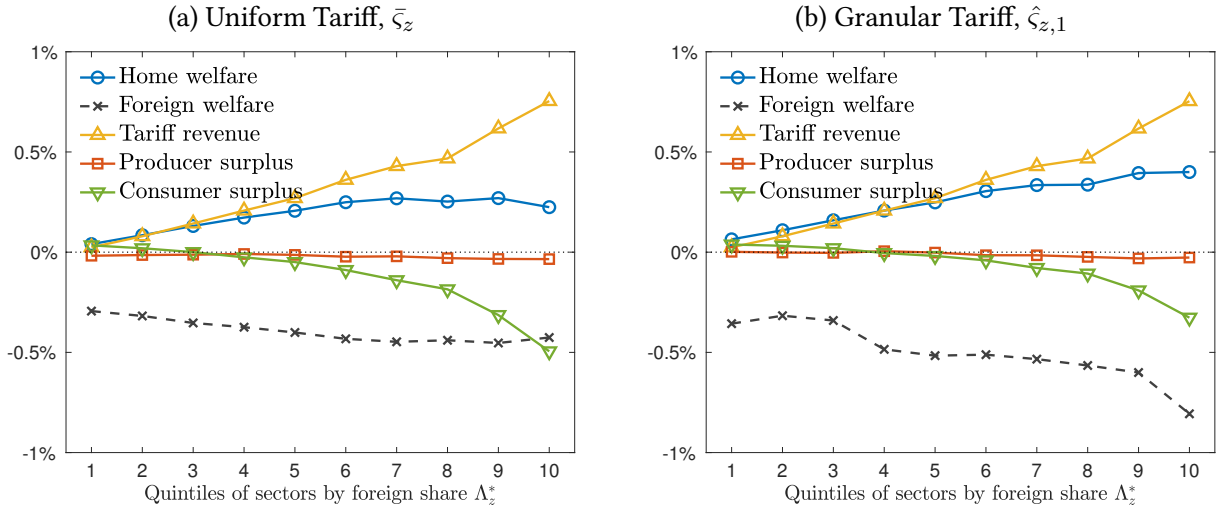


Figure 6: Welfare effect of a tariff: Decomposition

Note: Decomposition of the welfare effect \hat{W}_Z at home into three components according to (15), and the welfare effect abroad, from a uniform and a granular tariff, by deciles of sectors split by foreign comparative advantage.

consumer surplus, and producer surplus. A clear picture emerges. First, by construction, tariff revenues are equivalent between a granular and a uniform tariff in all sectors and increase proportionally with the ex post sectoral import share Λ_z' . Second, the impact of these tariffs on Domestic producer surplus are small, as these effects are indirect. Therefore, third, the major driver of the net welfare effects is the loss in domestic consumer surplus that these policies generate, offsetting a large part of the gains from tariff revenues. This is where the difference between uniform and granular tariffs plays a key role: home consumers are hurt more by the uniform tariff levied on all foreign exporters than by the granular tariff concentrated on a single largest foreign exporter.

The reason is that with a granular tariff, the pass-through of the import tariff to consumer prices at home is much lower. This is because the tariff hits the largest Foreign firm, which has typically a two digit market share at home, in high Λ_z and/or high Γ_z sectors. This firm exerts significant market power at home, and absorbs part of the increase in marginal costs coming from the tariff by lowering its markups. Overall, the increase in prices is therefore lower for home consumers than if the tariff had hit all firms in the sector. Put differently, the leading firm prices strategically to keep its market share and reduces its markup significantly in response to a loss in relative efficiency; if all firms are subject to a tariff, instead, their relative stance is largely unchanged, so that markup adjustments are minor. This makes granular tariff an efficient policy tool for the home government — it allows to extract same tariff revenue at minimal cost to consumer surplus.

Notice that this effect is not present in [Costinot, Rodríguez-Clare, and Werning \(2016\)](#),

who study a constant markup setup, with a continuum of heterogeneous firms pricing at constant markup and thus exhibiting complete pass-through of the tariff. We find that the pass-through effect, which operates even in partial equilibrium, is quantitatively large — the loss in consumer surplus is cut by more than a half in the most import intensive sectors.

The pass-through effect is present even when we apply a uniform tariff to the sector, so long as markups are variable and foreign share $\Lambda_z < 1$. This is seen in Figure 5 where we report, for comparison, the case of the uniform tariff in a counterfactual environment with constant markups set at the monopolistically competitive level, $\frac{\sigma}{\sigma-1}$. Of course, this effect is further reinforced by the granular tariff, as opposed to the uniform tariff. The former targets the firm that has the lowest pass-through rate in the sector. Therefore, consumer surplus losses are minimized, for an equivalent tariff revenue.

The right panel of Figure 5 plots the additional welfare effects from variable markups under a uniform tariff and the further gains from the granular tariff. About a third of the welfare effect is due to variable markups, which is roughly stable across all sectors. In contrast, the gains from granular tariff are only present in sectors with substantial foreign comparative advantage — otherwise even the largest foreign firm has a small market share in the domestic market, insufficient to result in a significantly lower tariff pass-through. In sectors with large foreign firms, the gains from the granular tariff are large in absolute terms, accounting for an additional third of the tariff's welfare effect.

This analysis suggests that variable markups and incomplete pass-through of large firms is a crucial quantitative component of the optimal tariff analysis. Furthermore, governments likely have strong economic incentives to target only the largest foreign firms with tariffs, which is an effective way of extracting foreign producer surplus with minimal consequences for domestic consumer surplus.

Welfare approximation Finally, we complement the quantitative general equilibrium analysis above with the partial equilibrium approximation introduced in (19)–(20) in Section 3, slightly modified to accommodate tariffs. In particular, the additional component of \hat{W}_z is government tariff revenue, $\frac{dTR_z}{\alpha_z \Lambda_z} = \bar{\varsigma}_z \Lambda_z$ (equivalent under granular tariff $\hat{\varsigma}_{z,1}$), levied on foreign exporters who in turn partially pass it through to home consumers. From the point of view of home consumers, a tariff is equivalent to an adverse productivity shock to foreign products, $\hat{\varphi}_{z,i} = -\varsigma_{z,i}$, and there is no direct effect on the home's producer surplus (only a second-round effect on their markups). As a result, using (19), the decline in consumer surplus is given by $\hat{P}_z = \frac{1-\bar{\varkappa}_z^F}{1-\bar{\varkappa}_z} \bar{\varsigma}_z \Lambda_z$, where $1-\bar{\varkappa}_z^F$ is the average pass-through rate of the tariff among the affected foreign firms.¹⁷ This erosion of consumer surplus is partially offset by an increase in producer

¹⁷Thus, $\bar{\varkappa}_z^F$ is equal to $\frac{1}{\Lambda_z} \sum_{i=1}^{K_z} (1 - \iota_{z,i}) s_{z,i} \varkappa_{z,i}$ under the uniform tariff and $\varkappa_{z,1}^F$ under the granular tariff.

surplus, as home firms increase their markups and prices by $\kappa_{z,i}\hat{P}_z$ according to (18).

Therefore, the net effect of a tariff on home welfare is given by:

$$\hat{W}_z = \bar{\varsigma}_z \Lambda_z - \left[1 - (1 - \Lambda_z) \frac{\bar{\kappa}_z^H}{\bar{\mu}_z^H} \right] \hat{P}_z = \bar{\varsigma}_z \Lambda_z \left[\frac{\bar{\kappa}_z^F - \bar{\kappa}_z}{1 - \bar{\kappa}_z} + (1 - \Lambda_z) \frac{\bar{\kappa}_z^H}{\bar{\mu}_z^H} \frac{1 - \bar{\kappa}_z^F}{1 - \bar{\kappa}_z} \right],$$

where $\bar{\kappa}_z^H$ and $\bar{\mu}_z^H$ are the average strategic complementarity elasticity and the average markup among domestic firms. Therefore, $\bar{\kappa}_z^F > \bar{\kappa}_z$ is sufficient (yet not necessary) for a positive welfare effect of an import tariff on home welfare.¹⁸ This condition is equivalent to the pass-through rate being lower among foreign exporters relative to an average firm serving the home market, $1 - \bar{\kappa}_z^F < 1 - \bar{\kappa}_z$. We generally expect this condition to hold due to the Melitz selection force of larger firms into the foreign market and pass-through being lower among the firms with greater market shares. Adopting a granular tariff maximizes $\bar{\kappa}_z^F$ and minimizes the tariff pass-through $1 - \bar{\kappa}_z^F$, thus delivering larger welfare gains to home, especially in sectors where the largest foreign firm commands a substantial market share in the home market.

This discussion requires two remarks. First, it focus exclusively on partial equilibrium effects, thus omitting the standard general equilibrium terms-of-trade effect, which is usually the focus of the optimal tariff argument. The welfare effect of a tariff in our partial equilibrium approximation would be altogether absent if the model were to feature constant markups and complete pass-through, $\kappa_{z,i} = 0$ for every firm. Our numerical analysis above combines both partial and general equilibrium forces, thus delivering a complete quantitative evaluation of the welfare consequences of different tariffs. Second, welfare consequences of a tariff are always negative if the impact on foreign countries, in particular on foreign producers, is taken into account. Indeed, the loss in foreign producer surplus is greater than the welfare benefit at home due to the increased Harberger's triangle and deadweight loss, independently of the type of the tariff adopted.

6 Industrial Policy in a Granular World

We consider an extension of the model, in which firms can make a one-time investment in boosting their productivity. We characterize under which circumstances the planner wants to subsidize such investment in comparative advantage sectors and by the industrial champions — the largest firms in the economy.

¹⁸For example, when $\bar{\kappa}_z^H = \bar{\kappa}_z^F = \bar{\kappa}_z > 0$ (e.g., if $\kappa_{z,i} > 0$ and constant across all firms), $\hat{W}_z > 0$ provided that $\Lambda_z \in (0, 1)$. Indeed, tax pass-through is incomplete iff the tax is levied on some but not all firms in the industry and firms feature incomplete cost pass-through. In contrast, if $\bar{\kappa}_z^F = 0$ and $\bar{\kappa}_z^H > 0$, the partial equilibrium effect of a tariff on home welfare is negative, as consumers bear out the full cost of the tariff on foreign firms and in addition home firms raise their prices in response to increased prices of foreign competitors.

Setup economy Consider an extension of the granular open economy in which a firm in sector z can invest

$$v_{z,i} = \kappa \alpha_z \frac{\varphi_{z,i}^\delta}{\sum_{j=1}^{K_z} \varphi_{z,j}^\delta} x_{z,i} \quad (22)$$

to boost its productivity from $\varphi_{z,i}$ to $\varphi'_{z,i} = \varphi_{z,i}(1+x_{z,i})^{1/\zeta}$ for some $\kappa, \delta > 0$ and $\zeta > \sigma - 1$. We are interested in the home planner's allocation of investment $\{v_{z,i}\}$ and associated productivity boosts $\{x_{z,i}\}$, and for concreteness limit the planners budget to V , so that

$$\int_{z \in [0,1]} \left(\sum_{i=1}^{K_z} v_{z,i} \right) dz \leq V. \quad (23)$$

In a counterfactual closed economy with constant markups, a planner is simply maximizing aggregate productivity given by:

$$\Phi = \exp \int_{z \in [0,1]} \frac{\alpha_z}{\sigma - 1} \log \left(\sum_{i=1}^{K_z} \varphi_{z,i}^{\sigma-1} (1+x_{z,i})^{\frac{\sigma-1}{\zeta}} \right) dz. \quad (24)$$

In open economy with variable markup pricing, the planner chooses $\{v_{z,i}, x_{z,i}\}$ to maximize the change in welfare $\hat{\mathbb{W}} = d \log(Y/P)$, as defined in (15), subject to (22) and (23).

For concreteness we consider a total budget $V = \frac{\kappa \zeta}{100}$ so that a uniform 1% productivity improvement ($x_{z,i} \equiv \bar{x} = \zeta/100$) is feasible for every firm in every sector.¹⁹ We ask the question under which circumstances the planner would indeed favor such uniform allocation of investment and when does she prefer to skew the investment towards certain sectors and firms, in particular national champions.

Welfare approximation Consider first a closed economy, using our partial equilibrium approximation developed in Section 3. The log productivity improvement is given $\hat{\varphi}_{z,i} \equiv \log(\varphi'_{z,i}/\varphi_{z,i}) \approx x_{z,i}/\zeta$. Using (19) and (20), we have the reduction in sectoral price levels and the increase in profits given by:

$$\hat{P}_z = -\frac{1}{1 - \bar{\kappa}_z} \sum_{i=1}^{K_z} s_{z,i} (1 - \kappa_{z,i}) \hat{\varphi}_{z,i} \quad \text{and} \quad \frac{d\Pi_z}{\alpha_z Y} = \sum_{i=1}^{K_z} \frac{s_{z,i}}{\mu_{z,i}} \kappa_{z,i} (\hat{\varphi}_{z,i} + \hat{P}_z), \quad (25)$$

as the firms increase their markups by $\hat{\mu}_{z,i} = \kappa_{z,i}(\hat{\varphi}_{z,i} + \hat{P}_z)$ according to (18). Therefore, the overall welfare effect can be evaluated as:

$$\hat{W}_z = \frac{d\Pi_z}{\alpha_z Y} - \hat{P}_z = \sum_{i=1}^{K_z} s_{z,i} \hat{\varphi}_{z,i} - \text{cov} \left(\hat{\varphi}_{z,i}, \frac{\kappa_{z,i}}{\varepsilon_{z,i}} + \frac{\bar{\kappa}_z}{1 - \bar{\kappa}_z} \frac{\kappa_{z,i}}{\bar{\varepsilon}_z} \right), \quad (26)$$

¹⁹Note that in this case, $\int_{z \in [0,1]} \left(\sum_{i=1}^{K_z} v_{z,i} \right) dz = \kappa \bar{x}$, as $\sum_{i=1}^{K_z} \frac{\varphi_{z,i}^\delta}{\sum_{j=1}^{K_z} \varphi_{z,j}^\delta} = 1$ and $\int_{z \in [0,1]} \alpha_z dz = 1$.

where the covariance term is market-share weighted.

Equation (26) has a number of implications. First, in a counterfactual economy with constant markups, that is with $\varkappa_{z,i} \equiv 0$, the distribution of productivity boosts across firms (and sectors) does not matter, and a sufficient statistic is the average productivity growth, $\sum_{i=1}^{K_z} s_{z,i} \hat{\varphi}_{z,i}$. This is a version of the Hulten's theorem. As a result, the planner should simply maximize the aggregate productivity (24) subject to her budget constraint (23). By inspecting this problem, it is optimal to have $\hat{\varphi}_{z,i}$ common across all firms ($x_{z,i} = \bar{x}$ for all firms) when $\delta = \sigma - 1$ in (22), while a smaller (larger) δ favors investment into the largest (smallest) firms. In what follows, we focus on the case of $\delta = \sigma - 1$, which establishes an indifference benchmark in a counterfactual closed economy with constant markups, whereby the planner is indifferent on the margin which firms should receive the productivity boost. Indeed, per unit of investment expenditure, this results in the same aggregate productivity gains independent of the details of the allocation.

Second, when markups are variable, both $\varkappa_{z,i}$ and $\varkappa_{z,i}/\varepsilon_{z,i}$ are increasing in the firm's market share $s_{z,i}$, as larger firms have both a greater strategic complementarity elasticity $\varkappa_{z,i}$ and a smaller elasticity of demand $\varepsilon_{z,i}$. Therefore, the planner can make the covariance term in (26) negative by allocating $\hat{\varphi}_{z,i}$ towards the smaller firms. If, in addition, $\delta = \sigma - 1$, the increase in the average productivity does not depend on the allocation of investments on the margin, as discussed above, and thus the preferences of the planner are shaped by the negative of the covariance term in (26). As a result the planner favors investment to increase productivity of the smallest firms. This result is intuitive, as such investment allows the smaller firms to catch up with the larger firms, thus eroding the monopoly power of the larger firms and bringing down the average markup in the closed economy. This reduces the deadweight loss and results in greater welfare gains for the same increase in the average productivity across firms. Another way to see this from (25) is that smaller firms have a greater pass-through $1 - \varkappa_{z,i}$ of their productivity gains into reduction of consumer prices, while the larger firms retain a larger share $\varkappa_{z,i}$ of productivity improvement by increasing their markups, which has a proportionally smaller (by a factor of $1/\mu_{z,i}$) effect on aggregate welfare.

To summarize, other things equal, the planner favors productivity gains by smaller firms in a closed economy with variable markups. That is, in such an economy, the planner would adopt a policy opposite to the policy of national champions and granular firms, as such firms are a source of the greatest monopoly distortions, which limit the aggregate welfare gains from increasing productivity. Matters are different, however, in an open economy, where gains in producer surplus abroad may become the goal of the policy, in which case large firms with low pass-through of productivity gains into foreign consumer prices may become the target of industrial policies of building national champions in sectors of comparative advantage. We

leave this hypothesis for a quantitative evaluation.

7 Conclusion

Granular firms play a pivotal role in international trade. The granular structure of the world economy offers powerful incentives for governments to adopt trade and industrial policies targeted at individual firms, creating negative international spillovers, which needs to be addressed with international coordination mechanisms such as WTO. Analyzing the role of granular firms and their location decisions in determining the productivity and growth trajectories of individual cities (e.g., the decisions of Microsoft to move from Albuquerque to Seattle in 1979) is another fascinating question that we leave for future research.

A Additional Figures

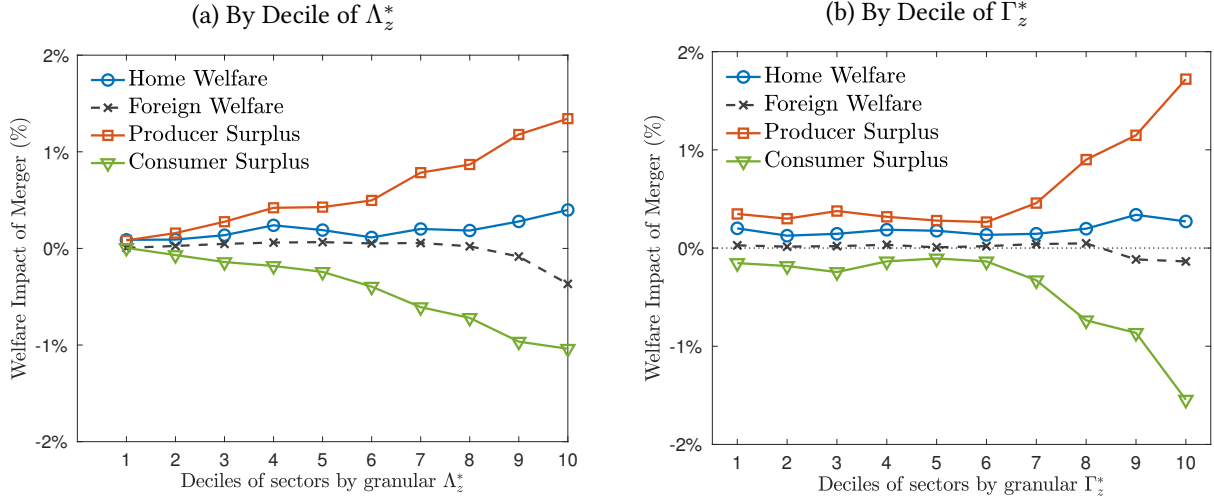


Figure A1: Welfare effects of a merger: Decomposition into producer and consumer surplus

Note: Decomposition of home welfare effects from the merger policy (see Figures 1 and 4).

B Theory Appendix

Foreign share Consider the foreign share Λ_z defined in (11). We reproduce

$$\Lambda_z = \sum_{i=1}^{K_z} (1 - \iota_{z,i}) s_{z,i},$$

where $\iota_{z,i}$ is an indicator for whether the firm is of home origin. There is no analytical characterization for the distribution of $s_{z,i}$, which are complex transformation of the realized productivity vector, which relies both on the price setting and entry outcomes (e.g., see (2), (5) and (7)). Nonetheless, following EKS, we can prove that the conditional distributions of $s_{z,i} | \iota_{z,i} = 1$ and $s_{z,i} | \iota_{z,i} = 0$ are the same, i.e. the distribution of $s_{z,i}$ is symmetric for firms of home and foreign origin, and hence the expectation of Λ_z simply equals the unconditional expectation that any entrant is of foreign origin (i.e., the relative extensive margin of entry into the home market).

The formal argument proceeds in two steps (all expectations $\mathbb{E}_T\{\cdot\}$ are conditional on the realization of fundamental productivity T_z and T_z^* , which are hence treated as parameters):

1. For any $s > 0$, $\mathbb{E}_T\{\iota_{z,i} | s_{z,i} > s\} = \mathbb{P}_T\{\iota_{z,i} = 1 | s_{z,i} > s\} = \frac{T_z w^\theta}{T_z w^\theta + T_z^* (\tau w^*)^\theta} = 1 - \Phi_z$, as defined in (12). Hence, $\mathbb{E}_T\{\iota_{z,i} | s_{z,i} > s\}$ does not depend on s , and $\mathbb{E}_T\{\iota_{z,i} | s_{z,i}\} = \mathbb{E}_T \iota_{z,i}$. See a sketch of a proof below.

$$2. \mathbb{E}_T \Lambda_z = \sum_{i=1}^{K_z} \mathbb{E}_T \{(1 - \iota_{z,i}) s_{z,i}\} = \sum_{i=1}^{K_z} \mathbb{E}_T \{s_{z,i} \cdot \mathbb{E}_T \{1 - \iota_{z,i} | s_{z,i}\}\} = \Phi_z \sum_{i=1}^{K_z} \mathbb{E}_T s_{z,i} = \Phi_z, \\ \text{since } \mathbb{E}_T \left\{ \sum_{i=1}^{K_z} s_{z,i} \right\} = \mathbb{E}_T \{1\} = 1, \text{ and where the third equality uses property 1.}$$

Property 1 follow from the Poisson-Pareto productivity draw structure and the application of the Bayes' formula. Indeed, in a given sectoral equilibrium, $s_{z,i}$ decreases with the cost of the firm $c_{z,i}$, which in turn decreases with the firm productivity ($\varphi_{z,i}$ if the firm is home and $\varphi_{z,i}^*$ if the firm is foreign; see (3)). Given the productivity draw structure, the number of home firms with productivity above φ is a Poisson random variable with parameter $\varphi^{-\theta} T_z$, and symmetrically for the foreign firms. Consequently, the number of home and foreign firms with a cost below c are independent Poisson random variables with parameters $(w/c)^{-\theta} T_z$ and $(\tau w^*/c)^{-\theta} T_z^*$, respectively. Therefore, we can calculate:

$$\mathbb{P}_T \{\iota_{z,i} = 1 | s_{z,i} > s\} = \mathbb{P}_T \{\iota_{z,i} = 1 | c_{z,i} < c\} \\ = \frac{\mathbb{P}_T \{c_{z,i} < c, \iota_{z,i} = 1\}}{\sum_{\iota \in \{0,1\}} \mathbb{P}_T \{c_{z,i} < c, \iota_{z,i} = \iota\}} = \frac{(w/c)^{-\theta} T_z}{(w/c)^{-\theta} T_z + (\tau w^*/c)^{-\theta} T_z^*} = 1 - \Phi_z.$$

Therefore, we conclude that indeed $\mathbb{E}_T \Lambda_z = \Phi_z$, and the granular residual $\Gamma_z = \Lambda_z - \Phi_z$ is zero in expectation for any sector z (see (12) and (??)).

Equilibrium system We reproduce here the full general equilibrium system of the granular model, which consists of the aggregate budget constraints and labor market clearing in both countries. Using (7) and (9), we write the home country budget $Y = wL + \Pi$ constraint as:

$$Y = wL + Y(1 - \Lambda) \frac{\bar{\mu}_H - 1}{\bar{\mu}_H} - wF K_H + Y^* \Lambda^* \frac{\bar{\mu}_H^* - 1}{\bar{\mu}_H^*} - w^* F^* K_H^*, \quad (\text{A1})$$

where

$$K_H = \int_0^1 \left[\sum_{i=1}^{K_z} \iota_{z,i} \right] dz, \\ K_H^* = \int_0^1 \left[\sum_{i=1}^{K_z^*} (1 - \iota_{z,i}^*) \right] dz, \\ 1 - \Lambda = \int_0^1 \alpha_z (1 - \Lambda_z) dz = \int_0^1 \alpha_z \left[\sum_{i=1}^{K_z} \iota_{z,i} s_{z,i} \right] dz, \\ \Lambda^* = \int_0^1 \alpha_z \Lambda_z^* dz = \int_0^1 \alpha_z \left[\sum_{i=1}^{K_z^*} (1 - \iota_{z,i}^*) s_{z,i}^* \right] dz, \\ \frac{1}{\bar{\mu}_H} = \frac{1}{1 - \Lambda} \int_0^1 \alpha_z \left[\sum_{i=1}^{K_z} \iota_{z,i} \frac{s_{z,i}}{\mu(s_{z,i})} \right] dz, \\ \frac{1}{\bar{\mu}_H^*} = \frac{1}{\Lambda^*} \int_0^1 \alpha_z \left[\sum_{i=1}^{K_z^*} (1 - \iota_{z,i}^*) \frac{s_{z,i}^*}{\mu(s_{z,i}^*)} \right] dz,$$

where $\mu(s) = \frac{\varepsilon(s)}{\varepsilon(s)-1}$ and $\varepsilon(s) = \sigma(1-s) + s$, as defined in (5). Note that:

- K_H and K_H^* are the total numbers of the home firms selling in the home and foreign markets respectively, across all industries;
- $1-\Lambda$ and Λ^* are the average shares of the home firm sales in aggregate home and foreign expenditure Y and Y^* respectively;
- $\bar{\mu}_H$ and $\bar{\mu}_H^*$ are the (harmonic) average markups of the home firms in the home and foreign markets respectively, and hence $(\bar{\mu}_H - 1)/\bar{\mu}_H$ and $(\bar{\mu}_H^* - 1)/\bar{\mu}_H^*$ are the average shares of operating profits in aggregate revenues of the home firms in the home and foreign markets respectively, since $\frac{\mu(s_{z,i})-1}{\mu(s_{z,i})} = \frac{p_{z,i}-c_{z,i}}{p_{z,i}}$ for a firm with market share $s_{z,i}$.

A similar equation defines foreign budget $Y^* = w^*L^* + \Pi^*$, which we write as:

$$Y^* = w^*L^* + Y^*(1-\Lambda^*)\frac{\bar{\mu}_F^* - 1}{\bar{\mu}_F^*} - w^*F^*K_F^* + Y\Lambda\frac{\bar{\mu}_F - 1}{\bar{\mu}_F} - wFK_F, \quad (\text{A2})$$

with K_F^* , K_F , $\bar{\mu}_F^*$ and $\bar{\mu}_F$ defined by analogy with the respective variables for home firms.

Now consider the home labor market clearing condition in expenditure terms (10), which we write as:

$$wL = wFK + Y(1-\Lambda)\frac{1}{\bar{\mu}_H} + Y^*\Lambda^*\frac{1}{\bar{\mu}_H^*}, \quad (\text{A3})$$

where

$$K = K_H + K_F = \int_0^1 K_z dz$$

is the total entry of firms in the home market across all sectors. A symmetric labor market clearing condition for foreign is:

$$w^*L^* = w^*F^*K^* + Y^*(1-\Lambda^*)\frac{1}{\bar{\mu}_F^*} + Y\Lambda\frac{1}{\bar{\mu}_F}, \quad (\text{A4})$$

where $K^* = K_H^* + K_F^*$ is the total entry of firms in the foreign market across all sectors.

It is immediate to verify that the equilibrium system (A1)–(A4) has the following properties:

1. It is linear in the general equilibrium vector (w, w^*, Y, Y^*) conditional on the vector

$$(\Lambda, \Lambda^*, K_H, K_H^*, K_F, K_F^*, K, K^*, \bar{\mu}_H, \bar{\mu}_H^*, \bar{\mu}_F, \bar{\mu}_F^*),$$

which depends on the outcome of the partial equilibrium $\{K_z, K_z^*, \{s_{z,i}\}_{i=1}^{K_z}, \{s_{z,i}^*\}_{i=1}^{K_z^*}\}_{z \in [0,1]}$.

2. It is linearly dependent, so that any of the four equations follow from the other three. Normalizing $w = 1$ and dropping any of the equations (for example (A2)) results in a linearly independent system of three equations in three unknown (w^*, Y, Y^*) with a

unique solution.

3. Substituting in labor market clearing (A3) into the budget constraint (A1) (or equivalently (A4) into (A2)) results in the current account balance condition (which in general differs from the trade balance $NX = \Lambda^*Y^* - \Lambda Y$):

$$\Lambda Y - wFK_F = Y^*\Lambda^* - w^*F^*K_H^*. \quad (\text{A5})$$

The equilibrium system can be represented by system of three linearly independent equations (A3)–(A5). Note the similarity and differences of this equilibrium system with a corresponding system in the continuous model (??)–(?). In particular, due to discreteness and variable markups, the shares of labor income and profits in aggregate income are no longer constants $(\sigma\kappa - 1)/(\sigma\kappa)$ and $1/(\sigma\kappa)$.

Finally, using the same strategy we used to prove that $\mathbb{E}_T\Lambda_z = \Phi_z$ above, we can show that

$$\Lambda = \frac{K_F}{K_H + K_F} = \Phi = \int_0^1 \alpha_z \Phi_z dz \quad \text{and} \quad \Lambda^* = \frac{K_H^*}{K_H^* + K_F^*} = \Phi^* = \int_0^1 \alpha_z \Phi_z^* dz,$$

where the integrals of Φ_z and Φ_z^* can be viewed as expectations taken over the joint distribution of $(\alpha_z, T_z/T_z^*)$. As α_z and T_z/T_z^* are assumed independent, the values of Φ and Φ^* depend only on the parameters θ , τ and (μ_T, σ_T) of the distribution of T_z/T_z^* . Using this result, we can simplify the equilibrium system. For example, conditions (A1) and (A5) can be rewritten as:

$$Y = wL + (1 - \Phi) \left[Y \frac{\bar{\mu}_H - 1}{\bar{\mu}_H} - wFK \right] + \Phi^* \left[Y^* \frac{\bar{\mu}_H^* - 1}{\bar{\mu}_H^*} - w^*F^*K^* \right],$$

$$\Phi[Y - wFK] = \Phi^*[Y^* - w^*F^*K^*],$$

which corresponds to the expression in footnote ??. Lastly, note that in a closed economy $\Phi = \Phi^* = 0$, and therefore the country budget constraint (A1) becomes $Y = \bar{\mu}w[L - FK]$, as we have it in footnote 5.

Granular tariff

Consider firm-specific tariffs $\{\varsigma_{z,i}\}$ imposed by the home government on foreign firms i in sector z . In particular, if a foreign firm generates revenues $r_{z,i} = s_{z,i}\alpha_z Y$ in the home market, it needs to pay $\varsigma_{z,i}r_{z,i}$ to the home government, and takes home $(1 - \varsigma_{z,i})r_{z,i}$.

Then the foreign firm's profit maximization in the home market is:

$$\Pi_{z,i} = \max_{p_{z,i}} [(1 - \varsigma_{z,i})p_{z,i} - c_{z,i}] p_{z,i}^{-\sigma} \frac{\alpha_z Y}{\sum_{j=1}^{K_z} p_{z,j}^{1-\sigma}} - wF,$$

with the solution for prices and markups as if its costs were increased to $c'_{z,i} = c_{z,i}/(1 - \varsigma_{z,i})$, or equivalently productivity draw reduced to $\varphi'_{z,i} = \varphi_{z,i}(1 - \varsigma_{z,i})$. We denote the resulting market shares $\{s'_{z,i}\}$, and the resulting profits for foreign firms:

$$\Pi'_{z,i} = (1 - \varsigma_{z,i})\alpha_z Y \frac{s'_{z,i}}{\varepsilon(s'_{z,i})} - wF,$$

where $\varepsilon(s) = s + \sigma(1 - s)$ is as before.²⁰

The expenditure on foreign goods in the home market is still given by $s'_{z,i}\alpha_z Y$, and the foreign share is still $\Lambda'_z = \sum_{i=1}^{K'_z} (1 - l'_{z,i})s'_{z,i}$. However now, the home government collects $TR_z = \alpha_z Y \sum_{i=1}^{K'_z} (1 - l'_{z,i})\varsigma_{z,i}s'_{z,i}$, while the rest $(\Lambda'_z \alpha_z Y - TR_z)$ is the revenue of foreign firms, which are split between production labor $\alpha_z Y \sum_{i=1}^{K'_z} (1 - l'_{z,i})(1 - \varsigma_{z,i}) \frac{s'_{z,i}}{\mu(s'_{z,i})}$, fixed costs $wF \sum_{i=1}^{K'_z} (1 - l'_{z,i})$, and profits $\sum_{i=1}^{K'_z} (1 - l'_{z,i})\Pi'_{z,i}$, where $\mu(s) = \frac{\varepsilon(s)}{\varepsilon(s)-1}$.

Therefore, there are changes to the three general equilibrium conditions (A1), (A2) and (A4). In particular, (A1) becomes:

$$Y = wL + \Pi + TR, \quad \text{where} \quad TR = Y \int_0^1 \alpha_z \left[\sum_{i=1}^{K'_z} (1 - l'_{z,i})\varsigma_{z,i}s'_{z,i} \right] dz,$$

and where the profits of home firms Π is still expressed as in (A1). Foreign income (A2) is still $Y^* = w^*L^* + \Pi^*$, but now the profits from the home market need to be adjusted for tariffs:

$$\Pi^* = Y^*(1 - \Lambda^*) \frac{\bar{\mu}_F^* - 1}{\bar{\mu}_F^*} - w^* F^* K_F^* + Y \Lambda \frac{\bar{\mu}_F - 1}{\bar{\mu}_F} - wF K_F - Y \int_0^1 \alpha_z \left[\sum_{i=1}^{K'_z} (1 - l'_{z,i}) \frac{\varsigma_{z,i}s'_{z,i}}{\varepsilon(s'_{z,i})} \right] dz.$$

Finally, the foreign labor market clearing (A4) also needs to be adjusted as follows:

$$w^*L^* = w^*F^*K^* + Y^*(1 - \Lambda^*) \frac{1}{\bar{\mu}_F^*} + Y \Lambda \frac{1}{\bar{\mu}_F} - Y \int_0^1 \alpha_z \left[\sum_{i=1}^{K'_z} (1 - l'_{z,i}) \frac{\varsigma_{z,i}s'_{z,i}}{\mu(s'_{z,i})} \right] dz.$$

Lastly, the current account balance (A5) becomes:

²⁰Note that a non-uniform tax creates a computational challenge for the entry game, as the effective condition for entry becomes $\alpha_z Y \frac{s'_{z,i}}{\varepsilon(s'_{z,i})} \geq \frac{wF}{1 - \varsigma_{z,i}}$, and ranking firms on $c'_{z,i}$ (and hence $s'_{z,i}$) does not guarantee monotonicity of $\Pi'_{z,i}$. We assume, however, that for a small enough $\varsigma_{z,i}$ (as is the case in our simulation), the approximation $F/(1 - \varsigma_{z,i}) \approx F$ is sufficient accurate in the entry game. Indeed, recall that entry is a discrete zero-one decision, in which most entering firms are inframarginal, with $\Pi'_{z,i} \gg 0$ due to the Zipf's law.

$$\Lambda Y - w F K_F - T R = Y^* \Lambda^* - w^* F^* K_H^*,$$

as now the foreign income from exporting is reduced by $T R$.

C Model Quantification

The model is estimated to match salient features of French firm-level data, as discussed in detail in [Gaubert and Itskhoki \(2020\)](#). Here we briefly summarize the main steps.

Data and estimation strategy To quantify the model, we first parameterize the distribution of fundamental comparative advantage across sectors. We assume that it is drawn from a log-normal distribution with parameters μ_T and σ_T , that is:

$$\log (T_z/T_z^*) \sim \mathcal{N}(\mu_T, \sigma_T^2). \quad (\text{A6})$$

While μ_T controls the home's absolute advantage, σ_T is the key parameter that determines the strength of the fundamental comparative advantage. We also parameterize the distribution of firm productivities in each sector: we assume that $\varphi_{z,i}$ are drawn from a Pareto distribution with shape parameter θ . This latter parameter governs the potential strength of the granular forces. Taking stock, in order to quantify the model, we therefore need to estimate the six parameters of the model, $\Theta \equiv (\sigma, \theta, \tau, F, \mu_T, \sigma_T)$, as well as the Cobb-Douglas shares α_z .

To estimate the model, we rely on French firm-level balance sheet data, which reports in particular sales at home and abroad, as well as the firm industry. This data is merged with international trade data from Comtrade, to get the aggregate imports and exports of France in each industry.

The estimation proceeds in two steps. In the first step, we calibrate Cobb-Douglas shares as equal to the sectoral expenditure shares read in the French data. We also calibrate $w/w^* = 1.13$, which corresponds to the ratio of wages in France to the average wage of its trading partners weighted by trade values. Lastly, in our estimation, we find that the elasticity of substitution σ and the productivity parameter θ are only weakly separately identified. Therefore, we choose to fix σ at a conventional value in the trade literature ($\sigma = 5$) (see [Broda and Weinstein 2006](#)), and estimate the constrained model with five parameters $\Theta' = (\theta, \tau, F, \mu_T, \sigma_T)$.

In the second step, we use simulated method of moments (SMM) to estimate the remaining parameters. We search for parameter values that minimize the distance between data moments and their model counterpart. We are particularly interested in the following salient feature of the data: (a) heterogeneity across sectors in top firm concentration, (b) heterogeneity across sectors in export stance and, importantly, (c) the extent to which the two are correlated, cap-

turing granular forces at play in shaping sectoral outcomes. To that end, we choose to target three types of moments.

Choice of moments The first set of moments are informative about the prevalence of large firms in domestic sectoral sales (point (a) above). Namely, we target the average and standard deviation across sectors of two measures of within-industry concentration (the relative sales shares of the largest and top-3 largest French firms within-industry relative to other French firms). We also target the average (log) number of French firms operating within sectors, as well as its standard deviation. This ensures that the model captures simultaneously the large number of firms operating in French sectors with the high concentration of sales. These moments particularly help inform the estimation of the fixed costs F , as well as the productivity dispersion parameter θ .

The second set of moments are informative about the intensity of sectoral exports (point (b) above). Specifically, we match the average and standard deviation of foreign shares in the French market $\tilde{\Lambda}_z$, and the French export intensity $\tilde{\Lambda}_z^{*'}$, as defined above. We also target the fraction of French sectors in which export sales exceed the overall domestic sales of French firms. These trade moments help inform the estimation of the size of the trade cost τ and the average productivity advantage of France μ_T .

Finally, the third set of moments are informative about the joint distribution of firm concentration and sectoral exports. We target four moments describing the correlation between French import and export shares and the sectoral sales concentration at home. Specifically, we target the regression coefficients of $\tilde{\Lambda}_z$ and $\tilde{\Lambda}_z^{*'}$ separately on $\tilde{s}_{z,1}$ and $\sum_{j=1}^3 \tilde{s}_{z,j}$, controlling in all four regressions for the size of the sector (log total domestic expenditure, $\log \tilde{Y}_z$). These moments are instrumental for identifying the relative importance of fundamental and granular forces in shaping trade patterns.

Estimation results The parameter values resulting from this SMM estimation is reported in Table 1, and the moment fit is reported in Appendix. Appendix Table A1 reports the model-based values of the 15 moments used in estimation, and compares them with their empirical counterparts. The table also reports the percentage contribution of each moment to the overall loss function $\mathcal{L}(\hat{\Theta})$, as we describe in Appendix ??.

Overall, the model provides a good fit to the data for the 15 moments targeted in estimation. Armed with these estimated model parameters, we are ready to proceed to a quantitative evaluation of various policies in a granular environment.

Table A1: Moments used in SMM estimation

Moments				Data, $\tilde{\mathbf{m}}$	Model, $\bar{\mathcal{M}}(\hat{\Theta})$	Loss (%)
1.	Log number of firms, mean	$\log \tilde{M}_z$		5.631	5.429	1.9
2.	— st. dev.			1.451	1.230	3.9
3.	Top-firm sales share, mean	$\tilde{s}_{z,1}$		0.197	0.205	3.0
4.	— st. dev.			0.178	0.148	4.5
5.	Top-3 sales share, mean	$\sum_{j=1}^3 \tilde{s}_{z,j}$		0.356	0.343	2.0
6.	— st. dev.			0.241	0.176	12.2
7.	Imports/dom. sales, mean	$\tilde{\Lambda}_z$		0.365	0.354	1.5
8.	— st. dev.			0.204	0.266	15.2
9.	Exports/dom. sales, mean	$\tilde{\Lambda}_z^{*'} \quad$		0.328	0.345	3.9
10.	— st. dev.			0.286	0.346	7.2
11.	Fraction of sectors with exports > dom. sales	$\mathbb{P}\{\tilde{X}_z > \tilde{D}_z\}$		0.185	0.095	39.7
Regression coefficients: [†]						
12.	export share on top-firm share	\hat{b}_1^*		0.215 (0.156)	0.240 (0.104)	2.2
13.	export share on top-3 share	\hat{b}_3^*		0.254 (0.108)	0.222 (0.090)	2.6
14.	import share on top-firm share	\hat{b}_1		−0.016 (0.097)	−0.011 (0.079)	0.1
15.	import share on top-3 share	\hat{b}_3		0.002 (0.074)	0.008 (0.069)	0.1

Note: Last column reports the contribution of the moment to the loss function $\mathcal{L}(\hat{\Theta})$, as described in Appendix ??.

[†]Moments 12–15 are regression coefficients of $\tilde{\Lambda}_z^{*'} \quad$ and $\tilde{\Lambda}_z$ on $\tilde{s}_{z,1}$ and $\sum_{j=1}^3 \tilde{s}_{z,j}$ (pairwise), controlling in all cases for the size of the sector with the log domestic sectoral expenditure Y_z ; OLS standard errors in brackets.

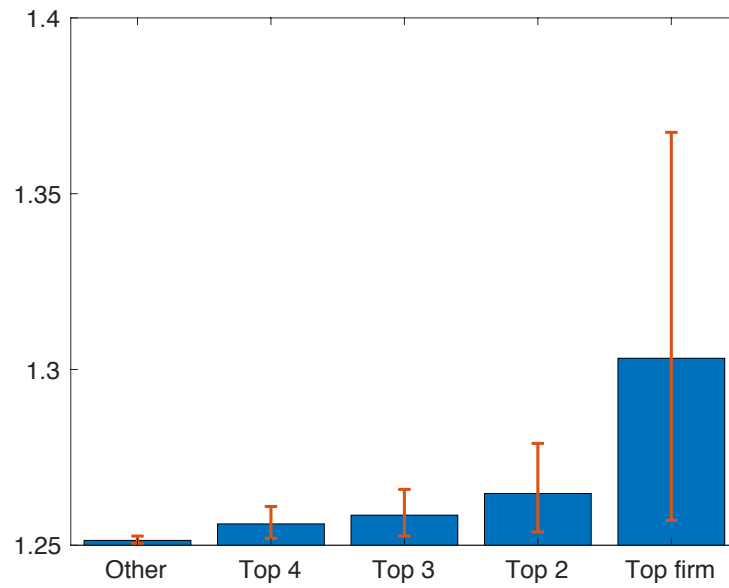


Figure A2: Equilibrium markups

Note: The bars in the figure correspond to markups for the four largest French firms in each sector and for the residual fringe of French firms, averaged across sectors, while the intervals correspond to the 10–90 percentiles across sectors. Markups under monopolistic competition with continuum of firms equal $\frac{\sigma}{\sigma-1} = 1.25$ for all firms, and this constitutes the lower bound for all markups in our oligopolistic model.

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