Productivity, (Mis)allocation and Trade*

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Abstract

We examine the impact of international trade on aggregate productivity. We show theoretically and numerically that bilateral and unilateral export liberalization increase aggregate welfare and productivity, while unilateral import liberalization can either raise or reduce them. However, all three trade reforms have ambiguous effects in the presence of resource misallocation. Using unique new data on 14 European countries and 20 manufacturing industries during 1998-2011, we empirically establish that exogenous shocks to both export demand and import competition generate large gains in aggregate productivity. Decomposing these gains, we find that both trade activities increase average firm productivity, but export expansion also reallocates activity towards more productive firms, while import penetration acts in reverse. We provide evidence for two adjustment mechanisms. First, both export and import exposure raise the minimum productivity among active firms. Second, efficient institutions, factor and product markets amplify the productivity gains from import competition, but dampen those from export expansion. We conclude that the effects of globalization operate through a combination of productivity-enhancing firm selection and reallocation across firms in the presence of resource misallocation.

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1 Introduction

World trade has steadily grown faster than world GDP since the early 1970s, and it expanded twice as quickly between 1985 and 2007.[1] Of great policy interest is how globalization affects aggregate productivity and welfare, and how its impact differs across countries at different levels of economic development. In advanced economies, increased competition from low-wage countries has exacerbated public debates about the gains from trade, in the face of rising concerns about domestic employment and inequality and China's dramatic trade expansion after joining the WTO in 2001. In developing countries, trade reforms have not always yielded all or only the desired benefits, leading policy makers to question the merits of trade openness in light of weak macroeconomic fundamentals and slow structural transformation.

Economics theory provides a clear rationale for trade liberalization: it enables a more efficient organization of production across countries, sectors and firms, which generates aggregate productivity growth and welfare gains. In particular, heterogenous-firm trade models emphasize the importance of firm selection, the reallocation of activity across firms, and within-firm productivity ugprading as key channels mediating these gains (e.g. Melitz 2003, Lileeva and Trefler 2010). At the same time, recent macroeconomics and growth research highlights that institutional and market frictions distort the allocation of productive resources across firms and thereby reduce aggregate productivity (e.g. Hsieh and Klenow 2009). However, how such frictions modify the gains from trade remains poorly understood.

This paper investigates the impact of international trade on aggregate productivity. We show theoretically and numerically that bilateral and unilateral export liberalization increase aggregate productivity and welfare, while unilateral import liberalization can either raise or reduce them. However, all three trade reforms have ambiguous effects in the presence of resource misallocation. Using unique new data on 14 European countries and 20 manufacturing industries during 1998-2011, we empirically establish that exogenous shocks to both export demand and import competition generate large gains in aggregate productivity. Decomposing these gains, we find that both trade activities increase average firm productivity, but export expansion also reallocates activity towards more productive firms, while import penetration acts in reverse. To unpack the adjustment mechanisms, we show that both export and import exposure raise the minimum productivity among active firms. We also document that efficient institutions, factor and product markets amplify the productivity gains from import competition, but dampen those from export expansion. We conclude that the effects of globalization operate through a combination of improved firm selection and reallocation across firms in the presence of resource misallocation.

Our first contribution is theoretical. We examine the impact of trade liberalization in a standard heterogeneous-firm trade model with potential resource misallocation. We also numerically simulate the model to assess its qualitative and quantitative predictions. We emphasize two main results.

First, in the absence of misallocation, reductions in bilateral trade costs and in unilateral export costs unambiguously raise aggregate productivity and welfare, as in Melitz (2003) and Melitz and Redding (2014). On the extensive margin, such reforms raise the productivity threshold above which domestic

[1] See Chapter 2 of the World Economic Outlook published by the International Monetary Fund in October 2016.

firms can operate. On the intensive margin, they shift activity from less towards more productive firms. By constrast, unilateral import reforms have ambiguous consequences because they increase market competitiveness both in the liberalizing country and in its trade partner, with opposite effects on the productivity cut-off at home. This results in welfare and productivity gains when wages are flexible, but leads to Metzler-paradox losses when wages are fixed in an outside sector, as in Demidova and Rodriguez-Clare (2013) and Bagwell and Lee (2016).

Second, with resource misallocation, the impact of both bilateral and unilateral trade liberalization on aggregate productivity and welfare becomes ambiguous. Moreover, this impact is not monotonic in the degree of misallocation, such that more severe distortions may amplify, dampen or reverse the gains from globalization. In the model, firms receive two exogenous draws, productivity φ and distortion η. Distortions η create a wedge between the social and the private marginal cost of production, and generate an inefficient allocation of production resources and market shares across firms that is based on distorted productivity $\underline{\varphi} = \varphi\eta$ rather than true productivity φ. Implicitly, this misallocation arises only due to institutional imperfections that cause frictions in the markets for factor inputs or output products, and is not driven by variable mark-ups as in Dhingra and Morrow (2014). Globalization has ambiguous productivity and welfare effects because distorted economies operate in a second-best equilbirum and trade reforms can worsen or improve allocative efficiency.

Our second contribution is methodological and provides an important bridge between theory and empirics. We demonstrate how key theoretical concepts in the model map to empirically observable variables, and how theoretical mechanisms can be assessed with available data. We first show that firm productivity measured by real value added per worker is monotonic in theoretical firm productivity, conditional on export status. We then demonstrate that welfare is generally not monotonic in measured aggregate productivity, defined as employment-weighted average firm productivity. However, the two are exactly proportional in the special case of no misallocation and free entry with Pareto-distributed productivity. They also move together in a wide segment of the parameter space away from this special case, but only as long as there is no misallocation.

We next decompose measured aggregate productivity into the measured unweighted average firm productivity and the measured covariance of firms' productivity and employment share, as in Olley and Pakes (1998). While it may be intuitive that the latter captures allocative efficiency, we show that it is not a sufficient statistic for the model parameters governing misallocation or for the resultant extent of resource misallocation. But crucially, the OP decomposition is nevertheless informative: Numerical simulations indicate that trade reforms can move the two OP components of aggregate productivity in opposite directions if and only if there is resource misallocation.

Our third contribution is empirical. Guided by the theoretical framework, we empirically assess the effect of international trade on aggregate productivity and the mechanisms through which this effect operates. We use rich new data assembled by the Competitive Research Network at the ECB on aggregate labor productivity for 14 European countries and 20 manufacturing industries during 1998-2011. These data are unique in capturing not only aggregate outcomes, but also multiple moments of the underlying distribution across firms. This makes it possible to implement the OP decomposition in a large cross-country, cross-sector panel for the first time.

Our baseline measures of countries' trade exposure are their gross exports and imports by sector from the World Input-Output Database. Since these trade outcomes are endogenous, we exploit a 2SLS IV strategy to identify the causal impact of plausibly exogenous shocks to export demand and import competition. This strategy uses the variation in the initial composition of countries' trade flows, and capitalizes on two WIOD features: the distinction between gross and value-added trade flows, and information on the sector of final use for each trade flow. We instrument for export demand with a Bartik-style weighted average of absorption across a country's export destinations, by sector. We instrument for import supply with import tariffs and a Bartik-style weighted average of value-added exports for final consumption across a country's import origins, by sector. We provide consistent results when we alternatively consider (instrumented) import competition specifically from China, and confirm the stability of our findings to a series of robustness exercises.

We establish four empirical results. First, both export expansion and import penetration significantly increase aggregate productivity. Our estimates imply that a 20% rise in export demand would boost overall productivity by 7.6%-8.2% depending on the specification, while a comparable change in import competition would generate productivity gains in the 1%-10% range.

Second, the productivity gains from export and import activity are mediated through different channels. Export growth induces higher average firm productivity and a reallocation of economic activity towards more productive firms, with the latter contributing 23%-39% of the total effect. By contrast, all of the benefits from import competition result from improved average firm productivity, with 17%-36% of these gains in fact negated by a shift in activity towards less productive firms.

Third, both export and import exposure raise the minimum productivity among active firms, consistent with international trade improving aggregate productivity by triggering exit from the left tail of the distribution. However, firm selection accounts for only about half of the total productivity gains.

Finally, the theoretical analysis indicates that these three empirical patterns can only be rationalized with resource misallocation moderating the impact of globalization. In line with this conclusion, we document that efficient institutions, factor and product markets amplify the productivity gains from import competition, but dampen those from export expansion. We measure overall institutional quality with rule of law, and exploit indices for labor market flexibility, creditor rights' protection and product market regulation to proxy institutional frictions in input and output markets.

These findings reveal the complex interaction between firm heterogeneity and resource misallocation that determine the aggregate welfare and productivity impact of trade liberalization. In particular, they point to asymmetries in the ability of distorted economies to respond to and gain from positive shocks to domestic firms such as growing export demand and negative shocks such as tighter import competition.

Our primary contribution is to characterize and quantify the productivity gains from trade while distinguishing between export and import exposure and assessing the adjustments to average firm productivity and resource allocation across firms. We thus speak to a vibrant theoretical trade literature on the role of firm heterogeneity for the welfare gains from globalization and inform the empirical validity of the mechanisms it highlights (e.g. Arkolakis, Costinot and Ridriguez-Clare 2012, Melitz and Redding 2014). Prior empirical work has typically analyzed one-sided trade liberalization episodes in specific countries, often exploiting micro-level data. By contrast, we provide systematic cross-country evidence which nevertheless allows us to examine the firm dimension, establish causality, and directly compare the impact of export and import expansion.

We find evidence consistent with several mechanisms identified in previous studies. For example, Pavcnik (2002) explores the aggregate productivity gains from trade reforms in Chile in the late 1970s. Using a decomposition similar to ours, she concludes that about 2/3 of the gains resulted from improvements in the OP covariance term. On the other hand, Harrison et al. (2013) find that most of the productivity benefits from trade liberalization in India during 1990-2010 came from changes in the average productivity of surviving firms. In the case of the US, Bernard, Jensen and Schott (2006) show that following a decline in trade barriers, liberalized sectors experienced faster productivity growth both because the least productive firms exited and because more productive firms expanded operations. Adjustments within surviving firms have also been documented in response to trade reforms, such as production technology upgrading (Lileeva and Trefler 2010, Bustos 2011, Bloom et al. 2016), product quality upgrading (Amiti and Koenings 2007, Amiti and Khandelwal 2013, Martin and Mejean 2014), reallocations across multiple products (Bernard, Redding and Schott 2011, Mayer, Melitz and Ottaviano 2014, Manova and Yu 2016), and product scope expansion (Goldberg et al. 2010, Khandelwal and Topalova 2013).

Our second contribution is to analyze the implications of resource misallocation for the adjustment to and welfare gains from trade. A burgeoning literature in macroeconomics shows that market frictions can distort the allocation of resources across firms and lower aggregate productivity (Hsieh and Klenow 2009, Epifani and Gancia 2011, Bartelsman, Haltiwanger and Sacrpetta 2013, Gopinath et al. 2015, Edmond, Midrigan and Xu 2015, Foster et al. 2008, Foster et al. 2015, 2016). At the same time, a growing body of work documents the detrimental impact of financial and labor market frictions on international trade activity (Chor and Manova 2012, Manova 2013, Foley and Manova 2015, Helpman, Itskhoki and Redding 2010, Cuñat and Melitz 2012). We draw on insights from these two strands of research to inform the fundamental question of welfare gains from trade in the presence of imperfect resource allocation. Our findings relate to several concurrent studies in this vein. Ben, Yahmed and Dougherty (2017) find that the impact of import competition on firm productivity depends on the degree of product market regulation, while Alfaro and Chen (2017) conclude that greater competition from multinational firms fosters productivity-enhancing reallocations of activity among domestic firms. Ding, Jiang and Sun (2016) document that import competition reduces productivity dispersion in China due to the exit of less productive firms.

The rest of the paper is organized as follows. Section 2 theoretically and numerically examines the impact of globalization on aggregate productivity. Section 3 introduces the CompNet and WIOD data. Section 4 presents the baseline OLS estimates, while Section 5 develops the IV estimation strategy and reports the main IV results. Section 6 explores the mechanisms through which international trade operates. The last section concludes.

2 Theoretical Framework

We examine the impact of international trade on aggregate welfare and productivity in a general-equilibrium model with firm heterogeneity in productivity as in Melitz (2003) and Chaney (2008) and potential resource misallocation as in Bartelsman, Haltiwanger and Scarpetta (2013). We formalize the main theoretical results and provide intuition for the underlying mechanisms in this section, and relegate detailed proofs to Appendix A.

Our goal is threefold. First, we highlight that in the absence of resource misallocation, bilateral and unilateral export liberalizations always raise aggregate welfare and productivity, while unilateral import liberalization can have ambiguous effects. Second, we show that all three types of globalization have ambiguous consequences in the presense of misallocation. Third, we characterize the relationship between the concepts of welfare and productivity in the model and measures of firm and aggregate productivity in the data to provide a bridge between theory and empirics.

2.1 Set Up

Consider a world with two potentially asymmetric countries $i = 1, 2$.[2] In each country, a measure L_i of consumers inelastically supply a unit of labor, such that aggregate expenditure is $E_i = w_i L_i$ due to free firm entry into production. The utility of the representative consumer U_i is a Cobb-Douglas function of consumption of a homogenous good H_i and a CES aggregate over consumption of available differentiated varieties $z \in \Omega_i$ with elasticity of substitution $\sigma \equiv 1/(1-\alpha) > 1$:

$$U_i = H_i^{1-\beta} Q_i^{\beta}, \quad Q_i = \left[\int_{z \in \Omega_i} q_i(z)^{\alpha} \, dz \right]^{1/\alpha}. \tag{2.1}$$

Demand $q_i(z)$ for variety z with price $p_i(z)$ in country i is thus $q_i(z) = \beta E_i P_{iQ}^{\sigma-1} p_i(z)^{-\sigma}$, where βE_i is total expenditure on differentiated goods, and $P_{iQ} = \left[\int_{z \in \Omega_i} p_i(z)^{1-\sigma} \, dz \right]^{1/(1-\sigma)}$ is the ideal price index in the differentiated sector.

The homogeneous good is freely tradeable and produced under CRS technology that converts one unit of labor into one unit of output. It proves important to distinguish between two cases. When β is sufficiently low, both countries produce the homogeneous good, such that it serves as a numeraire, $P_{iH} = 1$, and fixes worldwide wages to unity, $w_i = 1$. We will refer to this case simply as $\beta < 1$. When $\beta = 1$ by contrast, only differentiated goods are consumed, and wages are endogenously determined in equilibrium. The aggregate consumer price index is thus given by $P_i = P_{iQ}^{\beta}$.

[2] The model can be easily extended to a world with N asymmetric countries. In the global equilibirum, the equilibrium conditions below would hold for each country. From the perspective of country i, the impact of import or export liberalization in i that is symmetric with respect to all other countries would be independent of N; the impact of bilateral reforms with trade partner j would be qualitatively the same but moderated by j's relative market size.

In each country, a continuum of monopolistically competitive firms produce horizontally differentiated goods that they can sell at home and potentially export abroad. Firms must pay a sunk entry cost $w_i f_i^E$,[3] and should they commence production, fixed operation costs $w_i f_{ii}$ and constant marginal costs as specified below. Exporting from i to j requires fixed overhead costs $w_i f_{ij}$ and iceberg trade costs such that τ_{ij} units of a product need to be shipped for 1 unit to arrive, where $\tau_{ii} = 1$ and $\tau_{ij} > 1$ if $i \neq j$. We allow for $\tau_{ij} \neq \tau_{ji}$, and will analyze symmetric and asymmetric reductions in τ_{ij} to assess the impact of different trade reforms.

2.2 Firm Productivity and Resource Misallocation

In the absence of misallocation, firms in country i draw productivity φ upon entry from a known Pareto distribution $G_i(\varphi) = 1 - (\varphi_i^m/\varphi)^\theta$, where $\theta > \sigma - 1$ and $\varphi_i^m > 0$. This fixes firms' constant marginal cost to w_i/φ. In the presence of resource misallocation by contrast, firms draw both productivity φ and distortion η from a known joint distribution $H_i(\varphi, \eta)$. Firms' marginal cost is now determined by their *distorted productivity* $\underline{\varphi} = \varphi\eta$ and equals $w_i/\underline{\varphi} = w_i/(\varphi\eta)$. For comparability with the case of no misallocation, we assume that $\underline{\varphi}$ is Pareto distributed with scale parameter $\underline{\varphi}_i^m$ and shape parameter θ.

Conceptually, η captures any distortion that creates a wedge between the social marginal cost of an input bundle and the private marginal cost to the firm. Formally, this implies a firm-specific wedge in the first-order condition for profit maximization, as in Hsieh and Klenow (2009) and Bartelsman, Haltiwanger and Scarpetta (2013). Such a wedge may result from frictions in capital or labor markets or generally weak contractual institutions that support inefficient practices like corruption and nepotism.[4] Distortions η will lead to deviations from the first-best allocation of productive resources across firms: If a firm can access "too much" labor, this would be equivalent to a subsidy of $\eta > 1$. Conversely, capacity constraints would correspond to a tax of $\eta < 1$.

Modeling resource misallocation in this way has several appealing features. First, introducing distortions on the input side is qualitatively isomorphic to allowing for distortions in output markets instead, such as firm-specific sales taxes.[5] Our theoretical formulation thus ensures tractability without loss of generality. In the empirical analysis, we correspondingly exploit different measures of broad institutional quality, capital and labor market frictions, and restrictive product market regulations. Second, in our model misallocation describes the inefficient allocation of production resources and consequently market shares across firms in the differentiated industry, as well as across sectors when $\beta < 1$. Since the combination of CES preferences and monopolistic competition will imply constant mark-ups, no additional misallocation arises from variable mark-ups across firms as in Dhingra and Morrow (2016).

Finally, the functional form for firms' marginal costs permits a transparent comparison of firm and

[3] We consider a variant of the model with an exogenous mass of firms in Appendix B.

[4] Examples include the allocation of MFA export quota rights in China based on firms' state ownership and political connections, labor regulations that depend on firms' employment level, or credit provision based on personal or political connections due to weak contract enforcement (e.g. Khandelwal et al. 2013, Midrigan and Zhu 2014, Brandt et al. 2013).

[5] For example, one can specify the distortion on the revenue side such that firm profits equal $\pi_{ij}(\varphi, \eta) = \eta p_{ij} q_{ij} - w_i l_{ij}$. While profits will now be proportional to $\varphi\eta^{1/\alpha}$ instead of $\varphi\eta$, and firm selection along the extensive margin will be adjusted accordingly, the main intuitions and results in the baseline model with input distortions will remain valid.

economy-wide outcomes with and without misallocation. Under misallocation, firm selection, production and export activity depend on φ and η only through distorted productivity $\underline{\varphi} = \varphi\eta$, while optimal resource allocation in the first best depends on φ alone. Thus two parameters regulate the degree of misallocation: the dispersion of the distortion draw, σ_η, and the correlation between the distortion and productivity draws, $\rho(\varphi,\eta)$.[6] Misallocation occurs if and only if $\sigma_\eta > 0$, but its severity need not vary monotonically in the $\sigma_\eta - \rho(\varphi,\eta)$ space.[7]

2.3 Firm Behavior

We first characterize firms' optimal behavior in the absence of resource misallocation. Producers choose their sales price $p_{ij}(\varphi)$ and quantity $q_{ij}(\varphi)$ to maximize profits $\pi_{ij}(\varphi)$ separately in each market j they serve. The problem of a firm with productivity φ and its first-best outcomes are thus:

$$\max_{p,q} \pi_{ij}(\varphi) = p_{ij}(\varphi)q_{ij}(\varphi) - w_i\tau_{ij}q_{ij}(\varphi)/\varphi - w_i f_{ij} \quad \text{s.t.} \quad q_{ij}(\varphi) = \beta E_j P_{jQ}^{\sigma-1} p_{ij}(\varphi)^{-\sigma} \tag{2.2}$$

$$p_{ij}(\varphi) = \frac{w_i\tau_{ij}}{\alpha\varphi}, \quad q_{ij}(\varphi) = \beta E_j P_{jQ}^{\sigma-1}\left(\frac{\alpha\varphi}{w_i\tau_{ij}}\right)^{\sigma}, \tag{2.3}$$

$$l_{ij}(\varphi) = f_{ij} + \frac{\tau_{ij}q_{ij}(\varphi)}{\varphi}, \quad c_{ij}(\varphi) = w_i\left(f_{ij} + \frac{\tau_{ij}q_{ij}(\varphi)}{\varphi}\right) = \alpha r_{ij}(\varphi) + w_i f_{ij}, \tag{2.4}$$

$$r_{ij}(\varphi) = \beta E_j\left(\frac{\alpha P_{jQ}\varphi}{w_i\tau_{ij}}\right)^{\sigma-1}, \quad \pi_{ij}(\varphi) = \frac{r_{ij}(\varphi)}{\sigma} - w_i f_{ij}. \tag{2.5}$$

where $l_{ij}(\varphi)$, $c_{ij}(\varphi)$ and $r_{ij}(\varphi)$ are the employment, costs and revenues associated with sales in j.

Since profits are monotonically increasing in productivity, firms in country i sell in country j only if their productivity exceeds threshold φ^*_{ij}. The domestic and export cut-offs are implicitly defined by:

$$r_{ii}(\varphi^*_{ii}) = \sigma w_i f_{ii}, \quad r_{ij}(\varphi^*_{ij}) = \sigma w_i f_{ij}. \tag{2.6}$$

We assume as standard that the parameter space guarantees $\varphi^*_{ij} > \varphi^*_{ii}$ for any $\tau_{ij} > 1$. Along with consumer love of variety and fixed operation costs f_{ii}, this implies selection into exporting, such that no firm exports without also selling at home. In turn, firms commence production upon entry only if their productivity draw is above φ^*_{ii}, and exit otherwise.

Following the same solution concept, we next determine firms' constrained-optimal behavior in the case of misallocation. The profit-maximizing problem of a firm with distorted productivity $\underline{\varphi} = \varphi\eta$

[6] For example, with asymmetric information and imperfect contract enforcement in credit markets, creditors may base loan decisions on a noisy signal of firm productivity, such that $0 < \rho(\varphi,\eta) < 1$. Alternatively, if more productive firms optimally higher more skilled workers to produce higher-quality goods, labor market frictions may be especially costly in the specialized market for skilled workers, such that $\rho(\varphi,\eta) < 0$.

[7] We consider numerical simulations for the case of joint log-normal distribution $G_i(\varphi,\eta)$, which is fully characterized by $\rho(\varphi,\eta) < 1$ and σ_η. Higher-order moments may also matter under alternative distributional assumptions.

generates the following second-best outcomes:

$$\max_{p,q} \pi_{ij}(\varphi,\eta) = p_{ij}(\varphi,\eta)q_{ij}(\varphi,\eta) - w_i\tau_{ij}q_{ij}(\varphi,\eta)/\varphi\eta - w_i f_{ij} \quad \text{s.t.} \quad q_{ij}(\varphi,\eta) = \beta E_j P_{jQ}^{\sigma-1} p_{ij}(\varphi,\eta)^{-\sigma} \tag{2.7}$$

$$p_{ij}(\varphi,\eta) = \frac{w_i\tau_{ij}}{\alpha\varphi\eta}, \quad q_{ij}(\varphi,\eta) = \beta E_j P_{jQ}^{\sigma-1}\left(\frac{\alpha\varphi\eta}{w_i\tau_{ij}}\right)^{\sigma}, \tag{2.8}$$

$$l_{ij}(\varphi,\eta) = f_{ij} + \frac{\tau_{ij}q_{ij}(\varphi,\eta)}{\varphi}, \quad c_{ij}(\varphi,\eta) = w_i\left(f_{ij} + \frac{\tau_{ij}q_{ij}(\varphi,\eta)}{\varphi\eta}\right), \tag{2.9}$$

$$r_{ij}(\varphi,\eta) = \beta E_j\left(\frac{\alpha P_{jQ}\varphi\eta}{w_i\tau_{ij}}\right)^{\sigma-1}, \quad \pi_{ij}(\varphi,\eta) = \frac{r_{ij}(\varphi,\eta)}{\sigma} - w_i f_{ij}. \tag{2.10}$$

While it would be socially optimal to allocate input factors and output sales based on true firm productivity φ, in the market equilibrium this allocation is instead pinned down by distorted productivity $\underline{\varphi}$. Along the intensive margin, firms with low (high) distortion draws η produce and earn less (more) than in the first best, while charging consumers higher (lower) prices than efficient. Along the extensive margin, a highly productive firm might be forced to exit if it endures prohibitively high distortive taxes, while a less productive firm might be able to operate or export if it benefits from especially high subsidies. In particular, firms now produce for the domestic and foreign market as long as their distorted productivity exceeds cut-offs $\underline{\varphi}_{ii}^*$ and $\underline{\varphi}_{ij}^*$, respectively:

$$r_{ii}(\underline{\varphi}_{ii}^*) = \sigma w_i f_{ii}, \quad r_{ij}(\underline{\varphi}_{ij}^*) = \sigma w_i f_{ij}. \tag{2.11}$$

2.4 General Equilibrium

The general equilibrium is characterized by equilibrium conditions that ensure free entry, labor market clearing, income-expenditure balance, and international trade balance in ach country.

Consider first the case of no misallocation. With free entry, ex-ante expected profits must be zero:

$$\sum\nolimits_j \mathbf{E}\left[\pi_{ij}(\varphi)\mathbf{I}(\varphi \geq \varphi_{ij}^*)\right] = w_i f_i^E \iff \tag{2.12}$$

$$f_{ii}\int_{\varphi_{ii}^*}^{\infty}\left[\left(\frac{\varphi}{\varphi_{ii}^*}\right)^{\sigma-1} - 1\right]dG_i(\varphi) + f_{ij}\int_{\varphi_{ij}^*}^{\infty}\left[\left(\frac{\varphi}{\varphi_{ij}^*}\right)^{\sigma-1} - 1\right]dG_i(\varphi) = f_i^E. \tag{2.13}$$

where $\mathbf{E}[\cdot]$ is the expectation operator and $\mathbf{I}(\cdot)$ is the indicator function.

A key implication of the free-entry condition is that the productivity cut-offs in country i for production and exporting must always move in opposite directions following trade reforms that affect τ_{ij} or τ_{ji}. Intuitively, any force that lowers φ_{ij}^* tends to increase expected export profits conditional on production. For free entry to continue to hold, threshold φ_{ii}^* must therefore rise, such that the probability of survival conditional on entry falls and overall expected profits from entry remain unchanged.

When $\beta < 1$, wages are fixed and pinned down in the homogeneous-good sector. When $\beta = 1$, by contrast, wages are flexible and determined by labor market clearing in the differentiated-good sector:

$$L_i = \sum\nolimits_j M_i\mathbf{E}\left[l_{ij}(\varphi)\mathbf{I}(\varphi \geq \varphi_{ij}^*)\right] + M_i f_i^E, \tag{2.14}$$

where M_i is the mass of entering firms in country i.

In equilibrium, aggregate consumer income E_j must equal aggregate expenditure in the economy. With free entry, aggregate corporate profits net of entry costs are 0, such that total income corresponds to the total wage bill. Consumers' utility maximization implies the following income-expenditure balance:

$$\beta E_j = \beta w_j L_j = \sum\nolimits_i R_{ij} = \sum\nolimits_i M_i \mathbf{E}\left[r_{ij}(\varphi)\mathbf{I}(\varphi \geq \varphi_{ij}^*)\right], \tag{2.15}$$

where R_{ij} is aggregate spending by consumers in country j on differentiated varieties from country i.[8,9]

Consider next the case of resource misallocation. The free entry and labor market clearing conditions are analogous to those above after replacing productivity φ with distorted productivity $\underline{\varphi} = \varphi\eta$. The income-expenditure balance, however, has to be amended to account for the implicit dead-weight loss of misallocation. While firm (φ, η) incurs production costs $c_{ij}(\varphi,\eta) = w_i\left(f_{ij} + \frac{\tau_{ij} q_{ij}(\varphi,\eta)}{\varphi\eta}\right)$, the associated payment received by workers is $c'_{ij}(\varphi,\eta) = w_i\left(f_{ij} + \frac{\tau_{ij} q_{ij}(\varphi,\eta)}{\varphi}\right)$. The gap $c_{ij}(\varphi,\eta) - c'_{ij}(\varphi,\eta)$ is the social cost of distortionary firm-specific taxes or subsidies on labor costs, which we assume is covered through lump-sum taxation of consumers in i. The new equilibrium conditions become:

$$\sum\nolimits_j \mathbf{E}\left[\pi_{ij}(\varphi,\eta)\mathbf{I}(\varphi\eta \geq \underline{\varphi}_{ij}^*)\right] = w_i f_i^E, \tag{2.16}$$

$$L_i = \sum\nolimits_j M_i \mathbf{E}\left[l_{ij}(\varphi,\eta)\mathbf{I}(\varphi\eta \geq \underline{\varphi}_{ij}^*)\right] + M_i f_i^E \text{ (if } \beta = 1), \tag{2.17}$$

$$\beta E_j = \beta(w_j L_j - T_j) = \sum\nolimits_i R_{ij} = \sum\nolimits_i M_i \mathbf{E}\left[r_{ij}(\varphi,\eta)\mathbf{I}(\varphi\eta \geq \underline{\varphi}_{ij}^*)\right], \tag{2.18}$$

$$T_i = \sum\nolimits_j M_i \mathbf{E}\left[[c_{ij}(\varphi,\eta) - c'_{ij}(\varphi,\eta)]\mathbf{I}(\varphi\eta \geq \underline{\varphi}_{ij}^*)\right]. \tag{2.19}$$

2.5 Welfare

Welfare in country i is given by real consumption per capita and can be expressed as:

$$W_i = \left\{ \begin{array}{ll} (1-\beta)^{1-\beta}\beta^\beta \frac{w_i}{P_i}\chi_i & \text{if } \beta < 1 \\ \frac{w_i}{P_i}\chi_i & \text{if } \beta = 1 \end{array} \right\} \text{ where } \chi_i = \frac{E_i}{w_i L_i} = \frac{w_i L_i - T_i}{w_i L_i}. \tag{2.20}$$

Up to a constant, welfare is thus proportional to the real wage, w_i/P_i, and the ratio of disposable income to gross income, χ_i. In the absence of misallocation, all income accrues to worker-consumers, such that $E_i = w_i L_i$ and $\chi_i = 1$. In the presence of misallocation, by contrast, some income is not available to consumers due to the dead-weight loss of distortions, such that $E_i = w_i L_i - T_i$.[10]

One can show that the real wage, and therefore also welfare, is a function only of model parameters (market size L_i, fixed production costs f_{ii}, and demand elasticities β and σ) and two endogenous

[8] When $\beta = 1$, general equilibrium requires an additional condition for balanced trade in the differentiated-goods sector that implicitly links productivity thresholds and relative wages across countries: $\sum_i R_{ik} = \sum_j R_{kj}$.

[9] With an exogenous mass of firms, the free entry condition is moot, and the labor market clearing condition reduces to $L_i = \sum_j M_i E\left[l_{ij}(\varphi)\mathbf{I}(\varphi \geq \varphi_{ij}^*)\right]$. Since aggregate corporate profits Π_j are no longer 0, the income-expenditure condition becomes $\beta E_j = \beta(w_j L_j + \Pi_j)$. This condition also directly guarantees balanced trade when $\beta = 1$. See Appendix B.

[10] With an exogenous mass of firms instead of free entry, aggregate firm profits are positive. Assuming as standard that consumers hold a diversified domestic firm portfolio, firm profits accrue to consumers and are part of their disposable income.

equilibrium outcomes: the (distorted) productivity cut-off for domestic production, φ_{ii}^* or $\underline{\varphi}_{ii}^*$, and the ratio of disposable to gross income, χ_i. This is summarized by the following lemma and proportionality condition:[11]

$$W_i \propto \left\{ \begin{array}{ll} \left(\frac{L_i}{\sigma f_{ii}}\right)^{\frac{\beta}{\sigma-1}} (\varphi_{ii}^*)^{\beta} & \text{without misallocation} \\ \left(\frac{L_i}{\sigma f_{ii}}\right)^{\frac{\beta}{\sigma-1}} (\chi_i)^{\frac{\beta+\sigma-1}{\sigma-1}} (\underline{\varphi}_{ii}^*)^{\beta} & \text{with misallocation} \end{array} \right\}. \tag{2.21}$$

Lemma 1 *Without misallocation, welfare increases with the domestic productivity cut-off,* $\frac{dW_i}{d\varphi_{ii}^*} > 0$. *With misallocation, welfare increases with the distorted domestic productivity cut-off (holding χ_i fixed),* $\frac{\partial W_i}{\partial \underline{\varphi}_{ii}^*} > 0$*, and with the share of disposable income in gross income (holding $\underline{\varphi}_{ii}^*$ fixed),* $\frac{\partial W_i}{\partial \chi_i} > 0$.

With efficient resource allocation, a higher productivity cut-off φ_{ii}^* implies a shift in economic activity towards more productive firms, which intuitively tends to lower the aggregate price index and increase consumers' real income. With misallocation, distortions affect welfare through the reduction in disposable income χ_i and through the sub-optimal selection of active firms based on distorted productivity $\underline{\varphi}$ rather than true productivity φ. One direct implication of Lemma 1 is that welfare is proportional to the domestic productivity cut-off if and only if there are no allocative frictions. Another implication is that the welfare impact of trade liberalization depends on how a reduction in τ_{ij} affects φ_{ii}^*, $\underline{\varphi}_{ii}^*$, and χ_i.

2.6 From Theory to Empirics

A key challenge in empirically evaluating the gains from trade is that the theoretical concepts of productivity and welfare are not directly observed in the data. In this section, we show that measurement error and resource misallocation result in important disconnect between these theoretical objects and their measured counterparts that the literature typically ignores. This will closely guide our empirical design and interpretation.

2.6.1 Theoretical vs. measured firm productivity

The theoretical concept of firm productivity φ is quantity-based (TFPQ), while empirical measures $\Phi_i(\varphi)$ are generally revenue-based (e.g. TFPR or labor productivity). We now show that the observed real value added per worker is an attractive choice for $\Phi_i(\varphi)$, and we therefore use it in the empirical analysis.

Observed value added corresponds to the theoretical notion of total firm revenues $r_i(\varphi)$ from domestic sales and any exports, where $r_i(\varphi) = \sum_j r_{ij}(\varphi)\mathbf{I}(\varphi \geq \varphi_{ij}^*)$. Observed employment represents the total units of labor $l_i(\varphi)$ that a firm hires to produce for home and abroad, $l_i(\varphi) = \sum_j l_{ij}(\varphi)\mathbf{I}(\varphi \geq \varphi_{ij}^*)$. Denoting labor used towards fixed overhead and export costs as $f_i(\varphi) = \sum_j f_{ij}\mathbf{I}(\varphi \geq \varphi_{ij}^*)$ and normalizing by the consumer price index P_i, measured firm productivity becomes:

$$\Phi_i(\varphi) = \frac{r_i(\varphi)}{P_i l_i(\varphi)} = \frac{w_i}{\alpha P_i}\left[1 - \frac{f_i(\varphi)}{l_i(\varphi)}\right]. \tag{2.22}$$

[11]The exact expressions for W_i include an additional constant term: α when $\beta = 1$ and $(1-\beta)^{1-\beta}\beta^{\beta}\alpha^{\beta}$ when $\beta < 1$.

One can show that conditional on export status, measured firm productivity increases monotonically with theoretical firm productivity, $\Phi_i'(\varphi|\varphi < \varphi_{ij}^*) > 0$ and $\Phi_i'(\varphi|\varphi \geq \varphi_{ij}^*) > 0$. Note first that the ratio of sales to variable employment, $r_i(\varphi)/[l_i(\varphi) - f_i(\varphi)]$, is invariant across firms with constant mark-ups, but this does not hold for sales to total employment, $r_i(\varphi)/l_i(\varphi)$, because of economies of scale. However, the measured productivity of firm φ based on domestic sales should it not export exceeds its measured productivity based on global sales should it export, $r_{ii}(\varphi)/l_{ii}(\varphi) > r_i(\varphi)/l_i(\varphi)$. This is due to a downward shift in the function $\Phi_i(\varphi)$ at the export productivity cut-off φ_{ij}^*, because firms incur fixed export costs such that $r_{ii}(\varphi_{ij}^*)/l_{ii}(\varphi_{ij}^*) > r_{ij}(\varphi_{ij}^*)/l_{ij}(\varphi_{ij}^*)$. Finally, observe that measured firm productivity increases with the real wage, w_i/P_i, and implicitly depends on the productivity thresholds, φ_{ii}^* and φ_{ij}^*.

In the case of misallocation, there is an analagous relationship between theoretical and observed distorted productivity, $\underline{\varphi} = \varphi\eta$ and $\underline{\Phi}_i(\varphi, \eta)$:

$$\underline{\Phi}_i(\varphi, \eta) = \frac{r_i(\varphi, \eta)}{P_i l_i(\varphi, \eta)} = \frac{w_i}{\alpha P_i \eta}\left[1 - \frac{f_i(\varphi, \eta)}{l_i(\varphi, \eta)}\right]. \tag{2.23}$$

2.6.2 Measured aggregate productivity and OP decomposition

Define measured aggregate productivity $\tilde{\Phi}_i$ as the employment-weighted average of measured firm productivity:

$$\tilde{\Phi}_i \equiv \int_{\varphi_{ii}^*}^{\infty} \theta_i(\varphi)\Phi_i(\varphi)\, \frac{dG_i(\varphi)}{1 - G_i(\varphi_{ii}^*)}, \tag{2.24}$$

where $\theta_i(\varphi) = l_i(\varphi)/\left[\int_{\varphi_{ii}^*}^{\infty} l_i(\varphi)\, \frac{dG_i(\varphi)}{1-G_i(\varphi_{ii}^*)}\right]$ is firm φ's share of aggregate employment.[12] Note that the denominator in this employment share excludes labor used towards the sunk entry costs, which is unobserved in the data.

As an accounting identity, aggregate measured productivity $\tilde{\Phi}_i$ can be decomposed into the unweighted average measured productivity across firms, $\overline{\Phi}_i$, and the covariance between firms' measured productivity and share of economic activity, $\ddot{\Phi}_i$, known as the OP gap (Olley and Pakes, 1996):

$$\tilde{\Phi}_i = \overline{\Phi}_i + \ddot{\Phi}_i = \int_{\varphi_{ii}^*}^{\infty} \Phi_i(\varphi)\, \frac{dG_i(\varphi)}{1 - G_i(\varphi_{ii}^*)} + \int_{\varphi_{ii}^*}^{\infty} \left[\Phi_i(\varphi) - \overline{\Phi}_i\right]\left[\theta_i(\varphi) - \overline{\theta}_i\right] \frac{dG_i(\varphi)}{1 - G_i(\varphi_{ii}^*)}. \tag{2.25}$$

The OP decomposition reveals the mechanisms through which adjustments across and within firms shape aggregate measured productivity $\tilde{\Phi}_i$. Changes in $\overline{\Phi}_i$ reflect two effects of firm selection: exit/entry into production which modifies the set of active firms, and exit/entry into production and into exporting which preserves the set of firms but impacts measured firm productivity. Changes in $\ddot{\Phi}_i$ identify reallocations of economic activity across firms with different productivity levels through changes in their employment share and, implicitly, in their output and sales.

The OP decomposition remains valid in the case of misallocation, when $\underline{\varphi}$, $\underline{\varphi}_{ii}^*$, $\underline{\Phi}_i(\varphi, \eta)$, and $H_i(\varphi, \eta)$ replace φ, φ_{ii}^*, $\Phi_i(\varphi)$, and $G_i(\varphi)$ in (2.25). Note that the covariance terms is positive in a frictionless

[12] In the data, the firm weights are defined such that they sum to 1 across firms. Here, $\theta_i(\varphi)$ is defined such that it averages 1 across firms. This ensures that the residual in the OP decomposition is the covariance of $\Phi_i(\varphi)$ and $\theta_i(\varphi)$.

economy because both $\Phi_i(\varphi)$ and $\theta_i(\varphi)$ are (conditionally) increasing in φ, but it can be positive or negative in the presence of distortions.[13]

2.6.3 OP covariance vs. misallocation

The productivity covariance $\ddot{\Phi}_i$ is related to allocative efficiency in the sense that more productive firms would capture a bigger share of production resources and output sales in the absence of misallocation. While it may be tempting to therefore interpret a rise in $\ddot{\Phi}_i$ as an improvement in allocative efficiency, however, this is in fact not a general result.

Theoretically, one can show that the optimal allocation of resources across firms depends on the economic environment (i.e. demand structure, cost structure, market structure, and productivity distribution). This means that no unique value for $\ddot{\Phi}_i$ signals perfect allocative efficiency in an absolute sense. Even when the optimal covariance $\ddot{\Phi}_i^*$ is known for a given economic environment, both values below and above it would indicate distortions relative to the first best. Moreover, the absolute difference $|\ddot{\Phi}_i^* - \ddot{\Phi}_i|$ need not be proportional to or even monotonic in the degree of misallocation and the welfare loss associated with it.

Given this theoretical ambiguity, we numerically explore the association between welfare, the covariance, and the parameters governing misallocation. We simulate the model using standard parameters from the literature (see Section 2.8). We consider a joint log-normal distribution for the productivity and distortion draws $G_i(\varphi, \eta)$ with $\mu_\varphi = \mu_\eta = 1$, $\sigma_\varphi = 1$, and various degrees of distortion dispersion $\sigma_\eta \in [0.05, 0.3]$, and productivity-distortion correlation $\rho(\varphi, \eta) \in [-0.4, 0.4]$. Note that this parameterization produces Pareto-distributed distorted productivity $\underline{\varphi} = \varphi\eta$, and admits no closed-form solutions for W or $\ddot{\Phi}_i$ as functions of σ_η and $\rho(\varphi, \eta)$.

Figure 1A illustrates that the productivity-size covariance can be negative, zero or positive at different points in the $\sigma_\eta - \rho(\varphi, \eta)$ space. For a given correlation value, higher distortion dispersion is associated with lower covariance, consistent with relatively productive firms being sub-optimally small when input costs vary more across firms. Holding σ_η constant, on the other hand, higher $\rho(\varphi, \eta)$ tends to be associated with lower $\ddot{\Phi}_i$, consistent with productive firms getting inefficiently large. While misallocation would intuitively be lowest for low σ_η and $\rho(\varphi, \eta) = 0$, $\ddot{\Phi}_i$ does not peak at that point. Moreover, alternative parameterizations can produce non-monotonic patterns for $\ddot{\Phi}_i$, σ_η and $\rho(\varphi, \eta)$. These findings are consistent with results in Bartelsman et al. (2013).

Figure 1B shows how aggregate welfare varies with the misallocation parameters, under the same parameterization as above. All else constant, welfare decreases as the dispersion in distortion draws widens, and increases as the distortion and productivity draws become more positively correlated. The comparative statics for W and $\ddot{\Phi}_i$are thus aligned with respect to σ_η, but reversed with respect to $\rho(\varphi, \eta)$. This reinforces the conclusion that $\ddot{\Phi}_i$ cannot fully capture the degree or welfare cost of misallocation.

This discussion has direct implications for the empirical analysis. If one believes that an economy

[13] A sufficient condition for $\ddot{\Phi}_i > 0$ in the frictionless economy is that the average revenue productivity of exporters is higher than the average revenue productivity of non-exporters, in line with prior evidence in the literature.

lies strictly below its optimum covariance $\ddot{\Phi}_i^*$, and one is also willing to assume that economic shocks do not change this optimum, then increases (reductions) in $\ddot{\Phi}_i$ in response to such shocks can be interpreted as improvements (deteriorations) in allocative efficiency. Since it is difficult to validate this assumption, such inferrence is likely to be flawed. However, below we show that the OP decomposition is nevertheless informative because the effect of international trade on all three OP terms can reveal misallocation.

2.6.4 Welfare vs. measured aggregate productivity

Conceptually, welfare W_i differs from measured aggregate productivity $\tilde{\Phi}_i$ for two reasons. First, measured firm productivity $\Phi_i(\varphi)$ is a monotonic function of theoretical firm productivity φ only conditional on export status. An aggregate based on $\Phi_i(\varphi)$ need not be monotonic in an aggregate based on φ. Second, welfare in country i depends on the price index P_i faced by consumers in i, which reflects the prices of all varieties sold in i. Implicitly, W_i is related to the weighted average productivity of all domestic and foreign firms supplying market i, using their sales in i as weights. By contrast, $\tilde{\Phi}_i$ is the weighted average productivity of all domestic firms, using their global sales as weights. This distinction is irrelevant only with symmetric countries and bilateral trade costs, because then the measure, productivity, prices and market shares of firms exporting from i to j are identical to those of firms exporting from j to i. From a policy perspective, welfare and domestic aggregate productivity both matter but for different objectives: While W_i reflects consumer utility at a point in time, $\tilde{\Phi}_i$ indicates a country's competitiveness and productive capacity, improvements in which drive aggregate growth over time.

One can show that aggregate measured productivity is proportional to w_i/P_i under efficient resource allocation, but not under misallocation. In particular:

$$\tilde{\Phi}_i = \left\{ \begin{array}{ll} \frac{\sigma\theta}{\sigma\theta-(\sigma-1)} \frac{w_i}{P_i} & \text{without misallocation} \\ \frac{\sigma\theta}{(\sigma-1)\theta K_i+\theta-(\sigma-1)} \frac{w_i}{P_i} & \text{with misallocation} \end{array} \right\}, \tag{2.26}$$

$$\text{where } K_i = \frac{\sum_j \int\int_{\varphi\eta \geq \underline{\varphi}_{ij}^*} \eta\, (\varphi\eta)^{\sigma-1} dH_i(\varphi,\eta)}{\sum_j \int\int_{\varphi\eta \geq \underline{\varphi}_{ij}^*} (\varphi\eta)^{\sigma-1} dH_i(\varphi,\eta)}. \tag{2.27}$$

In the case of misallocation, the scaling factor K_i adjusts aggregate productivity for the inefficient allocation of productive resources across firms. Since firm sales are an increasing function of $(\varphi\eta)^{\sigma-1}$, K_i represents the size-weighted average distortion η to true firm productivity φ. When there is no misallocation, $\eta = 1$ for all firms and $K_i = 1$ drops out.

Together, equations (2.20) and (2.26) imply that measured aggregate productivity $\tilde{\Phi}_i$ can be proportional to and therefore a summary statistic for unobserved welfare W_i only in the absence of misallocation.[14] In addition, shocks that move the (distorted) productivity cut-offs for production and exporting

[14] Note that with free entry, $\tilde{\Phi}_i$ depends on the endogenous mass of firms, M_i. In the absence of misallocation, M_i is a constant determined solely by model parameters when productivity is Pareto distributed. This Pareto assumption is thus sufficient but not necessary to ensure that $\tilde{\Phi}_i$ is proportional to W_i; extensive numerical simulations indicate that W_i and $\tilde{\Phi}_i$ also move in the same direction under alternative productivity distributions and reasonable parameter assumptions from the literature. Separately, one can show that $W_i = \tilde{\Phi}_i$ holds exactly with no outside sector and an exogenous mass of firms instead of free entry.

In the case of misallocation, the Pareto assumption for distorted productivity delivers tractable expressions for W_i and $\tilde{\Phi}_i$

will shift $\tilde{\Phi}_i$ through their effect on the equilibrium wage w_i (if $\beta = 1$), the aggregate price index P_i, and the extent of misallocation K_i. This implies the following lemma:

Lemma 2 *Without misallocation, aggregate measured productivity increases with the domestic productivity cut-off,* $\frac{d\tilde{\Phi}_i}{d\varphi_{ii}^*} > 0$*. With misallocation, this relationship becomes ambiguous,* $\frac{d\tilde{\Phi}_i}{d\varphi_{ii}^*} \gtrless 0$*.*

2.7 Impact of Trade Liberalization

We can now examine the impact of trade liberalization on welfare W_i and measured aggregate productivity $\tilde{\Phi}_i$, average productivity $\overline{\Phi}_i$, and productivity covariance $\ddot{\Phi}_i$. We consider three forms of trade liberalization: symmetric bilateral reduction in variable trade costs τ_{ij} and τ_{ji}, unilateral reduction in export costs τ_{ij}, and unilateral reduction in import costs τ_{ji}. We characterize the adjustment mechanisms that each reform triggers, and demonstrate that some effects can be unambiguously signed, while others are theoretically ambiguous.

2.7.1 Efficient allocation and flexible wages

In the case of efficient resource allocation and no outside sector ($\beta = 1$), equilibrium wages w_i are determined by labor market clearing and balanced trade. Wages thus endogenously respond to changes in market conditions, including trade reforms.

Consider first symmetric bilateral liberalization. On the export side, a fall in τ_{ij} creates more export opportunities for firms in i, as lower delivery costs allow them to charge lower prices in j and thereby benefit from higher export demand. This decreases the productivity cut-off for exporting φ_{ij}^* and more firms commence exporting, while continuing exporters expand sales abroad. This bids up labor demand and wages in i, making it more difficult for less productive firms in i to survive. These forces act to raise the productivity threshold for survival, φ_{ii}^*. On the import side, a decline in τ_{ji} enables foreign firms to sell more cheaply to i. This intensifies import competition in i, reducing the aggregate price index and demand for locally produced varieties. This depresses domestic sales for all firms, and reinforces the rise in φ_{ii}^*. It follows from Lemmas 1 and 2 that bilateral trade liberalization unambiguously increases welfare W_i and measured aggregate productivity $\tilde{\Phi}_i$, as in Melitz (2003), Melitz and Redding (2014), and Arkolakis et al. (2012). This results from the reallocation of economic activity across firms via the exit of low-productivity firms on the extensive margin and the shift in market share towards more productive firms on the intensive margin.

In the case of flexible wages, unilateral export and import liberalization spur the same adjustment processes and exert the same effects as bilateral reforms, as in Demidova and Rodriguez-Clare (2013).

Turning to the OP decomposition, it is clear that if globalization raises $\tilde{\Phi}_i$, then either average productivity $\overline{\Phi}_i$, or the productivity covariance $\ddot{\Phi}_i$, or both must rise as well. However, one cannot analytically

that help build intuition for the role of distortions. In contrast to the frictionless economy, this assumption no longer guarantees a monotonic relationship between W_i and $\tilde{\Phi}_i$. Numerical exercises confirm that this relationship remains ambiguous with misallocation under various distributional assumptions.

sign the response of these OP terms without further parameter restrictions. This ambiguity arises due to the counteracting effects of several forces: the exit of the least productive firms in the economy, the shift in activity towards more productive surviving firms, and the differential increase in measured productivity $\Phi_i(\varphi)$ among producers. When trade costs fall, more efficient firms expand their foreign sales more and contract their domestic sales less than less efficient firms. In addition, the adjustments in φ_{ii}^* and φ_{ij}^* increase $\Phi_i(\varphi)$ disproportionately more for exporters than non-exporters. Nevertheless, the relative change in firm sales can vary non-monotonically along the productivity distribution without additional assumptions, such that $\overline{\Phi}_i$ and $\ddot{\Phi}_i$ can move in either direction.

Proposition 1 *Under no misallocation and flexible wages ($\beta = 1$), bilateral and unilateral trade liberalization (i.e. reduction in τ_{ij}, τ_{ji}, or both τ_{ij} and τ_{ji}) increase welfare W_i and aggregate productivity $\tilde{\Phi}_i$, but have ambiguous effects on average productivity $\overline{\Phi}_i$ and covariance $\ddot{\Phi}_i$.*

2.7.2 Efficient allocation and fixed wages

With efficient resource allocation and an outside sector ($\beta < 1$), wages are exogenously determined and do not respond to trade reforms. One can show that bilateral and unilateral export liberalization exert the same welfare- and productivity-enhancing effects as with flexible wages. By contrast, unilateral import liberalization now lowers W_i and $\tilde{\Phi}_i$ in the liberalizing country.[15]

With exogenous wages, the unilateral reduction in import costs τ_{ji} triggers two mechanisms that are also active with endogenous wages, but their overall impact is now reversed. The direct effect of the reform is to lower the productivity cut-off for exporting from country j to the liberalizing economy i, φ_{ji}^*, and to induce continuing foreign exporters to sell more in i. This intensifies import competition in i, reducing demand for its home varieties and pushing its domestic productivity cut-off, φ_{ii}^*, upwards. The indirect effect of the reform is to raise the productivity threshold for survival in j, φ_{jj}^*, such that free entry still holds now that j firms expect higher export profits. This makes j a more competitive market for firms from i, and raises the cut-off for exporting from i to j, φ_{ij}^*. In turn, free entry in i acts to depress the survival threshold φ_{ii}^*.

When wages are flexible, their endogenous adjustment dampens the indirect effect and the direct effect dominates: Since expected firm profits depend both on wages and productivity cut-offs, smaller cut-off movements are required for the free-entry condition to continue to hold when wages can move as well. Conversely, when wages are fixed, the indirect effect dominates. As a result, cut-off productivity φ_{ii}^*, aggregate welfare W_i, and measured aggregate productivity $\tilde{\Phi}$ all decline, as in Demidova (2008) and Bagwell and Lee (2016). The impact on average productivity $\overline{\Phi}_i$ and the OP gap $\ddot{\Phi}_i$ remains ambiguous.

Proposition 2 *Under no misallocation and fixed wages ($\beta < 1$), bilateral and unilateral export liberalization (i.e. reduction in τ_{ij} or both τ_{ij} and τ_{ji}) increase welfare W_i and aggregate productivity $\tilde{\Phi}_i$, but have ambiguous effects on average productivity $\overline{\Phi}_i$ and covariance $\ddot{\Phi}_i$. Unilateral import liberalization (i.e. reduction in τ_{ji}) reduces W_i and $\tilde{\Phi}_i$, but has ambiguous effects on $\overline{\Phi}_i$ and $\ddot{\Phi}_i$.*

[15] It also increases the consumer price index, a phenomenon known as the Metzler paradox.

2.7.3 Resource misallocation

In the presence of resource misallocation, economies operate in a sub-optimal equilibrium both before and after any trade reforms. From the theory of the second best, it is therefore not possible to unambiguously determine the impact of trade liberalization on aggregate welfare and productivity. Moreover, this impact need not be monotonic in the initial degree of misallocation, such that initially more severe market frictions may either amplify or dampen the gains from globalization. This occurs because trade triggers resource reallocation across firms based on distorted productivity $\underline{\varphi}$ rather than true productivity φ, which can improve or worsen allocative efficiency.

Intuitively, misallocation acts by distorting firm selection on the extensive margin and firm market shares on the intensive margin. Hence the gains from trade depend on how different firms respond. Misallocation would reduce the gains from trade if more productive firms cannot fully respond to growth opportunities, while less productive firms are not forced to exit. For example, trade liberalization could magnify existing distortions if firms with inefficiently abundant access to inputs are able to expand their activity relatively more than firms with inefficiently constrained resources. Conversely, misallocation may increase the gains from trade if trade has a cleansing effect on the economy and serves to reallocate activity towards truly more productive firms.

In sum, in the presence of misallocation, the welfare and productivity impact of trade liberalization hinges on initial state variables characterizing the economy and on model parameters, in particular the shape of the joint distribution $H_i(\varphi, \eta)$.

Proposition 3 *Under resource misallocation, bilateral and unilateral trade liberalization (i.e. reductions in τ_{ij}, τ_{ji}, or both τ_{ij} and τ_{ji}) have ambiguous effects on welfare W_i, aggregate productivity $\tilde{\Phi}_i$, average productivity $\overline{\Phi}_i$, and covariance $\ddot{\Phi}_i$.*

2.8 Numerical Simulation

Given the theoretically ambiguous effects of globalization in different economic environments, we explore the impact of counterfactual trade reforms through numerical simulations. We study the effects of reducing trade costs by 20% from an initial value of $\tau_{ij} = \tau_{ji} = 1.81$ in three scenarios: bilateral trade liberalization (shocks to both τ_{ij} and τ_{ji}), unilateral export liberalization (shock to τ_{ij}), and unilateral import liberalization (shock to τ_{ji}).

We use model parameters from the recent literature (e.g. Burstein and Cravino 2015), and set the elasticity of substitution to $\sigma = 3$ and the expenditure share of differentiated goods to $\beta = 0.7$, so that wages are exogenously fixed, $w_i = 1$. We assume that both countries have a unit measure of consumers, $L_i = L_j = 1$, and symmetric fixed costs of entry, production and exporting, $f_i^E = f_j^E = 0.1$, $f_{ii} = f_{jj} = 1.2$, and $f_{ij} = f_{ji} = 1.75$.

In the case of no misallocation, we assume productivity is symmetrically distributed in both countries, and provide simulation results for both Pareto ($\varphi \sim G(\varphi) = 1 - (\varphi^m/\varphi)^\theta$, $\varphi^m = 1$, $\theta = 2.567$) and log-

Normal distributions ($\ln\varphi \sim \mathcal{N}\left(\mu_\varphi, \sigma_\varphi\right)$, $\mu_\varphi = 0$, $\sigma_\varphi = 1$).[16] In the case of misallocation, we assume the productivity and distortion draws follow a bivariate log-Normal distribution:

$$\begin{bmatrix}\ln\varphi \\ \ln\eta\end{bmatrix} \sim \mathcal{N}\left(\mu, \Sigma\right), \quad \mu = \begin{bmatrix}\mu_\varphi \\ \mu_\eta\end{bmatrix}, \quad \Sigma = \begin{bmatrix}\sigma_\varphi^2 & \rho\sigma_\varphi\sigma_\eta \\ \rho\sigma_\varphi\sigma_\eta & \sigma_\eta^2\end{bmatrix}.$$

We choose $\mu_\varphi = \mu_\eta = 1$ and $\sigma_\varphi = 1$ for both countries. For the foreign economy, we fix $\sigma_\eta = 0.05$, and $\rho = 0$. For the home economy, we consider varying degrees of misallocation in the range $\sigma_\eta \in \{0, 0.05, 0.15\}$ and $\rho \in [-0.5, 0.5]$.

Figure 2 visualizes the full results of these numerical exercises. Table 1 presents an instructive snapshot for the cases of no misallocation and misallocation with high distortion dispersion ($\sigma_\eta = 0.15$) and either negative, zero or positive productivity-distortion correlation ($\rho \in \{-0.4, 0, 0.4\}$).

Four patterns stand out in Table 1. First, in the absence of misallocation, bilateral and unilateral export liberalization increase welfare and measured aggregate productivity whether wages are flexible or not (Panels A and B). By contrast, unilateral import liberalization increases W_i and $\tilde{\Phi}_i$ when wages are flexible, but reduces both when wages are fixed. This is consistent with Propositions 1 and 2.

Second, in the absence of misallocation, both components of aggregate productivity, average productivity $\overline{\Phi}_i$ and covariance $\ddot{\Phi}_i$, play an economically significant role and always move in the same direction. On average, changes in average productivity $\overline{\Phi}_i$ account for 75% of the overall change in aggregate productivity $\tilde{\Phi}_i$, while allocative efficiency captured by $\ddot{\Phi}_i$ mediates 25%. This indicates that both firm entry/exit and reallocations of activity across active firms are important mechanisms of adjustment in response to trade shocks. These results are not specific to this parameterization and hold under a wide range of alternative reasonable parameterizations.

Third, resource misallocation dramatically affects the welfare and productivity gains from trade, and this effect is not monotonic in the degree of misallocation, consistent with Proposition 3 (Panel C). For consistency, we compare the results in Panels B and C. With flexible wages, the welfare and productivity gains from trade are either marginally smaller or indistinguishably higher with misallocation than without, and decrease smoothly with the correlation parameter ρ. The effects of globalization become much more nuanced with fixed wages. Bilateral and unilateral export liberalization now increase welfare strictly less with than without misallocation, but the gains are non-monotonic in ρ: they peak when distortions are close to orthogonal to productivity ($\rho \approx 0$), but decline significantly and can turn negative away from $\rho \approx 0$. At the same time, unilateral import liberalization can reduce welfare more severely with misallocation than without when $\rho << 0$, but may conversely increase welfare when ρ is sufficiently positive. As for productivity, trade liberalization generates less negative or higher productivity gains at higher values for ρ, and there are more likely to be productivity gains when $\rho > 0$. However in general, the presence of misallocation can increase, reduce, preserve the sign or reverse the sign of the productivity gains that obtain without misallocation.

Finally, the three OP productivity terms ($\tilde{\Phi}_i$, $\overline{\Phi}_i$ and $\ddot{\Phi}_i$) can move in different directions only in

[16] The value for the Pareto parameter θ is based on Head et al. (2014), whose preferred estimate $(\sigma - 1)/\theta = 0.779$ implies $\theta = (3 - 1)/0.779 = 2.567$ when $\sigma = 3$.

the presence of misallocation and fixed wages. In particular, while they may all increase or all decrease, it is possible for $\tilde{\Phi}_i$ and $\overline{\Phi}_i$ to both rise while $\ddot{\Phi}_i$ falls in response to the same shock (or vice versa). Extensive numerical exercises indicate that this result cannot obtain in the absence of misallocation under reasonable parameter assumptions.

It is useful to foreshadow our empirical findings in light of this simulation analysis. Using point estimates from our baseline IV regressions, we tabulate the implied productivity effects of a 20% unilateral cut in export and import costs in Panel D. The empirical results are consistent with the sign pattern in Columns 6-8 and 10-12 in the last row of Panel C (misallocation with fixed wages and $\rho = 0.4$). The implied magnitudes are well in line with the numerical calculations for export reforms, and notably higher for import reforms. This anticipates our conclusion that in practice, export expansion and import competition both stimulate aggregate productivity, but they operate through different channels and their impact is moderated by resource misallocation.

2.9 Discussion

We conclude by discussing two model features that allow us to transition to the empirical analysis. First, for expositional simplicity, we have analyzed an economy with a single differentiated-good sector. We show in Appendix C that our main theoretical conclusions extend to a world with multiple symmetric differentiated-good sectors k, where consumer utility is a Cobb-Douglas aggregate across sector-specific CES consumption indices. The effect of any shock on aggregate welfare W_i and productivity $\tilde{\Phi}_i$ now depends on the weighted average response of sector-level productivity $\tilde{\Phi}_{ik}$. A uniform trade cost reduction affects $\tilde{\Phi}_{ik}$ equally across sectors, while a disproportionately bigger shock to sector k' changes $\tilde{\Phi}_{ik'}$ disproportionately more. This justifies our empirical estimation strategy which exploits variation across countries, sectors and time for identification purposes.

Second, in studying trade liberalization, we have considered the impact of reductions to trade costs, τ_{ij} and τ_{ji}. Intuitively, the effect of an exogenous shock to foreign demand - such as an increase to foreign market size L_j or aggregate expenditure E_j - would be qualitatively the same as the effect of a fall in export costs, τ_{ij}. Likewise, the effect of an exogenous shock to foreign supply - such as a rise in the measure of foreign firms M_j or a shift in the foreign productivity distribution $G_j(\varphi)$ - would be similar to the effect of a fall in import costs, τ_{ji}. This holds because all of these shocks operate through and only through movements in home's (distorted) productivity cut-offs for production and exporting. This justifies our choice of instruments in the IV analysis.

3 Data

We empirically evaluate the impact of international trade on aggregate productivity using rich cross-country, cross-sector panel data from two primary data sources, CompNet and WIOD. This section describes the key variables of interest, and presents stylized facts about the cross-sectional and time-series variation in productivity and trade activity in the panel.

3.1 CompNet Productivity Data

We exploit unique new data on the evolution of macroeconomic indicators for 20 NACE 2-digit manufacturing sectors in 14 European countries over the 1998-2011 period from the CompNet Micro-Based Dataset.[17] Two features of the data make it unprecedented in detail and ideally suited to our analysis. First, it contains not only aggregate measures at the country-sector-year level, but also multiple moments of the underlying distribution of economic activity across firms in each country-sector-year cell. This includes for example means, standard deviations and skewness of various firm characteristics, as well as key moments of the joint distribution of several such characteristics. The dataset is built from raw firm-level data that are independently collected in each country and maintained by national statistical agencies and central banks. These raw data have been standardized and consistently aggregated to the country-sector-year level as part of the Competitiveness Research Network initiative of the European Central Bank and the European System of Central Banks.[18]

Second, CompNet includes several productivity measures that are constructed specifically to permit an Olley-Pakes (1996) decomposition of aggregate productivity in country i, sector k and year t ($AggProd_{ikt}$) into unweighted average firm productivity ($AvgProd_{ikt}$) and the covariance of firm productivity and firm share of economic activity ($CovProd_{ikt}$).[19]

We examine labor productivity defined as log real value added per worker and weight firms by their share of total employment at the country-sector-year level.[20] These empirical measures correspond exactly to the theoretical objects $\Phi_i(\varphi)$ and $\theta_i(\varphi)$ in Section 2.4.1, such that the measured aggregate productivity components also map exactly to the OP decomposition in Section 2.4.2, i.e. $\tilde{\Phi}_i = AggProd_{ikt}$, $\overline{\Phi}_i = AvgProd_{ikt}$, and $\ddot{\Phi}_i = CovProd_{ikt}$. The labor productivity measure also has the advantage that it is based on directly observable data, rather than on a TFPR residual from production function estimates that is subject to endogeneity and omitted variable concerns.

Table 2 documents the variation in aggregate productivity and its constituent terms across countries, sectors and years in the panel. We report additional summary statistics for the variation across sectors and years within countries in Appendix Table 1. The panel contains 2,811 observations and is unbalanced because of different time coverage across countries. Aggregate productivity averages 3.21 in the panel (standard deviation 1.13), with allocative efficiency contributing 0.23 (7.2%) on average as

[17] The 14 countries are: Austria, Belgium, Estonia, Finland, France, Germany, Hungary, Italy, Lithuania, Poland, Portugal, Slovakia, Slovenia, Spain. While CompNet covers all NACE 2-digit industries in the European classification, we restrict the sample to 20 manufacturing industries for which we can obtain WIOD data on trade activity. These correspond to NACE-2 sectors 10 to 31 without sectors 12 (tobacco products) and 19 (coke and refined petroleum products).

[18] See Lopez-Garcia et al. (2015) for details on the data methodology and structure.

[19] The empirical counterpart to the theoretical OP decomposition in equation (2.25) at the country-sector-year level is:

$$AggProd_{ikt} = \underbrace{\frac{1}{N_{ikt}} \sum_f Prod_{ikft}}_{AvgProd_{ikt}} + \underbrace{\sum_f \left(Prod_{ikft} - \overline{Prod}_{ikt}\right)\left(\theta_{ikft} - \overline{\theta}_{ikt}\right)}_{CovProd_{ikt}} \tag{3.1}$$

[20] The empirical results are unchanged if we instead use firm sales as weights. We prefer employment weights because they produce a model-consistent measure of aggregate productivity that can be linked to welfare and because they are immune to potential variation in the price deflator across firms.

proxied by the covariance term (standard deviation 0.22). However, there are sizable differences in the level and composition of $AggProd_{ikt}$ across countries, with $CovProd_{ikt}$ capturing only 1.4% in Austria and 2.5% in Germany but up to 25.9% in Lithuania and 33.3% in Hungary. Moreover, the standard deviation of aggregate productivity across sectors and years reaches 0.56 for the average country, while the corresponding number for allocative efficiency stands at 0.17. Thus economy-wide productivity could be significantly lower if labor were randomly re-assigned across firms.

Table 2 also provides summary statistics for aggregate productivity growth at 1-, 3- and 5-year horizons. Figure 3 shows that the reallocation of labor across firms can account for a substantial share of aggregate labor productivity growth, as is the case for some Eastern European economies such as Austria, Italy, Hungary and Lithuania prior to the 2008-2009 global financial crisis.

3.2 WIOD Trade Data

We use data on international trade activity by country, sector and year from WIOD, the World Input-Output Database. While standard trade statistics report gross trade flows by country and output sector, WIOD exploits country-specific input-output tables to infer trade in value added by sector of final use. This makes it possible to identify the domestic value added embedded in a country's exports, as well as the foreign value added contained in its imports. WIOD also decomposes imports of a given sector into imports used for final consumption and imports used as intermediate inputs by producers in that sector and in other downstream sectors. Although WIOD relies on proportionality assumptions in value added and input use across countries and sectors, it is the first data of its kind and has been used in recent path-breaking studies of global value chains such as Bems and Johnson (2015).

WIOD reports the gross value of sales from input sector k in origin country i to output sector s in destination country j in year t, X_{ijkst}. Input sectors are in the NACE 2-digit classification, while output sectors comprise all NACE 2-digit sectors plus several components of final consumption. Trade values are recorded in US dollars, which we convert into euros using annual exchange rates.

We proxy export demand for exporting country i in sector k and year t, $ExpDemand_{ikt}$, with the log value of i's gross exports in sector k. We do not distinguish between exports used for final consumption or downstream production abroad, since both represent foreign demand from the perspective of i. By contrast, we measure import competition in importing country i, sector k and year t, $ImpComp_{ikt}$, with the log of the value of i's imports in sector k, less the value of sector k imports used by i in the production of sector k goods. We intentionally do not remove sector k imports used in i by producers in other sectors, since such imports too compete with locally produced k goods.

$$ExpDemand_{ikt} = \ln\left[\sum_{j,s} X_{ijkst}\right], \quad ImpComp_{ikt} = \ln\left[\sum_{j,s\neq k} X_{jikst}\right]. \tag{3.2}$$

Table 2 provides summary statistics for $ExpDemand_{ikt}$ and $ImpComp_{ikt}$ across the 14 countries and 20 NACE-2 sectors in our 1998-2011 sample with CompNet productivity data. $ExpDemand_{ikt}$ averages 7.65 in the panel, with a standard deviation of 1.74. The corresponding mean and dispersion for $ImpComp_{ikt}$ are 6.41 and 1.97, respectively. We summarize individual countries' trade exposure in Appendix Table 1, and plot its evolution over time in Figure 4. While all countries experienced steady import and export expansion prior to the 2008-2009 financial crisis, they underwent a sharp contraction in 2009 before regaining some ground by 2011 (Figure 4A). Although EU-15 members and new EU member states display broadly comparable import activity, the latter saw dramatically faster export growth during the period we study (Figures 4B and 4C).

Since observed trade flows capture aggregate supply and demand conditions in general equilibrium, $ExpDemand_{ikt}$ confounds exogenous foreign demand for the products of country i with i's endogenous export supply capacity. Analogously, $ImpComp_{ikt}$ reflects both the exogenous supply of foreign products to country i and i's endogenous import demand. While we use $ExpDemand_{ikt}$ and $ImpComp_{ikt}$ as baseline measures of export demand and import competition, our estimation strategy will therefore rely on instrumental variables to isolate the exogenous components of export demand and import competition. In particular, we will exploit import tariffs and Bartik-style shocks to foreign export supply and foreign import demand, as well as the rise of China on world markets.

4 Trade and Aggregate Productivity: OLS Correlation

We empirically examine the effects of international trade on aggregate productivity in three steps. In this Section, we first provide baseline OLS evidence that countries' export and import activity is systematically related to their aggregate output, value added, employment and productivity. While informative, this evidence is not conclusive because the empirical specifications cannot fully address concerns about the endogeneity of trade outcomes and economic performance. In order to identify the causal effects of globalization, in Section 5 we pursue an IV-2SLS estimation strategy and conduct a series of robustness checks on the IV specification. Finally, in Section 6 we perform additional analyses to explore the channels through which export demand and import competition shape aggregate productivity.

4.1 OLS Specification

We explore the link between international trade activity and aggregate economic performance with the following baseline OLS specification:

$$Y_{ikt} = \alpha + \beta_{EX}\, ExpDemand_{ikt} + \beta_{IM}\, ImpComp_{ikt} + \Gamma Z_{ikt} + \psi_{it} + \varepsilon_{ikt}. \tag{4.1}$$

Here Y_{ikt} refers to aggregate productivity in country i, sector k and year t, $AggProd_{ikt}$, or its two subcomponents, the unweighted average firm productivity, $AvgProd_{ikt}$, and the covariance between firm productivity and employment share, $CovProd_{ikt}$. By the properties of ordinary least squares and the Olley-Pakes decomposition, the coefficient estimates from the regressions for $AvgProd_{ikt}$ and $CovProd_{ikt}$ will mechanically sum to the coefficient estimates from the regression for $AggProd_{ikt}$. There is nevertheless value in separately estimating all three regressions in order to determine the sign, economic magnitude and statistical significance of the effects of globalization on each productivity outcome. There are no efficiency gains from estimating the three regressions as a simultaneous system of equations because they all include the same set of fixed effects and right-hand side variables.

The main coefficients of interest, β_{EX} and β_{IM}, would in principle identify the causal impact of exogenous shocks to export demand and import competition if the latter are measured without error. Given the endogeneity of our baseline proxies for $ExpDemand_{ikt}$ and $ImpComp_{ikt}$, however, we interpret the OLS estimates of β_{EX} and β_{IM} only as indicative correlations.

Specification (4.1) includes country-year pair fixed effects, ψ_{it}, for the 14 countries and 14 years in our sample, such that β_{EX} and β_{IM} are identified from the variation across sectors within countries at a given point in time. The ψ_{it} account for macroeconomic supply and demand shocks at the country-year level that affect trade and productivity symmetrically in all sectors, such as movements in aggregate income, productivity, labor supply, exchange rates, interest rates, or price indices. Implicitly, the fixed effects also capture non-transient country characteristics such as general institutional quality, capital and labor market frictions, infrastructure and geographic remoteness, as well as global shocks that are common across countries such as the 2008-2009 financial crisis. We cluster standard errors, ε_{ikt}, by sector-year to accommodate cross-country correlation in sector-specific shocks.

We include several control variables Z_{ikt} to alleviate concerns with omitted variable bias, measurement error and sample selection. First, there may be worldwide sector trends in supply and demand conditions. To capture these, we condition on the average log number of active firms, $\overline{\ln N}_{kt}$, and the average log employment, $\overline{\ln L}_{kt}$, by sector-year, which we obtain by averaging $\ln N_{ikt}$ and $\ln L_{ikt}$ across countries. In alternative specifications we further include sector or sector-year fixed effects.

Second, the firm-level data that underlie the CompNet dataset are subject to minimum firm size thresholds. These thresholds vary across countries but do not change within countries over time, and are controlled for with the country-year pair fixed effects. As extra precaution, we also include the log number of firms by country-sector-year, $\ln N_{ikt}$, but the results are not sensitive to this control.

Third, measurement error may bias β_{EX} and β_{IM} either upwards or downwards. On the one hand, classical measurement error in firm size L_{ikft} in the raw data would introduce negatively correlated noise in firms' labor productivity and employment share, and result in misleadingly low values for $CovProd_{ikt}$. This would lead us to underestimate β_{EX} and β_{IM} in specifications for allocative efficiency. On the other hand, non-classical measurement error in $\ln N_{ikt}$ may generate mechanical correlation between the left- and right-hand side variables of interest. Controlling for $\ln N_{ikt}$ helps alleviate both of these concerns.

Finally, we implement two sample corrections to ensure that our results are not driven by outliers. We always exclude from the regression sample country-sector-year observations that are based on data for fewer than 20 firms. We also always drop observations with extreme annual growth rates in the top or bottom percentile of the distribution for any of the key variables of interest (aggregate productivity, average productivity, covariance term, exports or import competition, number of firms). These two corrections filter out 11% of the raw sample.

4.2 OLS Results

We first assess the correlation between trade and aggregate economic activity. In Columns 1-3 of Table 3, we estimate specification (4.1) for log total output, log value added and log employment by country, sector and year as the outcome variable Y_{ikt}, from CompNet. We find that export expansion is associated with higher overall output, greater value added in production, and more factor resources (labor) engaged in manufacturing. Conversely, more intense import penetration is correlated with lower total domestic output and employment, but nevertheless higher value added.

Turning to the trade-productivity nexus in Columns 4-6, aggregate exports and imports are both positively correlated with aggregate productivity. These correlations are economically large and highly statistically significant at 1%: A 20% rise in $ExpDemand_{ikt}$ and $ImpComp_{ikt}$ is associated with 2.5% and 2.1% higher $AggProd_{ikt}$, respectively. While comparable, these magnitudes mask important differences between export and import activity. Export expansion is accompanied by both stronger average firm productivity $AvgProd_{ikt}$ and increased concentration of activity in more productive firms $CovProd_{ikt}$, with the former channel roughly twice the magnitude of the latter. By contrast, deeper import penetration entails higher firm productivity on average, but a shift in activity towards less productive firms.

Although not causal, this evidence is consistent with increased foreign demand boosting aggregate productivity and production activity, and with stiffer import competition stimulating productivity growth while depressing overall production. The OLS results also raise the possibility that different aspects of globalization may influence aggregate productivity through different mechanisms.

Specification (4.1) identifies the long-run correlation between productivity and trade activity. We explore this correlation in the short to medium term in Appendix Table 2, where we analyze how changes in productivity co-move with concurrent changes in imports and exports over 1-, 3- and 5-year overlapping periods.[21] By first-differencing all left- and right-hand side variables and including year fixed effects, we implicitly subsume country-sector pair fixed effects and accommodate global macroeconomic shocks affecting all countries and sectors. We observe that the productivity-trade relationship is stronger at medium horizons of 3 to 5 years, but nevertheless sizeable even in the very short run of 1 year.

5 Impact of Trade on Aggregate Productivity: IV Causation

5.1 The Endogeneity Problem

The baseline OLS results capture the correlation between countries' participation in international trade and their aggregate productivity performance. This correlation may not identify the causal effect of globalization because of two potential sources of endogeneity: simultaneity and reverse causality.

One possibility is that trade and productivity performance are jointly determined by some omitted variable. Given the country-year fixed effects in the OLS specification, such omitted variable bias would have to vary systematically across sectors within country-years to explain our findings. This rules out

[21] The exact estimating equation is $\Delta Y_{ikt} = \alpha + \beta_{EX}\, \Delta ExpDemand_{ikt} + \beta_{IM}\, \Delta ImpComp_{ikt} + \Gamma \Delta Z_{ikt} + \varphi_t + \varepsilon_{ikt}$.

many alternative explanations based on country-year characteristics such as strong institutions, favorable macroeconomic conditions, or abundant physical and human capital.

Reverse causality poses a more important concern: Aggregate productivity can endogenously affect trade activity. In general equilibrium, observed export flows reflect both endogenous supply conditions in the exporting country and exogenous demand conditions in the importing country. Standard trade theory implies that firms in a more productive country-sector would be more competitive on world markets and therefore undertake more exports. As a result, the OLS estimates of β_{EX} would be positively biased. Symmetrically, observed import flows reflect both endogenous demand conditions in the importing country and exogenous supply conditions in the exporting country. Given local demand, a less productive domestic country-sector would be less competitive from the perspective of foreign firms and could induce more entry by foreign suppliers. This would introduce negative bias in the OLS esimates of β_{IM}. These examples illustrate only two of various possible mechanisms that could generate reverse causality and bias our estimates of the productivity impact of globalization either upwards or downwards.

5.2 IV Strategy

In order to identify the causal effect of international trade on aggregate productivity, we adopt a two-stage least squares (2SLS) estimation strategy. In the first stage, we use instrumental variables IV_{ikt} to identify arguably exogenous movements in export and import activity, $\widehat{ExpDemand}_{ikt}$ and $\widehat{ImpComp}_{ikt}$, from observed export and import trade flows, $ExpDemand_{ikt}$ and $ImpComp_{ikt}$. In the second stage, we regress the productivity outcomes of interest on these predicted exogenous values in place of their endogenonus counterparts:

$$Y_{ikt} = \alpha + \beta_{EX}\, \widehat{ExpDemand}_{ikt} + \beta_{IM}\, \widehat{ImpComp}_{ikt} + \Gamma Z_{ikt} + \psi_{it}(+\psi_{kt}) + \varepsilon_{ikt} \text{ (second stage)} \quad (5.1)$$

$$\{ExpDemand_{ikt},\, ImpComp_{ikt}\} = \alpha_{IV} + \Gamma_{IV} Z_{ikt} + \Theta_{IV} IV_{ikt} + \phi_{it}(+\phi_{kt}) + \epsilon_{ikt} \text{ (first stage)} \quad (5.2)$$

We continue to condition on controls Z_{ikt} and country-year pair fixed effects, ψ_{it} and ϕ_{it}, as in the OLS baseline. In robustness checks, we further add sector fixed effects, ψ_k and ϕ_k, or sector-year fixed effects, ψ_{kt} and ϕ_{kt}. These account respectively for permanent or time-variant differences in supply and demand conditions across sectors that affect all countries, such as factor intensities, technological growth or consumer preferences. We continue to cluster standard errors, ε_{ikt} and ϵ_{ikt}, by sector-year.

The ideal instruments for trade exposure would be valid by having predictive power in explaining trade flows, and would meet the exclusion restriction by affecting productivity only through the trade channel. In the case of $ExpDemand_{ikt}$, we would therefore like to isolate exogenous foreign demand for ik products in year t from country i's endogenous export supply of sector k goods in year t. In the case of $ImpComp_{ikt}$, we would like to separate exogenous foreign supply of k products to i in year t from i's endogenous import demand for k goods in year t.

We use two Bartik instruments for foreign export supply and foreign import demand, which we construct by combining information on countries' initial trade structure at the beginning of the panel with the contemporaneous trade flows of their trade partners with the world.[22] This IV strategy capitalizes on two ideas: First, the share of country i's exports in sector k going to destination d at time $t = 0$, $\frac{X_{idk,t=0}}{X_{ik,t=0}}$, and the share of i's imports coming from origin o at time $t = 0$, $\frac{M_{oik,t=0}}{M_{ik,t=0}}$, are not influenced by subsequent exogenous shocks respectively to aggregate demand in d and to aggregate supply in o. Second, aggregate demand for sector k goods in destination d at time t can be proxied with d's total absorption of k products, defined as domestic production plus worldwide imports minus worldwide exports, $Y_{dkt} + M_{dkt} - X_{dkt}$. This picks up total expenditure in destination d on sector k which is the relevant measure of market size in the model. Symmetrically, aggregate supply of sector k goods from origin o at time t can be measured with o's export value added for final consumption of k products, XVA^{final}_{okt}. This accounts for the fact that country o may use imported inputs in producing k products, and aims to isolate supply shocks specific to o by considering only its own value added embedded in its exports. We focus on o's exports used for final consumption to capture the import competition rather than the imported-input supply emanating from origin o.

For each country-sector-year triplet ikt in our sample, we thus instrument export demand with foreign demand conditions, $FDemand_{ikt}$, computed as the weighted average absorption across i's export destinations using i's initial export shares as weights. We instrument import competition with foreign supply capacity, $FSupply_{ikt}$, calculated as the weighted average export value added for final consumption across i's import origins, using i's initial import shares as weights. We construct both instruments using the WIOD data. To guard against outliers due to measurement error or business cycle fluctuations, we average the initial import and export weights across the first three years in our data, 1998-2000.

$$FDemand_{ikt} = \ln\left[\sum_{d\neq i} \frac{X_{idk,t=0}}{X_{ik,t=0}} \left(Y_{dkt} + M_{dkt} - X_{dkt}\right)\right], \tag{5.3}$$

$$FSupply_{ikt} = \ln\left[\sum_{o\neq i} \frac{M_{oik,t=0}}{M_{ik,t=0}} XVA^{final}_{okt}\right], \tag{5.4}$$

$$MTariff_{ikt} = \frac{1}{NP_k} \sum_{p\subset\Omega_k} \tau_{ipt}. \tag{5.5}$$

In addition to the Bartik instruments, we also exploit the variation in import tariffs across countries, sectors and years, $MTariff_{ikt}$. We take the simple average applied tariff τ_{ipt} across all products p in sector k at time t using tariff data from WITS, where NP_k denotes the number of products mapped to a sector. $MTariff_{ikt}$ captures trade policy shocks that affect the degree of import competition by influencing foreign producers' incentives to enter the domestic market. In our panel, these tariffs vary primarily across sectors rather than across countries or over time.

Conceptually, we think of $FDemand_{ikt}$ as an instrument for $ExpDemand_{ikt}$, and view $FSupply_{ikt}$ and $MTariff_{ikt}$ as instruments for $ImpComp_{ikt}$. In practice of course, all three instruments enter as IV_{ikt} for both endogenous variables in the IV first stage.

[22] These instruments are similar in spirit to those in Hummels et al. (2014) and Berman et al. (2015) among others.

5.3 Baseline IV Results

The results in Table 4 indicate that the three instruments perform well in the first stage and meet the validity requirement. The Bartik measure of exogenous foreign demand has a positive impact on observed exports, the measure of exogenous foreign supply has a positive effect on observed import penetration, and import tariffs strongly deter imports. These patterns are highly statistically and economically significant and robust to adding sector or sector-year fixed effects. The most conservative estimates in Columns 3 and 6 (with both country-year and sector-year fixed effects) imply that a one-standard-deviation improvement in $FDemand_{ikt}$ leads to 34% higher $ExpDemand_{ikt}$, while a one-standard-deviation rise in $FSupply_{ikt}$ increases $ImpComp_{ikt}$ by 49%. Reducing import barriers by 10% translates into 13% lower imports. The R-squared in these regressions reaches 89%-99% across the various specifications.

Table 5 presents the second-stage estimates for the causal effect of international trade on aggregate productivity. Two findings stand out. First, export demand and import competition both significantly increase aggregate productivity, $AggProd_{ikt}$. In the baseline without sector fixed effects in Column 1, a 20% growth in export demand boosts overall productivity by 8%, while a 20% rise in import competition leads to 1.4% higher productivity. In the most restrictive specification that adds sector-year pair fixed effects in Column 7, export demand and import competition exert large effects of comparable magnitudes: The aggregate productivity gains following a 20% increase in export demand or import penetration now amount to 7.3% and 10%, respectively.

Second, Table 5 reveals that the productivity gains from export and import expansion are mediated through different channels. Export growth induces both sizeable improvements in average firm productivity, $AvgProd_{ikt}$, and a reallocation of economic activity towards more productive firms as manifested in higher $CovProd_{ikt}$. The reallocation of activity towards more productive firms contributes 26% (Column 3) to 38% (Column 9) of the total productivity benefit. By contrast, all of the productivity gains from import competition result from higher average firm productivity, and these gains are moreover partly countered by a shift in economic activity towards less productive firms. The latter negates 24% of average productivity growth in the baseline (Column 3) and 14% with sector-year fixed effects (Column 9).

5.4 Sensitivity Analysis

We perform extensive sensitivity analysis to establish the stability of our results to alternative specification choices. We record consistently large and significant effects of export demand and import competition on all three productivity outcomes with one exception: The impact of $ImpComp_{ikt}$ on allocative efficiency $CovProd_{ikt}$ always retains its negative sign but is often imprecisely estimated in specifications with both country-year and sector-year fixed effects.

First, we consider each dimension of trade exposure one at a time. This ensures that the magnitude and significance of the estimated effects of export and import activity are not driven by multi-colinearity. To focus on export activity, we include only $ExpDemand_{ikt}$ in the second stage and use $FDemand_{ikt}$ as the single instrument in the first stage. To examine import penetration, we introduce only $ImpComp_{ikt}$ in the second stage and exploit only $FSupply_{ikt}$ and $MTariff_{ikt}$ as instruments in the first stage. Panels A and B in Appendix Table 3 show that this delivers qualitatively similar results and quantitatively bigger magnitudes for each dimension of globalization.

Second, we perform additional tests to ensure that outliers are not driving the results. The baseline specification already excludes observations at the country-sector-year level that have been aggregated across fewer than 20 firms or that exhibit annual growth in the top or bottom percentile for key variables (i.e. $AggProd_{ikt}$, $AvgProd_{ikt}$, $CovProd_{ikt}$, $ExpDemand_{ikt}$, $ImpComp_{ikt}$, $FDemand_{ikt}$, $FSupply_{ikt}$). In Panel C of Appendix Table 3, we confirm that the results survive when we further winsorize these variables in levels at the 1st and 99th percentiles. In unreported regressions, we have checked that similar patterns hold if we alternatively drop each individual country or sector one at a time.

Third, we take into account the variation in different sectors' share of a country's overall economic activity, which matters for sectors' contribution to economy-wide outcomes like employment, productivity or welfare. In the baseline specification, sectors are treated symmetrically, such that β_{EX} and β_{IM} quantify the impact of trade on the average sector. Our findings remain unchanged or stronger when we instead weight observations by the initial country-specific employment share of each sector in Panel D of Appendix Table 3: In particular, both $ExpDemand_{ikt}$ and $ImpComp_{ikt}$ exert large significant effects on all three OP productivity terms even in the stringent specification with sector-year fixed effects.

Forth, we confirm that the results are robust to lagging $ExpDemand_{ikt}$ and $ImpComp_{ikt}$ by one year in Panel E of Appendix Table 3. This informs the possible delayed effects of international trade on aggregate productivity that arise through the gradual adjustment in economic activity within and across firms. The coefficient estimates remain virtually unchanged.

Finally, we establish that the results are robust to using a relative indicator of import competition instead of an absolute one. The baseline measure $ImpComp_{ikt}$ identifies the scale of foreign suppliers' activity in the home market, whose size is implicitly controlled for with the country-year fixed effects. Through the lens of the model, an equally valid measure of import competition is the ratio of imports to domestic production. We therefore construct $ImpCompRatio_{ikt} = \sum_{j,s\neq k} X_{jikst}/\overline{Output}_{ik}$, averaging the denominator by country-industry in the panel to mitigate concerns with domestic production endogenously responding to import penetration. In Panel A of Table 6, we estimate specification (5.1) using $ImpCompRatio_{ikt}$ in place of $ImpComp_{ikt}$ and an analagously constructed instrument $FSupplyRatio_{ikt}$ in place of $FSupply_{ikt}$. The evidence corroborates the baseline IV findings.[23]

5.5 Import Competition from China

A major shock to the global economy in the 21st century has been the dramatic rise of China. Chinese exports grew rapidly after China joined the WTO in 2001 and after MFA binding quotas on Chinese textiles and apparel were lifted in 2005. This shock has contributed significantly to the deepening of import competition in many developed economies not only because of its scale, but also because it has

[23] The results are also robust to proxying import competition with the ratio of imports to domestic employment - an alternative measure that is not theoretically founded but is independent of local factor and product prices.

increased competition specifically from producers in a large, lower-wage country.

In this section, we examine the impact of import competition specifically from China on aggregate productivity in Europe. This serves two purposes. First, this allows us to exploit a large trade shock that is exogenous from the perspective of individual countries and sectors in Europe and that acts as a quasi-natural experiment for identification purposes. Second, we can compare the effects of Chinese and overall import penetration to illuminate how local firms respond to competition from foreign firms with relatively low vs. high levels of productivity, cost and quality.

Using WIOD data as before, we measure import competition from China, $ChinaImpComp_{ikt}$, with country i's imports of sector k goods from China in year t, net of sector k imports used by i in the production of k products.

$$ChinaImpComp_{ikt} = \ln\left[\sum_{s\neq k} X_{China\rightarrow i,kst}\right], \tag{5.6}$$

$$ChinaSupply_{ikt} = \left\{\ln\left[\frac{M_{China\rightarrow i,k,t=0}}{M_{ik,t=0}} XVA^{final}_{China,kt}\right], \ln\left[\sum_{p\subset\Omega_k}\frac{M_{ip,t=0}}{M_{ik,t=0}} X_{China\rightarrow US,pt}\right]\right\} \tag{5.7}$$

We develop two new Bartik instruments $ChinaSupply_{ikt}$ for $ChinaImpComp_{ikt}$ in the spirit of Autor et al. (2015) and Bloom et al. (2015). The first instrument captures China's global export supply in sector k and year t with Chinese total export value added for final consumption, $XVA^{final}_{China,kt}$, and recognizes that the impact of this supply shock will vary across importing countries i based on China's initial share of i's imports of k goods at time $t = 0$, $\frac{M_{China\rightarrow ik,t=0}}{M_{ik,t=0}}$. The second instrument focuses on Chinese exports to the US as a reference country to exploit finer product disaggregation in the data and to avoid contamination from Chinese sales to European countries in our panel. We start with Chinese exports to the US by NACE 4-digit product p that belongs to sector k, $X_{China\rightarrow US,pt}$, and obtain a China supply shock specific to country i by taking the weighted average of $X_{China\rightarrow US,pt}$ across products using their share of i's initial imports in sector k from anywhere in the world, $\frac{M_{ip,t=0}}{M_{ik,t=0}}$.

We examine the productivity impact of Chinese import competition, $ChinaImpComp_{ikt}$, along with that of global export expansion, $ExpDemand_{ikt}$, in the new IV second stage. In the new IV first stage, we retain $FDemand_{ikt}$ and $MTariff_{ikt}$ as instruments, but we use $ChinaSupply_{ikt}$ in place of $FSupply_{ikt}$.

We present the results in Panel B of Table 6. Our findings for the productivity impact of worldwide export demand remain qualitatively and quantitatively similar. As with overall import competition, Chinese import competition too significantly raises average firm productivity and has either an insignificant or a negative significant effect on the productivity covariance term. Its net impact on aggregate productivity is positive but insignificant at standard confidence levels. In terms of magnitudes, the coefficient estimates indicate that the overall productivity gains induced by Chinese import competition are 16-18% of those generated by total import competition.

6 How Trade Affects Productivity: Interpretation and Mechanisms

How shall we interpret the empirical results in light of the theoretical framework in Section 2? Our estimation approach identifies the independent effects of export demand and import competition. Through the lens of the model, we can therefore interpret them as the effects of unilateral export and import liberalizations. In particular, recall from Section 2.9 that the theoretical impact of changes in export and import trade costs (τ_{ij} and τ_{ji}) are isomorphic to the impact respectively of changes in foreign market size (i.e. foreign's import demand) and foreign productivity (i.e. foreign's export supply capacity).

Consider first the case of no resource misallocation (see Panels A and B in Table 1). On the export side, increased export demand would in the first instance facilitate export entry by less productive firms by lowering the productivity cut-off for exporting. In general equilibrium with free entry, this would be accompanied by a rise in the productivity cut-off for domestic production and, correspondingly, in aggregate productivity, $AggProd_{ikt}$. The numerical exercises indicate that average firm productivity, $AvgProd_{ikt}$, would also rise, as would allocative efficiency, $CovProd_{ikt}$, because more productive firms would expand their exports by more.

On the import side, increased import competition has theoretically ambiguous effects on aggregate productivity. Its direct effect is to lower local demand for domestic firm output and raise the domestic productivity cut-off. At the same time, its indirect effect is to make the foreign market more competitive, and to thereby raise home's export productivity cut-off and lower home's survival cut-off due to free entry. With flexible wages, home wages can adjust down and ensure that the direct effect dominates, such that $AggProd_{ikt}$ goes up. When wages are fixed, by contrast, the indirect effect dominates, and $AggProd_{ikt}$ falls. These two scenarios also have different implications for the response of average productivity and the covariance term, determined respectively by firm entry/exit on the extensive margin and by the reallocation of activity across heterogeneous firms on the intensive margin. Of note, the numerical exercises establish that $AggProd_{ikt}$, $AvgProd_{ikt}$ and $CovProd_{ikt}$ always move in the same direction.

Consider next the case of resource misallocation (see Panel C in Table 1). Now both export and import liberalization can have ambiguous effects on aggregate productivity, because the economy transitions from one distorted steady state to another. As a result, trade shocks can trigger firm entry or exit and reallocate productive resources across inframarginal firms, in ways that bring the economy closer or further away from the first best. Numerical exercises show that export liberalization increases all three productivity terms, $\{AggProd_{ikt}, AvgProd_{ikt}, CovProd_{ikt}\}$, over a wide range of the parameter space. This holds regardless of whether wages are fixed or flexible. By contrast, import liberalization can move these outcomes in different directions across different segments of the parameter space. Moreover, with fixed wages it is possible that $AggProd_{ikt}$ and $AvgProd_{ikt}$ both rise, while $CovProd_{ikt}$ declines. This occurs for intermediate levels of dispersion σ_η in the distortion draw and sufficiently positive correlation $\rho(\varphi, \eta)$ between the productivity and distortion draws.

Empirically, the sign pattern for the effect of $ExpDemand_{ikt}$ on $\{AggProd_{ikt}, AvgProd_{ikt}, CovProd_{ikt}\}$ is $\{+, +, +\}$, while that for $ImpComp_{ikt}$ is $\{+, +, -\}$. This evidence is consistent with the presence of misallocation, whereby export expansion and import competition both improve aggregate productivity. However, export expansion generates productivity gains both through the exit of relatively less productive firms and the reallocation of market share towards more productive firms, while import competition exerts a cleansing effect along the extensive margin, but worsens allocative efficiency along the intensive margin. The direction of these effects, as well as the impact of a 20% increase in $ExpDemand_{ikt}$ and $ImpComp_{ikt}$ implied by our baseline IV results, are thus in line with the numerical simulation results for the case of fixed wages, intermediate distortion dispersion, and positive productivity-dispersion correlation (see Panel D and last line of Panel C in Table 1).

In this section, we present results from several additional exercises that are consistent with this interpretation and provide more direct evidence for the firm selection and resource misallocation channels.

6.1 Firm Selection

We first examine the impact of trade exposure on the extensive margin of firm selection and thereby on aggregate productivity. The logic of this analysis is as follows. In the absence of misallocation, globalization can affect aggregate productivity $AggProd_{ikt}$ by (i) raising the first-best productivity cut-off φ^*_{ii} and by (ii) reallocating resources across inframarginal firms. Theory implies that channels (i) and (ii) would manifest in the adjustment of $AvgProd_{ikt}$ and $CovProd_{ikt}$, respectively. Moreover, the change in φ^*_{ii} would be a sufficient statistic for both (i) and (ii) in general equilibrium. Since there is no misallocation, the observed minimum productivity across firms in a given country-sector-year, $\min Prod_{ikt}$, would be the empirical counterpart to φ^*_{ii}. Controlling for $\min Prod_{ikt}$, any residual impact of international trade on $\{AggProd_{ikt}, AvgProd_{ikt}, CovProd_{ikt}\}$ would therefore indicate that mechanisms other than (i) and (ii) must also operate.

In the presence of misallocation, globalization still affects aggregate productivity via (i) and (ii), but also by (iii) changing the degree of misallocation by shifting resources across firms along the extensive and intensive margins. The observed minimum productivity, $\min Prod_{ikt}$, would now be the empirical counterpart to the distorted productivity threshold $\underline{\varphi}^*_{ii}$ (recall that $\underline{\varphi} = \varphi\eta$). Controlling for $\min Prod_{ikt}$, any residual impact of international trade on $\{AggProd_{ikt}, AvgProd_{ikt}, CovProd_{ikt}\}$ would now be consistent with mechanism (iii) and the presence of misallocation.

Guided by theory, we therefore assess how globalization affects firm selection at the bottom end of the observed productivity distribution. We measure $\min Prod_{ikt}$ with the first percentile of log value added per worker across firms in CompNet, in order to guard against outliers due to measurement error or idiosyncratic firm shocks. We find in Panel A of Table 7 that export demand and import competition both raise $\min Prod_{ikt}$ (Columns 1 and 5). The estimates imply that the lowest productivity among surviving firms would increase by 4%-6.3% and 1.5%-5% following a 20% expansion in exports and import penetration, respectively.

We next quantify the contribution of firm selection to the overall productivity impact of trade, by expanding IV specification (5.1) to include $\min Prod_{ikt}$ in the second stage.[24] Higher $\min Prod_{ikt}$ is

[24] We have obtained similar results when controlling for a cubic polynomial in $\min Prod_{ikt}$. This more flexible approach

associated with higher aggregate and average productivity, but lower covariance between firm productivity and share of economic activity. Compared to the baseline in Table 5, the point estimates for β_{EX} and β_{IM} are reduced by 48% and 57% in the regressions for $AvgProd_{ikt}$ (Column 3). In the specification for $CovProd_{ikt}$, coefficient β_{EX} increases by 20%, while β_{IM} falls by 38% (Column 4). Overall, firm selection accounts for 31% of the impact of export demand and 62% of the impact of import competition on aggregate productivity $AggProd_{ikt}$ (Column 2). These numbers are respectively 48% and 54% when we further condition on sector-year fixed (Column 6).

Through the lens of the model, these results suggest that the observed productivity effects of globalization cannot be fully attributed to the reallocation of activity across firms in a frictionless economy via channels (i) and (ii). Instead, the patterns are consistent with the presence of resource misallocation, whereby international trade increases aggregate productivity in part by changing the efficiency with which resources are allocated across firms with different productivity and distortion levels. Along the extensive margin, the residual positive effects of trade in Columns 3 and 7 imply that export and import expansion cleanse the economy of low-productivity firms that would not have operated in the first best. Along the intensive margin, the evidence in Columns 4 and 8 indicates that higher export demand induces the reallocation of market share towards more productive firms that were previously suboptimally small, while steeper import competition worsens allocative efficiency.

6.2 Productivity Upgrading

The model in Section 2 ignores the potential impact of globalization on productivity upgrading within firms. However, international trade liberalization may change the costs and returns associated with the development of new technologies or the adoption of existing technologies that bring a firm closer to the frontier. In this subsection, we argue that accounting for this mechanism does not affect our conclusions for the role of firm selection and resource misallocation in the productivity response to trade.

Globalization may influence technological change through different channels, with ambiguous consequences for $AggProd_{ikt}$, $AvgProd_{ikt}$ and $CovProd_{ikt}$. Higher export demand may increase expected profits sufficiently to induce firms to upgrade productivity if there are economies of scale in innovation and adoption (e.g. Bustos 2011). Steeper import competition may discourage innovation by reducing profits from domestic sales, but it may conversely incentivize incumbents to upgrade productivity in order to remain competitive (e.g. Bloom et al. 2015, Dhingra 2013). These effects may be non-monotonic or non-linear across the firm productivity distribution (Aghion et al. 2018). In the presence of resource misallocation, distortions may prevent firms from upgrading in response to trade openness even when that would be profitable in the first best. At the same time, if distortion-induced constraints are not binding, trade-induced innovation may correct some of the misallocation in market shares across firms.

We explore this question empirically in Panel B of Table 7. We proxy the aggregate amount of productivity upgrading with CompNet data on log research and development expenditures at the country-

allows for the mapping between $\min Prod_{ikt}$, $AvgProd_{ikt}$ and $CovProd_{ikt}$ to be unique but non-linear under different modeling assumptions.

sector-year level, RD_{ikt}. We find that export demand growth has a positive but insignificant effect on R&D in the aggregate. The effect of import competition is large and significant, but its sign is sensitive to the inclusion of sector-year dummies (Columns 1 and 5).[25]

We then assess the extent to which firm selection and R&D activity together can account for the productivity impact of globalization, by controlling for both $\min Prod_{ikt}$ and RD_{ikt} in the IV second stage. The estimates for $\min Prod_{ikt}$, β_{EX} and β_{IM} remain similar to those in Panel A where we control only for $\min Prod_{ikt}$. Conditional on $\min Prod_{ikt}$, higher RD_{ikt} itself is associated with lower $AvgProd_{ikt}$ and higher $CovProd_{ikt}$, but not significantly correlated with $AggProd_{ikt}$.

6.3 Imperfect Institutions and Market Frictions

The results above are consistent with resource misallocation shaping the aggregate productivity response to trade. However, the evidence is indirect because we can neither observe nor measure misallocation in the data: As Section 2 demonstrates, neither the level nor the trade sensitivity of any productivity term $\{AggProd_{ikt}, AvgProd_{ikt}, CovProd_{ikt}\}$ is a sufficient statistic for the degree of misallocation.

In order to provide more direct evidence for the role of resource misallocation, we exploit the cross-country variation in the strength of institutions that govern the efficiency of factor and product markets. This approach rests on two premises. First, institutional imperfections constitute structural problems in an economy that generate an inefficient allocation of production inputs and market shares across firms. Institutional indicators thus identify primitive root causes that microfound resource misallocation in theoretical frameworks. For example, our model considers distortions to input costs that can be mapped to institutional measures of labor and capital market frictions. The theoretical results are, however, isomorphic to revenue or profit distortions via sales or corporate taxes, which can be mapped to institutional measures of product market regulation.

Our second premise is that countries at different levels of institutional efficiency will respond differently to trade shocks if and only if misallocation is present and influences the trade-productivity nexus. However, recall from Section 2 that trade expansion has theoretically ambiguous effects on aggregate productivity under misallocation, and these effects need not vary smoothly with the degree of misallocation.[26] Showing that institutional frictions moderate the impact of trade is thus sufficient to establish a role for misallocation, while estimating the direction and magnitude of this moderating force is of independent policy relevance.

We therefore obtain country measures of institutional quality, $Institution_{it}$, and expand IV specification (5.1) to include interactions of export demand and import competition with $Institution_{it}$. The level effect of institutions is subsumed by the country-year fixed effects. We instrument the main and interaction trade terms using the same instruments as before and their interactions with $Institution_{it}$.

We exploit five indicators of institutional strength, defined such that high $Institution_{it}$ signifies more

[25] We tabulate results for concurrent R&D, but similar findings obtain if we instead lag R&D.

[26] On the one hand, countries with more efficient resource allocation may more effectively adjust to trade reforms and reap greater productivity gains from globalization. On the other hand, such countries are closer to the first best to begin with, and may gain less on the margin from trade liberalization.

efficient and effective institutions. The first two are rule of law and corruption, from the *World Bank Governance Indicators* (Kaufmann et al. 2010). These are comprehensive indices respectively of general institutional capacity and scope for rent extraction for private gains, which arguably affect economic efficiency in both input and output markets. Rule of law has a mean of 1.11 and a standard deviation of 0.49 in the panel; the corresponding statistics for (inverse) corruption are 1.07 and 0.69.

The other three measures characterize institutional efficiency in specific markets. We quantify labor market flexibility with a 0-6 index that averages 21 indicators for firing and hiring costs, from the *OECD Employment Database* (mean 3.28, standard deviation 0.37). We proxy financial market development with a 0-12 index that captures the strength of creditor rights' protection necessary to support financial contracts, from the *World Bank Doing Business Report* (mean 5.86, standard deviation 1.79). Finally, we assess the (inverse) tightness of product market regulation with the a 0-3 index that aggregates 18 measures for state control, barriers to entrepreneurship, and barriers to trade and investment, from the *OECD Market Regulation Database* (mean 1.17, standard deviation 0.25).

Table 8 reveals consistent patterns across all five institutional measures: Strong rule of law, low corruption, efficient factor and product markets amplify the productivity gains from import competition and dampen the productivity gains from export expansion. This is true for aggregate productivity, average firm productivity and allocative efficiency. The interaction terms are highly statistically and economically significant for all but 2 out of 30 coefficient estimates.[27]

These results indicate the complex interactions between international trade and market frictions in shaping aggregate productivity. They also point to asymmetry between positive and negative shocks to domestic firms. The evidence suggests that growth opportunities, such as greater export demand, can partly correct accumulated misallocation and boost productivity more when markets and institutions are less efficient. This may occur if the "right" productive firms that start out with sub-optimal resources can more effectively scale up production than the "wrong" less productive firms. By contrast, contractionary shocks, such as heightened import competition, can engender more cleansing reallocation under more efficient markets and institutions, such that less productive firms downsize disproportinately more.

Note that the interaction analysis in Table 8 speaks to the differential effects of expansionary export demand shocks and contractionary import competition shocks across economies at different levels of institutional and market efficiency. This is conceptually distinct from the baseline asymmetric effects of export and import shocks on allocative efficiency $CovProd_{ikt}$ in Table 5, which capture instead average effects across countries holding countries' institutional and market environment fixed. This baseline asymmetry signals that the "right" firms may be able to access relatively more resources than the "wrong" firms during boom times, compared to bust times. This raises the possibility that the specific nature of institutional and market imperfections matters. In the case of financial market frictions, for example, asymmetric information may play out in different ways during peaks and troughs. Financiers may have

[27] These findings are generally robust to adding sector-year fixed effects, although several interaction terms become imprecisely estimated (Panel A of Appendix Table 4). The key aspect of labor market flexibility is the governance of regular individual contracts (Panel B of Appendix Table 4). Additional provisions under collective regular contracts, as well as the governance of temporary employment contracts play a much lesser role.

imperfect knowledge of firm fundamentals, and make financing decisions based on expected future profits (which depend on fundamentals such as productivity) and on past performance and collateralizable assets (which depend on previous distortions in capital allocation). Since rises in export demand and import competition have opposite effects on firm profits, our results are consistent with lenders being more willing to extend capital based on the net present value of future profits during boom times, and conversely tying funding more closely to collateral during bust times.

6.4 Misallocation Measures in the Literature

We conclude by examining the impact of international trade on several measures of resource misallocation that have been proposed in the literature. Although these measures have theoretical micro-foundations, they are valid under specific modeling assumptions that are difficult to test empirically but likely to fail in realistic economic environments. Under certain assumptions, Hsieh-Klenow (2009) and Gopinath et al. (2015) show that the observed dispersion across firms in revenue-based total factor productivity (TFPR), marginal revenue product of capital (MRPK), and marginal revenue product of labor (MRPL) monotonically increases with misallocation in input and output markets. Under certain assumptions, Edmond et al. (2015) likewise find that the observed dispersion in price-cost mark-ups (PCM) across firms signals output-market distortions.

There are several difficulties in interpreting these indicators in terms of allocative efficiency. First, measurement error in firm TFPR, MRPK, MRPL and PCM can inflate their observed dispersion. Second, they are inferred from produciton function estimates, such that treating them as regression outcomes can complicate econometric inference. Third, the nature of production technology and market competition can affect the productivity and mark-up dispersion even in the absence of resource misallocation. On market structure, Foster et al. (2008) and Berman et al. (2012) show that TFPR, MRPK and MRPL dispersion implies misallocation of production inputs under constant mark-ups, but not under variable mark-ups. Dhingra-Morrow (2014) further demonstrate that market-share misallocation arises in product markets with variable mark-ups even when there are no distortions in factor markets. On production technology, Bartelsman et al. (2013) and Foster et al. (2015, 2016) establish that TFPR, MRPK and MRPL dispersion signals resource misallocation under constant returns to scale and no shocks to firm demand or to quantity-based productivity (TFPQ). However, this is no longer the case if firms face increasing returns to scale or adjustment costs.

Given prior empirical evidence of variable mark-ups, increasing returns to scale, and adjustment costs, it can thus be difficult to interpret the four dispersion measures. We nevertheless explore the effect of international trade on these dispersion outcomes in our data in Appendix Table 5. For each country, sector and year, CompNet reports the standard deviations of TFPR, MRPK and MRPL, as well as the 80th-20th interpercentile range for PCM. Using our IV strategy, we generally find positive significant effects of import exposure across the four $Dispersion_{ikt}$ metrics, but mixed results for export demand (see also DeLoecker and Warczinsky 2012 on PCM). Were $Dispersion_{ikt}$ indicative of misallocation, our conclusion that export expansion (import competition) enhances (reduces) allocative efficiency would have been consistent with $Dispersion_{ikt}$ falling (rising) with $ExpDemand_{ikt}$ ($ImpComp_{ikt}$).

7 Conclusion

We examine the impact of international trade on aggregate productivity. Theoretically, we show that bilateral and unilateral export liberalization increase aggregate productivity, while unilateral import liberalization can either raise or reduce it. However, all three trade reforms have ambiguous effects in the presence of resource misallocation. Using unique new data on 14 European countries and 20 manufacturing industries during 1998-2011, we establish empirically that exogenous shocks to both export demand and import competition generate large gains in aggregate productivity. Although both trade activities increase average firm productivity, however, export expansion reallocates activity towards more productive firms, while import penetration acts in reverse. Unpacking the mechanisms of transmission, we show that improved firm selection can account for only half of the productivity gains from trade, suggesting a potential role for resource misallocation. Moreover, efficient institutions, factor and product markets amplify the productivity gains from import competition, but dampen those from export expansion.

Our findings have important implications for policy design in developing countries that aspire to promote growth through greater economic integration but suffer from weak institutions and significant frictions in capital, labor and product markets. The analysis suggests that reallocations across firms is a key margin of adjustment and that alleviating market distortions is important for realizing the full welfare gains from globalization. Our results further indicate that developed economies also stand to gain from import and export liberalization, despite concerns about the impact of import competition from low-wage countries.

There remains much scope for further research. Richer data would make it possible to examine how international trade affects the incentives for technological upgrading across the firm productivity distribution. From a policy perspective, it would also be valuable to assess the impact of different frictions in capital, labor and product markets on firm selection, firm innovation, and reallocations across firms. These constitute some steps towards understanding how to design trade policy and coordinate it with structural reforms that remove institutional and market imperfections in order to improve welfare.

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Table 1. Numerical Simulation: Productivity Gains from Trade Liberalization

This table reports numerical and estimation results for the impact of reducing bilateral trade costs, unilateral export costs or unilateral import costs by 20%. Panels A-C show the change in welfare, aggregate productivity, average firm productivity and the covariance of firms' productivity and employment share predicted by different model scenarios with free entry and endogenous or exogenous wages. In Panels A and B, there is no resource misallocation, and productivity is Pareto or Log-Normal distributed. In Panel C, there is misallocation, and productivity and distortion are joint Log-Normal with σ_η=0.15 and $\rho(\varphi,\eta)$={-0.4,0,0.4}. All other parameter values are calibrated as discussed in the text. Panel D reports the estimated effect of increasing export demand or import competition by 20% based on the baseline IV results in Table 5.

	Bilateral Liberalization				Export Liberalization				Import Liberalization			
	Welfare	Agg Prod	Avg Prod	Cov Term	Welfare	Agg Prod	Avg Prod	Cov Term	Welfare	Agg Prod	Avg Prod	Cov Term
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. No Misallocation (Pareto)												
Endogenous *w*	4.76%	4.76%	3.52%	1.23%	1.67%	1.67%	1.23%	0.43%	2.52%	2.52%	1.87%	0.65%
Exogenous *w*	3.31%	4.76%	3.52%	1.23%	4.96%	7.16%	5.32%	1.83%	-0.85%	-1.21%	-0.91%	-0.31%
Panel B. No Misallocation (Log-Normal)												
Endogenous *w*	3.92%	3.50%	2.75%	0.75%	1.39%	1.22%	0.96%	0.26%	1.95%	1.72%	1.35%	0.37%
Exogenous *w*	2.73%	3.50%	2.75%	0.75%	3.77%	4.88%	3.83%	1.05%	-0.49%	-0.60%	-0.48%	-0.12%
Panel C. Misallocation (Joint Log-Normal)												
Endogenous *w*												
$\rho = -0.4$	3.92%	3.49%	2.65%	0.84%	1.40%	1.22%	0.92%	0.30%	1.96%	1.72%	1.30%	0.42%
$\rho = 0$	3.87%	3.47%	2.80%	0.67%	1.37%	1.21%	0.98%	0.22%	1.93%	1.70%	1.38%	0.32%
$\rho = 0.4$	3.85%	3.47%	2.94%	0.53%	1.35%	1.20%	1.04%	0.16%	1.91%	1.70%	1.46%	0.24%
Exogenous *w*												
$\rho = -0.4$	-1.68%	-0.05%	-0.16%	0.11%	2.32%	2.26%	1.77%	0.49%	-3.27%	-1.55%	-1.37%	-0.18%
$\rho = 0$	2.70%	3.48%	2.81%	0.67%	2.62%	4.46%	3.54%	0.91%	0.58%	-0.21%	-0.13%	-0.08%
$\rho = 0.4$	0.92%	7.71%	6.42%	1.29%	0.15%	8.47%	7.11%	1.36%	1.38%	0.03%	0.11%	-0.09%
Panel D. Data												
Estimated Effects (ctry-year FE)						7.96%	5.90%	2.06%		1.36%	1.80%	-0.42%
Estimated Effects (ctry-year & sector-year FE)						7.34%	4.52%	2.82%		10.04%	11.70%	-1.66%

Table 2: Summary Statistics

This table summarizes the variation in aggregate economic activity, productivity, international trade activity, institutional and market frictions across countries, sectors and years in the 1998-2011 panel. All variables are defined in the paper. The unit of observation is indicated in the panel heading.

	N	Mean	St Dev
Panel A. Country-Sector-Year Level			
ln Output	2,811	8.09	1.77
ln Value Added	2,811	13.51	2.03
ln Employment	2,811	10.21	1.35
ln Exports	2,811	7.65	1.74
ln (Imports - Own-Sector Imp Inputs)	2,811	6.41	1.97
ln Aggregate Productivity	2,811	3.21	1.13
ln Average Productivity	2,811	2.98	1.19
Covariance Term	2,811	0.23	0.22
Δ ln Aggregate Productivity, Δ = 1 year	2,548	0.04	0.10
Δ ln Average Productivity, Δ = 1 year	2,548	0.03	0.09
Δ Covariance Term, Δ = 1 year	2,548	0.01	0.08
Δ ln Aggregate Productivity, Δ = 3 years	2,073	0.11	0.19
Δ ln Average Productivity, Δ = 3 years	2,073	0.09	0.17
Δ Covariance Term, Δ = 3 years	2,073	0.02	0.12
Δ ln Aggregate Productivity, Δ = 5 years	1,587	0.18	0.25
Δ ln Average Productivity, Δ = 5 years	1,587	0.16	0.22
Δ Covariance Term, Δ = 5 years	1,587	0.02	0.14
Panel B. Country(-Year) Level			
Rule of Law	144	1.11	0.49
(Inverse) Corruption	144	1.07	0.69
Labor Market Flexibility	130	3.28	0.37
Creditor Rights Protection	14	5.86	1.79
(Inverse) Product Market Regulation	13	1.17	0.25

Table 3. Trade and Aggregate Economic Activity: OLS Correlation

This table examines the relationship between aggregate economic activity, aggregate productivity and trade exposure at the country-sector-year level. The outcome variable is log output, log value added, log employment, or aggregate productivity terms from the OP decomposition as indicated in the column heading. All columns include country-year pair fixed effects, and control for the log number of firms by country-sector-year, the average log number of firms across countries by sector-year, and the average log employment across countries by sector-year. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

	Economic Activity			Aggregate Productivity		
Dep Variable:	ln Output (ikt)	ln Value Added (ikt)	ln Employ-ment (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
	(1)	(2)	(3)	(4)	(5)	(6)
Exp Dem (ikt)	**0.403*** **	**0.380*** **	**0.243*** **	**0.125*** **	**0.080*** **	**0.045*** **
	(0.029)	**(0.022)**	**(0.014)**	**(0.016)**	**(0.016)**	**(0.007)**
Imp Comp (ikt)	**-0.139*** **	**0.041*** **	**-0.066*** **	**0.106*** **	**0.124*** **	**-0.019*** **
	(0.015)	**(0.015)**	**(0.006)**	**(0.013)**	**(0.013)**	**(0.005)**
ln N Firms (ikt)	0.552***	0.573***	0.736***	-0.161***	-0.122***	-0.039***
	(0.023)	(0.023)	(0.019)	(0.020)	(0.018)	(0.007)
Avg ln N Firms (kt)	-0.969***	-0.710***	-0.727***	0.023	0.100***	-0.077***
	(0.032)	(0.033)	(0.023)	(0.033)	(0.033)	(0.010)
Avg ln Employment (kt)	1.285***	0.653***	0.858***	-0.182***	-0.245***	0.063***
	(0.065)	(0.045)	(0.028)	(0.040)	(0.041)	(0.020)
N	2,811	2,811	2,811	2,811	2,811	2,811
R2	0.927	0.928	0.949	0.849	0.868	0.519
Country*Year FE	Y	Y	Y	Y	Y	Y

Table 4. Instrumenting Export Demand and Import Competition: IV First Stage

This table presents the baseline IV first stage. It examines the impact of foreign export supply, foreign import demand and import tariffs on export and import activity at the country-sector-year level. The outcome variable is indicated in the column heading. All columns include country-year pair fixed effects and the full set of controls in Table 3. Columns 2 and 5 (3 and 6) also include sector (sector-year pair) fixed effects. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Dep Variable:	Exp Dem (ikt)			Imp Comp (ikt)		
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Demand (ikt)	**0.638***** **(0.034)**	**0.458***** **(0.056)**	**0.443***** **(0.062)**	**-0.002** **(0.022)**	**-0.007** **(0.027)**	**-0.036** **(0.030)**
Foreign Supply (ikt)	**0.087***** **(0.015)**	**0.139**** **(0.066)**	**0.140*** **(0.081)**	**0.868***** **(0.007)**	**0.422***** **(0.027)**	**0.345***** **(0.031)**
Import Tariff (ikt)	**-4.693***** **(0.847)**	**0.307** **(0.669)**	**0.662** **(0.816)**	**-2.802***** **(0.507)**	**-0.986**** **(0.407)**	**-1.332***** **(0.437)**
ln N Firms (ikt)	0.555*** (0.034)	0.564*** (0.032)	0.569*** (0.032)	0.036** (0.018)	0.008 (0.016)	0.007 (0.016)
Avg ln N Firms (kt)	-0.741*** (0.033)	-0.539*** (0.134)		-0.112*** (0.025)	0.110* (0.062)	
Avg ln Employment (kt)	0.344*** (0.065)	0.490*** (0.089)		0.113*** (0.042)	-0.042 (0.055)	
N	2,777	2,777	2,777	2,777	2,777	2,777
R2	0.889	0.921	0.924	0.974	0.985	0.986
Country*Year FE	Y	Y	Y	Y	Y	Y
Sector FE	N	Y	N	N	Y	N
Sector*Year FE	N	N	Y	N	N	Y

Table 5. Impact of Trade on Aggregate Productivity: IV Second Stage

This table presents the baseline IV second stage. It examines the impact of instrumented export demand and import competition on aggregate productivity at the country-sector-year level. The outcome variables follow the OP productivity decomposition and are indicated in the column heading. All columns include country-year pair fixed effects and the full set of controls in Table 3. Columns 4-6 (7-9) also include sector (sector-year pair) fixed effects. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Dep Variable:	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
^Exp Dem (ikt)	**0.398*** **	**0.295*** **	**0.103*** **	**0.300*** **	**0.197** **	**0.103** **	**0.367*** **	**0.226** **	**0.141*** **
	(0.039)	**(0.039)**	**(0.014)**	**(0.097)**	**(0.085)**	**(0.045)**	**(0.109)**	**(0.098)**	**(0.050)**
^Imp Comp (ikt)	**0.068*** **	**0.090*** **	**-0.021*** **	**0.294** **	**0.296** **	**-0.002**	**0.502*** **	**0.585*** **	**-0.083**
	(0.014)	**(0.014)**	**(0.005)**	**(0.131)**	**(0.118)**	**(0.042)**	**(0.185)**	**(0.166)**	**(0.059)**
ln N Firms (ikt)	-0.321***	-0.248***	-0.073***	-0.257***	-0.185***	-0.072**	-0.292***	-0.196***	-0.097***
	(0.029)	(0.027)	(0.012)	(0.062)	(0.054)	(0.029)	(0.067)	(0.061)	(0.032)
Avg ln N Firms (kt)	0.327***	0.334***	-0.007	0.061	0.030	0.031			
	(0.046)	(0.046)	(0.019)	(0.127)	(0.123)	(0.052)			
Avg ln Employment (kt)	-0.461***	-0.458***	-0.003	0.054	0.021	0.033			
	(0.054)	(0.055)	(0.027)	(0.128)	(0.125)	(0.052)			
N	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777
R2	0.820	0.852	0.485	0.869	0.897	0.635	0.856	0.887	0.649
Ctry*Year FE, Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector FE	N	N	N	Y	Y	Y	N	N	N
Sector*Year FE	N	N	N	N	N	N	Y	Y	Y

Table 6. Import Competition Ratio and Chinese Import Competition

This table examines alternative measures of import competition at the country-sector-year level. The outcome variables follow the OP productivity decomposition and are indicated in the column heading. Import competition is measured by the ratio of imports to domestic turnover instead of by log imports in Panel A and by import competition from China instead of total import competition in Panel B. All columns include country-year pair fixed effects and the full set of controls in Table 3. Columns 4-6 also include sector-year pair fixed effects. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Panel A. Import Competition Ratio

Dep Variable:	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
	(1)	(2)	(3)	(4)	(5)	(6)
^Exp Dem (ikt)	**0.433*** **	**0.329*** **	**0.104*** **	**0.465*** **	**0.345*** **	**0.121** **
	(0.038)	**(0.038)**	**(0.013)**	**(0.140)**	**(0.124)**	**(0.058)**
^Imp Comp Ratio (ikt)	**0.101*** **	**0.144*** **	**-0.043*** **	**0.153*** **	**0.181*** **	**-0.028**
	(0.020)	**(0.020)**	**(0.010)**	**(0.053)**	**(0.047)**	**(0.024)**
N	2,777	2,777	2,777	2,777	2,777	2,777
R2	0.811	0.845	0.495	0.860	0.891	0.652
Ctry*Year FE, Controls	Y	Y	Y	Y	Y	Y
Sector*Year FE	N	N	N	Y	Y	Y

Panel B. Import Competition from China

Dep Variable:	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
	(1)	(2)	(3)	(4)	(5)	(6)
^Exp Dem (ikt)	**0.438*** **	**0.388*** **	**0.051*** **	**0.263*** **	**0.171** **	**0.092** **
	(0.035)	**(0.036)**	**(0.009)**	**(0.089)**	**(0.077)**	**(0.040)**
^China Imp Comp (ikt)	**0.011**	**0.034*** **	**-0.023*** **	**0.090**	**0.105* **	**-0.015**
	(0.012)	**(0.012)**	**(0.003)**	**(0.057)**	**(0.053)**	**(0.024)**
N	2,777	2,777	2,777	2,777	2,777	2,777
R2	0.811	0.835	0.545	0.888	0.911	0.670
Ctry*Year FE, Controls	Y	Y	Y	Y	Y	Y
Sector*Year FE	N	N	N	Y	Y	Y

Table 7. Mechanisms: Firm Selection and Innovation

This table examines the mechanisms through which export demand and import competition affect aggregate productivity at the country-sector-year level. The outcome variables in Columns 2-4 and 6-8 follow the OP productivity decomposition and are indicated in the column heading. The outcome variable in Columns 1 and 5 is log firm productivity at the first percentile in Panel A and log R&D expenditure in Panel B. All columns include country-year pair fixed effects and the full set of controls in Table 3. Columns 5-8 also include sector-year pair fixed effects. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Panel A. Firm Selection

Dep Variable:	ln min Prod (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln min Prod (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
^Exp Dem (ikt)	**0.198*** **	**0.275*** **	**0.152*** **	**0.124*** **	**0.314*** **	**0.190*** **	**0.023**	**0.166*** **
	(0.040)	**(0.027)**	**(0.020)**	**(0.013)**	**(0.108)**	**(0.072)**	**(0.053)**	**(0.049)**
^Imp Comp (ikt)	**0.073*** **	**0.026*** **	**0.039*** **	**-0.013** **	**0.249**	**0.230* **	**0.324*** **	**-0.095**
	(0.015)	**(0.010)**	**(0.007)**	**(0.005)**	**(0.173)**	**(0.123)**	**(0.099)**	**(0.059)**
ln min Prod (ikt)		0.642***	0.733***	-0.091***		0.653***	0.676***	-0.023**
		(0.025)	(0.018)	(0.011)		(0.024)	(0.021)	(0.009)
N	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750
R2	0.911	0.913	0.948	0.473	0.930	0.938	0.959	0.619
Ctry*Year FE, Controls	Y	Y	Y	Y	Y	Y	Y	Y
Sector*Year FE	N	N	N	N	Y	Y	Y	Y

Panel B. Firm Selection & Innovation

Dep Variable:	ln R&D (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln R&D (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
^Exp Dem (ikt)	**0.103**	**0.282*** **	**0.154*** **	**0.129*** **	**0.370**	**0.237*** **	**0.055**	**0.182*** **
	(0.115)	**(0.027)**	**(0.019)**	**(0.012)**	**(0.448)**	**(0.083)**	**(0.057)**	**(0.052)**
^Imp Comp (ikt)	**0.164*** **	**0.016* **	**0.038*** **	**-0.022*** **	**-3.680*** **	**0.190**	**0.241** **	**-0.051**
	(0.046)	**(0.009)**	**(0.007)**	**(0.004)**	**(0.527)**	**(0.135)**	**(0.105)**	**(0.068)**
ln min Prod (ikt)		0.657***	0.736***	-0.079***		0.654***	0.676***	-0.022**
		(0.022)	(0.016)	(0.009)		(0.024)	(0.020)	(0.009)
ln R&D (ikt)		-0.000	-0.018***	0.017***		-0.018	-0.031***	0.012**
		(0.008)	(0.006)	(0.003)		(0.012)	(0.010)	(0.006)
N	2,777	2,750	2,750	2,750	2,777	2,750	2,750	2,750
R2	0.999	0.915	0.949	0.501	0.999	0.936	0.961	0.599
Ctry*Year FE, Controls	Y	Y	Y	Y	Y	Y	Y	Y
Sector*Year FE	N	N	N	N	Y	Y	Y	Y

Table 8. Mechanisms: Imperfect Institutions and Market Frictions

This table examines the role of institutional efficiency in moderating the impact of export demand and import competition on aggregate productivity at the country-sector-year level. The outcome variables follow the OP productivity decomposition and are indicated in the column heading. Institutional efficiency is measured by rule of law in Columns 1-3, the inverse of corruption in Columns 4-6, labor market flexibility in Columns 7-9, creditor rights protection in Columns 10-12, and the inverse of product market regulation in Columns 13-15. All columns include country-year pair fixed effects and the full set of controls in Table 3. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Institution Measure:	Rule of Law			(Inverse) Corruption			Labor Market Flexibility			Creditor Rights Protection			(Inverse) Product Market Regulation		
	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
^Exp Dem (ikt)	1.066***	0.862***	0.204***	0.850***	0.670***	0.180***	1.121***	0.763***	0.358***	0.718***	0.511***	0.207***	1.314***	1.047***	0.267***
	(0.126)	(0.111)	(0.037)	(0.096)	(0.085)	(0.031)	(0.261)	(0.238)	(0.063)	(0.158)	(0.147)	(0.040)	(0.172)	(0.155)	(0.045)
^Imp Comp (ikt)	-0.113**	-0.053	-0.060***	-0.063*	-0.013	-0.050***	-0.202**	-0.102	-0.100***	-0.108*	-0.063	-0.045***	-0.045	0.033	-0.078***
	(0.050)	(0.044)	(0.012)	(0.038)	(0.034)	(0.010)	(0.096)	(0.089)	(0.027)	(0.061)	(0.055)	(0.015)	(0.061)	(0.055)	(0.016)
^Exp Dem (ikt) x	**-0.476*** **	**-0.405*** **	**-0.070*** **	**-0.302*** **	**-0.252*** **	**-0.050*** **	**-0.218*** **	**-0.143** **	**-0.075*** **	**-0.048** **	**-0.033* **	**-0.015*** **	**-0.769*** **	**-0.636*** **	**-0.133*** **
Institution (it)	**(0.067)**	**(0.059)**	**(0.017)**	**(0.042)**	**(0.036)**	**(0.012)**	**(0.069)**	**(0.063)**	**(0.016)**	**(0.019)**	**(0.017)**	**(0.005)**	**(0.130)**	**(0.118)**	**(0.032)**
^Imp Comp (ikt) x	**0.136*** **	**0.106*** **	**0.030*** **	**0.095*** **	**0.074*** **	**0.021*** **	**0.083*** **	**0.060** **	**0.024*** **	**0.028*** **	**0.025*** **	**0.003**	**0.085* **	**0.039**	**0.046*** **
Institution (it)	**(0.031)**	**(0.028)**	**(0.006)**	**(0.020)**	**(0.018)**	**(0.004)**	**(0.027)**	**(0.026)**	**(0.008)**	**(0.009)**	**(0.008)**	**(0.002)**	**(0.046)**	**(0.043)**	**(0.013)**
N	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777
R2	0.792	0.835	0.459	0.797	0.839	0.460	0.747	0.802	0.447	0.811	0.848	0.463	0.825	0.858	0.398
Ctry*Year FE, Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Appendix Table 1. Summary Statistics

This table provides summary statistics for the variation in aggregate productivity (CompNet) and trade activity (WIOD) across country-sector-year triplets in the 1998-2011 panel, as well as for the variation in institutional and market efficiency (World Justice Project, OECD, World Bank) across country-years in the 1998-2011 panel.

Panel A. Country-Sector-Year Level

	Years	# Sector-Years	Avg # Firms per Sector-Year	ln Aggregate Productivity		ln Average Productivity		Covariance Term		ln Exports	ln (Imports - Own-Sector Imp Inputs)
				Mean	St Dev	Mean	St Dev	Mean	St Dev		
AUSTRIA	2000-2011	178	68	4.29	0.53	4.23	0.52	0.06	0.09	8.06	6.67
BELGIUM	1998-2010	254	709	4.07	0.56	3.87	0.48	0.20	0.17	8.26	6.92
ESTONIA	1998-2011	157	218	1.96	0.58	1.63	0.60	0.33	0.22	4.93	3.70
FINLAND	1999-2011	233	573	4.06	0.56	3.88	0.52	0.18	0.20	7.10	5.65
FRANCE	1998-2009	231	3,559	4.03	0.47	3.85	0.44	0.19	0.15	9.14	8.05
GERMANY	1998-2011	274	721	4.50	0.40	4.39	0.38	0.11	0.09	9.91	8.62
HUNGARY	2003-2011	164	1,484	1.58	0.64	1.06	0.55	0.53	0.31	6.88	5.62
ITALY	2001-2011	218	4,356	3.53	0.43	3.25	0.44	0.28	0.09	9.17	7.75
LITHUANIA	2000-2011	179	263	1.86	0.61	1.38	0.58	0.48	0.23	5.01	4.17
POLAND	2005-2011	128	709	2.30	0.80	2.12	0.79	0.18	0.15	8.12	6.65
PORTUGAL	2006-2011	110	1,637	2.76	0.63	2.48	0.59	0.28	0.12	7.14	6.18
SLOVAKIA	2001-2011	182	109	2.11	0.63	1.97	0.57	0.14	0.20	6.60	5.26
SLOVENIA	1998-2011	232	216	2.30	0.58	2.20	0.54	0.10	0.17	6.06	4.74
SPAIN	1998-2011	271	3,192	3.46	0.44	3.15	0.38	0.31	0.15	8.39	7.42
Mean (across countries)		201	1,272	3.06	0.56	2.82	0.53	0.24	0.17	7.48	6.24
St Dev (across countries)		52	1,416	1.03	0.11	1.12	0.11	0.14	0.06	1.51	1.47

Appendix Table 1. Summary Statistics (cont,)

This table provides summary statistics for the variation in aggregate productivity (CompNet) and trade activity (WIOD) across country-sector-year triplets in the 1998-2011 panel, as well as for the variation in institutional and market efficiency (World Justice Project, OECD, World Bank) across country-years in the 1998-2011 panel.

Panel B. Country-Year Level

	Years	Rule of Law		Corruption		Labor Market Flexibility		Creditor Rights Protection		Product Market Regulation	
		Mean	St Dev	Mean	St Dev	Mean	St Dev	Mean	St Dev	Mean	St Dev
AUSTRIA	2000-2011	1.86	0.05	1.92	0.22	3.31	0.12	6.00	0.00	1.39	0.00
BELGIUM	1998-2010	1.29	0.06	1.37	0.08	3.18	0.04	5.00	0.00	1.18	0.00
ESTONIA	1998-2011	0.94	0.23	0.83	0.14	3.71	0.20	6.25	0.00	1.63	0.00
FINLAND	1999-2011	1.94	0.03	2.41	0.13	3.92	0.07	8.00	0.00	1.49	0.00
FRANCE	1998-2009	1.39	0.08	1.37	0.06	3.32	0.05	4.38	0.00	1.11	0.00
GERMANY	1998-2011	1.65	0.06	1.84	0.14	3.05	0.00	7.50	0.00	1.19	0.00
HUNGARY	2003-2011	0.85	0.08	0.48	0.15	3.60	0.00	7.00	0.00	1.03	0.00
ITALY	2001-2011	0.48	0.13	0.31	0.19	2.85	0.00	3.00	0.00	1.23	0.00
LITHUANIA	2000-2011	0.59	0.17	0.17	0.11			5.00	0.00		
POLAND	2005-2011	0.52	0.15	0.32	0.12	3.59	0.00	8.38	0.00	0.61	0.00
PORTUGAL	2006-2011	1.01	0.04	1.01	0.05	2.28	0.22	3.00	0.00	1.01	0.00
SLOVAKIA	2001-2011	0.47	0.11	0.28	0.16	3.28	0.10	8.00	0.00	1.11	0.00
SLOVENIA	1998-2011	0.98	0.10	0.94	0.15	3.15	0.02	4.50	0.00	1.11	0.00
SPAIN	1998-2011	1.19	0.09	1.19	0.16	3.25	0.03	6.00	0.00	1.07	0.00
Mean (across countries)		1.08	0.10	1.03	0.13	3.27	0.06	5.86	0.00	1.17	0.00
St Dev (across countries)		0.50	0.05	0.70	0.05	0.41	0.08	1.79	0.00	0.25	0.00

Appendix Table 2. Trade and Aggregate Productivity Growth: OLS First Differences

This table examines the relationship between aggregate productivity and trade exposure at the country-sector-year level. The outcome variables follow the OP productivity decomposition and are indicated in the column heading. All left and right-hand side variables are first differences over rolling 1-year, 3-year or 5-year overlapping periods. All columns include year fixed effects and the full set of controls in Table 3. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

	Δ = 1 year			Δ = 3 years			Δ = 5 years		
	Δ ln Agg Prod (ikt)	Δ ln Avg Prod (ikt)	Δ Cov Term (ikt)	Δ ln Agg Prod (ikt)	Δ ln Avg Prod (ikt)	Δ Cov Term (ikt)	Δ ln Agg Prod (ikt)	Δ ln Avg Prod (ikt)	Δ Cov Term (ikt)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ Exp Dem (ikt)	**0.116*** **	**0.034**	**0.082*** **	**0.142*** **	**0.053***	**0.089*** **	**0.162*** **	**0.088*** **	**0.074*** **
	(0.028)	**(0.025)**	**(0.027)**	**(0.027)**	**(0.027)**	**(0.018)**	**(0.032)**	**(0.031)**	**(0.019)**
Δ Imp Comp (ikt)	**0.083*** **	**0.102*** **	**-0.019**	**0.062** **	**0.102*** **	**-0.040** **	**0.078*** **	**0.108*** **	**-0.030***
	(0.021)	**(0.022)**	**(0.019)**	**(0.025)**	**(0.024)**	**(0.017)**	**(0.030)**	**(0.027)**	**(0.016)**
N	2,546	2,546	2,546	2,073	2,073	2,073	1,587	1,587	1,587
R2	0.114	0.115	0.022	0.101	0.117	0.044	0.096	0.094	0.035
Year FE, Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y

Appendix Table 3. Impact of Trade on Aggregate Productivity: Robustness

This table examines the stability of the impact of export demand and import competition on aggregate productivity at the country-sector-year level. It replicates the regressions in Columns 1-3 and 7-9 in Table 5, but implements a different robustness check in each panel. Panels A and B add only one measure of trade exposure at a time. Panel C winsorizes productivity, trade, and foreign demand and supply instruments at the top and bottom 1 percentile. Panel D weights observations by the initial country-specific employment share of each sector. Panel E lags trade exposure by 1 year. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Dep Variable:	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Only Export Demand						
^Exp Dem (ikt)	0.461***	0.350***	0.111***	0.417***	0.304***	0.114**
	(0.039)	(0.041)	(0.018)	(0.112)	(0.097)	(0.047)
Panel B. Only Import Competition						
^Imp Comp (ikt)	0.148***	0.149***	-0.001	0.730***	0.728***	0.001
	(0.013)	(0.015)	(0.005)	(0.150)	(0.142)	(0.050)
Panel C. Winsorizing Outliers						
^Exp Dem (ikt)	0.393***	0.301***	0.092***	0.206*	0.078	0.127*
	(0.039)	(0.039)	(0.014)	(0.120)	(0.122)	(0.067)
^Imp Comp (ikt)	0.073***	0.094***	-0.021***	0.637***	0.792***	-0.154*
	(0.014)	(0.014)	(0.006)	(0.245)	(0.236)	(0.087)
Panel D. Weighting by Sectors' Initial Employment Share by Country, L (ikt=0) / L (it=0)						
^Exp Dem (ikt)	0.405***	0.352***	0.053***	0.967***	0.743***	0.225***
	(0.037)	(0.035)	(0.009)	(0.202)	(0.177)	(0.057)
^Imp Comp (ikt)	0.082***	0.097***	-0.015***	0.435**	0.579***	-0.144**
	(0.015)	(0.014)	(0.004)	(0.212)	(0.196)	(0.060)
Panel E. Lagged Trade Exposure						
^Exp Dem (ikt-1)	0.395***	0.292***	0.103***	0.297***	0.179*	0.118**
	(0.041)	(0.041)	(0.014)	(0.102)	(0.092)	(0.049)
^Imp Comp (ikt-1)	0.069***	0.091***	-0.022***	0.500***	0.569***	-0.069
	(0.015)	(0.014)	(0.006)	(0.180)	(0.163)	(0.062)
Ctry*Year FE, Controls	Y	Y	Y	Y	Y	Y
Sector*Year FE	N	N	N	Y	Y	Y

Appendix Table 4. Imperfect Institutions and Market Frictions: Robustness

This table examines the stability of the role of institutional efficiency in moderating the impact of export demand and import competition on aggregate productivity at the country-sector-year level. It replicates the regressions in Table 8, but adds sector-year pair fixed effects in Panel A, and examines different aspects of labor market flexibility in Panel B. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Panel A. Sector-Year Pair FE

Institution Measure:	Rule of Law			(Inverse) Corruption			Labor Market Flexibility			Creditor Rights Protection			(Inverse) Product Market Regulation		
	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
^Exp Dem (ikt)	1.902***	1.558***	0.343**	1.609***	1.243***	0.366**	-0.530*	-1.364***	0.835***	0.905*	0.142	0.762***	1.097***	0.910***	0.187***
	(0.429)	(0.359)	(0.152)	(0.411)	(0.327)	(0.156)	(0.319)	(0.296)	(0.287)	(0.516)	(0.340)	(0.293)	(0.222)	(0.220)	(0.065)
^Imp Comp (ikt)	-0.873**	-0.712**	-0.161	-0.859**	-0.655**	-0.204*	0.369**	0.491***	-0.122	0.179	0.416**	-0.237*	0.602***	0.701***	-0.099*
	(0.353)	(0.307)	(0.104)	(0.374)	(0.313)	(0.121)	(0.159)	(0.166)	(0.101)	(0.242)	(0.170)	(0.139)	(0.148)	(0.157)	(0.055)
^Exp Dem (ikt) x Institution (it)	**-0.754*** (0.148)**	**-0.653*** (0.125)**	**-0.101** (0.050)**	**-0.510*** (0.109)**	**-0.422*** (0.087)**	**-0.088** (0.040)**	**0.129 (0.081)**	**0.310*** (0.072)**	**-0.180*** (0.064)**	**-0.068 (0.045)**	**-0.009 (0.030)**	**-0.059** (0.024)**	**-0.683*** (0.135)**	**-0.602*** (0.131)**	**-0.082*** (0.031)**
^Imp Comp (ikt) x Institution (it)	**0.177*** (0.048)**	**0.138*** (0.042)**	**0.039*** (0.011)**	**0.140*** (0.038)**	**0.107*** (0.031)**	**0.033*** (0.010)**	**-0.031 (0.029)**	**-0.090*** (0.028)**	**0.059*** (0.022)**	**0.039** (0.019)**	**0.017 (0.013)**	**0.022** (0.010)**	**0.085 (0.061)**	**0.066 (0.060)**	**0.018 (0.017)**
N	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777
R2	0.727	0.808	0.549	0.731	0.821	0.487	0.896	0.907	0.431	0.840	0.904	0.086	0.856	0.876	0.642
Ctry*Year FE, Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector*Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Panel B. Different Components of Labor Market Flexibility

LMF Component:	1. Baseline: Regular Contracts (Individual & Collective)			1a. Individual Regular Contracts			1b. Collective Regular Contracts (Additional Provisions)			2. Temporary Employment Contracts			Synthetic Indicator (Regular & Temporary Contracts)		
	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Agg Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
^Exp Dem (ikt)	1.121***	0.763***	0.358***	0.611***	0.482***	0.129***	0.376***	0.204**	0.172***	0.336	0.069	0.267***	0.276	0.028	0.248***
	(0.261)	(0.238)	(0.063)	(0.072)	(0.067)	(0.022)	(0.095)	(0.093)	(0.027)	(0.275)	(0.233)	(0.073)	(0.223)	(0.187)	(0.063)
^Imp Comp (ikt)	-0.202**	-0.102	-0.100***	-0.122***	-0.081***	-0.042***	-0.019	0.022	-0.040**	0.220***	0.270***	-0.050***	0.225***	0.275***	-0.050***
	(0.096)	(0.089)	(0.027)	(0.033)	(0.031)	(0.010)	(0.057)	(0.055)	(0.016)	(0.059)	(0.051)	(0.018)	(0.053)	(0.046)	(0.017)
^Exp Dem (ikt) x Institution (it)	**-0.218*** (0.069)**	**-0.143** (0.063)**	**-0.075*** (0.016)**	**-0.089*** (0.016)**	**-0.077*** (0.015)**	**-0.012** (0.005)**	**0.000 (0.017)**	**0.017 (0.017)**	**-0.017** (0.007)**	**0.014 (0.071)**	**0.060 (0.059)**	**-0.046** (0.019)**	**0.031 (0.056)**	**0.071 (0.047)**	**-0.041** (0.016)**
^Imp Comp (ikt) x Institution (it)	**0.083*** (0.027)**	**0.060** (0.026)**	**0.024*** (0.008)**	**0.077*** (0.010)**	**0.068*** (0.010)**	**0.009** (0.003)**	**0.025* (0.013)**	**0.020 (0.013)**	**0.005 (0.004)**	**-0.040*** (0.015)**	**-0.048*** (0.013)**	**0.008* (0.005)**	**-0.042*** (0.013)**	**-0.050*** (0.012)**	**0.008* (0.005)**
N	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777	2,777
R2	0.747	0.802	0.447	0.758	0.809	0.463	0.752	0.805	0.455	0.748	0.802	0.456	0.748	0.802	0.457
Ctry*Year FE, Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Appendix Table 5. Impact of Trade on Dispersion of Productivity and Mark-Up

This table examines the impact of export demand and import competition on productivity and mark-up dispersion across firms at the country-sector-year level. The outcome variable is the standard deviation of the marginal revenue product of capital, the standard deviation of the marginal revenue product of labor, the standard deviation of revenue-based total factor productivity, or the 80th-20th interpercentile range of the price-cost mark-up as indicated in the column heading. All columns include country-year pair fixed effects and the full set of controls in Table 3. Columns 5-8 also include sector-year pair fixed effects. Standard errors clustered by sector-year in parentheses. ***, **, * significant at 1%, 5%, 10%.

Dep Variable:	MRPK St Dev	MRPL St Dev	TFPR St Dev	PCM p80 / p20	MRPK St Dev	MRPL St Dev	TFPR St Dev	PCM p80 / p20
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
^Exp Dem (ikt)	**-0.203*** **	**0.272*** **	**0.297*** **	**0.039*** **	**0.425*** **	**0.059**	**0.125**	**-0.156*** **
	(0.069)	**(0.038)**	**(0.035)**	**(0.015)**	**(0.145)**	**(0.082)**	**(0.155)**	**(0.045)**
^Imp Comp (ikt)	**0.193*** **	**0.095*** **	**0.059*** **	**-0.008**	**0.408* **	**0.483*** **	**0.981*** **	**0.189** **
	(0.026)	**(0.012)**	**(0.013)**	**(0.005)**	**(0.229)**	**(0.131)**	**(0.248)**	**(0.078)**
N	2,777	2,777	2,382	2,775	2,777	2,777	2,382	2,775
R2	0.552	0.810	0.784	0.693	0.703	0.872	0.792	0.733
Ctry*Year FE, Controls	Y	Y	Y	Y	Y	Y	Y	Y
Sector*Year FE	N	N	N	N	Y	Y	Y	Y

Figure 1. Welfare, Misallocation, and OP Covariance

This figure illustrates the relationship between aggregate welfare, the OP covariance and the parameters governing misallocation based on numerical model simulations. Figure A plots the covariance on the z-axis against $\ddot{\Phi}$e standard deviation of distortion σ_η on the x-axis and the productivity-distortion correlation *ρ(φ,η)* on the y-axis. Figure B plots welfare *W* on the z-axis instead. All other parameter values are described in the text.

Figure 1A. OP Covariance and Misallocation Parameters

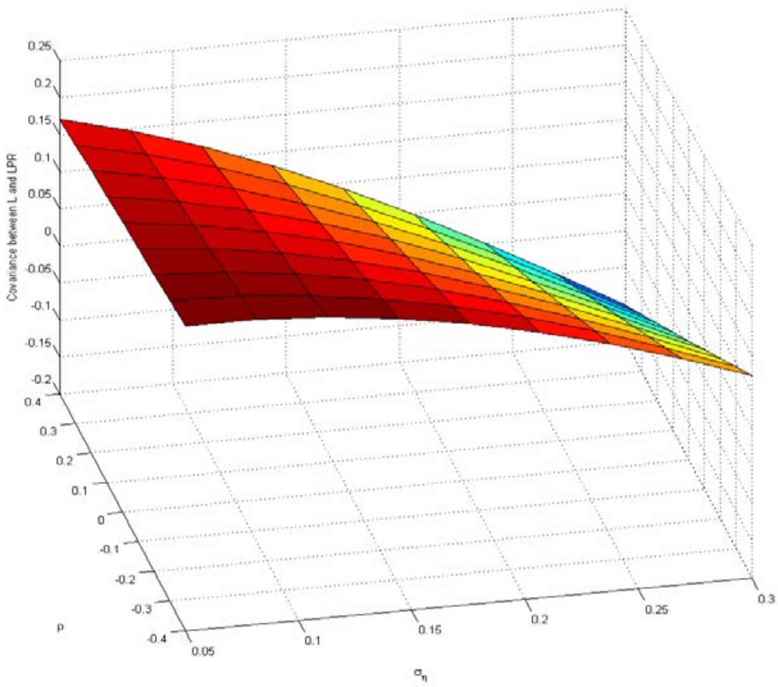

Figure 1B. Welfare and Misallocation Parameters

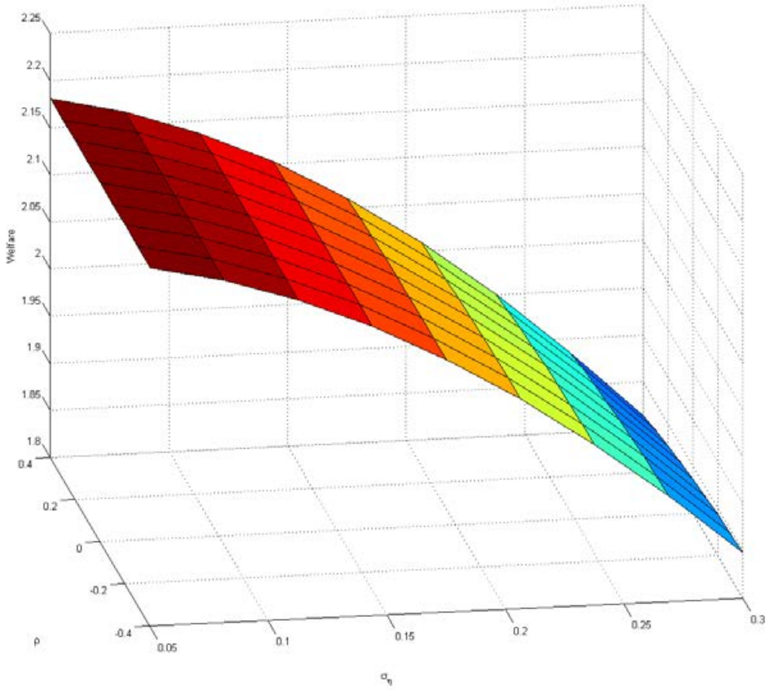

Figure 2. Numerical Simulation

This figure displays results from numerically simulating the model to assess the productivity impact of reducing bilateral trade costs by 20%. Each line shows how the predicted change in aggregate productivity, average firm productivity and the covariance of firms' productivity and employment share on the vertical axis varies with the correlation between firm productivity and distortion ρ(ϕ,η) on the horizontal axis. The flat line corresponds to the case of no misallocation (when the standard deviation of firm distortion is σ_η=0) to two possible degrees of misallocation (when σ_η={0.05,0.15}). All other parameter values are chosen as discussed in the text.

Figure 2A. Bilateral Trade Liberalization

Aggregate productivity (labor weighted average TFP) | **Average productivity (unweighted average TFP)** | **Covariance between labor share and productivity (TFP)**

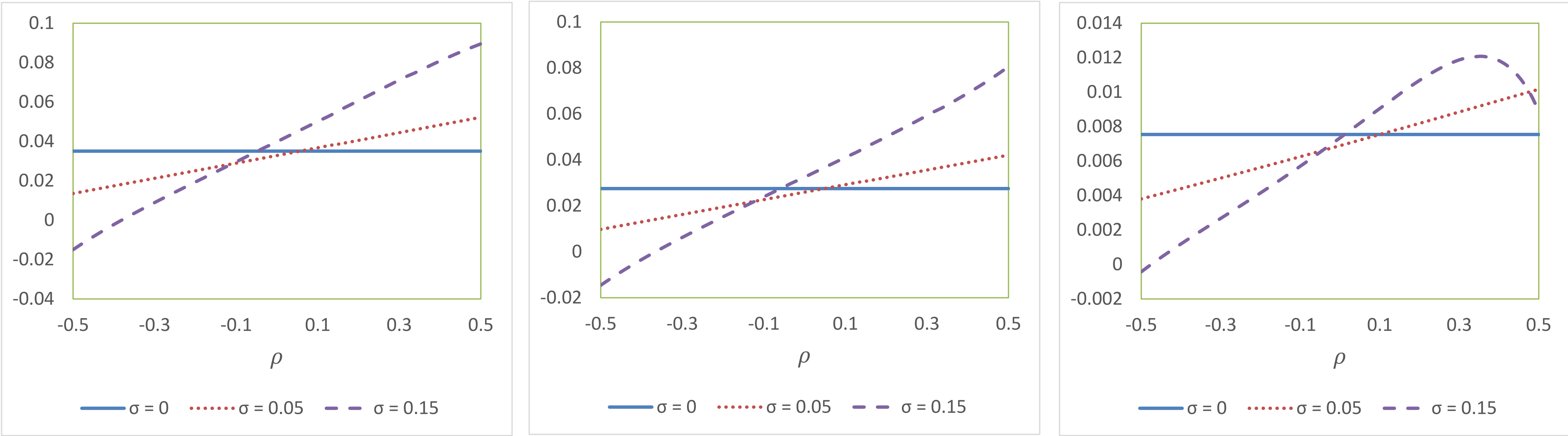

Figure 2. Numerical Simulation (cont.)

This figure displays results from numerically simulating the model to assess the productivity impact of reducing unilateral export or import costs by 20%. Each line shows how the predicted change in aggregate productivity, average firm productivity and the covariance of firms' productivity and employment share on the vertical axis varies with the correlation between firm productivity and distortion ρ(ϕ,η) on the horizontal axis. The flat line corresponds to the case of no misallocation (when the standard deviation of firm distortion is σ_η=0) to two possible degrees of misallocation (when σ_η={0.05,0.15}). All other parameter values are chosen as discussed in the text.

Figure 2B. Unilateral Export Liberalization

Aggregate productivity (labor weighted average TFP) | **Average productivity (unweighted average TFP)** | **Covariance between labor share and productivity (TFP)**

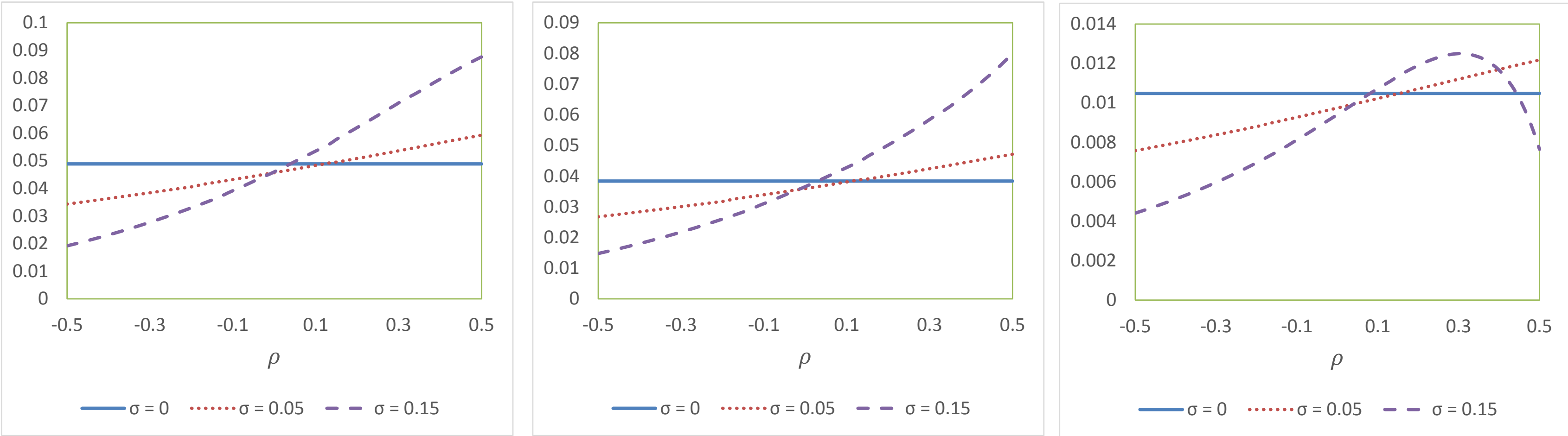

Figure 2C. Unilateral Import Liberalization

Aggregate productivity (labor weighted average TFP) | **Average productivity (unweighted average TFP)** | **Covariance between labor share and productivity (TFP)**

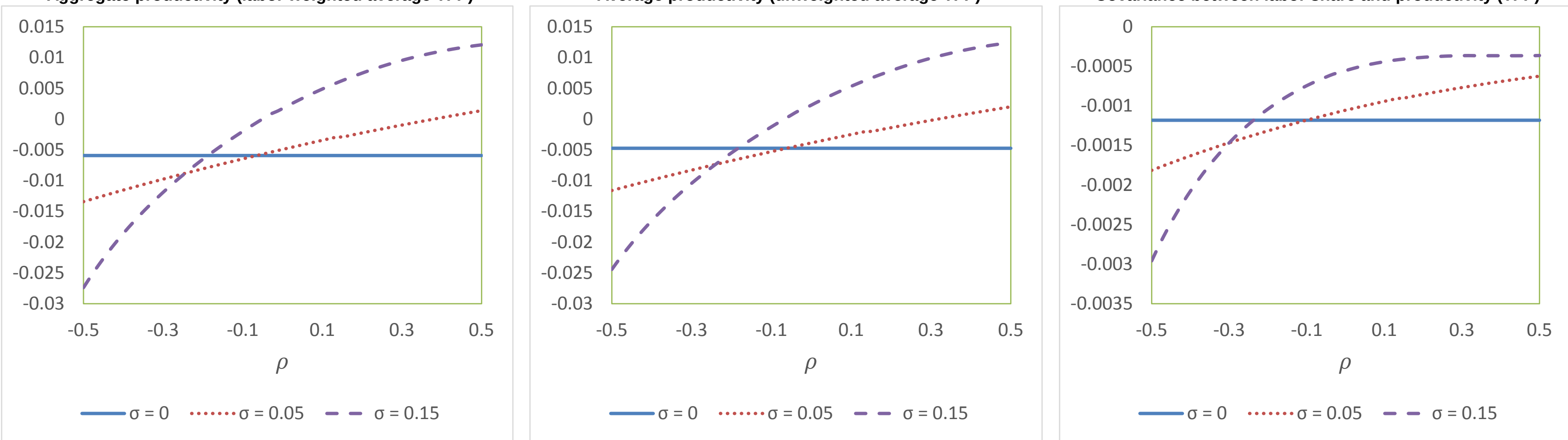

Figure 3. Sources of Productivity Growth: Overlapping 3-Year Growth Rates

This figure displays the variation in the 3-year growth rate of aggregate productivity and its OP decomposition components across countries in the panel. Each bar averages overlapping 3-year growth rates across sectors and years within a country. Figures A and B focus on the pre- and post-crisis periods of 2003-2007 and 2008-2011 respectively.

Figure 3A. Growth 2003-2007

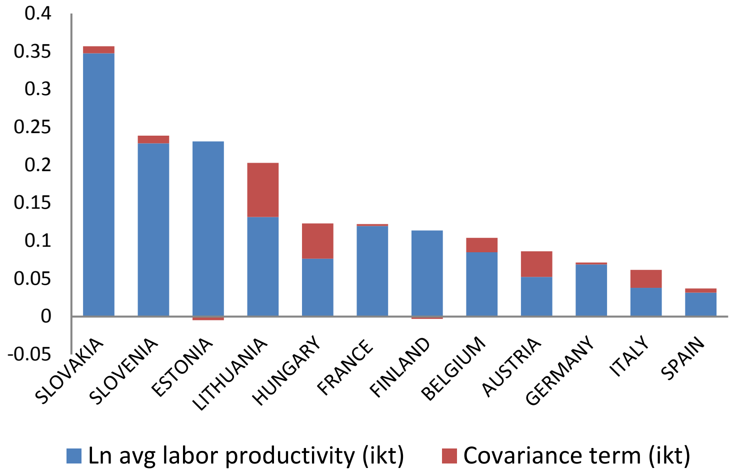

Figure 3B. Growth 2008-2011

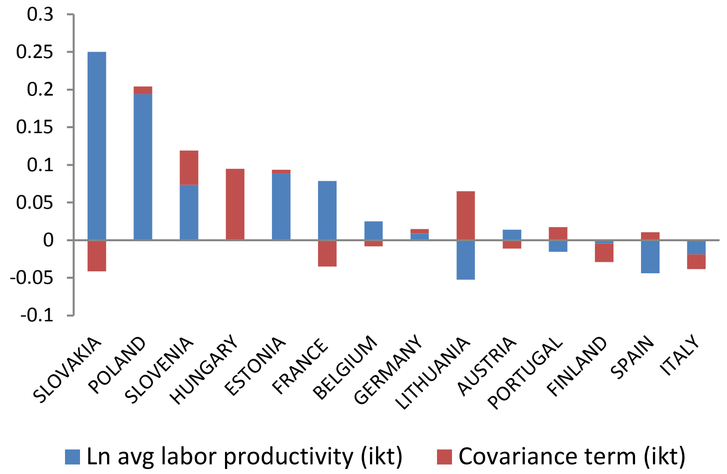

Figure 4. Trade Exposure Over Time

This figure displays the evolution of export and import activity in the panel. Each point represents an average value across countries and sectors in a given year. Each trade flow series is normalized to 1 in year 2000. Figure A covers all countries, while Figures B and C distinguish between EU-15 countries and new EU member states.

Figure 4A. All countries

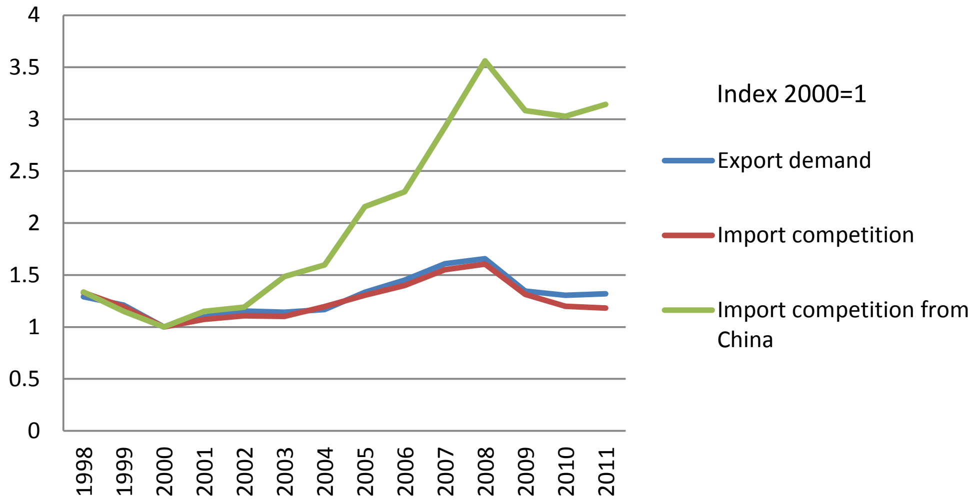

Figure 4B. New member states

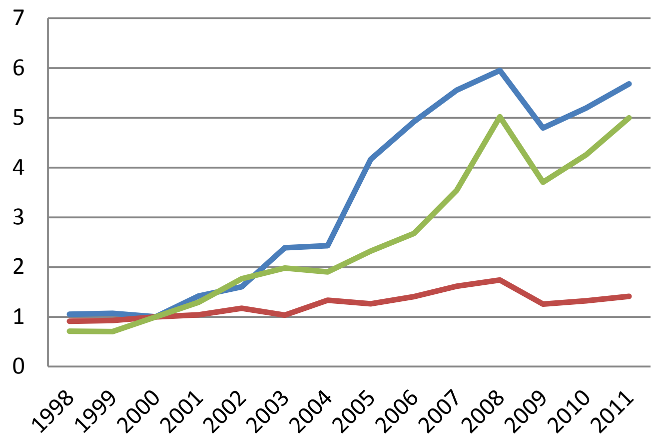

Figure 4C. EU 15 countries