Trade Competition and Reallocations in a Small Open Economy

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1 Introduction

In this chapter, I develop a simple model of firm heterogeneity with endogenous markups. The endogenous markups stem from preferences that feature variable elasticities of substitution (VES) in a monopolistically competitive environment. Although the model is kept general along some key dimensions (both preferences and technology heterogeneity are left un-parametrized), I show how it is still amenable to simple, mostly graphical, comparative statics analyses of asymmetric trade liberalization (for either imports or exports) by applying these to the case of a "small" open economy.[1] The comparative statics analyses for trade liberalization are applied to describe both short-run and long-run effects of liberalization – where the latter allows for a response of firm entry to liberalization. These effects are described both in a partial equilibrium setting where wages in a given sector are fixed and trade need not be balanced; as well as in a general equilibrium setting where wages across countries adjust to balance trade. Although the preferences are left un-parametrized, they are restricted to a broad class of additively separable preferences that generates predictions for markups under monopolistic competition that are consistent with a large set of established empirical patterns. These patterns include evidence for markup differences across firms (larger firms set larger markups), as well as for changes in markups associated with incomplete pass-through of cost changes into prices.[2]

A substantial portion of the theoretical trade literature analyzing the response of heterogeneous exporters assumes constant markups – based on the assumptions of constant elasticity of substitution

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[1]Demidova and Rodríguez-Clare (2013) show how to extend the standard competitive version of a small open economy to the case of product differentiation and imperfect competition with heterogeneous producers. This is the same version that is applied here.

[2]See the evidence reviewed in De Loecker and Goldberg (2014), Burstein and Gopinath (2014).

(CES) preferences along with monopolistic competition.[3] These models do a good job of capturing the extensive margin of trade: the selection effects that determine which products are sold where. However, those models cannot capture the intensive margin reallocations – between producers selling in the same market – stemming from trade, even though there is growing empirical evidence for this phenomenon.[4] The current model with endogenous markups highlights how trade liberalization induces such intensive margin reallocations towards more productive producers that reenforce the extensive margin reallocations that are stressed by models with exogenous markups – because they do not feature intensive margin reallocations. This generates another channel for the productivity enhancing effects of trade liberalization.[5]

2 Closed Economy

I start with a description of a closed economy with monopolistic competition, heterogeneous producers, and endogenous markups.[6] This introduces the key equilibrium concept of competition in a market, which in turn shapes the whole distribution of producer markups. I develop both a general equilibrium version with a single differentiated good sector for the whole economy, and a partial equilibrium version focusing on a single sector among many in the economy. In the latter, I also introduce a short-run version where entry is restricted (general equilibrium is inherently a long-run scenario). This closed economy setup is also used to examine an initial globalization scenario for an integrated world economy with no trade costs – captured by an overall increase in market size.

Consider a sector with a single productive factor, labor. I will distinguish between two scenarios. The first is the standard general equilibrium (GE) setup with a single sector. The exogenous labor endowment L indexes both the number of workers L^w with inelastic supply and consumers L^c. I choose the endogenous wage as the *numeraire*. Thus, all revenue and expenditure flows are measured in units of the wage.[7] Aggregate expenditures are then given by the exogenous labor endowment. In the partial equilibrium (PE) scenario, I focus on the sector as a small part of the economy. I

[3]See Melitz and Redding (2014) for a survey.

[4]In those models with constant markups and CES preferences, the relative market share of two firms in any market is determined by the productivity ratio between those two firms. Mayer et al. (2016) reviews this evidence and also provides some additional empirical support for intensive margin product reallocation by French firms.

[5]Dhingra and Morrow (2018) analyze the efficiency properties of a monopolistic competition equilibrium with similar additively separable preferences. They show how the new intensive margin reallocations induced by the endogenous markups generate an additional channel for the gains from trade (increased market size).

[6]The closed economy is a simplified version of the model developed in Mayer et al. (2016) without multi-product firms; it is also very similar to the model developed by Zhelobodko et al. (2012).

[7]In the closed economy, this is equivalent to normalizing the wage and per-consumer expenditure to 1. In the open economy, I will introduce a relative wage across countries.

take the number of consumers L^c as well as their individual expenditures on the sector's output as exogenously given. The supply of labor L^w to the sector is perfectly elastic at an exogenous economy-wide wage. This involves a normalization for the measure of consumers L^c in that sector: Aggregate accounting then implies that this normalized number of consumers L^c represents a fraction of the labor endowment L.[8]

2.1 Consumer optimization

There is a continuum of differentiated varieties indexed by $i \in [0, I]$, where I is the measure of products available. The demand for differentiated varieties q_i is generated by the L^c consumers who solve:[9]

$$\max_{q_i \geq 0} \int_0^I u(q_i) di \text{ s.t. } \int_0^I p_i q_i di = 1.$$

So long as

$$\textbf{(A1)}\ u(0) = 0;\ u'(q_i) > 0;\ \text{and } u''(q_i) < 0 \text{ for } q_i \geq 0$$

this leads to a downward sloping inverse demand function (per consumer)

$$p(q_i; \lambda) = \frac{u'(q_i)}{\lambda}, \text{ where } \lambda = \int_0^I u'(q_i) q_i di > 0 \tag{1}$$

is the marginal utility of income (spent on differentiated varieties). Given the assumption of separable preferences, this marginal utility of income λ is the unique endogenous aggregate demand shifter. Higher λ shifts all residual demand curves *inward*, which represents an increase in competition for a given level of market demand L^c.

Strict concavity of $u(q_i)$ ensures that the chosen consumption level from (1) also satisfies the second order condition for the consumer's problem. This residual demand curve (1) is associated with a marginal revenue curve

$$\phi(q_i; \lambda) = \frac{u'(q_i) + u''(q_i) q_i}{\lambda}. \tag{2}$$

[8]I will be using additively separable preferences that are non-homothetic. Thus, changes in consumer income will have different effects than changes in the number of consumers L^c. I focus on this functional form for tractability and do not wish to emphasize its properties for income elasticities. As first highlighted by Deaton and Muellbauer (1980), additively separable preference imply a specific relationship between price and income elasticities. I emphasize the properties of demand for those price elasticities. Thus, I analyze changes in the number of consumers L^c holding their income fixed. This is akin to indexing the preferences to a given reference income level.

[9]Note that the symmetric representation for these preferences assumes that these quantity units have been implicitly normalized to equate utility (and hence adjusted for quality); these quantity units should therefore not be interpreted as physical units for heterogeneous goods.

Let $\varepsilon_p(q_i) \equiv -p'(q_i)q_i/p(q_i)$ and $\varepsilon_\phi(q_i) \equiv -\phi'(q_i)q_i/\phi(q_i)$ denote the elasticities of inverse demand and marginal revenue.[10] Thus $\varepsilon_p(q_i) \geq 0$ is the inverse price elasticity of demand (less than 1 for elastic demand), capturing the sensitivity of price to changes in quantities. $\varepsilon_\phi(q_i)$ captures the sensitivity of marginal revenue to changes in quantities, which combines both the response of the price of the marginal unit as well as the impact on revenue from the change in price on infra-marginal units. Additional demand restrictions imposed later will ensure that this sensitivity measure is non-negative for profit maximizing firms.

Although the demand and marginal revenue curves are residual (they depend on λ), their elasticities are nonetheless independent of λ. These preferences nest the case of CES preferences where the elasticities $\varepsilon_p(q_i)$ and $\varepsilon_\phi(q_i)$ are constant.[11]

2.2 Firm optimization

The market structure is monopolistically competitive. There is an unbounded set of entrants who can pay a sunk entry cost f_E (in units of labor) for a variety blueprint with uncertain productivity. After this cost is incurred, the productivity φ of the blue print is revealed as a draw from a common continuous differentiable distribution $G(\varphi)$ with support over $[0, \infty)$.[12] This productivity is the inverse unit labor requirement for producing this variety, which can also be thought of as product quality.[13] Producing and selling this variety in the domestic market also entails a fixed cost f – assumed to be common across firms. Technology therefore exhibits increasing returns to scale at the product level. This production structure can also be extended to incorporate multi-product firms, as developed in Mayer et al. (2016).

A firm with productivity φ that produces positive output and faces market competition λ chooses an output level that maximizes operating profit per-consumer:

$$\pi(\varphi, \lambda) = \max_{q_i} \left[p(q_i, \lambda) q_i - q_i/\varphi \right], \tag{3}$$

$$q(\varphi, \lambda) = \arg\max_{q_i} \left[p(q_i, \lambda) q_i - q_i/\varphi \right]. \tag{4}$$

[10] Note that $\phi(q_i; \lambda) = p(q_i; \lambda) \left[1 - \varepsilon_p(q_i)\right]$.

[11] In the case of CES preferences, the marginal utility of income λ is an inverse monotone function of the CES price index.

[12] This assumption of infinite support is made for simplicity only to rule out the possibility of an equilibrium without any firm selection.

[13] I leave the concept of a physical unit of the product undefined. The units for the product are the ones that equate utility in the consumer's eye based on the symmetric preferences. Thus, higher productivity can also represent the production of a good with more utility units per worker.

The first order condition for this optimization problem is the well known equalization of marginal revenue with marginal cost:

$$\phi(q(\varphi,\lambda);\lambda) = 1/\varphi. \tag{5}$$

In order to ensure that the solution to this problem exists (for at least some $\varphi > 0$) and is unique, I further restrict the specification of preferences to satisfy:

(A2) $2u''(q_i) + u'''(q_i)q_i < 0$ for $q_i \geq 0$.

This assumption ensures that marginal revenue $\phi(q_i;\lambda)$ is decreasing for all output levels and positive for at least some output levels (as $q \to 0$). It also guarantees that demand is elastic along a top portion of the demand curve. One can also measure a firm's output using its generated revenues per consumer:

$$r(\varphi,\lambda) = q(\varphi,\lambda)p(q(\varphi,\lambda),\lambda). \tag{6}$$

Note that all these performance measures (operating profit, output, sales) are increasing in firm productivity φ and decreasing in the endogenous competition level λ: More productive firms are larger and earn higher profits than their less productive counterparts; and an increase in competition λ lowers production levels and profits for all firms.

A firm with productivity φ earns total – across consumers – net profit

$$\Pi(\varphi,\lambda) = L^c\pi(\varphi,\lambda) - f.$$

This is also increasing in firm productivity, leading to a unique cutoff productivity φ^* satisfying

$$\Pi(\varphi^*,\lambda) = 0. \tag{7}$$

Firms with productivity below this cutoff do not produce: they shut down in the short run, and exit in the long run. Tougher competition thus leads to tougher selection: only a proper subset of higher productivity firms survive.

2.3 Free Entry in the Long-Run

In the long-run when entry is unrestricted, the expected profit of a prospective entrant adjusts to match the sunk cost:

$$\int_{\varphi^*}^{\infty} \Pi(\varphi, \lambda) dG(\varphi) = f_E. \tag{8}$$

This free entry condition, along with the zero cutoff profit condition (7), jointly determine the equilibrium cutoff φ^* along with the competition level λ. The number of entrants N^E, which includes some firms with productivity below the cutoff φ^* that do not produce, is then determined by the consumer's budget constraint:

$$N^E \int_{\varphi^*}^{\infty} r(\varphi, \lambda) dG(\varphi) = 1. \tag{9}$$

These conditions hold in both the GE and PE scenarios.

Aggregating employment over all firms yields the aggregate labor demanded:

$$L^w = N^E \left\{ f_E + \int_{\varphi^*}^{\infty} \left[f + L^c q(\varphi, \lambda)/\varphi \right] dG(\varphi) \right\}.$$

As the free entry condition (8) entails no ex-ante aggregate profits (aggregate revenue is equal to the payments to all workers, including those employed to cover the entry costs), this aggregate labor demand L^w will be equal to the number of consumers L^c. This ensures labor market clearing in the GE scenario. In the PE scenario, this implies that the endogenous labor supply adjusts so that it equals the normalized number of consumers (recall that this is an exogenous fraction of the economy-wide labor endowment).[14] Thus, in this closed economy setup, the determination of the endogenous cutoff φ^* and competition λ will be identical in both long-run scenarios (GE and PE). This equivalence will be broken in the open economy where the two scenarios feature different wage responses.

2.3.1 Graphical Representation of Equilibrium

The determination of the long run equilibrium cutoff is represented in Figure 1 below. Consider a plot of total firm profit $\Pi(\varphi, \lambda)$ as a function of productivity φ for any given level of competition λ.

[14]This sector-level adjustment for labor supply is very similar to the case of CES product differentiation within sectors and Cobb-Douglas preferences across sectors. In the latter case, the sector's labor supply adjusts so that it is equal (as a fraction of the aggregate labor endowment) to the exogenous Cobb-Douglas expenditure share for the sector. See Melitz and Redding (2014) for an example of those preferences with firm heterogeneity.

In Figure 1, the productivity levels are rescaled to an index between 0 and 1 using the distribution $G(\varphi)$. The cutoff productivity φ^* from (7) is given by the intersection of the curve with the horizontal axis. This curve is strictly increasing for all firms with productivity above this cutoff. (The dashed line represents the hypothetical total profit from the maximization of operating profit from (3); unlike the case of CES preferences operating profits may be zero for firms with low productivity and marginal cost above a choke price.) Firms with productivity below the cutoff φ^* do not produce and earn zero total profit. Given our rescaling of productivity, the area below the profit curve (up to the maximum productivity index $G(\varphi) = 1$) represents the average profit (and hence the expected profit) from the left-hand side of the free entry condition (8). At the equilibrium level of competition λ, this area must be equal to the sunk entry cost – represented in the graph by the rectangle above the axis up to the f_E line. Or, rearranging, the two shaded areas in the graph must be equalized. The area above the f_E line to the right represents the post-entry gains by firms with high productivity while the area below the line to the left captures the post-entry losses by the low productivity firms. This includes firms that exit as well as some that produce. In the latter case, the firms' total profit $\Pi(\varphi, \lambda)$ is positive, but below the sunk entry cost.

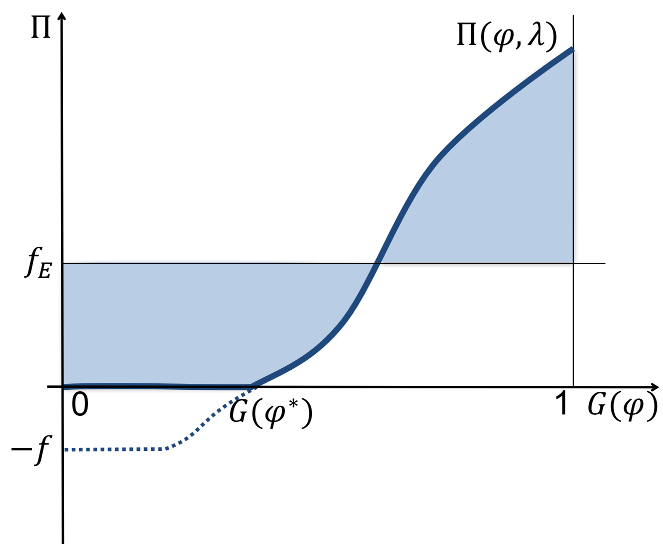

Figure 1: Graphical Representation of Equilibrium

2.4 Short-Run Equilibrium

I now consider an alternative short-run situation in which the number of incumbents is fixed at $\bar{N}$ in the PE scenario (with the same exogenous distribution of ex-ante productivity $G(\varphi)$). In this case, free entry (8) no longer holds: firms with productivity above the cutoff φ^* in (7) produce while the remaining firms shut-down. However, the budget constraint (9) still holds with the exogenous number of incumbents $\bar{N}$ now replacing the endogenous number of entrants N^E. Together with the zero cutoff profit (7), those two conditions jointly determine the endogenous cutoff φ^* and competition level λ.

2.5 Aggregate Productivity

As previously mentioned, the symmetric representation for quantities in the preferences assumes that those quantities have been adjusted for quality (in order to equate utility in the consumer's eye). A theoretical aggregation of productivity can therefore sum the quantity produced per worker:

$$\Phi = \frac{\int_{\varphi^*}^{\infty} q(\varphi, \lambda) d\mu(\varphi)}{L^w},$$

where $\mu(\varphi) = N^E G(\varphi)$ represents the cumulative mass of producing firms. This is a theoretical measure however, as the correspondence between physical and quality-adjusted units is not observed (even physical quantities are often poorly measured). Typically, labor productivity is measured as deflated aggregate sales (or value-added, when intermediates are used in production) per worker; where percentage changes in the price deflator capture expenditure weighted percentage changes in individual prices. The best representation of such a productivity measure within the structure of the model is:

$$\hat{\Phi} = \frac{\int_{\varphi^*}^{\infty} r(\varphi, \lambda) d\mu(\varphi)/P}{L^w},$$

where the price deflator

$$P = \frac{\int_{\varphi^*}^{\infty} r(\varphi, \lambda) p(q(\varphi, \lambda); \lambda) d\mu(\varphi)}{\int_{\varphi^*}^{\infty} r(\varphi, \lambda) d\mu(\varphi)}$$

is defined as the revenue-weighted average of firm-level prices.

3 Curvature of Demand

Up to now, I have placed very few restrictions on the shape of (residual) demand that the firms face, other than the conditions (A1)-(A2) needed to ensure a unique monopolistic competition equilibrium. The shape of demand determines how tougher competition λ (an inward shift of residual demand) impacts firm prices and markups. At their chosen production level $q(\varphi, \lambda)$, a firm sets a markup $\mu(q_i)$ (the ratio of price to marginal cost) that is tied down (inversely) by the price elasticity of demand: $\mu(q_i) = 1/(1 - \varepsilon_p(q_i))$. Thus, the response of markups is tied to changes in the price elasticity of demand (along the residual demand curve). If, moving up residual demand, demand becomes more elastic, $\varepsilon'_p(q_i) > 0$, then tougher competition λ leads to a lower markup (and hence price) for any given firm with productivity φ.[15] And conversely, if demand becomes more inelastic (again, moving up the demand curve), then tougher competition leads to higher markups and prices. Although theoretically possible, this latter case seems counter-intuitive. Indeed, this case was excluded by Marshall (1890) in his original exposition defining demand curves; it is often referred to as "Marshall's Second Law of Demand" (MSLD)[16] – that elasticity of demand increases with price along a demand curve, or alternatively that the demand curve is log-concave in log-price.[17] This is also the main demand assumption made "without apology" by Krugman (1979) (in order to yield "reasonable results") in his seminal paper on trade with economies of scale.

Violations of MSLD would also directly contradict the evidence on markups and pass-through that were mentioned in the introduction. Within a monopolistic competition framework (required for a well-defined residual demand curve), MSLD is equivalent to the property that more productive firms set higher markups. It is also equivalent to the property of incomplete pass-through: that a change to marginal cost is passed-on less than one-for-one into prices – with the remaining variation absorbed into the markup. Under CES preferences, markups are constant, both across firms and with respect to changes in competition λ. Changes to marginal costs are passed on one-for-one into prices, and pass-through is therefore complete. Lastly, the endogenous markups generated by MSLD demand also induce a pattern of endogenous trade elasticities that are broadly consistent with the empirical evidence.[18]

Under MSLD, the elasticity of inverse demand $\varepsilon_p(q_i)$ increases with output q_i. Since marginal revenue is everywhere below the inverse demand, its elasticity – on average – must also increase with output. A slightly stronger assumption than MSLD is that the elasticity of marginal revenue $\varepsilon_\phi(q_i)$ smoothly increases with output: $\varepsilon'_\phi(q_i) > 0$. I refer to this assumption as MSLD', which implies MSLD. Figure 2 depicts a log-log graph of the inverse demand and marginal revenue curves satisfying

[15] Recall that firm output per consumer $q(\varphi, \lambda)$ is decreasing in competition λ.

[16] Marshall's First Law of Demand is that it is downward sloping; this too can be violated with rational utility maximizing consumers.

[17] Several other terms have been used to describe MSLD demand in the literature on monopolistic competition with endogenous markups. Zhelobodko et al. (2012) describe those preferences as exhibiting increasing "relative love of variety" (RLV); Mrázová and Neary (2017) describe this as the case of "sub-convex" demand; and Bertoletti and Epifani (2014) use the term "decreasing elasticity of substitution".

[18] It is the key characteristic of the demand systems analyzed by Spearot (2013), Novy (2013), and Arkolakis et al. (2018) in order to explain the empirical variations in the trade elasticity (at the intensive product margin).

these restrictions. On its own, MSLD is equivalent to the concavity of the demand curve in log-log space. MSLD' is equivalent to the concavity of the marginal revenue curve in that space (relative to MSLD, it eliminates the possibility of inflection points in the marginal revenue curve).[19] From here on out, I assume that MSLD' holds ($\varepsilon'_{\phi}(q_i) > 0$), which implies that MSLD ($\varepsilon'_{p}(q_i) > 0$) also holds. I am tempted to add "without apology", but instead will lean on the accumulated empirical research in the intervening thirty years since Krugman (1979) and point out that violations of this demand-side restriction would generate counterfactual predictions against overwhelming empirical support on firm markup differences and how they respond to various shocks.[20]

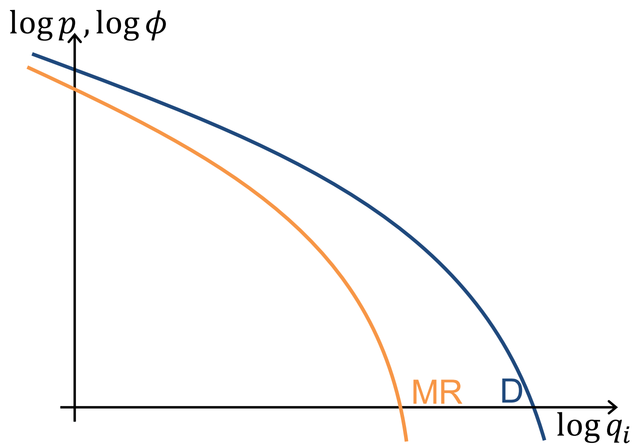

Figure 2: Graphical Representation of Demand Assumptions

Given MSLD', an increase in competition induces a downward shift in markups (lower markup at any given productivity level φ) as firms are pushed up their demand curves. This increase in price elasticities also results in a reallocation of output (and hence labor), revenue, and operating profit towards more productive firms. Put another way, for any two firms with productivity φ_1 and $\varphi_2 < \varphi_1$, the ratios $q(\varphi_1, \lambda)/q(\varphi_2, \lambda)$, $r(\varphi_1, \lambda)/r(\varphi_2, \lambda)$, $\pi(\varphi_1, \lambda)/\pi(\varphi_2, \lambda)$ increase with competition λ (so long as both firms produce after the increase in competition). This intensive margin reallocation of resources towards more productive firms generates an increase in aggregate productivity for a given set of producing firms. There is also an extensive margin effect that contributes to aggregate productivity changes. If selection toughens (higher cutoff φ^*), then this margin also contributes to an aggregate productivity increase; and conversely weaker selection (lower cutoff φ^*) contributes to lower aggregate productivity.[21]

[19] $u(q_i)$ quadratic, leading to linear demand $p(q_i)$ is a simple functional form satisfying MSLD' (and hence MSLD).

[20] Mayer et al. (2016) reviews this evidence and also provides some additional empirical support for MSLD' based on the pattern of intensive margin product reallocation for French firms.

[21] Dhingra and Morrow (2018) show how these productivity gains induced by both intensive and extensive margin

This MSLD' restriction on preferences excludes the very common case of CES preferences where the elasticities $\varepsilon_p(q_i)$ and $\varepsilon_\phi(q_i)$ are constant – and hence all firms share the same constant markup. In this case, no intensive margin reallocations are possible: the output, revenue, and operating profit ratios $q(\varphi_1, \lambda)/q(\varphi_2, \lambda)$, $r(\varphi_1, \lambda)/r(\varphi_2, \lambda)$, $\pi(\varphi_1, \lambda)/\pi(\varphi_2, \lambda)$ no longer vary with competition λ (they only depend on the productivity differential φ_1/φ_2 and exogenous parameters. In an open economy setting, such a model emphasizes the impact of trade (and trade liberalization) at the extensive margin (firm selection). The model developed in this chapter with MSLD' preferences will feature similar extensive margin predictions, but adds another important channel operating through intensive margin reallocations. In the following globalization scenarios, I will emphasize how these intensive margin reallocations generate a more robust prediction linking globalization to increased aggregate productivity.

4 Market Size

Before developing the open economy version of the model and analyzing various trade liberalization scenarios, I examine the impact of increased market size. This corresponds to a globalization scenario for an integrated world economy (with no additional frictions to international trade). I consider first the short-run response to an increase in the number of consumers L^c with a fixed number of producers (no entry). On impact (keeping the competition level λ fixed), an increase in market size increases firm net profit $\Pi(\varphi, \lambda) = L^c\pi(\varphi, \lambda) - f$ even though the operating profit per consumer $\pi(\varphi, \lambda)$ does not change. This is represented by the change from the solid line to the dotted line in Figure 3. This implies that some firms that previously entered and found production to be unprofitable (with productivity below the cutoff φ^*) now find it profitable to produce. This, in turn, increases competition λ leading to a short-run equilibrium with both higher competition λ and a lower cutoff φ^* as depicted by the dashed line in the figure. More formally, it is straightforward to show that this is the comparative static implied by the cutoff (7) and budget constraint (9) conditions for the short-run.[22]

The short-run equilibrium depicted in Figure 3 clearly violates the free entry condition: average firm profit – the area below the net profit curve – increases from its long-run equilibrium level

reallocations under endogenous markups generate additional welfare gains – over and above the standard channels for welfare gains under exogenous markups.

[22] Assume that competition λ were to *decrease* following an increase in market size L^c. Then, from (7), the export cutoff φ^* must decrease. This would then violate the budget constraint (9) as spending must then rise. So competition λ must increase; and given this, the cutoff φ^* must decrease to satisfy the budget constraint (9).

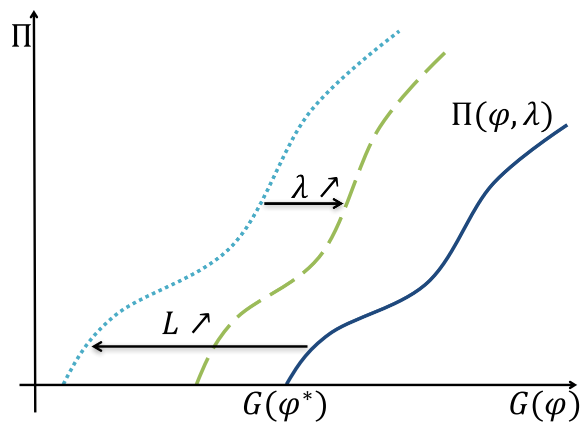

Figure 3: Increased Market Size: Short Run

matching the sunk entry cost (this is represented by the area below the solid line). This increase in average net profit in the short-run induces entry in the long-run. This entry further raises the competition level λ. Figure 4 shows the new long-run equilibrium profit curve (dashed curve) along with the same old long-run equilibrium profit curve (solid curve). The new net profit curve now satisfies the free-entry condition: so long as the area between the two profit curves – above and below their intersection – are equal, the total area below the new profit curve will be equal to the entry cost f_E (as is also the case for the old equilibrium profit curve). As depicted in the figure, the new profit curve must be steeper than the old one, and must intersect it only once, given that the ratio of operating profit $\pi(\varphi_1, \lambda)/\pi(\varphi_2, \lambda)$ increases (with competition λ) for any two producing firms with $\varphi_1 > \varphi_2$.[23] This further implies that the cutoff φ^* rises indicating tougher selection. As I previously discussed, this new long run equilibrium applies to both the GE and PE versions of the model in a closed world economy (the same cutoff and free entry condition applies in both cases). Lastly, I note that the demand assumptions play a critical role in generating this prediction for selection. Under CES preferences, changes in competition λ would not affect the steepness of the profit curves, and the new long-run equilibrium curve would coincide with the old equilibrium curve: only the number of firms would change.[24]

Thus, we see how more realistic demand assumptions strengthen the link between this initial globalization scenario and aggregate productivity. In both the short- and long-run, an increased market size for the world economy induces an increase in competition that generates intensive margin reallocations towards more productive firms. As production resources (labor in this one-factor

[23]One can choose the firm at the intersection of the two curves as the reference firm to show this directly.

[24]See Melitz (2003) and Melitz and Redding (2014) for a more detailed discussion of the equilibrium with CES preferences.

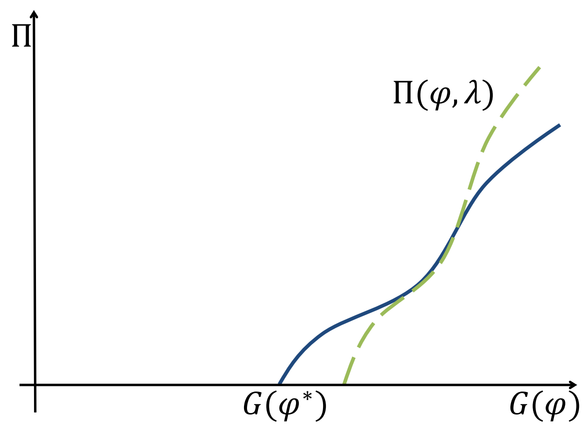

Figure 4: Increased Market Size: Long Run

model) are reallocated towards more productive firms, aggregate productivity increases. In the long-run, the impact on aggregate productivity is compounded by the extensive margin reallocations triggered by tougher selection. In the short-run, the extensive margin reallocations go in the opposite direction as selection weakens (the productivity cutoff φ^* decreases). Aggregate productivity increases so long as the impact of the intensive margin reallocations dominate. These predictions for aggregate productivity contrast with the case of CES preferences and exogenous markups where productivity remains constant in the long-run and decreases in the short-run (only the extensive margin effect is operative).

5 Small Open Economy

In order to analyze globalization scenarios in a world that is not completely integrated, I now develop an open economy with trade frictions. For simplicity, I consider the same domestic economy that was previously developed along with a unique foreign trading partner (F). This "rest of the world" economy is structured in the same way as the domestic economy. It features a market size indexed by L_F^c consumers and an equilibrium level of competition λ_F. Thus, a foreign firm with productivity φ will earn an operating profit per-consumer in F, $\pi(\varphi, \lambda_F)$, given by the same optimization problem (3) as was solved by firms in the domestic economy – though these profits are denominated in units of the foreign wage (just like the domestic profits are denominated in units of the domestic wage). Note that this per-consumer operating profit function – and the associated output and revenue per-consumer given by (4) and (6) – depends only on preferences, which we assume to be identical across countries.[25]

Domestic firms can export to F but then incur both a per-unit "iceberg" trade cost $\tau \geq 1$ as well a fixed export market access cost f_X (denominated in units of domestic labor). Thus, if a domestic firm with productivity φ exports to F, it would earn an operating profit per-consumer in F (in units of the foreign wage) given by $\pi(w_F \tau^{-1}\varphi, \lambda_F)$, where w_F indexes the relative wage difference in F (the foreign wage divided by the domestic wage).[26] Converting this export profit to the domestic wage numeraire then yields total (across consumers) net export profits

$$\Pi_X(\varphi, \lambda_F) = w_F L_F^c \pi(w_F \tau^{-1}\varphi, \lambda_F) - f_X.$$

This is increasing in firm productivity, leading to a unique export cutoff productivity φ_X^* satisfying

$$\Pi_X(\varphi_X^*, \lambda_F) = 0. \tag{10}$$

Firms with productivity below this cutoff do not export.

As in the closed economy, a domestic firm with productivity φ would also earn a total net profit from domestic sales given by

$$\Pi_D(\varphi, \lambda) = L^c \pi(\varphi, \lambda) - f,$$

where λ still indexes the level of competition in the domestic market. The same cutoff condition also holds:

$$\Pi_D(\varphi^*, \lambda) = 0. \tag{11}$$

Firms with productivity below this cutoff cannot profitably operate in their domestic market and do not produce. Here, we have assumed that market conditions in the export market are not so favorable relative to the trade costs that firms would find it profitable to export and not produce for their domestic market. Hence, we assume that selection into the export market is tougher, $\varphi_X^* > \varphi^*$, so that some firms with productivity in between those two cutoffs produce for the domestic market but do not export.[27] Total net profit for a firm with productivity φ then reflects both selection

[25] In other words, the same per-consumer performance functions $\pi(\varphi, \lambda)$, $q(\varphi, \lambda)$, and $r(\varphi, \lambda)$ apply to both the domestic and foreign economy.

[26] Note that the productivity shifter $w_F \tau^{-1}$ in the operating profit function represents the unit-cost differential between a Foreign and domestic firm with productivity φ.

[27] If this were not the case, we would then need to account for the overhead production cost – a portion of the fixed cost f – into the fixed export cost f_X and remove that portion from the fixed cost of serving the domestic market f.

decisions and can be written:

$$\Pi(\varphi, \lambda, \lambda_F) = \mathbf{1}_{[\varphi \geq \varphi^*]} \Pi_D(\varphi, \lambda) + \mathbf{1}_{[\varphi \geq \varphi_X^*]} \Pi_X(\varphi, \lambda_F). \tag{12}$$

As previously mentioned, the foreign economy is structured in the same way as the domestic economy, though with its own set of parameters. There are N_F^E entrants with a productivity distribution $G_F(\varphi)$. These foreign firms can then export into the domestic economy, subject to per-unit trade costs $\tau_F \geq 1$ and an overhead fixed costs $f_{F,X}$ (in units of foreign labor). As with the domestic economy, the foreign firms sort into production and exports given cutoffs φ_F^* and $\varphi_{F,X}^*$.

5.1 Small Open Economy Restriction

In order to analyze asymmetric trade liberalization scenarios with the simple graphical tools developed for the closed economy, I additionally assume that the domestic economy is small relative to its rest-of-the-world trading partner. I follow Demidova and Rodríguez-Clare (2013) in defining a small open economy with product differentiation and monopolistic competition. This amounts to assuming that changes in the domestic economy do not have repercussions for market aggregates in the foreign economy (other than its trade with the domestic economy). Thus, from the perspective of the domestic economy, the number of entrants N_F^E, the production cutoff φ_F^*, and the level of competition λ_F in foreign are all fixed and do not respond to domestic changes (including all trade costs to/from the domestic economy). The only foreign variables that remain endogenous are the relative wage w_F and the export cutoff into the domestic economy $\varphi_{F,X}^*$.[28]

5.2 Long-Run Equilibrium

In the long-run with free-entry, average post-entry profits for all firms must still match the sunk entry cost, yielding the same free-entry condition (8) as for the closed economy – except that profits in the open economy now involve the potential for export profits as shown in (12).

In the PE version of the model, the relative wage w_F is fixed as the wage in the sector is fixed relative to the economy-wide wage in both countries. Since the competition level λ_F in F is exogenous, the export cutoff condition (10) then independently determines the export cutoff φ_X^*. Given this cutoff, one can solve for the domestic economy cutoff φ^* and competition λ using the free-entry condition (8) and domestic cutoff condition (11). Given a domestic competition level λ,

[28] This is identical to assuming an exogenous foreign wage level and an endogenous domestic wage. If we pick the foreign wage as numeraire, then the domestic wage would be $1/w_F$.

one can then sequentially solve for the foreign export cutoff using a cutoff condition that is analogous to the one for the domestic exporters (10):

$$w_F^{-1} L^c \pi(w_F^{-1} \tau_F^{-1} \varphi^*_{F,X}, \lambda) - f_{F,X} = 0. \tag{13}$$

Lastly, the number of domestic entrants is then determined by the budget constraint:

$$N^E \int_{\varphi^*}^{\infty} r(\varphi, \lambda) dG(\varphi) + N_F^E \int_{\varphi^*_{F,X}}^{\infty} r(w_F^{-1} \tau_F^{-1} \varphi, \lambda) dG_F(\varphi) = 1. \tag{14}$$

In the GE version of the model, the relative wage w_F is endogenous and adjusts to balance trade:

$$w_F N^E \int_{\varphi^*_X}^{\infty} r(w_F \tau^{-1} \varphi, \lambda_F) dG(\varphi) = N_F^E \int_{\varphi^*_{F,X}}^{\infty} r(w_F^{-1} \tau_F^{-1} \varphi, \lambda) dG_F(\varphi), \tag{15}$$

with the aggregate domestic exports on the left-hand side and the aggregate foreign exports on the right-hand side. Together with the 5 equilibrium conditions from the PE version – budget constraint (14), free-entry (8), and three cutoff conditions (10,11,13) – this yields a system of 6 equations in the 6 endogenous variables (φ^*,φ^*_X,$\varphi^*_{F,X}$,λ,N^E,w_F). Since the relative wage appears in all but one of the 6 conditions, these variables can no longer be solved sequentially as in the PE equilibrium.

5.3 Short-Run Equilibrium

As was the case in the closed economy, the short-run equilibrium features a fixed number of firms $\bar{N}$ with the same exogenous distribution of ex-ante productivity $G(\varphi)$ and the free-entry condition no longer applies. This exogenous number of firms then replaces the endogenous number of entrants in the budget constraint (14). Again, I only consider the PE version in the short-run (the GE relative wage adjustments are inherently a long-run phenomenon). Given an exogenous relative wage w_F, the export cutoff φ^*_X is again independently determined by its cutoff condition (10). The remaining three endogenous variables (domestic cutoff φ^*, foreign export cutoff $\varphi^*_{F,X}$, competition λ) are solved using the remaining two cutoff conditions (11,13) and the budget constraint (14) with the exogenous number of firms.

6 Globalization Scenarios

One of the main advantages of the small open economy that I have just described is that it is easily amenable to the analysis of asymmetric trade liberalization. In order to built the intuition for those comparative statics, I begin with a simpler setup where trade runs in a single direction: only imports into or exports out of the small open economy. I will then discuss how the asymmetric trade liberalization scenarios with two-way trade feature very similar predictions. By construction, a scenario with one-way trade applies only to the PE case of an individual sector – and not the GE version that is economy wide. (Clearly, balanced trade cannot be imposed with one-way trade.)

6.1 One-Way Trade

6.1.1 Imports Only

I start by describing the impact of opening the PE version of the closed economy to imports. Firms in the small open economy cannot export (again, this relates to a specific sector), so there are no export profits and no associated export cutoff.[29] The free-entry condition for average profits thus only includes profits from domestic sales; and hence depends only on the domestic cutoff φ^*. Along with its associated cutoff condition (11), those conditions solve for that cutoff φ^* and the domestic competition level λ. Given this competition level, the foreign export cutoff condition (13) then solves for that cutoff $\varphi^*_{F,X}$. In the short-run, those two cutoff conditions (11,13) along with the budget constraint (14) jointly solve for those cutoffs φ^*, $\varphi^*_{F,X}$ and the competition level λ.

Now consider the short-run impact of opening up the closed economy to import competition. The new imports reduce the market share of domestic firms below one (in the domestic consumers' total expenditure). This, in turn, must lead to an increase in competition λ for the domestic economy.[30] The impact of the increase in competition λ on the domestic firms' profit curve is shown in Figure 5 (the change from the solid curve to the dotted one). As depicted in the Figure, this increase in competition is then associated with an increase in the domestic cutoff φ^*: the least productive firms are forced to shut-down in the short-run.

The solid profit curve in Figure 5 represents the domestic firms' profits before opening to imports in the closed economy long run equilibrium. The free-entry condition then holds so that the area

[29] Alternatively, one can think of this as a case where the export costs and foreign competition level λ_F are such that no domestic firms find it profitable to export.

[30] This can be shown by contradiction. A (weak) decrease in competition λ, given the cutoff conditions for domestic sales and foreign export sales would necessarily violate the budget constraint (14).

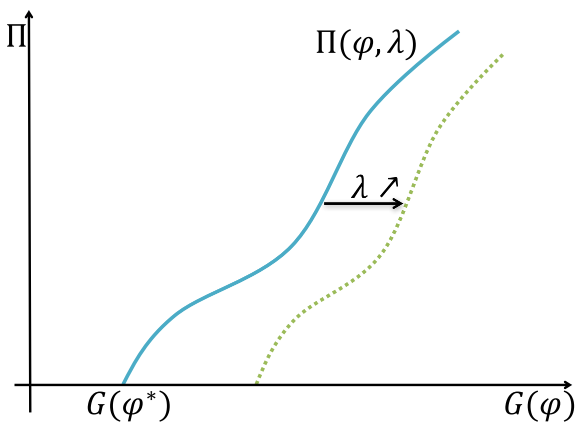

Figure 5: Opening the Economy to Imports

below this solid curve (average profits) is equal to the sunk entry cost. The short-run response to the import competition (dotted curve) clearly violates free-entry as the average profits are driven down. In the long-run, this leads to reduced entry, which then results in lower competition λ. This process unfolds until the free-entry condition is re-established: the average profits are driven back up to equal the sunk entry cost. As the figure makes clear, this occurs when the increase in competition λ from the short-run is fully reversed to its previous long-run competition level: this is the competition level that satisfies free-entry. Another way of seeing this is to note that the same free-entry and cutoff profit condition for domestic production φ^* hold in both the closed economy and the open economy with imports. They must then both exhibit the same competition level λ and cutoff φ^*.

Note that the impact of opening the economy to imports is very different than the impact of reducing the size of the domestic economy in terms of the number of consumers L^c. The latter would be associated with lower competition in both the short- and long-run. In both cases, the domestic sales are reduced. But in the case of import competition, a higher level of competition is sustained because the lost domestic sales and associated product variety is compensated from the consumer's perspective with increased imports and the associated imported product variety.

Starting in this economy open to imports, the impact of further import liberalization – a reduction in either the per-unit or fixed import costs τ_F and $f_{F,X}$ – will be similar to the impact of opening up from the closed economy that was just described. In other words, there are no discontinuities for the impact of lower import costs, starting with a limiting case when they are arbitrarily large and imports are non-existent: Decreases in those trade costs lead to increased competition λ and tougher selection in the short-run; in the long-run, decreases in entry reverse this increase in competition and it returns to its initial level. These effects also apply to a decrease in the relative wage w_F, which also induces an increase in imports – just like reductions in import trade costs.

Thus, we see how asymmetric import trade liberalization generates a force towards increased productivity. In the short-run, increased competition from imports generates both extensive margin reallocations (shut-down of least productive firms) as well as intensive margin reallocations towards more productive firms. This second channel is not operative in a model with CES preferences and exogenous markups. The model predicts that these productivity gains are erased in the long-run. I will show later that this reversal no longer holds in the GE version featuring an adjustment in the relative wage. Furthermore, even in the PE version, the long-run transition can unfold very slowly implying a substantial net present value effect for the productivity gain.

6.1.2 Exports Only

I now describe the impact of opening the small open economy to exports – with no foreign imports. As was previously noted, the exogenous relative wage w_F in this PE version implies that the export cutoff φ_X^* is independently determined by its cutoff condition (10). Given this cutoff, one can then solve for the domestic economy cutoff φ^* and competition level λ using the free-entry condition (8) and domestic cutoff condition (11). In the short-run, the budget constraint (14) – which now only includes domestic sales and depends only on the domestic cutoff φ^* and competition λ – replaces the free entry condition; and determines the equilibrium levels of those variables (along with the domestic cutoff condition).

Now consider the impact of opening up the closed economy to exports. The new export opportunities increase the total profits $\Pi(\varphi, \lambda, \lambda_F)$ for high productivity firms with $\varphi \geq \varphi_X^*$ who start exporting. This is shown in Figure 6 along with the domestic profits $\Pi_D(\varphi, \lambda)$ (dotted curve) for all producing firms. The export profits $\Pi_X(\varphi, \lambda_F)$ are represented by the difference between the other two profit curves. In the short-run, these increased profits do not affect the domestic cutoff φ^* and competition λ, which are still determined by the same budget constraint and domestic cutoff condition.

The dotted profit curve in Figure 6 also represents total firm profits before opening to exports in the closed economy long run equilibrium. The free-entry condition then holds so that the area below this dotted curve (average profits) is equal to the sunk entry cost. The short-run response in total profits (solid curve), which includes the new export profits, clearly violates free-entry as the average profits are driven up. In the long-run, this leads to increased entry, which then results in

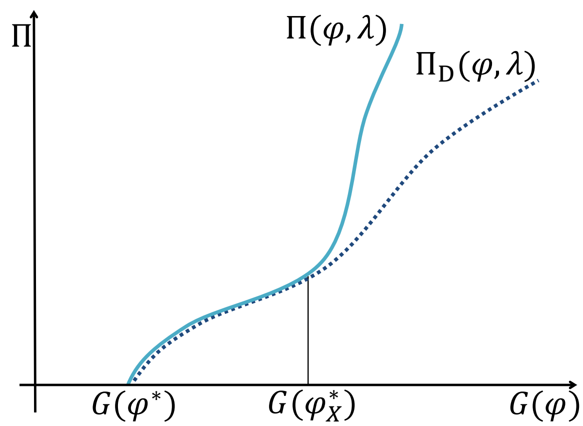

Figure 6: Opening the Economy to Exports

increased competition λ. This process unfolds until the free-entry condition is re-established: the average profits are driven back down to equal the sunk entry cost. This is depicted in Figure 7, where the areas between the new total profit curve (including export profits) in the solid line and the old domestic profit curve in the dotted line are equal.

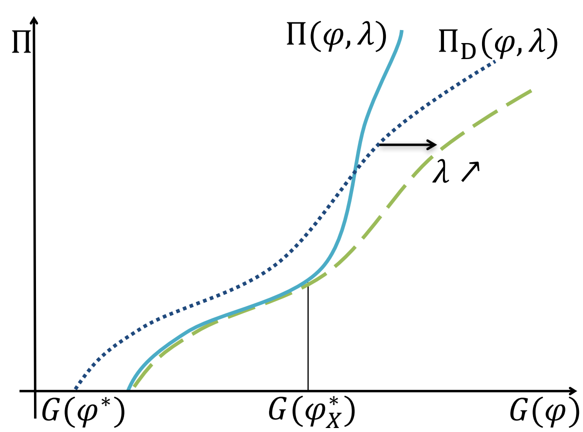

Figure 7: Opening the Economy to Exports in the Long-Run

Predictions for the impact of further export liberalization – a reduction in either the per-unit or fixed export costs τ and f_X – will be similar to the impact of opening up from the closed economy that was just described. In other words, there are no discontinuities for the impact of lower export costs, starting with a limiting case when they are arbitrarily large and exports are non-existent: Decreases in those trade costs do not affect competition in the domestic market in the short-run. Aggregate productivity increases nonetheless as market shares are reallocated towards more productive firms who export.[31] This is an extensive margin effect driven by changes in the set of markets served by a given firm.

In the long-run, decreases in the export costs induce entry into the domestic market, along with increased competition λ and tougher selection. This generates additional extensive margin reallocations (shut-down of least productive firms) as well as new intensive margin reallocations: increased competition shifts domestic sales towards more productive firms. Again, this intensive margin channel is not operative in a model with CES preferences and exogenous markups. All of these effects also apply to an increase in the relative wage w_F, which also induces an increase in export and the associated profit (just like reductions in export trade costs).

6.2 Two-Way Trade

I now return to the model with two-way trade that was developed in the previous section and describe the impact of asymmetric trade liberalization (for both imports and exports).

6.2.1 Exogenous Relative Wage (PE)

When the relative wage w_F is fixed, both import and export liberalization will have the same effects in an economy open to two-way trade as in the special case of one-way trade that we just analyzed. The consequences for aggregate productivity – including both extensive and intensive margin reallocations – will therefore also be identical.

Consider first the case of import trade liberalization. Unlike the case of one-way import trade, the export profits will play a role in determining the equilibrium levels of competition λ and production cutoff φ^* in the domestic economy. However, changes in import costs τ_F or $f_{F,X}$ then do not have any impact on those export profits. Thus, the effects of this liberalization will unfold just like the case of one-way trade: increased imports from Foreign raises competition λ and induces tougher selection in the short-run; these effects are then reversed in the long-run with decreased entry.

Now consider the case of export trade liberalization. Unlike the case of one-way export trade, the imports from Foreign will play a role in determining the equilibrium levels of competition λ and production cutoff φ^* in the domestic economy. In the short-run however, changes in export costs τ or f_X will have no impact on those imports from Foreign – because those trade costs do not affect the competition level λ in the domestic economy. The lower export costs induce higher

[31] If only the fixed export costs f_X are reduced, then the market share of existing exporters does not change. Only the new exporters expand their market share. The impact on aggregate productivity will nonetheless be positive so long as those new exporters are more productive than the industry average: $\varphi_X^* > \Phi$.

export profits for domestic firms and the entry of new exporters (lower export cutoff φ_X^*), but this only feeds back into the determination of the equilibrium competition level λ in the domestic economy in the long run. The increased export profits then induce increased entry into the domestic economy, raising competition λ and generating tougher selection (higher cutoff φ^*). This increase in competition λ then induces a decrease in foreign imports and fewer foreign exporters (higher cutoff $\varphi_{F,X}^*$). However, there is no feedback from those reduced imports to the determination of the competition level λ in the long-run: that level is determined by the free-entry (8) and cutoff profit (11) conditions.[32]

6.2.2 Endogenous Relative Wage (GE)

As discussed in the previous section, the relative wage w_F connects all but one of the equilibrium conditions, and these can no longer be solved sequentially as was done for the PE version in the long-run. Although this makes a formal solving of the full equilibrium cumbersome, the direction of the comparative statics in response to asymmetric trade liberalization are nonetheless straightforward – because the direction of change for the relative wage is known in these cases. This relative wage must adjust to rebalance trade following an asymmetric liberalization. If imports are liberalized (which induces an increase in imports and no change in exports for the domestic economy at a constant relative wage), then the relative wage w_F must increase in order to rebalance trade. When exports are liberalized (which induces an increase in exports and a decrease in imports for the domestic economy at a constant relative wage), then the relative wage w_F must decrease in order to rebalance trade.

Consider first the case of import liberalization. At a constant relative wage w_F, the small open economy returns to a long-run equilibrium with the same competition level λ and domestic cutoff φ^* (see previous subsection). However, this leads to a (negative) trade imbalance and an ensuing increase in the relative wage w_F. This relative wage adjustment increases export profits for the domestic firms, and induces similar effects to a decrease in export costs (as was previously discussed). Relative to the long-run equilibrium with a constant relative wage, this implies higher domestic entry associated with increased competition λ and tougher selection (higher production cutoff φ^*). Since import liberalization does not affect the equilibrium in the long-run at a given relative wage, the additional relative wage adjustment in GE must therefore induce increases in

[32] Only equilibrium entry into the domestic market is affected by those reduced imports in the long-run (given the budget constraint).

competition and tougher selection in response to import liberalization in the long-run.

Consider now the case of export liberalization. At a constant relative wage w_F, the increased export profits generate additional entry in the domestic economy and tougher competition and selection. This leads to a (positive) trade imbalance and an ensuing decrease in the relative wage w_F. This decrease in the relative wage partially offsets the increase in export profits (for any given firm); it also induces an increase in imports from foreign (and new foreign exporters). These effects dampen – but cannot overturn – the entry response into the domestic economy. Therefore, the same qualitative predictions hold as with the case of an exogenous relative wage in PE: Increased export liberalization leads to tougher competition and selection in the domestic market (as well as increased exports and new exporters).

Thus, we have just seen how both import and export trade liberalization lead to tougher competition and selection in the small open economy; and higher export profits and new domestic exporters. This involves some extensive margin reallocations towards more productive producers: the exit of the least productive firms and reallocations towards more productive exporters. These effects would all be present in a model with CES preferences and exogenous markups.[33] However, the current model with endogenous markups also features additional intensive margin reallocations towards more productive producers – driven by the increase in competition in the domestic market. Those intensive margin reallocations further contribute to an aggregate productivity increase in response to asymmetric trade liberalization in either direction.

7 Conclusion

I have just developed a simple model of firm heterogeneity with endogenous markups. Those endogenous markups stem from preferences that feature variable elasticities of substitution. These preferences are left un-parametrized within a broad class that generates empirical predictions for markups that are consistent with a large set of established empirical patterns. On the production side, the shape of the productivity distribution for firms is also left un-parametrized. By appealing to the concept of a small open economy, I have shown how comparative statics for the impact of asymmetric trade liberalization can be easily obtained without imposing any further parametric assumptions. Relative to a model with constant elasticities (CES) and exogenous markups, the

[33] Demidova and Rodríguez-Clare (2013) develop such a model with CES preferences for a small open economy (in GE with a relative wage adjustment to balance trade). The predictions for the relative wage change and all the cutoffs are identical to the model developed here.

current model highlights how trade liberalization – in either direction – induces intensive margin reallocations towards more productive producers that reenforce the extensive margin reallocations that are stressed by models with exogenous markups (because they do not feature intensive margin reallocations). Both of these reallocation margins generate aggregate productivity gains in response to asymmetric trade liberalization – especially when relative wage responses are incorporated. The predictions for the impact of trade liberalization are decomposed into a short-run response and then a long-run version that further incorporates the response of entry and potentially changes in relative wages induces by trade imbalances.

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