The Dynamics of Trade and Competition*†

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Abstract

We estimate a version of the Melitz and Ottaviano (2008) model of international trade with firm heterogeneity. The model is constructed to yield testable implications for the dynamics of prices, productivity and markups as functions of openness to trade at a sectoral level. The theory lends itself naturally to a difference in differences estimation, with international differences in trade openness at the sector level reflecting international differences in the competitive structure of markets. Predictions are derived for the effects of both domestic and foreign openness on each economy. Using disaggregated data for EU manufacturing over the period 1989-1999 we find short run evidence that trade openness exerts a competitive effect, with prices and markups falling and productivity rising. The response of profit margins to openness has implications on the conduct of monetary policy. Consistent with the predictions of some recent theoretical models we find some, albeit weaker, support that the long run effects are more ambiguous and may even be anti-competitive. Domestic trade liberalization also appears to induce pro-competitive effects on overseas markets.

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1 Introduction

Increased openness is widely believed to induce competitive effects. In response to greater foreign competition and increased imports, profit margins should fall as markups decline, and average productivity should increase as marginal firms exit the industry. The introduction of heterogeneous firms into models of international trade has provided detailed predictions on the distributional dynamics induced by greater openness and the patterns of entry, exit and relocation that occur in its wake. This paper is part of the research effort attempting to bring these predictions to the data.

We adopt the model of Melitz and Ottaviano (2008) and convert it into a form that is directly amenable to empirical analysis. In particular our empirical measure of openness is derived from our theoretical model as are the reduced form expressions we estimate. Our theoretical specification naturally suggests a difference in differences estimation in which international differences in sector-level inflation rates, productivity growth and markups are all ascribed to international differences in openness to trade. Thus, we are able to investigate the validity of the theoretical claim that it is relative openness that affects the relative extent of competition.

To test our model we use a cross section of manufacturing industries in seven European Union countries during the 1990s. We bring together data on prices, productivity, markups (price-cost margins), the number of domestically producing firms and total imports in order to assess the impact of import competition on economic performance. We uncover support for significant pro-competitive effects of trade openness, as measured by import penetration, in domestic markets. In response to increased imports, productivity rises and interestingly, measured margins fall. As a result, prices grow at a (temporarily) lower rate. These effects prevail over and above putative changes in aggregate monetary policy in response to increased openness.

Foreign and domestic openness to trade both affect prices, productivity and margins with opposite – and often equal – signs, in a manner consistent with our theory. In addition, market size and the number of firms matter significantly, in accordance with the model's predictions. We also uncover some evidence, although less marked, that the long run effects of trade liberalization may be reversed. Trade may eventually lead to anti-competitive effects, a result emphasized in Melitz and Ottaviano (2008). In our data, these reversals are not present across all specifications, nor always systematic for all variables considered. Still, their occasional presence suggests pro-competitive effects are most potent in the short run.

The difference in differences approach uses differential dynamics at the sector level to achieve identification. This is useful, for it enables us to purge from our estimates price effects arising from changes in monetary policy. For instance, Romer (1993) argues trade openness affects the conduct of monetary policy, as depreciation costs erode the benefits of surprise inflations to an extent that increases with openness. Open economies tend to experience lower inflation. With disaggregated data, we are able to eliminate these aggregate influences, and focus instead on the microeconomic effects of openness on sectoral relative prices. To the extent that the manufacturing sectors we examine form a substantial part of consumer price indices, our estimates also provide some insight into recent trends in measured inflation.

The response of profit margins is also potentially interesting from a macroeconomic standpoint. In a conventional framework with time inconsistent monetary policy, the inflation gap is directly proportional to the extent of competition. Rogoff (2003) conjectures that globalization and deregulation have lowered profit margins, affected the conduct of monetary policy and ultimately the extent of inflation. To Rogoff, this contributes to explaining the fall in inflation that has accompanied the recent globalizing period. The estimated decline in profit margins that we document in response to foreign competition adds qualitative support to Rogoff's speculation. But our identification rests on differential effects at the sector level, and that limits our ability to quantify Rogoff's claim in the aggregate.

Ours is by no means the first attempt at quantifying the competitive effects of trade. A first strand of the literature uses cross country panel studies to examine the effects of aggregate trade openness on economic (or productivity) growth.[1] Key issues are the importance of theoretically sound measures of openness, and the critical need to deal with the endogeneity of changes in openness. Here, we pay special attention to these concerns and derive our measure of openness directly from the theoretical model. In addition, we use disaggregated sectoral data, and test predictions that both domestic and foreign openness may affect domestic market structure.

[1] See *inter alia* Ades and Glaeser (1999), Frankel and Romer (1999), Alcalà and Ciccone (2003), Rodrik and Rodriguez (2001) or Irwin and Tervio (2002).

A second branch of the literature attempts to assuage endogeneity concerns by studying one-off liberalization events, typically in the developing world. These events often occur as part of more general reforms and are liable to have differential effects across firms, whose cross section helps identification.[2] The disaggregated approach inspires the present work although we focus not on "natural experiments" but on more gradual and continual processes of opening to trade. Although EU countries have jointly embarked on a process of trade liberalization, our data clearly show that the level of openness in European sectors at the beginning of the sample differed substantially across countries. It still does by the end of the period. It is this gradual process of increasing trade openness at differential rates across nations that we use to identify the impact of openness. In particular, we do not estimate how France responds to increased imports from the rest of the world but rather how French sectors have been effected differently than German ones through differential changes in openness.

By using a cross section of developed European economies we also address Trefler's (2004) plea that "what is needed is at least some research focusing on industrialized countries" (p.2). Although we focus on how European countries have responded to greater trade openness, ours is not a model of intra-European trade. Our focus is how increased imports from both inside *and* outside the EU have influenced member countries.

We measure changes in openness by changes in import penetration. As imports themselves represent the outcome of firms' decisions we need instruments. We achieve satisfactory explanatory power thanks to a combination of insights inspired from various literatures. We use gravity variables adapted to a sectoral cross section, some direct measures of transport costs, measures of transportability and an index capturing whether price fixing or collusion varies in a given industry and over time. In addition, inspired by work of Melitz and Ottaviano (2008) that provides our structure, we exploit the dynamic nature of our panel to investigate whether the short and long run effects of openness differ.

Closest to our work are recent papers using disaggregated data to examine the effects of openness on firm-level performance. In a similar theory to ours, Del Gatto, Mion and Ottaviano (2006) use firm level data to calibrate the impact of changes in trade openness

[2] See, among many others, Clerides, Lach and Tybout (1998); Corbo, de Melo and Tybout (1991) or Pavcnik (2002) on Chile; Ferreira and Rossi (2003) on Brazil; Harrison (1994) on Ivory Coast; and Krishna and Mitra (1998), Topalova (2004) or Aghion, Burgess, Redding and Zilibotti (2006) on India.

on productivity amongst EU nations. A number of recent papers utilize US firm level data to investigate the impact of openness on productivity and production. Bernard and Jensen (2007) investigate how organizational structure affects the exit probability of US firms. Bernard, Redding and Schott (2007) examine theoretically the response of firms' output to increases in imports. Bernard, Eaton, Jensen and Kortum (2003) fit a model of heterogeneous firms and empirically characterize the behavior of US exporters. Closely related to our work is Bernard, Jensen and Schott (2006), who investigate the response of firm-level productivity to falling trade costs at the sector level. Their data is focused on US firms, where they find evidence that increased openness spurs exit by unproductive firms, facilitates decisions to export and boosts productivity in general. The literature on trade with heterogeneous firms is surveyed in Bernard, Jensen, Redding and Schott (2007), where some evidence on the importance of an extensive margin in export decisions can also be found.[3]

The plan of the paper is as follows. In Section 2 we briefly review the model of Melitz and Ottaviano (2008), adapted to motivate our empirics. Section 3 develops from this theoretical framework the equations we actually estimate. We reformulate the model in terms of directly observable import shares and separate short and long run effects of openness. In Section 4 we tackle a number of econometric issues before proceeding in Section 5 to a discussion of our disaggregated dataset, which covers ten manufacturing sectors across seven European nations over the period 1989-1999. Section 6 presents our econometric results, and Section 7 considers various robustness checks. A final Section concludes.

2 Theory

We base our analysis on the model of Melitz and Ottaviano (2008) which links prices, productivity and markups to the number of firms supplying a market. Import penetration increases the number of firms and so influences firm level performance. In the short run, trade has pro-competitive effects: falling transport costs lead to an increase in imports, greater competition and a fall in prices and markups, which in turn raises average

[3] This list is far from exhaustive. Baldwin and Forslid (2004) focus on the welfare gains of trade liberalization in the presence of firm heterogeneity. Baldwin and Okubo (2005) review the testable predictions of Melitz (2003), some of which are picked up here. Kramarz (2003) estimates the impact on French wages, through reductions in workers bargaining power, of increased imports.

productivity as only the stronger firms continue to produce. In the long term however, firms can relocate, leading to potentially ambiguous effects. If trade liberalizations actually lower setup costs, then even more firms enter the liberalized market, accentuating the competitive effects. On the other hand, greater domestic competition induces firms to relocate overseas, which may reverse the pro-competitive effects, as emphasized by Melitz and Ottaviano (2008). The model provides structure to the short and long run dynamics of trade openness, draws a distinction between domestic and overseas openness and allows for rich patterns in the manner through which trade affects market structure.

We take this model as a foundation for our empirical analysis. We build on it in three ways. First the theory points to a critical role for a trade cost variable, reflecting either transportation costs or tariffs. Reliable data for these costs are scarce so we use the model to substitute out for them, and use instead the more readily observable import share.[4] Second the model naturally leads to a difference in differences estimation identifying the impact of greater openness. Finally, we allow for fixed costs to vary across countries in a manner that depends on trade tariffs. As a result trade liberalization can have ambiguous effects in the long run, in contrast to the predictions of Melitz and Ottaviano (2008) where firm relocation always leads to anti-competitive effects.

2.1 The Model

For a full description of the model underlying our empirical analysis we refer the interested reader to the original in Melitz and Ottaviano (2008). We keep our exposition succinct here in order to emphasize the grounding of our analysis in a theoretical structure and to clarify the steps we take towards estimable specifications. Here we outline the key features that underpin a relation between openness, prices, productivity and markups in both the short and long run.

2.1.1 Demand

A representative agent has preferences over a continuum of sectors, indexed by i. Utility from consumption in each sector is derived from quasi-linear preferences over a continuum of varieties indexed by $u \in (0, N]$, where N will be determined endogenously. Aggregate

[4] See Harrigan (1999) for a discussion of measurement issues for transport costs, or Bernard, Jensen and Schott (2006) for an example of US based sector data on transport costs.

demand for variety u in sector i can be derived as

$$Q_u^i = Lq_u^i = \frac{\alpha L}{\gamma + \eta N} - \frac{L}{\gamma} p_u^i + \frac{1}{\gamma} \frac{\eta N L}{\gamma + \eta N} \bar{p}^i$$

where L denotes the mass of consumers in the home country. Identical assumptions hold in the foreign country, whose variables we denote by an asterisk. Note that demand for each variety is linear in prices, but unlike the classic monopolistically competitive setup introduced in Dixit and Stiglitz (1977), the price elasticity of demand depends on N, the number of firms in the sector, a feature introduced in Ottaviano, Tabuchi and Thisse (2002). Variations in the number of competing firms is the key mechanism through which trade liberalization effects corporate performance.

2.1.2 Supply

Labor is the only factor of production and c denotes the firm's unit labor cost. Labor is perfectly mobile domestically between firms in the same sector, but not across countries. International wage differences are therefore possible in each sector.[5] As a result, unit costs vary across firms in a sector purely for technological reasons. Across countries on the other hand, unit costs may differ both because of wages or technology. Domestic firms can sell to the domestic market, or export but then they incur an ad-valorem cost $\tau^* > 1$, reflecting transportation costs or tariffs determined in the foreign economy. Production for domestic markets has unit cost c and for exports $\tau^* c$. Transportation costs for foreign goods entering the domestic economy are symmetrically denoted by τ. Entry and exit decisions entail a fixed cost f_E which firms have to pay to establish production in whichever economy. In the short run firms cannot change their location but can decide whether to produce or not, and if they choose to, whether they should also export.

Entry decisions are made prior to knowing a firm's productivity level, but production and export decisions are made once productivity (c) is revealed. We allow for entry costs to vary across countries ($f_E \neq f_E^*$) and let them depend on the extent of trade liberalization. Specifically we assume $f_E^* = \lambda(\tau^*, \tau) f_E(\tau)$. This reflects the possibility that reductions in tariffs or transport costs often come hand in hand with fewer restrictions on setting up business. Such would be the case if trade liberalization were implemented as part of a general program of reforms. In other words, $f_E' > 0$. For instance, this

[5] In the empirical section, we assume perfect labor mobility across firms in the same sector, but take no stance regarding labor mobility between sectors.

will happen if trade liberalization leads to a fall in the price of capital and construction goods.

Denote c_D (c_D^*) as the unit cost of the marginal domestic (foreign) firm achieving zero sales. A firm with unit costs c charges a price $p(c)$ and so we have $p(c_D) = c_D$ and $p^*(c_D^*) = c_D^*$. The marginal exporting domestic firm has costs $c_X = c_D^*/\tau^*$, while its foreign counterpart has costs $c_X^* = c_D/\tau$. Because of trade costs, markets in different countries are distinct and firms have to choose how much to produce for domestic markets [$q_D(c)$ and $q_D^*(c)$] and how much for exports [$q_X(c)$ and $q_X^*(c)$]. To obtain closed form expressions Melitz (2003) and Melitz and Ottaviano (2008) assume costs in each sector follow a Pareto distribution with cumulative distribution function $G(c) = (\frac{c}{c_M})^k$, $c \in [0, c_M]$. Cross-country productivity differences are introduced by letting the upper bound for costs differ, i.e. $c_M \neq c_M^*$. If $c_M <$ ($>$) c_M^* then the domestic economy displays relatively low (high) cost and high (low) productivity. This helps introduce our estimation strategy based on international differences in the model's endogenous variables.

The Pareto distribution is robust to truncation and multiplication. Therefore, the costs for domestic firms that produce for the domestic market or that export (inclusive of trade costs) both follow a Pareto distribution. As a result the aggregate sectoral price index $\bar{p}$ and average cost $\bar{c}$ are given by

$$\begin{aligned} \bar{p} &= \int_0^{c_D} p(c)dG(c)/G(c_D) = \frac{2k+1}{2(k+1)}c_D \\ \bar{c} &= \int_0^{c_D} cdG(c)/G(c_D) = \frac{k}{k+1}c_D \end{aligned}$$

With markups for domestic sales given by $\mu_u = p_u - c_u$, average sector markups are

$$\bar{\mu} = \frac{1}{2}\frac{1}{k+1}c_D$$

The same relations hold by symmetry in the foreign economy. Prices, markups, costs and productivity are all pinned down by the value of threshold costs c_D and c_D^*, whose determination in equilibrium we now consider.

2.2 Market Structure and Trade Liberalization

2.2.1 Demand, Varieties and Competition

N denotes the number of firms active in the domestic market, and N^* the number supplying to overseas markets. The number of firms supplying a market is made up of both active domestic producers and foreign exporters. Using expressions for average sectoral prices, the demand curve and the fact that for the marginal firm in the domestic economy $p(c_D) = c_D$ we have

$$N = \frac{2\gamma(k+1)}{\eta}\frac{\alpha - c_D}{c_D} \quad (1)$$

$$N^* = \frac{2\gamma(k+1)}{\eta}\frac{\alpha - c_D^*}{c_D^*} \quad (2)$$

The demand curve therefore implies a *negative* relation between the number of active firms supported by the market and the threshold cost of the marginal firm. This relation is shown in Figure 1 by the downward sloping curve. High values for c_D lead to high prices, limited demand, and so a limited number of firms and varieties. Note that equations (1) and (2) simply summarize the demand side of the economy and do not depend directly on transportation costs. The negative relation shown in Figure 1 is invariant to values of τ.

2.2.2 Short Run Equilibrium

In the short run, firm location is fixed and their decision is whether to produce or not and which markets to supply, bearing in mind that exports incur the transport costs τ or τ^*. High cost firms decide not to produce but do not relocate. The lowest cost firms produce for both domestic and export markets, and an intermediate group of firms produce only for the domestic market.

The number of firms located in each economy, $\bar{N}_{SR}$ and $\bar{N}_{SR}^*$, is assumed fixed in the short run. Given the distribution of costs and as only firms with $c < c_D$ ($c < c_D^*$ abroad) choose to produce, the number of firms active in each market is given by

$$N = \bar{N}_{SR}\left(\frac{c_D}{c_M}\right)^k + \bar{N}_{SR}^*\frac{1}{\tau^k}\left(\frac{c_D}{c_M^*}\right)^k \quad (3)$$

$$N^* = \bar{N}_{SR}^*\left(\frac{c_D^*}{c_M^*}\right)^k + \bar{N}_{SR}\frac{1}{(\tau^*)^k}\left(\frac{c_D^*}{c_M}\right)^k \quad (4)$$

Equations (3) and (4) reflect the supply side of the economy and firms production decisions. The higher the threshold level of costs, c_D, the larger the number of firms (both domestically located and exporters) that decide to produce. Equation (3) is represented in Figure 1 by the upward sloping relation. In contrast to the demand relation (1), changes in transport costs affect the production decisions of firms and shift the relation between N and c_D. For a given level of c_D, a fall in transport costs τ means more foreign firms selling to the domestic market, an increase in imports and a rise in N. This effect is captured in Figure 1 where the supply schedule shifts right in response to a fall in transport costs. In equilibrium, N rises and c_D falls in response to a fall in trading costs.

The increase in foreign firms exporting to the domestic market leads to a rise in varieties and so raises the elasticity of demand. Given the structure of the market this results in a fall in markups and prices, so that domestic firms with high costs cease production. The end result is a net increase in N (even though some domestically producing firms are displaced by foreign exports), lower prices, lower markups and a trade induced rise in average productivity. In the short run, trade liberalizations have standard pro-competitive effects.

2.2.3 Long Run Equilibrium

In the long run firms can decide to relocate elsewhere by incurring the fixed costs f_E or f_E^*. Letting N_{LR} and N_{LR}^* denote the endogenous long run equilibrium number of firms located in each country then equations (3) and (4) rewrite straightforwardly as

$$\begin{aligned} N &= N_{LR}\left(\frac{c_D}{c_M}\right)^k + N_{LR}^*\,\frac{1}{\tau^k}\left(\frac{c_D}{c_M^*}\right)^k \\ N^* &= N_{LR}^*\left(\frac{c_D^*}{c_M^*}\right)^k + N_{LR}\,\frac{1}{(\tau^*)^k}\left(\frac{c_D^*}{c_M}\right)^k \end{aligned}$$

Under the Pareto distributional assumption, zero expected profit conditions in both countries pin down closed form solutions for N_{LR} and N_{LR}^*. Recall that $c_X = c_D^*/\tau^*$ to obtain the following expressions for the costs of the marginal firm:

$$c_D^{k+2} = \frac{\phi(\tau)\; c_M^k}{\Upsilon(\tau,\tau^*)L}\left[1 - \frac{\lambda(\tau^*)}{(\tau^*)^k}\left(\frac{c_M^*}{c_M}\right)^k\right] \quad (5)$$

$$(c_D^*)^{k+2} = \frac{\phi^*(\tau)\;\,(c_M^*)^k}{\Upsilon(\tau,\tau^*)L^*}\left[1 - \frac{1}{\lambda(\tau^*)}\frac{1}{\tau^k}\left(\frac{c_M}{c_M^*}\right)^k\right] \quad (6)$$

where $\phi(\tau) = 2\gamma(k+1)(k+2)f_E(\tau)$ and $\Upsilon(\tau,\tau^*) = 1 - \tau^{-k}\,(\tau^*)^{-k}$. Equations (5) and (6) replace (3) and (4) in the long run, while equations (1) and (2), reflecting demand and preferences, remain unaltered. Because of endogenous entry and exit, there is no longer a direct relation between c_D and N. Instead the marginal level of costs is pinned down by the distribution of costs (c_M), the level of fixed costs ($\phi(.)$ and $\lambda(.)$), market size (L)

and trade costs ($\Upsilon(.)$). The supply side of the economy is no longer characterized by an upward sloping schedule but a horizontal line, as in Figure 2. The equilibrium number of firms located in an economy is determined by the intersection of this line with the downward sloping curve originating from consumer preferences.

Melitz and Ottaviano (2008) consider the case of constant and equal fixed costs, $\lambda(.) = 1$, $f_E(\tau) = f_E$. A decrease in domestic trading costs τ then leads to an upward shift in marginal costs through its impact on $\Upsilon(.)$. In equilibrium N falls and c_D rises, which implies higher prices and markups and lower productivity. In other words, with exogenous f_E and f_E^*, the long run impact of falling trade costs is the exact opposite of the short run. In the long run firms respond to increased competition by relocating to more protected markets overseas, as the fall in trade costs makes it more viable to serve the domestic market through exports from there.

The long run impact of liberalization remains unchanged even if fixed costs are allowed to differ between countries, $\lambda(.) = \lambda \neq 1$, provided they do not depend on τ. Without loss of generality, assume $\lambda > 1$. Then the supply side of the model is still given by a horizontal line but at a lower level. Reductions in domestic trade costs still lead to an upward shift in this line, a reduction in N and anti-competitive effects in the long run.

These anti-competitive effects can be reversed if we allow $\lambda = \lambda(\tau^*, \tau)$ and $f_E = f_E(\tau)$, $f_E' > 0$. In this case, reductions in τ lead to reductions in $\phi(\tau)$ and so the horizontal line in Figure 2 moves downward. The overall net effect of trade liberalization becomes ambiguous, and depends on whether the pro-competitive consequences of lower entry costs offset the anti-competitive impact of relocation to protected markets. A similar ambiguity applies to overseas trade liberalization (τ^* falling). The relocation effect stressed in Melitz and Ottaviano (2008) and captured by $1/(\tau^*)^k$ and $\Upsilon(.)$ means that overseas trade liberalization leads to a long run increase in the number of domestically located firms and so an increase in domestic competition. But this is offset by the $\lambda(.)$ term: as foreign setup costs fall, firms choose to relocate overseas, with anti-competitive consequences on the domestic market.

3 Towards an Estimable Model

The previous section offered a quick overview of the trade model we use and derived the short and long run implications of greater openness on key endogenous variables. In this section we lay the foundations for our empirical analysis. We recast the equations in terms of readily observable variables and embed the comparative static results of Melitz and Ottaviano (2008) into a dynamic structure.

3.1 Openness and Import Share

The key parameters of trade liberalization in our model are τ and τ^*, but reliable estimates of trade costs are notoriously difficult to obtain at the sectoral level. We use our model to substitute out for τ in terms of directly observable measures of trade openness. The key variable for our analysis will be domestic absorption which in the model is given by

$$\theta = \frac{\int_0^{c_X^*} p_X^*(c)\ q_X^*(c)\ dG^*(c)}{\int_0^{c_D} p_D(c)\ q_D(c)\ dG(c) + \int_0^{c_X^*} p_X^*(c)\ q_X^*(c)\ dG^*(c)}$$

Under the Pareto distributional assumption, this rewrites

$$\theta = \frac{1}{1 + \left[\frac{1}{\tau^k}\left(\frac{c_M}{c_M^*}\right)^k\right]^{-1}}$$

Domestic openness falls with the transport costs applied to foreign imports, and increases with domestic costs. Symmetric effects hold for foreign openness and

$$\theta^* = \frac{1}{1 + \left[\frac{1}{(\tau^*)^k}\left(\frac{c_M^*}{c_M}\right)^k\right]^{-1}}$$

It is useful to rearrange both expressions to obtain

$$\frac{1}{\tau^k}\left(\frac{c_M}{c_M^*}\right)^k = \frac{\theta}{1-\theta} \text{ and } \frac{1}{(\tau^*)^k}\left(\frac{c_M^*}{c_M}\right)^k = \frac{\theta^*}{1-\theta^*}$$

We use these expressions to replace trade costs with directly observable import shares in each of our equations for prices, markups and productivity.

3.2 Prices

3.2.1 Short Run

From our expressions for average sectoral prices we have $\left(\frac{\bar{p}}{\bar{p}^*}\right) = \left(\frac{c_D}{c_D^*}\right)$. In the short run, equations (3) and (4) yield

$$\begin{aligned} \left(\frac{\bar{p}}{\bar{p}^*}\right)^k &= \left(\frac{c_D}{c_D^*}\right)^k \\ &= \left(\frac{c_M}{c_M^*}\right)^k \frac{(\bar{N}_{SR}^*/N^*)}{(\bar{N}_{SR}/N)} \frac{1 + \frac{\bar{N}_{SR}}{\bar{N}_{SR}^*}\frac{\theta^*}{1-\theta^*}}{1 + \frac{\bar{N}_{SR}^*}{\bar{N}_{SR}}\frac{\theta}{1-\theta}} \end{aligned} \tag{7}$$

Equation (7) shows that in the short run relative prices fall with domestic openness (θ) but rise with foreign openness (θ^*).[6] A rise in θ corresponds to a fall in τ and our openness channel traces through the effects described in Figure 1. In the short run, conditional on $\bar{N}_{SR}/N$ and $\bar{N}_{SR}^*/N^*$, increases in (relative) openness lead to decreases in (relative) domestic prices. $\bar{N}_{SR}$ and $\bar{N}_{SR}^*$ are fixed, but N and N^* vary as trade liberalization leads to increased imports and fewer domestic firms producing.

Our data contain information on prices and openness but not on N, the total number of firms supplying to the domestic market. Instead we have data on D, the number of domestic firms producing for the home market. In terms of our model $D = N_{SR} \left(\frac{c_D}{c_M}\right)^k$ and one can show that $D = \Psi(\tau, \tau^*)\, N$ where $\Psi_\tau > 0$.[7] In other words, falls in τ lead to a negative relation between D and N. Equation (7) therefore suggests that, conditional on the level of openness, relative prices fall with an increase in the number of domestically producing firms (D) and rise with an increase in the number of foreign producing firms (D^*).

[6] Equation (7) is derived using only the upward sloping supply schedule in Figure 1. We could further use equations (1) and (2) to solve for non-linear expressions for N and N^*.

[7] In particular, we have $\Psi = (\frac{c_M}{c_{M^*}})\frac{\tau^{*k}}{1-\tau^k\tau^{*k}}\frac{\bar{N}_{SR}^*}{\bar{N}_{SR}}\frac{1+\frac{\bar{N}_{SR}}{\bar{N}_{SR}^*}\frac{\theta^*}{1-\theta^*}}{1+\frac{\bar{N}_{SR}^*}{\bar{N}_{SR}}\frac{\theta}{1-\theta}} - \frac{\tau^{*k}\tau^k}{1-\tau^k\tau^{*k}}$.

To see why $\Psi_\tau > 0$ consider the following. Figure 1 shows that decreases in τ lead to an increase in N and a fall in c_D. With $D = N_{SR} \left(\frac{c_D}{c_M}\right)^k$ and N_{SR} and c_M fixed in the short run, D must be increasing in τ.

3.2.2 Long Run

From (5) and (6) long run relative prices are given by

$$\left(\frac{\bar{p}}{\bar{p}^*}\right)^{k+2} = \left(\frac{c_D}{c_D^*}\right)^{k+2} = \frac{1}{\lambda(\theta,\theta^*)}\frac{L^*}{L}\left(\frac{c_M}{c_M^*}\right)^k \frac{1-\frac{\lambda(\theta,\theta^*)\theta^*}{1-\theta^*}}{1-\frac{1}{\lambda(\theta,\theta^*)}\frac{\theta}{1-\theta}} \tag{8}$$

The effect of openness is no longer conditional on the number of firms. If $\lambda(.)$ is a constant then an increase in domestic openness θ now leads to a rise in relative prices, while an increase in overseas openness θ^* engenders a fall. If on the other hand λ is allowed to depend on τ, the long run coefficients on openness are ambiguous *a priori*. In addition, large markets, as indexed by L, support a larger number of firms and have lower prices.

3.2.3 Combining Short and Long Run

We seek to evaluate simultaneously a short run relation between relative prices, the number of domestically producing firms and openness, and a long run relation between relative prices, market size and openness, where the effect of openness may differ from its short run impact. Our model suggests the following log-linear expression

$$\begin{aligned}\Delta\ln\left(\frac{\bar{p}_{it}}{\bar{p}_{it}^*}\right) &= \beta_0+\beta_1\ \Delta\ln\theta_{it}+\beta_2\ \Delta\ln\theta_{it}^*+\beta_3\ \Delta\ln D_{it}+\beta_4\ \Delta\ln D_{it}^* \\ &\quad +\gamma\ \{\ln\left(\frac{\bar{p}_{it-1}}{\bar{p}_{it-1}^*}\right)+\delta_0+\delta_1\ \ln L_{t-1}+\delta_2\ \ln L_{t-1}^* \\ &\quad +\delta_3\ \ln\theta_{it-1}+\delta_4\ \ln\theta_{it-1}^*\}+\varepsilon_{ijt}\end{aligned} \tag{9}$$

where i denotes sector, a star (or j in the residual) denotes the foreign country and t is time.[8] First differences capture short run relations, whilst the error correction term in brackets captures the long run relation in levels. The error correction model will improve the efficiency of our estimates so long as relative prices and relative openness are all integrated of order one, which we verify later. If $\beta_1 < 0$ then domestic openness has pro-competitive effects on domestic relative prices in the short run while we should expect $\beta_2 > 0$. The sign of δ_3 and δ_4 pin down the long run effects – if $\delta_3 < 0$ then long run effects are anti-competitive.

Our theory also has precise implications on the importance of firm dynamics and market size, both at home and abroad. In the short run, the number of domestic firms

[8] We leave the model's prediction that openness has non-linear effects on prices for future research. But in results available upon request and summarized in Section 7, we have verified that the inclusion of quadratic terms has no effect, at least on short run estimates.

affects prices negatively ($\beta_3 < 0$), while its foreign counterpart acts to increase domestic inflation ($\beta_4 > 0$). Equation (7) suggests coefficients should however not be equal. Market size should affect the long run dynamics of relative prices: the size of the domestic economy affects growth in relative prices negatively if $\delta_1 > 0$, a large foreign market should have the opposite effect ($\delta_2 < 0$) and the model requires $\delta_1 + \delta_2 = 0$.

Equation (9) captures our difference in differences approach. Prices (and all independent variables) are expressed in first differences – which accounts among others for the use of indices to measure some of our variables – and we identify differential effects across the same sector in different countries. As both equations (7) and (8) include terms in $\frac{c_M}{c_M^*}$ we also need to include intercepts for each sector in each country pair to control for cross-country and cross-industry variations in technology.[9]

3.3 Markups

In our model, relative international markups depend directly on $\frac{c_D}{c_D^*}$, just as prices do and so the model implies :

$$\begin{aligned}\Delta \ln \left(\frac{\bar{\mu}_{it}}{\bar{\mu}^*_{it}}\right) &= \beta_0 + \beta_1 \ \Delta \ln \theta_{it} + \beta_2 \ \Delta \ln \theta^*_{it} + \beta_3 \ \Delta \ln D_{it} + \beta_4 \ \Delta \ln D^*_{it} \\ &\quad +\gamma \ \{\ln \left(\frac{\bar{\mu}_{it-1}}{\bar{\mu}^*_{it-1}}\right) + \delta_0 + \delta_1 \ \ln L_{t-1} + \delta_2 \ \ln L^*_{t-1} \\ &\quad +\delta_3 \ \ln \theta_{it-1} + \delta_4 \ \ln \theta^*_{it-1}\} + \epsilon_{ijt} \qquad (10)\end{aligned}$$

3.4 Productivity

Our model is written in terms of unit costs, c, but under relatively mild assumptions we can derive implications for labor productivity, which is readily observed. Let z denote average sectoral labor productivity. We approximate $\bar{c} = w/z$, where w denotes nominal wages at the sector level. In so doing we are implicitly assuming away differences in capital costs. With mainstream theories of international trade based around variations in factor intensity this is a non-trivial assumption. It opens the door for the possibility that any role we find for openness in influencing productivity – but only productivity – may just reflect an omitted variable bias due to capital costs. We return to this issue in Section 7 when we review the robustness of our results.

[9] We also experimented with an intercept that varies per sector and per year, reasoning that the technological frontier may be sector-specific and time varying. All our results carry through, usually more strongly.

Assuming unit labor costs depend only on wages we have

$$\frac{z}{z^*} \equiv \frac{w}{w^*}\frac{\bar{c}^*}{\bar{c}} = \frac{w}{w^*}\frac{c_D^*}{c_D}$$

Perfect labor mobility between firms in a same sector implies $\frac{z_M}{z_M^*} = \frac{w}{w^*}\frac{c_M^*}{c_M}$, where z_M and z_M^* denote productivity in the least competitive firm for each sector. Using equation (7), we can derive an expression for relative labor productivity in the short run as

$$\left(\frac{z}{z^*}\right)^k = \left(\frac{z_M}{z_M^*}\right)^k \frac{(\bar{N}_{SR}/N)}{(\bar{N}_{SR}^*/N^*)} \frac{1+\frac{\bar{N}_{SR}^*}{\bar{N}_{SR}}\frac{\theta}{1-\theta}}{1+\frac{\bar{N}_{SR}}{\bar{N}_{SR}^*}\frac{\theta^*}{1-\theta^*}}$$

where international relative wages are subsumed in $\frac{z_M}{z_M^*}$, a measure of each country's relative distance from the productivity frontier. A rise in domestic openness boosts domestic productivity through a truncation effect on less productive domestic producers. This effect of openness is conditional upon $\bar{N}_{SR}/N$ which as before we approximate with D, the number of domestically producing firms (which we observe).

Using equation (8) in the definition for relative productivity implies that in the long run

$$\left(\frac{z}{z^*}\right)^{k+2} = \frac{1}{\lambda(\tau,\tau^*)}\left(\frac{w}{w^*}\right)^2 \frac{L}{L^*}\left(\frac{z_M}{z_M^*}\right)^k \frac{1-\frac{\lambda(\tau,\tau^*)\theta}{1-\theta}}{1-\frac{1}{\lambda(\tau,\tau^*)}\frac{\theta^*}{1-\theta^*}}$$

Productivity is highest in the larger economy (L) and the long run effects of trade liberalization are ambiguous depending on the relative importance of the relocation effect and the fall in fixed costs. The size of the foreign market, and foreign openness have the opposite effects. Taking into account both short and long run effects,

$$\begin{aligned}\Delta \ln\left(\frac{z_{it}}{z_{it}^*}\right) &= \beta_0 + \beta_1\ \Delta\ln\theta_{it} + \beta_2\ \Delta\ln\theta_{it}^* + \beta_3\ \Delta\ln D_{it} + \beta_4\ \Delta\ln D_{it}^* \\ &+\gamma\ \{\ln\left(\frac{z_{it-1}}{z_{it-1}^*}\right) + \delta_0 + \delta_1\ \ln L_{t-1} + \delta_2\ \ln L_{t-1}^* + \delta_3\ \ln\theta_{it-1} \\ &+\delta_4\ \ln\theta_{it-1}^* + \delta_5\ \ln w_{it-1} + \delta_6\ \ln w_{it-1}^*\} + \eta_{ijt} \qquad (11)\end{aligned}$$

The short term effects of domestic openness on domestic productivity are positive ($\beta_1 > 0$) and revert in the long run if $\delta_3 > 0$. The exact opposite is true of foreign openness ($\beta_2 < 0$, $\delta_4 < 0$). The number of domestic firms increases relative domestic productivity in the short run ($\beta_3 > 0$), the number of foreign firms does the exact opposite ($\beta_4 < 0$). Market size matters in the long run. Domestic and foreign coefficients should be equal as regards openness and market size in the long run, but not for the number of firms in the short run. In addition, relative wages enter only in the long run.

Equations (9), (10) and (11) are all estimated with country-pair industry specific intercepts. These will soak up putative international differences in technology, captured in the model by $\frac{c_M}{c_M^*}$ and $\frac{z_M}{z_M^*}$. They will also account for the fact that some of our variables are measured as indices, with normalized levels. Finally, they are general enough that they can capture the overall level of openness at the country level (for instance in small versus large economies), or indeed the extent of a home-bias in overall aggregate consumption.

4 Econometric Issues

4.1 Stationarity

In order to effectively discriminate between the short and long run implications of trade openness our approach requires our key variables be non-stationary in a unit root sense. In Table 1 we provide results of a battery of panel unit root tests applied to international relative prices, relative openness, relative productivity and relative markups. All these variables are measured at the sector level, and for all distinct pairs of countries in our data, but only over ten years. Given the limited time dimension of our panel we implement the procedure described in Im, Pesaran and Shin (2003), which allows for individual unit root processes. In addition, we also present the results of the tests proposed by Hadri (2000) and Levin, Lin and Chu (2002). In almost all cases we fail to reject the presence of a unit root in relative prices, productivity, openness and markups, whether the process is assumed to be common across individuals or not, and whether we allow for deterministic trends or not. These results support the error correction formulation in our estimated equations. Further support for error correction comes from cointegration tests (see Pedroni (1999)) which suggest that taking linear combinations of our main variables induces stationarity. However given well known concerns about the size and power of unit root tests we report results with and without the error correction terms.

4.2 Lagged Dependent Variables

We have utilized an error correction formulation so as to disentangle the short and long run response of variables to openness. The model is however silent on how long the short run lasts and how long the dynamics to the long run take to complete. To alleviate this problem we introduce lagged dependent variables into our estimations. In dealing with dynamics in this way we create the well known problem of estimating within-group equations with a lagged dependent variable. In Section 7, we verify that our conclusions withstand the induced bias by using recent GMM-based corrections. Reassuringly our main results are robust to the inclusion or otherwise of lagged dependent variables.

4.3 Nominal Prices

Our model is one of *real* relative prices at the sector level. However, prices in general are influenced by aggregate nominal developments, which are distinct from the pro-competitive effects of openness we are seeking to evaluate. Empirically however, aggregate influences on prices may well correlate significantly with openness, as exemplified by the mechanism stressed in Romer (1993). It is important to purge these effects from the estimates we obtain here. Our disaggregated approach makes this readily possible, under the hypothesis that aggregate monetary shocks affect all sectors homogeneously. To fix ideas, we augment equation (9) with measures of aggregate price indices P for each country, as follows

$$\begin{aligned}\Delta \ln\left(\frac{\bar{p}_{it}}{\bar{p}^*_{it}}\right) &= \beta_0 + \beta_1 \, \Delta \ln \theta_{it} + \beta_2 \, \Delta \ln \theta^*_{it} + \beta_3 \, \Delta \ln D_{it} + \beta_4 \, \Delta \ln D^*_{it} \\ &\quad + \beta_5 \, \Delta \ln\left(\frac{P_t}{P^*_t}\right) + \gamma \, \{\ln\left(\frac{\bar{p}_{it-1}}{\bar{p}^*_{it-1}}\right) + \delta_0 + \delta_1 \, \ln L_{t-1} + \delta_2 \, \ln L^*_{t-1} \\ &\quad + \delta_3 \, \ln \theta_{it-1} + \delta_4 \, \ln \theta^*_{it-1} + \delta_5 \, \ln\left(\frac{P_{t-1}}{P^*_{t-1}}\right)\} + \xi_{ijt} \qquad (12)\end{aligned}$$

Adding aggregate prices in this manner implicitly assumes that monetary influences have relatively homogeneous effects across sectors or, more precisely, that if some heterogeneity exists it is uncorrelated with openness. This is consistent with the evidence of Peersman and Smets (2005) who find that it is durability or the existence of financial constraints that are most important in explaining the differential effects of monetary policy across sectors, and not openness.

4.4 Country Pairs

We have manipulated theory-implied equilibrium conditions to obtain predictions on international differences in prices, productivity and margins. The empirical counterparts to these correspond to the cross section of (distinct) bilateral international differences in all the variables of interest.[10] In our estimation we consider bilateral differences in two ways. First, we compute the universe of distinct bilateral differences at the sector level implied by using all distinct pairwise combinations of our sample of countries. Second, we compute differences with respect to the economy in our sample where the change in openness was smallest, namely Italy. Naturally, the cross section is reduced in the latter case, which we leave for a sensitivity analysis in Section 7.

An issue with the first approach is the possibility that measurement error specific to a given country plague all (distinct) bilateral pairs involving the poorly measured economy, with implications on the resulting covariance matrix of residuals. Adapting the well known results in Case (1991), Spolaore and Wacziarg (2006) show this form of heteroskedasticity can be accounted for by including common country fixed effects. These are constructed as binary variables taking value one whenever a given country enters a pair. All our estimations effectively include fixed effects that are more general, since they vary by industry in each country pair. In other words, our estimates are immune to the issue of repeated observations and the corresponding heteroskedasticity.[11]

4.5 Endogeneity

The key variable in our model is τ, reflecting trade costs. In our empirical strategy we substitute θ for τ. But import penetration θ is an endogenous variable potentially reflecting the influence of many factors. For instance, consumers in high price economies will respond by buying imports, which leads to a positive bias for our estimates of the effect of openness on prices. Issues may also arise for the relation between productivity and openness. Firms in low productivity sectors may lobby for protectionism, which leads to a positive bias in the estimate of openness on productivity. Dealing with this endogeneity with appropriate instrumentation is of the essence.

Identification in this paper rests on the cross section of international differences in import penetration, prices, productivity and markups between European countries and

[10] Although our focus is on European economies, we are *not* modelling intra-European trade. Our trade data for each country and sector reflects *all* imports in the sector from the rest of the world. Further, although we outlined a bilateral model in Section 2, Appendix B in Melitz and Ottaviano (2008) shows a multilateral version with analogous equations to the ones we use.

[11] We verified that our results continue to hold with just the common country effects suggested in Spolaore and Wacziarg (2006). The presence of more general intercepts, specific to each country pair is however required by our theory.

at the level of individual sectors. The next section describes the main features of our data, and illustrates there is substantial dispersion in the variables of interest. This begs the question of what drives these international differences, given our focus on a sample of EU member states amongst whom the introduction of a single market meant that trade liberalization was effectively complete by the early 1990s, and *de jure* homogeneous with third-party economies.

Some differences undoubtedly arise from the intrinsic (and exogenous) transportability of some manufactures as compared to others, and indeed the possibility that these should alter over time with technological change or the emergence of new producers nearby. Equally important are barriers to imports not based on standard measures of tradability or tariffs, but which still act as determinants of τ. A large literature in industrial organization has taken interest in the empirical validity of collusion or cartel agreements on price fixing or market sharing. Goldberg and Verboven (2001) argue that vast international differences in car prices and market structure persist between European countries because of (implicit) barriers to entry in the distribution sector. Similar empirical arguments have emerged in a variety of other specific sectors, often in European countries, such as sugar, lysine or cement.[12] Such collusive behavior is likely to hamper the entry of foreign firms, with end effects on prices, productivity and markups, even in an environment where trade is *de jure* perfectly liberalized. Importantly, this has to do with the regulatory environment in the aggregate, and thus is presumably exogenous to prices or profit margins at the sectoral level.

The set of five instruments we propose for θ reflects both these influences on sector-level import penetration. Three instruments are combined to capture the inherent transportability of a given industry. First, sectoral information on transport costs is simply inferred from our trade data, which report the same flow from the perspective of both importer and exporter. The ratio between the two gives an indication of transport costs, as the former include "Costs, Insurance and Freight", whereas the latter are typically registered "Free On Board".[13]

[12] For sugar, see Genesove and Mullin (2001). For Lysine, see Connor (1997). On cement, see Roller and Steen (2006) .

[13] These data are too noisy to be used as direct proxies for τ or τ^*. For instance, Harrigan (1999) recommends averaging observed values for each sector across countries to minimize measurement error. This may raise issues of instrument weakness, the reason why we use jointly five variables to extract the exogenous component of θ. With all instruments, the first-stage R^2s are above 50 percent.

Second, we include a measure of the "bulkiness" of the goods imported, inspired from Hummels (2001). Bulkiness is usually measured as the ratio of weight to value, but since prices are a dependent variable it is important to ensure our instrument is computed on the basis of different values. We use the weight and value of exports to the US, which is not in our sample, and exclude the country whose openness we instrument. In other words, we instrument import penetration in sector i and country j with the average bulkiness of US imports in the same sector, where exports into the US from country j are excluded from the computations of both total weight and value. Identification requires here that the bulkiness of US exports be exogenous to prices, margins and productivity in each considered country.

Third we build on the large literature explaining trade flows with so called "gravity" variables. We instrument import penetration in sector i and into country j with a weighted average of output shares of sector i in all other countries with available data, where weights are given by geographic distance.[14] In particular, we compute

$$Gravity_{ijt} = \sum_{k \neq j} \varpi_{jk} \; y_{ikt}/Y_{kt}$$

where ϖ_{jk} denotes the (inverse of the) geographic distance between countries j and k. The intuition is straightforward: country j will tend to import goods i from country k if (i) the share of sector i is large in country k, (ii) country k is nearby.[15] High values of $Gravity_{ijt}$ lead to a higher import share. As the geographic proximity of competing firms should matter most for highly substitutable goods, we further interacted $Gravity_{ijt}$ with industry-specific measures of substitutability taken from Broda and Weinstein (2006). Here we require the average distance of foreign producers be exogenous to domestic performance.

Fourth we seek to account for the fact that market structure may well differ across sectors in European countries because of collusive behavior. We use the number of judgments on anti-trust cases given each year by the European Court of Justice, which we

[14] We also experimented with the estimates of trade restrictions calculated in Del Gatto, Mion and Ottaviano (2006), interacted with country population. Our results were broadly unchanged, although with somewhat weaker estimates of long run effects.

[15] The set of countries k includes: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Mexico, the Netherlands, Norway, South Korea, Spain, Sweden, the United Kingdom and the US.

interact with a sector-specific index of non-tariff barriers.[16] We use the categorization due to Buigues, Ilzkovitz and Lebrun (1990), which classifies industries as no, low, medium or high non-tariff barriers across European economies. This varies across sectors only. We expect anti-trust rulings to have maximal effects in those sectors where non-tariff barriers are most stringent, which is confirmed in our data. The interaction between the two variables, which varies across industries and over time, affects import penetration positively in our first-stage regressions.

Fifth and finally, we include some measure of changes in European policy, such as binary variables capturing the advent of the Single Market in 1992 and of the Euro in 1999. Taken together, these five instruments explain more than 50 percent of the variation in import shares.[17]

5 Data

Our database covers the period 1989 to 1999 for seven European Union countries and ten manufacturing sectors. We use for our price data domestic manufacturing production prices, as measured by factory gate prices in national currency. The source for these data is Eurostat, the Statistical Office of the European Commission. Price indices are available for most European Union countries between 1980 and 2001, and disaggregated at the two-digit NACE (revision 1) level.[18] We normalize all indices to equal 100 in 1995. Eurostat also collects data on total and bilateral exports and imports for manufacturing industries (in thousand Ecus), together with their corresponding weight (in tons), available at the four-digit NACE (revision 1) level. The data run between 1988 and 2001 for twelve EU countries. To achieve consistency with our price data we aggregate this trade data to the two-digit level.

To construct estimates of profit margins we use the Bank for the Accounts of Companies Harmonized (BACH) database, which contains harmonized annual account statistics

[16] The number of judgments by the European Court of Justice are available from http://ec.europa.eu/comm/competition/court/antitrust/iju51990.html.

[17] In results available upon request, we used the same set of instruments to also account for the possible endogeneity of the number of firms, reasoning that distance, transportability and barriers to entry do presumably also affect firms relocation decisions. Our main conclusions obtain.

[18] NACE (revision 1) is the General Industrial Classification of Economic Activities within the European Union.

of non-financial enterprises in eleven European countries, Japan and the US.[19] Data are available annually between 1980 and 2002 and are broken down by major sector and firm size. We focus on seven EU countries: Belgium, Denmark, France, Germany, Italy, the Netherlands and Spain. To compute markups in sector i, country j and year t, one would ideally need data on prices and marginal costs. Marginal costs are hard to observe. We follow a considerable literature in industrial organization and measure (average) markups using information on variable costs only. We compute

$$\mu_{ijt} = \left[\frac{turnover_{ijt}}{total\ variable\ costs_{ijt}}\right] = \left[\frac{unit\ price_{ijt}}{unit\ variable\ cost_{ijt}}\right]$$

where total variable costs are computed as the sum of the costs of materials, consumables and staff costs. We exclude fixed costs to avoid a bias that is damaging for our purposes. As trade costs fall, an increase in the number of foreign firms will lead to a falling market share for domestic producers and a rise in average total costs, as fixed costs are spread across a smaller level of production. This will generate a negative bias between measured markups and openness.[20] In order to ensure consistency between our two- and three- digit NACE price indices and the BACH data we aggregate up the price data, as described in Appendix A.[21]

The value of exports and imports, together with their tonnage, are also aggregated across NACE industries into their BACH equivalent. To compute openness we use the BACH database. We construct output using the definition that output equals the value of turnover, plus or minus the changes in stocks of finished products, work in progress and goods and services purchased for resale, plus capitalized production and other operating income. Our measure of openness is then the ratio of imports relative to the sum of imports and sectoral output net of exports.

Labor productivity is calculated as the ratio between real value added and total employment, as provided by the OECD. We use value added and employment data from Eurostat in the few cases where BACH sectors are not reported in the OECD data. The

[19] The data are at http://europa.eu.int/comm/economy_finance/indicators/bachdatabase_en.htm.

[20] Our choice of a measure for average markups follows a large literature. See among many others Conyon and Machin (1991).

[21] We weight each NACE sub-sector by its share in GDP. This is the reason why we lose many observations, relative to a potential of more than 2,000 observations (21 country pairs over 10 years and 10 sectors). The BACH dataset does not have information on prices, which are taken from Eurostat. The concordance between the two data sources implies many missing observations.

number of active firms is directly taken from the BACH database. The value of GDP is from the OECD *Economic Outlook* as are the CPI we use as our measure of aggregate prices. In total we observe five sectors in Belgium, Denmark and the Netherlands, eight in Germany, seven in Spain and four in France and in Italy. Sectoral output values (at the ISIC revision 3 level) used to calculate our gravity instrument, are taken from the OECD STAN database (in millions of units of national currency). Bilateral distances (in kilometers) are calculated based on the "great circle distance" formula due to Fitzpatrick and Modlin (1986).

We present summary statistics in Tables 2 and 3. Our measure of sectoral inflation is highest in Spain and Italy, and lowest in France, where a few sectors saw their relative prices fall. Denmark is the least open of our European economies on the basis of the import share of production, while the Netherlands and Spain are particularly open. The most open of our sectors is Textiles, followed by Machinery. Productivity is highest in France and lowest in Spain, and highest in Chemicals and lowest in Textiles. Our markup data suggest margins are lowest on average in Belgium, and highest in Denmark, the country that is least open in our sample. Markups range between 0.7 and 73.6 percent. They are highest on average in Non-Metallic Minerals. Table 3 suggests import penetration increased most in Belgium, while it actually fell (on average) in Italy, indeed across most of the four sectors we observe there. In terms of sectors, openness increased most in Office Machinery, followed by Chemicals, and least in Rubber Products and Furniture. Figure 3 illustrates the cross section of interest, where we plot the behavior of import penetration over time for nine sectors.[22] Two things are apparent from the Figure. First, some sectors opened up more than others. Second, within each sector, some countries opened up more than others. Both dimensions achieve identification, in that we conjecture that cross-country differences in the extent of and change in openness at the level of a given sector ought to have differential effects on productivity, margins and prices.

6 Results

Given the relatively short sample period for our data we focus first on the short run results, estimated on first differences only. Under non-stationarity, these are consistent

[22] Figure 3 plots our data for nine sectors out of ten available. The missing sector has observations in two countries only, i.e. a single point in Figure 3, which is omitted.

but not efficient. We then include error correction terms and investigate whether our data helps sign the ambiguous long run effects arising from openness that the model suggests.

6.1 Short Run

Tables 4, 5 and 6 present our results on the effects of openness on prices, productivity and markups, respectively. The theoretical counterparts to our estimations are equations (12), (11) and (10) without an error correction term. We have implemented the difference in differences approach on all available (distinct) country pairs in our sample. All three tables first present results under Ordinary Least Squares, and then instrument openness. We also investigate the importance of lagged dependent variables and test whether some of the coefficients of interest are equal across countries, as implied by theory.

Table 4 focuses on the price effects of openness in the short run. We first investigate in column (1) the relation between relative prices and import penetration, conditional on the number of firms located in each economy, D. The signs are as predicted, and almost always significant. Domestic and foreign openness have opposite signs that are significant and consistent with theory. In other words, domestic openness affects domestic prices negatively, whereas foreign openness affects them positively. The result stands when controls for aggregate price dynamics and sluggish price adjustments are included in columns (2) and (3), respectively, and indeed strengthens both in terms of significance and magnitude. Interestingly, tests of coefficient equality in columns (1) to (3) suggest that perfect symmetry in the effects of domestic and foreign openness cannot be rejected at standard confidence levels. Evidence that the impact of the number of firms is symmetric is weaker, as implied by theory.[23] This will be a feature of all our estimations: relative openness has symmetric effects, whereas firm dynamics do not. Column (4) constrains the coefficients on import penetration to be the same internationally, and includes relative openness, the relative number of firms and relative aggregate prices. This tends to sharpen the results. The last three columns of the table introduce the instruments for openness, with or without lagged dependent variables, and with or without controls for aggregate prices. All conclusions stand.

Table 5 focuses on productivity, based on equation (11). OLS results suggest domestic openness increases domestic productivity, while foreign openness acts to diminish it.

[23] In column (3), the former can be rejected at the 39% confidence level, whereas the latter at the 13% level only.

What is more, it is impossible to reject equality between the two coefficients (in absolute value). By the same token the number of domestic firms also acts (conditionally) to increase productivity, and vice versa as regards foreign market structure. But these coefficients are significantly different, as per the model. Columns (4) and (5) present Instrumental Variables results, which confirm all conclusions.

It is possible that significant effects of openness on productivity arise from the availability of cheap foreign intermediate goods, whose imports could act to increase θ_{it}. There are several reasons why this cannot account for our findings. The first is that we also find an effect of openness on markups, which cannot be explained through increases in intermediate inputs. In addition, imported intermediate goods cannot account for the effects of foreign openness on domestic productivity. Finally, it may be that intermediate goods are obtained cheaply because of movements in the nominal exchange rate rather than for differences in production efficiency. That would, for instance, happen if imports were priced in the exporter's currency, and it would imply that movements in the nominal exchange rate affect relative productivity, and therefore relative prices. In our sensitivity analysis we verify that the inclusion of nominal exchange rates in equation (12) affects none of our results.

Table 6 introduces markups as a dependent variable, as per equation (10). Once again, OLS results are strong: domestic openness acts to reduce profit margins, the opposite is true of foreign openness, and the coefficients are not significantly different. The number of domestic firms has a pro-competitive effect on margins, the number of foreign firms has the opposite impact, but the coefficients are significantly different. The results strengthen under IV estimations.

6.2 Long Run

Tables 7, 8 and 9 report the results corresponding to equations (12), (11) and (10), respectively, where we now include error correction terms. The inclusion of error correction terms enables us to estimate the long run impact of trade liberalization.

Table 7 suggests two interesting results.[24] First, there is a reversal of the effects of relative openness on prices. In the long run, domestic openness now exerts an upward pressure on relative prices, whereas it is foreign openness that acts negatively on relative

[24] To conserve space we no longer quote p-values that test whether coefficients are equal. As in Tables 4, 5 and 6, the restrictions cannot be rejected.

prices. Second, market size (measured here by real GDP) enters the estimation with the coefficients predicted by theory: a relatively large economy tends to have relatively low prices. What is more, the coefficients are not significantly different, as predicted by theory. These conclusions all stand (indeed strengthen) when we instrument.

Whilst these long run results are interesting they do raise some problematic questions. In particular although the short run pro-competitive effects still hold they are no longer statistically significant at standard confidence levels. In results available upon request, and described in Section 7, we show the loss of significance in short run effects when an error correction term is included is in fact not a robust feature of our data. For instance, short run effects remain strongly significant when controls for factor endowments are included or when a GMM estimator is implemented. In fact in these cases it is the *long run* result that becomes insignificant. The instability of our results in this setting suggests that in our short sample the data find it difficult to identify long from short run effects. In fact, Table 1 bolsters this hypothesis, as we see the evidence for non-stationarity is least strong for relative prices.

Table 8 summarizes the results that pertain to equation (11). Here the short run pro-competitive effects of relative openness (and the relative number of firms) stand significantly in all cases. As with the relative price equation, the data show some evidence of a reversal at longer horizon. Relative productivity apparently falls in the long run in the wake of trade liberalization, i.e. falls in relative openness. Relative market size also enters with signs that are consistent with theory and significant.

Finally, markups are examined in Table 9. Here the evidence is somewhat weaker. The pro-competitive effects of openness in the short run are only significant in column (2), but the importance of the relative number of firms prevails in all specifications. Once we instrument, there is some weak evidence of a significant reversal at long horizons.

7 Robustness

In this section we review a number of alternative specifications and controls we implemented to ensure the stability of our conclusions. To conserve space, the results referred to in this section are detailed in a companion document available from our websites. Here we simply comment on the alternative specifications we implemented, and to what extent our conclusions stand. First, we verified that including changes in nominal exchange rates is innocuous. It would not be under some specific kinds of pricing to market or if intermediate inputs were captured in our import share measure. In addition, this may differ across industries. To account for this possibility, we let the impact of nominal exchange rates vary per industry.

Second, we attempted to account directly for the possibility that some of our results could be explained by a simple Heckscher-Ohlin argument. The Heckscher-Ohlin view of international trade implies capital-rich countries (such as the EU) specialize in capital intensive sectors. As specialization occurs, labor intensive industries contract as imports take over. The decline in labor intensive industries will also lower wages and help lower prices in these sectors. We could therefore see systematically rising import shares and falling prices in a number of sectors with shrinking domestic production. But this will only happen if large enough international differences in factor intensity exist across countries to motivate international specialization in production. Given our sample of EU countries it is far from obvious that differences in manufacturing trade patterns are due to stark differences in factor endowments. In addition, Heckscher-Ohlin would only explain a negative correlation between prices and import shares in the receiving economy. In the exporting economy, prices and import shares will be positively correlated. For Heckscher-Ohlin to account for our results would require that factor intensity varies in the *same* sector across countries in a manner that correlates highly with openness.

We tackled the concern up-front empirically, and investigated whether our openness effect mattered only through an interaction with factor endowments. We augmented our specifications with an interaction term between aggregate capital accumulation and sectoral capital shares. As openness continues to affect relative productivities significantly, it suggests we are identifying a different effect than Heckscher-Ohlin.

Third we implemented the GMM estimator proposed by Arellano and Bond (1991) to account for the fact that we run a fixed effects estimation with lagged dependent variables.[25] We also estimated the impact of openness focusing just on deviations from a benchmark economy, rather than all possible (distinct) bilateral pairs as previously.

[25] We also used the more recent Blundell-Bond approach, with little differences in results. Monte-Carlo evidence – for instance in Hauk and Wacziarg (2006) – suggests the bias correction pertains mostly to the coefficient on the lagged dependent variable itself, which in our case is of little direct interest. That coefficient did indeed change across GMM based corrections, but the others hardly did.

Although this approximately divides the number of observations by four, it helps reduce measurement error problems and offers a sharper treatment effect for our difference in differences approach. We choose as our benchmark a country (Italy) where trade did not increase as much as in the rest of our sample across all sectors. Assuming this lack of openness reflects macroeconomic factors that are external to each sector's price dynamics (for instance exchange rate policies), the Italian benchmark may provide us with a classic treatment sample.

Fifth, we considered whether the impact of increased imports depends on their origin, in particular whether EU imports exert a more significant competitive impact than non-EU imports. During the period covered by our sample, the EU Single Market was established and EU imports could constitute closer substitutes for domestic production than non-EU imports. Sixth, we augmented our specifications with quadratic functions of openness to ascertain whether the non-linearities predicted by our theory do not invalidate our main conclusions. Seventh and finally, we used our set of instruments to account for the possibility that the number of firms is an endogenous variable.

Suffice it to say our main conclusions withstand these numerous alterations or variations. In some instances, the evidence of long run anti-competitive effects was muted, as was for instance the case when we used a GMM estimator, Italy as a benchmark economy or a quadratic term was included. But the short run pro-competitive effects of openness continued to prevail with controls for nominal depreciations and for an Heckscher-Ohlin corrective term, whether a GMM estimator was implemented, international differences were computed with respect to a benchmark economy, and irrespective whether non-linear terms were included. In addition, we were able to accept at standard significance levels the hypothesis that EU and non-EU imports have the same short and long run effects in our price, productivity and markup equations. Although EU imports may have increased more rapidly than non-EU imports the estimated elasticities do not differ by import origin.

8 Conclusion

We use the Melitz and Ottaviano (2008) model to derive directly estimable equations which enable us to test for the competitive effects of increased openness to trade. The equations we construct show how relative openness (and relative firm dynamics) affect relative prices, relative productivity and relative profit margins across the same sector in different countries and lead naturally to a difference in differences setup. The focus on relative openness means that our estimated effects are distinct from alternative explanations based on traditional trade theory or the aggregate impact of openness on inflation, which are both purged from our sector-specific estimates. We find strongly supportive evidence of the pro-competitive effects of relative openness in the short run: domestic import penetration tends to lower price inflation, accelerate productivity and reduce profit margins. We interpret this evidence as the empirical counterpart to the increased competition induced by foreign firms entering the domestic market as a result of diminished trade costs.

Our findings of short run pro-competitive effects from increased openness are robust to a range of specifications and estimators. We also uncover evidence that in some instances increased openness can lead to anti-competitive effects in the long run. Estimates of a long run reversal are less universally significant than our short run results, which may reflect the relative brevity of our sample and the problems of correctly identifying non-stationary behavior. Or perhaps they capture the theoretical ambiguity we discuss. But the results do suggest that the pro-competitive effects of openness are most pronounced in the short run, and that firm dynamics and location decisions are empirically relevant to the impact of trade on market structure. This is corroborated by the significant roles we uncover for firm dynamics and market size. Interestingly, the data also point to strong effects of foreign import penetration on relative prices, productivity and margins, with signs and relative magnitudes consistent with theory.

Our results have two relevant macroeconomic implications. First, greater openness has contributed to lower increases in manufacturing prices. This will have contributed to a fall in measures of aggregate inflation through simple short run arithmetical calculations. Second, markups are eroded in activities exposed to foreign competition. This brings qualitative support to Rogoff's (2003) conjecture that competitive pressures have changed the conduct of monetary policy. Our data coverage and estimation strategy fall short of evaluating quantitatively the relevance of the channel. In our view, this is a natural and important next step.

Appendix A

BACH sector groupings used in the paper and correspondence with NACE (revision 1) industries

BACH	NACE	Sector
211	13.0	Metal ores
	27.1	Basic iron & steel
	27.2	Tubes
	27.3	Other first processing of basic iron & steel
	27.4	Basic precious & non-ferrous metals
212	14.0	Mining & quarrying
	26.0	Other non-metallic mineral products
213	24.0	Chemicals & chemical products
221	27.5	Casting of metals
	28.0	Fabricated metal products (except machinery & equipment)
	29.1	Machinery for the production & use of mechanical power
	29.2	Other general purpose machinery
	29.3	Agricultural & forestry machinery
	29.4	Machine-tools
	29.5	Other special purpose machinery
	29.6	Weapons & ammunition
	33.0	Medical, precision & optical instruments
222	30.0	Office machinery & computers
	31.0	Electrical machinery & apparatus
	32.0	Radio, television & communication equipment
	29.7	Domestic appliances
223	34.0	Motor-vehicles, trailers & semi-trailers
	35.0	Other transport equipment
231	15.0	Food products & beverages
	16.0	Tobacco products
232	17.0	Textiles
	18.0	Wearing apparel; dressing & dyeing of fur
	19.0	Tanning & dressing of leather; luggage, handbags
233	20.0	Wood & products of wood & cork, excl. furniture
	21.0	Pulp, paper & paper products
	22.0	Publishing, printing & reproduction of recorded media
234	25.0	Rubber & plastic products
	36.0	Furniture

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Table 1: Unit Root Tests

	Prices	Productivity	Openness	Markups
Im-Pesaran-Shin				
Intercept	−0.779 (0.22)	0.462 (0.68)	2.785 (1.00)	−1.759 (0.04)
Intercept + Trend	−1.403 (0.08)	0.48 (0.66)	−1.869 (0.03)	−1.070 (0.14)
Levin-Lin-Chu				
Intercept	1.596 (0.94)	−0.662 (0.25)	−0.492 (0.31)	−4.309 (0.00)
Intercept + Trend	1.529 (0.94)	−1.174 (0.12)	1.398 (0.92)	−0.670 (0.25)
Hadri				
Intercept	9.572 (0.00)	9.526 (0.00)	10.132 (0.00)	6.071 (0.00)
Intercept + Trend	9.634 (0.00)	8.165 (0.00)	12.352 (0.00)	8.653 (0.00)

Notes: Test-statistics and p-values in brackets. Im-Pesaran-Shin reports values for the W-statistic corresponding to the null hypothesis that there is a unit root that is individual to each cross section. Levin-Lin-Chu report the Breitung t-statistic corresponding to the null hypothesis that there is a common unit root process. The Hadri test reports the Z-statistic corresponding to the null hypothesis that there is no common unit root process.

Table 2: Summary Statistics – Cross Sections

	Inflation (%)			Import Share (%)			Productivity (Ecus/worker)			Markups		
	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max
Country												
Belgium	0.4	-2.8	6.9	68.9	32.1	155.8	55,325	20,805	111,973	1.074	1.046	1.112
Germany	0.9	-2.6	5.8	60.4	32.2	129.4	42,066	20,942	58,731	1.308	1.139	1.666
Denmark	1.2	-10.0	16.5	8.2	2.3	24.1	46,139	28,890	99,810	1.358	1.089	1.736
Spain	2.2	-3.3	13.1	81.7	27.9	208.9	35,086	18,545	61,411	1.118	1.007	1.319
France	-0.7	-18.5	7.4	50.1	23.2	112.6	62,171	36,215	115,458	1.141	1.038	1.235
Italy	1.9	-7.3	15.2	40.5	21.5	63.3	45,583	24,335	76,245	1.094	1.035	1.127
Netherlands	0.8	-3.4	6.2	108.9	33.8	233.9	41,633	27,617	64,282	1.109	1.015	1.180
Sector												
Metals	-2.1	-18.5	15.2	67.0	48.3	112.6	62,415	36,215	88,808	1.072	1.035	1.127
Non-Metallic Minerals	1.6	-10.0	16.5	35.4	3.2	90.1	45,693	34,245	60,448	1.329	1.154	1.531
Chemicals	0.9	-3.3	13.0	52.6	9.2	146.1	75,003	52,359	115,458	1.198	1.062	1.736
Machinery	2.7	1.3	5.6	110.7	89.7	125.8	29,830	28,113	32,821	1.080	1.025	1.107
Office Machinery	0.4	-1.6	3.6	77.5	34.1	218.8	42,622	29,620	58,731	1.121	1.064	1.214
Motor Vehicles and Transport	2.1	-0.6	5.1	58.8	14.7	131.6	39,989	28,192	58,553	1.109	1.007	1.257
Food, Tobacco	0.9	-4.4	6.1	30.8	2.3	49.9	43,069	25,995	64,282	1.191	1.046	1.666
Textiles	1.1	-2.7	5.0	123.2	42.0	233.9	27,991	18,545	41,810	1.114	1.052	1.252
Wood, Paper and Printing	1.7	-2.4	13.1	46.4	24.2	75.3	40,550	30,834	61,110	1.166	1.075	1.355
Rubber Products, Furniture	2.0	-0.7	8.7	70.8	5.1	156.6	38,542	25,547	62,469	1.198	1.037	1.398

Source: Authors' calculations. Country averages are averages across all the sectors in our data and the sector averages are averages for each sector across all countries.

Table 3: Summary Statistics – Time Series

	Import Share (%)	
	1989	1999
Country		
Belgium	49.8	101.3
Germany	55.6	77.7
Denmark	8.2	9.2
Spain	64.6	94.8
France	41.3	67.5
Italy	47.1	38.7
Netherlands	98.6	133.9
Sector		
Metals	65.9	82.5
Non-Metallic Minerals	28.6	48.0
Chemicals	42.8	72.3
Machinery	89.7	113.4
Office Machinery	58.1	102.8
Motor Vehicles and Transport	51.8	71.3
Food, Tobacco	29.0	34.2
Textiles	105.5	151.3
Wood, Paper and Printing	45.5	53.6
Rubber Products, Furniture	70.1	80.3

Source: Authors' calculations.

Table 4: Prices (Short Run), all country pairs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Method	OLS	OLS	OLS	OLS	IV	IV	IV
$\Delta \ln \frac{\overline{p}_{it-1}}{\overline{p}^*_{it-1}}$	–	–	0.064 (1.905)	0.065 (1.920)	–	–	0.095 (1.920)
$\Delta \ln \theta_{it}$	−0.023 (−2.178)	−0.023 (−2.172)	−0.036 (−3.517)	–	–	–	–
$\Delta \ln \theta^*_{it}$	0.022 (2.207)	0.017 (1.796)	0.024 (2.620)	–	–	–	–
$\Delta \ln \frac{\theta_{it}}{\theta^*_{it}}$	–	–	–	−0.029 (−4.290)	−0.179 (−4.460)	−0.178 (−4.362)	−0.210 (−3.915)
$\Delta \ln D_{it}$	−0.009 (−0.747)	−0.010 (−0.892)	−0.018 (−1.691)	−0.016 (−1.530)	−0.046 (−2.713)	−0.046 (−2.692)	−0.054 (−2.909)
$\Delta \ln D^*_{it}$	0.004 (2.512)	0.002 (1.076)	0.002 (1.208)	0.002 (1.481)	0.011 (3.574)	0.013 (4.237)	0.012 (3.371)
$\Delta \ln P_t$	–	0.452 (5.584)	0.524 (6.589)	0.528 (6.655)	0.352 (3.269)	–	0.381 (3.103)
$\Delta \ln P^*_t$	–	−0.463 (−5.533)	−0.619 (−7.311)	−0.611 (−7.262)	−0.376 (−3.429)	–	−0.416 (−3.100)
N	800	800	720	720	800	800	720
$\Delta \ln \theta_{it} = (-1) \Delta \ln \theta^*_{it}$	0.91	0.69	0.39	–	–	–	–
$\Delta \ln D_{it} = (-1) \Delta \ln D^*_{it}$	0.71	0.47	0.13	0.20	0.03	0.04	0.01
$\Delta \ln P_t = (-1) \Delta \ln P^*_t$	–	0.89	0.21	0.27	0.81	–	0.74

Notes: Country/industry fixed effects are included in all regressions, t-statistics in parenthesis. We cannot reject the hypothesis that the coefficients on domestic and foreign variables are equal except for the number of domestic and foreign firms in the IV regressions (5) to (7). In (5) to (7) instruments for openness include cif/fob, EU directives interacted with NTBs, weighted distance interacted with the elasticity of substitution, weight to value and 1992 and 1999 dummies. The last three rows of the table report the p-values of the tests of coefficients' equality.

Table 5: Productivity (Short Run), all country pairs

	(1)	(2)	(3)	(4)	(5)
Method	OLS	OLS	OLS	IV	IV
$\Delta \ln \frac{z_{it-1}}{z^*_{it-1}}$	–	−0.077 (−2.050)	−0.077 (−2.064)	–	−0.116 (−1.855)
$\Delta \ln \theta_{it}$	0.043 (1.220)	0.061 (1.567)	–	–	–
$\Delta \ln \theta^*_{it}$	−0.061 (−1.872)	−0.073 (−2.096)	–	–	–
$\Delta \ln \frac{\theta_{it}}{\theta^*_{it}}$	–	–	0.067 (2.586)	0.694 (4.663)	0.935 (4.009)
$\Delta \ln D_{it}$	0.147 (3.871)	0.173 (4.390)	0.176 (4.667)	0.305 (4.940)	0.364 (4.562)
$\Delta \ln D^*_{it}$	−0.033 (−5.892)	−0.034 (−5.898)	−0.033 (−6.057)	−0.067 (−6.152)	−0.078 (−5.232)
N	800	720	720	800	720
$\Delta \ln \theta_{it} = (-1)\,\Delta \ln \theta^*_{it}$	0.71	0.82	–	–	–
$\Delta \ln D_{it} = (-1)\,\Delta \ln D^*_{it}$	0.00	0.00	0.00	0.00	0.00

Notes: Country/industry fixed effects are included in all regressions, t-statistics in parenthesis. We cannot reject the hypothesis that the coefficients on domestic and foreign openness are equal but we can reject it for the coefficients on the number of domestic and foreign firms. In (4) and (5) instruments for openness include cif/fob, EU directives interacted with NTBs, weighted distance interacted with the elasticity of substitution, weight to value and 1992 and 1999 dummies. The last two rows of the table report the p-values of the tests of coefficients' equality.

Table 6: Markups (Short Run), all country pairs

	(1)	(2)	(3)	(4)	(5)
Method	OLS	OLS	OLS	IV	IV
$\Delta \ln \frac{\mu_{it-1}}{\mu^*_{it-1}}$	–	-0.223	-0.223	–	-0.224
		(-5.947)	(-5.952)		(-5.043)
$\Delta \ln \theta_{it}$	-0.022	-0.025	–	–	–
	(-1.860)	(-2.021)			
$\Delta \ln \theta^*_{it}$	0.019	0.030	–	–	–
	(1.695)	(2.656)			
$\Delta \ln \frac{\theta_{it}}{\theta^*_{it}}$	–	–	-0.028	-0.110	-0.161
			(-3.300)	(-2.854)	(-3.022)
$\Delta \ln D_{it}$	-0.042	-0.051	-0.052	-0.062	-0.080
	(-3.269)	(-4.004)	(-4.270)	(-3.907)	(-4.418)
$\Delta \ln D^*_{it}$	0.005	0.006	0.006	0.010	0.013
	(2.750)	(3.227)	(3.274)	(3.594)	(3.711)
N	800	720	720	800	720
$\Delta \ln \theta_{it} = (-1)\,\Delta \ln \theta^*_{it}$	0.82	0.79	–	–	–
$\Delta \ln D_{it} = (-1)\,\Delta \ln D^*_{it}$	0.00	0.00	0.00	0.00	0.00

Notes: Country/industry fixed effects are included in all regressions, t-statistics in parenthesis. We cannot reject the hypothesis that the coefficients on domestic and foreign openness are equal but we can reject it for the coefficients on the number of domestic and foreign firms. In (4) and (5) instruments for openness include cif/fob, EU directives interacted with NTBs, weighted distance interacted with the elasticity of substitution, weight to value and 1992 and 1999 dummies. The last two rows of the table report the p-values of the tests of coefficients' equality.

Table 7: Prices (Long Run), all country pairs

	(1)	(2)	(3)	(4)
Method	OLS	OLS	IV	IV
$\Delta \ln \frac{\overline{p}_{it-1}}{\overline{p}^*_{it-1}}$	–	–	–	−0.027 (−0.486)
$\Delta \ln \theta_{it}$	−0.011 (−1.186)	–	–	–
$\Delta \ln \theta^*_{it}$	0.000 (0.053)	–	–	–
$\Delta \ln \frac{\theta_{it}}{\theta^*_{it}}$	–	−0.005 (−0.828)	−0.029 (−1.053)	−0.037 (−0.911)
$\Delta \ln D_{it}$	−0.008 (−0.828)	−0.005 (−0.614)	−0.018 (−1.592)	−0.017 (−1.281)
$\Delta \ln D^*_{it}$	0.000 (0.324)	0.001 (0.562)	0.004 (1.707)	0.005 (1.749)
$\Delta \ln P_t$	0.662 (6.488)	0.648 (6.589)	0.750 (5.719)	0.641 (3.473)
$\Delta \ln P^*_t$	−0.926 (−7.305)	−0.916 (−7.286)	−0.814 (−5.212)	−0.755 (−3.700)
$\ln \frac{\overline{p}_{it-1}}{\overline{p}^*_{it-1}}$	−0.419 (−17.670)	−0.419 (−17.687)	−0.337 (−7.582)	−0.297 (−6.068)
$\ln \theta_{it-1}$	0.018 (2.676)	–	–	–
$\ln \theta^*_{it-1}$	−0.012 (−2.064)	–	–	–
$\ln \frac{\theta_{it-1}}{\theta^*_{it-1}}$	–	0.015 (3.041)	0.072 (2.590)	0.098 (3.101)
$\ln L_{t-1}$	−0.063 (−5.304)	–	–	–
$\ln L^*_{t-1}$	0.062 (5.274)	–	–	–
$\ln \frac{L_{t-1}}{L^*_{t-1}}$	–	−0.063 (−6.315)	−0.066 (−5.716)	−0.072 (−4.736)
$\ln P_{t-1}$	0.296 (9.692)	0.293 (9.729)	0.255 (6.884)	0.206 (2.761)
$\ln P^*_{t-1}$	−0.359 (−10.183)	−0.353 (−10.121)	−0.317 (−7.339)	−0.289 (−3.512)
N	800	800	800	720

Notes: Country/industry fixed effects are included in all regressions, t-statistics in parenthesis. We cannot reject the hypothesis that the coefficients on domestic and foreign variables are equal except for the coefficients on domestic and foreign CPIs in the long run. In (3) and (4) instruments for openness include cif/fob, EU directives interacted with NTBs, weighted distance interacted with the elasticity of substitution, weight to value and 1992 and 1999 dummies. L_t denotes (real) GDP.

Table 8: Productivity (Long Run), all country pairs

	(1)	(2)	(3)	(4)	(5)	(6)
Method	OLS	OLS	IV	IV	IV	IV
$\Delta \ln \frac{z_{it-1}}{z^*_{it-1}}$	–	–	–	−0.152 (−1.918)	−0.087 (−1.371)	−0.111 (−1.630)
$\Delta \ln \theta_{it}$	0.043 (1.246)	–	–	–	–	–
$\Delta \ln \theta^*_{it}$	−0.054 (−1.645)	–	–	–	–	–
$\Delta \ln \frac{\theta_{it}}{\theta^*_{it}}$	–	0.051 (2.143)	0.359 (3.075)	0.413 (2.726)	0.490 (3.309)	0.530 (3.559)
$\Delta \ln D_{it}$	0.124 (3.437)	0.121 (3.571)	0.232 (4.030)	0.227 (3.560)	0.232 (4.084)	0.242 (1.838)
$\Delta \ln D^*_{it}$	−0.028 (−5.305)	−0.029 (−5.726)	−0.044 (−4.982)	−0.047 (−4.689)	−0.051 (−4.326)	−0.077 (−4.456)
$\ln \frac{z_{it-1}}{z^*_{it-1}}$	−0.317 (−10.064)	−0.313 (−9.988)	−0.268 (−4.947)	−0.280 (−4.067)	−0.307 (−4.242)	−0.246 (−3.606)
$\ln \theta_{it-1}$	−0.057 (−2.208)	–	–	–	–	–
$\ln \theta^*_{it-1}$	0.061 (2.199)	–	–	–	–	–
$\ln \frac{\theta_{it-1}}{\theta^*_{it-1}}$	–	−0.057 (−2.747)	−0.506 (−3.731)	−0.557 (−3.064)	−0.313 (−2.355)	−0.271 (−2.044)
$\ln L_{t-1}$	0.274 (5.614)	–	–	–	–	–
$\ln L^*_{t-1}$	−0.254 (−5.206)	–	–	–	–	–
$\ln \frac{L_{t-1}}{L^*_{t-1}}$	–	0.263 (6.572)	0.511 (6.220)	0.562 (5.263)	0.417 (3.042)	0.302 (2.697)
$\ln w_{it-1}$	−0.060 (−1.931)	–	–	–	–	–
$\ln w^*_{it-1}$	0.110 (3.980)	–	–	–	–	–
$\ln \frac{w_{it-1}}{w^*_{it-1}}$	–	−0.093 (−4.066)	−0.444 (−5.066)	−0.461 (−4.241)	−0.281 (−1.892)	−0.122 (−1.026)
N	800	800	800	720	720	720

Notes: Country/industry fixed effects are included in all regressions, t-statistics in parenthesis. We cannot reject the hypothesis that the coefficients on domestic and foreign variables are equal except for the coefficients on the number of domestic and foreign firms in (1) to (5). In (3) to (6) instruments for openness include cif/fob, EU directives interacted with NTBs, weighted distance interacted with the elasticity of substitution, weight to value and 1992 and 1999 dummies. In (5) wages are instrumented by the average income tax rate for married individuals and in (6) the number of firms is further instrumented by its own lags. L_t denotes (real) GDP.

Table 9: Markups (Long Run), all country pairs

	(1)	(2)	(3)	(4)
Method	OLS	OLS	IV	IV
$\Delta \ln \frac{\mu_{it-1}}{\mu^*_{it-1}}$	–	–	–	0.038 (0.884)
$\Delta \ln \theta_{it}$	−0.014 (−1.354)	–	–	–
$\Delta \ln \theta^*_{it}$	0.010 (0.965)	–	–	–
$\Delta \ln \frac{\theta_{it}}{\theta^*_{it}}$	–	−0.013 (−1.769)	−0.019 (−0.747)	−0.027 (−0.874)
$\Delta \ln D_{it}$	−0.042 (−3.701)	−0.038 (−3.565)	−0.038 (−3.065)	−0.040 (−2.953)
$\Delta \ln D^*_{it}$	0.005 (2.769)	0.005 (3.211)	0.006 (3.073)	0.007 (3.009)
$\ln \frac{\mu_{it-1}}{\mu^*_{it-1}}$	−0.539 (−15.741)	−0.542 (−15.925)	−0.531 (−15.054)	−0.590 (−12.494)
$\ln \theta_{it-1}$	0.006 (0.933)	–	–	–
$\ln \theta^*_{it-1}$	−0.011 (−1.482)	–	–	–
$\ln \frac{\theta_{it-1}}{\theta^*_{it-1}}$	–	0.008 (1.480)	0.033 (1.996)	0.037 (1.829)
$\ln L_{t-1}$	−0.030 (−2.885)	–	–	–
$\ln L^*_{t-1}$	0.017 (1.804)	–	–	–
$\ln \frac{L_{t-1}}{L^*_{t-1}}$	–	−0.024 (−3.453)	−0.034 (−3.577)	−0.035 (−3.023)
N	800	800	800	720

Notes: Country/industry fixed effects are included in all regressions, t-statistics in parenthesis. We cannot reject the hypothesis that the coefficients on domestic and foreign variables are equal except for the coefficients on the number of domestic and foreign firms. In (3) and (4) instruments for openness include cif/fob, EU directives interacted with NTBs, weighted distance interacted with the elasticity of substitution, weight to value and 1992 and 1999 dummies. L_t denotes (real) GDP.

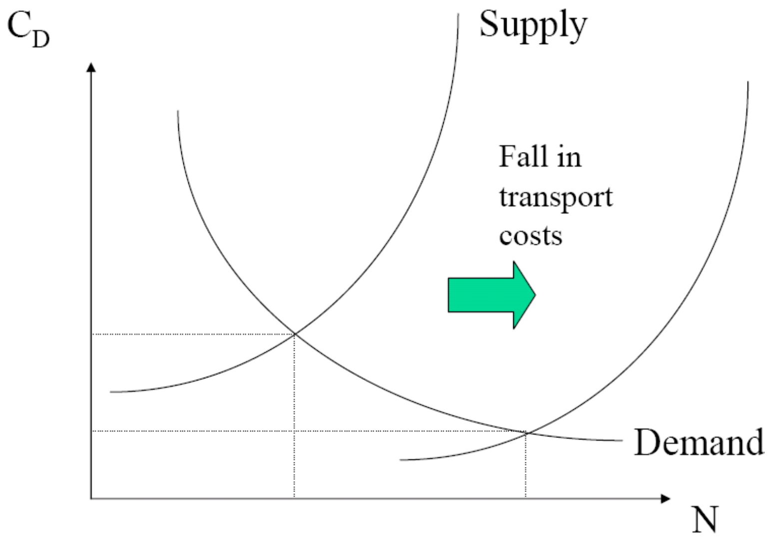

Figure 1: Short Run Effects of Liberalization

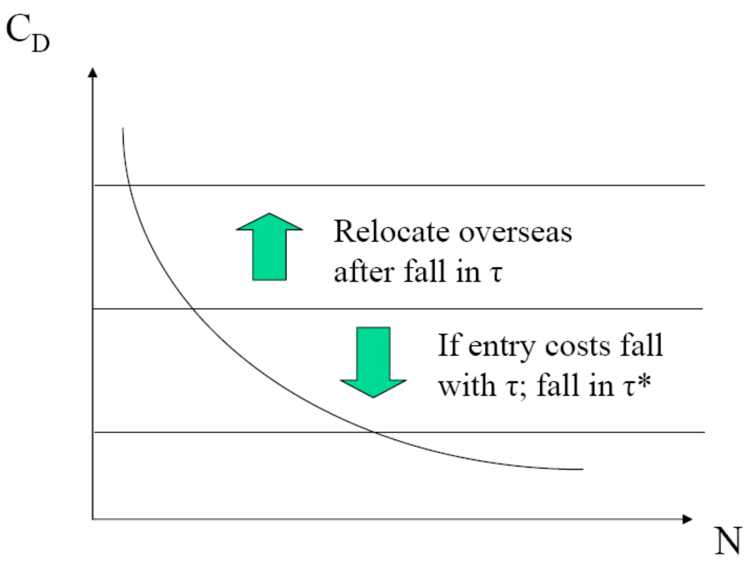

Figure 2: Long Run Effects of Liberalization

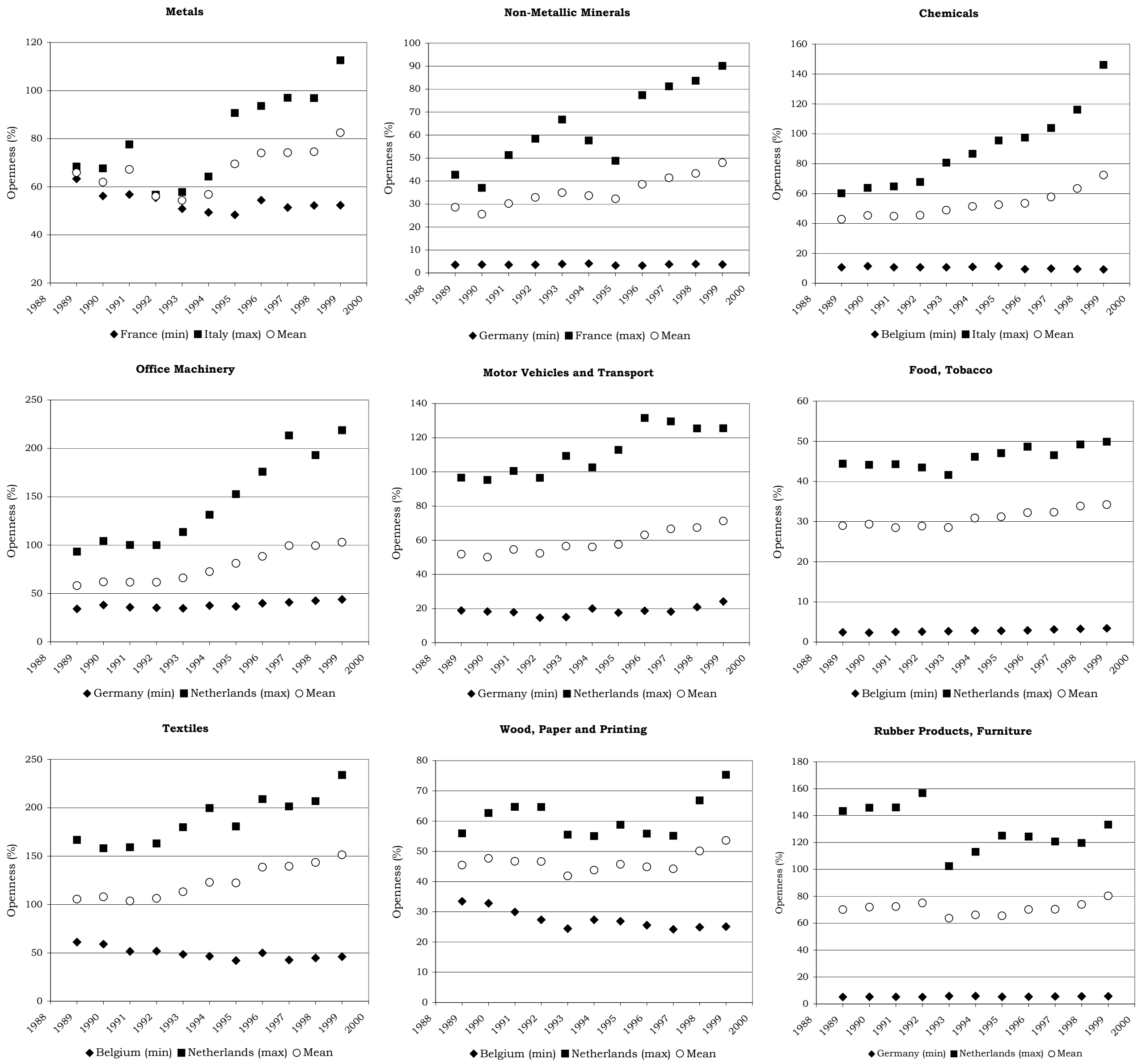

Figure 3: Maximum, Minimum and Average Openness per Sector and per Year