The Dynamics of Trade and Competition*†

Natalie Chen[a,e], Jean Imbs[b,c,e], Andrew Scott[d,e]
[a] *Warwick,* [b] *HEC Lausanne,* [c] *Swiss Finance Institute,*
[d] *London Business School,* [e] *CEPR*

August 2007

Abstract

We present, extend and estimate a model of international trade with firm heterogeneity in the tradition of Melitz (2003) and Melitz and Ottaviano (2005). 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. Consistent with the predictions of some recent theoretical models we find some, albeit weaker, evidence that in the long run these effects reverse themselves and greater openness leads to anti-competitive effects. We also provide evidence domestic trade liberalization induces pro-competitive effects on overseas markets.

JEL Classifications: E31, F12, F14, F15, L16.
Keywords: Competition, Openness, Globalization, Markups, Prices, Productivity.

---

*This paper was first begun when Imbs was visiting Princeton University, whose hospitality is gratefully acknowledged. The paper is part of the RTN programme "The Analysis of International Capital Markets: Understanding Europe's Role in the Global Economy", funded by the European Commission (contract No. HPRN-CT-1999-00067). For helpful comments, we thank Fabio Canova, Keith Cowling, Jordi Galí, Pierre-Olivier Gourinchas, Thierry Mayer, Donald Robertson, Silvana Tenreyro, Michael Woodford and seminar participants at the CEPR Conference on The Analysis of International Capital Markets (Rome 2003), CEPR's ESSIM 2004, CEPR's ERWIT 2006, NBER Summer Institute 2006, the Banque de France, the Banque Nationale de Belgique, the Central Bank of Ireland, ECARES, European University Institute, Federal Reserve Board, GIIS Geneva, Glasgow University, IDEI Toulouse, IGIER, Lancaster University, LSE, Oxford University, Paris Sorbonne, Princeton University, St. Andrews, Stockholm, Università degli Studi di Milano and Warwick University.

†Correspondence should be addressed to Natalie Chen, Department of Economics, University of Warwick, Coventry CV4 7AL, UK. E-mail: N.A.Chen@warwick.ac.uk

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 develop a version of Melitz and Ottaviano (2005) and adapt it to be 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 strategy 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 observe prices, productivity, markups, the number of domestically producing firms and total imports. 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, margins fall, and prices grow at a (temporarily) lower rate. Foreign and domestic openness to trade are both found to 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 (2005).

Ours is by no means the first attempt at quantifying the competitive effects of trade. A first strand of the literature used cross country panel studies to examine the effects of aggregate trade openness on economic (or productivity) growth.[1] Key issues there

[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).

were 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.

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 in some of these studies inspires the present work although we focus not on "natural experiments" but 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. By using a cross section of developed European economies we also make a nod to Trefler's (2004) plea that "what is needed is at least some research focusing on industrialized countries" (p.2).

Closest to our work are several 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 on productivity amongst EU nations. A number of 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.

[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.

The literature on trade with heterogeneous firms is surveyed in Bernard, Jensen, Redding and Schott (2007), where some evidence on the importance of the extensive margin in export decisions can also be found.[3]

Even though it was recently revived by the possibility of theories with closed form solutions, the use of disaggregated data in jointly understanding trade flows and firm performance is not new: see for instance Roberts and Tybout (1997) and more recently Das, Roberts and Tybout (2007). Our paper follows this literature building on the view that trade flows are determined at a microeconomic level. But we differ in several ways. Firstly we focus on the impact across a number of *European* countries of differential increases in *sector-level* import penetration, and provide an alternative means of identifying the impact of trade on non-US economies. Secondly our focus on European importers, and our model's implications on relative openness, lead naturally to a difference in differences approach to estimation. In other words, we do not estimate how France responds to increased imports from the rest of the world, for instance, but rather how French sectors have been effected differently than German ones through differential changes in openness. Finally, we exploit the dynamic nature of our panel to investigate whether the short and long run effects of openness differ.

Our identification scheme rests on cross-industry differences in import penetration, which we instrument to account for the fact that import flows are the result of firm decisions. The identification strategy follows from simple manipulations of the equilibrium conditions of the model we describe. We introduce instruments for sectoral openness across European countries. We obtain satisfactory explanatory power even at a disaggregated level thanks to a combination of insights inspired from various literatures. In particular, 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.

Thanks to our difference in differences approach, the aggregate component of sector inflation rates can be accounted for directly in the estimation. This is important for it helps focus the empirics upon the question of interest, namely the putative pro-

[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.

competitive microeconomic effects of trade openness, and away from alternative macroeconomic mechanisms. For instance, Romer (1993) has argued trade openness affects the conduct of monetary policy, as depreciation costs erode the benefits of surprise inflations to an extent that increases with openness. More recently Rogoff (2003) argues that the inflation bias under discretionary monetary policy decreases with the extent of competition, which in turn improves with openness. Both arguments can explain the negative long run correlation between inflation and trade over recent decades. Both effects are directly purged from our data thanks to their disaggregated dimension. Under our assumptions, the sectoral estimates of the pro-competitive effects of trade are immune to alternative macroeconomic explanations.

The plan of the paper is as follows. In Section 2 we outline a theoretical model which clarifies how changes in trade costs affect prices, productivity and markups. Falls in transport costs or tariffs lead to lower prices and margins due to heightened competition from imports. Because inefficient firms exit, trade also leads to lower average costs and higher productivity. Section 3 develops from this theoretical framework the equations we actually estimate. We reformulate the model in terms of directly observable import shares rather than transport costs. We pay particular attention to separating the short and long run dynamics of how openness impacts on the variables of interest. 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

This section outlines the main features of the theoretical model we use to structure the equations which we later estimate. The model, based on Melitz and Ottaviano (2005), links prices, productivity and in particular markups to the number of firms supplying a market. Trade liberalization affects the number of firms and so influences firm level performance, in a way that depends on the horizon considered. 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 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 set up 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 (2005). 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.

The main innovation in our paper is to take this theoretical structure and manipulate it to estimate the competitive impact of greater trade openness amongst EU nations. In order to do so we develop the model in three directions. Firstly the theory points to a critical role for a trade cost variable, reflecting either transportation costs or tariffs. Reliable data for trade costs are scarce so we use our model to substitute out for them, and use instead the more readily observable import share.[4] Secondly the model naturally leads to a difference in differences estimation to identify 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 (2005) where firm relocation always leads to anti-competitive effects.

2.1 The Model

2.1.1 Demand

A representative agent has preferences over a continuum of sectors, indexed by i. Following Melitz and Ottaviano (2005), utility from consumption in each sector is derived from quasi-linear preferences over a continuum of varieties indexed by $u \in (0, 1]$. Aggregate 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

[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.

(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 and 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. In other words, $f_E' > 0$. The same effect would be achieved if the cost of capital and construction goods became cheaper after liberalization.

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 $c_X^* = c_D/\tau$. Due to 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 export [$q_X(c)$ and $q_X^*(c)$]. To obtain closed form expressions Melitz (2003) and Melitz and Ottaviano (2005) assume costs in each sector follow

[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.

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.

As is well known, 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

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

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 therefore 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 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

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

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

The demand curve therefore implies a *negative* relationship between the number of active firms supported by the market and the threshold costs of the marginal firm. This relationship 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. As a consequence the negative relationship shown in Figure 1 is invariant to trade liberalization.

2.2.2 Short Run Implications of Trade Liberalization

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

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

$$N^* = \bar{N}^*_{SR}\left(\frac{c^*_D}{c^*_M}\right)^k + \bar{N}_{SR}\,\frac{1}{(\tau^*)^k}\left(\frac{c^*_D}{c_M}\right)^k \tag{4}$$

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 relationship. In contrast to the demand relationship (1), changes in transport costs affect the production decisions of firms and shift the relationship 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 and, as a result, the higher cost domestic firms and foreign exporters cease production. The end result is a net increase in N (even though some domestically produced 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 Implications of Trade Liberalization

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, using a zero expected profit condition for firm entry and the fact that $c_X = c_D^*/\tau^*$ gives the following expressions for the costs of the marginal firm:

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

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

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 relationship 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 ($\Upsilon(.)$). As a result 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 (2005) 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 an impact on $\Upsilon(.)$. In equilibrium N falls and c_D rises, which implies higher prices and markups and lower productivity. In other words, under 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.

Things change fundamentally if the model is generalized to 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 (2005) 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 set up costs fall, firms choose to relocate overseas, with anti-competitive consequences on the domestic market.

3 Towards an Estimable Model

In this section we lay the foundations for our empirical analysis. We do so by deriving estimable equations in terms of observable variables from the theory in the previous section.

3.1 Openness and Import Share

The key parameters of trade liberalization in our model are τ and τ^*, but reliable estimates are notoriously difficult to obtain, especially at the sectoral level. We use our model to substitute out for τ in terms of directly observable indicators of trade openness. The key variable for our analysis will be domestic absorption which in the model can be shown to depend only on domestic transport costs and relative productivity.[6] By definition, absorption is given by

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

which under the Pareto distributional assumption 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 – which are observed imperfectly – with directly observable import shares.

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

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

[6] Del Gatto, Mion and Ottaviano (2006) focus on exports rather than import share. They compare observed and model-implied patterns of exports to infer a measure of "trade freeness".

From equation (7) we see that in the short run relative prices fall with domestic openness (θ) but rise with foreign openness (θ^*).[7] 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 openness lead to falls 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 it can be shown that $D = \Psi(\tau, \tau^*)\; N$ where $\Psi_\tau > 0$.[8] In other words, falls in τ lead to a negative relationship 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^*).

3.2.2 Long Run

From (5) and (6) long run relative prices imply

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

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 *à priori*. In addition, large markets, as indexed by L, support a larger number of firms and have lower prices.

[7] Equation (9) 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^*.

[8] 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.

3.2.3 Combining Short and Long Run

We seek to evaluate simultaneously a short run relationship between relative prices, the number of domestically producing firms and openness, and a long run relationship 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

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

where i denotes sector, a star denotes the foreign country (denoted with j in the residual) and t is time.[9] The difference terms capture short run relationships, whilst the error correction term in brackets captures the long run relationship 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 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 $\delta_1 > 0$, and a large foreign market should have the opposite effect ($\delta_2 < 0$) with the model requiring $\delta_1 + \delta_2 = 0$.

Equation (9) exactly 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

[9] 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.

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.[10]

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 :

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

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 to alternative specifications and interpretations.

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),

[10] 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, even more strongly in most cases.

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. As in Figure 1, increases in the number of domestic firms leads to a fall in c_D and a rise in productivity. *Ceteris paribus*, foreign openness and the number of foreign firms have the opposite impact.

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 once more 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,

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

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.

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 to 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 possible 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 the inclusion of deterministic trends or not. These results support the error correction formulation in our estimated equations. However given well known concerns about the size and power of unit root tests in what follows we estimate our equations with and without the error correction terms.

4.2 Lagged Dependent Variables

We have used our error correction formulation to disentangle the short and long run response of variables to openness. Our 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. Reassuringly our main results are robust to the inclusion or otherwise of lagged dependent variables. 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 the proper GMM estimators introduced by Arellano and Bond (1991).

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. Peersman and Smets (2005) 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, rather than 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 bilateral international differences in all the variables of interest.[11] In our estimation we consider bilateral differences in two ways. First, we compute the universe of bilateral differences at the sector level implied by using all pairwise combinations of our sample of countries. Second, we compute differences with respect to the only economy in our sample where the change in openness was actually negative on average, namely Italy. Naturally, the cross section is smaller 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 should plague all (distinct) bilateral pairs involving the poorly measured

[11] 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 (2005) shows a multilateral version with analogous equations to the ones which we use.

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.[12]

4.5 Endogeneity

The key variable in our model is τ, reflecting trade costs. In our empirical strategy we substitute import shares for τ. However, import penetration θ is an endogenous variable reflecting the influence of potentially 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 at the level of individual sectors. The next section describes the main features of our data, and illustrates there is a 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 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 tradeability or tariffs, but which still act as determinants of τ. A large literature in industrial organization has

[12] We actually 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.

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.[13] 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.

The set of instruments we propose for θ reflects both these influences on sector-level import penetration. Three instruments are first combined to capture the inherent transportability of a given industry. 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".[14]

We then 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.

Last, 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,

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

[14] 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.

where weights are given by geographic distance.[15] 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.[16] 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).

We then 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 interact with a sector-specific index of non-tariff barriers.[17] 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.

We finally 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.[18]

[15] 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.

[16] 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.

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

[18] 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 continue to obtain.

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 this 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.[19] 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 markups we use the Bank for the Accounts of Companies Harmonized (BACH) database, which contains harmonized annual account statistics of non-financial enterprises in eleven European countries, Japan and the US.[20] 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.[21] 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 any biases in estimating markups. 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. In order to ensure consistency between our two- and three- digit

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

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

[21] See *inter alia* Conyon and Machin (1991).

NACE price indices and the BACH data we aggregate up the price data, as described in Appendix A.[22]

The value of exports and imports, together with their tonnage, are also aggregated across NACE industries into their BACH equivalent. To compute openness (as the share of imports into effective consumption) we use the BACH database. We construct output using the definition that value added 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 number of firms is directly taken from the BACH database. The value of GDP is from the OECD *Economic Outlook* as are the consumer prices 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

[22] 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 9 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.

percent. They are highest on average in Non-Metallic Minerals. Table 3 suggests import penetration increased most in Belgium, while it actually fell in Italy, indeed across most of the sectors we observe. 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.[23] 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 Empirical Results

We focus first on the short run results, estimated on first differences only. Under non-stationarity, these are consistent but not efficient. We then include error correction terms, and investigate whether in the long run increased openness exerts pro- or anti-competitive effects.

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 constrain some of the coefficients of interest to be equal across countries, as implied by theory.

Table 4 focuses on the price effects of openness in the short run. We first investigate 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. Columns (2), (3) and (4) include relative openness, relative aggregate prices and lagged dependent variables, respectively. First, domestic and foreign openness have

[23] 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.

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, and indeed strengthen 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 somewhat weaker, as implied by theory.[24] 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. 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 the foreign market structure. These coefficients are however 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 importation 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 (11) affects none of our results.

[24] The former can be rejected at the 39% confidence level, whereas the latter at the 13% level only.

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.

Estimates of equation (12) are shown in Table 7.[25] The short run results that relative openness and the relative number of firms have pro-competitive effects on prices continue to obtain, albeit not at standard significance levels. In results available upon request, described in Section 7, we show that the loss of significance in the short run impact of openness when an error correction term is included is not a robust feature of our data. For instance, the significance of short run effects remains strong when controls for factor endowments are included or when a GMM estimator is implemented. If anything, it is the long run impact that tends to be weaker in significance. Table 7 is interesting for two reasons. First, there is a reversal of the effects of relative openness on prices. In the long run, domestic openness exerts an upward pressure on relative prices, whereas it is now foreign openness that acts negatively on relative 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 remotely significantly different. These conclusions all stand (indeed strengthen) when we instrument.

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) on relative productivity stand significantly in all cases. As with the relative price equation, the data show 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.

[25] 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.

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 evidence of a significant reversal at long horizons. In the long run, domestic relative openness acts to increase margins, at least on the basis of our point estimates.[26]

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 upon request. 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

[26] Long run estimates are only valid if the explanatory variables are cointegrated. Applying the seven tests suggested by Pedroni (1999) provides strong support for cointegration, although the variance and Phillips-Perron ρ test provide some evidence to the contrary.

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 upfront 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. If 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. We also estimated the impact of openness focusing just on deviations from a benchmark economy, rather than all possible (distinct) bilateral pairs as previously. 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.

The detailed results of this battery of sensitivity tests are left for a companion document available upon request. 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 (which tended to have the sign implied by theory), 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, even though the former implied slightly larger point estimates, 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 present a theory where openness has pro-competitive effects in the short run but ambiguous long run impact. We set up the model in a way that is directly amenable to empirical testing, and in particular to a difference in differences estimation. We show how it is relative openness (and relative firm dynamics) that affect relative prices, relative productivity and relative profit margins across the same sector in different countries. This 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, and emphasizes the pro-competitive effects of trade in a model with heterogeneous firms. 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 finding of short run pro-competitive effects from increased openness are robust to a range of specifications and estimators. We also uncover evidence that in the long run increased openness may lead to anti-competitive effects, supporting the well known notion of tariff jumping whereby firms tend to relocate to more protected economies. Estimates of this long run reversal are less universally significant than our short run results, which may reflect the relative brevity of our sample, or indeed perhaps the theoretical ambiguity we discuss. They do however suggest that the pro-competitive effects of openness are most pronounced in the short run, and that firm dynamics and location decisions are relevant to the impact of trade on industry 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, as predicted by theory.

Identification in this paper rests on the differential effects of openness on prices, productivity and margins. We therefore cannot use these estimates directly to infer the magnitude of the effect globalization has had on aggregate inflation. That said, the magnitude of our estimated short run elasticities suggests import competition may have played an economically significant role in dampening manufacturing price inflation and profit margins, at least in the short run. Whether this generalizes to all sectors is a question the data in this paper will not let us answer.

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

References

[1] Ades, Alberto F. and Edward L. Glaeser, 1999, Evidence on Growth, Increasing Returns, and the Extent of the Market, The Quarterly Journal of Economics 114(3), pp. 1025-1045.

[2] Aghion, Philippe, Robin Burgess, Stephen Redding and Fabrizio Zilibotti, 2006, The Unequal Effects of Trade Liberalization: Evidence from Dismantling the License Raj in India, NBER Working Paper 12031.

[3] Alcalà, Francisco and Antonio Ciccone, 2003, Trade, Extent of the Market, and Economic Growth 1960-1996, mimeo.

[4] Arellano, Manuel and Stephen R. Bond, 1991, Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations, Review of Economic Studies 58(2), pp. 277-297.

[5] Baldwin, Richard E. and Rikard Forslid, 2004, Trade Liberalization with Heterogeneous Firms, CEPR Discussion Paper 4634.

[6] Baldwin, Richard E. and Toshihiro Okubo, 2005, Heterogeneous Firms and Trade: Testable and Untestable Properties of the Melitz Model, NBER Working Paper 11471.

[7] Bernard, Andrew B., Jonathan Eaton, J. Bradford Jensen and Samuel Kortum, 2003, Plants and Productivity in International Trade, The American Economic Review 93(4), pp. 1268-1290.

[8] Bernard, Andrew B. and J. Bradford Jensen, 2007, Firm Structure, Multinationals and Manufacturing Plant Deaths, The Review of Economics and Statistics 89(2), pp. 193-204.

[9] Bernard, Andrew B., J. Bradford Jensen, Stephen Redding and Peter K. Schott, 2007, Firms in International Trade, Journal of Economic Perspectives, forthcoming.

[10] Bernard, Andrew B., J. Bradford Jensen and Peter K. Schott, 2006, Trade Costs, Firms and Productivity, Journal of Monetary Economics 53(5), pp. 917-937.

[11] Bernard, Andrew B., Stephen Redding and Peter K. Schott, 2007, Comparative Advantage and Heterogeneous Firms, The Review of Economic Studies 74(1), pp. 31-66.

[12] Broda, Christian and David E. Weinstein, 2006, Globalization and the Gains from Variety, The Quarterly Journal of Economics 121(2), pp.541-585.

[13] Buigues, Pierre, Fabienne Ilzkovitz and Jean-François Lebrun, 1990, The Impact of the Internal Market by Industrial Sector: The Challenge for the Member States, European Economy (Social Europe), Special Edition, Brussels: Commission of the EC.

[14] Case, Anne, 1991, Spatial Patterns in Household Demand, Econometrica 59(4), pp. 953-965.

[15] Clerides, Sofronis K., Saul S. Lach and James R. Tybout, 1998, Is Learning By Exporting Important? Micro-Dynamic Evidence from Colombia, Mexico, and Morocco, The Quarterly Journal of Economics 113(3), pp. 903-947.

[16] Connor, John M., 1997, The Global Lysine Price-Fixing Conspiracy of 1992-1995, Review of Agricultural Economics 19(2), pp. 412-427.

[17] Conyon, Martin and Steve Machin, 1991, Market Structure and the Empirical Specification of Profit Margins, Economics Letters 35(2), pp. 227-231.

[18] Corbo, Vittorio, Jaime de Melo and James R. Tybout, 1991, The Effects of Trade Reforms on Scale and Technical Efficiency: New Evidence from Chile, Journal of International Economics 31(3/4), pp. 231-250.

[19] Das, Mita, Mark Roberts and James R. Tybout, 2007, Market Entry Costs, Producer Heterogeneity and Export Dynamics, Econometrica 75(3), pp. 837-873.

[20] Del Gatto, Massimo, Giordano Mion and Gianmarco I.P. Ottaviano, 2006, Trade Integration, Firm Selection and the Costs of Non-Europe, CEPR Discussion Paper 5730.

[21] Dixit, Avinash K. and Joseph E. Stiglitz, 1977, Monopolistic Competition and Optimum Product Diversity, The American Economic Review 67(3), pp. 297-308.

[22] Ferreira, Pedro C. and José L. Rossi, 2003, New Evidence from Brazil on Trade Liberalization and Productivity Growth, International Economic Review 44(4), pp. 1383-1405.

[23] Fitzpatrick, Gary L. and Marylin J. Modlin, 1986, Direct-Line Distances, International Edition, The Scarecrow Press, Inc, Metuchen, NJ and London.

[24] Frankel, Jeffrey A. and David Romer, 1999, Does Trade Cause Growth?, The American Economic Review 89(3), pp. 379-399.

[25] Genesove, David and Wallace Mullin, 2001, Rules, Communication, and Collusion: Narrative Evidence from the Sugar Institute Case, The American Economic Review 91(3), pp. 379-398.

[26] Goldberg, Pinelopi and Frank Verboven, 2001, The Evolution of Price Dispersion in the European Car Market, Review of Economic Studies 68(4), pp. 811-848.

[27] Hadri, Kaddour, 2000, Testing for Stationarity in Heterogeneous Panel Data, Econometrics Journal 3(2), pp. 148-161.

[28] Harrigan, James, 1999, Estimation of Cross-Country Differences in Industry Production Functions, Journal of International Economics 47(2), pp. 267-293.

[29] Harrison, Ann E., 1994, Productivity, Imperfect Competition and Trade Reform: Theory and Evidence, Journal of International Economics 36(1/2), pp. 53-73.

[30] Hummels, David L., 2001, Toward a Geography of Trade Costs, Krannert School of Management, Purdue University, mimeo.

[31] Im, Kyung So, M. Hashem Pesaran and Yongcheol Shin, 2003, Testing for Unit Roots in Heterogeneous Panels, Journal of Econometrics 115(1), pp. 53-74.

[32] Irwin, Douglas A. and Marko Tervio, 2002, Does Trade Raise Income? Evidence from the Twentieth Century, Journal of International Economics 58(1), pp. 1-18.

[33] Kramarz, Francis, 2003, Wages and International Trade, CEPR Discussion Paper 3936.

[34] Krishna, Pravin and Devashish Mitra, 1998, Trade Liberalization, Market Discipline and Productivity Growth: New Evidence from India, Journal of Development Economics 56(2), pp. 447-462.

[35] Levin, Andrew, Chien-Fu Lin and Chia-Shang J. Chu, 2002, Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties, Journal of Econometrics 108(1), pp. 1-24.

[36] Melitz, Marc J., 2003, The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity, Econometrica 71(6), pp. 1695-1725.

[37] Melitz, Marc J. and Gianmarco I.P. Ottaviano, 2005, Market Size, Trade and Productivity, Review of Economic Studies, forthcoming.

[38] Ottaviano, Gianmarco I.P., Takatoshi Tabuchi and Jacques-François Thisse, 2002, Agglomeration and Trade Revisited, International Economic Review 43(2), pp. 409-435.

[39] Pavcnik, Nina, 2002, Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants, Review of Economic Studies 69(1), pp. 245-276.

[40] Pedroni, Peter, 1999, Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors, Oxford Bulletin of Economics and Statistics, Special Issue 61, pp. 653-670.

[41] Peersman, Gert and Frank Smets, 2005, The Industry Effects of Monetary Policy in the Euro Area, Economic Journal 115(503), pp. 319-342.

[42] Roberts, Mark and James R. Tybout, 1997, The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs, The American Economic Review 87(4), pp. 545-563.

[43] Rodrik, Dani and Francisco C. Rodriguez, 2001, Trade Policy and Economic Growth: A Skeptic's Guide to the Cross-National Evidence, NBER Macroeconomics Annual 2000 (15), pp. 261-325.

[44] Rogoff, Kenneth S., 2003, Globalization and Global Disinflation, Paper presented for Federal Reserve Bank of Kansas 2003 Jackson Hole Conference.

[45] Roller, Lars Hendrik and Frode Steen, 2006, On the Workings of a Cartel: Evidence from the Norwegian Cement Industry from 1955-1968, The American Economic Review 96(1), pp. 321-338.

[46] Romer, David, 1993, Openness and Inflation: Theory and Evidence, Quarterly Journal of Economics 108(4), pp. 869-903.

[47] Spolaore, Enrico and Romain Wacziarg, 2006, The Diffusion of Development, NBER Working Paper 12153.

[48] Topalova, Petia, 2004, Trade Liberalization and Firm Productivity: The Case of India, IMF Working Paper 04/28.

[49] Trefler, Daniel, 2004, The Long and Short of the Canada-US Free Trade Agreement, The American Economic Review 94(4), pp. 870-895.

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

	Inflation (%)			Import Share (%)			Productivity (Ecus/worker)			Markups		
Country/Sector	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max
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
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.

Table 3: Summary Statistics

	Import Share (%)	
Country/Sector	1989	1999
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
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.

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.

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

	(1)	(2)	(3)	(4)	(5)
Method	OLS	OLS	OLS	IV	IV
$\Delta \ln \frac{\overline{\mu}_{it-1}}{\overline{\mu}^*_{it-1}}$	–	-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.

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.

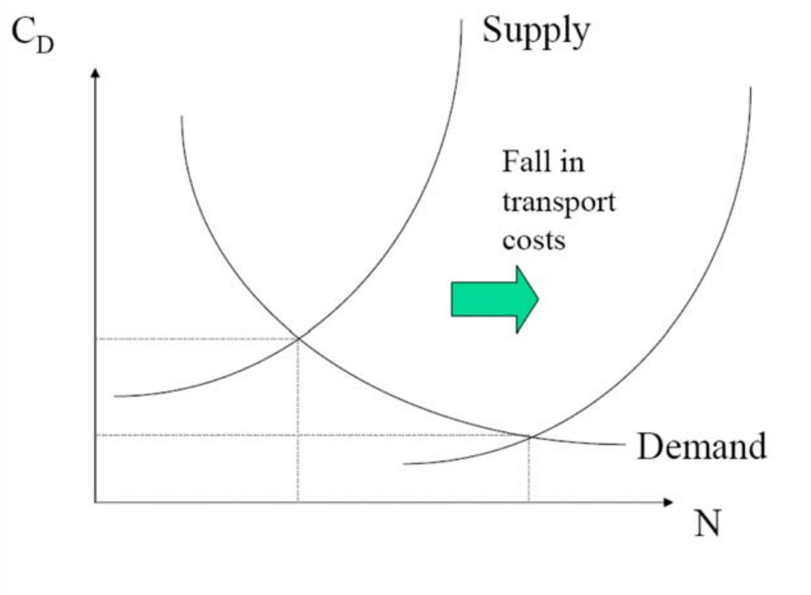

Figure 1: Short Run Effects of Liberalization

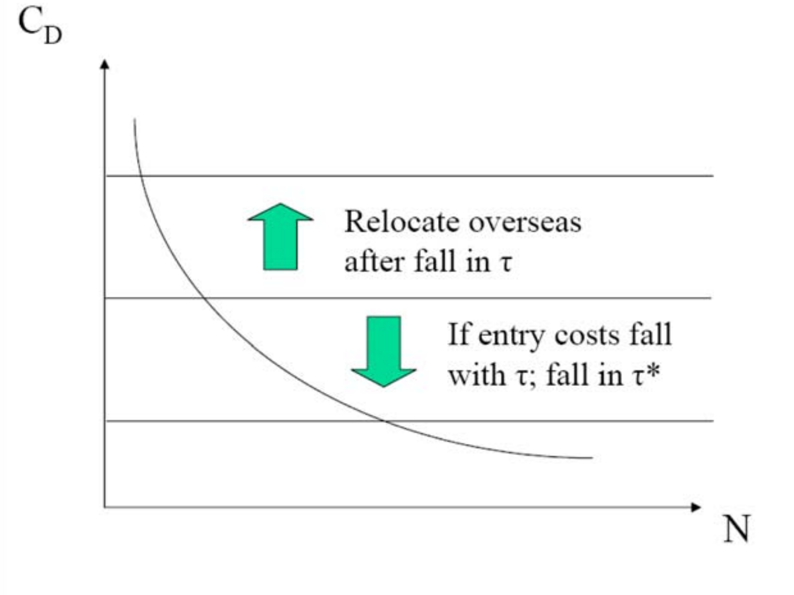

Figure 2: Long Run Effects of Liberalization

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