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ABSTRACT

Competition, Globalization and the Decline of Inflation*

We investigate theoretically and empirically the competitive effects of increased trade on prices, productivity and markups. Using disaggregated data for EU manufacturing over the period 1988-2000 we find increased openness exerts a negative and significant impact on sectoral prices. Increased openness lowers prices by both reducing markups and raising productivity. In response to an increase in openness, markups show a steep short run decline, which partly reverses later, while productivity rises in a manner that increases over time. Our estimates suggest that EU manufacturing prices fell by 2.3%, productivity rose by 11% and markups fell by 1.6% in response to the observed increase in manufacturing imports. The direct price restraint caused by greater imports, assuming unchanged monetary policy, can explain a fall in inflation of up to 0.14% per annum. The most substantial impact on inflation arises, however, from the role of lower markups in reducing the inflation bias of monetary policy. Our results suggest that increased trade could account for as much as a quarter of European disinflation over this period.

JEL Classification: E31, F12, F14, F15 and L16
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1 Introduction

I argue that the most important and most unusual factor supporting worldwide disinflation has been the mutually reinforcing mixture of deregulation and globalization and the consequent significant decrease in monopoly pricing power.
Kenneth S. Rogoff, Globalization and Global Disinflation, Jackson Hole Conference (2003).

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. As a result, prices fall, or at least their rate of increase does. A key contribution of this paper is to use disaggregated datasets for EU manufacturing sectors and gauge empirically the importance of these effects for the EU during the 1990s.

In explaining the substantial decline in global inflation experienced during the 1990s, most attention has rightly focused on changes to monetary and fiscal policy.[1] However, the competitive effects of greater openness also contribute to lower inflation through two channels. The first is a direct effect on price indices. As the economy experiences an increase in the level of competition, prices rise more slowly as markups are squeezed and costs are lowered as productivity increases. Assuming an unchanged monetary policy, this implies that the transition to a higher level of competition will produce lower inflation. The magnitude of this effect will depend on the size of the increase in openness, its impact on markups and productivity, and the relative weight of the tradeable sector in price indices.

A second channel operates through the effects of competition upon monetary policy. A standard result in the literature (e.g. Barro and Gordon (1983) and Rogoff (1985)) is that under discretion inflation is sub-optimally high. The extent of this inflation bias depends on the gap between the actual steady state level of output and the first-best level that would obtain in an efficient economy. If increased openness leads to lower markups, this output gap narrows and so therefore does the inflation bias. This implies

[1] See *inter alia* Alesina and Summers (1993), Romer (1993), Bernanke, Laubach, Mishkin and Posen (1998), Cecchetti, Flores-Lagunes and Krause (2001) and Rogoff (2003).

that even in the absence of central bank reforms, the 1990s would have witnessed a fall in inflation due to declining markups brought about by increased openness.

To identify the first channel we use sectoral data on manufacturing prices and control for the crucial role of changes in aggregate monetary policy. For the second channel, we require estimates of the response in markups, which we obtain using a new dataset based on homogenized EU corporate accounts.

While a number of studies have investigated the competitive effects of openness, evidence is typically based on event studies, applied to particular episodes of trade liberalization and usually focused on developing countries.[2] In contrast, we focus on a cross-section of developed European economies, and introduce estimates based on trend increases in globalization, as opposed to sudden large changes in policy. In part our paper is an answer to Trefler's (2004) plea that "what is needed is at least some research focusing on industrialized countries" (p.2).

Our focus on the links between openness and inflation is distinct from, but related to several strands of the literature. Our first channel concentrates on how trade affects the pricing decisions of firms, which is related to an extensive literature on international convergence to the law of one price (see *inter alia* Goldberg and Verboven (2001) and Rogers (2001)). However, convergence to the law of one price can occur entirely through arbitrage without any impact on domestic markups or productivity. We therefore go beyond just establishing the existence of price dynamics consistent with the law of one price. Instead we identify the channels through which the law of one price operates and consider their broader implications. For instance, evaluating the impact of openness on the inflation bias requires separate estimates of the response in markups, rather than just the total effect on prices.

Romer (1993) also contends that more open economies should experience lower inflation. In his case the mechanism is that exchange rate depreciations minimize the incentive for central banks to choose the high inflation equilibrium in a Barro-Gordon

[2] See, among many others, Corbo, de Melo and Tybout (1991) or Pavcnik (2002) on Chile; Ferreira and Rossi (2003) on Brazil; Harrison (1994) on Ivory Coast; and Aghion, Burgess, Redding and Zilibotti (2003), Krishna and Mitra (1998) and Topalova (2004) on India. Bernard, Jensen and Schott (2004) follow an approach similar to ours in using sectoral measures of trade exposure. However, they focus on the output response at the plant-level, rather than price changes and find trade to have substantial reallocation effects within sectors.

(1983) model.[3] Whereas Romer (1993) proposes a macroeconomic explanation, based on exchange rate fluctuations, we stress a sectoral mechanism. If openness increases competition and reduces monopoly power, inflation should decline as the economy moves closer to its first-best. The difference is an important one, as can be seen by considering European Monetary Union. Increased trade between members of a single currency will not see an effect on the inflation bias through the Romer channel (there are no exchange rate fluctuations) but inflation would still change if markups declined. Given our results point to strong effects on markups between EU countries, this is an important distinction.

The plan of the paper is as follows. In Section 2 we outline a theoretical model which clarifies how increases in trade, measured by a rise in import share, affect prices, productivity and markups. We develop a two-country general equilibrium model, inspired from Melitz and Ottaviano (2003), with trade in differentiated products, where productivity is allowed to vary across countries. Increases in the import share lead to lower prices because of heightened competition and low margins, and because of inefficient firms exiting, and lower average costs as a consequence. Section 3 feeds these theoretical results into an econometric framework. We develop both single and systems approaches, in order to gauge the impact of openness on sectoral prices and to estimate the relative magnitude of the markup and productivity effects. Section 4 introduces our disaggregated dataset, covering twenty-one manufacturing industries in eight European countries over the period 1988-2000. Section 5 presents our econometric results, while Section 6 considers various extensions and robustness checks. Section 7 uses our estimates to quantitatively assess the extent to which increased manufacturing trade affected European inflation, markups and productivity over the 1990s. A final Section concludes.

2 The Impact of Openness on Prices

In this section, we develop a two-country general equilibrium model built around the work of Melitz and Ottaviano (2003). We extend the model by allowing for cross-country heterogeneity in costs and deriving a tractable expression for import shares. We solve for prices, costs and markups as a function of the import share, and characterize the channels between openness and prices.

[3] This result has not gone unquestioned. See for instance Bleaney (1999), Terra (1998) or Lane (1997).

Consumers display a preference for variety which leads to the existence of imperfectly competitive firms who set prices as a markup over cost. This markup is determined by the elasticity of demand, which depends on preferences as well as the number of firms, as in Ottaviano, Tabuchi and Thisse (2002). A large number of firms increases product variety but also the elasticity of demand for each variety. The number of firms in the industry is endogenous and determined by a zero profit condition. As in Melitz (2003), firms pay a fixed cost to enter an industry, then discover their unit costs and decide whether or not to produce. Unit costs vary across firms, both within the sector and across countries and firms can produce for both domestic and export markets. The import share in a sector depends on relative productivity between countries as well as the level of trade costs. Falling trade costs (removal of tariffs or declining transportation costs) lead to a rising import share and an increase in the number of firms. Increased competition in turn reduces markups and so lowers price. In addition, low prices force less productive firms out, increasing average productivity, and creating further downward pressure on average prices. Therefore during a period of rising openness our model predicts, *ceteris paribus*, lower rates of change in producer prices, faster rates of productivity growth and shrinking margins.

2.1 The Model

2.1.1 Demand

A representative agent has preferences over a continuum of sectors, indexed by h, and a numeraire good denoted with a zero subscript. Utility is given by

$$U = C_0 + \left(\int_h C_h^{1-\rho} \, dh \right)^{\frac{1}{1-\rho}}$$

where ρ is the elasticity of substitution between sectors. Denote the mass of consumers in the home country by L. Utility from consumption in each sector is, in turn, derived from a continuum of varieties indexed by $i \in (0, 1]$ such that

$$C_h = \alpha \int_i q_i^h \, di - \frac{1}{2}\gamma \int_i \left(q_i^h \right)^2 \, di - \frac{1}{2}\eta \left(\int_i q_i^h \, di \right)^2$$

with $\alpha, \gamma, \eta > 0$. The varieties are perfect substitutes for $\gamma = 0$, in which case the representative agent only cares about sectoral consumption $Q^h = \int_i q_i^h \, di$. Identical assumptions hold in the foreign country, whose variables we denote by an asterisk. In what follows we omit sector-specific superscripts unless the context is ambiguous.

Inverted demand for each variety is given by

$$p_i = \alpha - \gamma q_i - \eta Q^h \tag{1}$$

for $q_i > 0$. This defines $Q^h = (\alpha - \bar{p})\ N\ /\ (\gamma + \eta N)$ where N is the number of firms competing in the sector (including domestic producers and foreign exporters), and $\bar{p} = \frac{1}{N}\int_i p_i\ di$ is the aggregate sectoral price index. Demand for variety i remains positive so long as

$$p_i \leq \frac{1}{\gamma + \eta N}\left(\alpha\gamma + \eta N\ \bar{p}\right) \tag{2}$$

Using (1) and (2) and summing over all consumers gives total demand in the home country for variety i as

$$Q_i = Lq_i = \frac{\alpha L}{\gamma + \eta N} - \frac{L}{\gamma}p_i + \frac{1}{\gamma}\frac{\eta N L}{\gamma + \eta N}\ \bar{p} \tag{3}$$

Demand for each variety is linear in prices, but crucially unlike the classic Dixit-Stiglitz monopolistically competitive setup, the price elasticity of demand depends on the number of firms in the sector. This is critical in producing the result that increased openness leads to lower prices and higher productivity.

2.1.2 Supply

Labor is the only factor of production and c denotes the firm's unit labor cost so that labor productivity is $1/c$. We assume unit costs vary across firms in a sector and also between sectors in different countries. Prior to discovering their costs, firms have to make an entry decision. If they decide to enter they pay a fixed cost f_E, which is allowed to vary across sectors but remains the same across countries.[4] Once they have paid their fixed costs firms discover their productivity and decide whether to proceed with production or withdraw. Firms can sell to the domestic market as well as export production, but exports incur an ad-valorem cost $\tau > 1$, reflecting tariffs and transportation costs.

[4] It is relatively straightforward to let f_E vary across countries. However, this produces substantially more cumbersome expressions for very little additional insight. We therefore focus only on cross-country differences in unit labor costs.

Production for domestic markets therefore has a unit cost c but for exports it increases to τc. We assume transportation costs are symmetric between countries.

Denote p^l as the price at which a firm would achieve zero sales (i.e. where the inequality (2) is binding). This defines the marginal firm for entry as one with costs c_D where $c_D = p^l$. The marginal exporting firm has costs $c_X = p^{l^*}/\tau$ where p^{l^*} is the price at which sales equal zero in the overseas market. Because of trade costs, markets in different countries are distinct and firms have to choose how much to produce for domestic markets $[q_D(c)]$ and how much for exports $[q_X(c)]$. Profits from domestic sales (Π_D) and from exports (Π_X) for a firm with cost c are given by

$$\begin{aligned} \Pi_D(c) &= [\, p_D(c) - c]\; q_D(c) \\ \Pi_X(c) &= [\, p_X(c) - \tau c]\; q_X(c) \end{aligned}$$

Using the demand curve, profit maximization implies

$$\begin{aligned} [\, p_D(c) - c]\, \frac{L}{\gamma} &= q_D(c) \\ [\, p_X(c) - \tau c]\, \frac{L^*}{\gamma} &= q_X(c) \end{aligned}$$

2.1.3 Solving for Prices

As in Melitz (2003), we assume costs in each sector follow a Pareto distribution with cumulative distribution function $G(c) = (\frac{c}{c_M})^s$ where $c \in [0, c_M]$. The upper bound of costs in the sector is given by c_M and s is a dispersion parameter. For $s = 1$ costs are distributed uniformly, and as s increases so does the relative proportion of high cost firms. To allow for cross-country productivity differences we assume that the upper bound for costs differs across countries, 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 is an extension to Melitz and Ottaviano (2003) that enables us to consider the differential impact of openness on prices and productivity in high and low cost countries.[5]

[5] Ghironi and Melitz (2003) introduce cross-country heterogeneity by assuming a stochastic country-specific productivity term. While this introduces some features shared by our model it differs in that heterogeneity arises from *ex post* variation. In our model *ex ante* variation in costs across countries affects firms entry decisions and industry cut-off costs.

Using these distributional assumptions, optimal pricing, and the definitions of c_D and c_X we have

$$
\begin{aligned}
p_D(c) &= \frac{1}{2}\ (c_D + c) \\
q_D(c) &= \frac{L}{2\gamma}\ (c_D - c) \\
p_X(c) &= \frac{\tau}{2}\ (c_X + c) \\
q_X(c) &= \frac{L^*}{2\gamma}\ \tau\ (c_X - c)
\end{aligned}
$$

Free entry in each country gives rise to a zero profit condition given by

$$\int_0^{c_D} \Pi_D(c)\ dG(c) + \int_0^{c_X} \Pi_X(c)\ dG(c) = f_E$$

Let N_E denote the number of firms who enter the sector domestically and N_E^* the number of firms who enter the same sector overseas then we have

$$G(c_D)\ N_E + G^*(c_X^*)\ N_E^* = N$$

We now use inequality (2), our definition of p^l and the Pareto distributional assumption to solve for the unit cost c_D defining the marginal firm, and the level of competition as determined by the number of firms N.[6] From our distributional assumptions and the industry zero profit condition in both countries, and since by definition $c_X^* = c_D/\tau$ and $c_X = c_D^*/\tau$ we have

$$L\ (c_D)^{s+2} + L^*\ \tau^2\ (c_D^*\ /\ \tau)^{s+2} = \gamma\phi \qquad (4)$$

$$L^*\ (c_D^*)^{s+2} + L\ \tau^2\ (c_D\ /\ \tau)^{s+2} = \gamma\phi^* \qquad (5)$$

where $\phi = 2f_E\ (c_M)^s\ (s+1)\ (s+2)$. Note that $\phi = \phi^*\ \omega^s$ where $\omega = (\frac{c_M}{c_M^*})$ is an index of relative cost, or relative competitiveness. If domestic productivity is relatively high (and costs relatively low), $\omega < 1$. When both countries have the same costs $\omega = 1$ and we have the model of Melitz and Ottaviano (2003).

From equations (4) and (5), we have

$$c_D = [\frac{\gamma\phi}{L} \frac{(1 - \tau^{-s}\omega^{-s})}{(1 - \tau^{-s})(1 + \tau^{-s})}]^{\frac{1}{s+2}}$$

[6] We do not invoke the assumption of balanced trade for each sector nor across all sectors. We leave implicit the capital account dynamics that would be required for a fully-fledged general equilibrium model (see Ghironi and Melitz (2003)).

Average sector costs for domestically producing firms are therefore

$$\bar{c} = \int_0^{c_D} c \, dG(c) \; / \; G(c_D) = \frac{s}{s+1} c_D$$

and for foreign firms exporting to the domestic economy we have $\bar{c}^* = \bar{c}/\tau$.

The price of output sold to the domestic market by a firm with costs c is $p_D(c) = \frac{1}{2}(c_D + c)$, with $c \in [0, c_D]$ and for imports the price is $p_X^*(c) = \frac{1}{2}(c_D + \tau c)$, $c \in [0, c_D/\tau]$. A Pareto distribution with cumulative distribution function $(c/c_M)^s$ over the range $[0, c_M]$ continues to follow a Pareto distribution when truncated over a range $[0, c_T]$, for $c_T < c_M$, with a cumulative distribution function given by $(c/c_T)^s$. Therefore, the costs for domestic firms and for exporters (inclusive of trade costs) both follow a Pareto distribution. As a result the aggregate sectoral price index is

$$\bar{p} = \frac{2s+1}{2(s+1)} c_D$$

Defining firm's markups for domestic sales as $\mu_i = p_i - c_i$, the average markup for the sector is given by

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

2.2 Import Shares

Our empirical section focuses on how increases in openness, as measured by import shares, affect prices, markups and productivity. In our model the import share is defined as

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

From our Pareto distributional assumption and firm's pricing decisions this simplifies to

$$\theta = \left(\frac{\omega}{\tau} \right)^s$$

so that import shares depend on trade costs and relative productivity. High trade costs act to lower import shares, whereas high relative costs / low productivity ($\omega > 1$) increase the import share.

Bringing together the key equations of our model we have:

$$\begin{cases} \bar{p} = \frac{2s+1}{2(s+1)}\left[\frac{\gamma\phi}{L}\frac{1-\tau^{-s}\ \omega^{-s}}{1-\tau^{-2s}}\right]^{\frac{1}{s+2}} = \bar{c} + \bar{\mu} \\ \bar{c} = \frac{s}{s+1}\left[\frac{\gamma\phi}{L}\frac{1-\tau^{-s}\ \omega^{-s}}{1-\tau^{-2s}}\right]^{\frac{1}{s+2}} \\ \bar{\mu} = \frac{1}{2}\frac{1}{s+1}\left[\frac{\gamma\phi}{L}\frac{1-\tau^{-s}\ \omega^{-s}}{1-\tau^{-2s}}\right]^{\frac{1}{s+2}} \end{cases} \tag{6}$$

These equations are key to our subsequent estimations and capture the link between prices, markups, productivity, and ultimately import share. Prices fall with the size of the market, L, because more firms compress markups and lower costs. Prices increase with γ, as greater product differentiation implies lower competition, greater markups, and higher costs. Prices also increase with ϕ, i.e. with the fixed costs f_E, since higher entry costs deter entry and thus competition. Total differentiating (6) with respect to ω and τ, we have

$$\begin{cases} \hat{p} = \hat{c} + \hat{\mu} \\ \hat{c} = a\ \hat{\omega} + b\ \hat{\tau} \\ \hat{\mu} = a\ \hat{\omega} + b\ \hat{\tau} \end{cases}$$

where hatted variables denote percentage deviations, $a = \frac{s}{s+2}\frac{\tau^{-s}\ \omega^{-s}}{1-\tau^{-s}\ \omega^{-s}} > 0$ and $b = a - \frac{s}{s+2}\frac{2\tau^{-2s}}{1-\tau^{-2s}} > 0$.[7]

Empirical measures of τ suffer notoriously from measurement error but we do have more reliable series for relative productivity ω and openness θ. Motivated by this and using the fact that $\hat{\theta} = s\ \hat{\omega} - s\ \hat{\tau}$, we can rewrite the system as

$$\begin{cases} \hat{p} = \hat{c} + \hat{\mu} \\ \hat{c} = (a+b)\ \ \hat{\omega} - \frac{b}{s}\ \hat{\theta} \\ \hat{\mu} = (a+b)\ \ \hat{\omega} - \frac{b}{s}\ \hat{\theta} \end{cases} \tag{S}$$

The system (S), which holds at the sectoral level, constitutes the backbone of our empirical estimation. Openness, as measured by import penetration, can affect directly costs and markups, and thus, indirectly, prices as well. Theory suggests these channels are the main (and only) influences openness has on prices. Further, international differences in productivity are key to price effects in this theory. In what follows we express our variables in deviations from a benchmark economy to account for the relative productivity term $\hat{\omega}$.

[7] $a > 0$ comes from a non-negativity condition on costs. For $b > 0$ we must have $\theta < \frac{1}{2}\frac{1-\tau^{-2s}}{1-\tau^{-s}\omega^{-s}}$.

The system (S) is singular, as costs and markups are proportional and thus respond identically to changes in import shares and/or productivity.[8] But in the data, a plethora of factors will drive a wedge between costs and markups across sectors and countries, ranging from measurement error to competition policy. It is these wedges that we use in our estimation to help identify, through appropriate instrumentation, the differential impact of openness on markups and productivity.

3 Estimation and Methodology

In this Section, we introduce our estimation strategy. First, we use our theory to motivate our specifications, and introduce our single and simultaneous equations frameworks. Second, we tackle endogeneity issues. Third we discuss dynamics.

3.1 The Setup

The main aim of our estimation is to identify and quantify the supply response of prices to openness. These supply effects are reflected in differences between sectoral and aggregate inflation rates due to sector-specific developments such as firm entry or changes in trading costs. To identify these sectoral effects we rely on cross-sectional data but it is also important that we control for shifts in aggregate inflation due to changes in monetary policy. We therefore augment our system by including an explanatory variable m_t reflecting the influence of nominal phenomena that affect aggregate inflation (e.g. changes in central bank independence, changes in exchange rate regime, etc.). With this addition our system becomes

$$\begin{cases} \hat{p}^N_{ij,t} = \hat{c}_{ij,t} + \hat{\mu}_{ij,t} + \hat{m}_{j,t} \\ \hat{c}_{ij,t} = \gamma_c \, \hat{\omega}_{ij,t} + \delta_c \, \hat{\theta}_{ij,t} \\ \hat{\mu}_{ij,t} = \gamma_\mu \, \hat{\omega}_{ij,t} + \delta_\mu \, \hat{\theta}_{ij,t} \end{cases} \tag{S*}$$

where i indexes sectors, j indexes countries, t denotes the time period, and we have relaxed the constraint of proportionality between costs and markups.

[8] This is an artefact of the distributional assumptions necessary to solve the model. It also happens in Melitz (2003) or Ghironi and Melitz (2003).

$\hat{p}^N_{ij,t}$ is now an index of nominal sectoral prices, whose specification reflects two key assumptions. (i) Nominal variables only affect prices and not real variables such as costs and markups. The sectoral change in openness has only a transient impact on prices, lasting only as long as the import share rises. As always, in the long run "inflation is always and everywhere a monetary phenomenon". (ii) By definition, $\hat{m}_{j,t}$ reflects aggregate influences and so does not vary across sectors.[9] Embedded in $\hat{m}_{j,t}$ are a range of factors, including the link between aggregate inflation and openness that Romer (1993) stresses. However, the focus of this section is on the direct pro-competitive effects of openness on prices. The alternative effect of aggregate monetary policy on prices captured by $\hat{m}_{j,t}$ is exactly what our estimation is *not* about.

Estimating the price equation in (S*) requires further assumptions regarding average costs (c) and markups (μ). In our theoretical model average cost (c) depends only on labor productivity and openness but in reality numerous additional variables also play a role. We make the following assumptions in order to arrive at a price equation that can be estimated econometrically:

a) We allow for sector and country-specific intercepts (α^c_{ij}).
b) We assume costs change over time because of two trend effects: a time trend specific to each series in our cross-section, $\beta^c_{ij}\ t$, and a time-varying sector-specific factor, $\beta^c_{i,t}$. This is a generalization of the standard exchange rate pass-through literature, which assumes costs are given by time-invariant sector-specific trends common across countries (see Goldberg and Knetter (1997)). In contrast, we allow the trend in sectoral costs to differ across countries, *and* add time-varying sector effects.[10]
c) We allow for exchange rate pass-through effects arising from the changing cost of intermediate goods priced in foreign currency terms. As the relative importance of raw materials varies across sectors we allow this effect to be sector-specific, i.e. $\eta^c_i\ \ln E_{j,t}$.[11]
d) As suggested by theory we assume costs are decreasing in labor productivity $Z_{ij,t}$.

[9] It is possible that monetary policy has different effects across sectors. For instance, Gourinchas (1999) shows evidence that exchange rate movements affect sectors non-homogeneously - a phenomenon we control for by including sector-specific exchange rate effects in our analysis. For these sectoral differences in the impact of monetary policy to explain our results it would have to be the case that they systematically correlate with sector openness. However, the evidence (see Peersman and Smets (2002)) suggests durability or financial constraints are most important in explaining the differential effects of monetary policy across sectors, rather than openness.

[10] The most general specification possible would be to include time-varying effects specific to each individual observation, namely $\beta_{ij,t}$, but this would make identification impossible.

[11] $E_{j,t}$ is the nominal exchange rate between country j and one whose currency is customarily used to

e) Last but not least, unit costs depend on sector openness, as measured by the import share $\theta_{ij,t}$.

Given these assumptions we have

$$\ln c_{ij,t} = \alpha^c_{ij} + \beta^c_{ij}\ t + \beta^c_{i,t} + \eta^c_i\ \ln E_{j,t} + \gamma^c\ \ln Z_{ij,t} + \delta^c\ \ln \theta_{ij,t} \tag{7}$$

We assume analogous properties for markups $\mu_{ij,t}$, so that

$$\ln \mu_{ij,t} = \alpha^\mu_{ij} + \beta^\mu_{ij}\ t + \beta^\mu_{i,t} + \delta^\mu\ \ln \theta_{ij,t} \tag{8}$$

Given these assumptions on average costs, markups and aggregate nominal factors and introducing an error term ($u^p_{ij,t}$) our reduced form expression for prices becomes

$$\begin{aligned} \ln p^N_{ij,t} &= \left(\alpha^c_{ij} + \alpha^\mu_{ij}\right) + \left(\beta^c_{ij} + \beta^\mu_{ij}\right)\ t + \beta^c_{i,t} + \beta^\mu_{i,t} + \eta^c_i\ \ln E_{j,t} + m_{j,t} \\ &+ \gamma^c\ \ln Z_{ij,t} + (\delta^c + \delta^\mu)\ \ln \theta_{ij,t} + u^p_{ij,t} \end{aligned} \tag{9}$$

It is this equation that we use to identify the impact of openness on prices. We focus on changes in the logarithm of prices, which removes the intercepts $\alpha^c_{ij}+\alpha^\mu_{ij}$. We also include country and sector-specific effects to account for the presence of the trend $\left(\beta^c_{ij} + \beta^\mu_{ij}\right)\ t$. The time-varying, sector-specific term $\beta^c_{i,t}+\beta^\mu_{i,t}$ requires that equation (9) be estimated in deviations from a benchmark country, thus introducing a term in $\omega_{ij,t}$ instead of absolute labor productivity $Z_{ij,t}$.[12] Finally we control for $m_{j,t}$ using directly observable measures of changes in aggregate prices, based on fluctuations in CPI or PPI.[13]

Where we have information on markups, (8) becomes redundant, and we include our measure of markups directly in (9) i.e.

$$\ln p^N_{ij,t} = \alpha^c_{ij} + \beta^c_{ij}\ t + \beta^c_{i,t} + \eta^c_i\ \ln E_{j,t} + m_{j,t} + \nu\ \ln \mu_{ij,t} + \gamma^c\ \ln Z_{ij,t} + \delta^c\ \ln \theta_{ij,t} + u^p_{ij,t} \tag{10}$$

to which the same transformations are applied as in (9).[14]

invoice imports, particularly of raw materials. We used both the USD and Ecu rate, with no apparent changes. As our estimations are run in deviations from a benchmark country, Germany, the exchange rate term is in practice relative to the DM.

[12] We use Germany as our benchmark country although our results remain robust to alternatives.

[13] Alternatively, we used the nominal interest rate or country-specific trends with no significant difference to our results.

[14] In our model, productivity has an effect on markups, as the system (S*) makes clear. For simplicity, we omitted this possibility from our specification in equation (8). We later show that allowing for this dependence does not alter any of our results.

3.2 Simultaneous Estimations

The reduced form equations (9) and (10) enable us to estimate the *total* impact of openness on prices, but cannot inform how much of this effect works via higher productivity as against lower margins. To do this we need a simultaneous equations approach. We therefore estimate the following system

$$\begin{cases} \ln p^N_{ij,t} = \alpha^c_{ij} + \beta^c_{ij}\ t + \beta^c_{i,t} + \eta^c_i\ \ln E_{j,t} + m_{j,t} \\ \qquad\qquad +\nu \ln \mu_{ij,t} + \gamma^c\ \ln Z_{ij,t} + \delta^c\ \ln \theta_{ij,t} + u^p_{ij,t} \\ \ln Z_{ij,t} = \alpha^Z_{ij} + \beta^Z_{ij}\ t + \beta^Z_{i,t} + \delta^Z\ \ln \theta_{ij,t} + I_{ij,t} + u^Z_{ij,t} \\ \ln \mu_{ij,t} = \alpha^\mu_{ij} + \beta^\mu_{ij}\ t + \beta^\mu_{i,t} + \delta^\mu \ln \theta_{ij,t} + u^\mu_{ij,t} \end{cases} \tag{S**}$$

This is the reduced form version of (S*) but where we model productivity rather than costs due to the absence of data available for the latter. Our theoretical model implies that productivity is given by the inverse of unit costs and so it should also depend on openness, as reflected by δ^Z in the system (S**). Because costs in our model depend negatively on openness our expectation is that $\delta^Z > 0$. We also replicate for productivity the various assumptions we made on costs regarding sector-specific fixed effects and trends. $I_{ij,t}$ is a vector of additional explanatory variables that affect only productivity and not prices nor markups and which we list in more detail below.

The system (S**) allows prices to depend on openness, productivity, and markups but by separately modelling productivity and markups we can identify the channels through which openness affects prices. The coefficients of interest are δ^Z, δ^μ and δ^c. δ^Z captures whether openness has any independent effect on firms' productivity, and δ^μ quantifies the response of markups, i.e. a pure pro-competitive effect. δ^c denotes any residual effect of openness on prices that does not work via productivity or markups. The third equation is omitted when we do not observe markups directly.[15]

3.3 Endogeneity and Instrumentation

A potential problem pervading our estimation strategy is the endogeneity of openness. However in theory, most of the endogeneity biases work against a negative relationship

[15] As before, for the sake of brevity we do not allow for markups to depend on productivity. Our results are virtually unchanged when we do.

between openness and prices (or a positive one between openness and productivity). For instance, consumers faced by high priced domestic goods will respond by buying imports, which leads to a *positive* bias in estimating how openness affects prices. As for the relationship between openness and productivity, sectors with high productivity increase their imports of intermediate goods, which potentially leads to a spurious correlation between imports and productivity. However, our use of import shares overcomes this problem as by definition productivity shocks produce a larger increase in gross output than in intermediate inputs, since value-added increases. Therefore higher productivity should be associated with a *falling* import share in this context - a bias against the implications of our model.

A potentially damaging bias remains, and it stems from the political economy of protectionism. There is a possibility that less competitive firms with low productivity will lobby for protection. As a result, we would see low imports in low productivity and high markup sectors, potentially generating a negative bias in our estimates. However, as protectionism against EU imports is illegal amongst EU members (but not against non-EU imports) we can control for this bias by estimating our equations using only intra-EU trade measures of openness.

Most importantly, we deal with all endogeneity problems through instrumental variable estimation. We first instrument import shares with a measure of the "bulkiness" of the goods imported.[16] While cross-sectional variation in imports is affected by their weight, it is unclear how bulkiness could affect sector productivity or competitiveness. Second, we build on the large literature explaining trade flows with so called "gravity" variables. We use the output share of sector i in country j (y_{ij}/Y_j), relative to a weighted average of output shares for the same sector in all other countries, where weights are given by geographic distance. In particular, we compute

$$Gravity_{ij,t} = \frac{y_{ij,t}/Y_{j,t}}{\sum_{k\neq j} \varpi_{jk} \; y_{ik,t}/Y_{k,t}}$$

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 relatively smaller in country j, (ii) country k is relatively

[16] The measure is the ratio of the imports weight (in tons) to their value. This approach follows Hummels (2001).

close.[17] In other words, low values of $Gravity_{ij,t}$ lead to a higher import share.

Our third instrument uses sectoral information on transport costs. Our trade data reports both intra-EU bilateral import and export flows, whose ratio gives an indication of transport costs, as the former include "Costs, Insurance and Freight", whereas the latter are typically registered "Free On Board". To minimize measurement error, we follow Harrigan (1993) and interact a sectoral average of these ratios with each country's aggregate import shares. In other words, we obtain sector-specific (and time-varying) measures of transport costs, which we interact with measures of each country's time path of aggregate imports. Taken together, these three instruments explain approximately 40 percent of the variation in import shares, $\theta_{ij,t}$. When we estimate our system using 3SLS we also include an equation for openness utilizing these instruments as explanatory variables and make the same assumptions regarding fixed effects and time trends as in equations (7) and (8).

Estimation of the system (S**) requires instruments for productivity, $I_{ij,t}$. We construct two variables. First, an average measure of firm size at the sectoral level, given by the ratio of sectoral employment to the number of firms. Increasing returns to scale would suggest a positive effect of firm size on productivity, whereas diffusion or congestion effects predict a negative sign. Either way firm size could be used as a potential instrument. Second, we use an interaction term between aggregate and sectoral spending in Research and Development. There is a lack of data for most countries on sectoral R&D and so we use Spanish shares of R&D spending in sectoral value-added, and interact them with aggregate R&D spending as a proportion of GDP in each of our countries to construct a proxy.[18] Taken together, these two instruments explain around 30 percent of our cross-section in productivity, $Z_{ij,t}$.[19]

[17] 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.

[18] We choose Spain because it has the maximal uninterrupted coverage of R&D data in our sample and helps preserve our degrees of freedom. Choosing an alternative sectoral benchmark does not change our results.

[19] We experimented with additional instruments for sectoral productivity i.e. a measure of sectoral capital shares interacted with aggregate capital accumulation. However, this variable was collinear with our sectoral R&D measure and did not substantially increase the instruments' explanatory power.

3.4 Dynamics

So far we have abstracted from dynamics by implicitly assuming long run relationships hold every period. To allow for adjustment dynamics we include Error Correction terms so that our system becomes

$$A(L)\Delta Y_t = B(L)\Delta X_t + \phi Y_t + u_t$$

where $Y_t = [\Delta \ln p_t^N, \Delta \ln Z_t, \Delta \ln \mu_t, \Delta \ln \theta_t]'$, X_t is a vector of exogenous variables (e.g. monetary policy, R&D, capital intensity, etc.), ϕ encapsulates the long run relationships between all variables and u_t is a vector of white noise residuals. The advantage of introducing Error Correction terms in our analysis is that it enables us to distinguish between short and long run elasticities for the effects of openness as well as dealing with any putative non-stationarity in the data.[20] However, our findings are entirely robust to their inclusion as revealed in our single equation estimates where we later quote both sets of results. Finally, we further account for the possibility that prices adjust sluggishly by including lags of the dependent variable. The presence of lagged dependent variables creates a well known bias which we correct where relevant by using the Arellano and Bond (1991) GMM estimator.

4 Data

We utilize two datasets to investigate the impact of openness on prices and productivity. Both focus on EU manufacturing but differ in their coverage. The most comprehensive dataset involves eight countries and twenty-one industries for the period 1988-2000 and enables us to focus on the effect of increased import share on sector level pricing and productivity. Our second dataset includes information on costs that enables us to extend our analysis to consider markups. The availability of cost and markup information for several sectors and countries is to our knowledge unprecedented, and thus interesting in its own right. This dataset includes only seven countries and ten (coarser) sectors over the period 1989-1999.

[20] Including Error Correction terms is also standard in the pass-through literature. Our short sample period means that the size and power of panel unit root tests will be far from satisfactory. Applying unit root tests to the data reveals some evidence for non-stationarity, but it is not unambiguous across sectors and countries.

4.1 Sample Without Markups

The key source for our data is Eurostat, the Statistical Office of the European Commission. The main variables of interest are domestic manufacturing production prices, as measured by factory gate prices in national currency. Price indices are available for most European Union countries between 1980 and 2001, and disaggregated at the two-digit NACE (revision 1) level.[21] 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.[22]

As our measure of openness we use import shares, defined as the ratio of imports to total turnover (defined as production less change in inventories). We use turnover rather than output to define import share as we wish to focus on imports relative to domestic consumption, as suggested by our model. We use import share rather than any empirical counterparts to τ in the belief that it is more reliably measured and certainly more readily available than other alternatives. For instance, it would be virtually impossible to achieve our sectoral coverage if we used instead measures of tariffs, trade costs or the number of foreign firms. Furthermore, our theoretical analysis suggests that import share is a sufficient statistic for the channels through which changes in τ operate. Our measure of openness is therefore to be interpreted as reflecting *any* factor which changes the level of foreign competition in a sector, irrespective of the source for that change. This broad interpretation means we are unable to attribute the competitive impact of openness to its ultimate causes, e.g. lower trade barriers or transportation costs but with the benefit that we alleviate the effect of significant measurement errors.

We calculate sectoral productivity using the OECD STAN database, with information at the ISIC (revision 3) level, equivalent to the two-digit NACE (revision 1) classification. Real labor productivity is obtained by deflating value-added by sectoral price indices, and

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

[22] In 1992, Eurostat stopped using information for customs to gather its trade data, as the Single Market came into effect. We account for the resulting jump in the trade measures by always including a dummy variable for the year 1992 in our estimations.

dividing by total employment (in persons), also taken from the OECD STAN database. To control for changes in aggregate monetary policy and their impact on manufacturing prices we include changes in the national Consumer Price Index published in OECD Economic Outlook (also normalized to 100 in 1995) as an explanatory variable. Data on Research and Development expenditures for the manufacturing sector are available (at ISIC revision 3 aggregation level and in millions of national currency units) from the OECD Analytical Business Enterprise Research and Development database. R&D intensity is then computed at both the sectoral and national level as expenditure expressed as a percentage of value-added. Average firm size in each sector is defined as the ratio of total employment to the number of establishments, where the latter comes from the OECD Industrial Structure database. Finally, 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 national currency). Bilateral distances (in kilometers) are calculated based on the "great circle distance" formula due to Fitzpatrick and Modlin (1986). Combining all data constraints, the sample includes eight countries and a total of twenty-one different industries between 1988-2000. The sample is unbalanced across industries, with eleven industries in Belgium, twenty-one in Germany, twenty in Denmark, fifteen in Spain, fourteen in Italy, eight in France, thirteen in the Netherlands and five in the United Kingdom, for a total of 1,391 observations.

Table 1 shows summary statistics for our key variables, aggregating across both sectors and countries. Focusing on cross-country variation shows modest levels of average inflation (between 0.6 and 2.5 percent) but substantial time variation (from -17 to 31 percent). All countries show large levels of openness, as well as considerable variation. Productivity levels also display substantial variation. Sectoral patterns show most sectors experienced nominal prices increases in our sample, with the exception of Office Machinery and Radio and Television. The least open sector is Tobacco (mean import share of 2.9 percent) and the most open is Office Machinery with an import share of 407 percent. Productivity is lowest in Wearing Apparel and highest in Tobacco. With such large variations in sectoral price inflation we have a number of significant outliers. For robustness purposes we experimented with a wider range of outlier exclusion criteria with little difference in the economic importance of our results and relatively minor variations in statistical significance.[23] In presenting our econometric results we focus on

[23] The main variation pertained to the effect of openness on productivity in our 3SLS system, which varied in magnitude and sometimes in significance according to sampling.

a central case where we exclude series with inflation rates larger than 12 percent during a single year. This leads to truncating approximately 8 percent of the data. However, when presenting stylized facts in tables and charts we show the full dataset.

4.2 Sample With Markups

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.[24] Accounts are harmonized through a common layout for balance sheets, profit and loss accounts, statements of investments and statements of depreciation. For most countries, data are available annually over the period 1980-2002 and are broken down by major sector and firm size. Unfortunately data for the UK are absent so that our focus is restricted to seven European countries, namely Belgium, Denmark, France, Germany, Italy, the Netherlands and Spain. BACH reports information for ten manufacturing sectors. For comparability with the BACH data, the two- and three-digit NACE (revision 1) industries used in the previous section need to be aggregated, and we report the mapping in the Appendix. The value of exports and imports, together with their tonnage, are aggregated across NACE industries into their BACH equivalent. Price indices at the BACH level are computed as a weighted average of NACE (revision 1) indices, where the weights are given by the average share of NACE sector output in GDP over the period.[25]

To compute markups across sectors i, countries j and years t, one would ideally need data on prices and marginal costs. Absent any direct information on marginal costs, an

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

[25] By using constant weights we may be creating a "substitution" bias in our inflation measure. Subsectors with falling prices should experience a rising output share if substitution occurs, and we may be overestimating inflation. If relatively closed sectors have greater substitutability between varieties then this may explain our findings that openness leads to lower inflation. We believe this to be unlikely. Firstly, this bias arises only in our small sample analysis but our results are common to both datasets. Secondly, differences in substitutability at the sectoral level should be picked up by our sector-specific fixed effects. Thirdly, it would seem intuitively plausible that those sectors with greater levels of imports would experience greater substitutability due to greater product variety. In this case the bias goes against finding our results.

approximation can be obtained using average unit costs and computing

$$\mu_{ij,t} = \left[\frac{turnover_{ij,t}}{total\ costs_{ij,t}}\right] = \left[\frac{unit\ price_{ij,t}}{unit\ cost_{ij,t}}\right]$$

Following EU practice, total costs are computed as the sum of variable costs (costs of materials, consumables and staff costs), fixed costs (depreciation on intangible and tangible assets and interest paid on financial debts) and other operating charges and taxes. We then subtract other operating income, which includes the subsidies received by enterprises, and the variation in stocks of finished goods and work in progress.

Labor productivity is again calculated as the ratio between value-added, deflated by sectoral price indices, 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. Other variables are taken from the same sources as for the large sample, except for the number of firms and the value of total turnover which are available directly from the BACH dataset. The sample, including information on inflation, openness, productivity and markups, contains seven countries over the period 1989-1999. We observe five sectors in Belgium, Denmark and the Netherlands, eight in Germany, seven in Spain and four in France and in Italy, for a total of 418 observations.

Given the importance of markups to our analysis and the originality of this dataset, it is useful to describe the data in more detail. Table 2 reports average markups and extrema across countries and sectors. In our sectors (and averaging across countries), markups vary from 1 percent in Metals to 8.2 percent in Non-Metallic Minerals. The lowest recorded markup is -9.2 percent, while the highest is 21.8 percent. Across countries (and averaging across sectors), the lowest average markups are in Belgium (1.3 percent) while the highest are in the Netherlands (8 percent). Table 3 details unconditional correlations between markups and import shares. The correlations are reported based on both the levels and growth rates. In most cases (and on average), import shares and markups tend to correlate negatively - both in levels and, more weakly, in growth rates. This is consistent with our conjecture that openness comes with pro-competitive effects.

Figures 1, 2 and 3 focus on these cross-sections.[26] In Figure 1, we plot for each sector the total sample period change in import share against the logarithmic change in sector

[26] To conserve space we omit similar Figures for our large sample - these are available upon request. Because we only have data for one country for Sector 221 we omit this sector from these cross-country plots. The sector is however included in our estimation results.

prices. To allow for differences in monetary policy across countries we focus on relative prices by subtracting national CPI inflation from each sectoral inflation measure. Figure 2 shows the same sectors and countries, but plots the relation between changes in import share and logarithmic changes in labor productivity. Finally Figure 3 shows the relation between changes in import shares and the change in the markup. These Figures display unconditional, univariate relations only and make no allowance for sector or country specific fixed effects. Even with these limitations the data suggest that increases in openness are correlated with lower rates of sectoral inflation, higher rates of productivity growth and falling markups. We now turn to whether these effects can be detected in a more rigorous and robust econometric setting.

5 Main Results

We first focus on our large sample, and then discuss the role of markups in explaining price behavior using our reduced sample. In each case, we first present single equation estimates before turning to simultaneous equation results.

5.1 Large Sample

5.1.1 Single Equation Estimates

Table 4 reports results for our single equation approach. First and foremost, estimates for δ (the impact of openness on sectoral inflation) are *always* significant and negative, across *all* specifications. In the first two specifications, we do not include any Error Correction terms or lagged dependent variables. Column (2) introduces our instruments for import shares, and as expected from our discussion of endogeneity bias, estimates of δ increase in magnitude. The same results obtain when we add Error Correction terms and lagged dependent variables, as seen when comparing columns (3) and (4). Openness has a negative effect on prices both in the short term (which tends to be larger in magnitude), and at longer horizons. It is also worth noticing the strong correlation between sectoral price indices and the CPI.[27] Productivity growth enters with a negative and significant

[27] A potential endogeneity bias exists as our endogenous variable, sectoral inflation, is a component of an explanatory variable, aggregate inflation. However, given the limited and declining size of manufacturing,

sign at both horizons, as we would expect if it approximates for decreasing production costs.

Columns (5) to (8) use a GMM estimator, which is appropriate in the presence of first-differenced lagged dependent variables. These show similar results, whether or not Error Correction terms are included. These single equation results unambiguously suggest that sectors which experience rising import shares see their relative prices fall. The effect operates over and above the possibility that it be caused by increased productivity growth or any influence of openness on aggregate monetary policy.

5.1.2 Simultaneous Equations

Table 5 documents 3SLS estimates of the system (S**) and attempts to decompose δ, the effect of openness on inflation, into δ^c, δ^μ and δ^Z, i.e. any *direct* effect of openness on prices plus the effects operating through changes in markups and productivity, respectively. Our large sample does not contain data on markups so in this section we can only estimate δ^c and δ^Z. A first pass towards answering this question is given by a comparison between specifications (1) and (2), where the former omits the openness variable. The direct effect of productivity on prices is estimated to be much larger when openness is absent, suggesting that a prominent reason why productivity is growing fast is the exposure of the sector to foreign imports.

Specification (2) introduces import shares, and in particular lets productivity depend on openness. As before, we instrument openness using weight-to-value ratios, our distance and transport costs based variables, along with lagged values of openness itself. In addition, we instrument productivity with $I_{ij,t}$. The main lesson in the Table is the high significance of δ^Z - the effect of openness on productivity. Increased import penetration enhances productivity growth, both in the short and the long run. However, a substantial direct channel still exists as shown by significant estimates of δ^c.

Table 6 summarizes our various estimation results by calculating short and long run elasticities for openness and productivity on prices and for the effect of openness

and the fact our data is only for a sub-sector of whole manufacturing, this is not a serious problem. Further, all our results obtain if $m_{j,t}$ is proxied with PPI, nominal interest rates, or simply country-specific trends.

on productivity. In all cases, we report the estimates corresponding to the full set of instruments. The first two columns show estimates of the partial elasticities from each equation in the system. The final column shows the indirect elasticity of prices to openness operating through the productivity effect (i.e. γ^c multiplied by δ^Z).

The long run elasticities all exceed those in the short run, suggesting the impact of openness accumulates over time. This accumulation is particularly dramatic for the impact of openness on productivity. In both the single equation and 3SLS estimates the relative importance of productivity on prices increases in the long run compared to the direct effect of openness. This suggests a dynamic pattern where the long run impact of openness mainly operates through changes in productivity and truncation or diffusion effects as firms exit or learn by importing. By contrast, in the short run there is a more substantial role for direct effects of openness on prices. A natural candidate to account for these direct effects are changes in markups - an issue we can investigate with our second dataset.

5.2 Markup Data

5.2.1 Single Equation Estimates

We first verify that our previous results hold using this reduced dataset by excluding markups from our estimations. Table 7 suggests they do, albeit with a slight decrease in significance. Table 8 introduces markups into our analysis. Several comments are in order. First, markups affect prices positively in almost all cases, both in the short and the long run. The coefficient on productivity continues to be negative at all horizons, while that on CPI is positive and significant everywhere. The direct impact of openness however is no longer significant once we include *both* markups and productivity. In the notation of system (S**) we find estimates of δ^c to be insignificant. This supports the view that the effect of import penetration on prices works either via heightened productivity, or via sharpened competition and lower markups. In order to quantify the relative magnitude of these two channels we need to move away from single equation estimation and to a systems setting.

5.2.2 Simultaneous Equations

Table 9 presents 3SLS estimates that disentangle the channels through which openness affects prices, including now an equation for markups. Columns (1) and (2) report results where openness is omitted. As before productivity is instrumented by $I_{ij,t}$, and increases in productivity serve to lower price increases, whether markups are included or not. Markups, in turn, act to increase prices. Column (3) adds openness and reveals that a large part of the measured effect of productivity on prices appears to work via openness, with estimates for γ^c significantly lower in specification (3) relative to (1). Confirming this result is the finding that δ^Z is significantly positive - increased openness raises productivity.

Column (4) confirms our single equation results that when we allow directly for markups (along with the possibility they depend on openness) we achieve non-significant estimates for δ^c. Openness ceases to have a direct significant effect on inflation. The impact of openness now works exclusively via both productivity ($\gamma^c < 0$ and $\delta^Z > 0$) and markups ($\nu > 0$ and $\delta^\mu < 0$). Openness matters for prices because it increases productivity growth and lowers markups. In column (5), we verify our conclusions hold when openness is actually omitted from the price equation. The final column allows for a further interaction between our endogenous variables. Our theoretical model of Section 2 suggests that markups may depend upon productivity. Column (6) extends our system to allow for this and finds no long run relationship but a short term positive effect of productivity growth on markups. However the rest of our results remain robust to this additional interaction.

Table 10 recomputes the various short and long run elasticities of interest using these results. The first column focuses on single equation estimates and suggests that productivity and markups exert both short and long run effects on prices, with the expected signs and with no significant residual effects on prices from openness. 3SLS confirm these results for the price equation. They also reveal a very large long run elasticity of openness on productivity of approximately 1.6 - around eight times higher than the short run impact. This result confirms the possibility that exit and bankruptcies occur sluggishly in the data, thus increasing average sectoral productivity only slowly as exit occurs gradually. Conversely the short run effect of openness on markups exceeds its long run impact. This is consistent with a short run response to greater openness in which less competitive firms do not immediately exit and competitive pressures increase, leading to a large fall in markups. However, as domestic firms begin to exit (an issue we investigate empirically in the next section), competition reduces compared to its initial intensity and markups recover slightly. However, markups remain on balance lower than before the increase in openness. The final column of Table 10 shows the impact of openness on prices operating through the induced changes in productivity and markups. Whilst both channels are important there is a relatively greater role for productivity compared to markups and both factors show a much larger long run response than their short run impact.

6 Extensions and Robustness

In this Section, we extend our results to consider how openness affects market structure and how the origin of imports affects the impact of openness. First, we investigate whether market structure, as measured by firm dynamics, is affected by openness in a way consistent with our general conclusions and our theory. Second, we examine non-linearities such that the impact of openness depends on the initial level of competition. We also explore whether the origin of imports influences the impact of openness. Finally we close with some robustness checks, meant to ensure our conclusions are not driven by alternative explanations.

6.1 Market Structure

In our theoretical model, prices, productivity and markups all respond to openness-induced changes in market structure. So far, we have subsumed these changes into our measured import shares. We now explore whether firm dynamics are related in any systematic manner to our measure of openness. Our data contain information on the number of domestically producing firms per sector, and so we are able to track changes in both the average size and the number of producing firms. We measure firm size using both average employment and average value-added per firm. Our theory suggests a rising import share should lower the number of (domestic) firms N_E (as the least productive firms exit), while raising average value-added per firm. Average employment per firm is indeterminate from the perspective of our theory, in the absence of any prediction regarding the fate of displaced workers.[28]

Since our purpose here is only to examine the relationship between firm dynamics and openness, we limit ourselves to single equation bivariate specifications, regressing our two measures of firm size, and the number of firms, on import penetration. As in the previous section our estimations are in first differences expressed as deviations from a benchmark country and using country and sector intercepts. We also allow for sluggish adjustment in market structure by including a lagged dependent variable. In other words, we estimate

$$\ln F_{ij,t} = \alpha_{ij}^F + \beta_{ij}^F \ t + \beta_{i,t}^F + \gamma^F \ \ln F_{ij,t-1} + \delta^F \ \ln \theta_{ij,t} + u_{ij,t}^F$$

where $F_{ij,t}$ denotes one of our measures of market structure.

For the sake of brevity Table 11 only reports OLS estimates, but GMM results that control for the lagged dependent variable bias are almost identical. In both our datasets we find that, in response to import penetration, the number of domestically producing firms falls significantly, and both value-added and employment per firm rise significantly. All coefficients are estimated with precision, at significance levels in excess of 1 percent. Openness increases competitive pressures through the entry of foreign firms. This increased competition leads to the exit of the more inefficient domestic firms and, as a result, to an increase in average productivity.

6.2 Non-Linearities

We next investigate potential non-linearities in the impact of openness. In particular we ask whether the initial level of competition affects the nature and magnitude of the channels between openness and prices. We use our markup data to split our samples according to the observed extent of competition. Intuitively it seems plausible that openness would have a greater effect in the least competitive sectors of the economy. We therefore partition our data around the sector with median markup in each country,

[28] If we assume a natural rate of unemployment and perfect labor mobility then employment per firm in the sector should rise.

so that "low competition" means above median markups.[29] The results are reported in Tables 12 and 13.

Table 12 presents our single equation results. $\theta^H_{ij,t}$ ($\theta^L_{ij,t}$) denotes observed import penetration in sectors with markups higher (lower) than the median. In all cases, the short term coefficient on $\theta^H_{ij,t}$ is significantly negative, whereas it is insignificant for $\theta^L_{ij,t}$. Openness exerts a downward pressure on prices, and particularly (perhaps exclusively) so in sectors with high markups, and thus presumably low competition to start with. The differences are less clear-cut for the long term coefficients, where estimates are not always significant. The data seem to support the view that import competition has its strongest effects in the presence of relatively large profit margins.

In Table 13, we perform an identical split on our data, but in the context of our system of simultaneous equations. Our previous results are confirmed regarding the channels through which openness impacts on prices and we find these competitive effects are strongest in initially high markup sectors. In contrast, the impact of openness on productivity is most prevalent in competitive sectors with low markups. These results suggest that exposure to foreign competition tends to lower markups in non competitive sectors, and improve productivity in competitive ones.

6.3 The Origin of Imports

Our theoretical model suggests that the greater the degree of substitutability between domestic production and imports the greater the competitive pressures exerted by openness. Given data limitations it is impossible to control for the type or quality of the good being imported but we can control for the origin of imports. Since our sample of importing countries is focused on European economies, it is natural to assume that imports originating from other rich, European economies will tend to be closer in nature and in quality than imports from other regions and should thus trigger more of an effect on prices, productivity and markups.[30]

[29] Our estimates are obtained in deviations from country and sector averages, which is why we partition our data according to sector medians. A partition over all individual observations would be incompatible with our estimation strategy, which expresses all variables, for each sector, in deviations from a benchmark country.

[30] Non-EU imports will include both Japan and the US as well as non-OECD nations. This is only an imperfect proxy for import quality.

In Table 14, we partition our import data into two variables according to whether imports originate from EU12 ($\theta^{eu}_{ij,t}$), or from elsewhere ($\theta^{neu}_{ij,t}$). The results suggest that the impact of EU imports is substantially larger than that from non-EU imports, the latter frequently being insignificant. This finding is consistent with the possibility that goods imported from the EU are closer substitutes to domestic European goods either due to their characteristics or due to the greater trade freedom between EU nations.

6.4 Robustness

A wide range of robustness checks have already been mentioned (*inter alia*, alternative controls for monetary policy, alternative instruments and estimators, single equation and 3SLS, allowing for ECMs and lagged dependent variables and a different benchmark country). We now focus on one important alternative mechanism whereby openness can induce higher productivity and thus affect prices. 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. Therefore according to Heckscher-Ohlin we should see systematically rising import shares and falling prices in a number of sectors with shrinking domestic production.

It should be noted that Heckscher-Ohlin cannot fully explain our small sample results using markup data as it has no implication for firm's price margins, nor on market structure. In addition, when we control for factor endowments our conclusions remain unchanged. In particular, we augment our specifications with an interaction term between aggregate capital accumulation and sectoral capital shares. If Heckscher-Ohlin is at the source of our results, openness should only matter inasmuch as it induces international specialization according to factor endowments, which the interaction term should capture. We implement the correction in both our single equation setup and in 3SLS. In the latter case we allow both prices and productivity to depend on factor endowments.

Table 15 reports single equation results for both samples, while Table 16 presents estimates from our simultaneous equation system. In all cases, openness continues to affect prices significantly, with an effect comparable to our previous results. The interaction term we added to account for trade-induced specialization is sometimes significant, but the continued significance of our openness term even when controlling for these sector endowment effects suggests that Heckscher-Ohlin cannot explain our results.[31]

7 The Macroeconomic Impact of Import Competition

We now use our empirical results to assess the impact of greater openness on European inflation and productivity growth in the 1990s. We take at face value our estimates and aggregate across sectors to calculate the effect of openness on markups, productivity and inflation in European manufacturing. We are also able to calculate the *indirect* effect on inflation through changes in monetary policy. In particular, we use our estimate of the decline in markups in a standard model of imperfect competition and evaluate the change in the inflation bias brought about by the economy moving closer to its first-best level. In other words, we use manufacturing data to quantify Rogoff's (2003) conjecture.

7.1 Impact on Markups and Productivity

Table 17 uses our estimated elasticities to calculate the implied response of markups to changes in openness. The first column shows the average level of markups in each country generated by our estimated long run relationships (specifically Table 9 specification (5)) evaluated at initial period values for productivity and openness. The second column reports the level of markups after one year, in response to an increase in openness equal to the average change observed for each sector in our sample, while the third column reports the implied markup level after ten years. The final column shows the level of markups in the country, given the *total* change in openness observed over our entire sample period, and allowing our estimated long run dynamics to operate. The final row in the Table contains a weighted average across all seven countries, where weights are given by each country's GDP. From hereon we shall refer to this as the European average.

The estimated impact of openness on markups varies across countries, as not all countries have experienced a similar increase in openness. After one year, markups fall and then recover somewhat after ten years, although still remaining below their initial

[31] Bernard, Jensen and Schott (2004) show that firm dynamics are affected by factor endowments.

level.[32] This is consistent with the estimates on firm dynamics in the previous section. Initially there is a sharp increase in the number of firms as importers enter but with exit the number of firms declines and markups recover. Overall our results suggest that the observed average increase in openness has reduced European manufacturing markups from 5.9 to 4.3 percent.

Table 18 shows the same information, but for manufacturing productivity. The dynamic responses differ from that of markups. Now it is the initial response that is modest, but the effect cumulates over time. Again this is consistent with the view that productivity gains occur via slow truncation of the distribution of firms, with least productive entities withdrawing from the market, and confirms our conclusions in Section 6.1. Across the countries in our sample, the average productivity response to the observed changes in openness over our entire sample has produced an average 11.2 percent increase in productivity.

It is difficult to compare the economic magnitude of these results with those from previous studies. Most have tended to focus on specific periods of trade liberalization in emerging markets, using indicator variables to capture the onset of trade reform. By contrast we focus on European countries and a continual process of increased openness. However, even allowing for problems of comparability our results have a flavour similar to the existing literature. For instance, Harrison (1994) finds that trade liberalization affected profit margins and raised productivity in two out of nine sectors in the Ivory Coast. Krishna and Mitra (1998) show the 1991 trade liberalization in India lowered profit margins, and, in some sectors, increased productivity growth by as much as 3 to 6 percent. Pavcnik (2002) documents that Chilean exiting plants had productivity lower by as much as 8 percent relative to remaining ones. Ferreira and Rossi (2003) show that the Brazilian trade liberalization in 1988-1990 increased Total Factor Productivity by as much as 6 percent, and labor productivity by a comparable magnitude. Topalova (2004) contends that a fall of Indian tariffs by 10 percent translated into increased Total Factor Productivity by 0.5 percent. Finally, Trefler (2004) estimates that NAFTA and its associated decline in tariffs boosted long run labor productivity in Mexico by as much as 1 percent per year. Our estimates confirm that even outside the realm of dramatic changes in trade policy, openness has a significant effect on margins and productivity.

[32] An exception is Italy, where openness declines over our sample.

7.2 Direct Impact of Openness on Inflation

In this subsection we use our estimates to calculate the direct effect of greater openness on disinflation, assuming an unchanged monetary policy. That is we use observed sectoral changes in openness to calculate the effect on prices arising from (i) the effect of openness on markups ($\nu.\delta^{\mu}$), and (ii) the impact of openness on productivity ($\gamma^{c}.\delta^{Z}$). We label this the "direct" effect of openness on inflation, as opposed to the "indirect" effect we analyze in the next section, whereby changes in markups, caused by openness, affect monetary policy. Table 19 computes for each country the weighted average impact of the observed average annual change in import share on the price level through this direct channel. The price level is an aggregate across the sectors in our dataset where we use sample average sector shares in GDP as weights. As before we show the impact after both one and ten years.

In the short run (after one year) the impact of openness on prices operates almost equally through its effect on markups and productivity. The magnitude of both channels accumulates over time but in the long run the productivity channel is most important. However, the total impact is relatively small. The ten-year effect of the *average* annual observed change in import shares is a decrease of around 0.3 percent in EU manufacturing prices. The implied response to the *total* observed rise in import share over the whole sample is a decrease of around 2.3 percent in our index of European manufacturing prices. Focusing on EU averages, our results suggest that markups fell by around 1.6 percent (from 1.059 to 1.043), productivity rose by 11 percent, and prices fell by 2.3 percent in response to the observed increases in import shares.

On average the sectors in our dataset account for approximately 9 percent of GDP. We can therefore make a range of assumptions about how openness affects the remaining sectors of the economy in order to calculate lower and upper bounds for the direct impact of openness on EU disinflation. One limitation of our analysis is we have data only on domestic production so we can only calculate the impact on inflation as measured by the GDP deflator. Assuming increased openness leads to increased consumption of lower priced imports the impact of openness on consumer prices will be even greater than the effects we calculate with the GDP deflator. Assuming that no other sectors experienced heightened import competition, the impact on inflation for the EU from the within sample decline in openness is -0.14 percent (the one period effect) multiplied by 0.09 (the share of these sectors in GDP) or a rather minuscule -0.013 percent. If the whole of the merchandise producing sector (including that not represented in our data) experienced similar openness effects then the impact on annual inflation is -0.066 percent. If we assume the whole tradeable sector experiences a similar increase in openness then this direct effect on inflation becomes -0.108 percent.[33] This suggests that while openness has been important in influencing sector prices and industry productivity, the direct competitive effects of openness on overall prices and inflation has not been substantial.

7.3 Policy Induced Effects on Inflation

While the direct effects of openness on inflation may have been minor the effect of greater competition on the implementation of monetary policy may have been more substantial. Consider the case of a policymaker maximizing the following objective function

$$-\frac{1}{2}E_t\left\{\sum_{i=0}^{\infty}\beta^i[\alpha(x_{t+i}-k)^2+\pi_{t+i}^2]\right\}$$

where β is a discount factor, π is inflation and x is an output gap measure. Define x as $y_t - y_t^N$, where y_t is aggregate output and y_t^N denotes the "natural rate of output", or the level of output that would prevail under imperfect competition but flexible prices. In the presence of distortions, the government may target $k > 0$. Let y^* denote the first-best level of output that would obtain in the fully flexible perfectly competitive equilibrium. It is for instance possible that $k = y^* - y^N$, and the government will try and stabilize output around its optimal level y^*. Assume the supply side of the economy is governed by the standard New Keynesian Phillips Curve, described for instance in Clarida, Galí and Gertler (1999),

$$\pi_t = \lambda x_t + \beta E_t \pi_{t+1} + u_t$$

where u_t denotes stochastic disturbances.

Without commitment, the standard Barro-Gordon result obtains, and there is an inflationary bias (IB) equal to $\frac{\alpha}{\lambda}k$. The reduction in this inflationary bias, and the related literature on central bank independence, is a prominent explanation for the decline in inflation over the 1990s. However, if markups fall, then the gap between the first-best

[33] Using sectoral GDP shares in 1990 we define the merchandise sector as Agriculture, Mining, Quarrying, and Manufactures. The traded goods sector adds to this Financial Services, Insurance and Transport, Storage and Communication. On average merchandise accounts for 46.9 percent of GDP and tradeables for 76.9 percent.

outcome and the economy's natural rate (k) will have declined, and the inflation bias narrowed. In other words, increased competition is an additional factor that can help explain the observed fall in inflation.

Assume the only distortion in the economy originates from imperfect competition and the presence of markups. The natural rate will then depend on markups, e.g. $y^N(\mu_0)$. Assuming a constant elasticity of marginal cost with respect to output the proportional change in the inflationary bias in response to a change in markups from μ_0 to μ_1 is given by

$$\frac{IB(1) - IB(0)}{IB(0)} = \frac{y^N(\mu_0) - y^N(\mu_1)}{y^* - y^N(\mu_0)} = \frac{mc(\mu_0) - mc(\mu_1)}{mc^* - mc(\mu_0)}$$

where mc denotes real marginal cost, which also depends on the markup as it will influence the level of output.

Since in the aggregate economy we have $P = \mu.MC$ in nominal terms, or $1 = \mu.mc$ in real terms, the percentage fall in the inflation bias is given by

$$\frac{IB(1) - IB(0)}{IB(0)} = \frac{\frac{1}{\mu_0} - \frac{1}{\mu_1}}{1 - \frac{1}{\mu_0}}$$

According to our estimation results, because of an increase in EU openness markups declined such that $\mu_0 = 1.059$ and $\mu_1 = 1.043$. These values point to a reduction in the inflation bias of 26 percent i.e. $IB(1)/IB(0) = 0.74$. In other words, even in the absence of improvements in the institutional design of monetary policy, the response of markups to globalization predicts that inflation should fall by roughly a quarter. This calculation does however assume the reduction in markups experienced in the sectors we observe is representative of the rest of the economy. Since our data cover 9 percent of GDP, if we assumed that in the rest of the economy markups remained unchanged, the average economy-wide markup will decline in a proportionately smaller manner, and so would the implied fall in the inflation bias, i.e. 2.3 percent (0.09 of 26 percent). If the entire merchandise sector experienced a similar decline in markups from openness then the reduction in the inflation bias totals 12.1 percent. If we also assume that the tradeable service sector experiences a similar fall in markups then the reduction in the inflation bias is 20 percent. Of the two channels through which declining markups from increased openness affect inflation it would seem that the inflationary bias effect is by far the more substantial.

8 Conclusion

We present a theory where rising import shares affect prices via changes in productivity and in markups. We verify these implications in a sectoral dataset that enables us to abstract from aggregate influences on prices, and that contains information on markups. We find that increased openness, as measured by import shares, leads to lower prices. In the short run this effect is produced equally by falling markups and rising productivity but in the long run the productivity effect becomes relatively more important. Increased openness lowers markups sharply in the short run although the long run impact is less marked. Increased openness has a pronounced effect on productivity which cumulates to a large long run effect. This seems to happen as entry of foreign firms puts immediate pressure on profit margins, and induces slow exit of the least competitive domestic producers. We find that the pro-competitive effects of openness tend to be greater in sectors with low initial levels of competition and operate most strongly through intra-EU trade. Our results are robust across a range of alternative specifications and controls.

Overall we find that increased openness in the EU during the 1990s lowered markups from 5.9 to 4.3 percent, and increased productivity by 11 percent. Assuming unchanged monetary policy this fall in markups and rise in productivity should bring about a decline in aggregate inflation. Based on the sample of sectors that we examine we calculate this as accounting for a 0.136 percent fall in inflation. A more substantial contribution arises from the impact of lower markups on monetary policy and the extent of the inflation bias. We calculate that this effect of openness can possibly account for around a quarter of observed European disinflation.

Appendix

BACH sector groupings and correspondence with NACE (revision 1) industries

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

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Table 1: Large Sample – Summary Statistics

	Inflation (%)			Import Share (%)			Productivity (Ecus/worker)		
Country/Sector	Average	Min	Max	Average	Min	Max	Average	Min	Max
Belgium	1.2	-12.0	18.4	78.7	16.4	517.7	52,107	23,526	111,973
Germany	0.9	-7.2	10.3	39.0	1.7	177.7	44,879	16,595	143,511
Denmark	1.5	-16.9	13.4	113.9	0.5	1290.8	46,324	21,581	158,081
Spain	2.5	-11.6	30.9	37.5	3.8	165.5	34,530	13,065	62,764
France	0.6	-9.3	14.9	31.7	16.4	55.1	53,620	29,016	115,716
Italy	2.4	-10.0	24.1	30.5	5.0	191.0	40,571	19,227	76,245
Netherlands	0.9	-8.4	17.2	153.1	6.5	928.7	46,403	11,750	107,373
United Kingdom	2.3	-3.4	8.3	35.0	21.7	46.9	45,776	22,967	104,007
Food, beverages	0.5	-4.5	5.8	24.4	14.2	45.4	39,940	25,569	57,671
Tobacco	3.9	-4.2	11.2	2.9	0.5	8.0	110,241	45,149	158,081
Textiles	0.8	-3.9	6.8	58.4	12.0	137.4	34,537	21,017	50,821
Wearing apparel	1.6	-1.0	5.1	142.8	8.6	641.1	21,654	11,750	38,277
Tanning of leather	1.9	-1.8	5.9	127.5	7.8	517.7	28,167	16,595	47,772
Wood products	2.0	-3.0	8.1	41.6	12.4	109.0	31,814	20,458	48,529
Pulp, paper	1.9	-11.6	30.9	56.9	21.8	109.6	56,170	37,982	78,296
Publishing, printing	2.2	-3.6	10.4	9.6	3.1	25.8	39,533	26,849	63,830
Chemicals	1.5	-4.5	17.2	50.8	22.7	105.2	74,649	46,946	115,716
Rubber, plastics	1.4	-4.0	15.2	40.6	14.0	93.6	46,978	32,766	73,391
Non-metallic minerals	2.0	-1.5	7.4	20.6	5.6	50.3	47,422	32,947	64,306
Basic metals	0.7	-12.0	18.4	81.5	24.8	201.9	52,898	31,602	75,813
Fabricated metals	2.0	-2.8	7.9	21.8	5.0	48.4	35,720	23,495	52,124
Machinery, equipment	2.6	-0.2	7.6	45.3	13.4	110.9	39,545	28,883	50,358
Office machinery	-2.7	-16.9	13.4	407.2	49.2	1290.8	50,348	26,763	102,679
Electrical machinery	1.4	-2.1	6.5	38.4	10.8	90.6	45,607	29,576	66,495
Radio, television	-0.5	-4.9	5.0	82.9	43.7	176.8	42,684	22,564	71,114
Optical instruments	2.0	-5.1	8.0	69.2	23.7	165.5	37,002	25,244	60,152
Motor vehicles	2.2	0.0	9.1	120.7	15.2	348.2	46,179	36,096	62,628
Other transport	2.5	-0.2	7.4	52.5	35.8	89.2	34,869	19,663	59,191
Furniture	2.5	0.9	6.9	29.3	22.0	43.1	35,045	28,917	40,311

Note: To compute means across countries and sectors, productivity is converted to Ecus per worker.

Table 2: Small Sample – Summary Statistics

	Inflation (%)			Import Share (%)			Productivity (Ecus/worker)			Markups		
Country/Sector	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max
Belgium	0.5	-2.7	7.2	77.3	31.2	171.6	51,786	20,260	111,973	1.013	0.961	1.038
Germany	0.7	-3.4	6.0	72.6	25.7	305.3	44,661	20,942	76,681	1.026	0.969	1.065
Denmark	1.2	-9.5	18.0	7.3	2.3	21.6	39,143	24,788	54,367	1.072	1.037	1.131
Spain	2.2	-3.2	14.0	97.0	31.2	253.9	37,417	25,547	61,411	1.038	0.925	1.167
France	-0.6	-16.9	7.7	51.0	22.2	130.6	62,171	36,215	115,458	1.052	0.977	1.111
Italy	2.0	-7.1	16.4	46.9	23.2	102.6	53,828	32,119	76,245	1.016	0.908	1.068
Netherlands	0.7	-4.5	6.4	173.3	39.0	570.4	45,935	27,617	107,373	1.081	0.950	1.218
Metals	-1.8	-16.9	16.4	82.7	58.6	130.6	62,415	36,215	88,808	1.010	0.908	1.076
Non-Metallic Minerals	1.7	-9.5	18.0	30.4	3.3	62.9	45,693	34,245	60,448	1.082	0.995	1.167
Chemicals	0.6	-4.5	13.9	60.0	33.7	110.1	75,182	47,246	115,458	1.054	0.961	1.218
Machinery	2.8	1.3	5.8	209.3	183.4	253.9	29,830	28,113	32,821	1.011	0.936	1.060
Office Machinery	0.2	-1.6	2.7	113.4	35.0	249.9	43,280	29,620	58,731	1.026	0.950	1.122
Motor Vehicles and Transport	2.2	0.2	4.0	87.7	25.7	212.5	41,290	28,192	58,553	1.012	0.925	1.093
Food, Tobacco	0.7	-4.3	6.1	28.9	2.3	54.9	42,699	25,995	57,754	1.032	1.009	1.073
Textiles	0.6	-2.6	4.7	188.5	15.0	570.4	31,414	20,805	43,084	1.040	1.004	1.084
Wood, Paper and Printing	1.6	-2.3	14.0	45.1	4.7	86.0	40,410	30,834	61,110	1.050	0.998	1.156
Rubber Products, Furniture	1.6	-1.5	6.0	78.0	5.0	171.6	35,920	20,260	54,498	1.041	0.944	1.100

Note: To compute means across countries and sectors, productivity is converted to Ecus per worker.

Table 3: Small Sample – Cross Correlations between Markups and Import Share

Country/Sector	Levels	Growth Rates
All	-0.114	-0.045
Belgium	0.176	0.121
Germany	-0.053	0.227
Denmark	-0.182	-0.059
Spain	-0.268	-0.053
France	-0.279	0.349
Italy	-0.415	0.068
Netherlands	-0.419	-0.323
Metals	0.237	0.176
Non-Metallic Minerals	-0.255	0.082
Chemicals	-0.274	-0.069
Machinery	-0.304	-0.464
Office Machinery	0.487	-0.230
Motor Vehicles and Transport	0.500	0.110
Food, Tobacco	-0.649	0.166
Textiles	0.082	-0.445
Wood, Paper and Printing	0.113	-0.033
Rubber Products, Furniture	-0.597	0.003

Table 4: Large Sample – Single Equation Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS-IV	OLS	OLS-IV	GMM	GMM	GMM	GMM-IV
$\Delta \ln \theta_{ij,t}$	−0.012 (−2.35)	−0.048 (−3.08)	−0.020 (−3.89)	−0.068 (−4.46)	−0.010 (−1.63)	−0.025 (−5.04)	–	−0.028 (−5.37)
$\Delta \ln Z_{ij,t}$	−0.044 (−5.56)	−0.043 (−5.31)	−0.072 (−8.91)	−0.075 (−8.68)	−0.058 (−5.89)	−0.079 (−9.87)	−0.082 (−10.02)	−0.079 (−10.47)
$\Delta \ln cpi_{ij,t}$	0.360 (7.81)	0.335 (6.86)	0.335 (6.24)	0.296 (5.08)	0.236 (5.07)	0.353 (8.68)	0.379 (9.24)	0.321 (8.33)
$\ln \theta_{ij,t-1}$	–	–	−0.010 (−2.29)	−0.024 (−2.59)	–	−0.014 (−5.08)	–	−0.011 (−4.13)
$\ln Z_{ij,t-1}$	–	–	−0.056 (−7.58)	−0.065 (−7.78)	–	−0.046 (−9.51)	−0.040 (−8.50)	−0.040 (−8.63)
$\ln cpi_{ij,t-1}$	–	–	0.029 (1.08)	0.032 (1.11)	–	0.005 (0.31)	−0.003 (−0.19)	−0.008 (−0.52)
$\ln p_{ij,t-1}$	–	–	−0.256 (−11.83)	−0.275 (−11.58)	–	−0.227 (−16.71)	−0.211 (−15.63)	−0.198 (−15.11)
Obs.	900	900	825	825	675	825	825	825

Notes: Openness is total import share. All variables are in deviation from a benchmark country (Germany). Industry-specific bilateral exchange rates and country/industry fixed effects are included in all regressions. In (2) and (4) instruments for openness include weight-to-value, weighted distance, weighted cif/fob and 1992 dummy; in (8) lags on openness are also included. In (5) to (8), the number of lagged dependent variables is chosen in order to reject autocorrelation of order 2. There is one lagged dependent variable in (6), (7) and (8) and three in (5). t-statistics are reported between parentheses.

Table 5: Large Sample – Three-Stage Least Squares

Eq.: $\Delta \ln p_{ij,t}$	(1)	(2)
$\Delta \ln \theta_{ij,t}$	–	-0.072 (-7.01)
$\Delta \ln Z_{ij,t}$	-0.165 (-3.38)	-0.078 (-2.94)
$\Delta \ln cpi_{ij,t}$	0.397 (6.43)	0.311 (5.94)
$\ln \theta_{ij,t-1}$	–	-0.027 (-5.25)
$\ln Z_{ij,t-1}$	-0.078 (-3.58)	-0.066 (-4.97)
$\ln cpi_{ij,t-1}$	0.041 (1.55)	0.036 (1.43)
$\ln p_{ij,t-1}$	-0.264 (-10.36)	-0.274 (-12.23)
Eq.: $\Delta \ln Z_{ij,t}$		
$\Delta \ln \theta_{ij,t}$	–	0.095 (2.72)
$\Delta \ln rd_{ij,t}$	0.012 (1.62)	0.017 (2.23)
$\Delta \ln size_{ij,t}$	-0.027 (-3.59)	-0.033 (-4.18)
$\ln \theta_{ij,t-1}$	–	0.077 (3.44)
$\ln rd_{ij,t-1}$	0.003 (0.60)	0.003 (0.60)
$\ln size_{ij,t-1}$	-0.013 (-2.60)	-0.022 (-3.92)
$\ln Z_{ij,t-1}$	-0.030 (-3.62)	-0.052 (-4.88)
Eq.: $\Delta \ln \theta_{ij,t}$		
$\Delta \ln wv_{ij,t}$	–	-0.112 (-4.68)
$\Delta \ln D_{ij,t}$	–	-0.545 (-9.83)
$\Delta \ln cfob_{ij,t}$	–	-0.332 (-7.21)
$\ln wv_{ij,t-1}$	–	-0.140 (-8.43)
$\ln D_{ij,t-1}$	–	-0.173 (-4.97)
$\ln cfob_{ij,t-1}$	–	-0.151 (-2.77)
$\ln \theta_{ij,t-1}$	–	-0.327 (-12.61)
Obs.	825	825

Notes: Openness is total import share. All variables are in deviation from a benchmark country (Germany). Industry-specific bilateral exchange rates, country/industry fixed effects, lagged dependent variables and 1992 dummy are included (not reported). $wv_{ij,t}$ denotes weight-to-value, $D_{ij,t}$ denotes weighted distance, $cfob_{ij,t}$ denotes weighted cif/fob, $size_{ij,t}$ denotes average firm size and finally $rd_{ij,t}$ denotes our sectoral measure of R&D. t-statistics are reported between parentheses.

Table 6: Large Sample – Short Run and Long Run Elasticities

Table/Equation		(4)/(8)	(5)/(2)	
Method		GMM-IV	3SLS	
Eq. $\Delta \ln p_{ij,t}$		(1)	(2)	(3)
$\Delta \ln \theta_{ij,t}$	short run	-0.028*	-0.072*	–
	long run	-0.055*	-0.098*	–
$\Delta \ln Z_{ij,t}$	short run	-0.079*	-0.078*	-0.007*
	long run	-0.204*	-0.241*	-0.354*
Eq. $\Delta \ln Z_{ij,t}$				
$\Delta \ln \theta_{ij,t}$	short run	–	0.095*	–
	long run	–	1.468*	–

Notes: * denotes significant at 10% level. Column (3) reports the indirect effect of openness on prices operating through the productivity channel. The significance of this effect is obtained using the delta-method.

Table 7: Small Sample – Single Equation Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS-IV	OLS	OLS-IV	GMM	GMM	GMM	GMM-IV
$\Delta \ln \theta_{ij,t}$	−0.017 (−1.99)	−0.046 (−1.21)	−0.014 (−1.58)	−0.055 (−1.26)	−0.021 (−2.10)	−0.020 (−2.15)	–	−0.030 (−2.89)
$\Delta \ln Z_{ij,t}$	−0.008 (−0.41)	0.000 (0.02)	−0.026 (−1.40)	−0.020 (−0.82)	−0.008 (−0.37)	−0.020 (−0.94)	−0.030 (−1.72)	−0.008 (−0.49)
$\Delta \ln cpi_{ij,t}$	0.440 (5.20)	0.407 (4.18)	0.540 (4.98)	0.441 (3.14)	0.208 (2.72)	0.634 (5.34)	0.490 (5.43)	0.430 (4.76)
$\ln \theta_{ij,t-1}$	–	–	0.008 (0.79)	−0.043 (−1.06)	–	0.000 (0.06)	–	0.008 (1.00)
$\ln Z_{ij,t-1}$	–	–	−0.038 (−2.75)	−0.027 (−1.50)	–	−0.016 (−1.25)	−0.016 (−1.76)	−0.020 (−2.15)
$\ln cpi_{ij,t-1}$	–	–	0.047 (0.81)	0.079 (1.13)	–	0.343 (3.23)	0.034 (0.72)	0.038 (0.81)
$\ln p_{ij,t-1}$	–	–	−0.274 (−5.37)	−0.333 (−4.46)	–	−0.555 (−8.32)	−0.283 (−8.06)	−0.282 (−7.81)
Obs.	230	230	207	207	207	161	207	207

Notes: Openness is total import share. All variables are in deviation from a benchmark country (Germany). Industry-specific bilateral exchange rates and country/industry fixed effects are included in all regressions. In (2) and (4) instruments for openness include weight-to-value, weighted distance, weighted cif/fob and 1992 dummy; in (8) lags on openness are also included. In (5) to (8), the number of lagged dependent variables is chosen in order to reject autocorrelation of order 2. There is one lagged dependent variable in (5), (7) and (8) and three in (6). t-statistics are reported between parentheses.

Table 8: Small Sample – Single Equation Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS-IV	OLS	OLS-IV	GMM	GMM	GMM	GMM-IV
$\Delta \ln \theta_{ij,t}$	−0.012 (−1.47)	−0.037 (−0.96)	−0.007 (−0.82)	−0.034 (−0.71)	−0.014 (−1.34)	−0.010 (−1.10)	–	−0.021 (−1.57)
$\Delta \ln Z_{ij,t}$	−0.022 (−1.12)	−0.012 (−0.52)	−0.043 (−2.27)	−0.042 (−1.36)	−0.027 (−1.22)	−0.036 (−1.87)	−0.047 (−2.56)	−0.036 (−1.71)
$\Delta \ln \mu_{ij,t}$	0.126 (2.95)	0.104 (1.89)	0.148 (2.82)	0.144 (1.51)	0.140 (2.73)	0.115 (2.09)	0.144 (2.74)	0.110 (1.74)
$\Delta \ln cpi_{ij,t}$	0.532 (6.00)	0.488 (4.34)	0.644 (5.79)	0.555 (3.39)	0.328 (3.79)	0.605 (6.05)	0.617 (6.23)	0.749 (6.16)
$\ln \theta_{ij,t-1}$	–	–	0.010 (1.09)	−0.042 (−1.05)	–	0.011 (1.49)	–	0.004 (0.45)
$\ln Z_{ij,t-1}$	–	–	−0.043 (−3.12)	−0.029 (−1.57)	–	−0.029 (−2.90)	−0.024 (−2.52)	−0.034 (−2.81)
$\ln \mu_{ij,t-1}$	–	–	0.182 (3.35)	0.145 (1.77)	–	0.123 (2.74)	0.128 (2.92)	0.159 (2.58)
$\ln cpi_{ij,t-1}$	–	–	0.139 (2.20)	0.145 (2.09)	–	0.112 (2.15)	0.111 (2.10)	0.258 (3.08)
$\ln p_{ij,t-1}$	–	–	−0.351 (−6.38)	−0.378 (−5.73)	–	−0.329 (−8.53)	−0.324 (−8.37)	−0.423 (−7.74)
Obs.	230	230	207	207	207	207	207	184

Notes: Openness is total import share. All variables are in deviation from a benchmark country (Germany). Industry-specific bilateral exchange rates and country/industry fixed effects are included in all regressions. In (2) and (4) instruments for openness include weight-to-value, weighted distance, weighted cif/fob and 1992 dummy; in (8) lags on openness are also included. In (5) to (8), the number of lagged dependent variables is chosen in order to reject autocorrelation of order 2. There is one lagged dependent variable in (5), (6) and (7) and two in (8). t-statistics are reported between parentheses.

Table 9: Small Sample – Three-Stage Least Squares

Eq.: $\Delta \ln p_{ij,t}$	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \ln \theta_{ij,t}$	–	–	−0.067 (−3.22)	0.007 (0.26)	–	–
$\Delta \ln Z_{ij,t}$	−0.234 (−3.54)	−0.325 (−4.95)	−0.104 (−2.93)	−0.154 (−4.10)	−0.167 (−4.85)	−0.165 (−4.78)
$\Delta \ln \mu_{ij,t}$	–	0.264 (3.07)	–	0.240 (2.40)	0.249 (3.66)	0.266 (3.92)
$\Delta \ln cpi_{ij,t}$	0.576 (5.51)	0.766 (6.70)	0.466 (4.57)	0.702 (5.14)	0.689 (6.67)	0.683 (6.61)
$\ln \theta_{ij,t-1}$	–	–	−0.022 (−1.61)	0.011 (0.70)	–	–
$\ln Z_{ij,t-1}$	−0.066 (−2.94)	−0.083 (−3.73)	−0.050 (−3.27)	−0.059 (−3.92)	−0.058 (−3.91)	−0.057 (−3.83)
$\ln \mu_{ij,t-1}$	–	0.301 (4.17)	–	0.254 (3.08)	0.255 (4.29)	0.264 (4.45)
$\ln cpi_{ij,t-1}$	−0.036 (−0.57)	0.098 (1.45)	0.028 (0.51)	0.124 (2.01)	0.124 (2.06)	0.127 (2.11)
$\ln p_{ij,t-1}$	−0.253 (−5.30)	−0.390 (−6.90)	−0.313 (−6.16)	−0.368 (−7.16)	−0.376 (−7.36)	−0.379 (−7.42)
Eq.: $\Delta \ln Z_{ij,t}$						
$\Delta \ln \theta_{ij,t}$	–	–	0.223 (3.29)	0.182 (2.75)	0.183 (2.77)	0.220 (3.34)
$\Delta \ln rd_{ij,t}$	0.008 (0.53)	0.002 (0.15)	0.032 (1.99)	0.026 (1.68)	0.026 (1.66)	0.023 (1.50)
$\Delta \ln size_{ij,t}$	−0.020 (−2.24)	−0.020 (−2.17)	−0.043 (−4.09)	−0.035 (−3.40)	−0.036 (−3.44)	−0.053 (−5.09)
$\ln \theta_{ij,t-1}$	–	–	0.059 (1.39)	0.050 (1.19)	0.043 (1.06)	0.052 (1.27)
$\ln rd_{ij,t-1}$	−0.004 (−0.61)	−0.003 (−0.46)	−0.001 (−0.14)	−0.001 (−0.13)	−0.001 (−0.10)	−0.001 (−0.16)
$\ln size_{ij,t-1}$	−0.017 (−2.94)	−0.021 (−3.66)	−0.025 (−3.76)	−0.025 (−3.80)	−0.025 (−3.84)	−0.028 (−4.22)
$\ln Z_{ij,t-1}$	−0.015 (−2.09)	−0.017 (−2.37)	−0.033 (−2.64)	−0.031 (−2.58)	−0.030 (−2.51)	−0.034 (−2.77)
Eq.: $\Delta \ln \mu_{ij,t}$						
$\Delta \ln \theta_{ij,t}$	–	–	–	−0.125 (−6.50)	−0.125 (−6.49)	−0.131 (−6.09)
$\Delta \ln Z_{ij,t}$	–	–	–	–	–	0.143 (3.72)
$\ln \theta_{ij,t-1}$	–	–	–	−0.042 (−4.48)	−0.042 (−4.48)	−0.047 (−3.11)
$\ln Z_{ij,t-1}$	–	–	–	–	–	0.003 (0.81)
$\ln \mu_{ij,t-1}$	–	−0.464 (−7.98)	–	−0.573 (−9.24)	−0.573 (−9.24)	−0.585 (−9.75)
Eq.: $\Delta \ln \theta_{ij,t}$						
$\Delta \ln wv_{ij,t}$	–	–	−0.143 (−2.08)	−0.135 (−2.02)	−0.139 (−2.08)	−0.138 (−2.03)
$\Delta \ln D_{ij,t}$	–	–	−0.003 (−1.57)	−0.003 (−1.81)	−0.003 (−1.77)	−0.004 (−1.83)
$\Delta \ln cfob_{ij,t}$	–	–	0.013 (0.11)	−0.079 (−0.68)	−0.071 (−0.61)	−0.073 (−0.62)
$\ln wv_{ij,t-1}$	–	–	−0.171 (−2.58)	−0.166 (−2.56)	−0.170 (−2.63)	−0.173 (−2.64)
$\ln D_{ij,t-1}$	–	–	−0.001 (−0.58)	−0.000 (−0.21)	−0.000 (−0.23)	−0.000 (−0.31)
$\ln cfob_{ij,t-1}$	–	–	−0.133 (−1.09)	−0.170 (−1.43)	−0.177 (−1.49)	−0.165 (−1.37)
$\ln \theta_{ij,t-1}$	–	–	−0.422 (−6.16)	−0.382 (−5.71)	−0.385 (−5.76)	−0.400 (−5.87)
Obs.	207	207	207	207	207	207

Notes: Openness is total import share. All variables are in deviation from a benchmark country (Germany). Industry-specific bilateral exchange rates, country/industry fixed effects, lagged dependent variables and 1992 dummy are included (not reported). $wv_{ij,t}$ denotes weight-to-value, $D_{ij,t}$ denotes weighted distance, $cfob_{ij,t}$ denotes weighted cif/fob, $size_{ij,t}$ denotes average firm size and finally $rd_{ij,t}$ denotes our sectoral measure of R&D. t-statistics are reported between parentheses.

Table 10: Small Sample – Short Run and Long Run Elasticities

Table/Equation		(8)/(8)	(9)/(4)	
Method		GMM-IV	3SLS	
Eq. $\Delta \ln p_{ij,t}$		(1)	(2)	(3)
$\Delta \ln \theta_{ij,t}$	short run	-0.021	0.007	–
	long run	0.010	0.031	–
$\Delta \ln Z_{ij,t}$	short run	-0.036*	-0.167*	-0.058*
	long run	-0.080*	-0.160*	-0.304*
$\Delta \ln \mu_{ij,t}$	short run	0.110*	0.249*	-0.028*
	long run	0.376*	0.691*	-0.253
Eq. $\Delta \ln Z_{ij,t}$				
$\Delta \ln \theta_{ij,t}$	short run	–	0.182*	–
	long run	–	1.586*	–
Eq. $\Delta \ln \mu_{ij,t}$				
$\Delta \ln \theta_{ij,t}$	short run	–	-0.125*	–
	long run	–	-0.073*	–

Notes: * denotes significant at 10% level. Column (3) reports the indirect effect of openness on prices operating through the markup or the productivity channel. The significance of this effect is obtained using the delta-method.

Table 11: Market Structure (Large and Small Samples)

	Large Sample			Small Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Number of Firms	Average Firm Productivity	Average Firm Employment	Number of Firms	Average Firm Productivity	Average Firm Employment
$\Delta \ln \theta_{ij,t}$	-0.389	0.303	0.354	-0.906	0.942	0.898
	(-3.58)	(2.76)	(3.22)	(-3.41)	(3.57)	(3.38)
$\ln \theta_{ij,t-1}$	0.005	0.046	-0.030	0.165	-0.150	-0.120
	(0.06)	(0.56)	(-0.37)	(0.95)	(-0.87)	(-0.69)
$\Delta \ln F_{ij,t-1}$	-0.115	-0.120	-0.095	-0.112	-0.117	-0.133
	(-3.13)	(-3.24)	(-2.57)	(-1.54)	(-1.61)	(-1.82)
Obs.	825	825	825	207	207	207

Notes: Openness is total import share. All variables are in deviation from a benchmark country (Germany). Country/industry fixed effects are included in all regressions. t-statistics are reported between parentheses.

Table 12: Small Sample – Single Equation Estimates – 50th percentile

	(1)	(2)
	GMM	GMM-IV
$\Delta \ln \theta^H_{ij,t}$	−0.030 (−2.30)	−0.033 (−2.47)
$\Delta \ln \theta^L_{ij,t}$	0.013 (0.63)	0.008 (0.38)
$\Delta \ln Z_{ij,t}$	−0.027 (−1.01)	−0.003 (−0.10)
$\Delta \ln cpi_{ij,t}$	0.569 (3.25)	0.433 (2.40)
$\ln \theta^H_{ij,t-1}$	0.003 (0.22)	0.009 (0.58)
$\ln \theta^L_{ij,t-1}$	−0.037 (−1.42)	−0.048 (−1.75)
$\ln Z_{ij,t-1}$	−0.014 (−0.74)	0.004 (0.22)
$\ln cpi_{ij,t-1}$	0.586 (3.91)	0.442 (2.86)
$\ln p_{ij,t-1}$	−0.683 (−6.61)	−0.504 (−4.82)
p-value[1]	0.075	0.100
p-value[2]	0.169	0.067
Obs.	138	138

Notes: Openness is total import share. $\theta^H_{ij,t}$ ($\theta^L_{ij,t}$) denotes openness for high (low) markup sectors. All variables are in deviation from a benchmark country (Germany). Industry-specific bilateral exchange rates and country/industry fixed effects are included in all regressions. In (2) instruments for openness include weight-to-value, weighted distance, weighted cif/fob, 1992 dummy and lags on openness. The number of lagged dependent variables is chosen in order to reject autocorrelation of order 2. There are four lagged dependent variables in all regressions. t-statistics are reported between parentheses. p-value[1] (p-value[2]) is the probability associated with the hypothesis that $\Delta \ln \theta^H_{ij,t}$ and $\Delta \ln \theta^L_{ij,t}$ ($\ln \theta^H_{ij,t-1}$ and $\ln \theta^L_{ij,t-1}$) are equal.

Table 13: Small Sample – Three-Stage Least Squares – 50th percentile

Eq.: $\Delta \ln p_{ij,t}$	(1)	(2)
$\Delta \ln \theta^H_{ij,t}$	-0.084 (-3.54)	-0.006 (-0.20)
$\Delta \ln \theta^L_{ij,t}$	0.062 (1.70)	0.073 (2.11)
$\Delta \ln Z_{ij,t}$	-0.115 (-3.29)	-0.146 (-4.07)
$\Delta \ln \mu_{ij,t}$	–	0.221 (2.30)
$\Delta \ln cpi_{ij,t}$	0.471 (4.63)	0.699 (5.22)
$\ln \theta^H_{ij,t-1}$	-0.028 (-1.72)	0.011 (0.57)
$\ln \theta^L_{ij,t-1}$	-0.004 (-0.16)	0.004 (0.19)
$\ln Z_{ij,t-1}$	-0.048 (-3.14)	-0.055 (-3.70)
$\ln \mu_{ij,t-1}$	–	0.238 (2.98)
$\ln cpi_{ij,t-1}$	0.029 (0.51)	0.115 (1.87)
$\ln p_{ij,t-1}$	-0.322 (-6.34)	-0.367 (-7.16)
Eq.: $\Delta \ln Z_{ij,t}$		
$\Delta \ln \theta^H_{ij,t}$	0.032 (0.44)	-0.007 (-0.09)
$\Delta \ln \theta^L_{ij,t}$	0.740 (4.47)	0.656 (4.06)
$\Delta \ln rd_{ij,t}$	0.032 (1.98)	0.028 (1.76)
$\Delta \ln size_{ij,t}$	-0.037 (-3.57)	-0.030 (-2.90)
$\ln \theta^H_{ij,t-1}$	-0.031 (-0.63)	-0.042 (-0.87)
$\ln \theta^L_{ij,t-1}$	0.229 (2.68)	0.200 (2.39)
$\ln rd_{ij,t-1}$	0.003 (0.38)	0.003 (0.39)
$\ln size_{ij,t-1}$	-0.023 (-3.42)	-0.023 (-3.43)
$\ln Z_{ij,t-1}$	-0.063 (-3.36)	-0.058 (-3.12)
Eq.: $\Delta \ln \mu_{ij,t}$		
$\Delta \ln \theta^H_{ij,t}$	–	-0.157 (-6.51)
$\Delta \ln \theta^L_{ij,t}$	–	-0.052 (-1.02)
$\ln \theta^H_{ij,t-1}$	–	-0.073 (-4.21)
$\ln \theta^L_{ij,t-1}$	–	-0.030 (-2.80)
$\ln \mu_{ij,t-1}$	–	-0.579 (-9.31)
Obs.	207	207

Notes: Openness is total import share. $\theta^H_{ij,t}$ ($\theta^L_{ij,t}$) denotes openness for high (low) markup sectors. All variables are in deviation from a benchmark country (Germany). Industry-specific bilateral exchange rates, country/industry fixed effects, lagged dependent variables and 1992 dummy are included (not reported). The system of equations contains two more equations, one for each openness variable (not reported). $size_{ij,t}$ denotes average firm size and $rd_{ij,t}$ denotes our sectoral measure of R&D. t-statistics are reported between parentheses.

Table 14: The Origin of Imports (Large and Small Samples)

	Large Sample		Small Sample	
	(1)	(2)	(3)	(4)
	GMM	GMM-IV	GMM-IV	GMM-IV
$\Delta \ln \theta^{eu}_{ij,t}$	−0.022 (−4.65)	−0.018 (−3.67)	−0.019 (−2.12)	−0.011 (−1.28)
$\Delta \ln \theta^{neu}_{ij,t}$	−0.009 (−2.58)	−0.004 (−1.14)	0.001 (0.10)	0.004 (0.37)
$\Delta \ln Z_{ij,t}$	−0.083 (−10.21)	−0.078 (−10.02)	−0.002 (−0.08)	−0.041 (−1.90)
$\Delta \ln \mu_{ij,t}$	–	–	–	0.170 (2.56)
$\Delta \ln cpi_{ij,t}$	0.367 (8.71)	0.330 (8.45)	0.509 (3.83)	0.673 (5.65)
$\ln \theta^{eu}_{ij,t-1}$	−0.011 (−4.09)	−0.006 (−2.28)	0.002 (0.17)	0.010 (1.23)
$\ln \theta^{neu}_{ij,t-1}$	−0.003 (−1.80)	−0.000 (−0.24)	−0.007 (−0.77)	−0.002 (−0.23)
$\ln Z_{ij,t-1}$	−0.045 (−9.34)	−0.038 (−8.12)	−0.012 (−0.84)	−0.032 (−2.70)
$\ln \mu_{ij,t-1}$	–	–	–	0.187 (3.00)
$\ln cpi_{ij,t-1}$	0.003 (0.18)	−0.007 (−0.42)	0.337 (2.89)	0.244 (2.84)
$\ln p_{ij,t-1}$	−0.222 (−16.33)	−0.192 (−14.78)	−0.443 (−6.34)	−0.346 (−6.39)
p-value[1]	0.007	0.005	0.101	0.170
p-value[2]	0.002	0.034	0.432	0.154
Obs.	825	825	161	184

Notes: Openness is total import share. $\theta^{eu}_{ij,t}$ ($\theta^{neu}_{ij,t}$) denotes imports originating from (outside of) the European Union. All variables are in deviation from a benchmark country (Germany). Industry-specific bilateral exchange rates and country/industry fixed effects are included in all regressions. In (2) to (4) instruments for openness include weight-to-value, weighted distance, weighted cif/fob, 1992 dummy and lags on openness. The number of lagged dependent variables is chosen in order to reject autocorrelation of order 2. There is one lagged dependent variable in (1) and (2), two in (4) and three in (3). t-statistics are reported between parentheses. p-value[1] (p-value[2]) is the probability associated with the hypothesis that $\Delta \ln \theta^{eu}_{ij,t}$ and $\Delta \ln \theta^{neu}_{ij,t}$ ($\ln \theta^{eu}_{ij,t-1}$ and $\ln \theta^{neu}_{ij,t-1}$) are equal.

Table 15: Controls for Factor Endowments - Single Equation Estimates (Large and Small Samples)

	Large Sample		Small Sample	
	(1)	(2)	(3)	(4)
	OLS-IV	GMM	OLS-IV	GMM
$\Delta \ln \theta_{ij,t}$	-0.066	-0.025	-0.063	-0.030
	(-4.36)	(-4.67)	(-1.44)	(-2.92)
$\Delta \ln Z_{ij,t}$	-0.075	-0.078	-0.006	-0.008
	(-8.68)	(-10.20)	(-0.25)	(-0.46)
$\Delta \ln cpi_{ij,t}$	0.306	0.353	0.631	0.583
	(5.13)	(8.78)	(4.00)	(5.29)
$\Delta \ln \alpha_{ij,t}$	-0.008	0.240	0.249	0.279
	(-0.12)	(3.70)	(2.35)	(2.61)
$\ln \theta_{ij,t-1}$	-0.029	-0.007	-0.004	0.008
	(-3.08)	(-2.30)	(-0.09)	(1.10)
$\ln Z_{ij,t-1}$	-0.061	-0.040	-0.037	-0.026
	(-6.67)	(-7.61)	(-1.84)	(-2.55)
$\ln cpi_{ij,t-1}$	0.033	0.025	0.188	0.157
	(1.14)	(1.30)	(2.20)	(2.34)
$\ln \alpha_{ij,t-1}$	-0.010	0.011	0.018	0.018
	(-0.74)	(1.12)	(0.66)	(1.07)
$\ln p_{ij,t-1}$	-0.272	-0.215	-0.386	-0.325
	(-11.13)	(-15.11)	(-5.05)	(-7.96)
Obs.	825	825	207	207

Notes: Openness is total import share. $\alpha_{ij,t}$ denotes an interaction term between aggregate capital stock and sectoral capital share. All variables are in deviation from a benchmark country (Germany). Industry-specific bilateral exchange rates and country/industry fixed effects are included in all regressions. Instruments for openness include weight-to-value, weighted distance, weighted cif/fob and 1992 dummy; in (2) and (4) lags on openness are also included. In (2) and (4) the number of lagged dependent variables is chosen in order to reject autocorrelation of order 2. There is one lagged dependent variable in the two regressions. t-statistics are reported between parentheses.

Table 16: Controls for Factor Endowments - Three-Stage Least Squares (Large and Small Samples)

	Large Sample	Small Sample
Eq.: $\Delta \ln p_{ij,t}$	(1)	(2)
$\Delta \ln \theta_{ij,t}$	-0.077	-0.044
	(-7.48)	(-2.24)
$\Delta \ln Z_{ij,t}$	-0.089	-0.065
	(-3.39)	(-1.97)
$\Delta \ln cpi_{ij,t}$	0.322	0.657
	(6.00)	(5.81)
$\Delta \ln \alpha_{ij,t}$	0.032	0.245
	(0.57)	(2.93)
$\ln \theta_{ij,t-1}$	-0.028	-0.008
	(-5.26)	(-0.59)
$\ln Z_{ij,t-1}$	-0.068	-0.044
	(-5.09)	(-2.91)
$\ln cpi_{ij,t-1}$	0.042	0.152
	(1.62)	(2.24)
$\ln \alpha_{ij,t-1}$	-0.005	0.012
	(-0.41)	(0.65)
$\ln p_{ij,t-1}$	-0.278	-0.353
	(-12.24)	(-6.71)
Eq.: $\Delta \ln Z_{ij,t}$		
$\Delta \ln \theta_{ij,t}$	0.097	0.223
	(2.78)	(3.27)
$\Delta \ln \alpha_{ij,t}$	-0.351	-0.192
	(-1.32)	(-0.61)
$\ln \theta_{ij,t-1}$	0.071	0.053
	(3.14)	(1.19)
$\ln \alpha_{ij,t-1}$	-0.116	-0.048
	(-2.19)	(-0.68)
$\ln Z_{ij,t-1}$	-0.032	-0.024
	(-2.21)	(-1.28)
Obs.	825	207

Notes: Openness is total import share. $\alpha_{ij,t}$ denotes an interaction term between aggregate capital stock and sectoral capital share. All variables are in deviation from a benchmark country (Germany). Industry-specific bilateral exchange rates, country/industry fixed effects, lagged dependent variables and 1992 dummy are included (not reported). The openness equation was omitted for brevity, as were the coefficients on the instruments for productivity. t-statistics are reported between parentheses.

Table 17: Impact of Openness on Markups

Country	Initial Markup	After One Year In Response to Average Change in Openness	After Ten Years In Response to Average Change in Openness	Markup after Whole Sample Change in Openness
Belgium	1.050	1.044	1.046	1.016
Germany	1.064	1.058	1.061	1.028
Denmark	1.206	1.205	1.205	1.199
Spain	1.016	1.011	1.013	0.990
France	1.086	1.081	1.083	1.060
Italy	1.050	1.057	1.054	1.088
Netherlands	0.991	0.987	0.988	0.967
Average	1.059	1.057	1.058	1.043

Notes: First column reports (weighted) average markup across sectors evaluated at beginning of the sample. Column (2) reports our estimates of average markup after one year, in response to average annual change in import share per sector. Column (3) shows the response after ten years. Final column reports final markup level in response to total observed change in import share over the period.

Table 18: Impact of Openness on Productivity

Country	Initial Productivity	After One Year In Response to Average Change in Openness	After Ten Years In Response to Average Change in Openness	Productivity after Whole Sample Change in Opennes
Belgium	100	100.763	102.043	122.409
Germany	100	100.852	102.281	125.297
Denmark	100	100.377	101.008	110.554
Spain	100	100.487	101.300	113.792
France	100	100.790	102.114	123.273
Italy	100	99.252	98.026	81.921
Netherlands	100	100.475	101.269	113.445
Average	100	100.398	101.070	111.231

Notes: First column reports (weighted) average productivity across sectors evaluated at beginning of the sample, normalized to 100. Column (2) reports our estimates of average productivity after one year, in response to average annual change in import share per sector. Column (3) shows the response after ten years. Final column reports final productivity level in response to total observed change in import share over the period.

Table 19: Impact of Openness on Manufacturing Prices (Percentage Deviation)

Country		Impact via Markups	Impact via Productivity	Response to Average Change in Openness	Response to Whole Sample Change in Openness
Belgium	1 year	-0.136	-0.134	-0.270	
	10 years	-0.218	-0.336	-0.555	-4.827
Germany	1 year	-0.146	-0.143	-0.289	
	10 years	-0.234	-0.360	-0.594	-5.294
Denmark	1 year	-0.026	-0.025	-0.051	
	10 years	-0.041	-0.063	-0.104	-1.036
Spain	1 year	-0.106	-0.104	-0.211	
	10 years	-0.171	-0.263	-0.433	-3.056
France	1 year	-0.104	-0.102	-0.206	
	10 years	-0.167	-0.257	-0.424	-3.982
Italy	1 year	0.149	0.146	0.295	
	10 years	0.239	0.367	0.606	7.070
Netherlands	1 year	-0.103	-0.102	-0.205	
	10 years	-0.166	-0.255	-0.421	-6.789
Average	1 year	-0.069	-0.067	-0.136	
	10 years	-0.110	-0.170	-0.280	-2.275

Figure 1: Changes in Import Shares and in Prices

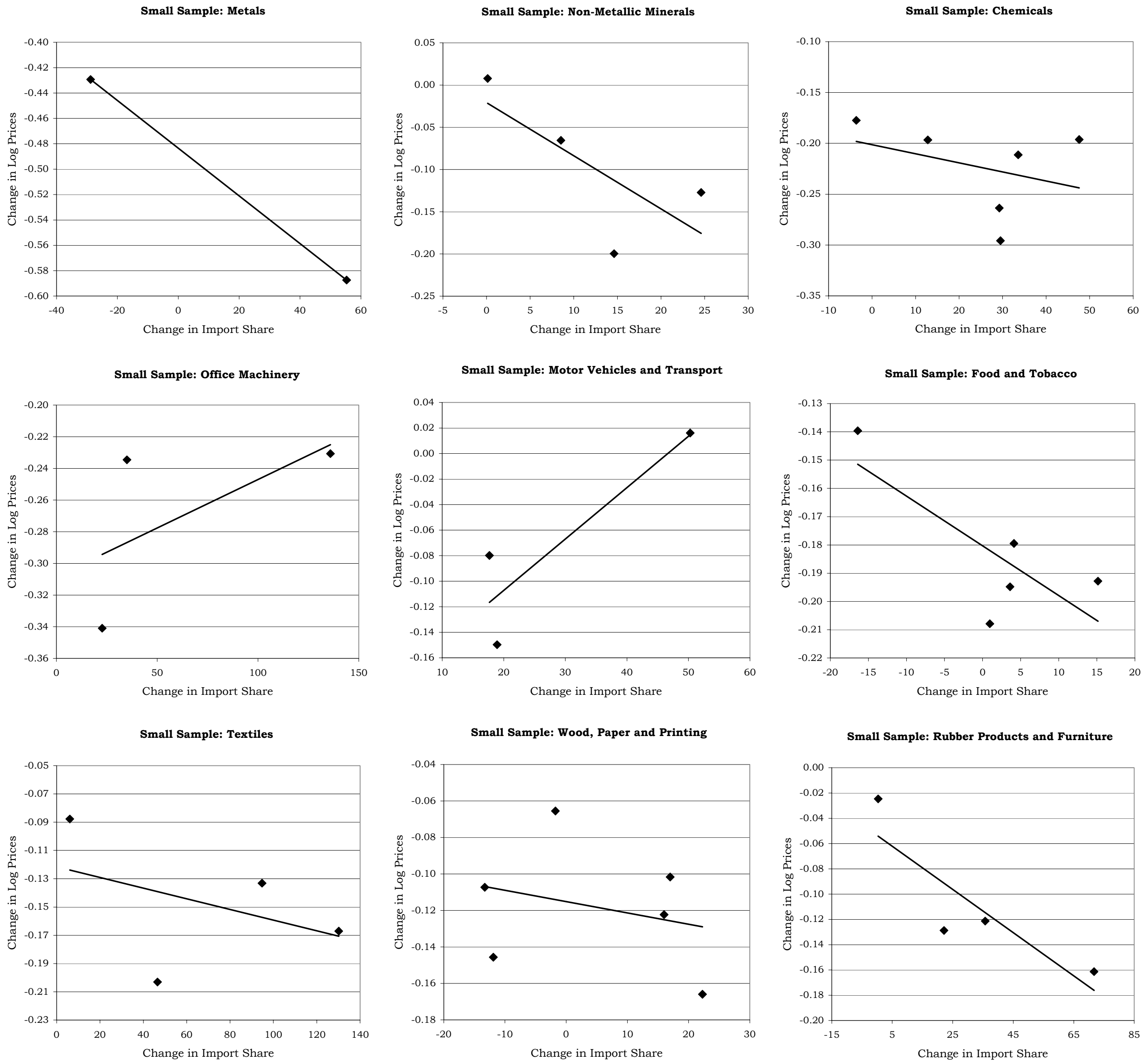

Figure 2: Changes in Import Shares and in Productivity

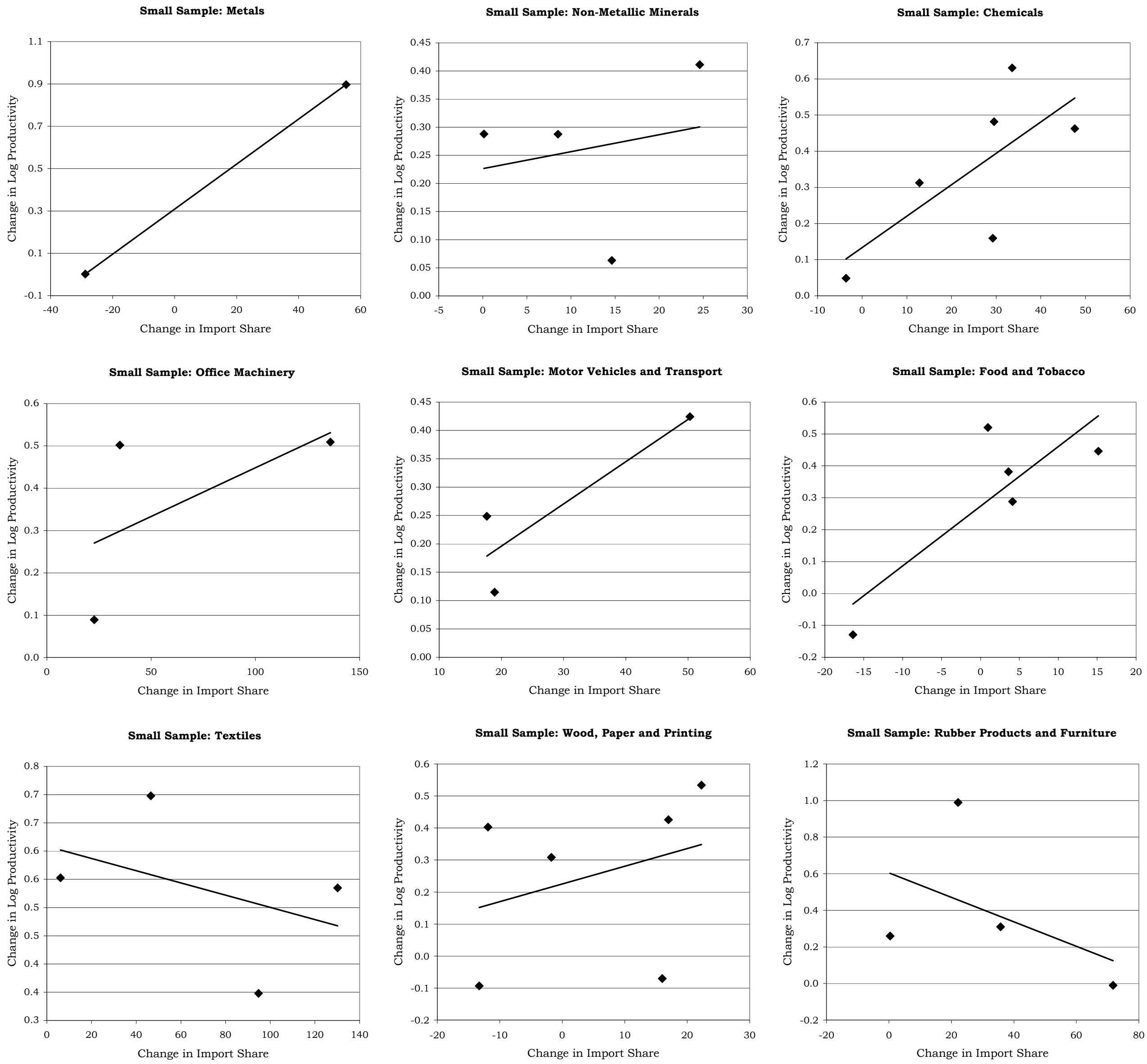

Figure 3: Changes in Import Shares and in Markups