SUMMARY

Much attention has been paid to the impact of a single currency on actual trade volumes. Lower trade costs, however, matter over and beyond their effects on trade flows: as less productive firms are forced out of business by the tougher competitive conditions of international markets, economic integration fosters lower prices and higher average productivity. We assess the quantitative relevance of these effects calibrating a general equilibrium model using country, sector and firm-level empirical observations. The euro turns out to have increased the overall competitiveness of Eurozone firms, and the effects differ along interesting dimensions: they tend to be stronger for countries which are smaller or with better access to foreign markets, and for firms which specialize in sectors where international competition is fiercer and barriers to entry lower.

— Gianmarco I.P. Ottaviano, Daria Taglioni and Filippo di Mauro
1. INTRODUCTION

A decade after the creation of the European Economic and Monetary Union (EMU), Denmark, Sweden and the United Kingdom still show reluctance towards adopting the euro. How much, if anything, are they losing in terms of the economic gains generated by the reductions in trade costs that a monetary union appears to imply?

More generally, has the introduction of the single currency affected – via the trade channel – the intensity of competition across countries while forcing the least efficient firms out of the market? If so, to what extent has this selection process affected unit delivery costs, mark-ups, prices, quantities, revenues and profits in participating and non-participating countries?

While these continue to be very relevant policy questions, there is currently no straightforward approach to deriving a quantitative assessment of the wider benefits
of monetary union. Existing studies are very much focused on its impact on trade flows.\(^1\) Trade flows, however, are only an imperfect measure of the gains that the euro may have created through the trade channel, as they fail to capture potential welfare improvements accruing to economic agents through a more efficient and productive economic environment. Such benefits stem from fostering countries’ specialization in sectors in which they are more efficient, enabling a richer product variety, weakening the market power of firms, enhancing the exploitation of economies of scale and improving the efficiency of production through the exit of the least efficient firms.

The main objective of this paper is to assess the impact of the adoption of the euro on the productivity and international competitiveness of firms belonging to different European countries and industries.

In principle, empirical estimates could be obtained through direct measures of firms’ productivity and competitiveness changes, which could be aggregated to perform cross-sector and cross-country comparisons. Unfortunately, firm level data are not detailed and homogenous enough across countries to allow for a consistent estimation (Mayer and Ottaviano, 2007); the analysis then has to be restricted to individual countries (see, for example, work by Berthou and Fontagné, 2008, on France).

This paper opts for an alternative solution. It bypasses the problems related to the lack of data by simulating counterfactual scenarios of euro membership on a general equilibrium multi-country multi-sector model of international trade which we calibrate using macro and micro data. Following the approach of Melitz and Ottaviano (2008), our model accounts for a number of real world features linking trade liberalization and firm productivity. These features include: richer availability of product varieties; tougher competition and weaker market power of firms; better exploitation of economies of scale; and efficiency gains via the selection of the best firms.

The model is calibrated on 12 manufacturing sectors across 12 EU countries for the years 2001–2003 and is used to evaluate the competitiveness of European manufacturing firms in terms of an efficient use of available inputs, given the institutional and market set-up in which they operate. In so doing, we derive a ranking of European countries in terms of the cost effectiveness of the firms located therein – which we use as a measure of the ‘overall competitiveness’ of the corresponding countries. This indicator is then adopted as a benchmark for a set of experiments, where we simulate three counterfactual scenarios designed to evaluate how alternative (and hypothetical) euro membership set-ups would have affected the baseline overall competitiveness of the European countries considered. The competitiveness effects we estimate range from 1.4% to 3.5% on average across countries, and up to a (negative) 5.8% for France in the scenario where that country abandons the Eurozone.

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\(^1\) Between 1998 and 2007, the value of exports and imports of goods within the euro area has increased from 26% to 33% of GDP, that of services from 5% to 7% of GDP. Controlling for exogenous effects, the early literature on the trade impacts of monetary unions has come up with an extremely large range of estimates, comprised between nil (Berger and Nitsch, 2005) and almost 1400% (Alesina \textit{et al}., 2002). The current consensus on the trade impact of the euro is that the single currency had a small, but positive effect on trade flows.
The analysis that yields such estimates establishes a link between trade barriers and industry performance indicators, and highlights fruitful directions for analysis of new statistical data in the future. The proposed approach produces micro-founded measures of countries’ competitiveness that are more comprehensive than international comparisons of prices, total factor or labour productivity, trade shares, and other traditional gauges of competitiveness, and can be decomposed in terms of various determinants for every country and sectors. This makes them very useful for policy impact evaluation purposes, not only in the international context but also for a variety of competition and industrial policies.

The structure of the paper is as follows. Section 2 provides some stylized facts and a brief account on how the trade literature has evolved in line with actual changes in the structure of markets and production patterns. This is useful to put in perspective the main characteristics of the model we use. The model itself is described in some detail in Section 3. Its empirical implementation – which consists in circumventing data limitations through the calibration of the model relationships – is presented in Section 4. Section 5 examines how firm competitiveness is affected within three different scenarios of euro membership. Section 6 concludes. Sections 3.2, 3.3, 3.4 are necessarily rather technical. They can be skipped without losing the flow of thought and the main message of the paper.

2. GAINS FROM TRADE: FACTS AND THEORIES

In the last few decades, developments in trade theory have been characterized by constant attempts to include ‘real life’ complexities in the basic trade models of Ricardo and of Heckscher and Ohlin. This includes a re-definition of (1) what gains have to be expected from trade and (2) what channels are likely to be most relevant for generating such gains. In what follows, we underline some of the most important stylized facts in recent economic history, which have been incorporated in theory, and most notably in the model we use in this paper.

During the ‘first wave of globalization’ – that is, from the industrial revolution to the First World War – the pattern of international trade was mainly characterized by the exchange of manufactured goods from industrialized countries for imports of raw materials from less developed countries. World trade was mostly ‘inter-sectoral’, and was explained by international differences in relative factor endowments, and technologies. Countries’ specialization in production and in exports was in accordance with their relative costs of production (i.e. having a ‘comparative advantage’ in relatively ‘cheap’ sectors): the so-called ‘specialization effect’ of trade liberalization. The theories of Ricardo and of Heckscher and Ohlin were developed to explain such patterns of international trade.

With the ‘second wave’ of globalization after the Second World War, the previous paradigm became partly obsolete as a dominant share of international trade was taking place within industries among countries having relatively similar endowments.
and technological development (Linder, 1961; Grubel and Lloyd, 1975). This led to the appearance of new trade theories, the principal characteristic of which is the attention to the details of market structure. Two distinct strands of literature – both relevant to the model proposed in this paper – underline the different mechanisms at play.

The first strand of literature underlines that horizontal product differentiation within sectors assigns market power to firms even in sectors characterized by a large number of competitors that are free to enter and exit the market (Krugman, 1980). In this set-up of ‘monopolistic competition’ with increasing returns to scale, the following results apply. First, firms operate at a given minimum scale if they want to break even. Second, within a sector, firms specialize in the production of distinct varieties of their differentiated goods. Third and last, intra-industry trade arises because consumers love variety, but countries can produce only a limited number of varieties, depending on their ‘size’, i.e. their resource endowment. Hence, trade liberalization has a ‘variety effect’ insofar as it broadens the range of varieties available for consumption.

A second strand of new trade theory is built on an ‘oligopolistic competition’ set-up where a few large firms sell homogeneous products and, due to trade barriers, achieve larger market shares at home than abroad (Brander and Krugman, 1983). Whenever they are able to discriminate in terms of prices between domestic and foreign customers, they are willing to accept smaller profit margins abroad than at home, therefore selling additional units of their output abroad. This gives rise to bilateral trade within industries even between identical countries. As firms charge lower margins on foreign than on domestic sales, the resulting exchange is sometimes called ‘reciprocal dumping’. In this set-up, trade liberalization reduces the market share of domestic firms with respect to their foreign rivals, thus increasing their perceived elasticity of demand. The result is an average compression of profit margins as prices fall towards marginal costs. This efficiency-enhancing consequence of freer trade is called the ‘pro-competitive effect’.

If production faces increasing returns to scale at the firm level, tougher competition due to freer trade has an additional efficiency-enhancing effect. The reason is that, to restore profitability, firms compensate for the decrease in prices resulting from the pro-competitive effect by raising their output. Then, in the presence of increasing returns, rising output leads to a decline in the average cost of production. This efficiency gain is called the ‘scale effect’ of trade liberalization.

Recent analyses of micro-datasets tracking production and international involvement at the firm and at the plant levels demonstrate that firms vary tremendously along a number of dimensions even within industries and this plays an important role in aggregate outcomes. In particular a hallmark regularity is that firms serving foreign markets are more productive than their purely domestic competitors. In this setting, allowing for heterogeneous firms, tougher competition and scale economies implies also that freer trade causes the most performing firms to expand and grow – both
domestically and internationally – and the least performing firms to exit the market altogether. In the ensuing selection process, the scale of surviving firms increases – as this improves their profitability – while their number drops. As a result, technologies are used more efficiently – the so-called ‘rationalization effect’ of trade liberalization. Average firm productivity also rises, as less productive firms exit – the so-called ‘selection effect’ of trade liberalization.²

3. THEORETICAL FRAMEWORK

Building on the stylized facts and theoretical insights described in Section 2, our model provides an account of the determinants of trade and mechanisms of adjustment to trade liberalization as realistically as possible, as this comprises the existence of intra-industry trade, firms’ market power and heterogeneity, existence of scale economies and consumers’ love of variety. The main purpose of the model is to provide a solid theoretical underpinning for the construction of broad-based indicators of competitiveness in Europe and to use this framework to study the gains from the introduction of the euro, considering the latter as an ‘instrument’ of trade liberalization among the countries participating in Stage 3 of EMU, i.e. the adoption of the euro.

The basic logic of the model is rather intuitive. Consider a sector in which firms differ in terms of efficiency in the use of available inputs. With trade liberalization, lower trade costs allow foreign producers to target the domestic markets, therefore lowering the mark-ups and the operating profits of domestic firms. At the same time, however, some domestic firms gain access to foreign markets and generate additional profits from their foreign ventures: these are the firms that are efficient enough to cope with the additional costs of reaching foreign customers (such as those due to transportation, administrative duties, institutional and cultural barriers). In the process, a number of firms – the least productive and those unable to afford access to foreign markets – will be forced to exit. The selection process will eventually increase the average efficiency of surviving firms, and lower average prices and mark-ups.

3.1. Main features

Our model is to be seen in the tradition of the new trade theories briefly surveyed in Section 2. Most notably, it exhibits the following five main features. First, the market structure is one of monopolistic competition. Each firm in a sector produces only one variety of a differentiated good. Consumers have inelastic demand and love to have as many varieties to choose from as possible. Second, in order to enter in a sector and start producing, firms must pay \textit{ex-ante} fixed entry costs, which include for example

² The above stylized facts have been highlighted by a growing empirical literature. For example, the exit of the least productive firms is reported by Clerides \textit{et al.} (1998), Bernard and Jensen (1999) as well as Aw \textit{et al.} (2000). Market share reallocation towards the most productive firms is reported by Pavcnik (2002) as well as Bernard \textit{et al.} (2003).
the research and development (R&D) costs needed to create and market a new variety. With respect to their nature these costs are therefore ‘sunk’, i.e. cannot be recovered, should firms exit the market later on. Bringing entry (and exit) to the forefront, our analysis focuses on the medium to long-run effects of trade liberalization. Third, in addition to the entry costs, firms incur production costs and delivery costs, which include not only transportation fees – both within a country and for shipping abroad – but also all tariff and non-tariff costs needed to reach the final consumers. We collapse these costs – which vary by sector and by country – into a single indicator, which we will call the ‘freeness of trade’. Fourth, trade flows are driven by technology and demand, and there is no role for international cost differentials arising from different relative resource endowments, which are instead critical in the Heckscher–Ohlin trade theory mentioned in Section 2. Fifth and last, in our model the size of the markets matters. The larger the markets, the tougher the competition in terms of the increased elasticity of demand faced by firms and thus the lower are the mark-ups. In this tougher competitive environment, firms have to achieve a larger scale of operations in order to break even, and this is possible only for the most efficient firms, i.e. those with the lowest marginal costs. Accordingly, the key indicator of industry performance in the model will be the ‘cut-off’ marginal cost. This is the maximum marginal cost that can be profitably sustained by firms in the market. The inverse of the cut-off cost is the minimum productivity or efficiency of firms that are able to at least break even. Knowing how the cut-off varies following trade liberalization will be enough to evaluate all the ensuing changes in terms of productivity, prices, mark-ups, output and overall welfare.

3.2. A stylized EU economy

With our empirical application and our data constraints in mind, we focus on an economy consisting of 12 countries and 12 manufacturing sectors (more on this in Section 4). Each manufacturing sector (henceforth indexed by the subscript ‘s’) supplies a differentiated good. This good is available in a certain range of varieties which are traded in monopolistic competitive markets. The model assumes that each firm produces one variety only. The rest of the economy is represented by a single residual homogeneous good, which serves as the numéraire (i.e. unit of value). The homogeneous good is freely traded in perfectly competitive markets and it is sold at the same price by all firms across the economy. The market for this good will also absorb all labour imbalances in the economy so that nominal wages – but not real ones – will be constant in the model.

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3 We consider this as a reasonable assumption for the EU countries that are the object of the empirical analysis in Section 4, given that their relative resource endowments are very similar and bilateral trade flows mostly intra-industry.

4 Monopolistic competition can be considered as a reasonable macroeconomic representation of the market structure in our manufacturing sectors as long as sectors are fairly aggregated and our model allows for the pro-competitive effect of richer variety presented in Section 2.
3.3. Industry equilibrium

Our model is formally described in Appendix 1. It accommodates several countries and several sectors that differ from each other along several dimensions. While this is important for the empirical application, the intuitive logic of the model can be usefully grasped by concentrating on the simplest case of a single manufacturing sector, labelled ‘s’, that operates in two identical countries, labeled ‘h’ (mnemonic for ‘here’) and ‘t’ (mnemonic for ‘there’). In the following description we focus on country h with the understanding that everything applies symmetrically to country t.

As already mentioned, to introduce a new variety of a good produced in sector s and country h, a firm incurs a (sector-and-country) specific R&D sunk cost, which we call $f_s^h$. Typically, due to the uncertain R&D outcome, the entrant does not know in advance what will be the marginal cost connected to the production of the new variety that he wants to launch on the market, i.e. it does not know how efficient it will be in producing its variety relative to the production of all other varieties in the market (and actually whether it will be able to produce it at all, given market conditions). To capture such uncertainty, we assume that the marginal cost of production $c$ is determined randomly upon entry as a draw from a sector and country-specific probability distribution.

The production cost distribution is portrayed in the middle panel of Figure 1 where, for any firm, possible cost draws range from a lower external bound equal to 0 (i.e. where $c$ can approximate 0, but always remaining strictly positive) to a country and sector-specific upper bound equal to $c_{As}$. The panel shows a realistic situation (see Box 1 for details) in which high cost draws for firms (large $c$) are much more likely than low cost draws (low $c$). There are two key parameters in this panel. The first is $c_{As}$, which identifies the maximum possible cost of producing a variety (i.e. the worst possible return from the investment in R&D) in sector s and country h. The inverse of $c_{As}$, which we call $d_s^h$, is an index of ‘absolute advantage’: the higher it is, the more cost effective country h is in producing good s and the more likely it is for a firm willing to introduce a new variety in sector s of country h to succeed. The second key parameter is represented by the curvature, or ‘shape’ $k_s$, of the cost distribution curve. The parameter $k_s$ is a direct measure of the bias of the distribution of sector s towards high cost outcomes (i.e. inefficient firms). Hence, the larger $k_s$ is, the more likely it is for a new variety in sector s to have high marginal costs of production. Given these parameters – technological in nature – country h has a ‘comparative advantage’ in sector s with respect to country t and another sector $S$ if $(c_{As}^h/c_{As}^s) < (c_{As}^t/c_{As}^s)$. In this case and other things equal, firms entering sector s are more likely to produce at lower cost (i.e. to be more productive) in country h than in country t.

While all firms have identical expectations on their future fortunes, when they enter, some may subsequently end up being luckier than others, giving rise to an ex-post distribution of firm efficiency that mirrors the ex-ante distribution of cost draws (provided that, as in our industries, there is a number of entrants large enough).
Box 1. Pareto distribution

Our model is based on the assumption that marginal costs draws $c$ in sector $s$ and country $h$ follow a Pareto distribution with possible outcomes ranging from $0$ to $c_{A,s}^h$ and shape parameter $k$. Formally, the *ex ante* cumulative density function (i.e. the share of draws below a certain cost level $c$) and probability density function (i.e. the probability of drawing a certain cost level $c$) are given by:

$$G(c) = \left( \frac{c}{c_{A,s}^h} \right)^k, \quad 0 \leq c \leq c_{A,s}^h \quad \text{and} \quad g(c) = \frac{k c^{k-1}}{(c_{A,s}^h)^k}, \quad 0 \leq c \leq c_{A,s}^h,$$

respectively.

On account of the law of large numbers, these are also the *ex post* cumulative density function and probability density function of entrants across marginal cost levels. The cumulative density function is represented in the middle panel of Figure 1. A useful property of this Pareto distribution is that any truncation thereof also belongs to the Pareto family with the same shape parameter $k$. This is due to the fact that, for any value of $c$, $d \ln G(c)/d \ln(c) = k_s$, i.e. a 1% increase in $c$ leads to a $k_s$% increase in $G(c)$. In particular, since firms produce for the domestic market as long as their cost draws fall below $c_{A,s}^h$, the distribution of producers across marginal cost levels is characterized by the following cumulative and probability density functions:

$$G_h(c) = \left( \frac{c}{c_{A,s}^h} \right)^k, \quad 0 \leq c \leq c_{A,s}^h, \quad \text{and} \quad g_h(c) = \frac{k c^{k-1}}{(c_{A,s}^h)^k}, \quad 0 \leq c \leq c_{A,s}^h.$$

Is this anywhere close to what we observe in the data? This is easily testable, as stated above, under the Pareto assumption $d \ln G(c)/d \ln(c) = k$, for any value of $c$. Then, if the marginal cost $c$ were indeed distributed as Pareto, a simple regression of $\ln G(c)$ on $\ln(c)$ plus a constant would fit the data perfectly ($R^2 = 100\%$) and, by definition, the estimated coefficient of $\ln(c)$ would provide a consistent estimate of $k_s$ as the constant elasticity of $\ln G(c)$ to $\ln(c)$. The results of such regression, run by sector, are reported in the table below. They clearly show that the Pareto distribution provides a very good description of the data. This has the additional useful practical implication that the average marginal cost in sector $s$ and country $h$ is equal to $c_{A,s}^h k_s/(k_s + 1)$, which can be used to obtain a consistent estimate of the cut-off cost from sector- and country-specific averages.
Accordingly, after entering, firms observe their own costs, as well as those of their competitors, and realize whether they can produce profitably. Firms that do not manage to make profits, will have to exit the market. This is shown by the Home sales schedule in the top panel of Figure 1, in which downward sloping demand implies that the quantity that firms are able to sell domestically decreases proportionally to the increase in marginal cost of their draw, as a higher marginal cost maps into a higher price. The extent to which a higher price reduces demand depends on product differentiation: the more differentiated products are, the fewer sales are lost on account of a given increase in price. Thus, a flatter slope of the Home sales schedule would portray stronger product differentiation. Henceforth, we will call $D_s$ the index of product differentiation in sector $s$.

The Export sales schedule is lower than the Home sales schedule because exporters face additional delivery costs than domestic producers and this increases the price they need to charge to final consumers, therefore lowering the latter’s demand for their products. The higher these delivery costs are, the further apart are the two lines. Accordingly, decisions to produce and export follow simple cut-off rules: firms with costs (and sales price) above $c^{hh}_s$ realize that they are too inefficient to sell in the domestic market, and thus quit; firms with costs below $c^{hh}_s$ but above $c^{ht}_s$ realize that they are too inefficient to export, and thus serve only the domestic market; firms with costs below $c^{ht}_s$ realize that they are efficient enough to sell both at home and abroad, and thus do both.

The outcome portrayed in the top panel of Figure 1 is anticipated by firms at the entry stage when they have to decide whether to incur the sunk R&D cost $f^h_s$ or not. In addition, the information contained in the middle panel of the same figure allows them to calculate the probability of drawing marginal costs above or below $c^{hh}_s$ and $c^{ht}_s$. They can, therefore, figure out their overall expected profits and check whether these

<table>
<thead>
<tr>
<th>Industry</th>
<th>$k_i$</th>
<th>Std. Error</th>
<th>Adj. $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Food, Beverages and Tobacco</td>
<td>1.91</td>
<td>0.0027</td>
<td>0.96</td>
</tr>
<tr>
<td>2 Textiles, Leather Products and Footwear</td>
<td>1.67</td>
<td>0.0028</td>
<td>0.96</td>
</tr>
<tr>
<td>3 Wood Products except Furniture</td>
<td>1.95</td>
<td>0.0044</td>
<td>0.95</td>
</tr>
<tr>
<td>4 Paper Products, Printing and Publishing</td>
<td>1.91</td>
<td>0.0015</td>
<td>0.99</td>
</tr>
<tr>
<td>5 Rubber and Plastic</td>
<td>2.42</td>
<td>0.0035</td>
<td>0.98</td>
</tr>
<tr>
<td>6 Chemicals, including Pharmaceuticals</td>
<td>1.68</td>
<td>0.0028</td>
<td>0.98</td>
</tr>
<tr>
<td>7 Non-metallic Mineral Prod., incl. Pottery and Glass</td>
<td>2.11</td>
<td>0.0033</td>
<td>0.98</td>
</tr>
<tr>
<td>8 Basic Metals and Fabricated Metal Products</td>
<td>2.55</td>
<td>0.0019</td>
<td>0.98</td>
</tr>
<tr>
<td>9 Non-electric Machinery</td>
<td>2.48</td>
<td>0.0021</td>
<td>0.99</td>
</tr>
<tr>
<td>10 Electric Machinery, incl. Prof. and Scient. Equip.</td>
<td>2.22</td>
<td>0.0029</td>
<td>0.98</td>
</tr>
<tr>
<td>11 Transport Equipment</td>
<td>2.32</td>
<td>0.0042</td>
<td>0.98</td>
</tr>
<tr>
<td>12 Other Manufacturing, incl. Furniture</td>
<td>2.02</td>
<td>0.0037</td>
<td>0.96</td>
</tr>
<tr>
<td>Average</td>
<td>2.10</td>
<td>0.0030</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Source: AMADEUS, authors’ calculations.
cover the sunk entry cost. The bottom panel of Figure 1 provides a graphical representation of the problem set faced by the firm. The upward sloping curve indicates that expected profits are a function of the domestic cut-off cost (threshold beyond which firms are forced to exit the market). As all firms are identical before investing in R&D, they all share the same expected profits. On their part, expected profits are an increasing function of the domestic cut-off cost since a higher cut-off implies that the average efficiency within the sector is lower and, therefore, that incumbents face weaker competition. The horizontal line identifies the sunk entry cost \( f^e \). It crosses
the curve of expected profits only once. The resulting intersection of those two lines identifies the equilibrium domestic cut-off level $c^h$. This is the only equilibrium cut-off compatible with a stable number of firms active in the market: if the domestic cut-off were above $c^h$, expected profits would be higher than the entry cost, thus inducing additional entry. Conversely, if the domestic cut-off were below $c^h$, expected profits would be lower than the entry cost, implying that some incumbent firms would shut down as they would be making losses.

Once $c^h$ is determined, the equilibrium export cut-off level can be derived by applying the additional delivery costs. In particular, if we call $d^h$ the factor measuring these additional costs of delivering goods from country $h$ to country $t$ (and vice versa), the equilibrium export cut-off level is simply $c^h/d^h$, implying that an exporter has to be $d^h$ times more efficient than a domestic producer in order to make the same amount of sales in the same country.

### 3.4. Key parameters

For a given domestic cut-off level, firms expect higher profits under the following conditions: (i) in larger countries as these would support larger firms; (ii) in sectors in which products are less differentiated as these would also support larger firms; (iii) in sectors and countries offering better chances of good cost draws as this would foster firms’ expected efficiency; and (iv) when trade is freer as this would allow firms to grow, thanks to easier access to the foreign market.

In all these cases the curve of expected profits in the bottom panel of Figure 1 would shift upwards. A detailed gallery of the corresponding outcomes is portrayed in Figure 2, where cases (i), (ii) and (iii) are presented in the top panel (a) while case (iv) is presented in the middle panel (b). For a given level of the domestic cut-off, a larger country size, weaker product differentiation, better technological opportunities and freer trade all imply higher expected profits. The effects of shocks leading to such structural changes are shown graphically by the upward shift of the Expected profits curve in panels (a) and (b) and the corresponding shift to the left of the intersection point between the curves representing respectively Expected profits and Entry costs. As shown graphically, the new equilibrium domestic cut-off $c^h$ will have a lower level. This outcome is due to the following sequence of events: the higher expected profits result in the entry of new firms, which increases competition in the market, thereby causing firms’ mark-ups to shrink and making survival harder for the weakest among the incumbents. Tougher competition hits all firms but sinks only some of the least efficient ones, i.e. those firms that had marginal costs just below the cut-off before the shock, and that, as a result of the shock, see their sales disappear thereby failing to break even. As only relatively more efficient firms survive, the average efficiency of the industry rises, thereby leading to a lower level for the domestic cut-off $c^h$, as previously mentioned. This selection effect is accompanied by an increase in average scale of firms as well as by a decrease in the average price and mark-up, revealing
that scale and pro-competitive effects are also at work. For a given reduction of the domestic cut-off, the intensity of the selection effects depends on the number of firms that exit the market. What percentage of firms exit when the cut-off falls by a percentage point? Given the discussion in the previous section (see Box 1 for details), the answer is clearly \( k_s \) per cent. Hence, we refer to \( k_s \) as the ‘sensitivity to firm selection’, or more technically to the ‘elasticity of the extensive margin’ of industry adjustment, which is high in sectors characterized by large fractions of high cost firms.

Figure 2. Industry reallocations
The difference between panels (a) and (b) in Figure 2 stems from the fact that in the former delivery costs are unaffected while they, of course, fall in the latter. This explains why in panel (a) a lower domestic cut-off leads to a lower export cut-off forcing the least efficient exporters in the initial equilibrium to discontinue their foreign operations. In panel (b), by contrast, as delivery costs fall due to trade liberalization, the export cut-off rises since some firms that were not exporting under the initial conditions are now able to serve the foreign market.

Finally, a fifth case is presented in panel (c) of Figure 2. This shows that countries and sectors in which entry costs are lower support lower equilibrium cost cut-offs for both domestic and foreign sales. The reason is that, for given cut-offs, lower entry costs foster the entry of additional firms. This increases competition forcing the least efficient domestic producers to shut down and the least efficient exporters to abandon their foreign operations. Hence, as in the other panels, selection leads to larger average scale of firms as well as to lower average price and mark-up.5

Summarizing what we have learned from Figure 1 and Figure 2, the domestic cut-off \( \epsilon_h \) determines the average efficiency, the average scale, the average price and the average mark-up of firms selling the products of sector \( s \) to consumers in country \( h \). Therefore, it determines the overall welfare generated by that sector for that country. In turn, the domestic cut-off is determined by six key parameters:

1. the country-specific market size, \( L_h \);
2. the sector-specific product differentiation, \( D_s \);
3. the sector-and-country specific absolute advantage, \( o_s^{bh} \);
4. the sector-specific elasticity of the extensive margin, \( k_s \);
5. the sector-and-country specific entry cost, \( f_s^{bh} \);
6. the delivery cost, \( d_s^{bh} \), which is specific to the sector, the country of origin and the country of destination.

In particular, we have argued that larger \( L_h \) and \( o_s^{bh} \) as well as smaller \( D_s \), \( k_s \), \( f_s^{bh} \) and \( d_s^{bh} \) reduce the equilibrium domestic cut-off (see Box 4 for the formal expression of \( \epsilon_h \) as a function of the various parameters and Appendix 1 for its derivation). The delivery cost parameter deserves further attention. First, \( d_s^{bh} \) determines the ratio between the number of exporters and the number of firms that sell only to domestic consumers. This ratio is inversely related to \( d_s^{bh} \) and can be interpreted as an index of the ‘freeness of trade’ as it equals zero in autarky and one when trade is perfectly free and exporters face no additional delivery cost with respect to domestic sellers. Second, in the more realistic set-up with several countries we will use for our empirical analysis, there are several export destinations and a reduction in any of the delivery costs to those destinations causes an upward shift of the Expected profit schedule as in the middle panel (b) of Figure 2. Then, if country \( h \) is characterized on average by lower delivery costs, \( d_s^{bh} \), the number of exporters is higher than in the autarky case (in contrast to the delivery cost which is lower than in the autarky case).

5 In general, the gains in terms of efficiency, scale and prices are associated with ambiguous effects in terms of product variety. Appendix 1 shows that in our model the former always dominate, implying that a lower domestic cut-off is always associated with higher national welfare and that, conversely, a higher domestic cut-off necessarily delivers lower national welfare.
delivery costs than country $t$ to all other countries, it will attract the entry of more firms, thereby leading to a higher average efficiency and average scale, a lower average price and mark-up, as well as to higher welfare.

4. EMPIRICAL IMPLEMENTATION

As mentioned in the introduction, a direct estimation of the gains to be attributed to the euro is at present not feasible because of the unavailability of sufficiently detailed and harmonized cross-country firm-level data. In particular, as shown by Mayer and Ottaviano (2007), existing data face five types of limitations. First, general information on firms is not always available. Second, the available data do not display the same information across countries. Third, important differences in coverage and methodology reduce the comparability of the available data. Fourth, when available, firm-level data collected homogeneously across Europe are not oriented towards international trade. Finally, confidentiality requirements typically prevent a single research team from directly accessing the source data in different countries. Hence, the econometric analysis of the competitiveness effects of the trade changes triggered by the euro is necessarily restricted to investigating individually the outcome for the very few countries for which all relevant data are available (such as Belgium and France).

To circumvent current data limitations, we use the theoretical structure of the model described in Section 3. In this respect, our approach should be seen as a practical second-best solution to overcome concrete – but hopefully temporary – data availability constraints. Specifically, in order to investigate the gains in competitiveness induced by the euro via the trade channel we test how the actual performance of European economies (as measured by our broadly defined indicators of competitiveness) compares with their simulated performances in counterfactual model scenarios in which some of them changes its official currency (i.e. to or from the euro). Adapting the methodology developed by Del Gatto et al. (2006), the analysis is developed in three steps. First, the model is fitted to reality. This is achieved by estimating as many of its parameters as possible and ‘calibrating’ the values of the remaining ones so that the model is able to reproduce selected patterns of the data. In particular, the calibration of the model allows generating the indicators of competitiveness needed to assess the impacts from the euro. Second, the model is ‘validated’ by checking its consistency with additional patterns of the data, different from the ones used in its calibration. Finally, the model is used to ‘simulate’ the counterfactual scenarios relative to the adoption of the euro and provide an assessment on the competitiveness effects of the euro.

Specifically, as we discuss in some technical detail in Appendix 1, in view of producing the above-mentioned indicators of competitiveness, the key objective of the empirical strategy is to compute the cut-offs from the model’s prediction (Equation 12 of Appendix 1) by ensuring that these latter fit the actual values observed – or calibrated – from the data (see Box 4 for details). As discussed in Section 3.4 and in Appendix 1, the cut-off cost in sector $s$ and country $h$ is determined by the following
six key parameters: the country-specific market size $L^i_h$; the sector-specific product differentiation $D_s$; the sector-and-country specific absolute advantage $\theta^i$; the sector-specific elasticity of the extensive margin $k_s$; the sector-and-country specific entry cost $f^i_s$, and the delivery costs to and from all other countries, with each bilateral delivery cost $d^i_{ht}$ being specific to a sector, a country of origin and a country of destination. Some of these parameters are directly measurable, such as the population, which proxies market size. Other parameters can be estimated. This is the case for the delivery costs and the sensitivity to firm selection (i.e. the elasticity of the extensive margin). The remaining parameters (i.e. product differentiation, entry costs and absolute advantage) are neither directly measurable nor estimable with the available data. This is the case for product differentiation, fixed entry costs and the absolute advantage. However, since we can estimate the cost cut-offs $c^i_{ht}$, the above unobservable parameters can be attributed values (i.e. ‘calibrated’) to ensure that the model exactly matches the cost cut-offs, with these latter estimated on the basis of the directly measured or estimated values of all other parameters.

4.1. Estimation

We consider data relative to 12 manufacturing sectors over the period from 2001 to 2003. We focus on 12 European countries. Nine of them belong to the euro area (Austria, Belgium, Finland, France, Germany, Italy, the Netherlands, Portugal and Spain). The remaining three are outsiders (Denmark, Sweden and the United Kingdom).

Notwithstanding the focus on 12 European countries, trade frictions across and within countries are estimated using a far larger panel of bilateral exports and domestic production data (212 countries worldwide), to ensure that our estimated coefficients of trade freeness for the 15 countries in the sample are as accurate as possible. Industry-level trade data and country-level geographical information come from the Centre d’Etudes Prospectives et d’Informations Internationales. Delivery costs within a country are calculated, by subtracting the country’s overall exports in a given sector from domestic production in the same sector, a standard procedure in international trade studies. This latter is measured by gross output at current basic prices, taken from the Industrial Statistics Database of the United Nations Industrial Development Organisation.

Marginal costs are calculated from sector- and country-specific productivity, measured as value added per hour worked, with data on value added and hour worked at the sectoral level from EU KLEMS. The sensitivity to firm selection is calculated using estimates of firm-level total factor productivity based on balance sheet data from the Amadeus database of the Bureau Van Dijk. Finally, population data come from the World Development Indicators by the World Bank.

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6 The robustness of our results when using alternative measures is discussed in the Web Appendix available at www.economic-policy.org.
7 Freely downloadable from www.cepii.fr.
8 Freely downloadable from www.euklems.net.
4.1.1. Measuring trade frictions. Trade frictions \( d_{ht} \) comprise the total costs of delivering a product from factory to consumers, irrespective of whether located at home or abroad. They include not only transportation fees, but also tariffs and non-tariff costs, and can be estimated through their negative impact on trade flows embedded in the ‘gravity regression’ detailed in Box 2.

**Box 2. Trade freeness estimation**

As shown in Appendix 1, our theoretical framework generates a ‘gravity relation’ between bilateral trade flows, country characteristics and trade impediments (Anderson and Van Wincoop, 2004). We exploit this relation to estimate bilateral trade freeness compatible with the observed flows between European countries. For trade flows from country \( h \) to country \( t \) in sector \( s \) we have:

\[
\ln(\text{EXP}_{st}) = \ln(\text{EX}_h + IM_t) + \delta \ln(\text{Distance}_{ht}) + \beta(\text{Border}_{ht}) + \lambda(\text{Language}_{ht} \text{Border}_{ht}) + \ldots
\]

where \( \text{EXP}_{st} \) are the exports of sector \( s \) from country \( h \) to country \( t \), while \( \text{EX}_h \) and \( IM_t \) are dummies specific to the countries of origin and destination. Trade barriers are captured by two variables: the bilateral distance (\( \text{distance}_{ht} \)) and the border effect (\( \text{Border}_{ht} \)). The former measures all distance-related trade frictions, the latter additional frictions due to crossing a border. These differ across importing countries and include a language dummy (\( \text{Language}_{ht} \)) that equals 1 when the two countries share a common language. The variables \( \text{Firmshare}_{ht} \) and \( \text{Selection}_{ht} \) control for the unobserved underlying firm-level heterogeneity, which is likely to be correlated with trade flows (Helpman et al., 2008). \( \text{Selection}_{ht} \) also corrects for biases arising from a possible non-random sample selection of the observations (Heckman, 1979). Finally, \( \text{Dummy}_{time} \) is a time dummy and \( \epsilon_{ht} \) is a residual term. We use data for the years from 1999 to 2004 to increase the statistical robustness of the estimated coefficients. Details and robustness checks are provided in Appendix 2 and in the Web Appendix. The interested reader will also find online an Excel spreadsheet providing the country-pair and sector specific values for trade freeness.

Following standard practice in the literature (see Head and Mayer, 2004a), trade freeness from country \( h \) to country \( t \) is defined as:

\[
T_{ht} = \exp(\beta^2 - \lambda \text{Language}_{ht}) \langle \text{Distance}_{ht} \rangle^\delta
\]

where crossing a border and speaking different languages induce a drop in bilateral trade beyond that implied by the distance effect. Within country \( h \) the above expression reduces to \( T_{hh} = \langle \text{Distance}_{hh} \rangle^\delta \), where the internal distance of \( h \) is the weighted average bilateral distance between its biggest cities, with weights reflecting their relative sizes.
Figure 3 shows the ‘freeness of trade’ \( T_{r,t}^{le} \), associated with delivery cost \( d_{r,t}^{le} \), as simple sectoral averages plotted relative to the median sector. *Paper products, printing and publishing* is the manufacturing sector with the highest trade frictions and lowest trade freeness, followed by *non-metallic mineral products, metals and wood products*. On the other hand, *electrical machinery, including professional and scientific equipment* is the sector with the highest trade freeness along with the residual sector of *other manufacturing*.

The results in Figure 3 are broadly in line with previous estimates of trade barriers and border effects in Europe. For instance, in a sample of 12 countries and 113 NACE industries, Head and Mayer (2000) find that, up to 1995, most industries producing machinery (electric and non-electric), leather goods and textiles were relatively open sectors, while carpentry, wooden containers and wood-saving recorded the highest estimated trade frictions along with oil refining and forging. Similarly, using a dataset of 7 European countries and 78 industries, Chen (2004) finds that in 1996 the home bias was highest for ready-mix concrete, carpentry, mortars, printing and publishing and metal structures. With respect to existing literature our results are different only for *food, beverages and tobacco*, a sector which – according to our estimates – enjoys good freeness of trade.

Turning to a geographic perspective, the left panel of Figure 4 shows that, unsurprisingly, accessing foreign markets is easier from core European countries than from peripheral countries.
ones. On the other hand, the accessibility of a country’s markets from abroad is related to its size, as well as to cultural and linguistic factors, though to a smaller extent. In particular, the markets of small countries and of Anglo-Saxon, Germanic and Nordic countries are, on average, more accessible from abroad than those of large and southern countries. These results are in line with Chen (2004), who finds that, in 1996, the reduction in trade flows due to crossing borders (i.e. the ‘border effect’) was the highest for exports from Finland, Spain and Portugal, followed by Italy and France. By contrast, the preference for domestic goods over imports (i.e. the ‘home bias’) was the lowest for the United Kingdom and Germany. Overall, the geographical mapping of trade frictions confirms that, while geography is an important determinant of delivery costs, other factors also have a strong influence.

4.1.2. Calculating the sensitivity to firm selection. As mentioned in Section 3.4, the degree at which sectors adjust to the process of firm selection (or the sector-specific elasticity of the extensive margin $k_s$) is determined by the percentage of firms that exit a sector when the cut-off cost falls by a percentage point. Hence, the larger the elasticity is, the stronger the selection effect of trade liberalization.

We derive such parameter from the distribution of firms across marginal cost levels, as detailed in Box 3. It exploits the fact that, given the same conditions in factor markets, different marginal costs of production across firms stem from their different efficiencies in using capital and labour (i.e. from ‘total factor productivity’ or simply ‘TFP’). In other words, more efficient firms produce more output with the same amounts of inputs, and thus have lower marginal costs. Indeed, the distribution of the inverse of TFP represents the distribution of the marginal costs.

Figure 4. Freeness of trade by country (2001–2003)

Source: CEPII trade data and author’s calculations.
Box 3. Estimation of firms’ marginal costs

We recover the marginal cost of firm $i$ as the inverse of its ‘total factor productivity’ (TFP), which measures its efficiency in the use of available inputs. Our baseline results come from a simple least square (LS) log-linear regression of value added over measures of capital and labour employment. The details of the TFP estimation are reported in Appendix 2. Specifically, we rely on the following log-linear estimation of a Cobb–Douglas production function on firm level data for the years 2001–2003:

$$\ln Y_{its} = \ln A_{its} + a \ln K_{its} + b \ln N_{its} + \text{timedummy} + u_{its},$$

where $Y_{its}$ is output (value added) of firm $i$ in sector $s$ at time $t$, $K_{its}$ is capital input (proxied by fixed tangible assets), $N_{its}$ is labour input (total employment), $A_{its}$ is firm efficiency in the usage of capital and labour (TFP), and $u_{its}$ is a white noise. Inputs $K_{its}$ and $N_{its}$ are recovered from the firm’s balance sheet whereas $A_{its}$ is estimated from the residual of the regression. LS estimations of productivity are carried out separately for each of the 12 manufacturing sectors. Given the likely presence of extreme outliers bound to bias the estimations, firm-level data for value added, employment and tangible assets are trimmed by eliminating the 1% lowest and 1% highest observations. Moreover, the usual LS estimates are replaced by iteratively reweighed least squares, a procedure designed to reduce the influence of outliers. We do not run separate estimations by country assuming de facto that in any given sector countries have the same technology up to a scale factor. While this hypothesis overlooks the possibility of some heterogeneity of technology across countries, it has the important advantage of yielding a more robust estimation of productivity, given that some countries have very few observations in some sectors.

As discussed in Box 1, our data strongly support the idea that, within sectors, marginal costs follow a distribution with a constant elasticity of the extensive margin $k_s$. Its estimates by sector are reported in Figure 5.9

Accordingly, the selection effect is estimated to be the largest in basic metals and fabricated metal products, non-electric machinery, as well as rubber and plastic. They are estimated to be the smallest in textiles, leather products and footwear, chemicals, as well as food, beverages and tobacco.

4.1.3. Computing sector- and country-specific cost cut-offs. In principle, we could have used the cost distribution estimated from firm-level data also to calculate the cut-off cost $\gamma_{kk}^h$. In practice, however, our firm-level data exhibit poor coverage for

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9 The robustness of our results when using alternative estimates of $k$ is discussed in the Web Appendix available at www.economic-policy.org.
some countries, and especially for Germany. This is not much of a problem for the estimation of \( k_s \) as firms in sector \( s \) are pooled across countries to obtain good estimates of such a sector but not country specific parameter. It is, instead, more of a problem for the estimation of the cut-off \( c_i^{bh} \), which is sector-and-country specific. While the cut-off estimates based on firm-level data are reported in the Web Appendix, we prefer to rely on the sectoral productivity statistics publicly available on the EUKLEMS website. For each country and sector, such statistics provide yearly levels of labour productivity (value added per hour worked). This is a productivity measure that differs from TFP in that it measures the efficient use of labour without controlling for non-labour inputs. Its advantage is that it is directly measurable. We use it as our measure of sector- and country-specific productivity after averaging across the years from 2001 to 2003, to smooth out business cycle fluctuations. The inverse of such productivity measure gives us an estimate of average marginal costs. These can be used to recover the cut-off cost \( c_i^{bh} \). Indeed, when the elasticity of the extensive margin is constant, as in our case, the cut-off in sector \( s \) and country \( h \) is obtained simply by multiplying the average cost by a discount factor accounting for the above-mentioned elasticity of the extensive margin (see Box 1 for an explanation of the methodology and Appendix 2 for the country and sector specific coefficients).

After calculating the weighted average of \( c_i^{bh} \) across sectors (with weights determined by sectors’ shares in manufacturing output), the resulting country-level average

![Figure 5. Sensitivity to firm selection](source: Amadeus, authors' calculations.)
cost cut-off represents a proxy for the country’s ‘overall competitiveness’ in the broad sense identified in our conceptual framework, which includes trade frictions, technology, institutional set-up and demand characteristics, among others. The lower the cut-off cost in a country, the higher its overall competitiveness in the sense of a lower average cost and a higher average productivity of its firms. The geographical pattern of overall competitiveness is portrayed in Figure 6, where competitiveness is higher in countries that are at the heart of Europe – such as Belgium, the Netherlands and Germany – and in Finland. This is consistent with the prediction of the theoretical framework that countries that are large or easily accessible to firms from trading partners should exhibit a tougher competitive environment and stronger selection. Italy, Spain and Portugal are at the bottom of the table because of a less central location and a possible technology disadvantage, which is associated with high entry costs in new sectors.

4.2. Calibrating the remaining parameters of the model and deriving the indicator of producer competitiveness

We are now ready to select values for the unobservable parameters (product differentiation $D_s$, the absolute advantage $o^b$ and the entry cost $f^b$) that make the model exactly match the estimated cost cut-offs $c^b_t$, given the values of all other directly measured or estimated parameters. See Box 4 for details.
Box 4. Calibration

In Appendix 1 we show that the equilibrium domestic cut-off in country $h$ is determined by the following expression:

$$
\epsilon^h = \left[ \frac{2D_s(k_s + 1)(k_s + 2) \sum_{s=1}^{12} |C_{st}^h|}{|T_s|} \right]^{\frac{1}{k_s+2}}
$$

where $\alpha^h = 1/\epsilon^h$ is the index of absolute advantage, $|T_s|$ is the determinant of the matrix whose element $T_{st}^{ht}$ indexes the freeness of trade from country $h$ to country $t$, and $|C_{st}^h|$ is the co-factor of that element.

In the above expression market size $L^h$ is directly measurable. The bilateral freeness of trade $T_{st}^{ht}$ and the elasticity of the extensive margin $k_s$ can be estimated. The remaining parameters – namely the product differentiation $D_s$, the absolute advantage $\alpha^h$ and the entry cost $f_i^h$ – are neither directly measurable nor estimable with the available data. For each sector, however, we can estimate the cost cut-off $\epsilon^h$ for our 12 countries. This allows us to select values for (i.e. to “calibrate”) the unobservable parameters $D_s$, $\alpha^h$ and $f_i^h$ so that the model exactly matches the estimated cut-offs. In particular, after writing an expression like the one above for each of our 12 countries, we can solve the resulting system of 12 equations for the 12 unknown parameter bundles $[f_i^h/(\alpha^h)^{k_s}]$ that make the model predict the 12 estimated values of the cut-offs. We can then separate the sector specific component $D_s$ from the sector- and country-specific one $[f_i^h/(\alpha^h)^{k_s}]$. Details are provided in Appendix 2.

In the simulations presented in Section 5, the above expression is used, in the opposite direction, to predict the impact of changing trade freeness $T_{st}^{ht}$ on the cost cut-off $\epsilon^h$, holding $D_s/[f_i^h/(\alpha^h)^{k_s}]$ constant at its calibrated value.

The results of the calibration allow us to obtain separate values for sector specific product differentiation $D_s$ from a sector- and country-specific bundle of technological parameters $[f_i^h/(\alpha^h)^{k_s}]$. This value measures the difficulty of country $h$ to generate low-cost firms in sector $s$ due to high entry costs and low absolute advantage in production. Hence, calculating its weighted average across sectors (with weights determined by sectors’ manufacturing output shares) yields an index of the ability of country $t$ to generate low cost firms abstracting from its market size and accessibility. We call this index ‘producer competitiveness’ (see Figure 7) to distinguish this concept from ‘overall competitiveness’. It is a measure of competitiveness that depends solely on technology.
(i.e. the ability to produce at low cost) and institutional factors (i.e. cost of entry in a sector). As such, the index ‘producer competitiveness’ can be interpreted as the relative performance of countries in an ideal world in which all firms face the same barriers to international transactions in all countries. The index of ‘overall competitiveness’, by contrast, quantifies the actual performance of countries in the real world.
According to this second ranking (see Table 1 for a comparison between the two indicators), the following interesting results emerge. First, Sweden becomes the second most competitive country in terms of producer competitiveness. This implies that the country shows a strong technology advantage (large \( o' \)) and/or a good institutional environment (low \( f' \)), but has a disadvantage in terms of location (since it ranks only eighth in terms of overall competitiveness). Hence, being at the periphery does not per se represent a problem for a country, unless it is compounded by clear relative technological and institutional disadvantages that hamper firm productivity. In this context, it is worth noticing a rather substantial improvement in the ranking of Denmark, in terms of producer competitiveness compared to its ranking in terms of overall competitiveness. The opposite is true for Belgium, Germany and the Netherlands, whose rankings in terms of producer competitiveness are substantially lower than those in terms of overall competitiveness. This signals weak technology advantages and/or a worse institutional environment, only partially offset by their central location. Finally, Portugal and Spain – and, to a lesser extent, Italy and UK – are consistently at the bottom of the competitiveness ranking, no matter how this is measured, suggesting the presence of parallel negative impacts of all the determinants of competitiveness identified in the model, namely geographical location, market access, technological and institutional (dis)advantage.

4.3. Validation

After fitting the model to reality and before using it to simulate counterfactual scenarios, we need to check its consistency with additional features of the data, different from those used in its calibration, i.e. different from the cut-off costs. Obvious targets are some key features at both firm and sector levels.

At the firm level, Table 2 reports several quantitative predictions of the model that could be compared with cross-country data. The second column shows the prediction that exporters are a small subset of the total number of producers. Moreover, the third, fourth and fifth columns respectively show that the model also predicts that exporters are a selected elite, being larger, more productive and more price competitive than non-exporters. The reported numbers are so-called exporters’ ‘premia’ defined as ratios of exporters’ values to non-exporters’ values.

Unfortunately, the limited availability of firm-level data constrains the number of predictions that can actually be compared with adequate observations. Mayer and Ottaviano (2007) report some information on a subset of countries. According to Table 2 of that study, the actual percentages of exporters in France and Germany are 67% and 59% respectively. These percentages are higher than those predicted in our Table 2 (45% and 36% respectively). Likewise, the predictions of the model for Italy and the United Kingdom (both at 20%) are smaller than the percentages reported in Mayer and Ottaviano (2007), namely 64% for Italy and 28% for the United Kingdom.

Table 4 in Mayer and Ottaviano (2007) also reports exporters’ premia. Their size premia for France, Germany, Italy and the United Kingdom are 2.24, 2.99, 2.42 and
1.01 to be compared with 3.08, 2.53, 2.31 and 2.11 in our Table 2. In the case of Belgium, the size premium reported by Mayer and Ottaviano (2007) is 9.16, which is far larger than the predicted 2.18. This can be explained by the fact that their Belgian sample is exhaustive and, therefore, includes a large number of small firms that are excluded from the Amadeus dataset. Overall, while better – but currently unavailable – firm-level data would be needed to refine both calibration and validation, there seems to exist some remarkable conformity between the actual patterns and those predicted by our stylized theoretical framework.

Turning to the sectoral level, we compare the pattern of competitiveness predicted by the model to check its consistency with aggregate export performance. In particular, our model predicts that, in some industries more than in others, countries generate highly productive and thus internationally competitive firms. As a result, they should be net exporters of the goods supplied by the former sectors and net importers of the goods supplied by the latter sectors. A way to see whether this prediction is consistent with reality is to check the sign of the correlation between an index of relative productivity and an index of export specialization across sectors (see Box 5 for details). If the predictions of the model are consistent with the observation, such a correlation should be positive. Table 3 confirms that this is indeed the case for 11 out of 12 sectors.

### 5. GAINS FROM THE EURO

Has the introduction of the single currency affected the intensity of competition in the euro area and forced least efficient firms out of the market? If so, to what extent has this selection process affected unit delivery costs, mark-ups, prices, quantities,
Box 5. Relative productivity and export specialization

Following Mayer and Ottaviano (2007), we measure the relative productivity for country $h$ in sector $s$ as the ‘estimated comparative advantage’ (ECA), which is defined as:

$$ECA_{h,s} = \frac{P_{h,s} / \bar{P}_h}{P_{w,s} / \bar{P}_w}$$

where $P_{h,s}$ is productivity (the inverse of the cost cut-off $c^t_{bh}$) of country $h$ in sector $s$ while $w$ is the label for the group of the other countries in our sample. The averages $\bar{P}$’s are defined as:

$$\bar{P}_h = \frac{\sum_{s=1}^{n} P_{h,s}}{n}, \quad \bar{P}_w = \frac{\sum_{h=1}^{m} \sum_{s=1}^{n} P_{h,s}}{m \cdot n}$$

where $n$ is the number of sectors (12) and $m$ is the number of countries (also 12). The index is larger (or smaller) than one if country $h$ is relatively more (or less) productive in industry $s$ than the other countries. In this case, country $h$ is said to exhibit an estimated comparative advantage (or disadvantage) in industry $s$.

We quantify export specialization of country $h$ in sector $s$ by a standard measure, the ‘index of revealed comparative advantage’ (RCA) which is defined as:

$$RCA_{h,s} = \frac{X_{h,s} / X_h}{X_{w,s} / X_w}$$

where $X$ designates exports. This index is larger (or smaller) than one if the exports of country $h$ are more (or less) specialized in industry $s$ than the exports of the other countries. In this case, country $h$ is said to exhibit a revealed comparative advantage (or disadvantage) in industry $s$.

The correlations between the two indices in our sample are reported in Table 3.

revenues and profits? Are countries that are eligible to adopt the euro losing anything in terms of economic gains?

To answer these questions, we simulate on our calibrated model three counterfactual scenarios of alternative euro area membership set-ups. The baseline is the actual cross-country pattern of overall competitiveness in 2003, as estimated through the cut-off costs in the previous section: countries with lower cut-off costs are generally more competitive. In the counterfactual scenarios, we let some countries change
status with respect to their participation in Stage 3 of the European EMU. Since changes in euro area membership affect trade frictions among our countries, the alternative scenarios are generated by altering the trade freeness parameters $T_{ij}^k$ in the appropriate way. Then, holding all other parameters constant, we use our model to simulate the resulting cut-off costs for each scenario (see Box 4), and compare them with the baseline.\(^\text{10}\)

### 5.1 Trade freeness and the euro

In the logic of our framework, abandoning the euro results in trade frictions. Accordingly, we generate our counterfactual scenarios by changing the bilateral trade frictions as follows. When two countries use the euro in the baseline scenario, while they do not do so in the counterfactual scenario, we increase their bilateral trade frictions. When two trading partners do not share the same currency in the baseline scenario, while they do so in the counterfactual scenario, we decrease their bilateral trade frictions.

In order to proxy the impact of the euro on trade frictions, we rely on the findings from the substantial body of empirical research that in the past decade has investigated the trade-enhancing effects of the euro and, in general, of monetary unions. Results are very heterogeneous due to the adoption of different econometric specifications. Nonetheless, economists seem recently to be reaching the consensus view that the euro has had a positive effect on trade, though smaller than previously thought. The single currency appears to have boosted the growth of euro area countries’ trade on average by a figure below 5 percentage points of the country’s total trade growth.\(^\text{11}\)

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\(^{10}\) We present here our baseline results. Their robustness to alternative measures of trade freeness and productivity is checked in the Web Appendix available at www.economic-policy.org.

\(^{11}\) For details on the comparative evaluation of methodologies used to capture the trade impact of the euro, see e.g. Baldwin and Taglioni (2007). On the need to disentangle appropriately the effects of the euro from those of other EU integration measures, see e.g. Baldwin (2006).
To generate our counterfactuals, we select two studies, by Flam and Nordström (2003) and by Baldwin and Taglioni (2008), as respectively providing the upper and the lower bounds of the estimated impacts of the euro on trade frictions. These are reported in Table 4 where column ‘FN’ refers to the former and column ‘BT’ to the latter. We use them to increase/decrease our bilateral measures of the freeness of trade in the various scenarios.

5.2. Three counterfactual scenarios

Three scenarios are particularly revealing when it comes to highlighting the effects of the euro on countries’ overall competitiveness. In the first, we see what happens when all euro area countries drop the single currency. In the second, we study the implications of Denmark, Sweden and the United Kingdom adopting the euro. In the third, we assess the impact of France abandoning the euro and reverting to the French franc as its national currency.

5.2.1. Scenario 1. For the first scenario, we increase trade frictions within the euro area by either 2% or 8.8% (see first row of Table 4) and those from the euro area to the non-euro area (Denmark, Sweden and the United Kingdom) by either 3% or 7.1% (see third row of Table 4).

The results, reported in Figure 8, are shown both in terms of new implied cut-off costs for individual countries and – in the chart on the right – as a difference with respect to the previously computed domestic cut-off, used as a baseline. Had all euro area countries reverted to their national currencies in 2003, the average loss in overall competitiveness for Europe as a whole – as measured by higher cut-off costs – would have been substantial. As expected, all euro area countries would have lost, in particular the relatively small euro area countries (most notably Finland, followed by Belgium and Austria). In comparison, gains accrued to non-euro area countries would have been rather minor and limited only to Denmark and Sweden, with the United Kingdom basically remaining unaffected.
In order to provide a benchmark for the gains/losses resulting from dropping the euro, Figure 8 also shows ranges resulting from a comparison of the effects of increasing or reducing trade protection by 5% in all countries in the sample. Two comments are in order. First, the extent of the losses in overall competitiveness resulting from a dissolution of the European currency union (Stage 3 of the EMU) are about the same size – or actually slightly larger – than the losses caused by a 5% increase in trade protection. Second, increasing trade protection by 5% has an asymmetric effect with respect to decreasing it by 5% from the same initial situation. For example, Finland appears to be clearly more disadvantaged by an increase in protection than it is favoured by a reduction. The opposite is true for other countries. This is due to the fact that the effects of trade liberalization are non-linear.

Taking a sectoral perspective, Figure 9 reveals that the industry in which firm productivity falls the most is electric machinery, followed by basic metals and fabricated metal products and transport equipment. This is due to a combination of trade freeness and the sensitivity to firm selection. In particular, according to the evidence reported in Figure 3 and Figure 5, electric machinery and transport equipment are both characterized by a relative dominance of small unproductive firms and a relatively high openness to international competition. For both reasons, selection effects are strong in these sectors, making them more sensitive to frictions related to the existence of different currencies and other trade barriers. While trade freeness is below the median in basic metals and fabricated metal products, this sector ranks first in terms of the sensitivity to firm selection (or elasticity of the extensive margin), which explains why it also exhibits a strong selection effect.
To summarize, reverting to national currencies reduces the overall competitiveness of all euro area countries while generating small productivity gains for non-euro area countries. These effects are stronger for smaller countries with better access to European markets and specialized in sectors with higher trade freeness and higher sensitivity to firm selection. The same logic will explain what we find in the following scenarios.

5.2.2. Scenario 2. For the second scenario, we reduce trade frictions between the euro area and Denmark, Sweden, the United Kingdom by either 3% or 7.1% (see third row of Table 4) while obviously leaving unchanged trade frictions within the euro area. The results of the corresponding simulation are reported in Figure 10. The benchmark range is now generated by the effects of increasing/decreasing trade protection between euro area and non-euro area countries by 5%.

Overall, the average impact for Europe as a whole is positive, although rather small. Only two of the three non-euro area countries (namely Denmark and Sweden) would gain in terms of overall competitiveness to an extent similar to an across-the-board reduction of trade frictions by 5%, while the United Kingdom would record an only minor gain. As for the euro area countries, the changes in overall competitiveness are very modest, except in the case of Finland, which sees its competitive position worsening because of proximity to Denmark and Sweden.

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**Figure 9. Impact on specific industries when all countries reverted to national currencies in 2003 (Scenario 1)**

*Note:* Higher values than the baseline cut-off costs indicate losses in competitiveness and are shown in the chart in terms of changes from baseline with a negative sign; term ‘5% more protection’ indicates the losses arising from a uniform 5% increase in all trade frictions relative to their real value. Conversely the term ‘gains 5% freer trade’ indicates the gains from a 5% reduction of all bilateral trade frictions.

*Source:* Authors’ calculations.

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12 Figure 10 also shows the rather remarkable gains for Denmark from a 5% decrease in trade frictions. The reason is the critical importance of Sweden as a trading partner for a rather small and nearby country like Denmark.
5.2.3. Scenario 3. Finally, for the third scenario, we change only the trade frictions for French exports to the euro area, increasing them either by 2% or 8.8% (see first row of Table 4). The benchmark range is generated by the effects of increasing/decreasing trade protection between France and the other euro area countries by 5%.

Figure 11 shows that the loss in overall competitiveness for France is rather notable, ranging from 1.4% to 5.8%. The fact that all other countries are hardly affected is in line with the logic of the model. When market size matters, a departing partner faces a sharp reduction in market access across the board, while remaining members compensate for the negative impact of such departure by strengthening trade among themselves.

To summarize, the introduction of the euro appears to have benefited the overall competitiveness of member countries as defined in our ‘holistic’ framework that combines the effects on delivery costs, mark-ups, prices, quantities, revenues and profits. The impact appears to be relatively stronger for small central countries specialized in sectors that (i) are relatively tradable, so that euro-related frictions are more relevant for them, and (ii) have large fractions of small inefficient firms, so that selection effects via firm entry and exit are stronger for them.

6. CONCLUSION AND POLICY IMPLICATIONS

In this paper, we have exploited available data to calibrate a state-of-the-art trade model that we have used to quantify the microeconomic benefits of the euro. These
benefits, which are due to an enhanced price transparency and lower transaction costs, arise from a further specialization of countries in sectors in which they are more efficient, from richer product variety, from weakened market power on the part of firms, from a better exploitation of economies of scale and from improved production efficiency through the exit of the least efficient firms.

The model has been calibrated on 12 manufacturing sectors across 12 EU countries for the years from 2001 to 2003 and has been used to evaluate the competitiveness of European manufacturing firms in terms of an efficient usage of available inputs. In so doing, we have derived a ranking of European countries in terms of the cost effectiveness of the firms located therein – which we have taken as an indicator of the ‘overall competitiveness’ of the corresponding countries. This indicator has then been used as a benchmark for two sets of experiments. First, in order to distinguish the extent to which the ability of a country to generate low-cost firms stems from aspects related to technology, versus market size and accessibility, we have derived another indicator, which we have called ‘producer competitiveness’. This indicator gives us the extent to which a country would be competitive in an ideal world in which trade frictions did not matter.

In the second set of experiments, we have simulated three counterfactual scenarios designed to evaluate how alternative (and hypothetical) euro membership set-ups would have affected the baseline overall competitiveness of the European countries considered. In the first scenario, in which all members of the euro area are assumed to have dropped the single currency in 2003, the average loss in their overall competitiveness ranges from 1.4% to 3.3%. In the second scenario, in which Denmark, Sweden and the United Kingdom adopt the euro in 2003, the average gain in overall

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**Figure 11. France reverts to the French Franc in 2003 (Scenario 3)**

*Note: Higher values than the baseline cut-off costs indicate losses in competitiveness and are shown in the chart in terms of changes from baseline with a negative sign; the term ‘5% more protection’ indicates the losses arising from a 5% increase in trade frictions for trade involving France.

*Source: Authors’ calculations.*
Competitiveness for those countries ranges from 1.5% to 3.4%. In the third and last scenario, in which France reverts to the French franc in 2003, the average loss in French overall competitiveness ranges from 1.4% to 5.8%.

Our findings have several policy implications. First, the impact on trade flows is at best only a first approximation of the possible gains arising from the euro. The reason is that trade creation is not a welfare gain in itself, but rather a channel through which different types of microeconomic gains can materialize. This casts a shadow on the customary obsession with the effects of the euro on trade flows.

Second, market size and accessibility are not the only key drivers of competitiveness. In particular, Mediterranean countries remain at the bottom of the competitiveness league even after controlling for their peripheral location, as shown by the rather insignificant difference between their indicators of overall and producer competitiveness. This suggests that being peripheral does not per se represent the problem with these countries. High entry barriers and poor technological opportunities seem to be more important.

Third, small central countries specialized in tradable sectors – especially if characterized by a relative dominance of small and medium-sized enterprises (SMEs) – experience the strongest reactions to our counterfactual experiments, which suggests that these countries gain most from the euro.

Finally, our methodological approach should be thought of as a practical second-best solution to concrete, but hopefully temporary, constraints on firm-level data availability that prevent a full-fledged econometric investigation. Its main shortcoming is its forced reliance on a complex theoretical structure. In this respect, our results should be interpreted as the ‘partial effects’ of the euro, holding constant all the features of the economy that the theoretical model keeps constant in the first place, such as nominal wages and aggregate employment in the selected European countries, as well as competitiveness elsewhere in the world.

Discussion

Kevin O’Rourke
Trinity College Dublin

This is an ambitious paper on an important issue. It is notable in its use of very recent developments in trade theory. It shows that these developments are helpful in understanding important policy issues. And the empirical strategy adopted in calibrating the model is extremely ingenious, and represents an astonishing amount of work.

I particularly welcome the close attention paid to calibration in this paper, since in any simulation exercise calibration will matter for the results as much as model structure, but too often little attention is paid to it. I like the fact that since the model is symmetric across countries, differences in the results for different countries will depend crucially on calibration. The question then arises is, do the numbers make sense? I was pleased
to see that in this version of the paper the numbers seem to make a lot more sense than in previous drafts, although there remains the question of how representative the Amadeus database is, and in particular the question of whether it is equally representative for all countries, given its focus on large firms. One finding that may strike some readers as strange is the low ranking of United Kingdom in the two competitiveness tables produced by the calibration exercise. This is a reminder, I suppose, that this exercise is limited to the manufacturing sector, and that one might expect the financial services sector to also be influenced by the introduction of the euro. However, one has to start somewhere, and the authors can hardly be accused of a lack of ambition.

The authors are to be commended for the way in which they confront the predictions of their model with reality, where this is possible. I find their predicted share of exporting firms for Portugal (1%) to be worryingly low, and the model seems to underpredict this figure more generally across all countries. I would be interested to find out more about why this is the case.

The results also depend crucially on the experiment conducted with the calibrated model. Drawing on existing gravity studies, the authors model the introduction of the euro as a lowering of trade costs between euro countries, and a lowering of trade costs for Eurozone exports to the non-euro area. There is, however, relatively little impact on the trade costs facing non-Eurozone firms exporting to the euro area. It is disappointing that the realism of these shocks depends crucially on the accuracy of gravity studies, since these have come up with such a wide range of estimates. More seriously, one might ask whether the effect of the euro was really the same as that of an across-the-board decline in trade costs. We typically think of single currencies as eliminating risk, and there may be reasons why such risk reduction would be more valuable in particular sectors than in others. On the other hand, it is hard to think of an alternative empirical strategy which the authors could realistically have pursued.

It is a shame, given the authors’ comments regarding gravity studies, and the fact that trade flows are not a measure of welfare, that this exercise has not yielded any welfare measures itself (although clearly the competitiveness results presented here are getting us a lot closer to welfare than results regarding the volume of trade). More generally, I would have liked the authors to discuss how the results of the study might be biased, if at all, by its partial equilibrium nature, and by its neglect of factor endowment differences between countries.

Ekaterina Zhuravskaya
New Economic School and CEFIR

The New Trade Theory paradigm (e.g., Melitz, 2003) implies important microeconomic effects of trade liberalization in addition to the classic Ricardian macroeconomic effect of specialization in sectors with a comparative advantage. Namely, trade liberalization should lead to significant changes within sectors: growth of the most efficient firms, a richer variety of goods, tougher competition (i.e., smaller mark-ups), and, consequently, exit of the least efficient firms. Despite the fact that these changes have (in theory) a
first order effect on the competitiveness of trading partner countries, many policy settings do not allow a direct estimation of the microeconomic effects of trade liberalization due to a lack of microdata comparable across countries. Ottaviano, Taglioni and di Mauro suggest an alternative approach: develop a model with a closed-form solution, estimate those parameters of the model which can be directly estimated with the available data, and deduce the rest of the parameters from a calibration exercise in which the verifiable model’s predictions fit the actual data patterns. They develop a state-of-the-art New Trade Theory general equilibrium model and calibrate it using country, sector, and firm-level data. The paper is a great and rare example of using cutting-edge theory tools to address policy-relevant questions.

Ottaviano et al. apply their methodology to study the effect of changes in the composition of the European Monetary Union (EMU), which are modelled as having a trade liberalization effect through an increase in price transparency and a decrease in transaction costs and exchange-rate risk. The paper addresses a very important policy issue: how the European currency union affects the competitiveness of European firms. To be more precise, the paper quantifies the effects of possible changes in the composition of the EMU on average productivity of manufacturing firms in each of 12 considered EU countries located both within and outside the Eurozone. The authors give definitive answers to these questions: What are the benefits of the Union for member countries? What would happen to the competitiveness of European firms if the UK, Denmark or Sweden were to join, or France were to exit the Eurozone?

The results of the paper constitute a significant contribution that informs the policy debate on the effects of currency unions. Ottaviano et al. conduct counterfactual experiments on the effects of changes in the Eurozone. Had all nine members of the EMU reverted to their initial national currencies in 2003 without any change in the national currencies of the UK, Denmark and Sweden, the average competitiveness of European firms would have dropped significantly. Moreover, every member of the EMU would have lost in competitiveness, with the largest losses occurring in Austria, Belgium and Germany; while there would have been hardly any gain in countries initially outside the EMU. Had the UK, Denmark and Sweden entered the Eurozone in 2003, Denmark and Sweden would have had a substantial increase in their competitiveness, the UK would not have gained much, while Finland would have been the only country which would have lost a substantial amount due to increased competition from its immediate neighbours. If France had switched back to the franc from the euro and no other country changed its currency in 2003, France would have had a sizeable decline in its competitiveness and other countries would have experienced practically no change in their competitiveness. These exercises demonstrate that the focus of previous literature on trade flows (see, for instance, Alesina, Barro and Tenreyro, 2007) missed out on important productivity gains from adopting the euro.

If applied to a wider set of countries, the methodology developed by Ottaviano et al. would also allow for answering a related question that is high on the European policy agenda after the EU enlargement: What are the costs and benefits of including
new member states (such as Poland or the Czech Republic) in the EMU from both the perspective of competitiveness of firms of the old member states and from the perspective of newcomers?

One of the building blocks of the methodology developed in the paper has a direct policy implication of its own. The paper evaluates the relative contribution of two sets of factors to the overall competitiveness of each country: the first group of factors are the standard inputs into the gravity equation, i.e., market size and accessibility; the second group of factors includes institutional quality and the technological possibility set of the country. In particular, the paper demonstrates the role of technological advances and freeness of entry regulation as key drivers of the competitiveness of such relatively peripheral European countries as Spain, Portugal and Finland. Spain and Portugal lose out to the rest of the 12 EU countries in terms of competitiveness even after taking their market size and distance into account; in contrast, Finland ranks very high in terms of overall competitiveness despite its remoteness and relatively small size. This suggests a public policy strategy to improve competitiveness for Spain and Portugal focusing on liberalization of entry regulations and general improvement of the business climate.

It is important to recognize that the authors’ approach is based on theory that necessarily implies assumptions leading to the simplification of reality. Some of these assumptions are more innocuous than others. For example, the authors’ calculation is valid under the assumption of fixed wages and labour supply, which gives it a short-run partial equilibrium flavour. In addition, throughout the paper, competitiveness of the rest of the world is held constant. Yet, the patterns predicted by the model for the 12 EU countries suggest that many countries outside the EU are also quite likely to be affected by changes in the Eurozone, and this, in turn, should have a spillover effect on EU countries that is not accounted for in the present calculation. Changes in the EMU should have especially pronounced effects in emerging markets which have (or potentially could have) high volumes of trade with European countries. There could be two countervailing effects at work here. On the one hand, the effect of the euro on trade liberalization is similar to that of a preferential trade agreement. Thus, one should expect trade diversion for emerging markets outside the European Union. On the other hand, enlargement of the Eurozone should substantially decrease trans-action costs and foreign exchange risk for emerging markets that use the euro as a reserve currency. This, in turn, may create an important competitive pressure from outside the EU. Therefore, policy analysis should try to take these effects into account.

A key input into the calculation of the size of the effects in the paper are the estimates of the effect of the euro on trade frictions. They are borrowed from the literature, and are used by Ottaviano et al. to assess changes in the bilateral freeness of trade in the considered hypothetical scenarios. There is, however, no consensus in the literature about the size of the effect of the euro on trade frictions. This is reflected in a four-fold difference in the size of estimates from two sources, Flam and Nordstrom (2003) and Baldwin and Taglioni (2008) (based on different methodologies and different time periods). These estimates are used by the authors as the upper and
lower bounds for the effect. Such a large spread of the input into the calculation, not surprisingly, produces a large spread in the predicted effect of EMU changes on competitiveness in the considered scenarios. Yet, there is a potentially more important concern that further lowers confidence in these estimates. The effect of the euro on trade frictions was estimated based on actual changes in the monetary union that can hardly be considered random; moreover, the decisions of countries to join the EMU surely are related to their expectations about the benefits from the Union. In particular, it is conceivable that countries that expected to have a larger liberalizing effect of euro on trade had already entered the EMU, and the rest of the eligible countries would have had a lower effect had they joined (which may have been the reason not to join in the first place). This creates a problem for applying these estimates when evaluating the counterfactual scenarios in which non-members (such as the UK, Denmark and Sweden) join the Eurozone. This is a serious concern that needs to be taken into account in the policy discussion, but it is worth keeping in mind that it applies to the whole body of literature in this area and not just to this paper. In addition, this concern applies to a lesser extent to the other two counterfactual exercises, as their focus is on the effects of reverting from the euro for those countries which initially joined the EMU. So, under a reasonable assumption of symmetry in the effects of entering and exiting the Eurozone, the predictions of this paper about the effects of reverting from the euro should be valid ones.

Panel discussion

The panellists focused first on the theoretical framework of the paper. Jean Imbs noticed that the Melitz and Ottaviano (2008) framework models both decisions to export and decisions about firm location, and wondered which of these are crucial in this paper’s approach. The authors replied that from a long-run perspective the decision is immaterial, but admitted that in the short run firms may be able to relocate production plants without drawing a new competitiveness realization in the new location. Jean Imbs agreed that exit and location effects of a permanent and credible regime change can be similar, however in the long run decisions about relocation are also potentially driven by market-access considerations, and this should be taken into account by the model. Diego Puga noted that while the theoretical model can only be solved with a specific distribution, this paper’s calibration exercise could use the actual observed distributions. The authors argued that the results would be similar for more general distributions, including the actual observed one. The panel then questioned the suitability of the paper’s framework of analysis. Josef Zweimuller wondered how robust the conclusions were to a general equilibrium experiment, where income effects would perhaps strengthen the effect of the introduction of the euro. Massimiliano Marcellino argued that joining or abandoning the euro would also have implications
for taxes and interest rates and wondered which assumptions the authors made with respect to the latter.

Then, the discussion focused on methodological issues. On calibration, Morten Ravn said that a structural model would allow the authors to generate data from the model and see whether the data generating process can be recovered from regressions like those used to calibrate it. Kevin O’Rourke suggested to validate the model on patterns of comparative advantage, too. On the simulation part, Ravn said that he had doubts that all the experiments are interesting ones. Christian Shultz added that Denmark and Sweden do not enter the euro for reasons different from monetary policy independence (Denmark, for instance, is already basically pegged); hence, tradability effects are likely to be different. Jacques Melitz noticed that the various numbers reported are not necessarily coherent, but intriguingly indicate that some countries may gain if a country exits but then lose if all exit.

APPENDIX 1: THE CALIBRATION MODEL

This appendix presents the main equations of the model we calibrate. It is aimed at making the paper self-contained, so that only necessary information is provided. Interested readers should refer to Melitz and Ottaviano (2006) as well as to Del Gatto et al. (2006).

The inverse demand of a consumer in country \( h \) for the variety of firm \( i \), when a set \( \Omega \) of alternative varieties are on offer in sector \( s \), is given by:

\[
p^h(i) = A_s - D_s e^h(i) - B_s \int_{i \in \Omega} e^h(i) \, di
\]

which shows that, if the firm wants to increase the quantity sold \( e^h(i) \), it has to lower its price \( p^h(i) \). For an envisaged increase in quantity, the price drop is the larger, the smaller is \( D_s \), which is thus a measure of product differentiation. The firm is unable to sell any quantity at all if it prices above the ‘choke price’ \( p^h_{i, \text{max}} = A_s - B_s \int_{i \in \Omega} e^h(i) \, di \) at which \( J_s^h e(i) \) nullifies. This threshold price falls as the total quantity \( \int_{i \in \Omega} e^h(i) \, di \) brought to the market by all firms increases. Equivalently, it falls as the average price \( p^h \) falls and the total number of firms \( N^h \) increases given that (1) allows us to write

\[
p^h_{i, \text{max}} = \frac{D_s A_s - B_s N^h}{D_s + B_s N^h}.
\]

Pricing closer to this choke price implies an increase in the elasticity of demand as this evaluates to

\[
\varepsilon^h(i) = \left( \frac{p^h_{i, \text{max}}}{p^h(i)} - 1 \right)^{-1}.
\]

The firm producing variety \( i \) for \( L^h \) consumers in country \( h \) faces a total demand equal to \( q^h(i) = L^h e^h(i) \). If it draws a marginal cost \( c \), the profit-maximizing quantity sold to domestic consumers is
where $c_{s}^{hh}$ is the maximum cost at which the quantity sold is (marginally) positive. Analogously, the profit maximizing quantity sold to foreign consumers in country $t$ is

$$q_{s}^{ht}(c) = \frac{L_h}{2D_t}(c_{s}^{ht} - c)$$

where $d_{ht}^{hh} > 1$ is the factor measuring the cost increase per unit sold that is linked to international deliveries. Hence, the marginal exporter from country $h$ to country $t$ is necessarily $d_{ht}^{hh}$ times more efficient than the marginal local producer in country $t$, i.e. $c_{s}^{ht} = c_{s}^{tt}/d_{ht}^{hh}$. Quantities (4) and (5) are both decreasing in $c$, meaning that less efficient firms are able to sell lower quantities and therefore achieve a smaller market share.

The case of two identical countries (such that $L_h = L_t$, $d_{ht}^{hh} = d_{tt}^{hh}$ and $c_{s}^{hh} = c_{s}^{tt}$) is represented in the top panel of Figure 1 in the main text.

If entrants draw their marginal costs from a Pareto distribution with cumulative density function $G_{s}^{h}(c) = (c/c_{s0}^{h})^{k}$ and probability density function $g_{s}^{h}(c) = k c^{k-1}/(c_{s0}^{h})^{k}$ (the latter is portrayed in the middle panel of Figure 1; see Box 1 for details), all average performance measures of the industry in country $h$ are directly determined by the domestic cut-off. In particular, the average marginal cost, the average price and the average markup are respectively:

$$\bar{c}^{h} = \frac{k_{s}}{k_{s} + 1} c_{s}^{hh}, \quad \bar{p}^{h} = \frac{2k_{s} + 1}{2(k_{s} + 1)} c_{s}^{hh}, \quad \text{and} \quad \bar{m}^{h} = \frac{c_{s}^{hh}}{2(k_{s} + 1)}.$$  

The average quantity, the average revenue and the average profit are:

$$\bar{q}^{h} = \frac{L_{h}}{2D_{t}} \frac{c_{s}^{hh}}{k_{s} + 1}, \quad \bar{r}^{h} = \frac{L_{h}}{2D_{t}} \frac{(c_{s}^{hh})^{2}}{k_{s} + 2}, \quad \text{and} \quad \bar{p}^{h} = \frac{L_{h}}{2D_{t}} \frac{(c_{s}^{hh})^{2}}{(k_{s} + 1)(k_{s} + 2)}.$$  

The (indirect) utility associated with demand (1), as achieved by a local resident, is

$$U^{h} = I^{h} + \frac{1}{2B_{s}} (A_{s} - c_{s}^{hh}) \left( A_{s} - \frac{k_{s} + 1}{k_{s} + 2} c_{s}^{hh} \right)$$

which shows that any decrease in the domestic cut-off $c_{s}^{hh}$ generates higher welfare.

At the entry stage firms incur the sunk entry cost $f_{s}^{h}$ in country $h$ until this is exactly matched by expected profits. Since all firms are identical before drawing their marginal costs, they share the same expected profits. For each possible country of destination $t$, these consist of two ingredients: the profit of the average seller in the market

$$\bar{\pi}^{ht} = \frac{L_{h}}{2D_{t}} \frac{(c_{s}^{tt})^{2}}{(k_{s} + 1)(k_{s} + 2)},$$

and the probability of being efficient enough to sell in that market
where the second equality is granted by $c^h_s = c^i / d^h_s$ and by the definition of the bilateral trade freeness index $T^h_s = (d^h_s)^{-k}$. Summing up across all 13 countries of destination, expected profits match the sunk entry cost as long as

$$\sum_{s=1}^{12} \text{prob}^h_s \cdot p^h_s = \frac{(c^h_s)^{-k}}{2D_s(k_s + 1)(k_s + 2)} \sum_{s=1}^{12} [T^h_s (c^i)^{k_s + 2} L_k] = f^h$$

which is portrayed in the bottom panel of Figure 1 in the case of two identical countries.

Since a free entry condition like (11) holds for each of our 12 EU countries, we have a system of 12 equations in 12 unknown domestic cut-off costs. Its solution gives an equilibrium domestic cut-off cost for each country:

$$c^h_s = \frac{2D_s(k_s + 1)(k_s + 2)}{L^k} \sum_{s=1}^{13} \left| C^h_s \right| \left[ \left( f^h (c^i)^{k_s} \right) \right] \left| T_s \right|^{1/k}$$

where $c^h_s = c^h / d^h_s$ is the index of absolute advantage, $\left| T_s \right|$ is the determinant of the trade freeness matrix, whose element $T^h_s$ indexes the freeness of trade from country $h$ to country $t$, and $\left| C^h_s \right|$ is the co-factor of its $T^h_s$ element. In the case of two identical countries the cut-off cost corresponds to the intersection between the entry cost and the expected profit curves in Figure 1.

Finally, the model also yields a ‘gravity equation’ for aggregate bilateral trade flows. A firm operating in sector $s$ with cost $c$ and exporting from country $h$ to country $t$ generates export sales $r^h_s(c) = p^h_s(c)q^h_s(c)$ where the quantity exported $q^h_s(c)$ is given by (5) with the associated price

$$p^h_s(c) = \frac{1}{2s} \left( c^h_s + d^h_s c \right).$$

Aggregating these export sales $r^h_s(c)$ over all exporters from country $h$ to country $t$ (with cost $c$ below $c^h_s = c^h / d^h_s$) yields the aggregate bilateral exports from country $h$ to country $t$

$$\text{EXP}^h_s = \frac{1}{2D_s(k_s + 2)} N^h_s (c^i)^k L^k (c^i)^{k+2} (d^h_s)^{-k}.$$

where $N^h_s$ is the number of entrants in sector $s$ and country $h$. This is a ‘gravity equation’ insofar as it determines bilateral exports as a log-linear function of bilateral trade barriers and country characteristics. As in Helpman et al. (2008), (14) reflects the joint effects of country size, technology (absolute advantage), and distance on both the extensive (number of traded goods) and intensive (amount traded per good) margins of trade flows. Similarly, (14) highlights how, holding the importing country size $L_k$ fixed, tougher competition in that country, reflected by a lower $c^h_s$, dampens
exports by making it harder for potential exporters to break into that market. The gravity equation (14) is used in Section 4.1.1 to estimate bilateral trade freeness.

**APPENDIX 2: EMPIRICAL IMPLEMENTATION AND ROBUSTNESS CHECKS**

**Trade freeness**

On the basis of Helpman *et al.* (2008) and in line with our theoretical model, the gravity estimation discussed in Box 2 consists of two stages. In the first stage, a probit regression is run on a dataset of world trade at the sectoral level. The dataset covers bilateral trade among 212 countries in 27 three-digit NACE manufacturing industries.13 It also accounts for domestic flows, constructed as the difference between a country’s domestic production and its exports. The probit equation specifies the probability that country $h$ exports to country $t$ as a function of observable variables:

$$p_{ht} = \Pr(EXP_{ht} = 1 | \text{observed variables}) = \Phi[\ln(distance_{ht}) + EX_h + IM_t + col + comcol + col45 + smctry] \quad (A.1)$$

where $\Phi(\cdot)$ is the cumulative density function of the unit-normal distribution, $EXP_{ht}$ are the exports of sector $s$ from country $h$ to country $t$, $EX_h$ and $IM_t$ are dummies specific to the countries of origin and destination. Trade barriers are captured by bilateral distance ($distance_{ht}$) and a range of other accessory geographical controls: $col$, indicating if two countries were ever in a colony-colonizer relationship; $col45$, indicating if the colony-colonizer relationship extended beyond 1945; $smctry$ indicating if two countries were ever part of the same nation. The probit estimation allows us to generate additional variables ($Firmshare_{ht}$ and $Selection_{ht}$) that can be used to control for the unobserved underlying firm-level heterogeneity, which is likely to be correlated with trade flows (Helpman *et al.*, 2008). $Selection_{ht}$ also corrects for biases arising from a possible non-random sample selection of the observations (Heckman, 1979). Predicted components of this equation are then used in the second stage to estimate the gravity equation expressed in log-linear form and reported in Box 2. This second estimation is free from biases arising from the non-random selection of observations as well as from potentially heterogeneous groups of firms selling to different export markets.

**TFP and elasticity of the extensive margin**

We have estimated the elasticity of the extensive margin in sector $s$ ($k_s$) from the sectoral distribution of total factor productivity (TFP). Such distribution is generated by estimating TFP at the level of the individual firm by exploiting the balance sheet

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13 While we are interested in bilateral trade between the EU-15, these include a very large number of observations (97%) whose characteristics are such that their estimated probability of trade is indistinguishable from 1. This jeopardizes the first step of the approach of Helpman *et al.* (2008). For this reason, we have expanded our sample to include as many trade partners as possible grouping the 27 NACE sectors in our 12 aggregated industries.
information (unconsolidated accounts) information provided by the Amadeus database of the Bureau van Dijk. This covers the value added, fixed assets (capital), sales and the cost of materials (intermediate consumption) in thousands of euros, as well as the number of employees from a large cross-section of European manufacturing firms. We have used data from a sample covering our 12 countries and eliminated firms with missing values and extreme observations. These are defined as having either value-added-to-employee or capital-to-employee ratios out of the range identified by the 1st and 99th percentiles. The resulting sample consists of 427,242 firms.

The simplest way to estimate TFP is by means of a log-linear OLS regression of value added over measures of capital and labour employment (see Box 3). This method, however, might lead to biased estimates due to the underlying assumption that TFP is constant over time. To correct for these biases, more sophisticated methods have been proposed by Olley and Pakes (1996) as well as by Levinsohn and Petrin (2003). These approaches are, nonetheless, more data demanding than OLS, as they require information on firms’ investment behaviour and intermediate inputs. Since such information is only available for a subset of firms and countries in our sample, we have opted for a standard log-linear OLS regression for our baseline.14 Summary statistics for the corresponding results are reported in Table A1. Moreover, Table A2 reports the average TFP, by country and sector.

Cost cut-offs

As discussed in Box 1, the cost cut-off in sector $s$ and country $h$ is computed by multiplying the corresponding average cost by the factor $k_s/(k_s+1)$. Results by sector and country are reported in Table A3. In turn, the baseline average cost in sector $s$ and country $h$ is computed as the inverse of the corresponding average labour productivity (value added per hour worked). This is reported in Table A4.

Producer competitiveness

Table A5 reports the values of producer competitiveness by sector and country. These are obtained from the calibrated bundle $D_s/\left[\frac{f_s}{(1+\phi_s)^{1+\phi_s}}\right]$ reported in Table A6. In particular, since the parameter of product differentiation $D_s$ is sector but not country-specific, we have separated it from $\left[\frac{f_s}{(1+\phi_s)^{1+\phi_s}}\right]$ by regressing the logarithm of $D_s/\left[\frac{f_s}{(1+\phi_s)^{1+\phi_s}}\right]$ on a complete set of sectoral dummies ($sdum$). Table A7 presents the estimated coefficients of such regression, which provide an indication of product differentiation across sectors.

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14 A comparison (not reported here) of results using the baseline TFP estimation and the one proposed by Levinsohn and Petrin (2003) for the subset of countries that allow such computation shows, however, that differences are minor.
### Table A1. Summary statistics on TFP (sectoral averages), 2001–2003

<table>
<thead>
<tr>
<th>Sector</th>
<th>Firms</th>
<th>Average TFP</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max</th>
<th>Adj. R²</th>
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</thead>
<tbody>
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<td>562.02</td>
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<tr>
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Source: AMADEUS and authors’ calculations.

### Table A2. TFP (firm-level based estimates), 2001–2003

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Source: AMADEUS and authors’ calculations.
### Table A3. Country and sector specific cost cut-offs, average 2001–2003

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### Table A4. Labour productivity, average 2001–2003

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Source: EUKLEMS.
### Table A5. Producer competitiveness: sector and country specific coefficients

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### Table A6. Calibrated parameter bundles $D_i(f_{i}^*/(o_{i}^*)^k$.

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Table A7. Regression results of OLS estimation of $D_{it}/(o_{it})^\gamma$ over a full set of sectoral dummies

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N 144
r²_a 0.91

REFERENCES


