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Eu enlargement and the gains from trade

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JEL: F11, F14, F15

Keywords: EU enlargement, Ricardian Model, structural estimates, welfare gains, multisector, calibration

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Abstract

In this paper I quantify the welfare gains of the 2004 EU enlargement as a result of the abolition of border controls, both for incumbents and for new members. I build a multi-sector Ricardian model, allowing for linkages across sectors, similar to the one in Caliendro and Parro (2011). As with a large number of quantitative trade models, the gains crucially depend on one key parameter, the dispersion of productivity. I extend the estimation methodology of Costinot et al. (2012) to a richer modelling setting and compute the dispersion in a way consistent with the underlying theoretical model. Within the model, I compare the welfare changes for 23 countries between 2003 and 2006. I find that new entrants gained significantly more than old members from enlargement. However, the overall changes in real income are rather small, measured in single digits for new entrants and fractions of a percent for old members. I also break down total gains by source and find that allowing for interconnectedness across sectors amplifies the changes in welfare.

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1 Introduction

Outside of the fall of communism, European Union (EU) integration has been the most significant political and economical event in the European landscape. Over its almost seventy year life, the EU in its various forms has experienced several enlargement waves along with a host of free trade treaties and complementary measures such as the Shengen Area or the Euro. All these measures were accompanied by promises of tighter integration and economic benefits. But were these promises based on reality or were they just a means to further a political goal? Looking at the statistics on Eurostat, the data clearly indicates that the economic situation of Europe improved: From 2000 to 2007, old EU members doubled the volume of exports and imports and new members tripled it. The share of imports and exports of new members to and from the EU25 roughly doubled in the same period. GDP per capita for Central and Eastern European (CEE) countries also doubled. However, ascribing a source to these gains is no easy feat. Most of the beneficial effects of EU enlargement are hard to quantify: institutional stability and modernization, economic growth etc. How much of the positive domestic changes are due to promises of EU accession and how much would have happened on their own? Most of these effects manifested slowly over a decade and a half.

There is one area, though, where the gains are more palpable: trade liberalization. The reason is that trade measure usually can be pinned down to at an exact moment in time and usually have concrete results. While it can be argued that the two decades since 1990 constitute a large and still on-going trade liberalization event, the gradual decrease in trade impediments along with the concurrence of several major economic events in this period (market reform in Central and Eastern Europe the Asian and Russian financial crises, the dot-com bubble, Euro adoption) make quantifying the total gains from trade a particularly daunting task. As a consequence, this paper is much more modest in scope: I only look at the 2004 enlargement wave when the European Union, then 15 members strong, gained an additional 10 members, most of them former Communist countries from Central and Eastern Europe (CEE). I compare welfare gains between 2003 and 2006 as a consequence of the abolition of border controls. I choose this time frame for three reasons: by 2004, virtually all traditional trade barriers (quantitative restrictions, rules of origin, tariffs) between the EU and CEE countries and between CEE countries themselves had been abolished or harmonized in previous trade liberalization episodes; a large chunk of CEE institutional reform had been completed by the time of accession so there are no confounding policy measures at the same time; there were no major economic events in the world in this period that could skew my results. Therefore, my results strongly rest on the natural experiment setting of this enlargement wave.

By defining welfare as real income, welfare gains are the changes in real income between two points in time. While real income is typically available in the data or can be computed with relative ease, the exact source of gains is difficult, if not outright impossible to pin point outside of a model, based on data alone. As a result I adopt and adapt the model developed by Caliendo and Parro (2011), CP from now on. The model is a multi-sector version of the basic multi-country Ricardian model of Eaton and Kortum (2002), henceforth EK. The key feature of the model is that it allows for linkages across sectors within a country: the output of one sector is used as an input in other sectors based on the input-output tables of the economy. The inclusion of linkages between sectors amplifies the gains from trade liberalization by multiplying the channels through which gains are realized: a fall in the price of goods in sector j has an effect on the price of all goods. My paper relates to a growing literature of multi-sector extensions to the basic EK model. See, for instance, Kerr (2009), Burstein and Vogel (2010), Chor (2010), Donaldson (2010) or Costinot et al. (2012).

As argued in Simonvska and Waugh (2011) and shown later in this paper, the size of gains in the model depends crucially on a single parameter that cannot be calibrated and must be estimated from the data. The second contribution of my paper is that I extend the estimation strategy of Costinot et al. (2012) to a richer model setting, by allowing linkages across sectors. I obtain estimates similar to those of Costinot et al. (2012) and comparable to the wider literature. The results differ from those of CP, however, as they use an estimation method that does not fully take into account the interdependences of sectors.

Based on the existing literature[1], I have several expectations about the results: the gains in new countries will be much larger than in old countries, and small countries, both incumbents and new members, will benefit more within their own group (the Casella (1996) effect and in CP the gains can be ranked by the country's economic size). However, the total effect is likely to be very small. This is due to the fact that trade liberalization measures usually do not entail significant gains, amplified by the fact that in the case I consider, the fall in trade costs is small and the time frame considered is short. The results are in line with expectations: New entrants gained more than incumbents several times over. There appears to be a weak link between geographical proximity and economic gains and country size seems to play no role. For incumbents the gains very small, often negligible, but for new members they quite significant going as high as 7%.

The rest of the paper is organized as follows: section 2 presents some facts about the 2004 EU enlargement, section 3 describes the theoretical model used, section 4 describes the data used, section 5 present the identification and calibration strategy necessary to solve the model, section 6 presents the results, section 7 concludes.

2 EU Enlargement

On May 1^{st} 2004, eight Central and Eastern European (CEE) Countries, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia and the Czech Republic along with Cyprus and Malta joined the European Union. This has been the largest enlargement to date in terms of country numbers. While, initially European integration started as a process to avoid another large scale European conflict, the focus has shifted towards deeper economic integration, especially in recent years.

EU Enlargement is not just a political process but also an economic one with deep implica-

[1] See for instance Klenow and Rodrguez-Clare (1997), Arkolakis et al. (2008), Waugh (2010), Blalock and Gertler (2008), Mohler (2009)

tions. The degree of the economic impact of enlargement depends crucially on the degree of economic integration. The countries joining the EU in 2004 entered the highest degree of economic integration: the single market with the eventual prospective of adopting a single currency, which some of them have done since.

However, for the purposes of this paper, EU enlargement will be treated solely as a trade block enlargement event. Theoretically, as borders open up, trade costs will fall making goods that had until than been unaffordable due to high trade costs, more appealing. This increased competitive pressure will make some importers switch suppliers, choosing the cheapest ones available under the new market conditions. While there will likely be shifts of bilateral trade flows among all countries, the most important effect will be on the share of expenditure devoted to domestic production. The fall in trade costs between countries i and n will make it more profitable for country n to import some goods from country i than to consume the goods produced domestically, as country i enjoys a comparative advantage in producing these goods and vice-versa. However, as new countries are much smaller than the old ones it is most likely that their effect on old members was not very significant.

Nevertheless, even looked at as trade-only event, EU enlargement has a few distinctive features. First of all, it takes place among highly diverse members in terms of absolute and relative economic size. This has been true for all EU enlargement waves including the 2004 one: in 2003 per capita GDP in new members was just 46% of that in incumbent EU members[2]. The same was true for labor productivity (Breuss, 2001). More importantly, while normally trade liberalizations episodes involve tariff reduction, this was not the case for the 2004 EU enlargement wave. Since 1997 there have been no tariffs on imports from CEE into EU15 and since 2002 none to CEE from EU15, except for agriculture (Breuss, 2001). This policy was the result of the European agreements and the interim agreements in the early 1990s: CEFTA (Central European Free Trade Agreement) in 1993 and BAFTA (Baltic Area Free Trade Agreement) in 1994. Concomitantly, traditional trade barriers (tariffs, quantitative restrictions, rules of origin) had been also abolished between the CEE countries themselves through various bilateral agreements.

As a result, the main trade effect of enlargement was the abolition of customs control. Before enlargement, lengthy border controls hindered trade, adding to the overall trade costs. While these costs are very real, their effect is indirect and quite hard to quantify. As customs controls were abolished only for land transport (Hornok, 2011), for the rest of the paper I will focus on CEE countries, as Malta and Cyprus saw no significant reduction in trade costs as a result of enlargement.

3 Theoretical Model

Unlike the more standard 'new trade' models, Ricardian models assumes that the main motive for trade is not the love of variety and increasing returns to scale, but technological

[2]Based on World Bank data adjusted for purchasing power parity and constant prices

differences between countries. The main advantage of these models, first pioneered by EK, is that they allow for more analytical flexibility and can provide more insight in the mechanism underpinning the model. The model used in this paper is that of CP, with minor modifications: i) I assume that all sectors use the same intermediate good as oppose to being a sector specific intermediate good; ii) I assume that the sector specific labor share of output is common to all countries and iii) I assume that the distribution of productivity model is common across sectors. While these changes make for a less rich model structure, they allow me to recover the dispersion of productivity in a manner consistent with the underlying theoretical model. I also modify the model not to include tariffs as they not relevant to the case I am studying.

Let the world consist of N countries and within each country, there are J sector, both traded and non-traded. Within each sector, output is produced by a combination of labor and an intermediary good. Labor is assumed to be immobile across countries, but mobile across sectors within the country.[3] Like in all multi sector models, trade is unbalanced sector by sector. I further allow trade to be unbalanced at the country level. Let S_n be the net trade surplus of country n.

In each sector there is a continuum of goods, ω^j. Each country has a different level of efficiency in the production of each good in each sector. Let $x_i^j\left(\omega^j\right)$ denote the efficiency of producing good ω^jin sector j in country i and let $\gamma_i^k{>}0$ be the amount of intermediary goods from sector k used to produce the composite good in country i. The production function for good ω^j is:

$$y_i^j\left(\omega^j\right)=x_i^j\left(\omega^j\right)^{-\frac{1}{\theta}}\left(l_i\right)^{\beta^j}\left(\prod_{k=1}^{J}\left(m_i^k\right)^{\gamma_i^k}\right)^{1-\beta^j} \tag{1}$$

where β^j is the share of labor in sector j. This share is sector specific but common to all countries. Denote c_i^j the cost of inputs for producing in sector j in country i. Let p_i^k be the cost of good k in country i. Then the cost of the input bundle is

$$c_i^j=\Upsilon_i^j w_i^{\beta^j}\left[\prod_{k=1}^{J}\left(p_i^k\right)^{\gamma_i^k}\right]^{1-\beta^j} \tag{2}$$

where Υ_i^j is a constant[4]. International shipments between countries i and n are subject to iceberg transport cost τ_{in}^j, which are allowed to be sector specific. These imply that in order for a quantity of 1 good j to arrive in country n from country i, a shipment of τ_{in}^j must be sent.

[3]This is an assumption with minor practical consequences: The European Commission estimates that between 2004 and 2009 only 1.6 million people migrated from new to old member states, which accounts for less than 1 % of the working-age population of the destination states.

[4]Specifically,

$$\Upsilon_i^j=\prod_{k=1}^{J}\gamma_i^{j-\gamma_i^j\left(1-\beta^j\right)}\beta^{j-\beta^j}\left(1-\beta^j\right)^{-\left(1-\beta^j\right)}$$

In each sector I assume a probabilistic representation of technology. Let country i's efficiency in producing good ω^j be drawn from the country-sector specific distribution $F_i^j(x)$. Distributions are assumed to be independent across countries and sectors. Using the law of large numbers this implies that $F_i^j(x)$ is also the fraction of goods for which the efficiency of country i in sector j is below **x**. Let productivities follow an exponential distribution:

$$F_i^j(x) = z_i^j e^{-xz_i^j} \tag{3}$$

This representation allows for a parsimonious representation of the state of the world and technology: z_i^j is a parameter shifting the location of the distribution and θ is a technology parameter common to all countries. Specifically, it refers to the dispersion of productivities across goods. That is, a high value of θ implies a higher level of average productivity and consequently, lower eventual gains from trade liberalization. Production is constant returns to scale so goods are priced at their unit cost: $c_i/x_i^j(\omega^j)$. Therefore, the price in country n of a good from sector j produced in country i is:

$$p_{ni}^j(\omega^j) = \frac{c_i^j \tau_{ni}^j}{x_i^j(\omega^j)} \tag{4}$$

On the consumer side, households maximize a Cobb-Douglass utility across sectors subject to the budget constraint. The only source of revenue for households is the wage. Formally, households in country n maximize the following two-tier utility function:

$$U(C_n) = \prod_{j=1}^{J} \left(C_n^j\right)^{\alpha_n^j}$$
$$C_n^j = \left[\int_0^1 u\left(\omega^j\right)^{(\sigma_j-1)/\sigma_j} du\right]^{(\sigma_j-1)/\sigma_j}$$

subject to

$$\sum_{j=1}^{J} p_n^j C_n^j = w_n L_n - S_n$$

where α_n^j is the share of sector j in the consumption of country n, w_n is the wage in country n and p_n^j is the price index of sector j goods in country n, to be defined later.

What sets apart Ricardian models is that consumers in country n search across all sources for good j and purchase only from the cheapest location. Let $p_n^j(\omega^j)$, the price of good ω^j in country n, be defined:

$$p_n^j\left(\omega^j\right) = \min\left\{p_{ni}^j\left(\omega^j\right), i = 1...N\right\} \tag{5}$$

Integrating over the set of goods that country n imports, it can be shown that the price index of sector j in country n is given by

$$p_n^j = A^j \left[\sum_i \left[\frac{\tau_{ni}^j c_i^j}{z_i^j}\right]^{-\theta}\right]^{-\frac{1}{\theta}} \tag{6}$$

where A^j is a sector-specific constant. Let π_{in}^j be the share of goods in sector j that country n imports from country i. Integrating the same way the bilateral shares, it can be shown that the share are given by:

$$\pi_{ni}^j = \frac{X_{ni}^j}{X_i^j} = \frac{\left(\frac{c_i^j \tau_{ni}^j}{z_i^j}\right)^{-\theta}}{\sum_{r=1}^{N}\left(\frac{c_r^j \tau_{nr}^j}{z_r^j}\right)^{-\theta}} \tag{7}$$

where X_{ni}^j is the expenditure of country n on sector j goods from country i and let X_n^j denote the expenditure of country n on sector j. The proofs to the above two equations can be found in CP.

Expenditure in sector j is given by the sum of household expenditure and firm demand in that sector to be used as intermediary in the other sectors of the economy.

$$X_n^j = \sum_{k=1}^{J}\left[\gamma_n^j\left(1-\beta^j\right)\sum_{i=1}^{N}\pi_{in}^k X_i^k\right] + \alpha_n^j\left(w_n L_n - S_n\right) \tag{8}$$

The budget condition for each country implies:

$$\sum_{j=1}^{J} X_n^j + S_n = \sum_{j=1}^{J}\sum_{i=1}^{N}\pi_{in}^j X_i^j \tag{9}$$

4 Solving for the General equilibrium:

Definition 1: *For a given trade cost structure, τ, an equilibrium is a vector of wages, $\boldsymbol{w}$, and a vector of prices, $\boldsymbol{p}$, such that for every n and j, the following hold:*

$$p_n^j = A^j\left[\sum_{i=1}^{N}\left[\frac{\tau_{ni}^j c_i^j}{z_i^j}\right]^{-\theta}\right]^{-\frac{1}{\theta}} \tag{10}$$

$$c_i^j = \Upsilon_i w_i^{\beta^j}\left[\prod_{k=1}^{J}\left(p_i^k\right)^{\gamma_i^k}\right]^{1-\beta^j} \tag{11}$$

$$\pi_{ni}^j = \frac{X_{ni}^j}{X_i^j} = \frac{\left(\frac{c_i^j \tau_{ni}^j}{z_i^j}\right)^{-\theta}}{\sum_{r=1}^{N}\left(\frac{c_r^j \tau_{nr}^j}{z_r^j}\right)^{-\theta}} \tag{12}$$

$$X_n^j = \sum_{k=1}^{J}\left[\gamma_n^j\left(1-\beta^k\right)\sum_{i=1}^{N}\pi_{in}^k X_i^k\right] + \alpha_n^j\left(w_n L_n - S_n\right) \tag{13}$$

$$\sum_{j=1}^{J} X_n^j + S_n = \sum_{j=1}^{J}\sum_{i=1}^{N} \pi_{in}^k X_i^j \tag{14}$$

Let us assume an exogenous change in trade costs $\widehat{\tau}$. Assuming, that S_n is constant, the economy will move to a new equilibrium, given by ***w'*** and ***p'***. Based on these two equilibria, I can compute the changes between them[5].

$$\widehat{p}_n^j = \left[\sum_i \pi_{ni}^j \left[\widehat{\tau}_{ni}^j \widehat{c}_i^j\right]^{-\theta}\right]^{-\frac{1}{\theta}} \tag{15}$$

$$\widehat{c}_i^j = \widehat{w}_i^{\beta^j} \left[\prod_k \left(\widehat{p}_i^k\right)^{\gamma_i^k}\right]^{1-\beta^j} \tag{16}$$

$$\widehat{\pi}_{ni}^j = \left(\frac{\widehat{c}_n}{\widehat{p}_n^j}\widehat{\tau}_{ni}^j\right)^{-\theta} \tag{17}$$

and the budget and market clearing conditions must hold under the new equilibrium as well.

$$X_n^{j'} = \sum_{k=1}^{J}\left[\gamma_n^j \left(1-\beta^k\right) \sum_{i=1}^{N} \pi_{in}^{k'} X_i^{k'}\right] + \alpha_n^j \left(w_n' L_n - S_n\right) \tag{18}$$

$$\sum_{j=1}^{J} X_n^{j'} + S_n = \sum_{j=1}^{J}\sum_{i=1}^{N} \pi_{in}^{j'} X_i^{'j} \tag{19}$$

Total welfare gains are defined as the change in real income, $\hat{w}_n / \prod_{j=1}^{J} \hat{p}_n^j$, which can be derived as:

$$\ln \widehat{W}_n = -\sum_{j=1}^{J} \frac{\alpha_n^j}{\theta} \ln \widehat{\pi}_{jj} - \sum_{j=1}^{J} \frac{\alpha_n^j}{\theta} \tilde{\beta}^j \ln \widehat{\pi}_{jj} - \sum_{j=1}^{J} \alpha_n^j \tilde{\beta}^j \left(\ln \widehat{p}_n^j - \sum_{k=1}^{J} \gamma_n^k \ln \widehat{p}_n^k\right) \tag{20}$$

where $\tilde{\beta}^j = \left(1-\beta^j\right)/\beta^j$, the first term represents the gains derived from the consumption of final goods, the second term represents gains derived from the consumption of intermediary goods and the third term represents price index effects.

4.1 Data

While at a first it may seem that the model requires a staggering amount of data, all the parameters are readily available or can be easily computed from the data. The model only

[5] I define hatted variables as the ratio between variables in the new equilbrium and the old one. The full derivations can be found in the technical appendix of Caliendro and Parro (2011)

requires disaggregated bilateral tradeflows, industry value added and output and input-output data. I further require producer price level and R & D sectoral expenditure for each country in estimating θ .

Trade data

Trade data comes from the UN COMTRADE database. For each considered country, bilateral trade data with each other country was downloaded along with aggregate trade flows for 2003 and 2006. Data was classified at a 2 digit level according to SITC rev 3. In order to match output data, trade flows were aggregated in 15 tradable sectors corresponding to the first sectors in table 1.

Domestic data

Output and Value added were taken from the EU KLEMS dataset, 2009 release. This dataset provides detailed annual information for 32 industries corresponding to the ISIC rev 3 classification for all EU25 countries along with several other developed countries. The advantage of this dataset is that as all the data were collected by the same institution, cross-country measurement differences are likely to be minimal. The data is collected at plant level and then aggregated at an industry level in a homogeneous way. In order to minimize the presence of zeros in my sample, I use a slightly broader classification resulting in the 26 industries in table 1. I also downloaded the same data for 2006 so that I could compute trade costs.

Research and development expenditure for 2003 was taken from the OECD STAN database for the year 2003. This data was not available for all countries[6].

In a perfect competitive world firms do not make any profits. A more productive firm will produce more output for the same inputs but still have zero profit as the price will adjust downward to clear the market. In other words, there is a negative link between producer prices and productivity. In order to proxy productivity, I used the relative sectoral price levels taken from GGDC Productivity Level Database (Timmer et al. 2007). As prices were available for 1997 only, I estimated the 2003 levels by using the producer price indices available in the EU KLEMS dataset. As both EU KLEMS and the GGDC were compiled by the same institution, methodological differences in combining the datasets are likely to be minimal.

Input-output tables for the 23 countries were taken from the EUROSTAT database. For all countries data was standardized according to NACE A60 or CPA P60 classification. This level proved to be too detailed for my purposes so I reclassified them into the 26 categories I used. Whenever possible I used 2005 data as this was the most common year available. When it was not available I chose the closest prior year. Choosing different years for the input-output table did not visibly affect the results.

Rest of the world

The ROW object is quite difficult to construct as worldwide detailed data is not available.

[6]Denmark, Estonia, Latvia, Lithuania, Luxembourg and Sweden had no R & D data available

Table 1: Sector classification along with NACE classifiation

Sector	**Code**
AGRICULTURE, HUNTING, FORESTRY AND FISHING	AtB
MINING AND QUARRYING	C
FOOD , BEVERAGES AND TOBACCO	15t16
TEXTILES, TEXTILE , LEATHER AND FOOTWEAR	17t19
WOOD AND OF WOOD AND CORK	20
PULP, PAPER, PAPER , PRINTING AND PUBLISHING	21t22
COKE, REFINED PETROLEUM AND NUCLEAR FUEL	23
CHEMICALS AND CHEMICAL	24
RUBBER AND PLASTICS	25
OTHER NON-METALLIC MINERAL	26
BASIC METALS AND FABRICATED METAL	27t28
MACHINERY, NEC	29
ELECTRICAL AND OPTICAL EQUIPMENT	30t33
TRANSPORT EQUIPMENT	34t35
MANUFACTURING NEC; RECYCLING	36t37
ELECTRICITY, GAS AND WATER SUPPLY	E
CONSTRUCTION	F
WHOLESALE AND RETAIL TRADE	G
HOTELS AND RESTAURANTS	H
TRANSPORT AND STORAGE AND COMMUNICATION	I
FINANCIAL INTERMEDIATION	J
REAL ESTATE, RENTING AND BUSINESS ACTIVITIES	K
PUBLIC ADMIN AND DEFENCE; COMPULSORY SOCIAL SECURITY	L
EDUCATION	M
HEALTH AND SOCIAL WORK	N
OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	O

In order to be able to calibrate the share of goods in consumption, α_{ROW}, the share of labor in production β_{ROW}, the share of intermediate goods in production, γ^k_{ROW} and income, I define the rest of the world as a conglomerate of countries and compute these statistics as the mean or sum, repsectively, across countries. The full list of countries is in the appendix. All data was taken from the input-output tables of the OECD STAN dataset.

Total imports by my countries from the ROW is defined as total imports in each sector minus imports from other EU countries. Imports of the ROW from each country in my sample are defined as total world imports from that country minus the imports of the other countries in my sample.

5 Calibrating the model

I assume N=24, representing the 15 EU old members, the 8 CEE new entrants and the rest of the world (ROW). I assume there are 15 tradable sectors and 11 non-tradable ones, corresponding to the tradable goods in the ISIC 3^{rd} revision classification. The list of sectors along with their classification codes can be found in table 1. The base year for calibration is 2003.

The share of labor, β_i^j, in each country and each sector is defined as value added divided by total output. As I assumed that this share is sector specific and compute β^j as the average across countries of β_i^j. This assumption is not so extreme as it may seem. Figure 1 plots the heatmap of the share of labor across countries and sectors while table 2 presents the results of the Anova analysis across sectors and countries. Within sector variability is sufficiently low to warrant my assumption.

Table 2: ANOVA results for sectoral labor share variation

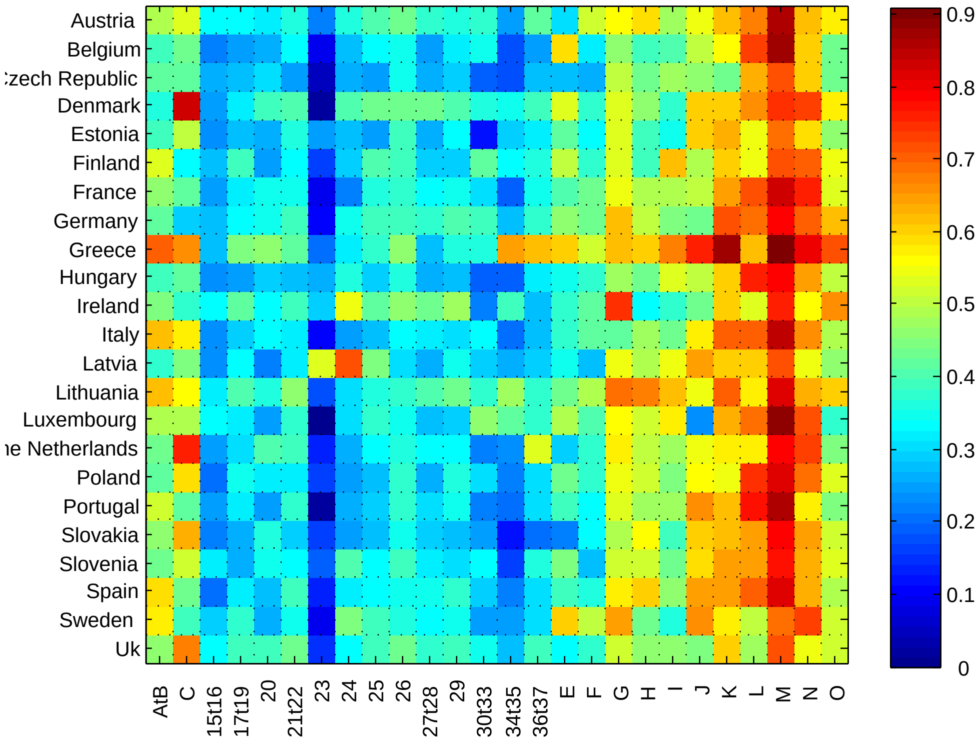
Source	**Partial SS**	**df**	**MS**	**F**	**Prob > F**
Model	13.00899	47	0.276787	49.22	0
Sector	12.15979	25	0.486391	86.49	0
Country	0.849207	22	0.0386	6.86	0
Residual	3.093043	550	0.005624		
Total	16.10204	597	0.026972		
Number of obs = 598			R-squared = 0.8079		
Root MSE = .074991			Adj R-squared = 0.7915		

Household income, $w_n L_n$, is equal to total value added in the economy. For the rest of the world, I only have domestic data for a handful of countries that together make up around 33 % percent of world GDP. I multiply value added in these countries by 2 to account for this (The other countries in my sample make up the rest of world GDP). The share of household expenditure on good j, α_n^j, is obtained by dividing final consumer expenditure on each sector j by total consumer expenditure, based on input-output tables. I can solve for $1 - \pi_{nn}^j$ by dividing import goods use by total use from the supply tables, and easily solve for π_{ni}^j for all n, i and j. Once I know $w_n L_n$ and π_{ni}^j, I can solve for the equilibrium consisten values of X_n^j and S_n from the system of equations (13) and (14). The shares of intermediate goods in the composite good are derived from the national input output matrices:

$$\gamma_n^j = \frac{intermediate\ consumption\ of\ good\ j}{total\ intermediate\ consumption} \tag{21}$$

Trade costs are difficult to estimate as they are unobserved and over the years a very large

Figure 1: Labor shares across countries and sectors



Note: The sector codes correspond to the ones in table 1

literature has developed aimed at investigating them. See Anderson and Van Wincoop (2004) for a review of the literature. In estimating trade costs, I assume they are symmetric and follow the approach used in Chen and Novy (2009) or Hornok (2011), for instance. While their approach is developed in the context of a new-trade monopolistic competition model, the same index can be derived in my model as the resulting gravity equations are similar. From equation (12), if I multiply the bilateral trade shares of countries i and n in commodity j and divide them by both their domestic shares I get

$$\frac{\pi^j_{ni}\pi^j_{in}}{\pi^j_{nn}\pi^j_{ii}} = \frac{X^j_{ni}}{X^j_n}\frac{X^j_{in}}{X^j_i} / \frac{X^j_{nn}}{X^j_n}\frac{X^j{}_{ii}}{X^j_i} = \left(\frac{c^j_i\tau^j_{ni}}{z^j_i}\right)^{-\theta}\left(\frac{c^j_n\tau^j_{in}}{z^j_n}\right)^{-\theta} / \left(\frac{c^j_i}{z^j_i}\right)^{-\theta}\left(\frac{c^j_n}{z^j_n}\right)^{-\theta} \tag{22}$$

Rearranging (22) , the average trade costs between i and n are given by

$$\bar{\tau} = \sqrt{\tau^j_{ni}\tau^j_{in}} = \left(\frac{\pi^j_{ni}\pi^j_{in}}{\pi^j_{nn}\pi^j_{ii}}\right)^{\frac{1}{2\theta}} \tag{23}$$

I estimate trade costs in two years, before and after enlargement: 2003 and 2006 respectively and compute the changes between them. As not all countries in my sample traded with all other countries in 2003 in each sector, I have values for which I have no observations. For these countries, I typically assume that the changes are 0.

5.1 Solving for θ

As can easily be seen from (12), (15) or (17), θ is the key parameter governing trade flows. Given its importance, finding a plausible calibration for the parameter is of paramount importance. While there have been several econometric attempts to recover the parameter of interest, there is no best method and the estimated coefficients vary wildly.

Virtually all papers aimed at recovering θ use a form of (7)[7]. Traditionally, the logarithmic form of (7) and θ is recovered as the parameter on some observable trade cost, such as tariffs. For instance, Head and Ries (2001) estimate the trade elasticity based on the changes in bilateral trade flows as a result of trade liberalization episodes. They find estimates between 7.9 and 11.4. Romalis (2007) uses the same approach on CUSFTA and NAFTA data and obtains and estimate between 6.2 and 10.9. This approach is appealing due to its simplicity but it is not without issues. The key assumption is that the entire change in trade frictions is due to changes in tariffs. However, during a trade liberalization event both observed and unobserved trade barriers fall, resulting in endogenous covariates.

CP use a similar approach and rely on triple difference across countries in order to estimate sectoral θs. However, tariff data is usually only available for a handful of countries, typically developed ones. In my case, this makes no sense as tariffs had been mostly eliminated between the EU and CEE countries by the early 2000s. While their approach has the advantage of allowing productivity dispersion heterogeneity across sectors, their results are very fragile, slight sample modification causing wild swings in the estimates, sometimes yielding negative values.

These problems have spurred the growth a new literature aimed at recovering θ, using different data sources. In their seminal paper, EK propose three methodologies to recover it, although they yield different results.First, having a random sample of the goods in the economy they compute the price index in each country. They compute the ratio of consumer prices between two countries for each good. This ratio will always be smaller than the trade cost for arbitrage reasons. They proxy trade cost by the second maximal ratio in order to alleviate measurement error. The intuition is that as the sample grows, the maximum ratio will hit the upper bound and provide a consistent estimate of the trade costs. Having all variables they recover θ by regressing the ratio of import shares to domestic trade shares on the price indices in two economies and the proxied trade costs.

Another method they propose to recover θ they propose is based on wage data. Having obtained the estimated country fixed effect from the gravity equation, they regress it on R&D expenditure, human capital and wage data. The estimated value for the productivity dispersion is the wage coefficient. The third method they propose to estimate the parameter of interest is similar to the first one but relies on country fixed effect rather than estimated price indices. Their estimates range from 3.6 to 12 depending on the method and their preferred estimate is of 8.28.

[7]Feenstra (1994) and papers based on its methodology make an exception as they use second moments of changes in prices and expenditure shares, but as argued in Simonovska and Waugh (2011) their estimate has a different structural interpretation

Simonovska and Waugh (2011) criticize the methods of EK due to their severe small sample bias. Instead they propose a Simulated Method of Moments variant on the first approach of EK. Based on the gravity equation coefficients they simulate a large number of goods from which they draw a random sample to serve as their "observed prices" in order to construct the price index and proxy trade costs. On the same sample they obtain a much smaller estimate of 4.42. Using the more refined and more recent EIU price dataset, they obtain even lower estimates, going as low as 2.47.

Donaldson (2010) estimates θ by looking at salt trade in India. He argues that, as salt is only produced in a few locations, the differences in the price of salt across markets fully reflect trade frictions. His estimates are in the range 3.8 – 5.2. Other estimates include Bertand et al. (2003) or Eaton et al. (2011) who estimate θ, using firm level sales data and obtain values in the range 3.6 – 4.8. Burstein and Vogel (2010)'s estimates based on skill intensity are 5.

Costinot et al. (2012) also use a form of the gravity equation to recover the trade elasticity in a multi-sector model without trade linkages. They argue that in a Ricardian world, firms are perfectly competitive and workers are paid their marginal product. Hence, the relative productivities across sectors and countries are fully reflected in the relative prices. They regress observed imports on the inverse of prices and fixed effects and recover the parameter of interest as the coefficient on wages.

This paper proposes a new identification strategy blending the methodology in Costinot et al. (2012) and EK's wage approach. Consider equation (12) for import and domestic share in a sector j for countries i and n. I get the following system of equations:

$$
\begin{aligned}
\pi^j_{ni} &= \frac{\left(\frac{\Upsilon^j_i w_i^{\beta^j} q_i^{1-\beta^j} \tau^j_{ni}}{z^j_i}\right)^{-\theta}}{\sum_{m=1}^{N}\left(\frac{\Upsilon^j_m w_m^{\beta^j} q_m^{1-\beta^j} \tau^j_{nm}}{z^j_m}\right)^{-\theta}} \\
\pi^j_{nn} &= \frac{\left(\frac{\Upsilon^j_n w_n^{\beta^j} q_n^{1-\beta^j}}{z^j_n}\right)^{-\theta}}{\sum_{m=1}^{N}\left(\frac{\Upsilon^j_m w_m^{\beta^j} q_m^{1-\beta^j} \tau^j_{nm}}{z^j_m}\right)^{-\theta}}
\end{aligned}
\tag{24}
$$

Taking their ratio I arrive at

$$
\frac{\pi^j_{ni}}{\pi^j_{nn}} = \frac{\left(\Upsilon^j_i w_i^{\beta^j} q_i^{1-\beta^j} \tau^j_{ni} z^j_n\right)^{-\theta}}{\left(\Upsilon^j_n w_n^{\beta^j} q_n^{1-\beta^j} z^j_i\right)^{-\theta}} \tag{25}
$$

from where, by rearranging, I can solve for q_i/q_n:

$$\frac{q_i}{q_n} = \left(\frac{\pi^j_{ni}}{\pi^j_{nn}}\right)^{\frac{1}{-\theta(1-\beta^j)}} \frac{\left(\Upsilon^j_n w_n^{1-\beta^j} z^j_i\right)^{\frac{1}{1-\beta^j}}}{\left(\Upsilon^j_i w_i^{\beta^j} \tau^j_{ni} z^j_n\right)^{\frac{1}{1-\beta^j}}} \tag{26}$$

Now consider another sector k for the same two countries i and n. By taking the ratio of country n's domestic share and import share and substituting in q_i/q_n from (26), I get:

$$\left(\frac{\pi^k_{ni}}{\pi^k_{nn}}\right)^{\frac{1}{(1-\beta^k)}} = \frac{\left(\Upsilon^k_i w_i^{\beta^k} \tau^k_{ni} z^k_n\right)^{\frac{-\theta}{1-\beta^k}}}{\left(\Upsilon^k_n w_n^{\beta^k} z^k_i\right)^{\frac{-\theta}{1-\beta^k}}} \left(\frac{\pi^j_{ni}}{\pi^j_{nn}}\right)^{\frac{1}{-\theta_j(1-\beta^j)}} \frac{\left(\Upsilon^j_n w_n^{1-\beta^j} z^j_i\right)^{\frac{1}{1-\beta^j}}}{\left(\Upsilon^j_i w_i^{\beta^j} \tau^j_{ni} z^j_n\right)^{\frac{1}{1-\beta^j}}} \tag{27}$$

While the above equation can be estimated as it is, it is far more convenient to work with an equivalent version of it. Notice that for a fixed sector j, the second and third terms of (27) are sector invariant across countries. That is, they can be incorporated in a pair-specific fixed effect. Taking logs, I get

$$\ln\left(\frac{\pi^k_{ni}}{\pi^k_{nn}}\right)^{\frac{1}{1-\beta^k}} = -\theta \ln\left(\frac{\Upsilon^k_i}{\Upsilon^k_n}\frac{w_i^{\beta^k}}{w_n^{\beta^k}}\frac{z^k_n}{z^k_i}\right)^{\frac{1}{1-\beta^k}} + \ln\delta_{ni} + \ln\tau^{k}_{ni}{}^{\frac{-\theta}{1-\beta^k}} \tag{28}$$

Costinot et al.(2012) note that the relation between productivity and export shares is actually more complicated. That is, countries only export a limited number of goods, those goods in which they are most productive. So even in an ideal world, with perfect statistical offices, we could not observe fundamental productivities, z^j_i, but only productivities for what is produced in a country ,$\tilde{z}^j_i$. As a result, observed bilateral trade shares need to be adjusted

$$\tilde{\pi}^j_{ni} = \frac{\pi^j_{ni}}{\pi^j_{ii}} = \frac{\left(\frac{c^j_i \tau^j_{ni}}{\tilde{z}^j_i}\right)^{-\theta}}{\sum_{r=1}^N \left(\frac{c^j_r \tau^j_{nr}}{\tilde{z}^j_r}\right)^{-\theta}} \tag{29}$$

Therefore, by correcting for this bias, equation (28) becomes

$$\ln(\tilde{\pi}^k_{ni})^{\frac{1}{1-\beta^k}} = -\theta \ln\left(\frac{\Upsilon^k_i}{\Upsilon^k_n}\frac{w_i^{\beta^k}}{w_n^{\beta^k}}\frac{\tilde{z}^k_n}{\tilde{z}^k_i}\right)^{\frac{1}{1-\beta^k}} + \ln\delta_{ni} + \ln\tau^{k}_{ni}{}^{\frac{-\theta}{1-\beta^k}} \tag{30}$$

Identification of θ is achieved through the first term of (30). While wage, labor share and input-output data are readily available, productivity data is not directly observed. As a result, I use the inverse of sectoral prices as a proxy for productivity as discussed earlier and, rather than run a constrained regression, I sum up the terms in brackets.

The proxy I use is likely to suffer from measurement error, causing endogeneity issues. Moreover, due to the general equilibrium nature of the model, as trade costs form part of the residual, they are likely to be correlated with the wages. Following Costinot et al. (2012), I choose to instrument productivities with the log of R & D expenditure ratios in each sector across countries. The identifying assumption here is that research and development has no other effect on bilateral trade shares than through the changes in productivity. As I have summed wages, productivities and Υ, I actually instrument the entire right hand side. This approach has an additional benefit: if the assumption holds that all terms on the right hand side have the same coefficient, this approach reduces the bias associated with instrumenting[8].

6 Results

Table 3 provides the estimated dispersion of productivity under various estimation strategies. Column (1) is obtained by running regression (28), without instruments and column (2) is regression (30), also without instruments. Columns (3) and (4) are the same regression but with instruments this time. The results are numerically very similar to the ones of Costinot et al. (2012), in that they also obtain unreasonable values for the OLS case, and the results can be ordered in the same fashion. Out of all estimates, column (4) provides the most reasonable one, that I will be using. The value is close to most reasonable estimates in the literature and also to the value obtained by Costinot et al. (2012). On one hand, this was to be expected as they use a very similar methodology on almost the same set of countries. On the other hand, it is reassuring, given that the samples were 6 years apart and there are notable differences in the estimation equation.

Table 3: Estimates of θ

Dependent variable:	log (export share)	log (corrected export share)	log (export share)	log (corrected export share)
θ estimate	0.167	0.026	5.785***	4.700***
Standard error	0.1017	.09925	1.1763	1.0866
Estimation	OLS	OLS	IV	IV
Observations	7,218	7,218	3,875	3,875

Note:*** indicate the coefficient is significant at 1 % level. Reported standard errors are heteroskedasticity robust.

Several remarks are in order about the estimation procedure. First of all, *R&D* is a particularly strong instrument candidate, showing a 42 % correlation with the endogenous variable. Second, the OLS estimates are very different from the IV ones and are not statistically different from zero, indicating that the OLS bias is very large, indeed. Last, the IV sample is significantly smaller than the OLS one. This is as noted earlier, *R&D* data was not available for all countries. However, it is unlikely that much meaningful economic data is lost as the

[8]Monte Carlo tests showed that instrumenting in this fashion produces a closer estimate to the true value than just instrumenting the variable of interest.

non-reporting countries are among the smallest. Running the OLS on just the data available for the IV, does not alter the results significantly.

Armed with the estimate of θ and the parameters obtained as described in section 4, I can proceed to solve for the changes between equilibria. For the model presented in this paper to be in equilibrium at under the cost structure τ', it must be such that equations (13) and (14) hold.

That is, equations (15), (16), (18), (19) and (17) form the system to be solved.

First I guess a vector of values for $\widehat{\mathbf{w}}$. Then, given this guess, from (15) and (16), I solve for the vectors of changes in prices and changes in costs, which I plug in (17) and obtain the estimated change in the bilateral trade shares. Once I recover $\widehat{\pi}^{j}_{in}(\widehat{\mathrm{w}})$, I compute trade shares under the new cost structure $\pi^{'j}_{in}(\widehat{\mathrm{w}})$. Notice that (18) forms a linear identified system in $\boldsymbol{J}$ **x** $\boldsymbol{N}$ unknown expenditures. By defining $w'_n = \widehat{w}_n w_n$, the system can be easily solved. Plugging the new expenditures in (19), I check whether balanced budget holds. If it does not, I adjust the guess for $\widehat{\mathbf{w}}$ until it does.

One I have solved for the changes in prices, wages and import shares, I estimate the welfare gains through equation (20). Table 4 and Figure 2 present the welfare gains from EU enlargement by country and broken down by source of gains. However, due to the non-linear nature and high dimensionality of the system considered, the results are only approximate as they were obtained by numerical methods, although the approximation error should be small.

In the majority of cases, allowing for sectors to be interdependent amplifies the gains from trade. Accounting for the general equilibrium price effects increases the gains from liberalization, sometimes tenfold compared to the final good channel. The natural point of comparison for my results is CP. In part, the results are in line with those of CP who find that, for NAFTA as well, intermediate goods play a strong role. However, in their case the price index, which they break down into two distinct components, has a net effect close to zero. In addition, the overall size of gains is much larger in my exercise than in theirs. The reason for these two discrepancies can be found in the drastically different size of countries considered and their degree of trade openness. CP look at the US, Canada and Mexico and the smallest of these (Mexico) is comparable in size to the larger countries in my sample. While Canada and Mexico are among US' largest trading partners the value of bilateral trade makes up only a smaller part of GDP compared to a small economy like the Czech Republic for which trade with other EU countries constitutes a sizeable chunk of GDP. Moreover, for a small open economy, a change in trade costs will have stronger domestic effects on the non-tradable sector, prices and wages than for a large economy, hence the larger pricer index effect I notice.

In rest, the results are pretty much in line with expectations: new entrants gained significantly more than incumbents: Poland, the new entrant with the lowest gains, still had a welfare increase ten times larger than Austria, the incumbent which enjoyed the largest gains. For incumbents, the welfare gains I observed are positive but negligible. This makes sense given that these countries are much larger than their Eastern neighbours and the short

Table 4: Total gains from trade by country and source

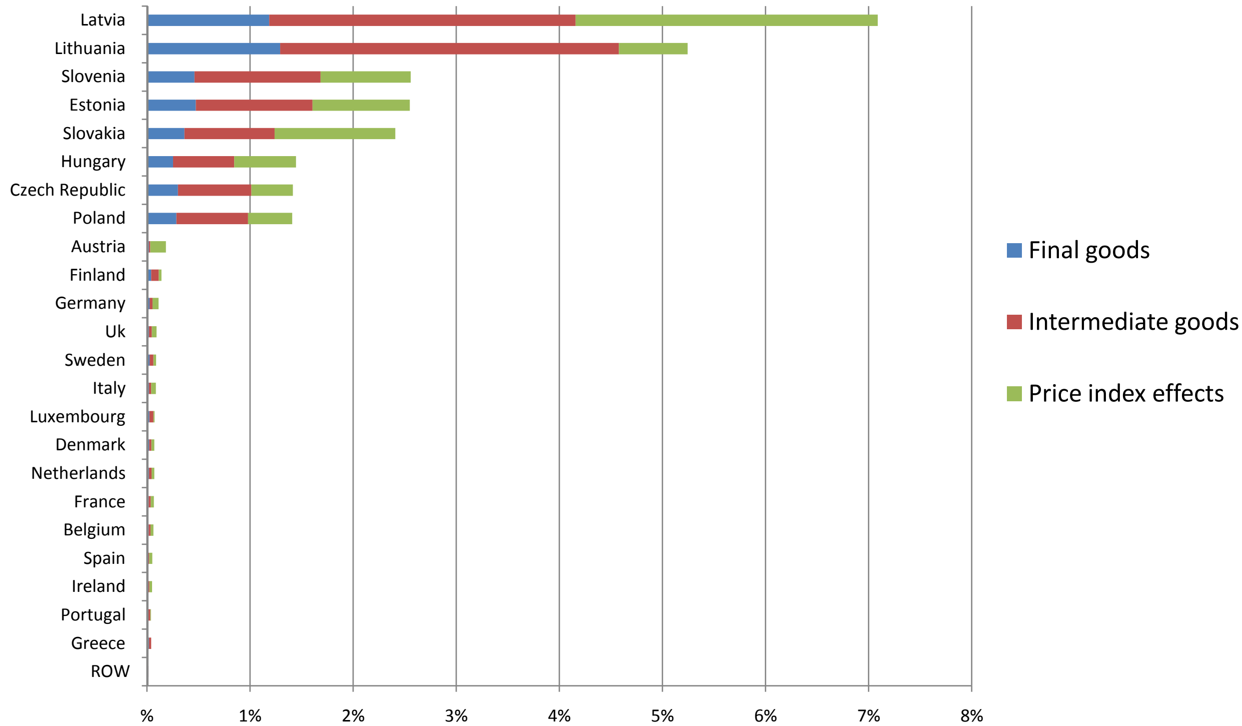
	Final goods %	Intermediate goods %	Price index effects %	Total gains%
Austria	0.008400	0.014900	0.149900	0.173200
Belgium	0.007200	0.017500	0.027400	0.052100
Czech Republic	0.290100	0.712600	0.403700	1.406400
Denmark	0.011000	0.022000	0.028800	0.061800
Estonia	0.465100	1.131500	0.943800	2.540400
Finland	0.031200	0.072600	0.026100	0.129900
France	0.007900	0.018600	0.029760	0.056260
Germany	0.016300	0.028100	0.059100	0.103500
Greece	0.009600	0.021100	-0.005800	0.024900
Hungary	0.242600	0.594700	0.598400	1.435700
Ireland	0.003800	0.009300	0.026400	0.039500
Italy	0.009000	0.022000	0.045400	0.076400
Latvia	1.175400	2.972100	2.931200	7.078700
Lithuania	1.281800	3.286300	0.666000	5.234100
Luxembourg	0.014800	0.038700	0.009600	0.063100
Netherlands	0.010400	0.025500	0.024900	0.060800
Poland	0.275900	0.694000	0.430000	1.399900
Portugal	0.006100	0.015700	0.007700	0.029500
Slovakia	0.354500	0.874600	1.170100	2.399200
Slovenia	0.451500	1.222000	0.875300	2.548800
Spain	0.003600	0.008700	0.028600	0.040900
Sweden	0.016400	0.035300	0.027200	0.078900
United Kingdom	0.009400	0.027900	0.045400	0.082700
ROW	-0.000150	-0.000030	-0.000540	-0.000720

Note: Underlined countries are new entrants

time frame I consider. Part of this result is driven by modelling assumptions: I assumed that trade costs between old member countries are unchanged between the two equilibria. Column (2) of table 5 relaxes this assumption and column (1) reproduces the main results in table 4 for comparison. As a consequence of tighter economic integration, most trade costs appear to go down over time. In this case, the gains for incumbents are larger, between 0.5 and 1%. In this counterfactual new members gain slightly more. However, this scenario captures all welfare gains from trade whatever their cause, not just directly associated with EU enlargement.Overall, all countries gained, with the exception of the rest of the world. CP also find this feature in their model[9]. The near zero result for Greece, Spain, Ireland and Portugal, indicate poor economic integration, in a way foreshadowing the current European troubles.

[9] This appears in an earlier version of the working paper. The latest version does not report the data for the rest of the world.

Figure 2: Source of welfare gains for EU countries



There appears to be no relation between size and gains, rejecting the Casella hypothesis: while the largest gains were enjoyed by small countries such as Lithuania and Latvia, large countries such as Germany or the UK did among the best of the incumbents whereas other large countries, Spain and Italy did significantly worse. There appears to be a weak relation between geographic proximity and gains, that is, countries that already had strong economic ties gained the most. Still, due to the small number of observations, these inferences are anecdotal at best.

6.1 How much does θ matter?

A large part of this paper was devoted to estimating a reliable θ so the natural question to ask is: Does it really matter? The answer is strongly yes. Table 5 details the welfare gains under various values for the dispersion of productivity. When looking at these results, one needs to keep in mind that they are based on ad-hoc values and nothing in the model or the data indicates the underlying parametrization is sensible. Rather, the following should be viewed as a purely numerical exercise on the features of the model. Column (3) shows the gains were θ equal to 12. In this case the gains are basically scaled down: the ranking of gains is roughly the same but no country gains more than 2.8 %. : All countries gain less and the link between θ and welfare is almost linear. It has already been argued in Simonovska and Waugh (2011) that an estimate of 4 roughly doubles the gains compared to an estimate of 8 in the basic EK model. The same pattern is present in my model: an estimate of 12 halves the gains compared to $\theta = 4$. Finally, column (4) uses the values estimated by CP. Under these parametrization, the results are starkly different. All new members gains more, double in some case and up to 17% in the case of Latvia, which is highly unlikely. Incumbents also mostly enjoy larger gains, with the exception of Germany. While all four calibration tell the same story: new members gained much more, their quantitative implication are very different. Different values of θ yield different gains and just plugging in the results someone else has obtained on a different sample, in a different model, using a different technique can generate nonsensical results.

Table 5: Welfare gains under different assumptions

	Original Estimate	Unrestricted Trade Costs	θ=12	Heterogeneous θ
Austria	0.173200	0.99	0.07	0.09
Belgium	0.052100	0.61	0.03	0.10
Czech Republic	1.406400	1.58	0.56	2.38
Denmark	0.061800	0.60	0.03	0.12
Estonia	2.540400	2.86	1.01	5.06
Finland	0.129900	1.34	0.06	0.37
France	0.056260	0.54	0.03	0.08
Germany	0.103500	0.75	0.05	-0.03
Greece	0.024900	1.08	0.02	0.00
Hungary	1.435700	1.62	0.57	2.92
Ireland	0.039500	1.22	0.02	0.04
Italy	0.076400	0.57	0.04	0.13
Latvia	7.078700	7.25	2.78	17.25
Lithuania	5.234100	5.51	2.06	9.68
Luxembourg	0.063100	2.95	0.03	0.18
Poland	1.399900	1.58	0.56	2.06
Portugal	0.029500	0.95	0.02	0.10
Slovakia	2.399200	2.58	0.95	3.01
Slovenia	2.548800	2.81	1.01	3.38
Spain	0.040900	0.68	0.02	0.06
Sweden	0.078900	0.84	0.04	0.16
The Netherlands	0.060800	0.57	0.03	0.07
United Kingdom	0.082700	0.51	0.04	0.13
ROW	-0.000720	-0.02	0.00	0.00
Correlation with original estimate		0.95	0.99	0.97

7 Conclusion

In this paper I investigated the implications of EU Enlargement on member countries by looking at the changes in trade flows, in a multi-country multi-sector general equilibrium

Ricardian model allowing for interconnectedness across sectors. In order to have reliable gains estimates, all paramenters must be estimated from the underlying data. Therefore, I derived a method to estimate the dispersion of productivity, a key parameter governing trade flows in the equilibrium and welfare gains. Testing whether different values of θ provide different gains, I found that the results differ significantly across parametrizations.

Using my preferred estimate, the welfare gains from enlargement are moderate, below 8%, for new entrants and negligible for incumbents. Allowing for sectoral links provides a channel through which additional gains can be obtained and in most cases these gains are considerable. While the gains are modest in size, one needs to remember the freer trade was only one facet of EU enlargement benefits.

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APPENDIX

Table 6: Countries in the rest of the world

Countries	**2003**	**2006**
AUS: Australia	x	x
CAN: Canada	x	x
CHL: Chile		x
JPN: Japan	x	x
KOR: Korea	x	x
MEX: Mexico		x
NZL: New Zealand	x	
NOR: Norway	x	x
CHE: Switzerland	x	x
TUR: Turkey	x	x
USA: United States	x	x
BRA: Brazil	x	x
BGR: Bulgaria	x	x
CHN: China	x	x
TWN: Chinese Taipei	x	x
CYP: Cyprus	x	x
IND: India	x	x
IDN: Indonesia	x	x
MLT: Malta	x	x
ROU: Romania	x	x
RUS: Russian Federation	x	
ZAF: South Africa	x	x
VNM: Viet Nam	x	x

Note: Value added and Input-Output shares were computed from the 2003 data. 2006 data is only used to pin down the total value added for the rest of the world