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EURO AREA EXTERNAL IMBALANCES AND THE BURDEN OF ADJUSTMENT

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THE COMPETITIVENESS RESEARCH NETWORK

CompNet The Competitiveness Research Network

This paper presents research conducted within the Competitiveness Research Network (CompNet). The network is composed of economists from the European System of Central Banks (ESCB) - i.e. the 28 national central banks of the European Union (EU) and the European Central Bank – a number of international organisations (World Bank, OECD, EU Commission) universities and think-tanks, as well as a number of non-European Central Banks (Argentina and Peru) and organisations (US International Trade Commission).

The objective of CompNet is to develop a more consistent analytical framework for assessing competitiveness, one which allows for a better correspondence between determinants and outcomes.

The research is carried out in three workstreams: 1) Aggregate Measures of Competitiveness; 2) Firm Level; 3) Global Value Chains

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The paper is released in order to make the research of CompNet generally available, in preliminary form, to encourage comments and suggestions prior to final publication. The views expressed in the paper are the ones of the author(s) and do not necessarily reflect those of the ECB, the ESCB, and of other organisations associated with the Network.

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Abstract

The objective of this paper is to explore the consequences of the correction of Euro area trade imbalances on real exchange rates. This analysis requires one additional dimension with respect to the standard Global Imbalances framework à la Obstfeld and Rogoff (2005), since the adjustment takes place within and outside the Euro area. Both types of adjustments are analyzed in a three-country general equilibrium model with a tradable and a non-tradable sectors, and heterogeneous firms built upon Pappadà (2011). ECB (*CompNet*) data are used to measure the differences in firm size and productivity dispersion across Euro area countries. With respect to the surplus country (Germany), countries running a trade deficit (Spain, Italy) are characterised by a productivity distribution with a lower mean and a less fat right tail. This increases the relative price movement associated with the external adjustment because of the limited role played by the extensive margin. We show that the real exchange rate movements are underestimated when the cross-country differences in terms of productivity distributions are neglected.

Keywords: trade imbalances, transfer problem, firm heterogeneity.
JEL codes: F32, F41.

Non-technical summary

The rebalancing of external accounts across countries is traditionally seen in the economic literature, in the context of the so called "transfer problem". The basic mechanism of the adjustment is a transfer of real resources from debtor countries to the rest of the world, leading to a decrease in domestic spending relative to production, and to a simultaneous relative increase abroad. The macroeconomic costs of the external rebalancing may be divided conceptually in two parts: the decrease in domestic spending and welfare (the primary burden of a transfer), and the real exchange rate depreciation (the secondary burden of a transfer). As Obstfeld and Rogoff (2001), (2005), (2007) point out in a series of papers on the sustainability of the US current account position, a reduction of the U.S. current account deficit would lead to a large real depreciation of the U.S. dollar, as well as a sharp reduction in U.S. consumption and welfare. While there is consensus in the literature on the need for the real exchange rate depreciation to rebalance a deficit in the current account, the size of such depreciation is subject to more debate. As shown by Pappadà (2011) - in a model which explicitly takes into account that firms are heterogeneous in terms of productivity - the dispersion of firm productivity may affect the size of the secondary burden of a transfer.

Drawing from this literature, this paper adds two main elements. First, it concentrates on the external readjustment of Euro area countries, which has the double dimension of adjustments within the area (i.e. in the common currency) and outside the euro area (which include changes in the euro exchange rate). To do so, the paper presents a three-country general equilibrium model with a tradable and a non-tradable sector, where firms are heterogeneous in terms of their productivity. Second, it utilises for the calibration of the model a novel firm level data base collected by CompNet, a competitiveness research network among EU central banks. The firm-level empirical evidence collected by the network shows that firm size and productivity are highly heterogeneous across Euro area countries. More specifically, in each Euro area country, firm productivity is not normally distributed. The distribution of firm productivity is rather characterised by a relatively large number of low productive firms and a small number of highly productive firms.

The mechanism of transmission in the model is as follows. The transfer of resources associated with the external adjustment increases the demand of exports of the deficit countries, while decreasing their demand of imports. The higher relative demand for tradable goods produced by the deficit country leads to a decrease in the productivity threshold of exporting firms, and a simultaneous increase abroad. The changes in aggregate exports in response to the transfer therefore reflect extensive and intensive adjustments, as the sales of new heterogeneous exporting firms (extensive margin) contribute to the external account adjustment along with the sales (old and new) of existing exporting firms (intensive

margin). The thickness of the right tail of the productivity distribution determines the extent to which the extensive margin of trade contributes to the increase in aggregate exports that drives the trade rebalancing. For given external adjustment, the larger is the contribution of the extensive margin, the lower is the required change in relative prices.

Data show that, with respect to the surplus country (Germany), countries running a trade deficit (Spain, Italy) are characterised by a productivity distribution with a lower mean and a less fat right tail (lower skewness). For these countries, the adjustment of trade balances requires a larger relative price movement because of the limited role played by the extensive margin. Importantly, also among deficit countries, there are rather important differences in the firm productivity distribution, which implies - ceteris paribus - lesser need of relative price adjustment for given combinations of higher mean and/or higher skewness of the productivity distribution.

The paper presents simulations of an external accounts rebalancing (benchmark case) and a counterfactual where countries do not differ in terms of productivity dispersion, but only in terms of the mean of their productivity. For both simulations, it explore how the real exchange rates would need to adjust according to the model, under two main scenarios: (i) Actual external rebalancing over the period 2007-13, and (ii) complete rebalancing, where all the external imbalances of the three Euro area countries considered are closed to zero. In the first round, Germany is the surplus country and Spain is the deficit country. In the second round, Spain is replaced by Italy, in order to explore the consequences of the different productivity distribution across deficit countries on the required real exchange rate movement.

For both deficit countries, the counterfactual exercise related to the two scenarios highlights the importance of the cross-country differences in productivity distribution. In particular, when countries differ only in terms of their relative average productivity (but not their dispersion), the real exchange rate of both deficit countries vis-a-vis Germany would depreciate less than in the benchmark case. Two are the main interconnected implications. First, a model that does not consider the differences in productivity dispersion between surplus and deficit countries within the Euro area may underestimate the required real exchange rate depreciation in deficit countries. Second, productivity distribution differences across deficit countries are informative on the extent in which real depreciations can be expected to be an effective source of readjustment. More specifically, the larger is the scope for resource reallocation implied by a wider productivity distribution, the larger the supply response of the economy in the phase of readjustment. In turn, this will reduce the need for real exchange rate adjustment.

1 Introduction

A corollary of the Euro area (EA) crisis has been an unusually large surplus of the current account of the area as a whole, resulting from a combination of strong external demand and rapid readjustment of external accounts in the EA countries which had previously accumulated large imbalances. Against this background, there is a renewed interest in Europe for analyzing drivers and patterns of external rebalancing, which - for the Euro area - has the additional dimension of the readjustment within the area itself.

Starting with the drivers of external rebalancing, the basic mechanism of the adjustment is a transfer of real resources from debtor countries to the rest of the world, leading to a decrease in domestic spending relative to production, and to a simultaneous relative increase abroad. The macroeconomic costs of the external rebalancing may be divided conceptually in two parts: the decrease in domestic spending and welfare (the primary burden of a transfer), and the real exchange rate depreciation (the secondary burden of a transfer). As Obstfeld and Rogoff (2001), (2005), (2007) points out in a series of papers on the sustainability of the US current account position, a reduction of the U.S. current account deficit would lead to a large real depreciation of the U.S. dollar, as well as a sharp reduction in U.S. consumption and welfare. While there is consensus in the literature on the need for the real exchange rate depreciation to rebalance a deficit in the current account, the size of such depreciation is subject to more debate. As shown by Pappadà (2011) in a model where firms are heterogeneous in terms of productivity, the dispersion of firm size and productivity may affect the global rebalancing and the size of the secondary burden of a transfer.

The objective of this paper is to explore the consequences of an adjustment of external imbalances by euro area countries on relative price movements, when the country-specific distributions of firm productivity is taken into account. The firm-level empirical evidence collected at the European Central Bank by the *CompNet* network shows that firms size and productivity are highly heterogeneous across Euro area countries. More specifically, in each Euro area country, firms productivity (as well as firms size) is not normally distributed. The distribution of firms productivity is rather characterised by a relatively large number of low productive firms and a small number of highly productive firms. The transfer of resources associated with the external adjustment increases the demand of exports of the deficit countries, while decreasing their demand of imports.[1] The higher relative demand for tradable goods produced by the deficit country leads to a decrease in the productivity threshold of exporting

[1] As it focuses on the real adjustment of current account imbalances, this paper leaves aside other margins of adjustment like the financial adjustment channel.

firms, and a simultaneous increase abroad. The changes in aggregate exports in response to the transfer therefore reflect extensive and intensive adjustments, as the sales of new heterogeneous exporting firms (extensive margin) contribute to the external account adjustment along with the sales (old and new) of existing exporting firms (intensive margin). The thickness of the right tail of the productivity distribution determines the extent to which the extensive margin of trade contributes to the increase in aggregate exports that drives the trade rebalancing. For given external adjustment, the larger is the contribution of the extensive margin, the lower is the required change in relative prices. *CompNet* data show that, with respect to the surplus country (Germany), countries running a trade deficit (Spain, Italy) are characterised by a productivity distribution with a lower mean and a less fat right tail (lower skewness). For these countries, the adjustment of trade balances requires a larger relative price movement because of the limited role played by the extensive margin. Importantly, also among deficit countries, there are rather important differences in the firm productivity distribution, which implies - *ceteris paribus* - lesser need of relative price adjustment for given combinations of higher mean and/or higher skewness of the productivity distribution.

The macroeconomic effects of the Euro area external rebalancing are studied in a three-country general equilibrium model with a tradable and a non-tradable sector. In both sectors, firms are heterogeneous in terms of their productivity. In the tradable good sector, trade flows are determined by the sales of heterogeneous exporting firms as in Chaney (2008). We extend the original framework in Pappadà (2011) by considering two sources of external adjustment. First, the intra-EA adjustment, which considers the impact on the real effective exchange rate among two countries (surplus and deficit) within the Euro area, i.e. in absence of nominal exchange rate movements. Second, the extra-EA adjustment, that is the impact of the external rebalancing on the relative prices of both Euro area countries (surplus and deficit) with respect to the rest of the world.

We simulate an external accounts rebalancing (benchmark case) and a counterfactual where countries do not differ in terms of productivity dispersion, but only in terms of the mean of their productivity. For both simulations, we explore how the real exchange rates would need to adjust according to the model, under two main scenarios: (i) actual external rebalancing over the period 2007-13, and (ii) complete rebalancing, where all the external imbalances of the three Euro area countries considered are closed to zero. In the appendix, we report also on two additional cases, i.e (iii) partial rebalancing, where external accounts are closed to zero one country at the time, and (iv) partial bilateral rebalancing, where bilateral external accounts are closed to zero one at the time.

We first take Germany as the surplus country and Spain as the deficit country. We then replace Spain

by Italy, in order to explore the consequences of the different productivity distribution across deficit countries on the required real exchange rate movement. For both deficit countries, the counterfactual exercise related to the two scenarios highlights the importance of the cross-country differences in productivity distribution. In particular, when countries differ only in terms of their relative average productivity (but not their dispersion), the real exchange rate of both deficit countries vis-à-vis Germany would depreciate less than in the benchmark case. Two are the main interconnected implications. First, a model that does not consider the differences in productivity dispersion between surplus and deficit countries within the Euro area may underestimate the required exchange rate depreciation in deficit countries. Second, productivity distribution differences across deficit countries are informative on the extent in which real depreciations can be expected to be an effective source of readjustment.

This paper attempts a synthesis of two very different streams of literature related to macro-trade and to firm level heterogeneity. As for the first stream, it relates to the international macroeconomics literature which studies the effect of a transfer on exchange rate movements, and the recent literature on the extensive margin of trade. In their two-country model, Corsetti et al. (2013) find that the extensive margin of trade dampens the required depreciation of the exchange rate associated to a transfer. Nevertheless, Corsetti et al. (2013) do not capture the extent in which the supply response of the firma (new and existing) impact on the current account adjustment. This paper also differs from Corsetti et al. (2013) as it builds a three-country model to analyze the indirect impact of a bilateral adjustment (e.g. between the deficit and the surplus in the Euro Area) to the trade balance with the rest of the world. Dekle et al. (2008) also analyze the implications on relative wages of eliminating current account imbalances in a multilateral Ricardian model of trade. They find that the wage of the debtor country should fall relative to the surplus country. For a given elasticity of substitution among goods, the drop in relative wages is larger in the short run, when the extensive margin of trade is shut down. Contrary to Dekle et al. (2008), this paper allows for cross-country differences in the productivity distribution, and explores the sensitivity of real exchange rate movements to the adjustment of Euro area external imbalances.

As for the second stream, the paper draws from the vast literature studying the impact of firm heterogeneity on productivity drivers. For instance, Bartelsman et al. (2009) shows that aggregate productivity enhancement is considerably driven not only by higher productivity of existing firms, but importantly via resource reallocation from lower to higher productive firms. Using as a proxy of allocative efficiency a simple indicator proposed by Olley and Pakes (1996), he provides empirical evidence of heterogeneity of such efficiency across countries, possibly to be attibuted to highly differentiated

istitutional set up and regulations in the respective product and labor markets. The policy results of this literature, which is very relevant for the analysis and implications of this paper, is that a wide and skewed firms productivity distribution provides important opportunity for raising aggregate productivity via inducing resources reallocation towards the higher end of the firm productivity spectrum. In turn, wider and more skewed distribution of productivity are generally associated to countries and sectors where policies and institutional set up are conducive to easier reallocation of factors. Structural reforms should therefore aim to facilitate such reallocation, over and above the more traditional aim to raise average productivity. In the context of our paper, larger scope for reallocation and thus for increase in aggregate productivity would overall enhance supply response of the economy in the phase of readjustment. In turn, this will reduce the need for real exchange rate adjustment.

The remainder of the paper is organized as follows. Section 2 motivates the use of firm-level evidence in the analysis of external adjustments. Section 3 introduces a three-country model of external account imbalances with a tradable and a non-tradable sectors and firm heterogeneity. Section 4 provides a quantitative assessment of the impact of a transfer that eliminates Euro area external account imbalances under different scenarios. Section 5 concludes.

2 Motivation

Firm level heterogeneity is by now well established in the empirical literature. Firms are very different to each other across critical dimensions such as size, productivity, cost structure, regardless of the sector they pertain to. Also, firms' distribution is typically not symmetric - like in a normal distribution - but rather skewed, with few firms being large and highly productive and others, the vast majority, being small and low productive. A critical implication of heterogeneity is that the impact of macro policies will vary depending upon the prevailing firm distribution in the economy, and that knowing this information is essential as one cannot assume anymore the existence of a representative homogeneous firm. The extent of the bias will depend therefore to the extent in which the actual distribution will differ to a normal one, which more technically is proxied by the extent of the difference between the median and the mean of the distribution.

As we will show in our theoretical model, the firm level producivity dimension can have a critical impact on the change in relative prices that is required in order to equilibrate trade imbalances. The novelty in this paper is that such needed firm-level data are now available and reliable, and most importantly are now sufficiently solid and homogeneous to be comparable across a large number of EU countries. The theoretical model can therefore be calibrated in order to offer indication on the relative importance of

adding such new dimension. We can already anticipate that this additional dimension is significant.

2.1 Data base and validation

Firm level data are highly confidential and typically cannot be elaborated by entities outside the national borders. In this respect *CompNet*, the competitiveness research network of the EU Central Banks, has rather sharply reduced this constraint. The aim of *CompNet* has been to produce information which is (i) comparable across countries, and that (ii) does not breach confidentiality rules despite being rich of micro level content. The project is based on the sharing of a protocol aimed at the construction of competitiveness indicators at country level in the EU. Each country team runs the protocol using its own country firm-level balance sheet data. The exercise, similar in nature to other by the World Bank and the OECD (see Bartelsman et al. (2009)), involved 11 National Central Banks (NCBs) of the EU System of Central banks as well as one National Statistical Institute (ISTAT) and the EFIGE team, covering 11 EU countries: Belgium, Czech Republic, Germany, Estonia, France, Hungary, Italy, Poland, Spain, Slovakia, and Slovenia.

Data include (i) the distribution of firm productivity/cost/employment, for about 60 sectors in 11 countries based on representative samples of individual firms' balance sheets, (ii) several moments of the distribution (average, mean, and skewness), and (iii) a number of critical correlations between size/productivity/cost of labor for different ranges of firm productivity.

In order to ensure comparability, special care was devoted to achieve full harmonization on industry classification, use of deflators, outlier treatment and variable definition and computation. The time coverage of the sample is generally the period 1995-2011. Coverage rate in terms of firms varies widely, but the coverage in terms of value added or number of employees, however, is much more homogeneous and complete, due to the fact that countries with low coverage have typically sampled larger firms. As reported in the paper describing the results of the exercise (ECB-Compnet (2014)), the indicators data base is rather superior in terms of coverage and cross country comparability to other existing ones, most notably the Amadeus database.[2]

In the remainder of the paper, we will focus on the cross-country differences between surplus and deficit countries in the Euro area. In particular, we will focus on Germany as surplus country and Italy/Spain

[2]The set of indicators available in the dataset is broadly organized around three topics: (1) inputs and output of the production function, including value added, turnover, employment, fixed assets, intermediate inputs and wages; (2) productivity-related indicators such as labor productivity, total factor productivity (TFP) and unit labor cost (ULC); and (3) allocative efficiency indicators, such as the Olley-Pakes (1996) and the Foster-Haltiwanger-Krizan (2006). For each of the listed indicators, the dataset contains a number of descriptive statistics, including not only the mean values of each country/year/industry, but also different moments of the distributions as well as standard deviation and skewness.

as the larger countries running a trade deficit.

2.2 Euro area external imbalances and productivity distribution

In the following we provide evidence on the recent evolution of external imbalances in the Euro area, with a special look at the external positions of Germany, Italy and Spain. We then report the most relevant findings on productivity distribution across these Euro area countries.

External imbalances in the Euro area.

The Euro area external accounts have been in broad balance since mid 2000s, howering around +/- 0.5 per cent of Euro area GDP, though lately the surplus (for both current account and trade balance) has tended to be unusually high (see figure 2). The latest developments were a combination of two main factors. On the one hand, German exports were increasing rapidly, resulting from strong demand from outside the euro area (figure 4) and resilient cost and price competitiveness (figure 7). This in turn lead to a doubling of its trade surplus vis-à-vis the ROW : from 2 to 4% of GDP between 2009 and 2013 (figure 4), only partially countered by a lower surplus with respect to the euro area.
On the other hand, debtor countries were rapidly readjusting, but mostly with respect to the economies outside the Euro Area. For Italy and Spain, for instance, the two largest debtor countries, the overall trade balances, over the same period 2009-2013, turned from a deficit to a surplus (figure 5 and 6). The external readjustment has been particularly notable in Spain, as it was equivalent to some 8 percentage points of its GDP. However, the adjustment took place mostly with respect to economies outside the Euro area, with only minor adjustments of the deficits with Germany.

Labor productivity.

Figure 1 displays the distribution of firm level labor productivity (calculated as real value added per employee) across the three countries of interest, averaging all available years per country.
Two observations are in order. First, the data replicate well known rankings calculated at the macro (aggregate) level across countries: Germany has a higher levels of labor productivity than Italy and Spain. Second, data confirm that the shape of the distribution of firm productivity in each country does not proxy a normal distribution, but rather it is highly asymmetric with many relatively "bad" firms, but also a certain number of particularly good ones. As a result, median labor productivity is significantly below the mean in all countries, which reflects a relatively long right tail. In Germany the right tail is remarkably more fat with respect to Spain and Italy. Among the latter two, the shape of the distribution appears rather similar, though with marginally higher mean for Italy and higher

dispersion for Spain. More in general, as shown in ECB-Compnet (2014) productivity dispersion across firms is highly correlated with the level of productivity.[3]

Patterns of external adjustments.

The speed and composition of external adjustment is of course strictly related to the nature and the size of the original imbalances. The case of Spain and Italy are in these respects rather different, and this matters for the simulations conducted in this paper. In the case of Spain, pre-crisis external deficits were large and widening, driven mostly by declining unemployment, especially in the construction sector. In particular, construction employment reached a peak of 13.1 percent right before the crisis (against an average of 9.9 percent in the last 30 years).[4]

Post-crisis external adjustment in Spain has taken place through this channel. The large decline in construction employment produced an improvement in productivity and - together with wage moderation - a rather sharp improvement in price competitiveness, especially when measured via unit labor costs (figure 7). This, in turn, has fostered a shift of production and exports from non-tradable to tradable goods, with the bulk of the adjustment though driven by import contraction. In this context, the higher dependence of Spain on trade within the euro area (representing 50 per cent of its total trade, against 40 percent for Italy) represented an additional constraining factor, at the time import demand by EA trading partners was weak beacuse of the recession.

For Italy, external accounts were roughly on balance in 2007, with a small deficit with Germany compensated by a small surplus with respect to the rest of the world. As the crisis erupted, deteriorating export performance and unabated import demand brought to a temporary deterioration of the trade balance with respect to the rest of the world, rapidly reversed over the last couple of years as price competitiveness improved and import demand fell.

3 Model

This section introduces a three-country general equilibrium model with a tradable and a non-tradable sectors. In both sectors, firms are heterogeneous in terms of productivity and the structure of trade flows is determined by the sales of heterogeneous exporting firms as in Chaney (2008). The world economy consists of three countries: two countries in the Euro area and one country representing the

[3] Given that sector-specific characteristics could be driving these differences, the above paper regresses sector (log) productivity levels in each sector against the within-sector (log) productivity skewness, controlling for specific sector and year effects, finding that they are indeed positively correlated.

[4] See Atoyan et al. (2013).

rest of the world.

We denote the Euro area deficit country by D, the Euro area surplus countries by S, and Rest of the World by R. The size L_i for each country $i = [D, S, R]$ is defined in terms of labor units. In each country $i = D, S, R$, domestic labor units are assumed to be the domestic numéraire. All prices (and wages) in each country i are measured in terms of country i units of labor. As a consequence of the choice of the numéraire, we can define three bilateral exchange rates :

$$\varepsilon_{D,S} = \frac{w_S}{w_D} \qquad \varepsilon_{D,R} = \frac{w_R}{w_D} \qquad \varepsilon_{S,R} = \frac{\varepsilon_{D,R}}{\varepsilon_{D,S}}$$

The exchange rate ε_D is defined as units of Deficit labor per unit of Surplus labor. An upward (downward) change in ϵ_D therefore refers to a depreciation (appreciation) of Deficit labor vs. Surplus labor. The same applies for the exchange rates $\varepsilon_{D,R}$ and $\varepsilon_{S,R}$.

Households

In each country i, the representative household supplies h units of labor inelastically at the nominal wage w_i. The household maximizes utility from consumption

$$C_i = \left[k_i^{\frac{1}{\theta}} C_{i,T}^{\ \frac{\theta-1}{\theta}} + (1-k_i)^{\frac{1}{\theta}} C_{i,N}^{\ \frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}$$

where $C_{i,T}$ denotes the consumption of tradable goods, $C_{i,N}$ the consumption of non-tradable goods, $0 < k_i < 1$ measures the share of tradable goods in total consumption, and $\theta \geq 1$ is the (constant) elasticity of substitution between tradable and non-tradable goods.

The consumer price index for country i is :

$$P_i = \left[k_i P_{i,T}^{1-\theta} + (1-k_i) P_{i,N}^{1-\theta} \right]^{\frac{1}{1-\theta}}$$

The basket of tradable goods $C_{i,T}$ is defined over a continuum of tradable goods $\omega \in \Omega_i$:

$$C_{i,T} = \left[\int_{\omega \in \Omega_i} c(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}$$

where $\sigma > 1$ is the elasticity of substitution across goods. Let $p_i(\omega)$ denote the country i currency price of a good $\omega \in \Omega_i$. The country i price index for tradable goods is then:

$$P_{i,T} = \left[\int_{\omega \in \Omega_i} p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}$$

and the demand for each individual tradable good is $c_i(\omega) = \left[\frac{p_i(\omega)}{P_{i,T}} \right]^{-\sigma} C_{i,T}$. The basket of tradable goods $C_{i,T}$ is therefore a function of total expenditure : $C_{i,T} = k_i \left(\frac{P_{i,T}}{P_i} \right)^{-\theta} C_i$.

In a similar fashion, the basket of goods $C_{i,N}$ is defined over a continuum of non-tradable goods $\upsilon \in \Upsilon_i$:

$$C_{i,N} = \left[\int_{\upsilon \in \Upsilon_i} c(\upsilon)^{\frac{\sigma-1}{\sigma}} d\upsilon\right]^{\frac{\sigma}{\sigma-1}}$$

Let $p_i(\upsilon)$ denote the country i currency price of a good $\upsilon \in \Upsilon_i$. The country i price index for non-tradable goods is then:

$$P_{i,N} = \left[\int_{\upsilon \in \Upsilon_i} p_i(\upsilon)^{1-\sigma} d\upsilon\right]^{\frac{1}{1-\sigma}}$$

and the demand for each individual non-tradable good is $c_i(\upsilon) = \left[\frac{p_i(\upsilon)}{P_{i,N}}\right]^{-\sigma} C_{i,N}$. Finally, the basket of non-tradable goods $C_{i,N}$ is also a function of total expenditure: $C_{i,N} = (1-k_i)\left(\frac{P_{i,N}}{P_i}\right)^{-\theta} C_i$.

Firms

In each country, there is a continuum of firms in the tradable and non-tradable sector. In the tradable good sector, each firm produces one different variety $\omega \in \Omega$. In the non-tradable good sector, each firm produces one variety $\upsilon \in \Upsilon$. Labor is the only factor of production. Firms are heterogeneous as they produce goods with different productivities. A firm with a productivity level x is able to produce x units of good using one unit of labor.

In each country i, firms selling their goods in the domestic market pay a fixed cost of production $F_{i,i}$ expressed in units of labor of country i. The fixed cost is assumed to be the same in the tradable and non-tradable sectors. When firms in the tradable sector export goods, they incur higher costs. Because of the iceberg transport cost $\tau > 1$, for one unit shipped, only a fraction $\frac{1}{\tau}$ arrives at destination, the rest being melt in the transportation. Then, in each country i, firms exporting to country j have to pay a fixed cost of production $F_{i,j} \geq F_{i,i}$, expressed in units of labor of country i.

Prices of tradable and non-tradable goods

Prices are set by profit maximizing firms as a constant mark-up $\phi = \frac{\sigma}{\sigma-1}$ over marginal costs. All prices are denominated in units of labor of the country where they are produced.

The prices of tradable goods are :

$$p_{i,i}(x) = \frac{\phi}{x} \qquad p_{i,j}(x) = \frac{\tau\phi}{x}$$

where $p_{i,i}$ denotes the price of a tradable good produced by a firm in country i and sold in the domestic market (country i), whereas $p_{i,j}$ denotes the price of a tradable good produced by a firm in country i and sold in abroad (country j). The prices of non-tradable goods are: $p_{i,N}(x) = \frac{\phi}{x}$.

Productivity distribution and zero-profit conditions

We assume that firm productivity is Pareto distributed in each country i with a scale parameter $\bar{x}_i$ and a shape parameter $\gamma_i > \sigma - 1$[5] :

$$G_i(x) = 1 - \left(\frac{\bar{x}_i}{x}\right)^{\gamma_i}$$

Because of the Pareto assumption, the distribution of firm size in each country i is also Pareto with shape $\psi_i = \frac{\gamma_i}{\sigma-1}$. The assumption of Pareto distributed productivities is made both for analytical tractability and on the basis of firm-level evidence. *CompNet* data show that firm productivity is Pareto distributed, and the skewness of the distribution varies across Euro area countries. The Pareto distribution of firm productivity and size is not peculiar to firms in Euro area countries. Axtell (2001) estimates the power law exponent for the distribution of U.S. firm size and find a value close to 1 (a phenomenon known as Zipf's law).[6]

In each country i, firms produce in the domestic market and export if and only if this is profitable. The zero-profit conditions therefore determine the productivity thresholds $\bar{x}_{i,i}$, $\bar{x}_{i,j}$ and $\bar{x}_{i,N}$, $\forall j \neq i$. For instance, in country D, firms producing tradable goods are active on the domestic market if their level of productivity x is above the threshold $\bar{x}_{D,D}$, and export in country S (in country R) if their level of productivity x is above the threshold $\bar{x}_{D,S}$ ($\bar{x}_{D,R}$). Then, firms producing non-tradable goods are active on the domestic market if their level of productivity x is above the threshold $\bar{x}_{D,N}$. The productivity thresholds are given by the following zero-profit conditions:

$$\pi_{D,D}(x) = \frac{1}{\sigma}\left[\frac{p_{D,D}(\bar{x}_{D,D})}{P_{D,T}}\right]^{1-\sigma} P_{D,T}C_{D,T} - F_{D,D} = 0$$

$$\pi_{D,S}(x) = \frac{1}{\sigma}\left[\frac{\frac{1}{\varepsilon_{D,S}}p_{D,S}(\bar{x}_{D,S})}{P_{S,T}}\right]^{1-\sigma} P_{S,T}C_{S,T} - \frac{F_{D,S}}{\varepsilon_{D,S}} = 0$$

$$\pi_{D,R}(x) = \frac{1}{\sigma}\left[\frac{\frac{1}{\varepsilon_{D,R}}p_{D,R}(\bar{x}_{D,R})}{P_{R,T}}\right]^{1-\sigma} P_{R,T}C_{R,T} - \frac{F_{D,R}}{\varepsilon_{D,R}} = 0$$

$$\pi_{D,N}(x) = \frac{1}{\sigma}\left[\frac{p_{D,N}(\bar{x}_{D,N})}{P_{D,N}}\right]^{1-\sigma} P_{D,N}C_{D,N} - F_{D,N} = 0$$

Similar zero-profit conditions determine the productivity thresholds in country S and R.

[5] This assumption on the shape parameters γ_i and elasticity σ ensures a finite mean for the sales of the firms.

[6] di Giovanni et al. (2011) estimate the power law exponent for the distribution of French firm size in the context of international trade with heterogeneous firms as in Melitz (2003). They also find a value for ψ close to 1 (around 1.05).

Aggregate budget constraint and equilibrium

As in Chaney (2008), the total mass of potential entrants in each country is assumed to be proportional to the size of the country, so that larger countries have more potential entrant firms. The price indexes for tradable and non-tradable goods in each country i can be then written as follows:

$$P_{i,T} = \left[L_i \int_{\overline{x}_{i,i}}^{\infty} p_{i,i}(x)^{1-\sigma} dG(x) + \sum_{j \neq i} L_j \int_{\overline{x}_{j,i}}^{\infty} \left[\varepsilon_{i,j} p_{j,i}(x) \right]^{1-\sigma} dG(x) \right]^{\frac{1}{1-\sigma}}$$

$$P_{i,N} = \left[L_i \int_{\overline{x}_{i,N}}^{\infty} p_{i,N}(x)^{1-\sigma} dG(x) \right]^{\frac{1}{1-\sigma}}$$

The final conditions to close the model are given by the aggregate budget constraint, labor market clearing conditions and the balance of payments. In the following, we assume that country D is running an external deficit both with respect to the surplus country S and the rest of the world R. As in Obstfeld and Rogoff (2005), this paper analyzes the adjustment of external imbalances driven by a trasfer of resources between deficit and surplus countries. In particular, for country D, the external adjustment is such that the aggregate demand of surplus countries increases whereas the domestic aggregate demand in country D decreases. As regards the external imbalances in the Euro area, this scenario corresponds to an increase in consumption expenditure by Germany, which would support the exports of goods produced by deficit countries. However, the increase in consumption expenditure by Germany also determines an increase in exports of the rest of the world. In this respect, the three-country dimension is essential for the outcome of the adjustment. The larger is the increase in German demand of goods imported from the rest of the world, the lower is the extent of the within Euro area trade rebalancing.

In the scenario of complete external adjustment, the international transfers of resources are determined as follows. Households in country D transfer a positive amount of resources $TB_{D,S}$ and $TB_{D,R}$ to households in country S and country R respectively. Finally, households in country R transfer a positive amount of resources $TB_{R,S}$ to households in country S.

The aggregate budget constraint for each country i is:

$$P_i C_i = Y_i - \sum_{j \neq i} TB_{i,j}$$

The left hand side of the aggregate budget constraint represents the value of aggregate consumption in country i, whereas the right hand side reports the aggregate income Y_i (labor income plus the share

in global profits) minus the transfers of resources $TB_{i,j}$.[7]

The transfers of resources are equivalent to trade balances $TB_{i,j}$. The external balances are defined $\forall j \neq i$ as :

$$TB_{i,j} = EXP_{i,j} - EXP_{j,i}$$

For instance, the aggregate budget constraint of country D is:

$$P_D C_D = Y_D - TB_{D,S} - TB_{D,R}$$

where the trade balances $TB_{D,S}$ and $TB_{D,R}$ are :

$$TB_{D,S} = EXP_{D,S} - EXP_{S,D} \quad \text{and} \quad TB_{D,R} = EXP_{D,R} - EXP_{R,D}$$

The zero-profit conditions and the aggregate budget constraints in each country i jointly determine the equilibrium productivity thresholds $\overline{x}_{i,i}$, $\overline{x}_{i,N}$, $\overline{x}_{i,j}$ for each country i and $\forall j \neq i$, and the bilateral exchange rates $\varepsilon_{D,S}$, $\varepsilon_{D,R}$ and $\varepsilon_{S,R}$.

4 Quantitative simulations

We simulate our model by considering the larger Euro Area countries with external imbalances. As shown in figures 3 - 6, Germany had consistent trade balance surpluses over the past decade, whereas Italy and Spain had trade balance deficits that have been reduced since the beginning of the Great Recession. In 2007, the bilateral trade deficit of Spain and Italy with respect to Germany were both at their highest level. We calibrate our three-country model by taking Germany as the surplus country S, Spain as the deficit country D and Rest of the world as the third country R. We then replace Spain by Italy as deficit country D. In our simulations, we reproduce the external adjustment process of Spain and Italy between 2007 and 2013, and we explore how the differences in the productivity distribution may affect the extent of the relative prices adjustment.

4.1 Calibration

As shown by *CompNet* data, the distribution of firm productivity across Euro Area countries may be represented by a Pareto distribution. We use our database to estimate the Pareto scale and shape parameters of productivity distribution for European countries : surplus country S (Germany), and

[7] The global profits Π, the sum of profits of firms in the three countries, can be shown to be a constant equal to $\sum_i \frac{\sigma-1}{\gamma_i \sigma - \sigma + 1} L_i$, thus the aggregate income in each country i is $Y_i = \left(1 + \frac{\sigma-1}{\gamma_i \sigma - \sigma + 1}\right) L_i$.

deficit country D (Spain/Italy). We normalize the mean of the productivity in the surplus country and set it equal to 1. Define the spread between the mean and the median of the distribution as :

$$\frac{\text{mean}_i - \text{median}_i}{\text{median}_i} = \frac{\gamma_i}{(\gamma_i - 1)} \frac{1}{\sqrt[\gamma_i]{2}} - 1$$

We use this definition to back out the shape parameter γ_i for each country $i = (D, S)$. Then, we use the ratio of the mean of productivity of country D relative to the mean of country S (normalized to 1) :

$$\frac{\text{mean}_D}{\text{mean}_S} = \frac{\gamma_D}{(\gamma_D - 1)} \bar{x}_D$$

to find out the Pareto scale parameter $\bar{x}_D$. *CompNet* data (see figure 1) show that the ratio of the average productivity in Spain to the average productivity of Germany is equal to 0.5002, whereas this ratio is equal to 0.5489 for Italian firms. Finally, as we normalize the mean of the productivity in country S to 1, we obtain the Pareto scale parameter $\bar{x}_S = \frac{\gamma_S - 1}{\gamma_S}$. As regards the rest of the world R, we calibrate the shape parameter γ_R using the standard deviation of log U.S. plant sales (equal to 1.67 in Bernard et al. (2003)). As in Ghironi and Melitz (2005), since this standard deviation is equal to $\frac{1}{\gamma_R - \sigma + 1}$ in the theoretical model, we only need the elasticity of substitution to back out γ_R. In the benchmark calibration, the elasticity of substitution among goods σ is set to 4, which is quite a standard level in the open macroeconomics literature, where the elasticity of substitution ranges between 2 (cf. Obstfeld and Rogoff (2005)) and 7 (cf. Imbs and Mejean (2009)). Finally, we assume that the mean of the productivity distribution in the rest of the world is the same as in the deficit country. Therefore, the Pareto scale parameter is $\bar{x}_R = \frac{\text{mean}_D}{\text{mean}_S} \frac{\gamma_R - 1}{\gamma_R}$.

Following Obstfeld and Rogoff (2005), the share of tradable good sector is set to 25 percent of consumption in the rest of the world ($k_R = 0.25$), trade costs are set to $\tau = 1.3$, and the elasticity of substitution among tradable and non-tradable goods is set to $\theta = 1$. The size of the world economy is normalized to 100 and the size of each country is set such that it roughly approximates the weight of each economy in world GDP. Fixed costs of production in the domestic ($F_{i,i}$) and export market ($F_{i,j}$), and the share of tradable good sector in country D and S are set to match the ratio of exports to GDP for each country. Changing the fixed domestic cost $F_{i,i}$ while maintaining the same ratio $\frac{F_{i,j}}{F_{i,i}}$ does not affect the exports to GDP ratio of country i. The fixed domestic costs $F_{i,i}$ are therefore set to 1 without loss of generality. Finally, the trade balances within and extra-Euro area (see section Motivation) allows to set the initial equilibrium values of $TB_{i,j}$.[8] Table 1 summarizes the values of the parameters in the benchmark calibration.

[8] Note that, by construction, $\underbrace{TB_D}_{(TB_{D,S}+TB_{D,R})} + \underbrace{TB_S}_{(-TB_{D,S}+TB_{S,R})} + \underbrace{TB_R}_{(-TB_{D,R}-TB_{S,R})} = 0.$

Table 1: Benchmark calibration.

Parameter	Symbol	Value
Elasticity of substitution among goods	σ	4
Elasticity of substitution tradable/non tradable	θ	1
Transport costs	$\tau_{i,j}$	1.3
Pareto shape Germany	γ_{DE}	3.98
Pareto shape Spain	γ_{ES}	3.94
Pareto shape Italy	γ_{IT}	4.73
Pareto shape ROW	γ_{R}	3.60
Pareto scale Germany	$\bar{x}_{DE}$	0.75
Pareto scale Spain	$\bar{x}_{ES}$	0.37
Pareto scale Italy	$\bar{x}_{IT}$	0.43
Pareto scale ROW	$\bar{x}_{R}$	0.36
Share of tradable good sector Germany	k_{DE}	0.80
Share of tradable good sector Spain	k_{ES}	0.35
Share of tradable good sector Italy	k_{IT}	0.33
Share of tradable good sector ROW	k_{R}	0.25
Relative size Germany/World	$\frac{Y_{DE}}{\sum_i Y_i}$	0.0590
Relative size Spain/World	$\frac{Y_{ES}}{\sum_i Y_i}$	0.0256
Relative size Italy/World	$\frac{Y_{IT}}{\sum_i Y_i}$	0.0378

Sources: *CompNet* and Eurostat. Year : 2007.

We simulate an external accounts rebalancing (benchmark case) and a counterfactual where we keep the cross-country differences in the mean of productivity while we switch off the differences in terms of productivity dispersion. In the counterfactual we perform a mean-preserving contraction of the productivity distribution of each country, as we set the Pareto shape parameter equal to 10. As in the benchmark case, the mean of productivity in country S is normalized to 1, and the countries differ in terms of mean of productivity relative to country S (Germany). This counterfactual is meant to capture what would be the consequences of the adjustment in a model where only the differences in average productivity are considered.

For both simulations, we explore the consequences of the adjustment under two different scenarios:

1. External adjustment 2007/2013 :

we reproduce the actual external adjustment of trade balances of Spain and Italy over the period 2007/2013. We compute the exchange rate adjustment predicted by the model given the observed change in the trade balances of country D, S and R between 2007 and 2013.

2. Complete rebalancing :
   we compute the real exchange rate adjustment needed in order to close to 0 the trade balance positions of country D, S and R.

In the Appendix, we report the results of our simulations in the case of i) partial rebalancing, where the trade balance positions of each country are closed to 0 one at the time, and ii) partial bilateral rebalancing, where the bilateral trade balance positions are closed to 0 one at the time. We now turn to the results.

4.2 The external accounts rebalancing of Euro Area deficit countries

In this section, we present the results of our simulations. We first study the external adjustment of Spain in our three-country general equilibrium model where Spain is the deficit country D, Germany represents the surplus country S and the rest of the world is country R. We then replace Spain with Italy as the deficit country D, and study its external rebalancing.

4.2.1 The Spanish external adjustment

As shown in figures 3 and 6, the trade balance position of Spain hit the higher level of deficit in 2007. The overall trade balance deficit accounted for 6.73% of Spanish GDP, where the bilateral trade balance with Germany alone accounted for 2.45% of GDP, the highest level over the past decade. At the same time, the overall trade surplus of Germany amounted to 7% of German GDP. After the beginning of the Great Recession in 2008-2009, the external account position of Spain has steadily improved as the trade balance turned into a surplus of 2.41% of GDP in 2013. The bilateral trade balance shows that the external adjustment relied on the remarkable improvement of the trade balance position with the rest of the world rather than the one with Germany. As a consequence, the overall trade balance position of Germany still has a surplus in 2013 of 6.34 of GDP, resulting mostly from an expansion of the German surplus vis-à-vis the rest of the world over the period 2007-2013.

The objective of our simulations is to reproduce the external rebalancing of Spain and explore the consequences of such adjustment on real exchange rates. We first calibrate our three-country model to the external account positions of Spain, Germany and rest of the world in 2007, and solve for the equilibrium real exchange rates. We then impose transfers of resources among the three countries such

to replicate the external account positions in 2013, and we solve the model to explore the real exchange rate movements associated with the external adjustment. We then perform an alternative experiment which is close in the spirit to Obstfeld and Rogoff (2001), as we set the external account positions of the three countries to 0 (complete adjustment).

Table 2: External accounts rebalancing : Spain.

Main experiment	θ	σ	γ_{ES}	γ_{DE}	γ_R	$\varepsilon_{ES,DE}$	$\varepsilon_{ES,R}$	$\varepsilon_{DE,R}$
2007-2013	1	4	3.94	3.98	3.60	3.63	3.79	0.08
complete	1	4	3.94	3.98	3.60	4.10	2.29	-1.10
Counterfactual	θ	σ	γ_{ES}	γ_{DE}	γ_R	$\varepsilon_{ES,DE}$	$\varepsilon_{ES,R}$	$\varepsilon_{DE,R}$
2007-2013	1	4	10	10	10	1.26	1.53	0.02
complete	1	4	10	10	10	1.36	0.95	-0.46

Note: columns 7-9 report the percentage change in real exchange rates. A positive number refers to a real exchange rate depreciation.

The second row of table 2 reports the results for the external accounts rebalancing between 2007 and 2013. As the bilateral trade balance of Spain with Germany moved from -2.45% of GDP in 2007 to -0.62% in 2013, the real exchange rate between Spain and Germany $\varepsilon_{ES,DE}$ depreciates by 3.63%. Similarly, the real exchange rate between Spain and the rest of the world $\varepsilon_{ES,R}$ depreciates by 3.79% as the Spanish trade balance with the rest of the world (-4.28% of GDP in 2007) turned into a surplus of 3.03% in 2013. Finally, as the trade balance position of Germany with respect to the rest of the world slightly improved over the period, the real exchange rate between Germany and the rest of the world $\varepsilon_{DE,R}$ also slightly depreciates.

The complete external adjustment experiment shows that the real exchange rate between Spain and Germany should depreciate more (4.10%) in order to fully close the deficit with Germany. Similarly, a lower real exchange rate depreciation (2.29%) would be sufficient to close the external account position of Spain vis-à-vis the rest of the world, whereas the balanced trade position of Germany vis-à-vis the rest of the world would require an appreciation of the German real exchange rate of 1.10%.

The movements in the real exchange rates increase with the extent of the external adjustment. However, the relationship is not linear and is different across countries. We define the exchange rate elasticity to the external adjustment as $\eta_{i,j} = \frac{\Delta\varepsilon_{i,j}}{\Delta TB_{i,j}}$. This ratio represents the percentage change in the real exchange rate between country i and country j associated with a 1 pct change in the trade balance

between country i and country j. For Spain, the elasticity with respect to Germany is larger than the elasticity with respect to the rest of the world, as $\eta_{ES,DE} = 1.98$ and $\eta_{ES,R} = 0.52$.
The exchange rate elasticity to the external adjustment vis-à-vis Germany is higher because the difference in average productivity between Spain and Germany is higher than the difference in average productivity between Spain and the rest of the world. The larger is the gap in terms of productivity, the larger is the exchange rate depreciation required by the external adjustment. This is due to the fact that the lower productivity of Spanish firms (see figure 1) limits the extent to which Spanish exports may contribute to the external adjustment. In particular, the model simulations show that the extensive margin of trade contributes for about 17% of the overall external adjustment of the Spanish trade balance.

4.2.2 The Italian external adjustment

We now turn to the analysis of another large Euro Area country that has experienced external imbalances: Italy. Although to a lesser extent than Spain, Italy also had an external adjustment over the period 2007-2013, with the bilateral trade deficit with Germany almost shrinking to zero (from -1.06% to -0.29% of GDP), and the trade surplus with respect to the rest of the world rising from 0.81% to 2.76 of GDP. As shown in figure 3, the overall Italian trade balance moved from a deficit (-0.25% of GDP) to a surplus (2.47% of GDP).

Table 3: External accounts rebalancing : Italy.

Main experiment	θ	σ	γ_{IT}	γ_{DE}	γ_R	$\varepsilon_{IT,DE}$	$\varepsilon_{IT,R}$	$\varepsilon_{DE,R}$
2007-2013	1	4	4.73	3.98	3.60	1.38	0.87	-0.01
complete	1	4	4.73	3.98	3.60	1.32	-0.40	-1.24
Counterfactual	θ	σ	γ_{IT}	γ_{DE}	γ_R	$\varepsilon_{IT,DE}$	$\varepsilon_{IT,R}$	$\varepsilon_{DE,R}$
2007-2013	1	4	10	10	10	0.53	0.44	0.00
complete	1	4	10	10	10	0.45	-0.16	-0.44

Note: columns 7-9 report the percentage change in real exchange rates. A positive number refers to a real exchange rate depreciation.

Table 3 shows that the actual external adjustment of Italy over the period 2007-2013 would call in the model for a real exchange rate depreciation both with respect to Germany (1.38%) and the rest of the world (0.87%). At the contrary, in the alternative scenario of complete adjustment, the real exchange

rate vis-à-vis the rest of the world would have to appreciate (-0.40%), as the Italian trade balance with the rest of the world would turn to a balanced position from the initial surplus. Similarly to Spain, the elasticity of the real exchange rate to the external adjustment is higher for Germany than for the rest of the world, as $\eta_{IT,DE} = 1.79$ and $\eta_{IT,R} = 0.44$.[9] However, both real exchange rate elasticities are lower than the Spanish ones. With respect to Spanish firms, Italian firms are characterised by a smaller productivity dispersion but a higher mean (cf. figure 1). This implies that there is a larger increase in the export capability of Italian firms (both at the intensive and the extensive margin) than Spanish firms. Moreover, in our simulations the extensive margin of trade accounts for about 25% of the overall external adjustment of the Italian trade balance, whereas it accounts for 17% of the overall external adjustment of Spain. For this reason, the exchange rate depreciation associated with a 1 pct external rebalancing is lower for Italy than for Spain ($\eta_{IT,DE} < \eta_{ES,DE}$).

4.2.3 The role of firm productivity dispersion.

The counterfactual experiment highlights the importance of the assessment of productivity dispersion. In the counterfactual, the mean of productivity for each country is preserved at its benchmark level, whereas the dispersion of productivity is set to a lower level, the same for the three countries (Pareto shape $\gamma = 10$). The counterfactual experiment is meant to replicate a standard model where only the differences in average productivity are considered. By increasing the Pareto shape of the productivity distribution, we decrease the heterogeneity among firms. The external rebalancing in the counterfactual exercise is strongly affected by the lower dispersion of firm productivity. As new exporter firms are as productive as incumbent exporters, the external rebalancing relies more on the extensive margin of trade. In our simulation, the contribution of the extensive margin of trade to the overall external rebalancing is about 50%, a figure much higher than what we find in the benchmark calibration for both countries (17% for Spain and 25% for Italy). The results in the last two rows of tables 2 and 3 show that both in the 2007-2013 external adjustment and in the complete adjustment scenario, the movements in the real exchange rates are smaller than in the benchmark case. The dampening effect on the exchange rate movements is due to the artificially high contribution of the extensive margin of trade.

The counterfactual experiment also shows that the cross-country differences in productivity dispersion matter for the extent of the real exchange rate movements. The gap between the elasticity of the exchange rate to the external rebalancing in the benchmark calibration and its counterpart in the

[9] The elasticities $\eta_{IT,DE}$ and $\eta_{IT,R}$, as well as the elasticities $\eta_{ES,DE}$ and $\eta_{ES,R}$ are computed for the 2007-2013 external adjustment.

counterfactual is larger for Spain (where firm productivity is more dispersed) than for Italy.

Finally, the results of our benchmark calibration are in line with the change in the relative ULC of Spain and Italy vis-à-vis Germany observed over the period 2007-2013. Figure 7 shows that the ratio of German ULC over Spanish ULC, that may be interpreted as a measure of the real exchange rate between these two countries, has decreased over the period 2007-2013. On the other hand, the external rebalancing of Italy was not associated to a relevant real exchange rate depreciation, as the ULC of Germany relative to Italy has remained virtually unchanged over the same period.
The counterfactual experiment shows that a model that neglects the differences in the level and the dispersion of productivity between deficit countries (Spain/Italy) and the surplus country (Germany) is bound to underestimate the change in real exchange rate associated with the external rebalancing. In this respect, this result stresses how important is the assessment of firm productivity distribution for exchange rate movements. Moreover, this result may be interpreted as a warning for policy makers on the possibly larger than expected impact of the external adjustment on the secondary burden of an international transfer of resources.

5 Conclusion

In this paper, we investigate the consequences of the adjustment of Euro area external imbalances on real exchange rates in a three-country general equilibrium model. With respect to the standard literature on international transfer, our general equilibrium three country model is augmented by the introduction of heterogeneous firms as in Chaney (2008). Contrary to previous papers that analyze the consequences of external adjustment both in a two country (see Pappadà (2011) and Corsetti et al. (2013)) and a multi-country framework (Dekle et al. (2008)), this paper allows for cross-country differences in productivity distribution. The cross-country differences in the mean and the dispersion of firm productivity determine the extent to which aggregate exports react to an international transfer. As a consequence of the adjustment, the external demand for the goods produced by deficit countries increases. This leads to an increase in the exports by existing exporters (intensive margin of trade) and the entry of new exporters (extensive margin of trade). A large increase in the sales by new exporting firms may play an important role on the adjustment of external imbalances, as it decreases the size of the secondary burden of a transfer.
CompNet data show that the firm productivity distribution of the surplus country (Germany) is characterized by a higher mean and a thicker right tail with respect to deficit countries (Italy, Spain). As

a consequence, the extensive margin of trade in deficit countries plays a limited role for the increase in aggregate exports as opposed to Germany. The external rebalancing for these countries therefore requires a relevant exchange rate depreciation.

As a counterfactual, we switch off the differences in productivity dispersion across Euro area countries and only allow for differences in average productivity. The results show that neglecting the cross-country differences in productivity dispersion tends to underestimate the exchange rate depreciation in deficit countries. This may be a warning for policy makers on the possibly large impact of the external adjustment on the secondary burden of an international transfer of resources. At the same time, it would show that structural reform aimed at widening the firm productivity distribution - and related easier reallocation of resources across firms - would result in lesser cost for the economy when external adjustments are needed.

Obviously, the overall real exchange rate response would depend critically on additional factors. These include the relative openness within and outside the euro area, directly addressed in the paper, as well as others - such as demand factors, relative trade elasticities, as well as the original sources of the imbalances - only discussed in the paper and left to further extensions.

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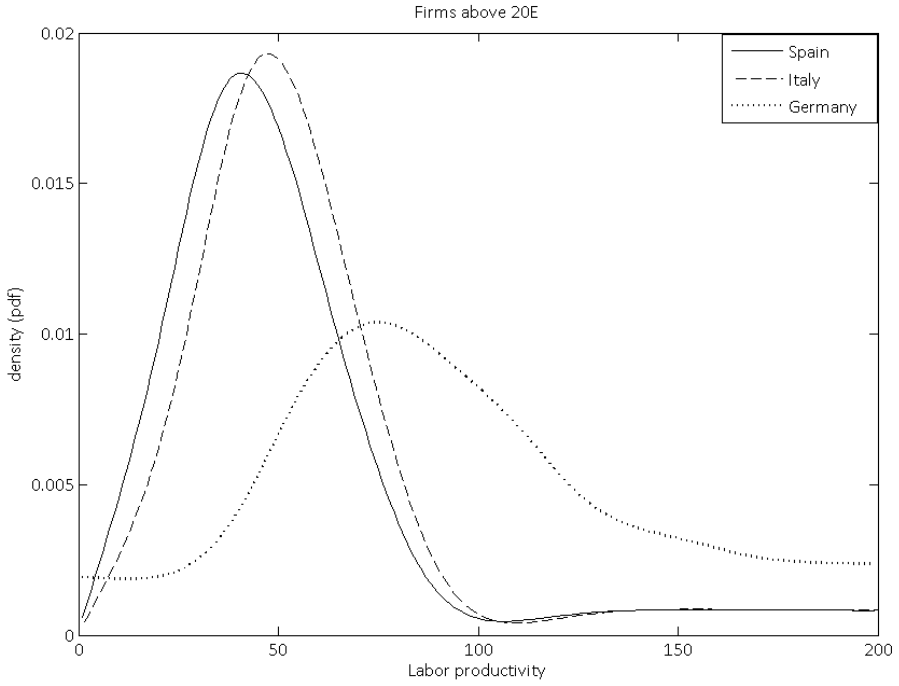
A Figures

Figure 1: Labor productivity distribution across countries, average over the period.



Source: ECB, *CompNet*. Note: Productivity level is computed at a sector-year level. The sample is restricted to firms with more than 20 employees. Country-year averages are computed as simple average across years of the percentiles using common weights across countries. Units are euros per employee.

Figure 2: Euro Area current account and trade balance.

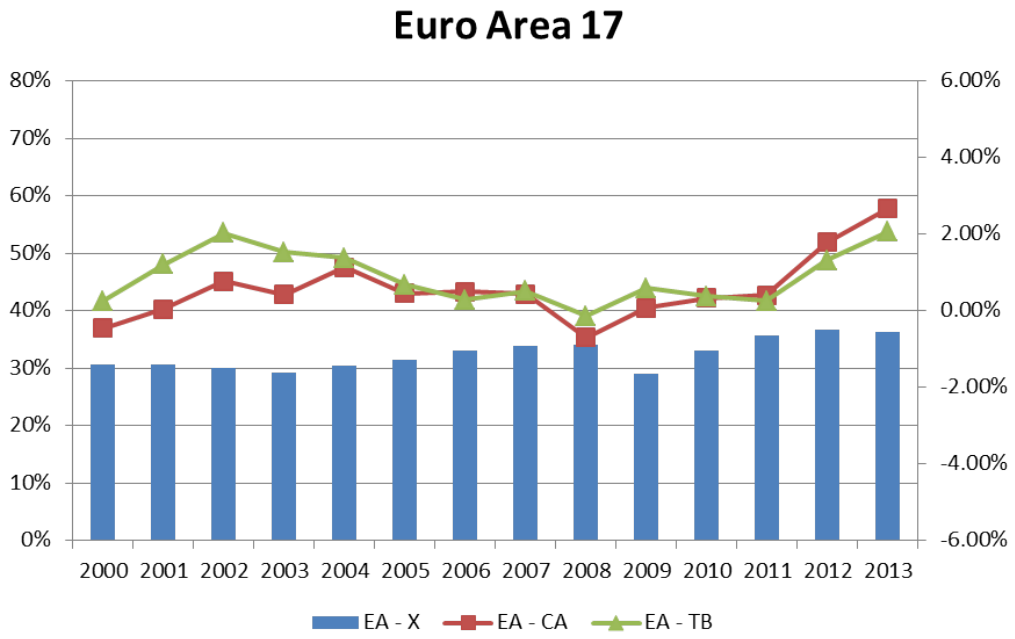


Figure 3: Trade balance Germany, Italy and Spain.

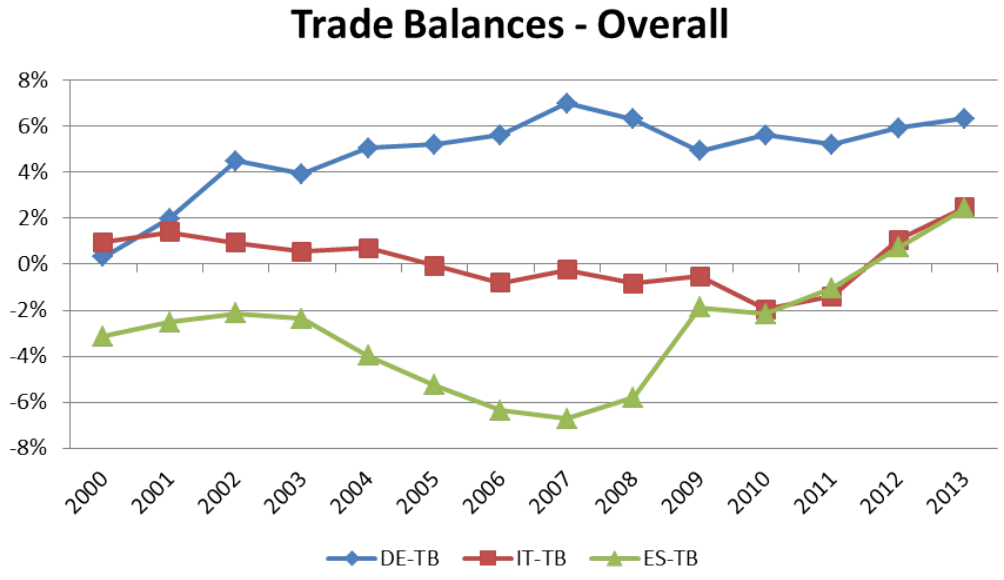
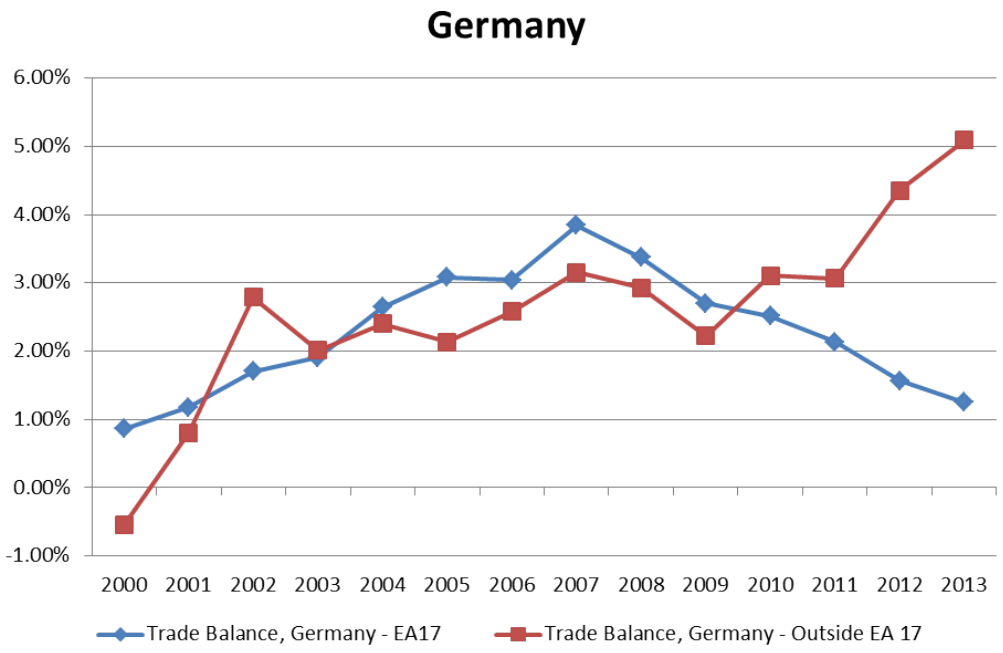
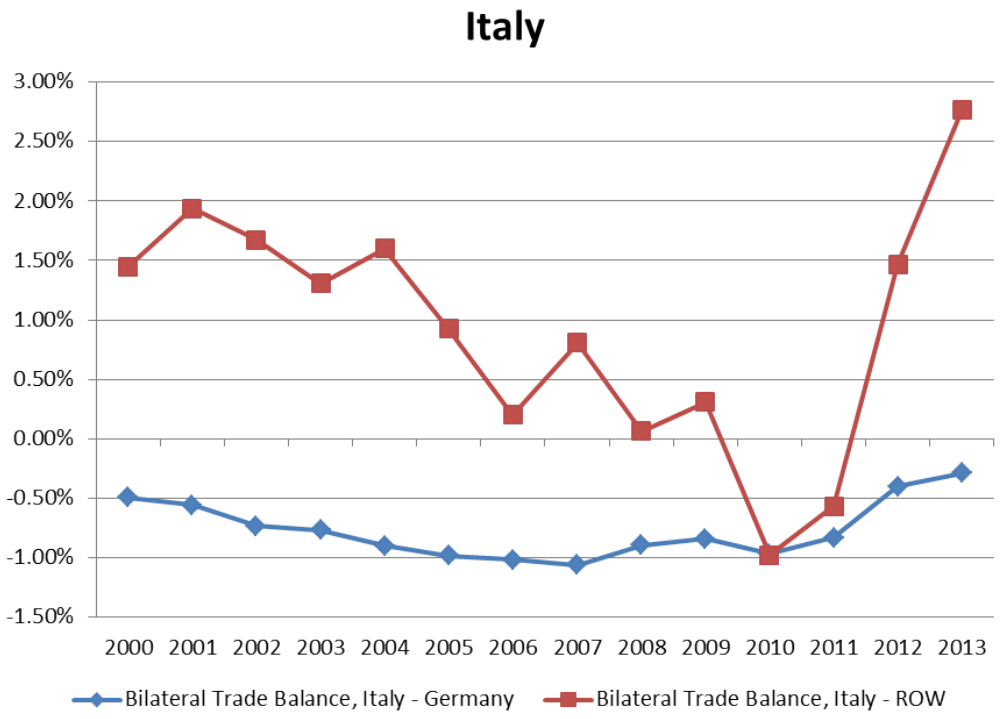


Figure 4: Germany : Bilateral trade balance (within and outside the EA).



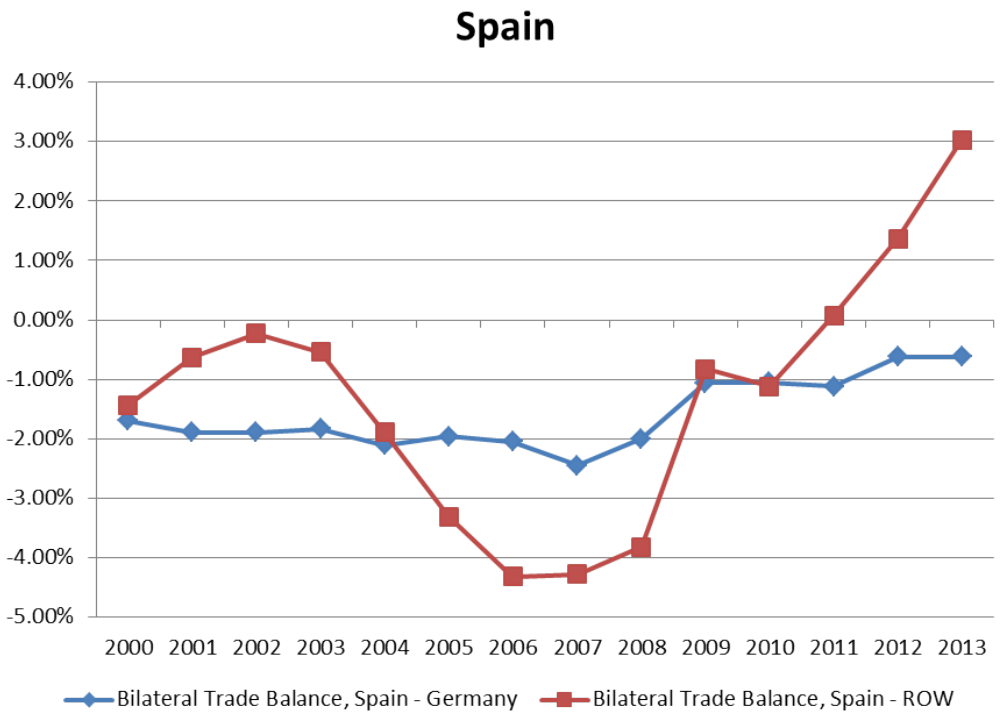
Note: the bilateral trade balance Germany-Outside EA 17 (red line) refers to the trade balance of Germany with respect to countries outside the EA 17. The sum of the blue and the red line represents therefore the overall trade balance of Germany.

Figure 5: Italy: Bilateral trade balance (with Germany and the rest of the world).



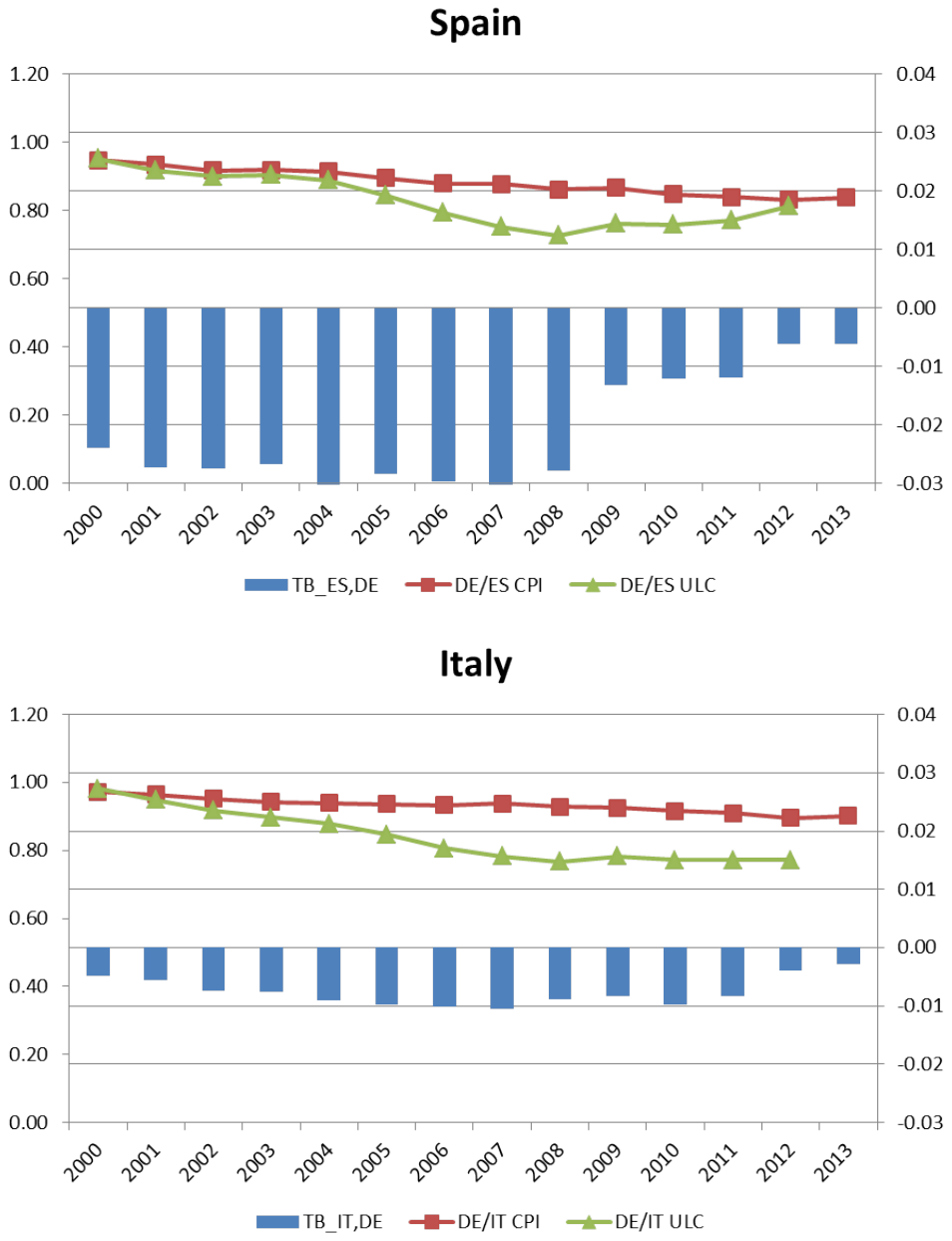
Note: the bilateral trade balance Italy-ROW (red line) refers to the trade balance of Italy with respect to the rest of the world, Germany excluded. The sum of the blue and the red line represents therefore the overall trade balance of Italy.

Figure 6: Spain: Bilateral trade balance (with Germany and the rest of the world).



Note: the bilateral trade balance Spain-ROW (red line) refers to the trade balance of Spain with respect to the rest of the world, Germany excluded. The sum of the blue and the red line represents therefore the overall trade balance of Spain.

Figure 7: Relative REER Spain and Italy vs. Germany.



Note : Real effective exchange rate (REER) measured using the ratio of Total Unit labor costs (ULCT) or HICP/CPI of Germany w.r. to Italy and Spain. A lower (higher) value reflects a loss (improvement) of price-cost competitiveness of Italy and Spain relative to Germany.

B Appendix

B.1 Partial rebalancing of external accounts

In this section we report the results of our simulations on the partial external rebalancing. We first consider the scenario where one country at the time adjusts its external imbalances, while the remaining external accounts are unchanged. This scenario may be interpreted as the unilateral policy of each single country to reduce its own external imbalances. We then study the bilateral external rebalancing, where only the bilateral trade imbalances are shut down, while keeping fixed the remaining external positions.

Table 4: Partial rebalancing of external accounts : Spain.

Main experiment	θ	σ	γ_{ES}	γ_{DE}	γ_{R}	$\varepsilon_{ES,DE}$	$\varepsilon_{ES,R}$	$\varepsilon_{DE,R}$
$TB_{ES} = 0$	1	4	3.94	3.98	3.60	4.59	2.38	0.06
$TB_{DE} = 0$	1	4	3.94	3.98	3.60	3.90	0.11	-1.11
$TB_{R} = 0$	1	4	3.94	3.98	3.60	-0.17	2.11	-1.15
$TB_{ES,DE} = 0$	1	4	3.94	3.98	3.60	4.48	0.22	0.26
$TB_{ES,R} = 0$	1	4	3.94	3.98	3.60	0.25	2.20	0.01
$TB_{DE,R} = 0$	1	4	3.94	3.98	3.60	-0.42	-0.09	-1.16

Note: Partial rebalancing of external accounts. Deficit country is Spain. Columns 7-9 report the percentage change in real exchange rate. A positive number refers to a real exchange rate depreciation.

The results in the second row of table 4 show that the unilateral external account adjustment by Spain ($TB_{ES} = 0$) involves an exchange rate depreciation both with respect to Germany and the rest of the world, whereas a little change applies for the exchange rate between Germany and rest of the world. Interestingly, the third row investigates the consequences of the reduction of the external account surplus of the Surplus country, which has been very much relevant in the recent debate (cf. US Treasury report on October 31, 2013). The reduction of German external surplus implies an increase in its demand of goods produced in Spain and in the rest of the world. This adjustment requires a larger depreciation for Spain (3.90%) than the rest of the world (1.11%) vis-à-vis Germany, as the extensive margin of trade for Spain plays a smaller role for the increase in its aggregate exports. Then, the fourth row of table 4 reports the exchange rate movements under the scenario of an extra Euro area rebalancing. The external rebalancing of the rest of the world towards Germany and Spain implies an

exchange rate appreciation for Germany (-1.15%) and a slight appreciation for Spain as well (-0.17%). As the trade deficit between Spain and Germany stays unchanged in this scenario, an exchange rate appreciation of Spain with respect to Germany is also required (-0.26%).

Table 5: Partial rebalancing of external accounts : Italy.

Main experiment	θ	σ	γ_{IT}	γ_{DE}	γ_R	$\varepsilon_{IT,DE}$	$\varepsilon_{IT,R}$	$\varepsilon_{DE,R}$
$TB_{IT} = 0$	1	4	4.73	3.98	3.60	1.86	-0.31	0.02
$TB_{DE} = 0$	1	4	4.73	3.98	3.60	1.33	-0.04	-1.23
$TB_R = 0$	1	4	4.73	3.98	3.60	-0.53	-0.44	-1.26
$TB_{IT,DE} = 0$	1	4	4.73	3.98	3.60	1.94	0.05	0.15
$TB_{IT,R} = 0$	1	4	4.73	3.98	3.60	-0.02	-0.36	0.00
$TB_{DE,R} = 0$	1	4	4.73	3.98	3.60	-0.51	-0.08	-1.25

Note: Partial rebalancing of external accounts. Deficit country is Italy. Columns 7-9 report the percentage change in real exchange rate. A positive number refers to a real exchange rate depreciation.

The results in table 5 show that, contrary to Spain, in the case of partial rebalancing by Germany ($TB_{DE} = 0$), the exchange rate of Italy with respect to Germany depreciates slightly more (1.33%) than in the complete adjustment (1.32%) scenario. The partial rebalancing of Germany implies the reduction of the trade deficit that both the rest of the world and Italy run with Germany. As the German rebalancing implies an important real exchange rate appreciation of Germany vis-à-vis the rest of the world, the real exchange rate of Italy vis-à-vis the rest of the world also has to appreciate (-0.04%), and this requires a larger depreciation vis-à-vis Germany.[10]

[10] Both in the case of Spain and Italy, note that the movement in the exchange rates in the case of complete external rebalancing (third row of tables 2 and 3) is approximately equal to the sum of the exchange rate movements in the partial and bilateral adjustments : rows 2 and 7, rows 3 and 6, rows 4 and 5 respectively of tables 4 and 5.