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The role of the Exchange Rate Regime in the process of Real and Nominal Convergence

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Abstract

The Balassa-Samuelson (B-S) hypothesis suggests that, in catching-up countries, inflation will be comparatively higher, as prices of non-traded goods “catch up” with the growth of productivity in the tradable goods sector; as a result, these countries will experience real appreciation. However, a general result of the literature is that the B-S effect can only explain part of the excess inflation observed in European catching-up countries. One feature of these studies is their neglect of the role of the exchange rate regime in affecting price convergence. In this paper, instead, we argue that the choice of the exchange rate regime may affect nominal convergence. To show this, we first model the regime choice and, in a second stage, estimate a B-S type of regression for each regime. Our results show that, for countries that pegged to or adopted the euro, the effect of an increase in dual productivity growth (the difference in productivity growth between the traded and non-traded sectors) on the dual inflation differential is twice as large as that in “flexible” countries. We conclude that, in catching-up countries, too early adoption of the euro may foster excess inflation, beyond what would be implied by B-S convergence only.

Keywords: Exchange Rate Regimes; Balassa-Samuelson Effect; Inflation; Euro adoption.

JEL classification: C34; E52; F31.

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1 Introduction

The aim of this paper is to study the process of real and nominal convergence in Europe, accounting for the role of the exchange rate regime in the catching up process. By making international prices comparison easier and removing one source of variability, a fixed exchange rate regime – and, even more so, entry in a monetary union – can foster price convergence at a higher speed with respect to real convergence.

As postulated by the Balassa-Samuelson (Balassa 1964, Samuelson 1964; henceforth B-S) hypothesis, in a catching-up country there will be a comparatively higher inflation, of a structural nature, as prices of non-traded goods and services “catch up” with the growth of productivity in those sectors producing tradable goods and services. With respect to this hypothesis, we argue that, due to the adoption of a fixed exchange rate regime in a catching-up country, a higher inflation might follow. In fact, fixing the exchange rate might accelerate the convergence of the non-tradable sectors’ prices, beyond what is implied by the B-S effect. This will be our first tested hypothesis. Furthermore, this additional inflation may “contaminate” wage and price setting in the sectors producing tradable goods and services. If this also happens, then fixing the exchange rate at an early stage of catching-up might be accompanied by loss of price competitiveness and large international imbalances, and thus become in principle unsustainable. Whether this additional effect (which is suggested by the recent experience of some Southern European countries¹) can be empirically documented is the second hypothesis that we will test.

The focus of this paper will be on European countries that are in the process of catching up, which we identify as having a level of GDP per capita lower than 75% of the average of EU-15 countries at the initial date of our sample. We select these countries as they either have recently joined the euro, or are expected to do so in due time. The variety of exchange rate regimes adopted by these countries in recent years provides a good opportunity to study the effects that different regimes might have on the process of real and nominal convergence.

During the last 15 years, there has been considerable research on B-S convergence in Europe, with an eye in particular on transition countries (see Égert, Halpern and MacDonald 2006). The B-S hypothesis states that countries that are in the process of catching up experience real exchange rate appreciation (measured in CPI terms); this is due to the fact that productivity grows faster in the tradable goods sector than in the non-tradables sector. In the former sector, productivity gains translate into

¹ For instance, Kasimati and Verarios (2013) observe that “the result of Greece’s accession to the EMU in January 2001 was a rapid deterioration in both its fiscal and current account deficits”. One may also add that the second deterioration took place much more promptly than the first one. The same authors observe that the current account deficits were mostly due to “mounting losses in competitiveness”.

wage increases which, due to free inter-sectoral labor mobility, are transferred throughout the economy. The increase in wages in the non-tradables sector, in turn, pushes up the prices of non-traded goods, which causes the increase in the CPI that determines real exchange rate appreciation.

Studies on B-S convergence in Europe have looked at the issue from different perspectives, and using alternative methods². A general result seems to be that the B-S effect can account only for a minor part of the excess inflation observed in catching-up countries (see Égert 2007). For example, Klau and Mihaljek (2004) find that productivity differentials explain a negligible share of observed inflation differentials in Poland, Slovakia and Hungary. According to Coricelli and Jazbec (2004), however, once the initial phase of transition, with adverse conditions and structural reforms, was completed, the B-S effect dominated other causes in explaining real exchange rate appreciation. Nevertheless, the finding that the B-S effect *per se* has limited predictive power to explain excess inflation in Central and Eastern Europe suggests that other factors may indeed be at play³. In this respect, Fischer (2004) suggested that productivity shocks may affect the dual inflation differential also via investment demand and government consumption, and Lane and Perotti (2003) find that the composition of fiscal policy changes (for instance, reduction in wage government spending vs. increases in labor taxes) may induce different effects on the profitability of the traded vs. non-traded sector. In addition, Galstyan and Lane (2008) suggested that an increase in government consumption will increase the relative demand and price of nontradable goods and lead to a real appreciation of the exchange rate, although the effects of government investment are theoretically more ambiguous. Empirically, Galstyan and Lane (2008) find that increased government investments are generally associated with a decline in the relative price of nontradables, but have no effect on the real exchange rate.

Strangely enough, however, the literature on convergence that flourished in the last decade has mostly left aside the role of the nominal exchange rate regime in the process of convergence. This is surprising because there is a wide strand of literature showing robustly that exchange rate regimes affect macroeconomic performance, for example growth (Levy-Yeyati and Sturzenegger 2003), after-crisis recovery (Tsangarides 2012) and inflation dynamics (Ghosh et al. 2007). Also Lane and Perotti (2003) noted that the above-mentioned effects of fiscal policy changes will differ according to the exchange rate regime (fixed vs. flexible).

² In terms of their different empirical approaches, one can distinguish between studies employing descriptive statistics or an accounting framework (Begg et al. 1999 and Dobrinsky 2006); time series econometrics (for example, Golinelli and Orsi 2002, and Égert 2002) and panel econometrics (Égert 2002 and Fischer 2004, among others).

³ One effect that has been suggested in particular is related to Engel's law, which postulates that, during the catching up process, consumers move to higher-quality goods, thus indirectly pushing up the observed CPI (Égert and Podpiera 2008, Égert 2010).

More recently, an additional channel has been informally suggested by Krugman (2013): *“After the creation of the euro, (...) there was massive capital movement from Europe’s core – mainly Germany, but also the Netherlands – to its periphery, leading to an economic boom in the periphery and significantly higher inflation rates in Spain, Greece, etc. than in Germany”*.

Finally, even under the assumption that traded goods price setting is dominated by the law of one price, euro adoption might additionally make also the prices of non-tradable goods and services more comparable across countries. Indeed, Sturm et al. (2009) show that the β -convergence of prices in the EU after 1998 has been faster within the subset of EMU countries. They also show that the rate of convergence in the price of non-tradables has increased after the introduction of the euro, both for EMU and non-EMU countries, although the speed of convergence is significantly higher for the former group.

To take into account the effects of the exchange rate regime on the patterns of relative price adjustment and real exchange rate appreciation, however, induces substantial complications in the empirical analysis. Since the choice of the regime itself is endogenous, it would be necessary to estimate alternative models of the B-S effect, depending on the exchange rate regime in place. The main contribution of this paper is thus to propose and implement a way to measure the role of the exchange rate regime in accelerating price convergence, modeling the choice of the regime. In addition, by establishing a link between the exchange rate regime and the decoupling of price and productivity convergence, our results provide one rationale why adopting the euro “too early”, i.e. when real convergence is far from being completed, may entail a potentially high cost in terms of competitiveness.

The paper is structured as follows: in section 2 we present a general formulation of the B-S effect, along the lines of Froot and Rogoff (1995). In section 3 we introduce the dataset and discuss econometric issues. Section 4 reports the results on the choice of the exchange rate regime and section 5 the different estimates of the B-S effect across regimes. In section 6 we tentatively assess whether the choice of the exchange rate regime has had additional implication on the competitiveness of catching up countries. Section 7 summarizes and concludes.

2 A stylized model of the B-S effect

As confirmed by the evidence on the Penn effect, the price index should be expected to increase with real GDP per capita. For instance, in 2007 – the last year before the crisis – the correlation between the two series in the EU-27 was 0.87. Thus, we should expect that over time price convergence should go in parallel with real catching up. In addition, as argued in the introduction, we might also expect that euro adoption accelerates the rate of price convergence. The B-S hypothesis looks

at this issue from the point of view of productivity: productivity growth in catching-up countries, which, as we will see below, is higher in the traded goods sector, is associated with a positive inflation differential, i.e. higher inflation in the non-traded with respect to traded goods sector.

The main theoretical reference for the empirical analysis of the B-S effect is Froot and Rogoff's (1995) model. There are two countries: home, which is in the process of catching up, and a foreign, more developed country (indicated with an asterisk). There are two sectors, producing respectively traded goods and services (T) and non-tradables (N). Production in both sectors uses two inputs, capital (K) and labor (L). Capital is freely mobile across sectors and countries, and this ensures international and inter-sectorial equalization of the rental rate of capital. Labor is freely mobile across sectors but it is internationally immobile. This ensures that we have inter-sectoral wage equalization in each country, while $W \neq W^*$.⁴ The production function is Cobb-Douglas for each country and sector:

$$Y_T = A_T K_T^{1-\alpha} L_T^\alpha \quad (1)$$

$$Y_N = A_N K_N^{1-\beta} L_N^\beta \quad (2)$$

$$Y_T^* = A_T^* K_T^{*1-\gamma} L_T^{*\gamma} \quad (3)$$

$$Y_N^* = A_N^* K_N^{*1-\vartheta} L_N^{*\vartheta} \quad (4)$$

Call P_T the price of traded goods and P_N the price of non-traded goods. Profit maximization implies that the rental rate of capital and wages in each sector and country will equate the marginal products. Taking logs of (1)-(4) and solving the maximization problem yields the *internal* version of the B-S effect (note: lower case letters indicate logs, dots indicate changes):

$$\dot{p}_N - \dot{p}_T = \frac{\beta}{\alpha} \dot{a}_T - \dot{a}_N \quad (5)$$

i.e. the differential growth rate between the prices of non-traded and traded goods has the opposite sign of, and increases with, the absolute value of the productivity growth differential. The reason is clear: as productivity grows faster in the traded goods sector, and wages are equalized across sectors, firms in N will need to increase prices faster than in T , to keep up with the surge in labor costs.

This leads to the first Proposition of the B-S effect, (BS1):

Proposition BS1 (Internal B-S Effect). In a catching up country, N goods prices grow at a higher rate than T goods prices. The difference between N goods

⁴ While the assumption that labor does not move across countries may look too strong for EU member states, since the Treaties guarantee free mobility of goods, people and services, the evidence shows that only 4% of workers in the EU come from a different EU member state, against an average of 33% in the U.S. Thus, notwithstanding the freedom of labor mobility, other barriers (mainly linguistic and cultural) still keep the EU labor market far from being perfectly integrated.

inflation and T goods inflation will be higher the higher the productivity growth differential between T and N , and the more production of N is relatively labor-intensive.

The two-country version of (5) is therefore simply:

$$(\dot{p}_N - \dot{p}_T) - (\dot{p}_N^* - \dot{p}_T^*) = \left(\frac{\beta}{\alpha} \dot{a}_T - \dot{a}_N\right) - \left(\frac{\beta}{\alpha} \dot{a}_T^* - \dot{a}_N^*\right) \quad (6)$$

i.e. excess relative inflation at Home with respect to the Foreign country (the *dual inflation differential*) is determined by the difference between dual productivity (productivity growth in the traded vs. non-traded goods sector) at home and abroad (the *dual productivity growth differential*). Proposition BS2 formally states this result:

Proposition BS2 (External B-S Effect). For a catching up country, the dual inflation differential is proportional to the dual productivity differential. Other things equal, dual inflation differential will be higher the more N is relatively labor-intensive in the Home country with respect to the Foreign country.

Equations (5) and (6) have been estimated, in the most recent literature on the B-S effect, in the following respective forms⁵:

$$\dot{p}_N - \dot{p}_T = \delta_0 + \delta_1(\dot{a}_T - \dot{a}_N) + \varepsilon \quad (7)$$

$$(\dot{p}_N - \dot{p}_N^*) - (\dot{p}_T - \dot{p}_T^*) = \delta_0 + \delta_1(\dot{a}_T - \dot{a}_N) + \delta_2(\dot{a}_T^* - \dot{a}_N^*) + \varepsilon \quad (8)$$

where a priori, we expect $\delta_1 > 0$ and $\delta_2 < 0$. In order to incorporate into an empirical model the idea that the exchange rate regime affects B-S convergence, let us assume, for simplicity, that we only had two different exchange rate regimes, fixed and flexible. Thus, we could re-write equations (7) and (8), respectively, as:

$$(\dot{p}_N - \dot{p}_T) = \rho_0 + \rho_1 D_R + \rho_2(\dot{a}_T - \dot{a}_N) + \rho_3 D_R * (\dot{a}_T - \dot{a}_N) + \varepsilon \quad (9)$$

$$(\dot{p}_N - \dot{p}_N^*) - (\dot{p}_T - \dot{p}_T^*) = \mu_0 + \mu_1 D_R + \mu_2(\dot{a}_T - \dot{a}_N) + \mu_3 D_R * (\dot{a}_T - \dot{a}_N) + \mu_4 D_R * (\dot{a}_T^* - \dot{a}_N^*) + \mu_5 D_R * (\dot{a}_T^* - \dot{a}_N^*) + \varepsilon \quad (10)$$

where D_R is a dummy variable, which is equal to 1 if the regime is fixed, or the country has adopted the euro, and zero otherwise. However, while empirical studies analyzing the impact of the exchange rate regime on macroeconomic performance often employ exchange rate dummies in inflation or growth equations, in the case of equations (9) and (10) we shall require a particular estimation procedure, which we explain at the end of section 3.

⁵ See Égert (2002), Égert *et al.* (2003) and Klau and Mihaljek (2004), among others.

3 The data and the empirical approach

Our focus on catching up countries among the group of EU members and candidates, chosen with a threshold equal to 75% of average GDP per capita in the EU 15 in 1998, results in an unbalanced sample of the following 14 countries: Bulgaria, Cyprus, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Poland, Portugal, Romania, Slovak Republic, Slovenia, Turkey.⁶

The “foreign country” in our analysis is the euro area. More specifically, we created a “core” euro area that includes Austria, Belgium, Finland, France, Germany, Italy, Netherlands and Spain⁷. This definition of the core euro area seems appropriate in our context, as it includes all those countries that have been consistently above the catching up threshold at least since 1998.

We use quarterly data from 1998:1 until 2011:4. Price and productivity data are from Eurostat (for Turkey also national sources). Following the literature on the B-S effect, we use the price index for manufactured goods as a proxy for p_T , and the price of services as a proxy for p_N . This choice of proxies is of course objectionable, on the twin grounds that not all manufactured goods are tradable while an increasing number of services is, and that the distinction between services and manufacturing is by itself imprecise.⁸ However, it would not be feasible – to our knowledge – to achieve a more precise identification of the tradable potential of each sector’s production in this case, and thus we stick to the distinction that has been traditionally maintained in the literature.⁹ In its defense, we observe that, even if the distinction tradables/non tradables does not coincide with that between manufactured goods and services, nevertheless in general the tradable potential of goods is considerably higher than that of services. Productivity is defined as gross value added per hour worked. Due to lack of data on thousands of hours worked for Greece and Turkey, we used thousands of workers.¹⁰

⁶ The choice of the GDP threshold is consistent with the definition of “converging regions” in EU regional policy (although the term of comparison for the policy is currently the EU-28). To ensure within-sample data homogeneity, and to avoid problems related to data non-availability, we excluded Serbia, Croatia and Macedonia; we excluded Malta due to the small size of its economy.

⁷ This leaves out Luxembourg and Ireland, due to data availability issues. To calculate the CPI of the “core” euro area, we used country data and weighted them using the weights provided by Eurostat.

⁸ As Christensen (2013) observes, “the increasing complexity of production, inertia in changes to statistical systems and the increasing integration of manufacturing products and services are some of the primary and interrelated explanations for this lack of precision”. In addition, Nordas and Kim (2013) remark that services competitiveness is a key ingredient of manufacturing competitiveness.

⁹ Sturm *et al.* (2009) study the convergence of prices among 18 European countries using the data for 224 product groups. However their data cover only the period between 1995 and 2005 and cannot be matched with data on trade openness.

¹⁰ Using thousands of hours worked to define employment is preferable because this indicator is not affected by changes in the importance of part-time jobs in the economy. However, in Greece and Turkey there was not a significant change in the ratio of part-time contracts over the total.

Table 1 presents a descriptive view of the (internal) Balassa-Samuelson effect for our sample countries. In all countries, the inflation differential ($\dot{p}_N - \dot{p}_T$) is positive, while productivity grew faster in the traded goods sector, $(\dot{a}_T - \dot{a}_N) > 0$; at the same time, while the evolution of the nominal exchange rate (defined as units of local currency per euro, e) has been diverse, due, among other things, to different exchange rate regimes, the real exchange rate q has appreciated *vis à vis* the euro, which is what we would expect from convergence *à la* Balassa-Samuelson. Moreover, Figure 1 shows the average annual dual inflation differential and dual productivity growth differential for each country (over the whole sample). There is a positive relationship between the two variables, as countries showing a higher dual productivity growth differential also present higher dual inflation, as the external B-S hypothesis would predict. From a descriptive point of view, note in Figure 1 that the line resulting from a linear regression of (mean) dual inflation on (mean) dual productivity has a positive slope and an R^2 of 0.314.

[Insert Table 1 here]

[Insert Figure 1 here]

Since this paper deals with exchange rate regimes, the first question we need to pose is: which regimes have been in place? Broadly speaking, there are two alternative criteria for exchange rate regimes classification: *de jure* and *de facto*. In the former case, we would classify regimes based on what the Central Bank declares to be the official exchange rate regime. This criterion may present a problem if a Central Bank pursues an exchange rate policy which is inconsistent with the official regime. Indeed, this happens quite frequently, as documented by Calvo and Reinhart (2002), whose work opened the path to a wide strand of literature aimed at estimating *de facto* as opposed to *de jure* exchange rate regimes (see also Reinhart and Rogoff, 2004; Levy Yeyati and Sturzenegger, 2005, among others). On the other hand, *de facto* classifications are based on algorithms which look at the volatility of (bilateral) exchange rates and other key variables such as foreign exchange reserves.

However, within our sample, the issue is less controversial, given on the one hand the relatively small number of countries included and, on the other hand, the fact that, in most countries and quarters in our sample, Central Banks' behavior was consistent with the official policy¹¹. For this reason, and given that also purely *de facto* classifications do not always coincide, in this paper we use the *de jure* classification, and only complement it with *de facto* considerations (from Reinhart and Rogoff, 2004) in some cases, as we explain below.

In order to have a broad picture of the issue, Table 2 reports the countries and corresponding exchange rate regimes over the selected sample period. In particular, in columns 2-3, we report countries' exchange rate regimes based on our

¹¹ See the discussion on Table 2 below.

classification. For comparison, columns 4-5 report the IMF (2009) *de facto* classification. As a robustness check, in Section 5.2 we will repeat the estimations using the *de facto* classification.

[Insert Table 2 here]

First of all, note that in Table 2 (column 3) we identify 5 different regimes: EMU membership, peg, managed floating (MF), inflation targeting (IT) and freely falling (FF). A country is classified as “EMU” if it has adopted the euro and “Peg” if a currency board or a *de jure* strict peg has been in place (this applies to Estonia, Latvia, Lithuania and Bulgaria). “MF” applies to all cases where a limited flexibility regime has been declared: fluctuation bands (including EMS membership), crawling bands, crawling pegs. We classify a regime as IT when the Central Bank’s official monetary policy objective is price stability and an explicit target for the inflation rate has been stated. This distinction is not present in Reinhart and Rogoff (2004) as in most of the literature on regimes classification, that actually ignores IT as a separate regime. However, as discussed in Ball and Reyes (2008), “honest” IT may contribute to reduce the fluctuations in the exchange rate, and therefore may be mistakenly considered as a *de facto* managed float if the classification criterion only focuses on exchange rate volatility. Since, in our sample, “freely flexible” regimes are IT, we include it as a separate regime in Table 2. Finally, as in Reinhart and Rogoff (2004), we name a regime as “freely falling” when inflation exceeds 40% and/or in the 6 months following an exchange rate crisis, regardless of the *de jure* regime: we do this to avoid that periods of extreme exchange rate and macroeconomic instability water down the results. Due to the very limited number of observations for this latter regime, we will not include them in the empirical analysis. When comparing this paper’s (de jure) classification with the IMF *de facto* classification, we can see that the main differences are the following:

- (1) IMF regime 1 includes both currency union membership and strict pegs;
- (2) Periods that we identify as being “freely falling” as in Reinhart and Rogoff (2004) are listed as “freely floating” by the IMF;
- (3) Regimes 2, 3 and 4 in the IMF classification map into MF and IT in the *de jure* classification;
- (4) However, in some countries/periods, the *de facto* classification is stricter than the de jure, i.e. the exchange rate fluctuated within bands narrower than the official bands (for example in the case of Cyprus).

Although in Table 2 we identify a number of different (de jure or de facto) regimes, in the empirical analysis we will only consider two alternatives: fixed and flexible. The former includes pegs and EMU membership, while the latter includes IT and MF. In fact, in our sample, the four regimes included in Table 2 (i.e. excluding “freely falling” cases) are pairwise hard to distinguish from each other, as “Peg” regimes in our dataset have been very hard pegs (i.e. Currency Boards and/or two-year ERM II

membership anticipating the entry to EMU with no change in the nominal exchange rate); on the other hand, Inflation Targeting may be, as discussed above, observationally equivalent to a managed float.¹² We come back to this issue in section 4.

We conclude this section by examining two econometric problems that arise in the estimation of equations (9) and (10). First, the choice of the exchange rate regime may be endogenous, as it will depend on a country's economic fundamentals. Thus, D_R will be presumably correlated with the error term. Second, there is a related sample selection problem, as equations (9)-(10) embody two different models, one for each regime. In fact, the exchange rate regime should not only affect the constant, but at the time of the regime switch also the coefficients associated with the dual productivity growth change. As countries do not choose their exchange rate regimes randomly, this choice hinges on a set of fundamentals, which, in turn, affects macroeconomic outcomes. Moreover, for some countries we can only observe one of the regimes, either fixed or flexible. For these reasons, it is not correct to simply estimate the equation separately for the different regimes and then test for equality of coefficients, nor to use 2SLS.

On the other hand, by addressing the sample selection problem we solve the endogeneity issue. Following the solution proposed by Domac et al. (2003), we estimate (9) and (10) using a switching regression model, which allows us to endogenize the choice of the exchange rate regime, so that the parameters are allowed to be different across regimes, and being in a fixed or flexible exchange rate regime depends on the country's fundamentals.

Consider the regime dummy D_R . Its value will depend on a latent variable D_R^o which describes the willingness to adopt a fixed rather than a flexible exchange rate regime. The latent variable is defined by

$$D_{R,it}^o = Z_{it}\Gamma + \epsilon_{it}$$

where Z is a column vector including all variables that affect the choice of the regime, including a constant, and Γ are the coefficients. While we cannot observe the latent variable, we observe its realization, the dummy variable D_R : thus, we can proceed in two steps: first estimate Γ using a probit and then use it in a second step to estimate the B-S equation separately for each regime.

The proposed approach amounts to a two-step Heckman (1979) procedure to correct for the sample selection bias, and therefore we will need to include the Inverse Mills Ratio of the probit estimation as a regressor, bootstrapping the standard errors, since the IMR's are estimated rather than observed variables.

¹² See Ball and Reyes (2008).

4 The Choice of the Exchange Rate Regime

As stated above, the choice of the exchange rate regime depends on macroeconomic factors that affect the relative inflation differential and would be left in the error term of equation (9) and (10). In this section, we model how countries self-select in a fixed or a flexible exchange rate regime.

Based on the theory of the Optimal Currency Area (OCA) and on previous research (Heller 1978; Holden et al. 1979 and 1981; Edwards 2006; Levy Yeyati et al. 2010) we may classify the variables that affect the choice of the exchange rate regime in two broad groups: economic and political. The first group includes:¹³

- a. Degree of Trade Openness. As suggested by the OCA theory, the more a country is open to international trade, the more it will be averse to an excessive volatility of the exchange rate and thus also more likely to adopt a fixed exchange rate. We define the degree of trade openness of country i as:

$$OPENNESS_i = \frac{IMP_i + EXP_i}{GDP_i}$$

- b. Economic Size. The larger a country's size, the less it will find it beneficial or attractive to fix or manage the exchange rate. We proxy economic size by the (log) GDP level.

The second group of variables is introduced on the basis of the fact that the political environment also plays a role in the choice of the exchange rate regime:

- c. Years of EU membership. We expect that the longer a country has been a member of the European Union, the more it should be willing to fix the exchange rate or adopt the euro. Indeed, with the exception of countries with an opt-out clause, adoption of the euro is an eventual requirement of EU membership.
- d. Effectiveness score. This variable, taken from the Polity IV "State Fragility Index" (SFI) Database, measures Political Effectiveness (Regime durability, Current Leader Years in office, Total Coup events), Economic Effectiveness (GDP per Capita) and Social Effectiveness (Human Capital Development). It takes integer values from 0 to 9, where 0 equals maximum effectiveness. A country with a low

¹³ Other variables that have been suggested in the literature on the choice of the exchange rate regime are the product and the geographical concentration of trade. In both cases, higher concentration should lead to a preference for fixing. In our case, we found that the estimated coefficient for geographical concentration (measured as the share of total trade within the EMU) is never significant. For product concentration, we estimated a model including a Hirschmann-Herfindahl Index (HHI) of product concentration; the fit of this model, however, is worse with respect to that including the degree of openness. In addition, we have data for this variable only from 1999 or 2000 and not for Turkey. Since also on a priori grounds we prefer to use the degree of openness, we decided to use only this variable and to neglect the use of the HHI index.

effectiveness score should be more willing to give up its sovereignty over the exchange rate, or less capable to keep a flexible exchange rate without incurring into the risk of large fluctuations, or to establish a credible inflation targeting regime. On the contrary, for a country having, say, a credible and independent Central Bank, the costs related to giving up monetary policy independence, in terms of risk of asymmetric shocks, may outweigh the benefits coming from joining a solid and credible monetary union.

Given the dummy variable *FIX*, equal to 0 when the country has a managed float or inflation targeting regime, and 1 in case of peg or EMU membership, we model the choice of the exchange rate regime as:

$$FIX_{it} = \gamma_1 OPENNESS_{it} + \gamma_2 LogGDP_{it} + \gamma_3 EFFECT_{it} + \gamma_4 YEARS_{it} + \varepsilon_{it} \quad (11)$$

where, given our previous discussion, we expect $\gamma_1 > 0$; $\gamma_2 < 0$; $\gamma_3 > 0$; $\gamma_4 > 0$.

[Insert Table 3 here]

Table 3 reports the results of the probit estimation of Equation (11). The model has a good fit with the data, with 73,3% of the outcomes correctly predicted.

Looking at Table 3, we note that *OPENNESS* and *YEARS* have a positive coefficient (the more open to trade, and the more years in the EU, the higher the probability to *FIX*); *LogGDP* has a negative sign (the lower is GDP, i.e. the “smaller” the country, the higher the probability to *FIX*). Finally, a higher value of *EFFECT* (which implies *lower* political and economic effectiveness), as expected, has a positive sign: the higher the score, the higher the probability to fix. These results are consistent with those of Levy-Yeyati et al. (2010), who found that the probability of pegging the exchange rate is negatively correlated with the quality of institutions.

To validate the choice of focusing on two regimes only, in a preliminary analysis, we modeled the choice of the exchange regime using an ordered probit, where the regime variable was equal to 1 for EMU membership, 2 for peg, 3 for managed float/limited flexibility and 4 for flexible regimes. This analysis confirmed that EMU membership and Peg, on the one hand, and Managed Float and Inflation Targeting on the other are observationally equivalent regimes, at least within our sample¹⁴.

Models of exchange rate regime choice have been recently criticized by Rose (2011), for several reasons. First, because of the existence of conflicting exchange rate regime classification schemes. Second, as empirical models of regime choice, according to Rose, so far have performed poorly. As Rose (2011) points out, country-specific fixed effects are more important in explaining between-country variation in the regime than fundamentals. In order to address these critiques, in section 5.2 we will (i) test for the robustness of our results to a different exchange rate regime

¹⁴ Results of this preliminary estimation are available from the authors upon request.

classification scheme and (ii) employ an alternative approach to address regime endogeneity that avoids the estimation of the first-stage equation.

5 The B-S Effect across Exchange Rate Regimes

5.1 Basic analysis

As anticipated in Section 3, in the second step we estimate the fundamental B-S regression for each regime, correcting for the sample selection bias by including the Inverse Mills Ratio calculated from the estimation of equation (11) and bootstrapping standard errors. While our focus on convergence means that our discussion will mainly be centered on the external Balassa-Samuelson effect, it is interesting, for completeness, to perform our analysis also on the internal effect. Before introducing the two-stage estimation, as a simple exercise we estimate the modified B-S equation (both for the internal and the external B-S effect) separately for each regime, i.e. estimate equation (9) and (10), where $FIX = D_R = 1$ when the regime is a peg or EMU membership, and $D_R = 0$ if it is a managed float or IT:

$$\begin{aligned} (\dot{p}_N - \dot{p}_T) &= \rho_0 + \rho_1 FIX + \rho_2 (\dot{a}_T - \dot{a}_N) + \rho_3 FIX * (\dot{a}_T - \dot{a}_N) + \varepsilon \\ (\dot{p}_N - \dot{p}_T) - (\dot{p}_N^* - \dot{p}_T^*) &= \mu_i + \varphi_0 FIX + \varphi_1 (\dot{a}_T - \dot{a}_N) + \varphi_2 (\dot{a}_T^* - \dot{a}_N^*) + \varphi_3 FIX * (\dot{a}_T - \dot{a}_N) \\ &\quad + \varphi_4 FIX * (\dot{a}_T^* - \dot{a}_N^*) + \varepsilon \end{aligned}$$

We denote this approach as “*naïve*” since, by ignoring the endogeneity of D_R , it fails to capture the causal link between macroeconomic fundamentals and the exchange rate regime. Hence these estimates suffer from a sample selection problem. Nevertheless, as a preliminary exercise it might still be helpful to identify some ways in which the different exchange rate regimes have an impact on structural inflation. We report the results of this *naïve* estimation in Table 4, where fixed exchange rate regime is taken as the baseline.¹⁵

[Insert Table 4 here]

First of all, we note that, as expected, the productivity differential is positively related to dual inflation, which is the common result of the *internal Balassa Samuelson Effect*. This is confirmed in the next column, where we see that the home productivity growth differential has a positive and significant coefficient and the foreign productivity growth differential has a negative coefficient, which is what the external B-S hypothesis predicts. Moreover, the coefficient of the interaction term between the home productivity growth differential and the regime dummy

¹⁵ In these estimates, accounting for the role of the exchange rate regime boils down to checking the significance of the coefficients of the two interaction terms. If they are not significantly different from zero, then the choice of the exchange rate regime does not affect the rate of B-S convergence.

$(\dot{a}_T - \dot{a}_N) * FIX$ is significantly different from zero in both cases, meaning that the dual inflation (differential) is higher in fixed regimes. This, instead, is not the case for the coefficient of the interaction term of the foreign productivity differential with the regime dummy, $(\dot{a}_T^* - \dot{a}_N^*) * FIX$.

This makes sense: remember from equation (6) that φ_2 is proportional to the output share of labor in the non-traded sector relative to the traded sector in the *foreign* country, thus we do not expect that it should change across exchange rate regimes of the *home* country. However, the significance of the interaction term for the home productivity differential in the external version implies that a productivity growth differential of 1% is associated with a change in the relative terms of trade of 0.08% when the exchange rate regime is (more or less) flexible, but is stronger, at 0.175%, when the exchange rate is fixed. In other terms, for a given productivity growth differential in favor of the traded goods sector, the growth in non-traded goods prices is more than double in a fixed versus flexible exchange rate regime. This “naïve” estimation suggests that a stricter exchange rate regime is associated with a larger size of the B-S effect. However, as we remarked earlier on that these estimates may be biased because of the endogeneity of the chosen regime, we now move on to discuss the results of adopting the switching regression approach, as described in Section 3.

[Insert Table 5 here]

Table 5 reports the results of the switching regression model for both the internal and external B-S effect^{16, 17}. The significance of the Inverse Mills Ratio (*IMR*) in the model for Flexible regimes in both cases means that indeed there is a significant sample selection.

From a qualitative point of view, the results obtained using the *naïve* approach are confirmed: convergence à la B-S is faster for countries that have pegged their exchange rate or have joined the EMU, and significantly so (at 5%), while the coefficient of the foreign productivity differential is not significantly different between the two regimes.

These results imply that ignoring the role of the exchange rate regime in the estimation of the B-S effect leaves aside one element that significantly affects the process of price convergence. During the last decade, the economic literature has demonstrated that the B-S Effect can only explain a small part of the excess inflation experienced by Central and Eastern European Countries. Égert (2007) pointed out some additional factors explaining price convergence, in particular the change in the

¹⁶ The reported standard errors are robust to heteroskedasticity. We tested for residual autocorrelation and the null of no AR(1) could not be rejected at any significance level using the DW test proposed by Drukker (2003).

¹⁷ All series were tested for the presence of a unit root using Pesaran CADF test and they came out to be I(0).

composition of the consumption basket towards higher-quality goods, different economic structures. With our analysis, we provide an additional element that so far has been neglected by the literature, as we show that, for a given degree of productivity convergence, price convergence is faster if the exchange rate regime is fixed. This is confirmed when looking at the contribution of the home productivity growth differential to dual inflation and the dual inflation differential, reported in Table 6. The third and fourth column in Table 6 report, respectively, the average inflation differential (dual inflation differential in the bottom panel) and the home productivity growth differential. We compute the contribution of the productivity differential as equal to the estimated coefficient times the average productivity differential over the sample period, divided by the (dual) inflation differential. Internal productivity growth differential explains about 40% of the (dual) inflation differential, whether we look at the internal or external B-S effect, in fixed exchange rate regimes. However, the contribution of the productivity growth differential is much lower in flexible regimes, below 19%.

[Insert Table 6 here]

So far, our results do not necessarily imply that adopting the euro or pegging the exchange rate when the catching-up process is still under way would imply a loss of competitiveness, given that what matters for competitiveness is only the inflation differential for traded goods, $\dot{p}_T - \dot{p}_T^*$. We would additionally observe a loss of competitiveness only to the extent that the higher inflation in the non-traded sector induced a faster growth of prices in the traded sector, relative to that of the benchmark competitors. Although a full analysis of this issue goes beyond the scope of the present paper, we will address it in a preliminary fashion in section 6.

5.2 Robustness checks

In this subsection, we test for the robustness of our results to a modification of the sample and a different empirical approach.¹⁸

[Insert Table 7 here]

(a) Changing the sample. In this respect, we did three tests. First, since the “foreign country” used as a reference includes a group of heterogeneous economies, we focused on a narrower “core Euro Area” (Germany, France, the Netherlands and Belgium), and report the results in column (i) of Table 7. Second, we re-estimated the model for a narrower group of catching up countries, which excludes Greece and Portugal, since they have a longer history of EU membership (column (ii))¹⁹. Third, we shortened the sample at 2008Q3, to exclude observations from the Great

¹⁸ Due to space limitations, we only report the results for the external B-S effect. However, the internal B-S analysis proved robust as well.

¹⁹ We performed this test excluding Cyprus as well, since, together with Greece and Portugal, it had “less catching up” to perform with respect to other countries, but results were unchanged.

Recession (column (iii)). In all the three cases, the robustness checks confirm the validity of the estimates reported in Table 5. Moreover, point estimates are very close to those in Table 5, only the coefficient for $(a_T^* - a_N^*)$ seems somewhat larger in column (iii), with a higher standard error which might be due to a smaller sample. However, this difference is quantitatively small and qualitatively results are confirmed.

The robustness checks that follow contribute to address Rose’s (2011) critique, which was mentioned in Section 4.

(b) Different exchange rate regime classifications. We re-estimated equation (10) using the IMF classification of exchange rate regimes discussed in section 3. To make the analysis comparable with that in section 5.1, we collapsed the six regimes of the IMF classification into two. If a country has a regime of 1 with the IMF, we classify it as “fixed”, otherwise it is flexible. The results are reported in column (iv) of Table 7 and again confirm our previous results. Interestingly, the p-value of the coefficient equality test is smaller, since the coefficient of $(\dot{a}_T - \dot{a}_N)$ in fixed regimes is slightly higher, while that for flexible regimes is lower. This is consistent with the fact that, while the *de jure* and *de facto* classifications are, in our sample, highly consistent with each other, in some episodes the actual regime has been stricter than what was declared (as in the case of Cyprus) and confirms our paper’s overall conclusion.

(c) An alternative approach to deal with exchange rate regime endogeneity. The estimates from the “naïve approach” (which neglects the possible endogeneity of the regime dummy) and the Heckman procedure are very close. Moreover, we have discussed Rose’s (2011) criticism of the empirical models of exchange rate regime choice. To consider this, we re-estimated equation (10) excluding the observations corresponding to a regime switch²⁰. The results are reported in column (v) of table (7), and confirm those obtained using the two-stage procedure.

5.3 Investment demand and government consumption

The literature on the B-S effect has shown that productivity shocks may affect the dual inflation differential also via investment demand and government consumption (Fischer, 2004). Moreover, changes in government spending and its composition may have different effects on the real exchange rate (and, therefore, on the dual inflation differential) depending on the exchange rate regime (Lane and Perotti, 2003). To capture these additional channels that may affect the dual inflation differential, we rewrite our equation (10) as:

$$(\dot{p}_N - \dot{p}_T) - (\dot{p}_N^* - \dot{p}_T^*) = \beta_0 + \beta_1(a_T - \dot{a}_T^*) + \beta_2(a_N - \dot{a}_N^*) + \beta_3g\dot{o}v + \beta_4g\dot{o}v^* + \epsilon_t,$$

²⁰ In particular, we exclude observations pertaining to the quarter of and immediately following a change in the exchange rate regime. We thank an anonymous referee for this suggestion.

where gov is the rate of change in government consumption. According to Fischer (2004), in a small open catching-up economy, productivity changes affect the real exchange rate not only through the usual B-S supply channel, but also through an investment demand channel: if TFP increases in one sector, investment demand increases, thus raising the prices of non-tradeables. Within our framework, finding $\beta_1 > 0$ would be consistent with both the B-S effect, and the presence of an investment demand channel. Instead, finding that $\beta_2 > 0$ in equation (12) would imply that the investment demand channel has been at play. More precisely, if $\beta_2 > 0$, one might be tempted to argue that services are tradeables like goods. This, however, is not possible since, if they were, the CPI in transition countries would be determined entirely by world market prices. Therefore, rejecting the suggestion that services are tradeables, leaves open only the possible explanation that the investment demand channel plays a significant role: the B-S effect alone cannot explain why productivity increases in each sector entail a real appreciation²¹.

Results of this alternative specification are reported in Table 8. We do not find support for the hypothesis that the investment demand channel played a role in our sample countries. Even in fixed regimes the β_2 coefficient is at most not significantly negative. As for government consumption, also this variable has no significant effects. In any case, also in these regressions we observe that the impact of (relative) productivity growth in the traded sector on the dual inflation differential is significantly stronger in fixed regimes than in flexible regimes: this confirms our previous results.

6 Exchange rate regimes, dual inflation differential and competitiveness

Our results so far have pointed to the fact that, for any given dual productivity differential, we observe a higher dual inflation differential in those countries that have opted for a fixed exchange rate regime or euro adoption, relative to those countries that opted for a flexible regime or managed float. A crucial question – which we anticipated in section 5.1 – is whether this also implies a loss of competitiveness. More generally, is it possible to find a relationship between the exchange rate regime and competitiveness? As we discussed in the introduction, for a country that is still in the process of convergence, the perceived stability guaranteed by membership of the euro area, or by setting up a hard peg or a currency board, may lead to large capital inflows and optimism-driven booms. This may indeed have been the case for the euro area periphery and the Baltics²². Such economic booms were driven by domestic consumption which, on the one hand,

²¹ See Fischer (2004), p.196-197.

²² See Kang and Shambaugh (2013).

determined a worsening of the current account and, on the other hand, pushed prices and wages up, damaging the countries' competitiveness and thus contributing to further worsening of the current account.

Based on this reasoning, we look at our countries' competitiveness using, as a reference variable, the export market share (EMS), i.e. a country's total exports as a share of world exports. Then, to check the robustness of our results, we will repeat the analysis using real labor costs as an indicator for competitiveness²³.

Figure 2 shows the evolution of the EMS during our sample period. For Cyprus, Portugal and Greece it declined throughout the last decade, and also that of Slovenia since 2007. It has instead been increasing for the rest of the countries.

[Insert Figure 2 here]

To obtain a clearer picture and analyze the issue more formally, we then regress the competitiveness measure on the dual inflation differential and the exchange rate regime, including country and time fixed effects. Thus, although we are not estimating a model of the determinants of a country's competitiveness, we can disentangle the relationship between the exchange rate regime, the dual inflation differential and competitiveness, while controlling for year effects which may be important (for example, the outbreak of the Great Recession, entrance into the EU, and the signing of international trade agreements may have had important independent effects on the EMS of many catching up economies). Since the dual inflation differential may affect exports with some delay, we use its lagged value as an explanatory variable. For the exchange rate regime, we use two alternative definitions: (i) *FIX*: the fixed regime dummy as introduced in our paper, i.e. *FIX* = 1 if the regime is either membership in the EMU or a de facto peg, and 0 otherwise and (ii) *ERR*: Exchange Rate Regime index, based on the IMF *de facto* classification introduced in Section 3, from 1 (freely falling) to 6 (monetary union or strict peg)²⁴. Thus, a positive and significant coefficient for *FIX* (*ERR*) means that a more rigid exchange rate regime is associated with lower competitiveness.

Table 9 reports the results of the fixed effects regression. For robustness, we ran different regressions both for the whole sample (until 2011) and until 2008. We will rely mostly on the shorter sample, as we expect post-2008 instability and also the results to depend heavily, after 2008, on the adoption of austerity policies and internal devaluations.

[Insert Table 9 here]

²³ We thank an anonymous referee for this suggestion.

²⁴ Note that, to make comparability with our "FIX" dummy easier, we inverted the original scale of the IMF classification where, as indicated in Table 2, the higher the value of the index, the higher the degree of flexibility.

When we use the regime dummy *FIX*, having adopted a fixed ER is associated with an EMS about 8% lower (column (i)). A higher dual inflation differential, as we would expect, is associated with a lower EMS. The effect of the dual inflation differential is lower in fixed regimes, as the coefficient on the interaction term implies, but the overall marginal effect of *FIX* on *EMS* stays negative²⁵. These effects are confirmed in the whole sample, although the F-test of post-sample stability is rejected.²⁶ When the regime is measured using *ERR*, our results are confirmed, i.e. a more rigid regime is associated with lower EMS. The coefficients of the dual inflation differential and the interaction term have the expected sign, but they are not significant. Results are confirmed in the whole sample.

As we mentioned above, as a further robustness check we used an alternative measure of competitiveness, the (rate of growth in) real labor costs, which is related to a country's cost competitiveness²⁷. While there are feedback effects between wages and prices, endogeneity is avoided here using the one-quarter-lagged dual inflation differential. Results are reported in Table 10. In this case, we find that, when using either measure of the exchange rate regime, the effect of the dual inflation differential is stronger for more rigid regimes. In particular, a higher dual inflation differential is associated with lower real labor costs; however, this effect is reversed in a peg or monetary union (*ERR* = 6) since the sum of the total marginal effect would be positive. Therefore, a higher dual inflation differential worsens competitiveness in fixed regimes, while it does not in a float. Overall, these results are suggestive that a worsening of the dual inflation differential may especially endanger competitiveness in countries that have adopted a fixed regime.

[Insert Table 10 here]

7 Conclusions and policy implications

In this paper we have argued that the adoption of a fixed exchange rate may significantly amplify the “Balassa-Samuelson Effect”. The main supporting evidence is that, in a group of 14 “catching up” European countries, in which we have observed 8 cases of adoption of, or transition to, a fixed exchange rate, the impact of the domestic productivity growth differential (between the traded and non-traded goods sectors) on the dual inflation differential (i.e. the relative inflation

²⁵ The marginal effect of *FIX* here would be $-0.076 + 0.577 \cdot 0.0015$, where the last term is the sample mean of the dual inflation differential, and it is easy to see that it is negative.

²⁶ The F-test statistic is calculated as $\frac{[RSS(n_1+n_2) - RSS(n_1)]/n_2}{RSS(n_1)/(n_1-k)}$, where *RSS* is the residual sum of squares, n_1 is the sample 1998-2008, n_2 is the sample 2009-2011 and k is the number of estimated coefficients. See Kennedy (2009).

²⁷ As a measure of labor costs, we used Eurostat's Labor Cost Index for wages and salaries in the business economy and deflated it using the HCPI.

differential between the prices of non-traded and traded goods) is more than double in the case of a fixed exchange rate, relative to a floating rate regime.

The choice of the exchange rate regime has been a matter of continued and often controversial policy debate, especially within the EU and since the creation of the euro. However, while it has been generally acknowledged that fixing the exchange rate may have the effect of imposing overall inflation “discipline” to a country that joins a low inflation currency area, the implications that this might have for the dual (or “structural”) inflation differential have been largely unexplored.

In fact, these implications are somewhat paradoxical, as we have found that the adoption of a fixed exchange rate or also of the euro will accelerate the path of price convergence, in particular in the non-traded sector. Possibly, one reason for this result is that fixing the exchange rate enhances the comparability across countries also of the prices of non-traded goods. Hence, relative inflation (between non-traded and traded goods prices) will be higher for countries that fix the exchange rate with respect to floating countries, other things equal. As a result, also the aggregate inflation rate, measured by the CPI, should be higher in those countries – and may actually increase after, and as a consequence of euro adoption.

Does this finding have relevant implications? If the dual inflation differential increases after adopting the euro (or pegging the exchange rate to it), then prices in the non-traded sector increase more, relative to the traded sector, when productivity increases. Since non-traded goods are part of the CPI, then, even if PPP held for traded goods, a catching up country within a fixed exchange rate arrangement will have higher CPI inflation, other things equal, and will also experience a faster appreciation of the real exchange rate. By itself, this will not reduce that country’s competitiveness, which would only be affected by changes in the terms of exchange for traded goods. However, two implications are worth noting. First, if a catching up country fulfils the Maastricht Criteria for euro adoption, including the inflation criterion, and adopts the euro, it may well experience an increase in inflation, due to the dynamic effects that we described. Therefore, the inflationary discipline imposed by the single monetary policy on new members of the euro area may become *ex post* less effective. This, in turn, may reduce the local effectiveness of monetary policy, as the local real rate of interest will be comparatively lower.

Second, the conclusion that higher inflation in the non-traded sector will not harm a country’s competitiveness is true only to the point that higher inflation does not extend also to the traded sector. Nevertheless, the opposite result is also plausible, as the accelerated growth of prices and wages in the non-traded sector may well “contaminate” wages and prices in the traded sector, prevailing to some extent on the competitive pressures from foreign markets. In this case, a country that has entered into a monetary union or irrevocably fixed the exchange rate will find itself

with no dedicated policy instruments to overcome the loss of international competitiveness. At the same time, the urgency to adopt appropriate remedies might no longer be perceived, as the common currency contributes to de-emphasize the warning signals from a worsening current account or a reduced share in the foreign markets. To show the relevance of this effect, we documented in section 6 that, in our sample, a fixed ER is associated with an export market share lower by approximately 8% (see Table 9).

These implications may also suggest two normative considerations: first, the “Maastricht inflation criterion” does not provide a robust indicator of a country’s suitability for euro adoption, nor a reliable indicator of its post-adoption inflation performance; second, euro adoption or exchange rate fixing by catching-up countries may in some cases be premature and lead to a loss of external competitiveness and to non-responsiveness to the common monetary policy, hence it should not be (possibly, it should not have been?) encouraged. We leave it to others to articulate these points into a positive policy message.

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Data Appendix

<i>Variable</i>	<i>Definition and Source</i>
\dot{p}_T (\dot{p}_N)	Annual % change in the HCPI for Goods (Services). <i>Source:</i> Eurostat.
\dot{a}_T (\dot{a}_N)	Annual % change in labor productivity in the goods (services) sector, calculated as gross value added per hour worked. <i>Source:</i> Eurostat and authors’ calculations.
<i>EMS</i>	Export Market Share, calculated as a country’s exports as a share of world exports. <i>Source:</i> DOTS and authors’ calculations.
<i>LCI</i>	Labor Cost Index (wages and salaries). <i>Source:</i> Eurostat.
<i>ERR</i>	Exchange Rate Regime Variable, going from 1 (currency union) to 5 (freely falling). <i>Source:</i> Ilzetzki, Reinhart and Rogoff (2010).
<i>FIX</i>	Dummy equal to 1 for countries and periods when the exchange rate regime in Table 1 is either Peg or EMU, zero otherwise.
<i>OPENNESS</i>	Trade openness. See Section 4. <i>Source:</i> Eurostat
<i>GDP</i>	<i>Source:</i> Eurostat.
<i>YEARS</i>	Years since EU membership.
<i>gov</i>	Government Consumption. <i>Source:</i> Eurostat.
<i>EFFECT</i>	Effectiveness Score. See Section 4. <i>Source:</i> Polity IV, State Fragility (SFI) Database.

Table 1. Summary Statistics – yearly averages

Full Sample				
	$(\dot{p}_N - \dot{p}_T)$	$(\dot{a}_T - \dot{a}_N)$	\dot{e}	\dot{q}
Bulgaria	0.8630	1.6096	0.077	-4.464
Cyprus	0.8260	0.7322	0.011	-0.713
Czech R.	0.4490	0.8921	-2.801	-4.058
Estonia	0.0419	0.5851	0	-2.726
Greece	0.3963	1.3356	0.715	-1.136
Hungary	0.3250	0.9471	1.942	-3.023
Latvia	-0.0189	0.4058	0.594	-5.122
Lithuania	0.3802	1.0569	-2.051	-0.673
Poland	0.2719	0.7634	0.496	-2.113
Portugal	0.5606	0.7125	0	-0.700
Romania	0.0731	0.8986	12.527	-3.549
Slovenia	0.5609	1.4273	2.128	-1.130
Slovakia	0.2429	0.9141	-1.807	-5.341
Turkey	0.9988	2.544	18.138	-3.896

1998-2008				
	$(\dot{p}_N - \dot{p}_T)$	$(\dot{a}_T - \dot{a}_N)$	\dot{e}	\dot{q}
Bulgaria	1.1948	1.3583	0.091	-4.961
Cyprus	0.8469	0.8704	0.014	-0.761
Czech R.	0.6115	0.8138	-3.320	-4.784
Estonia	0.2854	0.3436	0	-3.110
Greece	0.3916	1.0274	0.845	-0.897
Hungary	0.5459	0.7616	1.415	-3.821
Latvia	0.2392	0.3671	0.594	-6.071
Lithuania	0.6834	0.9993	-2.424	-0.553
Poland	0.3964	0.8424	-0.374	-3.025
Portugal	0.5539	0.7959	0	-1.000
Romania	0.1750	0.3189	13.742	-4.396
Slovenia	0.6380	1.4745	2.514	-1.227
Slovakia	0.4902	0.7739	-2.136	-6.184
Turkey	1.2907	2.968	21.451	-3.907

Note: yearly averages calculated as change with respect to the same quarter of previous year.
 $(\dot{p}_N - \dot{p}_T)$ = inflation differential; $(\dot{a}_T - \dot{a}_N)$ is the productivity differential; \dot{e} is the (percentage) change in the nominal exchange rate and \dot{q} is the percentage change in the real exchange rate.
The exchange rate is expressed as units of domestic currency per euro. Source: Eurostat and authors' calculations.

Table 2. Chronology of Exchange Rate Regimes

	<i>De jure</i> classification		IMF <i>de facto</i> classification	
	Period	Regime	Period	Regime
Bulgaria	1996Q1–1997Q3	FF	1996Q1–1996Q4	4
	1997Q4–2011Q4	Peg	1997Q1–2011Q4	1
Cyprus	1996Q1–2007Q4	MF	1996Q1–1997Q4	1
	2008Q1–2011Q4	EMU	1998Q1–2001Q4	3
			2002Q1–2011Q4	1
Czech Republic	1996Q1–1997Q4	MF	1996Q1–1997Q2	1
	1998Q1–2011Q4	IT	1997Q3–2000Q4	3
			2001Q1–2001Q4	4
			2002Q1–2011Q4	3
Estonia	1996Q1–2010Q4	Peg	1996Q1–2011Q4	1
	2011Q1–2011Q4	EMU		
Greece	1996Q1–2000Q4	MF	1996Q1–1998Q1	3
	2001Q1–2011Q4	EMU	1998Q2–2000Q4	2
			2001Q1–2011Q4	1
Hungary	1996Q1–2001Q2	MF	1996Q1–1996Q4	1
	2001Q3–2011Q4	IT	1997Q1–2001Q3	3
			2001Q4–2011Q4	1
Latvia	1996Q1–2011Q4	Peg	1996Q1–1996Q4	3
			1997Q1–2011Q4	1
Lithuania	1996Q1–2011Q4	Peg	1996Q1–Q4.2011	1
Poland	1996Q1–1997Q4	MF	1996Q1–1998Q4	3
	1998Q1–2011Q4	IT	1999Q1–2011Q4	4
Portugal	1996Q1–1998Q4	MF	1996Q1–1998Q4	2
	1999Q1–2011Q4	EMU	1999Q1–2011Q4	1
Romania	1996Q1–2001Q2	FF	1996Q1–1996Q4	4
	2001Q3–2005Q2	MF	1997Q1–2001Q4	3
	2005Q3–2011Q4	IT	2002Q1–2004Q4	2
			2005Q1–2011Q4	3
Slovenia	1996Q1–2006Q4	MF	1996Q1–2001Q3	3
	2007Q1–2011Q4	EMU	Q4.2001–2004Q2	2
			2004Q3–2011Q4	1
Slovakia	1996Q1–2008Q4	MF	1996Q1–1998Q3	1
	2009Q1–2011Q4	EMU	1998Q4–2005Q4	3
			2006Q1–2011Q4	1
Turkey	1996Q1–2001Q4	FF	1996Q1–1999Q4	3
	2002Q1–2011Q4	IT	2000Q1–2011Q4	4

Source: IMF (2009), Ilzetzki et al. (2009), Reinhart and Rogoff (2004), Central Bank historical data and the authors. *Legenda*; De jure classification: EMU= EMU membership; Peg = strict peg or currency board, MF = Managed Float, IT= inflation targeting, FF= freely falling. IMF Classification as reported in Ilzetzki et al. (2009): 1= no separate legal tender, de facto peg, pre-announced peg or currency board or horizontal band; 2= pre-announced or de facto crawling peg/ band (narrower than 2%); 3=pre-announced or de facto crawling band wider than 2%; moving band; managed floating. 4= freely floating. 5= freely falling. 6= dual market in which parallel market data is missing.

Table 3. Probit regression, Equation (11)

	Coefficient	St. Error	P-value	Marginal Effect
<i>OPENNESS</i>	2.369	0.295	0.000	0.941
<i>LogGDP</i>	-3.766	0.410	0.000	0.347
<i>EFFECT</i>	0.874	0.174	0.000	-1.496
<i>YEARS</i>	0.609	0.065	0.000	0.242
$(\dot{a}_T - \dot{a}_N)$	-0.847	1.688	0.616	-0.336
$(\dot{a}_T^* - \dot{a}_N^*)$	-3.416	7.072	0.629	-1.357
Constant	28.744	3.257	0.000	-

N=622. No. of countries: 14.

Legenda: Sample: 1998Q1-2011Q4. Probit estimation of equation (11). Dependent variable is *FIX*. See text in Section 4 and Data Appendix for definition of variables. .

Table 4. “Naïve” estimation, Equation (9) and (10)

	Internal B-S Effect	External B-S Effect
Const	0.005*** (0.002)	0.004** (0.002)
<i>FIX</i>	-0.003 (0.003)	-0.001 (0.003)
$(\dot{a}_T - \dot{a}_N)$	0.087*** (0.020)	0.080*** (0.018)
$(\dot{a}_T - \dot{a}_N) * FIX$	0.092** (0.046)	0.095** (0.046)
$(\dot{a}_T^* - \dot{a}_N^*)$	-	-0.210*** (0.067)
$(\dot{a}_T^* - \dot{a}_N^*) * FIX$	-	-0.034 (0.091)
Country Fixed Effects	YES	YES
Time Fixed Effects	YES	YES
	N=645. R ² = 0.166	N=633. R ² : 0.174

Legenda: Sample: 1998Q1-2011Q4. FE OLS estimation. Dependent variable is the inflation differential, $\dot{p}_N - \dot{p}_T$, for the Internal B-S effect and the dual inflation differential for the external B-S effect. *= significant at 10%; **= significant at 5%; ***: significant at 1%. The p-value of the test of coefficient equality is reported in brackets. Robust SE in parenthesis.

Table 5. Balassa-Samuelson effect in fixed and flexible exchange rate regimes

	Internal B-S Effect	External B-S effect
Fixed		
Const	0.003 (0.002)	0.004* (0.002)
$(\dot{a}_T - \dot{a}_N)$	0.174** (0.066)	0.176** (0.068)
$(\dot{a}_T^* - \dot{a}_N^*)$	-	-0.238** (0.051)
IMR	-0.001 (0.008)	-0.002 (0.008)
N=350. R ² : 0.194		
Flexible		
Const	0.006** (0.002)	0.006** (0.002)
$(\dot{a}_T - \dot{a}_N)$	0.082 (0.044)	0.075 (0.043)
$(\dot{a}_T^* - \dot{a}_N^*)$	-	-0.217** (0.052)
IMR	-0.013** (0.004)	-0.010* (0.005)
N=272. R ² : 0.124		
Test of coefficient equality		
	$(\dot{a}_T - \dot{a}_N)$	$(\dot{a}_T^* - \dot{a}_N^*)$
	10.33 [0.001]	4.63 [0.032]
	-	0.15 [0.696]

Legenda: Sample: 1998Q1-2011Q4. Results of the FE OLS estimation of equations (9) - (10), on the basis of the probit estimation of the choice of the exchange rate regime described in Sect. 5, Table 3. Dependent variable is the dual inflation differential. All regressions include country and year fixed effects. See text in Sect. 3 for definitions of variables. * = significant at 10%; ** = significant at 5%; ***: significant at 1%. Standard errors are bootstrapped. Test of coefficient equality is distributed as F(1, 602) and the p-value is reported in brackets.

Table 6. The relevance of the Balassa-Samuelson Effect

		$(\dot{p}_N - \dot{p}_T)$	$(\dot{a}_T - \dot{a}_N)$	ρ_2	Contr. (%)
Internal B-S effect	Fixed	0.375%	0.848	0.176	39.3
	Flexible	0.498%	1.136	0.075	18.7
		$(\dot{p}_N - \dot{p}_T) - (\dot{p}_N^* - \dot{p}_T^*)$	$(\dot{a}_T - \dot{a}_N)$	φ_2	Contr. (%)
External B-S effect	Fixed	0.364%	0.848	0.174	41.0
	Flexible	0.450%	1.136	0.082	18.9

Legenda. The coefficients ρ_2 and φ_2 are those of equation (10) estimated in Table 5. Average (dual) inflation differential and productivity growth differentials calculated over the period 1998-2011.

Table 7. Robustness Checks

	(i)	(ii)	(iii)	(iv)		(v)
Fixed						
Const	0.005* (0.002)	0.003 (0.002)	0.007** (0.002)	0.003** (0.001)	Const	0.003** (0.001)
$(\dot{a}_T - \dot{a}_N)$	0.176* (0.070)	0.167* (0.071)	0.174* (0.065)	0.182** (0.052)	<i>FIX</i>	0.000 (0.002)
$(\dot{a}_T^* - \dot{a}_N^*)$	-0.286** (0.050)	-0.239** (0.056)	-0.306** (0.103)	-0.257** (0.052)	$(\dot{a}_T - \dot{a}_N)$	0.080** (0.019)
IMR	-0.002 (0.008)	0.002 (0.015)	-0.010 (0.008)	-0.000 (0.005)	$(\dot{a}_T - \dot{a}_N) * FIX$	0.099* (0.047)
N	346	267	270	350	$(\dot{a}_T^* - \dot{a}_N^*)$	-0.207** (0.068)
R ²	0.228	0.188	0.214	0.197	$(\dot{a}_T^* - \dot{a}_N^*) * FIX$	-0.038 (0.092)
Flexible					N	629
Const	0.006* (0.002)	0.005** (0.002)	0.007** (0.002)	0.006* (0.002)	R ²	0.175
$(\dot{a}_T - \dot{a}_N)$	0.084* (0.041)	0.078* (0.043)	0.087 (0.052)	0.065** (0.021)		
$(\dot{a}_T^* - \dot{a}_N^*)$	-0.234** (0.050)	-0.209** (0.049)	-0.400** (0.074)	-0.188** (0.035)		
IMR	-0.010* (0.005)	-0.008 (0.028)	-0.007 (0.006)	-0.012* (0.049)		
N	260	272	236	255		
R ²	0.172	0.123	0.156	0.106		
Test of coefficient equality across regimes						
$(\dot{a}_T - \dot{a}_N)$	7.83 [0.005]	8.53 [0.004]	7.01 [0.008]	11.9 [0.001]		
$(\dot{a}_T^* - \dot{a}_N^*)$	0.51 [0.476]	0.00 [0.981]	0.57 [0.450]	0.45 [0.501]		

Legenda: Dependent variable: dual inflation differential. Regressions include country and year fixed effects. Robust SE in parenthesis. *= significant at 10%; **= significant at 5%; ***: significant at 1%.

Robustness checks: (i) narrower euro Area; (ii) smaller sample excluding Portugal and Greece; (iii) sample until 2008Q3; (iv) estimation using IMF classification; (v) estimation excluding observations corresponding to a regime switch.

Test on coefficient equality is distributed as F(1, 602) and the p-value is reported in brackets.

Table 8. Investment demand and government consumption

Fixed		
Const		0.002 (0.002)
$(\dot{a}_T - \dot{a}_T^*)$		0.230** (0.068)
$(\dot{a}_N - \dot{a}_N^*)$		-0.085 (0.067)
$g\dot{o}v$		0.039 (0.059)
$g\dot{o}v^*$		0.121 (0.332)
IMR		-0.003 (0.008)
N= 346		R ² = 0.274
Flexible		
Const		0.003 (0.002)
$(\dot{a}_T - \dot{a}_T^*)$		0.081 (0.047)
$(\dot{a}_N - \dot{a}_N^*)$		-0.174** (0.044)
$g\dot{o}v$		0.021 (0.034)
$g\dot{o}v^*$		0.048 (0.235)
IMR		0.000 (0.006)
N=260		R ² =0.168
Test of coefficient equality across regimes		
$(\dot{a}_T - \dot{a}_T^*)$		5.870 [0.016]
$(\dot{a}_N - \dot{a}_N^*)$		0.620 [0.431]

Legenda: Sample: 1998Q1 – 2011Q4. Dependent variable: dual inflation differential. Estimation of equation (12), regressions include country and year fixed effects. Robust SE in parenthesis. *= significant at 10%; **= significant at 5%; ***: significant at 1%. Test on coefficient is distributed as F(1, 602) and the p-value is reported in brackets.

Table 9. Export Market Share, dual inflation differential and the Exchange Rate Regime

	Sample: 1998Q1 – 2008Q3		Sample: 1998Q1 – 2011Q4	
	(i)	(ii)	(i)	(ii)
$(\dot{p}_N - \dot{p}_T) - (\dot{p}_N^* - \dot{p}_T^*)_{t-1}$	-0.330** (0.154)	-0.271 (0.361)	-0.377** (0.143)	-0.474 (0.381)
<i>ERR</i>		-0.029*** (0.007)		-0.020*** (0.006)
<i>FIX</i>	-0.076*** (0.011)		-0.078*** (0.011)	
$(\dot{p}_N - \dot{p}_T) - (\dot{p}_N^* - \dot{p}_T^*)_{t-1} * ERR$		0.053 (0.069)		0.091 (0.073)
$(\dot{p}_N - \dot{p}_T) - (\dot{p}_N^* - \dot{p}_T^*)_{t-1} * FIX$	0.577*** (0.191)		0.674*** (0.181)	
Const	0.234*** (0.013)	0.373*** (0.039)	0.255*** (0.016)	0.338*** (0.036)
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
R ²	0.417	0.424	0.405	0.410
N	608	616	788	784
Stability test (p-value)			1.892 (0.00)	1.769 (0.00)

Legenda: Dependent variable: EMS. Robust standard errors in parenthesis. *= significant at 10%; **= significant at 5%; ***: significant at 1%.

Table 10. Labor Costs, dual inflation differential and Exchange Rate Regime

	Sample: 1998Q1 – 2008Q3		Sample: 1998Q1 – 2011Q4	
	(i)	(ii)	(i)	(ii)
$(\dot{p}_N - \dot{p}_T) - (\dot{p}_N^* - \dot{p}_T^*)_{t-1}$	-0.066 (0.098)	-1.627** (0.813)	-0.059 (0.069)	-1.376** (0.686)
<i>ERR</i>		0.001 (0.003)		0.001 (0.002)
<i>FIX</i>	-0.006 (0.005)		-0.006 (0.004)	
$(\dot{p}_N - \dot{p}_T) - (\dot{p}_N^* - \dot{p}_T^*)_{t-1} * ERR$		0.364** (0.185)		0.312** (0.157)
$(\dot{p}_N - \dot{p}_T) - (\dot{p}_N^* - \dot{p}_T^*)_{t-1} * FIX$	0.638*** (0.117)		0.554 (0.339)	
Const	0.013* (0.007)	0.005 (0.021)	0.001 (0.003)	0.001 (0.011)
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
R ²	0.182	0.182	0.185	0.188
N	580	575	749	733
Stability test (p-val.)			0.456 (0.99)	0.485 (0.99)

Legenda: Dependent variable is $\Delta r_labcost$. Robust standard errors in parenthesis. *** = significant at 1%; ** significant at 5%; * significant at 10%.

Figure 1. Dual inflation and productivity differentials

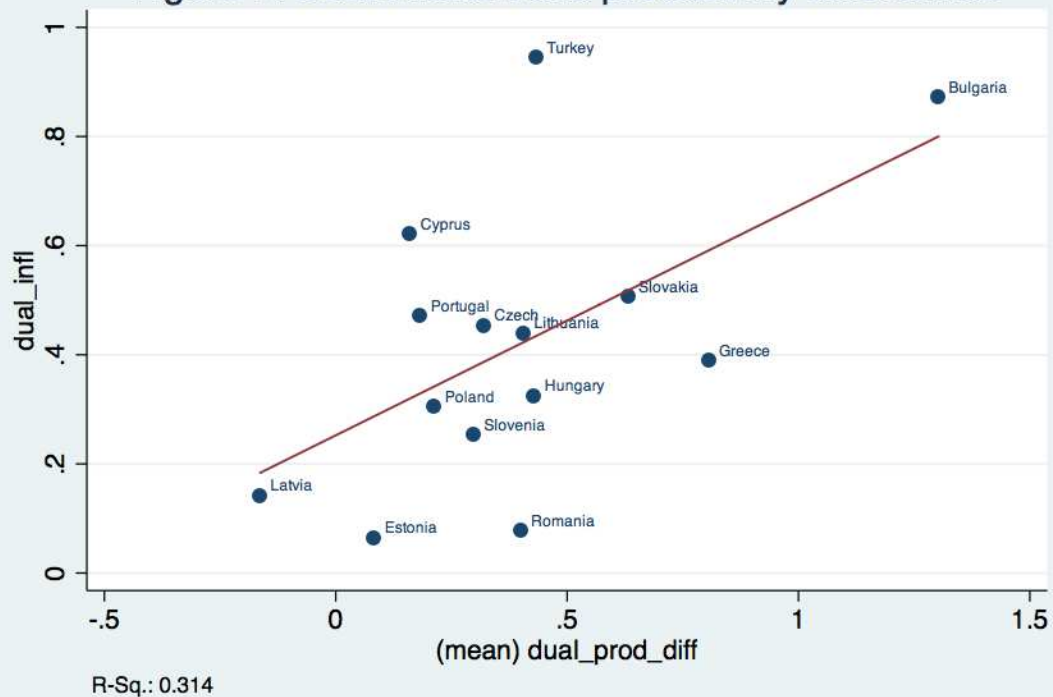


Figure 2. Export Market Share

