

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

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

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## **Abstract**

This paper studies the role of the exchange rate regime in the process of price convergence in Europe. During the last decade, a large strand of literature has flourished which studies the importance of the Balassa-Samuelson hypothesis in explaining nominal convergence. However, a general result of this literature is that such hypothesis can only explain a minor part of the excess inflation registered in European catching-up countries, while other factors may be at play. The role of the exchange rate regime in convergence in Europe, however, has so far been overlooked. First, we model the (endogenous) choice of the exchange rate regime and, in a second stage, estimate a Balassa-Samuelson type of regression for each regime. The results show that, for countries which pegged to or adopted the euro, the effect of a 1% increase in dual productivity growth (i.e. the difference between traded and non-traded sector productivity growth) on the dual inflation differential is more than twice as big as that of “flexible” countries. Our results suggest that too early adoption of the euro may *per se* foster excess inflation in a catching-up country which cannot be accounted for by the process of real convergence.

**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. In this case, entry in a monetary union “too early” might be harmful for a catching up country, and the whole process might be not sustainable, since it will be accompanied by loss of competitiveness and large international imbalances, as the experience of Southern European countries has recently shown.

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

Research on this topic has generally focused on the Balassa-Samuelson effect (Balassa 1964, Samuelson 1964; henceforth B-S), and especially for transition countries (see, for example, Egert *et al.* 2006), since this effect should explain excess inflation observed in these countries *vis-à-vis* the euro area. The B-S hypothesis states that countries which are in the process of catching up experience real exchange rate appreciation; such appreciation is due to the fact that productivity grows faster in the tradable goods sector than in the non-tradables sector, thus pushing up wages in the former, and inter-sectoral labor mobility ensures wage equalization across domestic macro sectors. The increase in wages in the non-tradables sector, in turn, pushes the prices of non-traded goods up, which ultimately causes the increase in the CPI that determines real appreciation. The literature that focused on convergence in the last decade has been using alternative approaches<sup>3</sup> to measure the importance of the B-S effect but, broadly speaking, the main result seems to be that such effect can account only for a minor part of the excess inflation observed (see Egert 2007). These results appear to suggest that other factors may indeed be at play<sup>4</sup>.

Quite surprisingly, however, the literature on convergence that flourished in the last decade has so far left aside the role of the 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 (Levi-Yeyati and Sturzenegger 2003) and inflation dynamics (Ghosh et al. 2007). Accounting for the effect of

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<sup>3</sup> The approaches used in the literature can be divided in three groups: descriptive statistics or the accounting framework (see for example Begg et al. [1999] and Dobrinsky [2006]); time series econometrics (Golinelli and Orsi [2001], Egert [2002]) and panel econometrics (Mihaljek and Klau [2003], Egert [2002], Fischer [2004]).

<sup>4</sup> 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 (Egert and Podpiera 2008).

the exchange rate regime, as we will see below, complicates somehow the empirical analysis, as we need to estimate alternative models of the B-S effect, depending on the exchange rate regime in place, since the choice of the regime itself is endogenous.

Our contribution is threefold: first, as stated above, no empirical work to date, to our knowledge, has measured the role of the exchange rate regime in enhancing price convergence; to do so, in our empirical approach, we directly model the choice of the exchange rate regime. Second, we shall refer to *de facto* rather than *de jure* exchange rate regimes to allow for a more precise and detailed classification of regimes. Third, by establishing a link between the exchange rate regime and the decoupling of price and productivity convergence, we provide one rationale why adopting the euro “too early” may entail a potentially high cost in terms of competitiveness, for countries whose convergence process is still far from being completed.

The paper is structured as follows: section 2 presents a general theoretical representation of the B-S effect, along the lines of Froot and Rogoff (1995); section 3 introduces the data used in the paper and the empirical approach; section 4 reports the result of the analysis of the choice of the exchange rate regime and section 5 presents the results of our “core” empirical model. Section 6 concludes.

## 2. A stylized model of the B-S effect

Froot and Rogoff’s (1995) model of the B-S effect is the main theoretical reference for papers that, in the last decade, have been trying to measure the importance of the B-S effect in explaining the excess inflation experienced by transition countries.

In this model, we have two countries, a home country (H) which is in the process of catching up, and a foreign (F), developed country. There are two sectors, a Traded sector,  $T$ , and Non-traded sector,  $N$ , and two inputs, capital,  $K$  and labor,  $L$ . Capital is freely mobile across sectors and across countries, and this ensures international and inter-sectorial equalization of the rental rate of capital,  $R : R_H = R_F$ . Labor, instead, is freely mobile across sectors but it is not internationally mobile, and therefore we have inter-sectoral wage equalization in each country:  $W_{H,T} = W_{H,N} = W_H$ ;  $W_{F,T} = W_{F,N} = W_F$  but at the same time  $W_H \neq W_F$ .<sup>5</sup>

The production function is Cobb-Douglas for each country and sector:

$$Y_{T,H} = A_{T,H} K_{T,H}^{1-\alpha} L_{T,H}^{\alpha} \quad (1)$$

$$Y_{N,H} = A_{N,H} K_{N,H}^{1-\beta} L_{N,H}^{\beta} \quad (2)$$

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<sup>5</sup> While the assumption that labor does not move across countries may look too strong for countries which are member states of the European Union, where free mobility of goods, people and services is guaranteed by the Treaties, it is actually confirmed by the evidence that only 4% of workers in the E.U. come from a different E.U. 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 E.U. labor market far from being a perfectly integrated one.

$$Y_{T,F} = A_{T,F} K_{T,F}^{1-\gamma} L_{T,F}^{\gamma} \quad (3)$$

$$Y_{N,F} = A_{N,F} K_{N,F}^{1-\theta} L_{N,F}^{\theta} \quad (4)$$

where we have specified the production functions with sufficient generality to allow for different relative labor intensities across sectors and countries, i.e.  $\alpha \neq \beta \neq \gamma \neq \delta$ .

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):

$$\dot{p}_{N,H} - \dot{p}_{T,H} = \frac{\beta}{\alpha} \dot{a}_{T,H} - \dot{a}_{N,H} \quad (5)$$

i.e. the growth rate differential between prices of non-traded goods and traded goods is proportional to the productivity growth differential. The reason is clear: due to the fact that productivity grows faster in the traded goods sector, and wages are equalized across sectors, in order to avoid incurring into losses firms in  $N$  will have to increase prices due to productivity growth in  $T$ . This difference will be larger, the higher the share of labor in the production of non-traded goods relative to traded goods.

Moreover, note that as long as  $N$  are more labor intensive than  $T$ , i.e.  $\beta > \alpha$ , non-traded goods prices will tend to appreciate with respect to traded goods prices *even if* we have a balanced growth of productivity in the two sectors. This leads us 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 inflation and  $T$  goods inflation will be higher the higher the productivity growth differential between  $T$  and  $N$ , and the more  $N$  are relatively labor-intensive.

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

$$(\dot{p}_{N,H} - \dot{p}_{T,H}) - (\dot{p}_{N,F} - \dot{p}_{T,F}) = \left( \frac{\beta}{\alpha} \dot{a}_{T,H} - \dot{a}_{N,H} \right) - \left( \frac{\theta}{\gamma} \dot{a}_{T,F} - \dot{a}_{N,F} \right) \quad (6)$$

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 differential*). Proposition BS2 formally states this result, also known as the External B-S Effect:

Proposition BS2 (External B-S Effect). For a catching up country, the dual inflation differential, i.e. the difference between non-traded vs. traded goods inflation with respect to the foreign country, is proportional to the dual productivity differential, i.e. the difference between traded and non-traded productivity growth with respect to the foreign country. 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.

The dual inflation differential may also be defined as the change in relative terms of trade. Let us now call  $\sigma_H$  the share of traded goods in the Home CPI, so that  $1 - \sigma_H$  is the share of non-traded goods and, similarly,  $\sigma_F$  the share of traded goods in the Foreign CPI. We thus have:

$$p_i = (1 - \sigma_i)p_N + \sigma_i p_T ; i = H, F \quad (7)$$

Where  $p_i$  is the overall CPI in country  $i$ . Given the definition of the real exchange rate (written in terms of changes):

$$\dot{q} = \dot{e} + \dot{p}_F - \dot{p}_H \quad (8)$$

we can plug (7) and (8) in (6) and we end up with the B-S hypothesis for the real exchange rate:

$$\dot{q} = \dot{e} + \dot{p}_{F,T} - \dot{p}_{H,T} - \left( (1 - \sigma_H) \left( \frac{\beta}{\alpha} \dot{a}_{T,H} - \dot{a}_{N,H} \right) - (1 - \sigma_F) \left( \frac{\beta}{\gamma} \dot{a}_{T,F} - \dot{a}_{N,F} \right) \right) \quad (9)$$

Given our theoretical model, equation (9) is the most general formulation of the B-S effect, which states that, *ceteris paribus*, to the extent that dual productivity (i.e. excess productivity growth in the traded vs. the non-traded sector) at home is higher than in the foreign country, the real exchange rate will appreciate in real terms.

The B-S effect determines a real exchange rate appreciation but, in theory, no competitiveness loss, since traded goods prices are set internationally and wages in the traded goods sector grow in step with productivity. In other terms, as long as relative purchasing power parity holds for traded goods, the process of real and nominal convergence occurs while keeping the international accounts balanced.

Equations (5) and (6) have been estimated by the most recent literature on the B-S effect, respectively, in the following forms<sup>6</sup>:

$$\dot{p}_N - \dot{p}_T = \delta_0 + \delta_1(\dot{a}_T - \dot{a}_N) + \varepsilon \quad (10)$$

$$(\dot{p}_N - \dot{p}_N^*) - (\dot{p}_T - \dot{p}_T^*) = \delta_0 + \delta_1(\dot{a}_T - \dot{a}_N) + \delta_2(\dot{a}_T^* - \dot{a}_N^*) + \varepsilon \quad (11)$$

where we use an asterisk to denote the foreign (i.e. “rich”) country variables and, a priori, we expect  $\delta_1 > 0$  and  $\delta_2 < 0$ .

The introduction of a fixed exchange rate regime or the adoption of the euro may affect the process of price convergence by making international prices more comparable. Indeed, Sturm et al. (2009) show that  $\beta$ -convergence since the creation of the EMU was faster for EMU than for non-EMU countries. Moreover, they show that also the rate of convergence in the price of non-tradables has increased. As these prices are also part of the CPI and since, as it is suggested by the evidence on the Penn effect, the price level index is directly related to real GDP per capita (in 2007 – the last year before the crisis– the correlation between the two series for the 27 EU members was 0,87), then we should expect that euro adoption would

<sup>6</sup> See Egert (2002, 2003); Klau and Mihaljek (2004), among others.

accelerate the rate of price convergence. As a consequence, also the inflation rate for those catching up countries that choose to adopt the euro or to otherwise fix their exchange rate may rise, relative to the inflation rate of non-adopting countries.

In principle, to estimate the role of the exchange rate regime, we could re-write equation (11) as:

$$(\dot{p}_N - \dot{p}_T) - (\dot{p}_N^* - \dot{p}_T^*) = \mu_i + \varphi_0 \mathbf{D}_R + \varphi_1 (\dot{a}_T - \dot{a}_N) + \varphi_2 (\dot{a}_T^* - \dot{a}_N^*) + \varphi_3 \mathbf{D}_R * (\dot{a}_T - \dot{a}_N) + \varphi_4 \mathbf{D}_R * (\dot{a}_T^* - \dot{a}_N^*) + \varepsilon \quad (12)$$

where  $\mathbf{D}_R$  is a vector of dummy variables defining the exchange rate regimes, which will depend on the regimes' classification chosen. Indeed, empirical studies analyzing the impact of the exchange rate regime on macroeconomic performance often employ exchange rate dummies in inflation or growth equations, where the coefficient of the exchange rate regime dummy reveals the effect of the regime on the dependent variable.

The problem with equation (12) is that the choice of the exchange rate regime may be endogenous, since it is itself determined by the economic fundamentals of the country and therefore will presumably be correlated with the error term,  $\varepsilon$ . There is not only a problem of endogeneity of  $\mathbf{D}_R$ , however. Rather, there is a sample selection problem, which arises from the fact that countries do not choose their exchange rate regimes randomly. For this reason, it is not feasible to estimate the equation separately for the different regimes and then testing for equality of coefficients. The choice of the exchange rate regime hinges on a set of fundamentals, which, in turn, affects macroeconomic outcomes. Consequently, the use of standard econometric techniques such as OLS or 2SLS would produce biased results resulting from the correlation between the regime choice and the error term in (12).

As shown by Domaç et al. (2001), addressing the sample selection problem also solves the issue of the endogeneity of the choice of the exchange rate regime, which, instead, is not achieved by instrumenting the regime dummy, but rather achieved by assuming constant covariance between the error term in equation (12) and the normally distributed random variable whose realization determines the exchange rate regime.

For this reason, we estimate equation (12) by using a switching regression model, which allows us to endogenize the choice of the exchange rate regime.<sup>7</sup>

In the following section, we present an empirical model to estimate model (12) for alternative exchange rate regimes that addresses these issues.

### 3. The data and the empirical approach

We have an unbalanced sample composed of 14 EU or candidate countries that may be considered to be in the process of catching up. We focus on the period from 1998:1 until

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<sup>7</sup> See Domaç et al. (2001).

2011:4. To discern between “catching-up” countries and other countries, we choose a cut-off level of GDP per capita equal to or lower than 75% of the EU-15 average in 1998<sup>8</sup>. The choice of the threshold is consistent with the definition of “converging regions” in the EU regional policy (although the term of comparison for the policy is the EU-27).

Since our objective is to have a sample as homogeneous as possible, to avoid problems related to the compatibility of the series used, we choose to include the following countries: Bulgaria, Cyprus, the Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Poland, Portugal, Romania, Slovak Republic, Slovenia, Turkey. Serbia, Croatia and FYROM (Former Yugoslav Republic of Macedonia) were excluded due to non-available data; Malta was excluded because the small size of its economy makes it less relevant for our purposes. The “foreign country” in our analysis is the euro area. More specifically, since Greece and Portugal were in the euro area since its creation, we created a “core” euro area which includes Austria, Belgium, Finland, France, Germany, Italy, Netherlands and Spain<sup>9</sup>.

Data are from Eurostat and, in the case of Turkey, also national sources. Following the literature on the B-S effect, we choose as a proxy for  $p_T$  the prices of goods, and as a proxy for  $p_N$  the prices 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.<sup>10</sup>

An important issue to deal with is how to classify exchange rate regimes. In principle, there are two alternatives: *de jure* and *de facto* classification. In the former case, we classify regimes based on what the Central Bank declares to be the official exchange rate regime. The problem with this classification is that it may lead to a mistake when a Central Bank pursues an exchange rate policy which is inconsistent with the official regime. Indeed, this has been proved to be very frequent by a large strand of recent literature (Calvo and Reinhart 2002, Reinhart and Rogoff 2004, Frankel and Wei 2008, to name but a few). More precisely, it is common for Central Banks to adopt a *de facto* exchange rate regime which is stricter than the official regime so that *de jure* floaters actually frequently intervene to stabilize the nominal exchange rate, a behavior that Calvo and Reinhart (2002) call “fear of floating”. On the other hand, however, the volatility of the exchange rate *per se* cannot be the only indicator to discern whether a country has “fear of floating”. Nominal exchange rate volatility may be low due to the absence of large shocks, or because the business cycle of the countries considered reaches a higher degree of synchronization, i.e. stability of the exchange rate may be, in this sense, endogenous.

Table 1 reports the countries and corresponding exchange rate regimes over the selected sample period. Regimes are classified using a mixed *de jure* - *de facto* classification scheme

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<sup>8</sup> In 1998, the country with the highest GDP per capita (in PPS) was Cyprus, with 74% of EU-15 average. The countries with the lowest GDP pc were Bulgaria and Romania (23.5% of EU-15 average).

<sup>9</sup> This leaves out Luxembourg and Ireland, due to data availability issues. To calculate price indices of the “core” euro area, we used country data and weighted them using the weights provided by Eurostat.

<sup>10</sup> 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.

adapted from Reinhart and Rogoff (2004). In particular, we take into account the *de jure* regime as a starting point; thus, we classify the country as “EMU” if it is a member of the Monetary Union; “Peg” if it has a currency board; “Managed Float” if it declared any limited flexibility regime: fluctuation bands, crawling bands, crawling pegs; and “Inflation Targeting” when the Central Bank’s official monetary policy objective is price stability and an explicit target for the inflation rate has been stated. However, in the case of *de jure* managed floats, if the average monthly percentage change of the bilateral exchange rate *vis à vis* the euro has remained within a  $\pm 1\%$  band over a 5-year rolling window, we classify it as a *de facto* peg. Finally, as in Reinhart and Rogoff (2004), we classify a regime as “freely falling” when inflation exceeds 40% and/or in the 6 months following an exchange rate crisis. However, due to the reduced number of observations for this latter regime, it will later not be taken into consideration in the empirical analysis.

In the empirical analysis, however, we only consider two alternatives: fixed or flexible. The former includes pegs and membership of the EMU, and the latter includes inflation targeting and managed float. In fact, within our sample, the four regimes included in Table 1 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 Targeters have, in many occasions, engaged in foreign exchange intervention to stabilize the home currency.<sup>11</sup> In practice, this makes Inflation Targeting regimes observationally equivalent to a *de facto* managed float.<sup>12</sup>

As anticipated in section 2, we cannot simply estimate equation (12) by OLS, because  $D_R$  is endogenous, nor by 2SLS because (12) actually embodies two alternative models depending on how our countries self-select into alternative exchange rate regimes. Therefore, we estimate a switching regression model where the parameters of (12) are allowed to be different across regimes, and where being in a fixed or flexible exchange rate regime depends on the country’s fundamentals.

Thus, consider the regime dummy  $D_R$ . This is set equal to 1 if a country has a fixed or to 0 if it is in a flexible exchange rate regime. Now the value of  $D_R$  will depend on a latent variable  $D_R^o$ :

$$\begin{cases} D_R = 1 & \text{if } D_R^o > 0 \\ D_R = 0 & \text{if } D_R^o \leq 0 \end{cases}$$

In turn, the latent variable describes the willingness to adopt a fixed rather than a flexible exchange rate regime. Therefore, it is defined by

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

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<sup>11</sup> One example was the National Bank of Hungary which openly intervened in the FOREX markets to stabilize the exchange rate of the Florint in November 2003.

<sup>12</sup> Indeed, in a preliminary analysis, the results on modeling the choice of the exchange regime reported in the following section was done using an ordered probit as a “regime” variable, with regimes ordered from the most rigid to the most flexible, but EMU membership and Peg, on one hand, and Managed Float/Inflation Targeting on the other resulted observationally equivalent.

**Table 1.** Chronology of Exchange Rate Regimes.

|                       |                   |                     |
|-----------------------|-------------------|---------------------|
| <b>Bulgaria</b>       | Q1.1996 – Q3.1997 | Freely Falling      |
|                       | Q4.1997 – Q4.2011 | Peg                 |
| <b>Cyprus</b>         | Q1.1996 – Q4.2007 | Managed Floating    |
|                       | Q1.2008 – Q4.2011 | EMU                 |
| <b>Czech Republic</b> | Q1.1996 – Q4.1997 | Managed Floating    |
|                       | Q1.1998 – Q4.2011 | Inflation Targeting |
| <b>Estonia</b>        | Q1.1996 – Q4.2010 | Peg                 |
|                       | Q1.2011 – Q4.2011 | EMU                 |
| <b>Greece</b>         | Q1.1996 – Q4.2000 | Managed Floating    |
|                       | Q1.2001 – Q4.2011 | EMU                 |
| <b>Hungary</b>        | Q1.1996 – Q2.2001 | Managed Floating    |
|                       | Q3.2001 – Q4.2011 | Inflation Targeting |
| <b>Latvia</b>         | Q1.1996 – Q4.2011 | Peg                 |
| <b>Lithuania</b>      | Q1.1996 – Q4.2011 | Peg                 |
| <b>Poland</b>         | Q1.1996 – Q4.1997 | Managed Floating    |
|                       | Q1.1998 – Q4.2011 | Inflation Targeting |
| <b>Portugal</b>       | Q1.1996 – Q4.1998 | Managed Floating    |
|                       | Q1.1999 – Q4.2011 | EMU                 |
| <b>Romania</b>        | Q1.1996 – Q2.2001 | Freely Falling      |
|                       | Q3.2001 – Q2.2005 | Managed Floating    |
|                       | Q3.2005 – Q4.2011 | Inflation Targeting |
| <b>Slovenia</b>       | Q1.1996 – Q4.2006 | Managed Floating    |
|                       | Q1.2007 – Q4.2011 | EMU                 |
| <b>Slovakia</b>       | Q1.1996 – Q4.2008 | Managed Floating    |
|                       | Q1.2009 – Q4.2011 | EMU                 |
| <b>Turkey</b>         | Q1.1996 – Q4.2001 | Freely Falling      |
|                       | Q1.2002 – Q4.2011 | Inflation Targeting |

Where  $Z$  is a column vector including all variables which affect the choice of the exchange rate regime, including a constant, and  $\Gamma$  are the coefficients. Consequently, our empirical model will be the following:

$$\begin{cases} Y_{it} = X_{it}B_{1,it} + u_{1,it} & \text{if } D_R^o < Z_{it}\Gamma \\ Y_{it} = X_{it}B_{2,it} + u_{2,it} & \text{if } D_R^o < Z_{it}\Gamma \end{cases} \quad (13)$$

Where:

$$Y_{it} = (p_{N,it} - p_{T,it}) - (p_{N,it}^* - p_{T,it}^*); \quad X_{it} = \begin{bmatrix} 1 \\ \dot{a}_T - \dot{a}_N \\ \dot{a}_T^* - \dot{a}_N^* \end{bmatrix}.$$

As discussed by Domaç et al. (2001), 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  $\Gamma$  using a probit and then use it in a second step to estimate model (13).

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 resulting from the probit estimation as a regressor in the regressions in (13). Moreover, since the errors will not be correct, we will have to bootstrap them.

#### 4. The Choice of the Exchange Rate Regime

As stated above, the choice of the exchange rate regime will depend on macroeconomic factors which affect the relative inflation differential and are left in the error term of the regression equation. 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) 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:<sup>13</sup>

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

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

- b. **Economic Size of the Country.** 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.

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<sup>13</sup> Other variables which have been suggested in the literature modeling the choice of the exchange rate regime are the product and the geographical concentration of trade. For both variables, a higher concentration should lead to a stronger 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) was never significant. For product concentration, we estimated a model including an Hirschmann-Herfindahl Index (HHI) of product concentration; the fit of this model, however, is worse with respect to that of the model including the degree of openness. In addition, we have data for this variable only from 1999 or 2000 (and not for Turkey). As also on a priori grounds we prefer to use the degree of openness, we decided to use only this variable (as described in the text) and to neglect the use of the HHI index.

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 since 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. In addition, except for countries with an opt-out clause, adoption of the euro is a requirement of the EU Treaties.
- d. **Effectiveness score.** This variable, taken from the Polity IV “State Fragility Index” (SFI) Database, measures Political Effectiveness (Regime durability, Current Leader Year’s 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 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 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 is in a managed float or inflation targeting, and 1 in case of peg or EMU membership, our model of the choice of the exchange rate regime is:

$$FIX_{it} = \gamma_1 OPENNESS_{it} + \gamma_2 LogGDP_{it} + \gamma_3 EFFECTIVENESS_{it} + \gamma_4 YEARS_{it} + \varepsilon_{it} \quad (14)$$

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

Table 2 reports the results of the probit estimation of Equation (14). We can look at the percentage of correctly predicted outcomes as a rough measure of the goodness of fit. This is calculated as follows:

$$pcp = \frac{N_{1|1} + N_{0|0}}{N_1 + N_0},$$

where  $N_{1|1}$  is the number of cases where the model predicts  $FIX=1$  and it is indeed 1,  $N_{0|0}$  is the number of cases where the model predicts  $FIX=0$  and it is indeed 0,  $N_1$  is the total number of cases where  $FIX=1$  and  $N_0$  is the total number of cases where  $FIX=0$ . From our estimates  $pcp$  is equal to 73.3%, which shows that the model is fairly good in explaining why a country finds itself in a fixed or flexible regime.

Moreover, looking at Table 2, we note that  $OPENNESS$  and Years of EU membership have a positive coefficient (the more open to trade, and the more years in the EU, the higher the probability to  $FIX$ );  $Log GDP$  has a negative sign (the lower is GDP, i.e. the “smaller” the country, the higher the probability to  $FIX$ ). Finally, higher  $EFFECTIVENESS$  (which means lower political and economic effectiveness), as expected, has a positive sign: the higher the score, the higher the probability to fix.

**Table 2.** Probit regression, Equation (14).

|                               | Coefficient | St. Error | P-value | Marginal Effect |
|-------------------------------|-------------|-----------|---------|-----------------|
| Openness                      | 2.369       | 0.295     | 0.000   | 0.941           |
| Log GDP                       | -3.766      | 0.410     | 0.000   | 0.347           |
| Effectiveness                 | 0.874       | 0.174     | 0.000   | -1.496          |
| Years EU                      | 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   | -               |

## 5. The B-S Effect across Exchange Rate Regimes

As anticipated in Section 3, in the second step we estimate the fundamental B-S regression (as specified in (12)) for each regime, correcting for the sample selection bias by including the Inverse Mills Ratio calculated from the estimation of equation (14) and bootstrapping standard errors.

Before introducing the two-stage estimation, as a simple exercise we estimate the modified B-S equation separately for each regime, i.e. estimate equation (12):

$$\begin{aligned}
 (\dot{p}_N - \dot{p}_T) - (\dot{p}_N^* - \dot{p}_T^*) \\
 = \mu_i + \varphi_0 \mathbf{D}_R + \varphi_1 (\dot{a}_T - \dot{a}_N) + \varphi_2 (\dot{a}_T^* - \dot{a}_N^*) + \varphi_3 \mathbf{D}_R * (\dot{a}_T - \dot{a}_N) + \varphi_4 \mathbf{D}_R \\
 * (\dot{a}_T^* - \dot{a}_N^*) + \varepsilon
 \end{aligned}$$

We denote this approach as “naïve” since, by ignoring the endogeneity of  $\mathbf{D}_R$ , 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 3, where the FIX regime is taken as the baseline.<sup>14</sup>

First we note that, as expected, in the base regime 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 B-S hypothesis predicts. Moreover, while the coefficient on the interaction term relative to the home productivity differential  $(\dot{a}_T - \dot{a}_N) * flex$  is significantly different from zero, this is not the case for the coefficient on the interaction term relative to the productivity differential in the foreign country,  $(\dot{a}_T^* - \dot{a}_N^*) * flex$ , which suggests that this effect is equal across regimes. This makes sense:

<sup>14</sup> In this 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 would have no impact on the rate of nominal convergence, i.e. it would not affect the rate of B-S convergence.

remember from equation (6) that  $\varphi_2$  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 not change across exchange rate regimes of the *home* country. However, the significance of the interaction term for the home productivity differential 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 much 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, since we observed that these estimates cannot take into account 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.

Table 4 reports the results of the switching regression model<sup>15, 16</sup>. The significance of the Inverse Mills Ratio (IMR) in the Flexible model means that indeed there is a significant sample selection.

However, from a qualitative point of view, the results obtained using the *naïve* approach are confirmed also here: convergence à la B-S is faster for countries that have pegged their exchange rate or have joined the EMU, 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 composition of the consumption basket towards higher-quality goods, different economic structures. With our analysis, we provide an additional element that had so far not been considered by the literature and show that, for a given degree of productivity convergence, price convergence is faster if the exchange rate regime is fixed.

This does 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 traded goods inflation differential,  $\dot{p}_T - \dot{p}_T^*$ . As we remarked in section 2, we would observe a loss of competitiveness only to the extent that the higher inflation in the non traded sector would induce a faster growth of prices in the traded sector, relative to that of the benchmark competitors.<sup>17</sup>

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<sup>15</sup> 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).

<sup>16</sup> All series were tested for the presence of a unit root using Pesaran CADF test and they came out to be I(0).

<sup>17</sup> This aspect is examined in detail in a parallel research.

**Table 3.** “Naïve” estimation, Equation (12)

|                                      | Coefficient | Robust Std. Error | P-Value |
|--------------------------------------|-------------|-------------------|---------|
| M                                    | 0.003       | 0.002             | 0.103   |
| <i>flex</i>                          | 0.001       | 0.003             | 0.724   |
| $(\dot{a}_T - \dot{a}_N)$            | 0.175       | 0.042             | 0.000   |
| $(\dot{a}_T - \dot{a}_N) * flex$     | -0.095      | 0.046             | 0.039   |
| $(\dot{a}_T^* - \dot{a}_N^*)$        | -0.245      | 0.062             | 0.000   |
| $(\dot{a}_T^* - \dot{a}_N^*) * flex$ | 0.034       | 0.091             | 0.708   |

Note: Model estimated using country fixed effects. N=633. R<sup>2</sup>: 0.174.

**Table 4.** Balassa-Samuelson effect in fixed and flexible exchange rate regimes

|                                      | Coefficient | Robust Std. Error | P-Value |
|--------------------------------------|-------------|-------------------|---------|
| <b>Fixed</b>                         |             |                   |         |
| $\mu$                                | 0.004       | 0.002             | 0.051   |
| $(\dot{a}_T - \dot{a}_N)$            | 0.176       | 0.069             | 0.010   |
| $(\dot{a}_T^* - \dot{a}_N^*)$        | -0.238      | 0.052             | 0.000   |
| IMR                                  | -0.002      | 0.008             | 0.844   |
| Country Fixed Effects                | YES         | -                 | -       |
| Note: N=350. R <sup>2</sup> : 0.194. |             |                   |         |
| <b>Flexible</b>                      |             |                   |         |
| $\mu$                                | 0.006       | 0.002             | 0.007   |
| $(\dot{a}_T - \dot{a}_N)$            | 0.075       | 0.043             | 0.080   |
| $(\dot{a}_T^* - \dot{a}_N^*)$        | -0.217      | 0.052             | 0.000   |
| IMR                                  | -0.010      | 0.005             | 0.042   |
| Country Fixed Effects                | YES         | -                 | -       |
| Note: N=272. R <sup>2</sup> : 0.124. |             |                   |         |

However, since non-traded goods are part of the CPI, our results do imply that, other things equal, adoption of a strict peg or the euro may determine higher CPI inflation for a catching-up country.<sup>18</sup>

## 6. Conclusions and policy implications

In this paper we have shown, in reference to a group of 14 “catching up” European countries, that the adoption of a fixed exchange rate may significantly amplify the so-called “External Balassa-Samuelson Effect”, that is the dual inflation differential, i.e. the relative inflation differential between the prices of non-traded and traded goods of “catching up” versus “core countries”.

The literature on the Balassa-Samuelson Effect in Eastern Europe which has flourished mostly since the last decade has shown that the B-S effect has a limited role in explaining the excess inflation experienced by European catching-up countries with respect to the euro area (Egert

<sup>18</sup> Moreover, to the extent that non-traded goods are used as inputs for traded goods, this may have second-round effects on traded goods prices and, finally, on competitiveness. However, this goes beyond the scope of the present paper.

2006). Instead, several works have been investigating alternative sources of price level convergence, such as investment demand (Fischer 2004), the change in the consumption basket towards higher quality goods, different economic structure (for example, a different role of energy goods), as well as business cycle convergence (Egert 2007).

The purpose of our research was to shed light on one aspect of the choice of the exchange rate regime which has been almost neglected so far: while it has been generally acknowledged that fixing the exchange rate has the effect of imposing inflation “discipline” in a country that joins a currency area characterized by a lower inflation, the implications that this might have for the dual (or “structural”) inflation differential have been largely unexplored. In fact, even if we assume that traded goods prices are internationally equalized in the case of free trade, this need not be (and, generally, it is not) the case for non-traded goods prices. However, the adoption of a strict exchange rate peg or, in the extreme case, the euro may favour price convergence in the non-traded sector because it makes international prices (and wages) more comparable. To the extent that this is the case, non-traded goods inflation relative to traded goods inflation will be higher in countries that fix the exchange rate with respect to floating countries. As a result, the aggregate inflation rate would be higher, although this, in principle, need not harm a country’s competitiveness, since the latter depends on the evolution of traded goods prices.

To measure the impact of the exchange rate regime on the process of price convergence à la Balassa-Samuelson, we have used a two-step approach. In fact, since countries self-select themselves into different regimes, we first modelled the choice of the exchange rate regime with a probit regression. In a second stage, we used a switching regression model to estimate a Balassa-Samuelson type of equation for fixed and flexible exchange rate regimes.

Our results show that, for any percentage point of relative productivity growth in the traded goods, the increase in non-traded goods prices is higher in fixed rather than flexible exchange rate regimes. In other words, if the exchange rate is fixed, 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 therefore experience a faster real exchange rate appreciation.

The implication is somewhat paradoxical, in the sense that after a catching up country has joined the euro area, having fulfilled the Maastricht Criteria on inflation, it may become subject to excess inflation (above the inflation rate targeted by the ECB), due to the dynamic effects that we have described. More precisely, to the extent that joining a currency area amplifies the External B-S Effect, that is the difference between non-traded vs. traded goods inflation with respect to the foreign country, the inflationary “discipline” imposed by the single monetary policy may well become *ex post* less effective. On this basis, one may question the appropriateness of criteria (such as the “Maastricht criteria”) which define a country’s suitability to fix the exchange rate on the basis of the observed CPI differential.

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## References

Balassa, B. (1964) "The Purchasing-Power Parity Doctrine: a Reappraisal" *Journal of Political Economy* 72(6), December, pp. 584-96.

Begg, D., Halpern, L. and C. Wyplosz (1999) "Monetary and exchange rate policies, EMU and Central and Eastern Europe" Forum report on the Economic Policy initiative No. 5, CEPR: London, EastWest Institute: New York, Prague.

Calvo, G.A. and Reinhart, C.M. (2002) "Fear of Floating", *The Quarterly Journal of Economics* vol. 118, Issue 2, p. 379-407.

D'Adamo, G. (2011) "Wage spillovers across sectors in Eastern Europe". WPAE-2011-22, Working Papers in Applied Economics, Universitat de Valencia.

Domaç, I.; Peters, K. and Y. Yuzefovich (2003) "Does the Exchange Rate Regime matter for Inflation? Evidence from Transition Economies" Central Bank of Turkey Working Paper n.304.

Dobrinsky, R. (2006) "Catch-up inflation and nominal convergence: the balancing act for new EU entrants" *Economic Systems* 30 (4) pp. 424-442.

Edwards, S. (1996) "The determinants of the choice between fixed and flexible-exchange rate regimes", NBER Working Paper, No. 5756.

Egert, B. (2002) "Investigating the Balassa-Samuelson hypothesis in the transition" *Economics of Transition* Vol. 10 (2), pp. 273-309.

Egert, B. and I. Drine, K. Lommatzsch, C. Rault, (2003) "The Balassa-Samuelson effect in Central and Eastern Europe: myth or reality?" *Journal of Comparative Economics* vol. 31 (3), pp. 552-72.

Egert, B., Halpern, L. and R. MacDonald (2006) "Equilibrium Exchange Rates in Transition Economies: taking stock of the issues", *Journal of Economic Surveys* 20 (2), pp. 257-324.

Egert, B. (2010) "Catching Up and Inflation in Europe: Balassa-Samuelson, Engel's Law and other culprits" OECD Economics Department Working Paper N° 792, OECD Publishing.

Egert, B. and J. Podpiera (2008) "Structural Inflation and Real Exchange Rate Appreciation in Visegrad-4 countries: Balassa-Samuelson or something else?" CEPR Policy Insight No. 20.

Fischer, C. (2004) "Real Currency Appreciation in Accession Countries: Balassa-Samuelson and Investment Demand" *Review of World Economics* 2004, 140 (2) pp.179-210.

- Frankel, J. and Wei, S.J. (2008) "Estimation of de facto exchange rate regimes: synthesis of the techniques for inferring flexibility and basket weights", IMF Staff Papers Vol. 55, N.3.
- Froot, K. and K. Rogoff (1995) "Perspectives on PPP and Long-Run Real Exchange Rates" in G. Grossman and K. Rogoff (eds.), *Handbook of International Economics* 3. Amsterdam: Elsevier.
- Ghosh, A.R.; Ostry, J.; Gulde, A.M. and H.C. Wolf (1997) "Does the Exchange Rate Regime Matter for Inflation and Growth?", IMF Economic Issues #2, IMF.
- Golinelli, R. and R. Orsi (2001) "Modelling inflation in EU accession countries: the case of the Czech Republic, Hungary and Poland", paper presented at Eastern European transition and EU enlargement: a quantitative approach, Gdansk, June 15-21 2001.
- Heckman, J. (1979) "Sample selection bias as a specification error", *Econometrica* 47: 153-161.
- Heller, H.R. (1978) "Determinants of Exchange Rate practices", *Journal of Money, Credit and Banking* vol. 10, pp. 308-321.
- Holden, M.; Holden, P. and H. Suss (1981) "Policy objectives, country characteristics and the choice of the Exchange Rate Regime", *Rivista Internazionale di Scienze Economiche e Commerciali*, October-November 1981, v.28, pp. 1001-14.
- Klau, M. and D. Mihaljek (2004): "The Balassa-Samuelson effect in central Europe: a disaggregated analysis", *Comparative Economic Studies*, vol 46, March, 63-94.
- Levy-Yeyati and Sturzenegger (2003) "To float or to fix: evidence on the impact of exchange rate regimes on growth", *American Economic Review* 93 (4): 1173 – 1193.
- Reinhart and Rogoff (2004) "The modern history of exchange rate arrangements: a reinterpretation", *Quarterly Journal of Economics* 119 (1): 1 – 48.
- Samuelson P.A. (1964) "Theoretical Notes on Trade Problems" *The Review of Economics and Statistics* vol. 46, No. 2, 145-154.
- Sturm, J.E.; Fritsche, U.; Graff, M.; Lamla, M.; Lein, S.; Nitsch, V.; Liechti, D. and D. Triet (2009) "The euro and prices: changeover-related inflation and price convergence in the euro area" *European Economy – Economic Papers* n. 381, June 2009.