AN OUT-OF-SAMPLE ASSESSMENT OF THE EFFICACY OF CURRENCY BOARDS IN EUROPEAN TRANSITION ECONOMIES

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ABSTRACT

We assess the contribution of the new-generation currency boards (CB) in European transition economies to macroeconomic performance (growth and inflation). Focusing on more recent data to exclude the volatile effects around the launch of the currency board arrangements, we identify the long run contribution of currency boards to growth. This fills a major gap in the literature as previous studies cannot exclude post-launch effects and results driven by colonial currency boards. We find a (borderline) significant positive (negative) effect of CBs on growth (inflation).

KEYWORDS: Currency boards, macroeconomic performance, European transition economies.

1. INTRODUCTION

Assessing costs and benefits of alternative exchange rate regimes has been one of the key questions in international finance. However, empirical literature on ex-post evaluation of the contribution of exchange rate regimes, in particular currency boards (CB), is fairly limited. We are aware of only two papers that aim at measuring the efficacy of CBs: Ghosh et al. (2000), Levy-Yevati and Sturzenegger (2002), which cover a long period of post-Bretton Woods era and CBs across the world including colonial currency board arrangements. However, the currency boards in Eastern Europe differ in many respects, as discussed below. The present paper offers an out-of-sample test of the efficacy of currency boards, free from volatile post-launch effects, focusing on European transition economies.

European transition economies offer an ideal set-up to assess the efficacy of the CB regimes, as they are a group of small and similar economies among which there is sufficient variety in terms of exchange rate regime. This enables us to identify what difference a currency board makes in terms of growth and inflation performance. Our sample covers 14 countries. Three of them have currency board regime: Bulgaria, Lithuania, Estonia. By choosing a recent sample period 1997 - 2011, we abstract from effects as such broken trade dependencies (former Soviet republics), initial conditions, the volatile period just prevailing around the launch of the CB and post-launch rebound in growth ("catch-up growth").[1]Thus, the current study aims at documenting the long term performance of CB regimes, in particular to assess whether the stabilization brought about by CB regimes translates into achieving the ultimate goal of fostering growth. Our sample period includes a substantial global crisis, which offers a good test of any macroeconomic policy's efficacy robust to business cycle variation.

CB's credibility effect on inflationary expectations is the main theoretical argument to establish a link between CB regimes and growth performance. Even though much has been written about CBs institutional and organizational aspects, only two papers systematically test whether the hypothesized ultimate benefit of CBs on growth and inflation materializes. Ghosh et al. (2000) find that countries with currency boards have experienced lower inflation and higher growth compared to either floating regimes or simple pegs. However, their growth results do not account for the rebound effect from depressed pre-adoption levels. Accounting for those rebound effects might significantly change their results. The findings of Ghosh et al. (2000) are consistent with the descriptive analysis of Gulde and Keller (2000), who claim that Bulgaria, Lithuania and Estonia have experienced lower inflation and higher growth than those EU accession economies with other regimes. Levy-Yeyati and Sturzenegger (2002) find, however, lower inflation at the cost of lower growth for both conventional pegs and currency board countries. Korhonen (2000) discusses the anecdotal evidence: he concludes that while favorable effects of currency boards in the Baltic countries[2] is more difficult to find, a comparative

[1]In Bulgaria, CB was launched in July 1997. We exclude this period for Bulgaria with a dummy.

[2] Latvia's intitial peg in February 1994 to the IMF special drawing right's (SDR) basket renders it as having had a regime very similar to that of a currency board. This is why the three Baltic countries are often considered together when investigating the impact of fixed pegs on macroeconomic performance (De Haan et al. 2001). However, for the purposes of the current paper, we treat Latvia as having a fixed peg for the 1997-2002 period.

analysis shows that currency boards have not produced worse economic performance.

An interesting common characteristic of European CBs is the unorthodox nature which allows temporary deviations from the one-to-one relationship between H (high-powered money) and foreign exchange (FX) reserves. This is achieved by a buffer of over-backed H (i.e., a smaller H than FX reserves, which creates some room for the CB to play the role of lender of last resort in cases of emergency. (Nenovsky and Hristov, 2002). In addition, there are some atypical items in the balance sheet of the quasi currency boards and the monetary institution can employ a number of monetary policy instruments. Last, but not the least, under the quasi-CBs the monetary authority can vary reserve requirements hence conduct monetary policy. These atypical items and monetary policy tools differ among the CB countries Bulgaria, Lithuania and Estonia (Nenovsky et al. 2001). Our results will reveal the effect of these unorthodox CB arrangements.

Section II reviews the literature on currency boards in general, and those in European transition economies in particular. It also presents the main ideas from the literature on growth determinants, which will guide our selection of controls in our empirical specificadtion. Section III describes the data employed in this study and empirical strategy implemented. Section IV presents the results and Section V concludes.

2. LITERATURE REVIEW

Currency Boards

For a general introduction on currency board regime see Hanke (2001). In an orthodox CB, the home currency is pegged at an official parity to a foreign currency that is deemed reliable. The monetary base (H) is 100% covered by gold and foreign exchange reserves (FX). H follows any changes in FX. CBs in their orthodox form evidenced a strong record of ensuring stabilization and domestic currency credibility in colonial regimes before World War I. After World War II and with the fall of colonial regimes, however, the newly independent countries largely abandoned their CBs.

Currency Boards in European Transition Economies

Nenovsky et al. (2001) compare the institutional and organizational aspects of quasi currency boards in Bulgaria, Lithuania and Estonia and find some noteworthy differences. As a quasi CB-type discretionary tool, the monetary authority in all three countries can manipulate reserve requirements, responding to inflows or outflows of foreign exchange in a flexible manner without an impact on the exchange rate. However, the presence of the government fiscal account on the liabilities section of the central banks' balance sheets in Bulgaria and Lithuania is an additional monetary tool available to these countries. For Bulgaria, **Nenovsky and Hristov (2002)** find that the inclusion of the government fiscal account on the liabilities section of the balance sheet weakens the cointegration relationship between the monetary base and foreign reserves and introduces macroeconomic instability.

Minea & Rault (2011) investigate whether the adoption of the currency board in Bulgaria has helped towards a differentially better integration with the European Monetary Union (EMU) and meeting the Maastricht criteria. They find that the responses of Bulgarian variables to ECB interest rate fluctuations are less persistent and less significant than what the literature has suggested for other CEE economies with more flexible exchange rate regimes. Their result still holds when accounting for different sources of cross-country heterogeneity. **Ivanova (2009)** argues that the introduction of the currency board in Bulgaria enhanced the confidence of foreign creditors and facilitated borrowing from international markets. Thus, the currency board in Bulgaria has significant implications for both growth and inflation in the country.
Purfield and Rosenberg (2010) look at the impact of the global financial crisis of 2008-09 on the Baltics, which, despite bringing per-capita income in these countries back to 2005-6 levels, fuelling inflation, and forcing a devaluation with huge fiscal and nominal wage adjustment, did not destroy confidence in the exchange rate or cause a banking system crisis. However, this result by itself does not speak in favor of currency boards as the study does not compare the performance of flexible or other pegged regimes' performance over the period of the crisis as control groups. **De Haan et al. (2001)** finds that Estonia has been the most successful Baltic country in reducing inflation, which was partly due to its initial choice of a pegging currency in line with Estonia's output and inflation characteristics. At the same time, the author claims that Latvia's less appropriate peg, and Lithuania's inadequate peg are consistent with their worse inflation performance compared to Estonia. Once again, since the study does not compare Baltic countries' performance in reducing inflation to that of alternative exchange rate regimes, it is not indicative of the performance of the currency board in macroeconomic stabilization.

Using SVAR methodology, **López (2007)** casts light to the growth performance of alternative exchange rate arrangements. The author finds that the exchange rates of Czech Republic and Hungary have propagated shocks during the period 1995-2005, whereas the exchange rate of Poland has been used as an output stabilizer. Additionally, the author finds that demand and monetary shocks account for most of the variability in both nominal and real exchange rates in the Czech Republic and Hungary. The somewhat disappointing performance of alternative exchange rate regimes in bringing macroeconomic stability could be wrongly interpreted as evidence in favor of a currency board. However, **Lakchieva (2003)** finds that the volatility of the euro-dollar exchange rate in Estonia and Bulgaria,

both of which with currency boards, implies currency risk to these countries. As both countries fix their exchange rates to the euro in the framework of a currency board, the findings of Lakchieva (2003) are an argument against the stabilizing impact of a currency board regime.

Using a standard growth equation with a current account reversal impulse dummy, **Melecky (2005)** investigates the direct impact of current account reversals on growth in CEE countries. According to theory, a current account reversal must have a significantly negative impact on growth. The author finds that after a current account reversal, the growth rate declines by 1.10 percent in the current year and the negative impact of the reversal subsides in 3.3 years , when the actual growth rate is back at its equilibrium level. Unfortunately, in the analysis, results are interpreted on the basis of the whole panel, and no differentiation among the performance of alternative exchange rate arrangements has been made.

Sohinger (2005) explores the impact of foreign direct investment (FDI) on growth and convergence of the CEE and Baltic economies to the European Union, arguing in favor of a differentially positive impact of FDI on institution building. Because of the endogeneity problem between growth and FDI and because the author does not differentiate between countries with different exchange rate arrangements, it is impossible to determine the contribution of both FDI and currency boards to growth for the transition economies. **Staehr (2010)** finds evidence for concurrent real and nominal convergence among the CEE countries in terms of growth and inflation performance. This suggests that despite the presence of alternative exchange rate regimes in CEE countries, their macroeconomic performance does not significantly differ.

Growth Determinants

There is no consensus in the literature about the variables significantly and robustly affecting growth. Therefore, different model specifications employ a different set of variables with only very few consensus variables appearing in all models. In order to identify which variables are related to growth by being the ones showing significance most of the time in combinations with other variables, **Sala-i-Martin (1997**) runs two million regressions. In his regressions, the author combines a couple of consensus variables each time and combinations of all the rest of the variables proposed in the literature. He is able to identify a set of 65 variables that are important to growth in the general case.

It is imperative to employ a comprehensive set of carefully-selected control variables. Synthesizing the findings of Sala-i-Martin (1997) and a large body of literature on determinants of economic growth (see **Barro, 1991; Murphy et al. 1993; Acemoglu, Johnson and Robinson 2002**), we abstract from certain variables generally employed in growth regressions, as we believe that these are either irrelevant to our transition economies and observation period (war, tropic, disease), do not exhibit significant country-specific differences (religion, crops), or are endogenous to other important variables (e.g, FDI is endogenous to growth). At the same time, we consider variables proposed as impacting growth in transition economies (**Falcetti et al. 2002, 2006; De Melo et al. 1996, 2001; Levy-Yeyati and Sturzenegger 2002; Gulde et al. 2000; Havrylyshyn et al. 2003**).

Sala-i-Martin (1997) proposes variables accounting for country-specific initial conditions as important for growth in the general case. In their growth studies of transition economies, De Melo et al. **(2001)** and Falcetti et al. **(2006)** employ an index of initial conditions[3]. The initial conditions index incorporates the extent of prior reforms for each country in its initial value. I employ this index as it lowers endogeneity among different initial conditions variables.

Since we abstract from the first post-transition years, we are not interested in the initial conditions at the beginning of the period, but rather, in the interaction of this variable with time. Initial conditions can be broken up into two principal component clusters, the first of which positively and the other - negatively related to growth (**De Melo et al. 1996**). Therefore, the expected sign of the variable is undetermined. Most studies find that different starting points matter for growth, yet their impact decreases over time (e.g., **Berg et al. 1999; De Melo et al. 2001**). At the same time, the effect of policies on growth should increase (**Korhonen 2000**).

Romer (1990) and **Barro (1991)** consider education as a major variable affecting growth in general. **Senhadji (2000)** and **Rapacki**, & **Próchniak (2009)** find that changes in TFP are the most important determinant of growth for transition economies. Although in their study of transition economies, **Falcetti et al. (2006)** dismiss education on the claim that data on education is of doubtful quality, the newly available dataset by **Barro and Lee (2011)** provides the needed information.
Following the discussions in the wider economic literature about the importance of ethnic fractionalization on growth, we furthermore consider the interaction with time of initial level of ethnic fractionalization as a proxy for equal access to participation in economic activity. The rationale for including the interaction terms of education with time and ethnic fractionalization with time as separate variables in the growth regression is that albeit important to growth, neither variable has been included in the

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computation of the initial conditions indicator developed by **De Melo (1996)**. I do not believe that re-computing the initial components indicator to include education and fractionalization would render the results significantly different, as neither education, nor ethnic fractionalization are much correlated with any of the component variables of the initial conditions index. Therefore, the separate inclusion of initial conditions, education time- interaction term, and ethnic fractionalization time-interaction term should not be a problem.

Campos and Coricelli (2002) propose liberalization as important to growth in transition economies. To account for liberalization, I use the liberalization, or the so-called structural policy reform index computed as the weighted average of all EBRD transition ratings. **Radulescu et al. (2002)** and **Havrylyshyn et al. (1999)** find that this weighted average has a better explanatory power on growth than any of the individual ratings alone. According to **Falcetti (2006)**, the impact of structural policy reforms on growth is strong and robust. De Melo et al. (2001) claim that whereas the contemporaneous liberalization step is expected to have a negative sign, the accumulated stock of reforms is expected to show a positive sign. Using alternative specifications but the same liberalization index, **Fischer et al. (1996)** and **Selowsky and Martin (1997)** confirm these claims. In their studies, **Heybey and Murrell (1999)** and **Wolf (1999**) allow for a feedback of growth to structural reforms and **Berg et al. (1999)** and **Ghosh (1997)** do likewise by adopting an instrumental variables approach. Finding a significant feedback effect from growth to reforms, **Falcetti et al. (2002)** suggest a simultaneous equation estimation. I follow Falcetti et al. (2006) in considering the lagged value of structural policy reform to enter the growth model instead of both the current-and lagged values, in order to avoid endogeneity.

North (1991), **Acemoglu, Johnson and Robinson (2002), Glaeser et al. (2004) and Fisher and Sahay (2004)** propose institutions as important to economic growth. **Havrylyshyn et al. (2003) and De Melo et al. (2001)** consider the impact of institutions on growth in transitional economies. **Faia et al. (2008)** finds that with a higher quality of institutions, the effects of political pressures on the exchange rate are lower. Following **De Melo (2001**), I use an institutional proxy based on the EBRD transition indices[4].

A consensus variable I employ to model growth is the size of the fiscal balance relative to GDP, whereby its expected sign is negative in the growth regression. As Beck and Laeven (2005) suggest, not all variables are robust to controlling for additional variables. Therefore, my final model discards some of the abovementioned variables.

Together with the excess coverage of monetary base with foreign exchange, quasi-CB are peculiar with that they include the government fiscal account in the liabilities section of the balance sheet. For the case of Bulgaria, Nenovsky and Hristov find that this inclusion distorts the perfect cointegration relationship between the monetary base and foreign exchange (Nenovsky and Hristov 2002) and destabilizes the Bulgarian economy. Thirdly, under the orthodox CB, the monetary authority can manipulate reserve requirements and thereby respond to inflows or outflows of foreign exchange in a flexible manner without an impact on the fixed exchange rate.

Control Variables

In selecting the variables to consider for our out-of sample study on growth and inflation, we abstract from some of the variables employed in growth regressions by other authors, such as FDI, war (Sturzenegger 2002), and religion (Sala-i-Martin 1997). Specifically, we do so as we believe that FDI is endogenous to growth. In addition, there were no military conflicts in our sample of countries over the transition period. Finally, we exclude religion as the religious make-up of our countries is rather homogenous (Christian or non-religious).

At the same time, we consider variables proposed by Sala-i-Martin as important to general growth, as well as such proposed by De Melo et al. (1996, 2001 and Falcetti et al. 2006) as important to growth in transition economies. Whereas Sala-i-Martin also uses variables to proxy initial conditions in his growth regressions, De Melo et al. (1996, 2001) and Falcetti et al. (2006) compute an index of initial conditions with the help of principal component analysis, thereby eliminating endogeneity among the variables. The initial conditions index of De Melo et al. (1996) captures a variety of variables at their initial levels, like initial level of income at PPP, urbanization, overindustrialization (typical for transition economies), geographical proximity to thriving market economies, natural resource endowments, prior economic growth rates, repressed inflation, trade dependence on other communist economies, black market exchange rate premium, change in the state structure (new nation states versus members of the decentralized economy), prior economic growth rates, and familiarity with market economy at the beginning of transition. The initial conditions index incorporates the extent of prior reforms for each country in its initial value.
Since we abstract from the first post-transition years, we are not interested in the initial conditions at the beginning of the period, but rather, in the interaction of this variable with time. It is not possible to determine the expected sign of the initial conditions index in the growth equation, as it comprises a variety of variables, half of which positively and the other half- negatively related to growth. However, at least empirically, most studies find that different starting points matter for growth, yet their impact decreases over time (e.g., Berg et al. 1999, De Melo et al. 2001).

[4] For an alternative institutional proxy, see Beck and Laeven (2005).

Traditionally accepted as a very important determinant of growth (Romer 1990, Barro 1991), education is a variable that is absolutely essential to consider for our model. Although Falcetti et al. (2006) dismiss education on the claim that data is of doubtful quality, the newly available dataset by Barro and Lee (2011) provides the needed information. We decide to consider the initial level of education in its interaction with time rather than education each period, as we believe that subsequent period education rates are endogenous to each other. We find support for the inclusion of education in the growth regression for our transition economies in the work by Senhadji (2000), who finds that TFP is the most important determinant of growth for these economies. Following the suggestion of Sala-i-Martin (1997) that fractionalization impacts growth, we furthermore take the interaction with time of initial level of ethnic fractionalization as a proxy for equal access to participation in economic activity. The rationale for including the interaction terms of education with time and ethnic fractionalization with time as separate variables in the growth regression is that albeit important to growth, neither variable has been included in the computation of the initial conditions indicator developed by De Melo (1996). We do not believe that re-computing the initial components indicator to include education and fractionalization would render our results significantly different, as neither education, nor ethnic fractionalization are much correlated with any of the component variables of the initial conditions index. Therefore, the separate inclusion of initial conditions, education time- interaction term, and ethnic fractionalization time-interaction term should not be a problem.

Another important index besides initial conditions is the structural policy reform index, or the so-called liberalization index, computed as the weighted average of all EBRD ratings for transitional economies. Radulescu et al. (2002) and Havrylyshyn et al (1999) find that this weighted average has a better explanatory power on growth than any of the individual rankings alone. In addition, the impact of structural policy reforms on growth is strong and robust (Falcetti 2006). As De Melo et al. (2001) point out, empiric work shows a negative sign for the contemporaneous liberalization step but a positive one for the accumulated stock of reforms (De Melo et al. 2001). Heybey and Murrell (1999) and Wolf (1999) allow for a feedback of growth to structural reforms, and Berg et al. (1999) and Ghosh (1997) do likewise by adopting an instrumental variables approach. Falcetti et al. (2002) finds a significant feedback effect from growth to reforms and therefore suggest a simultaneous equation estimation to identify this interaction. We use the lagged value of structural policy reform as determinant for current growth, following Falcetti et al. (2006), rather than both current period and lagged value of structural policy reforms, as some other studies do, due to the inherent endogeneity resulting from the small number of observation periods in our study.

Two consensus variables we employ to model growth are the annual inflation rate and the size of the fiscal balance relative to GDP. Thereby, the expected signs are negative for both variables (Loungani and Sheets 1997, Fischer and Sahay 2004).

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3. DATA AND METHODOLOGY

Data
The countries covered are Belarus, Bulgaria, Croatia, Estonia, Estonia, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, Russia, Slovakia, Slovenia, Turkey and Ukraine. Thereby, we deliberately exclude the initial years of transition from our sample. The reason for this is that the improved macroeconomic performance after the initial shock of break with the command regime could hardly be attributed to the subsequent country-specific post-transition policy reforms. The sample period is 1997-2011 (15 years). Our target variables of macroeconomic performance are growth rate and inflation. We measure growth as annual rate of increase in GDP at constant prices in local currency, adjusted for the size of population. In other words, our first dependent variable is per capita GDP growth rate. These data are obtained from
It is imperative to employ a comprehensive set of carefully-selected control variables. These control variables, however, must be non-endogenous to growth performance. Synthesizing a large body of literature on determinants of economic (see Barro, 1991; Sala-i Martin, 1997; more ?)

As our purpose is to control for determinants, but not symptoms, of growth, we should not include endogenous variables that co-move with growth. For example, FDI inflows are highly correlated with growth measured over 3-year windows, however ....
Specifically, the variables (with the corresponding sources) we choose to include in our model, are the following:
GDPGi,t - real per-capita GDP growth in local currency units, taken from the World Bank for all years except for 2011. In calculating the 3-year period average, the 2011 values were obtained from EBRD

[4] For an alternative institutional proxy, see Beck and Laeven (2005).

Time - number of years since transition, defined each 3-year period, own calculations

TimeSQ – squared Time to capture non-linear effects of time

ICixTime – the interaction of initial conditions with time; ICi obtained from the EBRD 2001 Transition report

FRACi xTime – the interaction of ethnic fractionalization with time; FRACi obtained from the website of The Macro Data Guide International Social Science Resource

EDUCi xTime - completed tertiary education as % of the population aged 15 and over; taken from the Barro and Lee dataset (2011), which reports the values over 5-year periods starting from 1995; exceptions are Belarus and Turkey, for which there is no online available data on tertiary education completion

INFLi,t – consumer price inflation at the year-end in %, taken from the World Bank for all years except for 2011. In calculating the 3-year period average, the 2011 values were obtained from EBRD. Bulgarian inflation for the first observation period has been dropped as the country experienced a big economic crisis that could bias our results on growth and inflation performance.

SPRi,t-1 – lagged structural policy reform, also called liberalization; calculated as a weighted average of all EBRD reform ratings, specifically: price liberalization and competition policy (weight 0.3); trade and foreign exchange system (weight 0.3); large scale privatization, small scale privatization, and banking reform and interest rate liberalization (weight 0.4)

SPRSQi,t-1 – squared SPRi,t-1 to capture non-linear effects of liberalization

INSTi,t - institutional development and property rights and contract enforcement institutions; INSTi,t is different in nature from SPRi,t; INSTi,t is the simple average of EBRD reform ratings for competition policy, enterprise restructuring and governance, banking reform and non-bank financial institutions reform. Its scale ranges from 1-no reform to 4.33-standard typical of market economies; INSTi,t obtained from the yearly EBRD Transition reports

GOVEXPi,t-1 – lagged government consumption expenditure in %, taken from the World Bank

WGROWTHi,t – lagged real per-capita GDP world growth, taken from the World Bank for all years except for 2011. In calculating the 3-year period average, the 2011 values were obtained from the IMF

POLREFi,t - the Polity IV indicator for political reform as a proxy for civil liberty with a scale ranging from +10 (strongly democratic) to -10 (strongly autocratic); obtained from the Polity IV Project for all years except for 2011; In calculating the3-year period average, the 2010 value was taken.

COINTEGR - the degree of cointegration between the domestic monetary base and foreign exchange in countries with a currency board

CB – currency board dummy with a value of 1 for the presence of a currency board in and 0 otherwise

Float – dummy with a value of 1 for a flexible exchange rate regime and 0 otherwise. As the only country with a non-CB fixed peg over the years, Latvia would be defined with a value of 0 for both the CB and Float dummies

ERM2 – dummy with a value of 1 for participation in the European Exchange Rate Mechanism II and 0 otherwise; information obtained from
Euro – dummy with a value of 1 for having the euro as official currency and 0 otherwise

NonEU - dummy with a value of 1 for non-EU members; The EU-accession countries would be defined by a value of 0 for both EU and NonEU

Methodology

We employ a panel data model which captures both cross-sectional and time-variation. As some of the determinants of growth display some (sluggish) variation over time, we control for such variation by dividing our 15-years sample into five 3-year periods. The average growth rate of country i in each 3-year subperiod t, Gi,t, is our fist dependent variable. Our key explanatory variable is the CB dummy, Di,t, which takes the value of 1 for Bulgaria, Lithuania and Estonia (1997-2010), and 0 otherwise. We have no time variation in this variable (except one subperiod for Estonia), hence a fixed effects estimator would not be suitable for our purposes. We therefore estimate the following pooled regression with a random effects estimator:

$$G_{i,t,} = \beta_0 + \beta_1 D_{ij,t} + \beta_C X^C_{i,t} + e_{i,t} \quad (1)$$

where $X^c_{i,t}$ is a vector of control variables ($X^c_{i,t}$ =). The null hypothesis is $\beta 1 = 0$. A statistical rejection with a positive (negative) t-statistic would imply positive contribution of CBs to the growth performance.

4. RESULTS

1. Growth results

I checked for unit roots with the help of the Fisher unit root test for unbalanced panels and found that my panel variables do not contain unit roots. Due to the similar specification of INSTi,t and SPRi,t-1 from the EBRD indices, they

exhibit collinearity (0.6933). Therefore, I drop the variable institutions INSTi,t and I use SPRi,t-1 instead. Likewise, the variables SPRi,t-1 and POLREFi,t cannot be used in the same regression due to a collinearity of 0.82311. The rationale for these two sets of variables being collinear is that reforms (both structural, institutional, political, etc.) tend to have a complementary impact, that is, act together. In addition to dropping INSTi,t, I drop the dummies for different exchange rate regimes, which turned out to be insignificant under different model specifications. The interaction terms EDUCi x Time and FRACi x Time have been dropped from the growth regression due to the same reason. VARi,t was also not used in the final model specifications, as it turned out insignificant.

Exhibit 1. FE estimator on growth.

```
. xtreg growth cb lspr lgovexp, fe robust

Fixed-effects (within) regression               Number of obs      =        71
Group variable: id                              Number of groups   =        15

R-sq:  within  = 0.0769                         Obs per group: min =         1
       between = 0.0964                                        avg =       4.7
       overall = 0.0335                                        max =         5

                                                F(2,14)            =         .
corr(u_i, Xb)  = -0.8725                        Prob > F           =         .

                                          (Std. Err. adjusted for 15 clusters in id)
------------------------------------------------------------------------------
             |               Robust
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          cb |   8.468882   1.184218     7.15   0.000     5.928986    11.00878
        lspr |    -.45131   .6399506    -0.71   0.492    -1.823868    .9212476
    lgovexp |   -.194015   .3528391    -0.55   0.591    -.9507796    .5627496
       _cons |   9.447845   8.216579     1.15   0.269    -8.174965    27.07066
-------------+----------------------------------------------------------------
     sigma_u |  3.0826013
     sigma_e |  3.7464059
         rho |  .40370617   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Running the growth model with a FE estimator (Exhibit 1) and making the interpretations on the basis of heteroskedasticity-adjusted t-values, I find the CB-dummy to be significantly and positively affecting growth for my sample of transition economies at the 1%- significance level. However, the rest of the variables are insignificant.

Exhibit 2. BE estimation on growth.

```
. xtreg growth cb lspr lgovexp, be

Between regression (regression on group means)  Number of obs      =        71
Group variable: id                              Number of groups   =        15

R-sq:  within  = 0.0064                         Obs per group: min =         1
       between = 0.5989                                        avg =       4.7
       overall = 0.0742                                        max =         5

                                                F(3,11)            =      5.47
sd(u_i + avg(e_i.))=  .9963673                  Prob > F           =    0.0151

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          cb |   1.425747   .7061413     2.02   0.069    -.1284595    2.979954
        lspr |  -.8493369   .2502522    -3.39   0.006    -1.400138   -.2985354
    lgovexp |   .1532476   .0819968     1.87   0.088    -.0272261    .3337214
       _cons |   7.075462   2.240363     3.16   0.009     2.144456    12.00647
------------------------------------------------------------------------------
```

Likewise, running the growth model with a BE estimator (Exhibit 2), I find that the CB-dummy continues to be significantly and positively impacting growth, this time at the 5%-significance level. The positive and significant impact of the CB-dummy under both the FE and BE estimator shows that the imputed "credibility" effect of the currency board inspired trust in the local currency and markets and fostered market activity in our transition economies. In addition, the rest of the variables become significant as well. Howver, their signs variables are not unequivocally determined, but rather are determined empirically in the literature, especially by the newer papers, which show a rather blurry picture[7].

Despite the suggested by literature negative sign of government expenditures on growth, one cannot claim this with certainty, since growth does not only depend on the amount of expenditure, but also on the quality of the investment projects the government is investing in. If one assumes that the government expenditures during transition were efficient, then the results are consistent when the BE estimator is used and inconsistent when the FE estimator is used. A note of caution is needed about the temporal impact of government expenditures on growth, too. A lot of arguments can be made here, but the sign of the variable will ultimately be determined by empirics and vary across samples and observation periods.

[7]For a more detailed discussion, see Falcetti et al. (2006).

Structural reform has been claimed by the literature to have a negative effect on growth in the current period but a posive cumulative impact. However, the sign of the variable will also be affected by the quality of reform and reform continuity. Since the transitional economies exhibited differences in the level of reform in the beginning of the transition period, and over time, their pace of reforms differed, I assume that this variable will be significant under the RE-estimator.

I check the RE estimator to make a conclusion on the temporality of the effect of lgovexp ans lspr on growth.

Exhibit 3. RE estimator on growth.

```
. xtreg growth cb lspr lgovexp, re robust

Random-effects GLS regression                   Number of obs      =        71
Group variable: id                              Number of groups   =        15

R-sq:  within  = 0.0193                         Obs per group: min =         1
       between = 0.5213                                        avg =       4.7
       overall = 0.0842                                        max =         5

Random effects u_i ~ Gaussian                   Wald chi2(3)       =      7.97
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0466

                                    (Std. Err. adjusted for 15 clusters in id)
------------------------------------------------------------------------------
             |               Robust
      growth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          cb |   1.838156    .927334     1.98   0.047     .0206152    3.655698
        lspr |  -.7292101    .3065518   -2.38   0.017    -1.330041   -.1283795
     lgovexp |   .0464082    .1287907    0.36   0.719    -.206017    .2988334
       _cons |   8.163931    2.581793    3.16   0.002     3.103709    13.22415
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  3.7464059
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

The RE estimator on growth with robustness-adjusted t-values (Exhibit 3) shows that government expenditures do not significantly impact growth. Looking at the data, one can claim that for each country, government expenditures were fluctuating around a constant mean across time. Therefore, the FE estimator cannot explain the behavior of lgovexp in affecting inflation and the RE estimator will shows the impact of the BE-estimator. The BE output shows that lgovexp had a positive impact on growth in the transition economies over 1997-2011.

Exhibit 4. RE estimator on final growth model.

```
. xtreg growth cb lspr, re robust

Random-effects GLS regression                   Number of obs      =        71
Group variable: id                              Number of groups   =        15

R-sq:  within  = 0.0261                         Obs per group: min =         1
       between = 0.4565                                        avg =       4.7
       overall = 0.0823                                        max =         5

Random effects u_i ~ Gaussian                   Wald chi2(2)       =      7.69
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0214

                                    (Std. Err. adjusted for 15 clusters in id)
------------------------------------------------------------------------------
             |               Robust
      growth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          cb |    1.86938    .9387356    1.99   0.046     .0294918    3.709268
        lspr |  -.7293569    .3096437   -2.36   0.018    -1.336247   -.1224664
       _cons |   9.038543    2.301278    3.93   0.000     4.528121    13.54896
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  3.7328986
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Dropping lgovexp from our RE model estimation (Exhibit 4), I still confirm my previous conclusions about the positive and significant impact of the CB-dummy. In fact, the CB-dummy is also positive and significant under alternative model specifications.

2. Inflation Results

Exhibit 5. FE estimator on inflation.

```
. xtreg infl cb d_nbg lspr, fe robust

Fixed-effects (within) regression               Number of obs      =        71
Group variable: id                              Number of groups   =        15

R-sq:  within  = 0.8587                         Obs per group: min =         1
       between = 0.8971                                        avg =       4.7
       overall = 0.8668                                        max =         5

                                                F(1,14)            =         .
corr(u_i, Xb)  = 0.0592                         Prob > F           =         .

                                          (Std. Err. adjusted for 15 clusters in id)
------------------------------------------------------------------------------
             |               Robust
        infl |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          cb |  -2.729916   3.717889    -0.73   0.475    -10.70399    5.244162
       d_nbg |   332.7679   12.38309    26.87   0.000     306.2088     359.327
        lspr |  -10.05963   5.924922    -1.70   0.112    -22.76732    2.648067
       _cons |   84.81891   42.82675     1.98   0.068    -7.035336    176.6732
-------------+----------------------------------------------------------------
     sigma_u |  7.1778202
     sigma_e |  17.780754
         rho |  .14012626   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Employing the FE estimator with robustness-adjusted t-values on my inflation model (Exhibit 5), I get an insignificant negative effect of the CB-dummy on inflation. The negative sign of the dummy is line with theory. At the same time, the sign of the lspr is borderline significant and negative. The dummy controlling for the inflation period in Bulgaria is likewise significant.

Under a BE-estimation (Exhibit 6), the CB-dummy is likewise insignificant and negative. Structural policy reform becomes very significant at the 0.01-significance level. The positive sign of the CB dummy is not in line with theory. Therefore, to account for this incosistency, I include the **D_NBG** dummy. It is significant.

Exhibit 6. BE estimator on inflation.

```
. xtreg infl cb lspr d_nbg, be

Between regression (regression on group means)  Number of obs      =        71
Group variable: id                              Number of groups   =        15

R-sq:  within  = 0.8578                         Obs per group: min =         1
       between = 0.9046                                        avg =       4.7
       overall = 0.8680                                        max =         5

                                                F(3,11)            =     34.76
sd(u_i + avg(e_i.))=  7.733053                  Prob > F           =    0.0000

------------------------------------------------------------------------------
        infl |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          cb |  -.0537905   6.789914    -0.01   0.994    -14.99829    14.89071
        lspr |  -12.06636   1.966217    -6.14   0.000    -16.39397   -7.738746
       d_nbg |   317.3594   49.80913     6.37   0.000     207.7303    426.9886
       _cons |   98.75121   13.88609     7.11   0.000     68.18813    129.3143
------------------------------------------------------------------------------
```

Exhibit 7. RE estimator on inflation.

```
. xtreg infl cb lspr d_nbg, re robust

Random-effects GLS regression                   Number of obs      =        71
Group variable: id                              Number of groups   =        15

R-sq:  within  = 0.8583                         Obs per group: min =         1
       between = 0.9039                                        avg =       4.7
       overall = 0.8684                                        max =         5

Random effects u_i ~ Gaussian                   Wald chi2(3)       =  76430.35
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

                                          (Std. Err. adjusted for 15 clusters in id)
------------------------------------------------------------------------------
             |               Robust
        infl |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          cb |  -1.281172   2.432653    -0.53   0.598    -6.049085    3.48674
        lspr |   -11.6682   2.412354    -4.84   0.000    -16.39633   -6.940074
       d_nbg |   328.1808   5.789693    56.68   0.000     316.8332    339.5284
       _cons |   95.97863   18.33962     5.23   0.000     60.03363    131.9236
-------------+----------------------------------------------------------------
     sigma_u |           0
     sigma_e |  17.780754
         rho |           0   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Under the RE estimation (Exhibit 7), the CB becomes less insignificant and the sign remains negative. This result is consistent with theory and the "credibility effect" of the currency board's operation. Since the significance of the variables in the inflation model did not change drastically when employing the FE-, BE-, and RE estimators, one can claim that the RE-estimator is indeed the optimal one for describing the impact of the currency boards on inflation.

5. CONCLUSION

Whether the new-generation currency boards in Eastern Europe attain their basic goals of price stability and ultimately higher average growth rates was a pending question in the international finance literature. We fill this gap by providing out-of-sample evidence free of post-launch effects.

Appropriately controlling for other determinants of growth that are not endogenous, we establish a mild positive effect of CBs on growth performance and a negative effect on inflation. As is usually the case in the general growth literature, the statistical significance of our results is sensitive to the specification and other control variables employed, but a synthesis of our results suggests that the effect of CBs on inflation and growth performance is in the desired sign and at borderline levels of significance. Hence, our results imply that currency boards in European transition economies basically fulfill the role expected of them.

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