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Analysis of Exchange-Rate Regime Effect on Growth: Theoretical Channels and Empirical Evidence with Panel Data

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Abstract

The aim of this paper is to empirically investigate the relationship between exchange-rate regime and economic growth, building on underlying theoretical examination and shortcomings of empirical literature. Channels through which regime might influence growth could be distinguished at: i) level of uncertainty imposed by certain regime, which than affects trading and investment decisions; ii) regime as shock absorber; iii) its linkage to productivity growth, which usually interferes with financial development. Empirical research offers divergent result though and is criticized because of: measurement error in regimes' classification; appropriateness of growth framework; endogeneity of exchange-rate regime and/or other regressors; Lucas critique; sample-selection bias and survivor bias. Applying dynamic system-GMM panel estimation on 169 countries over the period 1976-2006 and addressing all shortcoming of the empirical literature, this paper finds that the exchange-rate regime is not statistically significant in explaining growth. The conclusion is robust to dividing the sample on developing versus advanced countries and considering two sub-periods. In all specifications, the exchange-rate regime does not even approach conventional significance levels. Observation de-facto versus de-jure regime matters neither. No empirical grounds were established that coefficients in the regression suffer the Lucas critique. Hence, the main conclusion is that, as nominal variable, the exchange rate regime does not have explanatory power over growth.

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1. Introduction

The aim of this paper is to test the relationship between the exchange-rate regime and economic growth. The natural-rate hypothesis implies that the best that macroeconomic policy can hope to achieve is price stability in the medium-term. In terms of exchange-rate policy, the nominal exchange rate can not be used to keep unemployment rate away from its natural level on a sustained basis. Therefore, an attempt to over-stimulate the economy, by expansionary monetary policy or currency devaluation will result in higher rate of inflation, but no increase in real economic growth (Goldstein, 2002). Hence, as a nominal variable, the exchange rate (regime) might not affect the long-run economic growth. However, there is no unambiguous theoretical evidence what impacts the exchange-rate target exhibits on growth.

Many studies argue that the linkage between regime and growth exists, but the sign of the influence is blurred. The channel through which the regime might influence growth is trade, investment and productivity. Theoretical considerations relate the exchange-rate effect on growth to the level of uncertainty imposed by flexible option of the rate. However, while reduced policy uncertainty under a peg promotes an environment which is conductive to production-factor growth, trade and hence to growth, such targets do not provide an adjustment mechanism in times of shocks, thus stimulating protectionist behaviour, price distortion signals and therefore misallocation of resources in the economy. Consequently, the relationship remains blurred and requires in-depth empirical investigation.

The empirical research offers divergent result though. While one group of studies found that a pegged exchange rate stimulates growth, while a flexible one does not, another group concluded the opposite holds. Moreover, a third group of studies came up with no effect or inconclusive results. The empirical evidence is condemned because of growth-framework, endogeneity, sample-selection bias and the so-called peso problem.

This paper aims to establish the relationship between exchange-rate regime and growth by considering the theoretical arguments and by accounting for the drawbacks present in the empirical literature. It investigates data for 169 countries over the period 1976-2006. We find that the exchange rate regime is not significant in explaining growth. No empirical grounds were established for the coefficients in the regression as suffering from the Lucas critique. Observing two sub-periods or developing countries only led to the same conclusion. Using the de-facto versus de-jure classification of exchange rates did not matter in that respect. Specifically, although the de-facto classification accounts for the actual behaviour of the exchange rate, including any capital controls and any devaluation or crises episodes, which were all apparent in the developing, including transition, economies during 1990s and early 2000s, the conclusion is the same – the exchange-rate regime does not affect economic growth, no matter the classification, observed time period or level of development of countries. The duration of peg is also not of importance. The duration and developing-countries group was especially considered for the period 1991-2006, with numbers of episodes of devaluation and currency crises, which were expected to have played a role in affecting growth. However, these expectations proved incorrect.

The paper is organized as follows. The next section investigates the theoretical channels through which the exchange-rate regime might affect growth and particularly focuses on how it might affect production factors and hence growth. It then summarizes all studies published on the relationship between exchange-rate regime and growth, focusing on their possible flaws. Section three portrays the data. Section four describes the methodology. Section five presents the results and offers discussion. The last section concludes the paper.

2. Theoretical overview and empirical-literature review

Limited literature (Domac *et al.*, 2004b; Levy-Yeyati and Sturzenegger, 2002; Moreno, 2000 and 2001; Edwards and Levy-Yeyati, 2003; Husain *et al.* 2004; De Grauwe and Schnabl, 2004; Eichengreen and Leblang, 2003; Bailliu *et al.* 2003) investigates the exchange-rate regime's effect on economic growth. Levy-Yeyati and Sturzenegger (2002) argue that the linkage between regime and economic growth exists, but the sign of the influence is blurred. Advocates of pegs usually highlight that by the reduced policy uncertainty and lowered interest-rates variability, this strategy promotes an environment which is conductive to trade, investment and, hence, growth. Gylfason (2000) explains that the macroeconomic stability (certainty) imposed by pegging promotes foreign trade, thus "stimulating economic efficiency and growth over the long haul and restraining inflation, which is also good for growth" (p.176). Fixing the exchange rate may enable faster growth in the medium and long run by supporting greater openness to international trade. Also, the latter may spur growth by easing technology transfer, thus aiding the productivity growth, and which in turn is boosted by promoting greater openness (Moreno, 2001).

Besides this indirect effect of the exchange-rate regime on growth, Bailliu *et al.* (2003) argue that regime's influence on growth could also be direct through shock adjustments. This effect is channelled by "dampening or amplifying the impact and adjustment to economic shocks" (p.385), thus allowing a flexible rate to enable fast and easy accommodation and absorption of aggregate economic shocks. Consequently, "when the adjustment to shocks is smoother, one would expect the growth to be higher, given that the economy is, on average, operating closer to capacity" (p.385). This could stimulate protectionist behaviour, distorted price signals and therefore misallocation of resources in the economy (Levy-Yeyati and Sturzenegger, 2002). However, Nilsson and Nilsson (2000) argued that exchange-rate volatility under flexible option of the exchange rate could be the one that stimulates erecting trade barriers; hence, the literature is not consensual on this issue.

The peg's impact on productivity growth is especially emphasised in emerging markets, where credit markets appear to be thin. However, the ultimate effect of a peg channelled through productivity growth remains unclear. For instance, Aghion *et al.* (2005) argue that an aggregate external shock, under a peg, transmits into real activity and causes a higher share of the firms in the economy to experience credit constraints, given the under-developed financial market. Suppose that producers can decide whether to invest in short-run capital or in a long-term productivity-enhancing venture. Typically, the long-term productivity-enhancing investment creates higher need for liquidity in order to face medium-term idiosyncratic liquidity shocks, the latter mainly stemming from the aggregate shock that hit the economy. With perfect credit markets, the necessary liquidity is always supplied, but this is no longer the case when credit markets are imperfect. The liquidity shock is only financed when the firm has enough profits, because only profitable firms can borrow enough to cover their liquidity costs. A negative aggregate shock, by making all firms less profitable, makes it less likely that the liquidity needs of any of them will be met. As a result, a fraction of the potentially productivity-enhancing long-term investments will go to waste, with obvious consequences for growth. A main implication is that firms in countries with better financial markets will deal better with the aggregate shock, and therefore will tend to go more for long-term investments, which in turn should generate higher aggregate growth, while the shock in developing markets will result in distorting real activity and lower productivity growth.

In conclusion there are some theoretical channels through which the exchange rate regime affects growth: i) uncertainty imposed in the economy and its effect on investment and trade; ii) shock-adjustment mechanism, the level of financial development and their interference with productivity growth. However, directions in which the regime may impinge on productivity, investment, trade and thus, on the growth are ambiguous. Hence, the relationship between the exchange-rate regime and growth becomes an empirical issue.

Nevertheless, the few published empirical studies have also indicated divergent results. A review of the empirical literature is Petreski (2009) and we only summarize these studies in Table 1. Whereas one group of studies found that a pegged exchange rate stimulates growth, while a flexible one does not, another group concluded the opposite holds. Moreover, a third group of studies came up with no effect or inconclusive results. The latter could be due to a measurement error in the exchange-rate regimes' classifications (Levy-Yeyati and Sturzenegger, 2002), divergences in measuring exchange-rate uncertainty (Du and Zhu, 2001) or sampling bias (Huang and Malhorta, 2004). A great part of the studies focuses on the parameter of the exchange-rate dummy, but do not appropriately control for other country characteristics nor apply appropriate growth framework (Bleaney and Francisco, 2007). Also, the issue of endogeneity is not treated at all or inappropriate instruments are repeatedly used (Huang and Malhorta, 2004; Bleaney and Francisco, 2007), while all published studies on the topic, except one, do not treat the Lucas critique al all. Very few studies pay attention to the capital controls, an issue closely related to the exchange-rate regime and only one study puts the issue in the context of monetary regimes. Du and Zhu (2001) add that results from many empirical studies differ among counties when the same method of examination is applied and even for the same country at different points of time.

Table 1. Summary-table of the empirical research of the exchange-rate regime effect on growth

Study	Data and sample	ER classification	Model	Technique	Endogeneity	Result (Peg and Growth)	Other problems
Baxter and Stockman (1989)	1946-1984; 49 countries	Only sub-periods of general fixing and general floating considered	Descriptive analysis	Averages and standard deviations	-	NO EFFECT No systematic relationship between real aggregates and exchange rate system	Unconditional analysis
Mundell (1995)	1947-1993; US, Japan, Canada, EC, other Europe	Only sub-periods of general fixing and general floating considered	Descriptive analysis	Average growth rates between two sub-periods	-	POSITIVE Considerable higher growth under generalized pegging	Unconditional analysis
Ghosh *et al.* (1997)	1960-1990; 145 countries	De-jure supplemented by categorizing non-floating regimes by the frequency of the parity changes	Descriptive analysis	Means and standard deviations comparison across ERRs	-	INCONCLUSIVE Slightly higher growth under a exchange-rate floating regime; Growth the highest under soft peg or managed float	Unconditional analysis; no evidence of whether ERR affects productivity; causal relationships and the effect on productivity only assumed
Moreno (2000 and 2001)	1974-1999; 98 developing countries East-Asia countries	De-facto classification	Descriptive analysis	Means and standard deviations comparison across ERRs	-	POSITIVE Higher growth under a peg by 1,1 p.p and 3 p.p respectively in both studies. The difference narrows when survivor bias considered	Unconditional analysis
Levy-Yeyati and Sturzenegger (2002)	1974-2000; 183 countries	De-facto	Pooled regression; Real growth = f (inv/GDP; ToT; GC; political instability; initial per capita GDP; population; openness; secondary enrolment; regional dummies and exchange-rate dummies)	OLS	2SLS to correct for endogeneity; Logit model estimated and predicted values used as instruments	NEGATIVE NO RELATION Slower growth under a peg for developing countries; No association for developed countries	

Edwards and Levy-Yeyati (2003)	1974-2000; 183 countries	De-facto	Pooled regression; Real growth = f (inv/GDP; GC; political instability; initial per capita GDP; population; openness; secondary enrolment; regional dummies and exchange-rate dummies)	FGLS	Not treated	NEGATIVE Lower growth under fixed regime then compared to flexible	
Husain *et al.* (2004)	1970-1999; 158 countries	De-jure	Pooled regression; Real growth = f(investment ratio; trade openness; terms of trade growth; average years of schooling; tax ratio; government balance; initial income/US income; population growth; population size; exchange rate dummies)	Fixed effects panel	Lagged values of the exchange-rate dummy used as an instrument	INCONCLUSIVE Pegs do not harm growth, but flexible rates do not deliver growth rates	Weak robustness checks; Classification issues
Garofalo (2005)	1861-1998; Italy	De-facto	Simple regression; Real growth = f (inv/GDP; ToT; GC; political instability; initial per capita GDP; population; openness; secondary enrolment; regional dummies and exchange-rate dummies)	OLS	2SLS to correct for endogeneity; Logit model estimated and predicted values used as instruments	INCONCLUSIVE Highest growth under soft peg or managed float	Weak robustness checks
Dubas *et al.* (2005)	1960-2002; 180 countries	De-facto versus de-jure especially considered	Random-effects panel regression; Real per capita growth = f(initial year GDP; initial year population; population growth; investment to GDP; secondary education attainment; a political indicator of civil liberties; trade openness; terms of trade; dummies for transitional economies; regional dummies for Latin America and Africa; time-specific dummies; exchange-rate dummies)	Random-effects estimation	Not treated	POSITIVE De-facto fixers, on average, have 1% higher growth than de-facto floaters; de-jure floaters - de-facto fixers grow at 1,12% above de-facto and de-jure floaters. Conclusions significant for non-industrialized economies only.	No robustness or diagnostics checking. Other variables not reported if in line with theory.
Huang and Malhorta (2004)	1976-2001; 12 developing and 18 developed countries	De-facto	Panel regression; Per capita growth = f(Financial crisis; Openness; Government consumption; Initial GDP; Fertility rate; Secondary school enrolment ratio; exchange-rate dummies)	OLS	Not treated	INCONCLUSIVE NO RELATION For developing economies, fixed and managed float outperform the others in terms of growth; for developed economies, no relationship revealed	Weak growth-framework; no robustness checks
Bleaney and Francisco (2007)	1984-2001; 91 developing countries	De-facto	Growth = f(growth[-1]; exchange-rate dummies; time dummies)	OLS	Not treated	NEGATIVE Growth is slower under more rigid exchange-rate regime	Very weak growth specification; no robustness checks

Domac *et al.* (2004b)	10 years (1990s, different period for each country); 22 transition countries	De-jure	Growth = f (budget balance, lagged liberalization index, inflation, years under communism, share of industry, urbanization, share of CMEA trade)	Switching regression technique	Address endogeneity "through the assumption of constant covariance between the error term in the structural equation and the normally distributed random variable whose realization determines the exchange rate regime".	INCONCLUSIVE There is an association ERR-growth, but the strength is different for different ERRs	Weak growth specification. Small period and small sample; does not account for de-facto exchange-rate behaviour.
De Grauwe and Schnabl (2004)	1994-2002; 10 CEE countries	De-facto	Real growth = f(inv/GDP, export, fiscal balance/GDP, short-term capital flows/GDP, real growth of EU-15, ER dummy)	GLS	Not treated	POSITIVE ER peg does not reduce economic growth	Weak growth specification. Short time period and small sample
Eichengreen and Leblang (2003)	1880-1997; 21 countries	De-jure	Real per capita growth = f(Per capita income as a share of US income; primary and secondary enrolment rates; capital controls and exchange-rate dummy)	Dynamic GMM and IV estimators	The technique generates internal instruments, but they also run probit model of the exchange-rate dummy to obtain fitted values, which are then used as instruments.	NEGATIVE More flexible exchange rates associated with faster growth	Weak growth specification. De-jure classification and sample selection; weak robustness
Bailliu *et al.* (2003)	1973-1998; 60 countries	De-jure and de-facto, but the latter more important in terms of findings	Real per capita growth = f(initial growth; investment-to-GDP; secondary schooling; real government share of GDP; trade-to-GDP; M2-to-GDP; private sector credit-to-GDP; domestic credit-to-GDP; gross private capital flows-to-GDP; exchange-rate dummies)	Dynamic GMM	Internal lags generated by the technique itself.	POSITIVE ERR exercised by any monetary anchor positively affects growth; otherwise, ERR other then peg destructs growth	Weak on robustness check

An overall critique of the literature examining the relationship between exchange-rate regime and growth is offered by Goldstein (2002), whose assertion might be helpful: as a nominal variable, the exchange rate (regime) does not affect the long-run economic growth. In addition, the empirical evidence is condemned because of growth framework, endogeneity bias, classification issue and changing parameters under regime switch. Moreover, in the majority of studies, parameters in the regressions are time-invariant which might be problematic, because conditions on the world capital market changed, especially since the end of the Breton-Woods system. This study will address these issues in its empirical framework, which is considered to be its main contribution to the existing literature.

3. Data and methodology

3.1. Data issues

We use the Reinhart and Rogoff (2004) exchange-rate regime de facto classification for 169 countries, which gives a sufficient country-set in order to account for the sample-selection bias. The empirical investigation will deal with the post-Bretton-Woods monetary/exchange-rate era, hence covering the period 1976-2006. The variables used and their sources are fully described in Appendix A. The provider for the majority of the data is the IMF; educational-attainment and life-expectancy variables are obtained from the World Bank; the fertility rate is obtained from the United Nations; the democracy index and the index of civil liberties are provided by Freedom House, which, as a source, might be contested, but no alternative is presently available.

For the definitions of the growth-regression variables, we follow Barro and Sala-i-Martin (2004). In order to account for the Lucas critique, we use interaction terms of all independent variables with the dummies representing the exchange-rate regimes. In such specification, the significance of the estimated coefficients in front of the interaction terms will indicate if and how parameters change when the exchange-rate regime switches. In order to account for the survivor bias (the peso problem), we will exclude the high-inflationary episodes. Some studies and textbooks (Federal Reserve Bank of Boston, 2008; Baumol and Blinder, 2006; Poulson, 1994) define high inflation as within the range of 30-50% per year. Hence, we will exclude all years where the inflation rate exceeds 30%. In order to account for the monetary integration in Europe (the common currency and the ERM-2 as its predecessor), we exclude 12 countries in the period 1991-2006[2]; this is done because the common currency in Europe might follow different pattern in terms of growth as compared to a country that unilaterally adopted an other-country currency (as Montenegro or

[2] However, with minor adjustments in terms of when did those joined or left ERM-2.

Ecuador). We define regional dummies, which along all remaining dummies are described in Appendix A.

3.2. Instrumental-variables and dynamic panel techniques

The revitalization of the interest in long-run growth, its treatment as being a dynamic process (Islam, 1995) and the availability of macroeconomic data for large panels of countries and time spans, has raised the interest in estimating dynamic panel models (See: Barro and Sala-i-Martin, 2004; Mankiw *et al.*, 1992; Fisher, 1993; Levine and Renelt, 1992; and others). Judson and Owen (1996) argue that the utilization of panel data is appropriate because it allows the identification of country-specific effects that control for missing or unobserved variables. The term "dynamic", in econometrics, refers to adding the lagged dependent variable as a regressor in the equation (Baltagi, 2008). Furthermore, Bond *et al*. (2001) argue that the right-hand-side variables in a standard growth regression are "typically endogenous" (p.1) and hence suggest GMM estimation of growth model within dynamic context. A dynamic fixed-effects model could be specified as follows (Lokshin, 2006):

$$y_{i,t} = y_{i,t}\gamma + x_{i,t}\beta + \eta_i + \varepsilon_{i,t} \qquad (1)$$

whereby, the dependent variable, $y_{i,t}$, is determined by its one-period lag, $y_{i,t-1}$, an exogenous regressor, $x_{i,t}$, which is assumed not to be correlated with the error term $\varepsilon_{i,t}$, an unobserved individual effect (the so-called, unobserved heterogeneity), η_i, and a random error, $\varepsilon_{i,t} \sim \mathrm{N}(0,\sigma_\varepsilon^2), \sigma_\varepsilon^2 > 0$. Judson and Owen argue that the fixed-effects model is preferred in macroeconomics because of two reasons: the unobserved individual effect, representing country characteristics, is highly likely to be correlated with the other regressors; and it is fairly likely that a macro-panel will not represent a *random* sample from a large number of countries, but rather the majority of countries of interest.

Since the model contains the lagged dependent variable, the least squares dummy variable (LSDV) estimator produces biased coefficients (Behr, 2003). Namely, since the dependent variable is included as a regressor with one lag, the latter will be correlated with the error term, rendering estimated coefficients biased (Sevestre and Trognon, 1985). Nickel (1981) shows, however, that when there are no exogenous regressors, the LSDV estimator's bias approaches zero as the time dimension approaches infinity. However, Judson and Owen (1996) found that even when T is as large as 30, the bias could span up to 20% of the coefficient's true value. The effort to account for this bias resulted in two classes of estimators: bias-corrected (BC) and instrumental-variables (IV) estimators (Behr, 2003).

Two practical questions arise in applied econometrics: i) which estimator/technique to proceed with; ii) how large should T be for the bias to vanish? From the viewpoint of this study, since we have only 31 years of data use LSDV does not seem appropriate, given the findings reported above. However, the first question asks for more attention. Before we have a look at the results of several Monte Carlo analyses, we briefly review the different estimators within the BC and IV groups, which is simultaneously the chronology of the dynamic-panel developments.

Following the investigation of the bias by Nikel (1981), Kiviet (1995) suggested a direct BC method, whereby a formula for the LSDV bias is subtracted from the estimated LSDV coefficients. Based on this, Hansen (2001) suggested an alternative BC method, with a two-step procedure where residuals from the first-step consistent estimator are used in the second-step calculation of the bias. Everaert and Pozzi (2007) further developed the BC approach, with an iterative bootstrap procedure. The general idea behind the correction procedures is to take advantage of the variance which is much smaller under LSDV than compared to IV estimators (Behr, 2003). Because of this, it is found that BC methods perform well, i.e. produce more efficient estimates than IV estimators (Judson and Owen, 1996; Lokshin, 2006). However, they rely on the assumption of the other regressors being exogenous (Behr, 2003) and cannot be applied to unbalanced panels (Judson and Owen, 1996; Roodman, 2008b). These drawbacks are directly applicable to the case of this study (with an unbalanced panel data set and a model with possibly endogenous regressors).

The use of instrumentation methods, mentioned at the beginning of the section, removes the endogeneity bias resulting from the correlation between the regressor and the error term (Wooldridge, 2007). Anderson and Hsiao (1981) and (1982) were the pioneers in proposing use of the GMM procedure within a dynamic context; they differenced equation 9 in order remove the fixed effects in the error term which are correlated with the lagged dependent variable; however, the difference of the lagged dependent variable will still be correlated with the error term and, hence, should be instrumented. These researchers proposed using the second lag of the dependent variable ($y_{i,t-2}$) or the lagged difference ($y_{i,t-2} - y_{i,t-3}$) as instruments of $\Delta y_{i,t-1}$, because those are expected to be uncorrelated to the error term. Arellano (1989); Arellano and Bond (1991); and Kiviet (1995) analysed the properties of the two instruments suggested by Anderson and Hsiao and found that the "level" instrument has smaller variance and is, hence, superior to the "differenced" one.

Arellano and Bond (1991) suggested exploiting an enlarged set of instruments; namely, all available lagged values of the dependent variable and the lagged values of the exogenous regressors. A possible drawback of this, so called, difference-GMM estimator, is that by enlarging the number of periods, the number of instruments gets considerably larger. Moreover, instruments could be weak, because they use information contained in differences only (Ahn and Schmidt, 1995) and because they do not account for the differenced structure of the residual disturbances (Baltagi, 2008). Ahn and

Schmidt (1995), Arellano and Bover (1995), and Blundell and Bond (1998) consequently suggested using additional information contained in levels, which should result in more efficient estimator, known as a system-GMM estimator. This augments the difference-GMM by simultaneously estimating in differences and levels, the two equations being distinctly instrumented (Roodman, 2008b). In the system-GMM estimator, both predetermined and endogenous variables in first differences are instrumented with suitable lags of their own levels (used by Arellano-Bond); and predetermined and endogenous variables in levels are instrumented with suitable lags of their own first differences. As a consequence, the system-GMM estimator should produce more efficient estimates and, hence, outperform the difference-GMM estimator. All Arellano-Bond, Arellano-Bover and Blundell-Bond estimators can be estimated as one- or two-step procedures; the one-step estimator makes use of a covariance matrix that accounts for autocorrelation, while the two-step estimator uses the residuals from the first step to estimate the covariance matrix.

Nevertheless, when either difference- and system-GMM are applied, a problem arises: increasing the number of instruments adds efficiency but adds bias as well. The problem has been acknowledged in the literature (Roodman, 2008b; Tauchen, 1986; Altonji and Segal, 1996; Andersen and Sørensen, 1996; Ziliak, 1997; Bowsher, 2002; and others). For instance, Windmeijer (2005) found that when the number of instruments is reduced from 28 to 13, the average bias reduces by 40%. Similar results were obtained by Ziliak (1997) and Tauchen (1986). It is inherent that the number of instruments gets larger as the number of endogenous and predetermined variables increases and as T grows. Moreover, the researcher can add external instruments. However, "the overall count [of instruments] is typically quadratic in T" (Roodman, 2008b, p.6) and this makes asymptotic inference of the estimators and the specification tests misleading. Moreover, the asymptotics could be even doubled – the bias rises as both T and N grow (Arellano, 2003b).

The development of the dynamic-GMM panel techniques in recent years established that both difference- and system-GMM panels can generate moment conditions prolifically (Roodman, 2008b). A crucial assumption for the validity of GMM is that generated instruments are exogenous, i.e. do not correlate with the error term. Sargan and Hansen-J tests have been designed to detect violation of this assumption, but there is no formal test to check how many instruments should be cut (Ruud, 2000). Sargan and Hansen-J set the null as "instruments are valid", which is the assumption that we want to support. However, the Hansen-J test grows weaker with more moment conditions and a p-value of 1 is a classic sign of instrument proliferation, because it points out that the test does not detect the problem. Sargan/Hansen tests can be also used to test the validity of subsets of instrument, through the difference-in-Sargan specification. Roodman (2008b) suggests combining two ways to cut instruments: collapsing them and/or limiting lag length. Using simulation, he found that the problem of too many instruments becomes apparent when T>15; also, the bias slightly increased when both collapsing and lag-limiting commands were used (from 0.03 to 0.05), but strangely lessened as T went from 5 to 20.

There are two great additional advantages of the GMM estimator in addition to those already discussed (Verbeek, 2000): i) it does not require distributional assumptions, like normality; and ii) it can allow for heteroskedasticity of unknown form. The first feature means that normality is not an assumption that should be a subject of diagnostic testing, while the potential heteroskedasticity can be allowed for by estimating "robust" parameters. However, if the errors are serially correlated, than these will not be independent of the instruments; the GMM estimator, hence, requires no (second-order) serial correlation in the error term of the differenced equation (Arellano and Bover, 1995). Moreover, the above-mentioned Sargan and Hansen-J tests (Roodman, 2006b; Baltagi, 2008) test if instruments are uncorrelated with the error term, i.e. it checks for over-identifying restrictions in the model.

An early trial to evaluate the different dynamic-panel estimators has been made by Judson and Owen (1996). However, the study was done when the system-GMM estimator was in its launch-phase and it is thus not included in the analysis. This Monte Carlo study shows that OLS definitely generates significant bias, even when T gets large. The bias is lessened, but still spans up to 20% under LSDV estimator even when T=30, but the estimator does not become more efficient. In any case, LSDV was acknowledged to be inappropriate in many cases, among which is this study. To account for the computation difficulty of including too many instruments in the difference-GMM estimator, Judson and Owen (1996) restrict the number of instruments to a maximum of eight; vary T from 10 to 30 and N from 20 to 100. The one-step difference-GMM estimator is found to outperform the two-step in terms of producing a smaller bias and a lower standard deviation of the estimates. When compared to all dynamic-panel estimators, difference-GMM again shows superiority when N is large. "[F]or a sufficiently large N and T, the differences in efficiency and bias of the different techniques become quite small" (p.12), suggesting that the estimators improve as T gets larger (up to 100 periods). Albeit, results suggest that the Anderson-Hsiao estimator produces the lowest average bias and lower bias as T gets larger. Therefore, "a reasonable strategy … for panels with larger time dimension [would be to] use the Anderson-Hsiao estimator" (p.12). On the other hand, the Monte Carlo study by Arellano and Bond (1991) (N=100, T=7) showed that the difference-GMM estimator has negligible finite sample bias and substantially smaller variance than the Anderson-Hsiao estimator. However, the estimated standard error of the two-step estimator was found to suffer downward bias, which is attributed to the estimation of the weight matrix (Windmeijer, 2005). Hence a correction has been proposed, based on a Taylor-series expansion that accounts for the estimation of the weighted matrix[3].

[3] And a Roodman's (2008a) xtabond2 command implements this correction.

Behr (2003) conducted Monte Carlo analysis which includes the system-GMM Blundell-Bond estimator. When N=100, T=10, the Anderson-Hsiao estimator is found to be unbiased but rather inefficient because of the large standard deviation. The system-GMM estimator is found to be unbiased and the most efficient. The same conclusion holds, although both estimators improve, when N=1000, T=10. If predetermined endogenous variables are used, then the system-GMM is again found to be superior. A drawback of the simulation is that it does not enlarge the number of periods in order to observe how these estimators perform, but rather focuses on the cross-section dimension. Changes in the number of periods are examined in Harris and Matyas (2004) who found that both difference- and system-GMM estimator suffer bias when sample is small and the number of instruments very large. They found that the bias is reduced as T gets larger.

In summary, the evidence of the Monte Carlo studies is not overwhelming, but they tend to suggest that the least biased and the most efficient estimator is the system-GMM. The biasness is further lowered by increasing T, which is of particular importance in this study. The number of instruments, however, matters in terms of the trade-off between biasness and efficiency: limiting instruments slightly increases biasness, although efficiency as well, and makes computation less cumbersome. Consequently, next we estimate growth regression within the system-GMM framework.

4. Results and discussion

We specify the growth regression as follows:

$$GROWTH_{i,t} = \alpha_0 + \delta\, GROWTH_{i,t-1} + \beta_j X_i + \gamma_j Z_{i,t} + \tau_j N_{i,t} + \kappa_j INT_{i,t} + \psi_j LAG_{i,t-1} + \vartheta_j T_{i,t} + \varepsilon_{i,t} \quad (2)$$

The coefficients are specified according to the groups of variables, as follows:

- δ is for the lagged dependent variable;
- βs for predetermined variables $X_i = (LGDP75; LIFE1)$;
- γs for endogenous variables $Z_i = (EDUC; GCGDP; TO; INF; INVGDP; LFERTIL; DEM; RRx / IMFx)$;
- τs for exogenous variables $N_i = (LPOPUL; EURER; SURVIVOR; LATCAR; SAHAR)$. Dummies for Sub-Saharan Africa and Latin America and the Caribbean enter as routinely suggested in the growth literature;
- κs for interaction terms of exchange-rate regime dummies with all policy variables $(GCGDP; TO; INF; INVGDP; DEM)$, including variables which are objects of policy

actions $(EDUC; FERTIL)$. Interaction terms are added in order to reflect the Lucas critique. We believe that interacting policy variables may be sufficient to capture the possible parameters-change, according to Lucas (1976);

- ψs for one-lag regressors from the policy variables $(GCGDP; TO; INF; INVGDP)$ and from the two object-policy variables $(EDUC; FERTIL)$. This is because of Bond *et al*.'s (2001) and Roodman's (2008a) argument that the right-hand-side variables in a standard growth regression are dynamic as well, which means the process of adjustment to changes in these factors may depend on the passage of time;
- φs for time dummies, which, according to Sarafidis *et al.* (2006) and Roodman (2008a) is always suggested as a wise strategy to remove any global time-related shocks from the errors.

Variables are as defined in Appendix A. We estimate this regression for 169 countries and 31 periods. One of the exchange-rate dummies is dropped to represent the base and is indicated as "omitted category" in Tables 3, 4 and 5. The log of the average GDP per capita (1970-74) enters as external instrument to correct potential measurement error in GDP per capita in 1975.

We utilize system-GMM dynamic panel estimation, according to the discussion in 3.2. Bond *et al.* (2001) argue that utilizing system-GMM approach in a growth framework has at least four advantages: i) it produces estimates not biased by omitted variables (like the initial efficiency); ii) produces estimates which are consistent even in presence of measurement error; iii) accounts for the endogenous right-hand-side variables (like investment in growth-context); and iv) exploits an assumption about the initial conditions to obtain moment conditions that remain informative even for persistent series (i.e. series that contain unit root, like the output). In their empirical work, Bond *et al.* (2001) found that the difference-GMM in growth models is seriously biased, due to the high degree of persistence of output and the resulting weak instruments. On the other hand, they found the system-GMM to be unbiased and consistent when some of the series contains a unit root. Hence, this study discards the earlier recommendation by Caselli *et al.* (1996) to use differenced-GMM estimator for empirical growth models.

Nevertheless, although system-GMM is found to be unbiased and consistent when some of the series are persistent, no solution has been offered when variables cointegrate, i.e. when they are all I(1), but a linear combination of those is I(0). We add this caution following the recent work of Pesaran and Smith (1995) and Pesaran *et al.* (1997, 1999) who treat the non-stationarity and cointegration properties of the underlying data-generating process. Though, the system might cointegrate only if all variables contain a unit root. Table 2 presents the results from two panel unit-root tests proposed by Maddala and Wu (1999) and Pesaran (2003), respectively. The first, so-called Fisher's test combines the p-values from N independent unit-root tests and assumes that all series are non-stationary under the null hypothesis. Pesaran's test applies to heterogeneous panels with cross-section dependence and it is based on the mean of individual Dickey-Fuller (or Augmented DF) t-statistics of each unit in the panel. Null hypothesis also assumes that all series are non-stationary. To eliminate the cross dependence, the standard DF (or ADF) regressions are augmented with the cross-section averages of lagged levels and first-differences of the individual series.

Table 2. Panel unit-root tests (growth regression)

	Maddala and Wu (1999)		Pesaran (2003)	
	Constant	*Constant and trend*	*Constant*	*Constant and trend*
Real per capita GDP growth	1540.38***	1370.20 ***	-15.53***	-10.90***
Inflation	1410.18***	1265.26***	-13.05***	-13.14***
Trade openness	499.14***	459.84***	-0.77	-2.85***
Government consumption to GDP	617.53***	559.70***	-0.99	0.38
Investment to GDP	702.35***	742.97***	-3.84***	-4.52***
Democracy index	565.71***	527.91***	No obs	No obs
Log of population	140.79	754.03***	9.44	6.74
Δ Log of population	1156.57***	968.74***	-11.96***	-4.96***

Note: Numbers represent Chi2 statistics or t-statistics. *, ** and *** indicate that the null of unit root is rejected at 10, 5 and 1% level of significance, respectively.
Regressions for testing unit roots include one lag to eliminate possible autocorrelation.

The results suggest that there are little empirical grounds for being concerned that the variables are non-stationary. As expected, the only non-stationary variable is population, where both tests indicate a presence of unit root; hence, we use the first difference, reflecting population growth. Pesaran's test indicates unit root in the government-consumption variable, but this is not the case with the Fisher's test. Considering those findings, we proceed with the system-GMM estimation, as explained above.

We use both the lag-limiting and collapse commands available under Roodman's (2008a) xtabond2 command to reduce the number of instruments. These methods are important in reducing the number of instruments, whose number otherwise will be enormous because of the number of regressors and the large T. Lag-limits are set so that the number of instruments does not exceed the number of cross sections and/or to get good Hansen's statistics (p-value above 0.25, but below values near unity)[4].

We start with equation 10; the null that the effect of the policy variables do not change when regime switches could not be rejected for all exchange-rate regimes and, in consequence, there is no evidence for the Lucas critique. The F-test for the joint significance of the lagged independent variables also indicates that these do not play any explanatory role. Hence, our final specification in the one without interactions and lagged independent variables. Within this regression, some of the

[4] Our general principle in all specification was to expand the number of instruments until Hansen's p-value deteriorates, i.e. approaches 0.25 or unity.

variables are statistically significant, some are not, but all of them have the expected sign and magnitude. The lagged dependent variable has the expected positive coefficient of 0.158, which is below one and is in line with the literature (Roodman, 2008a), pointing to a stable dynamic process. The convergence rate estimates that if country's initial GDP level is lower by 1%, the economy will, on average, grow faster by 2.47 percentage points, which could be expected and is in line with other findings (Barro and Sala-i-Martin, 2004), but the coefficient lacks statistical significance.

The variable of main interest – the de-facto *exchange-rate regime*, is statistically insignificant at conventional levels. The insignificance of the de-facto exchange-rate regime in explaining growth is confirmed by the F-test of the joint effect of the regimes (p=0.1720). The main conclusion is that the de-facto exchange-rate regime is not significant in explaining growth. The results are confirmed if the specification is applied to developing countries only, reducing the sample to 139 countries[5]. In these specifications also the de-facto exchange-rate regime did not come close to conventional significance levels. Columns (5) and (6) of Table 3 present the estimates for two distinct sub-periods: 1976-1990 and 1991-2006. The intuition behind this division is to capture the early post-socialism period (past 1991), when transition countries experienced accelerating inflation and nearly all of them subsequently established a form of fixed exchange rate. The de-facto regime again is insignificant at conventional levels in both periods, although coefficients in the overall regression slightly differ between the two periods. Finally, column (7) distinguishes de-facto regimes between advanced, developing and transition economies for the period 1991-2006, but finds no different results.

Table 4 advances the issue by considering peg duration. Some studies and findings mentioned (Table 1), argued that a peg delivers early benefits since it curbs inflation, but long pegs strangle growth. To check for this, we make an arbitrary cut-off of the pegs duration at: pegs up to 5 years, pegs longer than 5 but shorter than 10 years, and pegs longer than 10 years. All specifications are diagnostically valid. However, signs, magnitudes and significance, and hence, conclusions are similar to those in Table 3. De-facto exchange-rate regime and its duration are not significant in explaining growth, no matter the level of development of countries or the observed sub-periods.

[5] We do not run a regression for advanced-countries group because they comprise a sample of 30 countries, so that N=T. In this case, it could be argued that dynamic system-GMM is not the best estimator. Refer to section 3.4.2.

Table 3. Growth regression under RR (de-facto) classification of exchange-rate regimes

Dependent variable: *Real per capita GDP growth*	**FE** (1)	**OLS** (2)	**System-GMM** (3)	**Developing countries** (4)	**Sub-periods** **1976-1990** (5)	**1991-2006** **(6)**	**1991-2006 – Lev. of devel.** **(7)**
Real per capita GDP growth(-1)	0.118***	0.232***	**0.157*** **	0.163**	0.167	0.295***	0.298***
Initial GDP in 1975	-	-0.192	**-2.469**	-0.455	3.875	-1.945	-1.551
Life expectancy at birth (inverse)	-	-0.422	**33.276**	14.424	10.707	-6.976	-11.084
Inflation	-0.383	0.158	**-2.649**	-3.367**	4.820	3.107	2.673
Average years of schooling	-	-0.062	**2.254**	1.925**	-2.650	0.037	-1.047
Log of fertility rate	0.119	0.00078	**-11.978** **	4.153	-6.831	-0.394	-0.544
Trade openness	4.771***	1.961***	**8.272** **	12.880***	7.384	0.210	1.327
Government consumption to GDP	-23.068***	-7.453***	**13.436**	18.389	13.807	0.561	8.085
Investment to GDP	-0.032	0.014	**0.775***	0.870	-0.446	0.196	-0.122
Democracy index	-0.091	-0.058	**-0.786**	-1.162	-3.666	-0.229	-0.537
Democracy index squared	0.005	-0.015	**0.073**	0.155	0.492	0.028	0.023
Fixed ERR	*1.206**	*0.106*	***2.317***	*-1.564*	*0.415*	*1.160*	*3.382*
Limited flexible ERR	*0.446*	*0.312*	***-0.183***	*-3.004*	*2.572*	*-0.355*	*-0.918*
Flexible ERR	*0.022*	*0.149*	***1.134***	*-0.110*	*-1.090*	*0.025*	*0.303*
Free floating ERR	*Omitted cat*	*Omitted cat*	***Omitted cat***	*Omitted cat*	*Omitted cat*	*Omitted cat*	*Omitted cat*
Other cat. (dual market / free fal.)	*-2.073****	*-1.766****	***0.124***	*-1.543*	*-3.670*	*-2.672*	*-2.804*
Δ Log of population	-87.489***	-65.394***	**-0.075**	-117.391	-99.67	-80.729	-89.059**
Dummy for the Euro zone	-0.716	-0.782**	**-1.788**	-	-2.081	-1.865	-5.153
Dummy for survivor bias	0.580	0.931	**1.641**	1.504	-	-0.438	0.0067
Dummy for Latin A. and Caribbean	-	-0.765**	**3.698***	-0.147	-0.102	-0.414	-0.059
Dummy for Sub-Saharan Africa	-	-0.240	**-2.704**	-5.159	-0.757	1.288	2.794
Fixed ERR in Transition countries							-0.480
Lim-flex ERR in Transition countries							3.786
Flexible ERR in Transition countries							4.079
Fixed ERR in Developing countries							-3.852
Lim-flex ERR in Developing countries							1.307
Flexible ERR in Developing countries							0.478
Wald test (p-value)	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
AR(2) (p-value)	**-**	**-**	**0.860**	**0.539**	**0.565**	**0.901**	**0.838**
No instruments	**-**	**-**	**54**	**52**	**36**	**48**	**56**
Hansen (p-value)	**-**	**-**	**0.646**	**0.662**	**0.617**	**0.308**	**0.505**
Difference in Hansen (p-value)			**0.572**	**0.746**	**0.684**	**0.365**	**0.454**

Notes: *, ** and *** refer to a significance level of 10, 5 and 1%, respectively. All regressions are two-step system GMM. The Windmeijer (2005) corrected standard errors are reported in parentheses.

The specification for the period 1991-2006 uses the initial level of real per capita GDP in 1990. The level in 1989 is used as instrument to correct for possible measurement error. Life expectancy at birth refers to 1990.

Table 4. Growth regression under RR (de-facto) classification of exchange-rate regimes – peg's duration

Dependent variable: *Real per capita GDP growth*	**FE** (1)	**OLS** (2)	**System-GMM** (3)	**Developing countries** (4)	**Sub-periods** **1976-1990** (5)	**1991-2006** **(6)**	**1991-2006 – Lev. of devel.** **(7)**
Real per capita GDP growth(-1)	0.118***	0.224***	**0.159****	0.136**	0.119*	0.287***	0.276***
Initial GDP in 1975	-	-0.317*	**-2.033**	-4.603	8.889	-2.350	-1.280
Life expectancy at birth (inverse)	-	-0.537	**21.952**	14.598	41.597	-9.795	-11.856
Inflation	-0.373	-0.012	**-1.877**	-4.138*	7.036	3.219	3.302
Average years of schooling	-	-0.048	**1.562***	2.491*	2.889	0.124	-0.316
Log of fertility rate	0.101	0.068	**-8.247***	1.691	16.845	2.389	3.621
Trade openness	4.816***	2.049***	**8.771*****	13.059***	23.764	-0.644	-0.198
Government consumption to GDP	-23.198***	-7.113***	**3.538**	24.247	84.155	8.310	9.374
Investment to GDP	-0.03	0.016	**0.601***	0.784	2.817	0.149	-0.069
Democracy index	-0.088	-0.092	**-0.180**	-0.2	5.125	-0.722	-0.363
Democracy index squared	0.0049	-0.01	**0.017**	0.023	0.604	0.073	0.001
Fixed ERR under 5 years	*1.154**	*0.975***	***1.506***	*-3.937*	*10.984*	*0.102*	*-1.878*
Fixed ERR 5 to 10 years	*1.405**	*0.557*	***1.458***	*-7.544*	*9.135*	*-1.848*	*-5.512*
Fixed ERR over 10 years	*1.312*	*-0.449*	***0.251***	*-16.384*	*9.978*	*-2.137*	*-5.956*
Limited flexible ERR	*0.461*	*0.304*	***-0.801***	*-3.410*	*9.488*	*-1.071*	*-4.856*
Flexible ERR	*0.040*	*0.131*	***0.332***	*-0.068*	*9.472*	*-0.433*	*-2.172*
Free floating ERR	*Omitted cat*	*Omitted cat*	***Omitted cat***	*Omitted cat*	*Omitted cat*	*Omitted cat*	*Omitted cat*
Other cat. (dual market / free fal.)	*-2.068****	*-1.724****	***-0.934***	*-1.074*	*10.613*	*-2.996*	*-3.995*
Δ Log of population	-87.631***	-66.026***	**-31.845**	-70.086	218.957	-93.556**	-92.09**
Dummy for the Euro zone	-0.768	-0.836**	**-1.423**	-	4.284	-0.037	1.35
Dummy for survivor bias	0.598	0.848	**0.939**	1.504	-	-0.714	-0.796
Dummy for Latin A. and Caribbean	-	-0.681**	**2.652**	3.018	6.681	-1.149	-1.427
Dummy for Sub-Saharan Africa	-	-0.128	**-1.651**	-1.380	5.112	1.004	1.921
Fixed ERR 5 in Transition countries							3.044
Fixed ERR (5-10) in Transition countries							7.698
Fixed ERR 10 in Transition countries							7.325
Fixed ERR 5 in Developing countries							5.338
Fixed ERR (5-10) in Developing countries							4.238
Fixed ERR 10 in Developing countries							1.621
Wald test (p-value)	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
AR(2) (p-value)	**-**	**-**	**0.939**	**0.536**	**0.519**	**0.802**	**0.921**
No instruments	**-**	**-**	**58**	**50**	**40**	**52**	**60**
Hansen (p-value)	**-**	**-**	**0.693**	**0.740**	**0.439**	**0.440**	**0.637**
Difference in Hansen (p-value)			**0.738**	**0.649**	**0.306**	**0.430**	**0.732**

Notes: *, ** and *** refer to a significance level of 10, 5 and 1%, . For others, see Table 3.

The above testing-down procedure is repeated with the de-jure (IMF) classification. Contrary to the de-facto classification, in the overall specification, the IMF's de-jure classification of the exchange-rate regime reveals some significant effect on growth. Namely, estimates suggest that a de-jure peg performs better than de-jure float with a magnitude of almost 4 p.p, while de-jure flexible rate delivers better growth performance with a magnitude of about 2 p.p. Hence, studies that use de-jure classification and terminate their investigation at that point might end up with invalid conclusion. This discrepancy compared to the de-facto classification disappears when specifications for developing countries and two sub-periods are observed; in those specifications de-jure exchange-rate regimes are insignificant in explaining growth. For the same reasons specified above, column (7) in Table 5 differentiates transition, developing and developed economies, but finds no different results. All the other coefficients in the regressions are of similar magnitude and sign as when de-facto classification is used and this is a kind of robustness check of the obtained results. Considering the duration of peg yields to similar conclusions – insignificance of peg (duration) in explaining growth and hence it is not reported.

Table 5. Growth regression under IMF (de-jure) classification of exchange-rate regimes

Dependent variable: *Real per capita GDP growth*	FE (1)	OLS (2)	System-GMM (3)	Developing countries (4)	Sub-periods 1976-1990 (5)	Sub-periods 1991-2006 (6)	1991-2006 – Lev. of devel. (7)
Real per capita GDP growth(-1)	0.124***	0.248***	**0.219****	0.146*	0.091	0.336***	0.360***
Initial GDP in 1975	-	-0.15	**0.827**	-0.039	-3.031	-3.631	-0.069
Life expectancy at birth (inverse)	-	-0.279	**15.067**	11.321	6.532	-18.507	-5.643
Inflation	-1.277***	-0.831	**0.674**	-2.999*	-1.688	4.624	3.421
Average years of schooling	-	-0.074	**0.926**	2.328*	3.096	-0.173	-0.958
Log of fertility rate	0.428	0.077	**-3.878**	7.0	-0.165	2.426	-0.283
Trade openness	4.007***	2.468***	**5.541**	14.07***	31.196	-0.614	-5.060
Government consumption to GDP	-23.16***	-6.82***	**-34.085**	4.024	-3.680	-3.770	-26.776
Investment to GDP	-0.007	0.003	**0.054**	0.727	-0.371	-0.126	-0.013
Democracy index	-0.362	-0.229	**-0.307**	-1.873	-2.05	-0.248	-1.817
Democracy index squared	0.034	0.003	**-0.016**	0.221	0.407	-0.112	0.143
Fixed ERR	*0.435*	*0.012*	***3.884****	*3.138*	*1.412*	*2.853*	*3.381*
Limited flexible ERR	*0.329*	*0.202***	***1.128***	*-2.875*	*3.718*	*1.570*	*0.620*
Flexible ERR	*0.348*	*0.495*	***2.166****	*1.344*	*4.881*	*2.076*	*12.962*
Free floating ERR	*Omitted cat*	*Omitted cat*	***Omitted cat***	*Omitted cat*	*Omitted cat*	*Omitted cat*	*Omitted cat*
Other cat. (dual market / free fal.)	*-0.666*	*-1.776*	***-8.252***	*-3.61*	*1.079*	-	-
Δ Log of population	-94.227***	-64.77***	**-49.797**	-113.017	4.560	-99.55*	-57.152**
Dummy for the Euro zone	-0.393	-0.91***	**-1.266**		-7.513	-2.459	-4.061
Dummy for survivor bias	0.923	0.656	**0.127**	2.444		-1.301	-0.617
Dummy for Latin A. and Caribbean	-	-0.834***	**-0.693**	-1.177	-0.388	-2.505	-2.143
Dummy for Sub-Saharan Africa	-	-0.287	**-1.367**	-5.904	-4.138	2.709	0.646
Fixed ERR in Transition countries							-0.924
Lim-flex ERR in Transition countries							2.892
Flexible ERR in Transition countries							-10.599
Fixed ERR in Developing countries							-3.348
Lim-flex ERR in Developing countries							-0.790
Flexible ERR in Developing countries							-13.309
Wald test (p-value)	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
AR(2) (p-value)	**-**	**-**	**0.724**	**0.460**	**0.612**	**0.415**	**0.461**
No instruments	**-**	**-**	**54**	**52**	**36**	**44**	**52**
Hansen (p-value)	**-**	**-**	**0.191**	**0.345**	**0.756**	**0.197**	**0.557**
Difference in Hansen (p-value)			**0.143**	**0.638**	**0.980**	**0.145**	**0.749**

Notes: *, ** and *** refer to a significance level of 10, 5 and 1%, respectively. All regressions are two-step system GMM. The Windmeijer (2005) corrected standard errors reported in parentheses.

The specification for the period 1991-2006 uses the initial level of real per capita GDP in 1990. The level in 1989 is used as instrument to correct for possible measurement error. Life expectancy at birth refers to 1990.

In general the conclusion, having encompassing all theoretical and modelling aspects discussed in section 2 and in this study, is that the empirical evidence suggests that *exchange-rate regime does not affect growth*, as a general rule. No empirical grounds were established that coefficients in the regression suffer the Lucas critique. Observing two sub-periods or developing countries led to the same conclusion – insignificance of the exchange-rate regime. Observation of the de-facto versus de-jure regime does not matter in that respect. Specifically, although de-facto classification accounts for the actual behaviour of the exchange rate, any capital controls and any devaluation or crises episodes which were all apparent in the developing, including transition, economies during 1990s and early 2000s, conclusion is the same – the exchange-rate regime does not affect economic growth, no matter of the regimes' classification, observed time period or level of development of countries. The duration of peg is not important either. The duration and developing-countries group was especially considered for the period 1991-2006, a period in which episodes of devaluation and currency crises were observed, which might have played a role in affecting growth. However, this was not the case. The empirical findings suggest, however, that there is very marginally significant positive effect of an exchange-rate peg on growth according to the de-jure classification for the entire sample, but is insignificant in all other de-jure specifications.

5. Conclusion

The aim of this study was to empirically investigate whether and how the exchange-rate regime affects growth, by addressing some of the drawbacks in the current empirical studies. For the purpose of the empirical investigation, a minimally specified growth model has been defined. The study addressed other important issues, which are presently - partially or entirely - missing from the exchange-rate regimes literature. Namely, the investigation contrasts use of the de-jure (IMF) versus a de-facto (Reinhart and Rogoff, 2004) exchange-rate classification; draws attention to the Lucas critique, i.e. how parameters in the equation may change when the exchange-rate regime changes; and discusses and addresses the endogeneity bias, present in the growth and exchange-rate-regimes literature. The empirical investigation covers the post-Bretton-Woods era (1976-2006) and includes 169 countries. A dynamic system-GMM panel method has been used to account for the potential endogeneity of the lagged dependent and all independent variables in the growth regression, by using valid lags of explanatory variables' levels and differences as instruments.

The main finding is that the exchange-rate regime is not significant in explaining growth. No empirical grounds were established for the coefficients in the regression as suffering from the Lucas critique. Observing two sub-periods or developing countries only led to the same conclusion – the insignificance of the exchange-rate regime. Using the de-facto versus de-jure classification of exchange rates did not matter in that respect. The duration of peg is also not of importance. Reverting to the general findings, though, if the exchange-rate regime, as a nominal variable, is found not to affect growth, then it might be important in affecting its departure from the long-run level, i.e. the output volatility. Further research should examine if the exchange-rate regime is significant in explaining output volatility.

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APPENDIX A – Variables

A.1. Growth variables: definitions, sources and expected signs

Variable		Theory and expected sign	Source	Notes
Dependent variable				
Real Per Capita GDP growth	GROWTH		IMF, World Economic Outlook	This variable is expressed in percentages (i.e. value of 3 refers to 3% and is not settled as 0.03).
Independent variables				
Initial values				
Log(Initial Per Capita GDP)	LGDP75 LGDP90 (for regressions 1991-2006)	Neo-classical theory - Solow model (-)	IMF, World Economic Outlook	Observation for 1975 (1990) – a predetermined variable. Earlier values (average over 1970-1974; and value in 1989) are used in the list of instruments in order to lessen the tendency to overestimate the convergence rate because of temporary measurement error in GDP
Life expectancy at birth (reciprocal value)	LIFE1 LIFE2 (for regressions 1991-2006)	Neo-classical theory - Augmented Solow model (-)	World Bank Database	An observation in 1975 (1990)– a predetermined variable. The reciprocal value is multiplied by 100 to avoid parameter with many decimals.
Log of Population	LPOPUL	Neo-classical theory - Solow model (-) Endogenous theories (+)	IMF, World Economic Outlook UNSD, Demographic statistics	Exogenous
Policy and object-to-policy variables				
Educational attainment	EDUC	Neo-classical theory - Augmented Solow model (+)	World Bank Database	Average years of secondary and higher schooling, observed as average values over 5-year periods for 1985-2006. Previous values are unavailable.
Log of Fertility rate	LFERTIL	Neo-classical theory - Solow model (-)	UNPD World Population Prospects, 2006	Total lifetime live births for the typical woman over her expected lifetime. It enters as a log of the averages 1985-1990; 1990-1995; 1995-2000 and 2000-2005. Previous and annual values are unavailable.
Government consumption ratio	GCGDP	Neo-classical theory - Solow model (-) Endogenous theories (-)	IMF, World Economic Outlook World Bank estimated	Ratio of nominal government consumption to nominal GDP.
Trade openness	TO	Neo-classical theory - Solow model (+) Endogenous	IMF, Trade Statistics	Ratio of export plus import over two over GDP.

		theories (+)		
Investment ratio	INVGDP	Neo-classical theory - Solow model (+)	IMF, World Economic Outlook	Ratio of gross capital formation to GDP.
Inflation rate	INF	Neo-classical theory - Solow model (-) Endogenous theories (-)	IMF, World Economic Outlook	Consumer price inflation
Exchange rate regimes	RRx IMFx	Exchange-rate regime theories (insignificant or sign mixed)	Official IMF classification De-facto classification by Reinhart and Rogoff (2004)	x represents the type of ERR: 1 – fix; 2 – limited flexibility; 3 – flexible; 4 – free float; 5 – free falling (RR only); OT –other (like dual markets; IMF only)
Institutional variables				
Democracy index	DEM	Theory of institutional factors of growth (-); squared term (+)	Freedom House	The index of political rights

A.2. Full specification of dummy variables

Notation	Value 1	Value 0	Source
Exchange-rate regimes			
RR1	If fixed	Otherwise	De-facto RR classification
RR2	If limited-flexible	Otherwise	De-facto RR classification
RR3	If flexible	Otherwise	De-facto RR classification
RR4	If free float	Otherwise	De-facto RR classification
RR5DUAL	If free falling or dual market	Otherwise	De-facto RR classification
IMF1	If fixed	Otherwise	IMF web
IMF2	If limited-flexible	Otherwise	IMF web
IMF3	If flexible	Otherwise	IMF web
IMF4	If free float	Otherwise	IMF web
IMFOT	If dual market exists	Otherwise	IMF web
Other dummies related to the exchange-rate regime			
EURERM	If a country belongs to the Euro zone and the ERM II - 12 (mainly the period 1991-2006) + UK in 1991 and 1992	Otherwise	Eurostat
Survivor bias			
SURVIVOR	If in the particular year inflation rate exceeds 30%	Otherwise	Based on CPI measure; IMF, World Economic Outlook
Geographic groupings			
LATCAR	If the country belongs to the region **Latin America and the Caribbean:** Argentina; Belize; Bolivia; Brazil; Chile; Colombia; Costa Rica; Dominica; Dominican Republic; Ecuador; El Salvador; Grenada; Guatemala; Guyana; Haiti; Honduras; Jamaica; Mexico; Nicaragua; Panama; Paraguay; Peru; St.	Otherwise	World Bank groupings

	Kitts and Nevis; St. Lucia; St. Vincent and the Grenadines; Suriname; Uruguay; Venezuela.		
SAHAR	If the country belongs to the region **Sub-Saharan Africa:** Angola; Benin; Botswana; Burkina Faso; Burundi; Cameroon; Cape Verde; Central African Republic; Chad; Congo, Rep; Côte d'Ivoire; Ethiopia; Gabon; Gambia, The; Ghana; Guinea; Guinea-Bissau; Kenya; Lesotho; Liberia; Madagascar; Malawi; Mali; Mauritania; Mauritius; Mozambique; Namibia; Niger; Nigeria; Rwanda; São Tomé and Principe; Senegal; Seychelles; Sierra Leone; South Africa; Sudan; Swaziland; Tanzania; Togo; Uganda; Zambia; Zimbabwe.	Otherwise	World Bank groupings
Development groupings			
ADVAN	**Developed (advanced) market economies** Australia; Austria; Belgium; Bermuda; Brunei Darussalam; Canada; Cyprus; Denmark; Finland; France; Germany; Greece; Hong Kong, Iceland; Ireland ; Italy; Japan; Rep.; Kuwait; Luxembourg; Netherlands; New Zealand; Norway; Portugal; Qatar; Singapore; Slovenia; Spain; Sweden; Switzerland; United Arab Emirates; United Kingdom; United States.	Otherwise	World Bank groupings, Group high-income countries
TRANS	**Transition markets** Albania; Armenia; Azerbaijan; Belarus; Bosnia-Herzegovina; Bulgaria; China; Croatia; Czech Republic; Estonia; Georgia; Hungary; Kazakhstan; Kyrgyzstan; Latvia; Lithuania; Macedonia; Moldova; Mongolia; Poland; Romania; Russian Federation; Serbia/Montenegro; Slovakia; Slovenia; Tajikistan; Ukraine; Uzbekistan; Vietnam	Otherwise	SSRN
DEVEL	**Developing economies (includes transition countries)** Albania; Armenia; Azerbaijan; Belarus; Bosnia-Herzegovina; Bulgaria; China; Croatia; Czech Republic; Estonia; Georgia; Hungary; Kazakhstan; Kyrgyzstan; Latvia; Lithuania; Macedonia; Moldova; Mongolia; Poland; Romania; Russian Federation; Serbia/Montenegro; Slovakia; Slovenia; Tajikistan; Ukraine; Uzbekistan; Vietnam + All the remaining in the sample	Otherwise	Residual