Economic Issues, Vol. 16, Part 1, 2011

Revisiting the Relationship between Inflation and Growth: A Note on the Role of Exchange Rate Regimes

Andrew Abbott and Glauco De Vita[1]

ABSTRACT

Drawing from recent advances in the classification of exchange rate regimes, this note revisits empirically the relationship between inflation and growth under alternative exchange rate regimes. The results, based on a panel of 125 industrialised and developing countries over the period 1980-2004, indicate that the costs of inflation for economic growth are significant only in the case of developing countries, and are higher for floating exchange rates than they are under fixed or intermediate regimes.

1. INTRODUCTION

FOR BOTH INDUSTRIALISED AND DEVELOPING COUNTRIES a key policy objective is to sustain high economic growth alongside low inflation. Not surprisingly, for decades, there has been considerable debate on the nature of the relationship between inflation and growth. Economic theories reach a variety of conclusions. Traditionally, the consensus view was that inflation lagged changes in growth, with theory postulating a positive relationship between the two whereby as growth increased, so did inflation (a prediction also postulated by the standard aggregate supply — aggregate demand framework). However, in the 1970s, the emergence of stagflation, the simultaneous presence of low or negative output growth and high inflation, highlighted the inadequacy of the widely held view, and the validity of the positive relationship between inflation and growth began to be questioned. In the 1990s, several theoretical models emerged predicting a negative relationship (see, *inter alia*, De Gregorio, 1993; Jones and Manuelli, 1995; Roubini and Sala-i-Martin, 1995; Wu and Zhang, 1998) and most empirical studies (Kormendi and

Meguire, 1985; Barro, 1991 and 1995; De Gregorio, 1992; Fischer, 1993; etc.) found significant, albeit small, negative coefficients of inflation in growth equations. According to these studies, a 10 per cent increase in inflation a year, reduced the growth of GDP by 0.2 per cent to 0.7 per cent per year.[2]

However, an important contribution by Andrés, Hernando and Krüger (1996) pointed out that many of these econometric studies did not control for the influence of exchange rate regimes and, because of this, were likely to have underestimated the costs of inflation. The argument Andrés *et al* (1996) put forward for this downward bias finds its theoretical underpinnings in the Balassa-Samuelson model (Balassa, 1964; Samuelson, 1964). One prediction of the model is that growth and inflation should be positively correlated in economies with pegged currencies since, under fixed rates, the appreciation induced by high productivity growth can only manifest itself through higher inflation. By contrast, under flexible rates, fast productivity growth leads to a (real) currency appreciation. Given the widespread adoption of fixed exchange rates by most industrialised countries in the past (during the 1960-1973 period nearly all of them pegged their currencies in the Bretton Woods system), Andrés et al (1996) argued that the previous findings of a negative relationship between inflation and growth are surprising. Using 1961-1992 data for a sample of OECD countries, they estimated different specifications of a growth model augmented with the inflation variable as well as dummy variables to reflect periods of fixed and floating currencies. They found that the negative impact of inflation on the growth of real per capita GDP was higher for floaters than it was for countries pegging their currencies. However, it should be borne in mind that their analysis is exclusively reliant upon the IMF classification of exchange rate regimes, neglects potential differences between developing and industrialised countries, and omits the examination of intermediate exchange rate regimes. Although it has been argued that intermediate regimes are not sustainable in the long run as they lack credibility and make economies more susceptible to currency attacks (Fischer, 2001), Williamson (2000) suggests that, especially in developing countries, regimes are often of the intermediate type and will continue to be seen as a viable option to reap the benefits of fixed and flexible rates without having to incur some of their costs.

In this note we aim to extend the analysis of the role of exchange rate regimes on the relationship between inflation and growth by addressing the above issues. Using data for 125 industrialised and developing countries over the period 1980-2004, we exploit recent developments in the classification of exchange rate regimes that allow us to compare the costs of inflation on economic growth under fixed, intermediate and flexible rates according to both de jure and de facto classification schemes.

The remainder of this note is organised as follows. The next section formalises the specific hypothesis of the Balassa-Samuelson effect that forms the theoretical justification for the analysis that follows, and provides a discussion of the methodology and data employed. Section 3 presents and discusses the empirical results. Section 4 elaborates further on the findings and their policy implications. Finally, the last section draws conclusions.

2. MODEL, METHODOLOGY AND DATA

The theoretical justification of the role of exchange rate regimes on the inflation-growth relationship can be illustrated with reference to the Balassa-Samuelson model, which can be formally expressed as:

$$\Theta = P/P^* = \frac{[f'(L_T)/g'(L_N)]^i}{[F'(L^*_T)/G'(L^*_N)]^j} \qquad (1)$$

where Θ = P/eP* = P/P* is the real exchange rate between countries i and j (the asterisk denotes the foreign country), L is labour, T and N refer to traded and non-traded goods, and the prime after the functions denotes the marginal productivity of labour. Drawing inferences purely from the viewpoint of the role of exchange rate regimes (the focus of our analysis), the model shows that if traded goods productivity relative to non-traded goods productivity is growing faster at home than abroad, then — under flexible exchange rates — the home country should experience a (real) currency appreciation. On the other hand, growth and inflation should be positively correlated in economies with pegged currencies since — under fixed exchange rates — the appreciation induced by the higher (traded goods) domestic productivity growth can only manifest itself through higher inflation.[3]

We take the predictions of the model expressed in equation (1) as our theoretical rationale for the investigation of the role of exchange rate regimes on the relationship between inflation and growth though, the econometric model specification that follows, also accounts for the potential effect of intermediate regimes for which no implication can be inferred from the Balassa-Samuelson model. Specifically, our baseline model to be subjected to empirical testing is as follows:

$$y_{it} - y_{it-1} = \alpha_0 + \alpha_1 \pi_{it} + \alpha_2 Z_{it} + \alpha_3 DFIX_{it} + \alpha_4 DINT_{it} + \alpha_5 (DFIX \times \pi)_{it} + \alpha_6 (DINT \times \pi)_{it}$$
$$+ \alpha_7 DCFA_{it} + \alpha_8 DCUNR_{it} + \alpha_9 DHINF_{it} + \varepsilon_{it} \qquad (2)$$

where y_{it} is the log of GDP per capita for country i at period t, π_{it} is the annual inflation rate and Z_{it} is a vector of control variables. Included in Z_{it} is physical investment as a share of GDP, the growth rate of population and a trend term (for the full details of the variables and data sources used, see the Data Appendix). The parsimonious specification reflects our exclusive interest in investigating the relationship between inflation and growth under different exchange rate regimes rather than the study of the wider macroeconomic

Table 1: Full list of countries

Industrial countries			
Australia	Finland	Italy	Portugal
Austria	France	Japan	Saudi Arabia
Belgium	Germany	Korea	Slovak Rep.
Canada	Greece	Kuwait	Slovenia
Cyprus	Hong Kong, China	Luxembourg	Spain
Czech Republic	Hungary	Netherlands	Sweden
Denmark	Iceland	New Zealand	Switzerland
Equatorial Guinea	Ireland	Norway	United Kingdom
Estonia	Israel	Poland	United States
Developing countries			
Low-income countries			
Benin	The Gambia	Lao	Niger
Burkina Faso	Ghana	Liberia	Tanzania
Burundi	Guinea	Madagascar	Uganda
Central African Rep.	Haiti	Malawi	Zambia
Chad	Kenya	Mali	Zimbabwe
Congo, Dem. Rep.	Kyrgyz Republic	Nepal	
Lower-middle income countries			
Armenia	Egypt	Jordan	Paraguay
Belize	El Salvador	Lesotho	Philippines
Bolivia	Georgia	Moldova	Senegal
Cameroon	Guatemala	Mongolia	Sri Lanka
China	Guyana	Morocco	Swaziland
Congo, Rep.	Honduras	Nicaragua	Syria
Côte d'Ivoire	India	Nigeria	Thailand
Ecuador	Indonesia	Pakistan	Tunisia
			Ukraine
Upper-middle income countries			
Albania	Chile	Latvia	Peru
Algeria	Colombia	Lebanon	Romania
Argentina	Costa Rica	Libya	Russian Federation
Azerbaijan	Dominican Rep.	Lithuania	South Africa
Belarus	Gabon	Macedonia	Suriname
Bosnia and Herzegovina	Guinea-Bissau	Malaysia	Turkey
Botswana	Iran	Mauritius	Venezuela
Brazil	Jamaica	Mexico	
Bulgaria	Kazakhstan	Panama	

determinants of economic growth, which goes beyond the scope of this note. DFIX is a dummy variable that equals one whenever the country has a fixed exchange rate whilst DINT=1 denotes the presence of an intermediate regime. The floating exchange rate case constitutes our default (benchmark) regime type. Inflation is expected to exert a negative influence on economic growth (α_1<0) and the negative impact is expected to be most pronounced for countries that float their currency, so the differential effect (with respect to α_1) of the interaction parameters α_5 and α_6 should be positive. In addition, to control for the possibility that structural breaks, caused by significant economic and political events, may exert an impact on the economic growth rate of a particular country in a given period, we add a series of dummy variables. These dummies are: i) DCFA, which equals one for the CFA franc member countries after 1993;[4] ii) DCUNRit, which equals one when a country has a period of civil unrest (with information regarding those episodes coming from Fearon and Laitin, 2003; and Blattman and Miguel, 2010); and iii) DHINFit, which equals one for those countries that experienced hyperinflation (defined as an inflation rate greater than 50 per cent).[5]

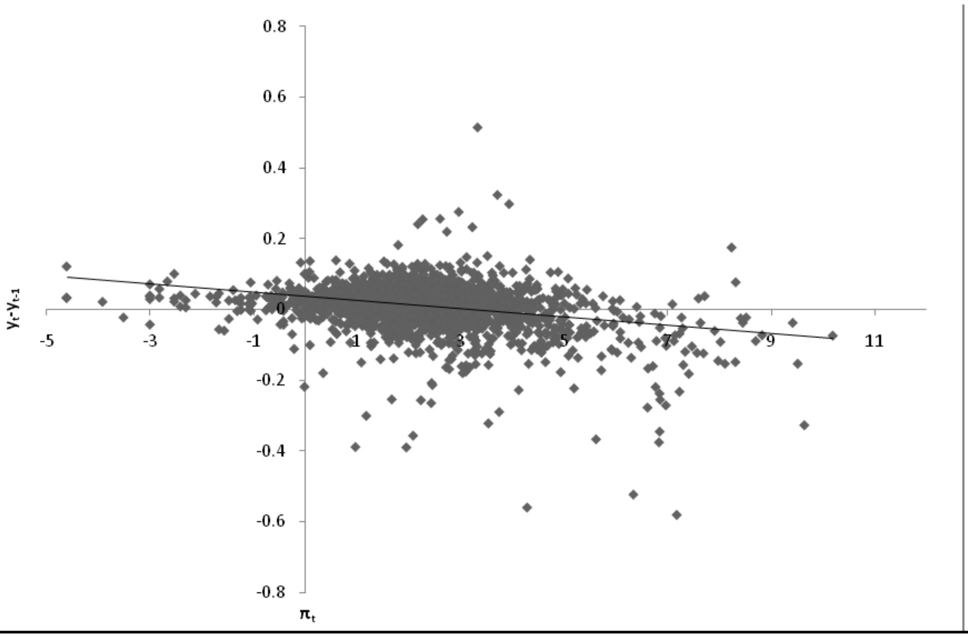
Traditionally, applied economists have relied on the IMF's Annual Report on Exchange Rate Arrangements and Exchange Restrictions as the main source of information about countries' exchange rate policies. Since 1999, the IMF moved from a purely *de jure* classification (based solely on what countries declare they do) to a hybrid one calibrated by the IMF officials' 'informed judgement' about the actual behaviour of the exchange rate. In spite of this development, several authors have questioned the validity of the IMF classification scheme on several grounds. In addition to the argument that in terms of exchange rate policy countries rarely do what they say they do, concerns with the IMF classification include the exact nature of the algorithm used to construct the scheme and the precise boundaries of the fine codes used to define the many regime category types (for an in-depth discussion of the many issues surrounding the construction of such schemes, see Bleaney and Francisco, 2007). New classifications, therefore, have emerged to better represent countries' *de facto* exchange rate policy. Genberg and Swoboda (2005) recently analysed the extent of agreement between the *de jure* and *de facto* exchange rate regime classification schemes. They conclude that empirical investigations on the impact of exchange rate regimes on economic performance can benefit from the simultaneous use of both types of classification. For comprehensiveness, therefore, we utilise three different classification schemes: the one published by the IMF; the one developed by Shambaugh (2004); and the one proposed by Reinhart and Rogoff (2004). The latter isolates flexible rates characterised by episodes of very high inflation through a separate 'freely falling' category (resulting in much fewer observations recorded as floats), and incorporates data on market determined exchange rates.

Equation 2 was estimated through fixed effects panel estimation. Following the approach adopted in similar studies that aim to uncover the existence of a meaningful general pattern in the data (see, for example, Levy-Yeyati and Sturzenegger, 2003), rather than focusing on single case study evidence from individual countries, we employ a large panel of annual data for 125 industrialised and developing countries over the period 1980 to 2004. Our sample period ends in 2004 given the constraints posed by the availability of data on exchange rate regime classifications from our sources. The fixed effects model was chosen since calculation of a Hausman test (see diagnostics reported in Table 3), indicated that the random effects specification was not appropriate for the individual effects in our model. The statistically significant statistics indicate that the assumption of randomly and normally distributed individual effects is rejected by the data, thus leading us to use the fixed effects model, where the individual effects are treated as fixed and estimable. Table 1 lists all the countries included in our sample.

3. Estimation results

Before proceeding to the full econometric analysis it is useful to plot the two series against one another, firstly to consider the relationship between inflation and economic growth and, secondly, to identify whether our data set is characterised by a large number of outlier observations, which may be possible for developing countries that have a history of high and volatile inflation. Figure 1 produces the cross-plot of the two series. As expected, the relationship between both series is negative and there appears to be few outlier observations, relative to the size of the sample as a whole.

Figure 1: Plot of economic growth versus inflation



Prior to the fixed effects estimations, it is also essential to verify the panel unit root properties of the data. Pre-testing of the data series with the panel unit root tests of Choi (2001) confirms that all the series are stationary in levels and, thus, that they are suitable for use with the fixed effects panel estimator (see Table 2). Table 3 presents the results of fixed effects estimation of equation (2) for the full sample. For all three exchange rate regime classification specifications, we find a statistically significant and negatively signed inflation coefficient. The mean value of the three coefficients is -0.011, indicating that an annual increase in average inflation of ten per cent would result in a decrease of per capita GDP growth of 0.11 per cent.

These estimates are broadly similar to those reported by Andrés et al (1996), whose work suggests a growth reduction of 0.2 per cent, and those presented by Barro (1995), where the estimated coefficient is, approximately, -0.24. The estimates for $(DFIX \times \pi)_{it}$ and $(DINT \times \pi)_{it}$ are positively signed and statistically significant in five out of six cases, with considerable consistency being displayed across regime classification specifications. Thus, the cost on growth arising from higher inflation is greater for floaters than it is for

Table 2: Panel unit root tests

	Zero lags	*One lag*	*Zero lags*	*One lag*
$y_t - y_{t-1}$	-24.106*	-17.980*	-19.906*	-14.282*
π	-10.427*	-3.962*	-9.520*	-2.706*
Investment (% of GDP)	-3.130*	-7.727*	0.7642	-5.772*
Population growth rate	-4.623*	-13.836*	11.450	-19.838*

Notes: To ascertain the stationarity properties of the data series panel unit root tests were undertaken using the panel unit root test of Choi (2001). From the augmented Dickey-Fuller regression: $\Delta y_{it} = \phi_i y_{i,t-1} + z'_{it}\gamma_i + \varepsilon_{it}$ (where y is the variable being tested, includes the deterministic components (panel specific means and trend) and z'_{it} is the white noise error term), the Fisher-type test of Choi (2001) is derived from an aggregate test statistic of the p-values of individual unit root tests performed separately on all members of the panel. The null hypothesis is that all panels contain unit roots, while the alternative hypothesis is that at least one panel is stationary. Our chosen statistic has an inverse normal distribution under the null hypothesis. * indicates the test statistic is statistically significant at the 5% level.

countries adopting fixed or intermediate regimes.

Estimation of the full sample, however, masks important differences

Table 3: Panel estimates for all countries

	Reinhart and Rogoff classification	*Shambaugh classification*	*IMF classification*
Constant	0.013	0.006	0.012
	(1.75)	(0.98)	(1.51)
Investment (% of GDP)	0.020*	0.002*	0.002*
	(9.31)	(9.14)	(9.32)
Population growth rate	-0.010*	-0.010*	-0.010*
	(-5.81)	(-6.09)	(-5.53)
Trend	0.0001	0.0002	-0.00001
	(0.74)	(1.31)	(-0.08)
π	-0.015*	-0.007*	-0.010*
	(-9.58)	(-5.19)	(-6.11)
DFIX	-0.011	-0.009	-0.008
	(-1.73)	(-1.79)	(-1.31)
DINT	-0.013*	0.003	-0.004
	(-1.99)	(0.30)	(-0.60)
DFIX x π	0.012*	0.005*	0.0008
	(5.90)	(2.65)	(0.44)
DINT x π	0.012*	0.0003	0.005*
	(5.03)	(0.11)	(2.35)
DCFA	0.016*	0.016*	0.017*
	(2.46)	(2.66)	(2.62)
DCUNR	-0.011	-0.013*	-0.015*
	(-1.90)	(-2.32)	(-2.61)
DHINF	-0.023*	-0.034*	-0.046*
	(-4.07)	(-6.92)	(-9.10)
R^2 – overall	0.213	0.187	0.209
R^2 – between	0.363	0.423	0.360
R^2 – within	0.206	0.131	0.194
Overall significance	$F_{11,2343}$ = 55.11*	$F_{11,2372}$ = 32.33*	$F_{11,2361}$ = 51.78*
Hausman test: $\chi^2(8)$	27.14*	18.89	22.54*

Notes: R^2 values are calculated using all observations (R^2-overall); from a model using group means (R^2-between); and using deviations from the group mean (R^2-within). The Hausman misspecification tests reported, test for systematic differences between fixed and random effects estimates. T-ratios are shown in parentheses. * indicates significance at the 5% level.

between developing and industrial countries. As shown in Table 4, while the results for developing countries are broadly in line with those obtained across the whole panel, the inflation coefficient is not statistically significant in any case for the industrial countries' sample, with the regime interaction coefficients being positive and significant in only two cases. The weak evidence of a negative impact of inflation on growth for industrial countries may be explained by reference to the 'inflation threshold' hypothesis, according to which only inflation rates above a certain threshold have a negative effect on growth (Khan and Senhadji, 2001). When considering that, across our panel, median inflation rates are 3.75 per cent for industrial countries and 9.46 per cent for developing countries, it is plausible to suggest that only the inflation rates of the latter were sufficiently high to have crossed the threshold, thus triggering a negative effect on growth.

Given the differences in the effect of inflation on economic growth observed between developing and industrial countries it is interesting to also consider whether there are different effects across developing countries. This may arise since the effect of inflation on economic growth could vary for countries at different stages of economic development. With this in mind, we re-estimated the model, only for developing countries, stratifying the sample into sub-groups of countries classified according to income level. Using the World Bank income classification we have sub-groups of broadly similar economies: low-income countries; lower-middle income countries and upper-middle income countries. The results of this exercise are presented in Table 5. Interestingly, the negative effect of inflation on economic growth is strongest for the low-income countries, with a mean coefficient of -0.018 across the three regime classifications. By contrast, the mean coefficients for the lower- and upper-middle income countries are -0.0083 and -0.0081, respectively. The interaction coefficients, as before, are generally not significant, though the Reinhart and Rogoff classification produces positive and statistically significant coefficients for $(DFIX \times \pi)_{it}$ and $(DINT \times \pi)_{it}$. The dummies DCUNR and DHINF are negative and significant in most specifications, confirming that periods of civil unrest and hyperinflation, have detrimental effects on economic growth.

The analysis would be incomplete without some tests for robustness. To check for potential endogeneity problems, we re-estimated equation (2) treating inflation as endogenous, with lagged inflation as our chosen instrument. To establish whether the results were influenced by contamination across regimes due to regime switches, we also dropped the first observation following a regime switch. These new estimations (not reported to conserve space but available from the authors upon request) do not change the conclusions reached heretofore.

4. Further discussion

The aim of this note was to provide evidence on the effect of the choice of a

Table 4: Panel estimates for industrial versus developing countries

	Reinhart and Rogoff classification	*Shambaugh classification*	*IMF classification*	*Reinhart and Rogoff classification*	*Shambaugh classification*
Constant	0.022*	0.015	0.027*	-0.002	0.003
	(2.14)	(1.67)	(2.37)	(-0.14)	(0.28)
Investment (% of GDP)	0.002*	0.002*	0.002*	0.002*	0.001*
	(7.17)	(7.27)	(7.15)	(3.98)	(2.99)
Populationg rowth rate	-0.008*	-0.008*	-0.008*	-0.017*	-0.016*
	(-3.52)	(-3.91)	(-3.40)	(-6.50)	(-6.40)
Trend	0.0002	0.0001	-0.0001	0.0002	0.0004
	(0.74)	(0.65)	(-0.38)	(0.97)	(1.72)
DFIX	-0.017*	-0.008*	-0.013*	-0.003	-0.001
	(-8.76)	(-5.32)	(-6.34)	(-1.29)	(-0.70)
π	-0.017*	-0.016*	-0.017*	0.003	0.004
	(-1.96)	(-2.37)	(-2.08)	(0.39)	(0.65)
DINT	-0.019*	-0.003	-0.010	0.004	0.032*
	(-2.14)	(-0.32)	(-1.15)	(0.48)	(3.55)
DFIX×π	0.013*	0.005*	0.003	0.006	0.005
	(5.04)	(2.18)	(1.34)	(1.67)	(1.82)
DINT×π	0.015*	0.003	0.007*	-0.002	-0.022*
	(4.83)	(0.99)	(2.46)	(-0.57)	(-4.32)
DCFA	0.013	0.013	0.015*	0.120*	0.135*
	(1.75)	(1.89)	(1.98)	(3.92)	(4.70)
DCUNR	-0.010	-0.016*	-0.014*	-	-
	(-1.54)	(-2.08)	(-2.14)		
DHINF	-0.018*	-0.032*	-0.042*	-0.062*	0.026*
	(-2.66)	(-5.52)	(-6.91)	(-4.87)	(-2.34)
R2 - overall	0.220	0.190	0.222	0.256	0.289
R2 - between	0.275	0.371	0.274	0.699	0.749
R2 - within	0.221	0.142	0.209	0.185	0.180
Overall significance	$F_{11,1627}$=42.04*	$F_{11,1689}$=24.59*	$F_{11,1669}$=40.09*	$F_{10,706}$=16.01*	$F_{10,693}$=15.36*
Hausman test: $X^2(11)$	18.51	8.35	9.39	53.84*	16.45

Notes: R^2 values are calculated using all observations (R^2-overall); from a model using group means (R^2-between); and using deviations from the group mean (R^2-within). The Hausman misspecification tests reported, test for systematic differences between fixed and random effects estimates. T-ratios are shown in parentheses. * indicates significance at the 5% level.

Table 5: Panel estimates for developing countries disaggregated according to income classification

	Reinhart and Rogoff classification	*Shambaugh classification*	*IMF classification*	*Reinhart and Rogoff classification*	*Shambaugh classification*	*IMF classification*	*Reinhart and Rogoff classification*	*Shambaugh classification*	*IMF classification*
Constant	0.028	0.004	0.009	-0.003	-0.004	0.013	0.045*	0.038*	0.046*
	(1.41)	(0.20)	(0.43)	(-0.15)	(-0.27)	(0.70)	(2.26)	(2.13)	(2.06)
Investment (% of GDP)	0.001*	0.001*	0.001*	0.002*	0.002*	0.003*	0.001*	0.001	0.001*
	(3.06)	(3.27)	(3.31)	(5.24)	(6.83)	(6.25)	(2.62)	(2.08)*	(2.23)
Population growth rate	0.0008	0.001	0.004	-0.010*	-0.011*	-0.010*	-0.014*	-0.014*	-0.014*
	(0.18)	(0.27)	(0.81)	(-2.92)	(-3.87)	(-3.01)	(-2.81)	(-2.88)	(-2.82)
Trend	0.0005	0.0005	-0.00008	-0.0002	-0.00005	-0.0005	0.0001	0.00009	0.00007
	(1.06)	(1.16)	(-0.14)	(-0.43)	(-0.18)	(-1.38)	(0.34)	(0.23)	(0.15)
π	-0.024*	-0.014*	-0.015*	-0.011*	-0.006*	-0.008*	-0.017*	-0.006*	-0.013*
	(-5.87)	(-4.24)	(-4.01)	(-3.02)	(-2.52)	(-2.21)	(-4.98)	(-2.12)	(-3.50)
DFIX	-0.049*	-0.034*	-0.037*	0.011	-0.0007	-0.006	-0.038*	-0.030*	-0.023
	(-2.81)	(-2.25)	(-2.25)	(0.83)	(-0.08)	(-0.47)	(-2.29)	(-2.36)	(-1.49)
DINT	-0.042*	-0.051*	0.004	0.002	0.003	-0.024	-0.022	0.0008	0.022
	(-2.48)	(-2.06)	(0.18)	(0.15)	(0.25)	(-1.78)	(-1.29)	(0.05)	(0.16)
DFIX×π	0.019*	0.008	0.008	0.006	0.003	-0.005	0.017*	0.007	0.008
	(3.94)	(1.87)	(1.79)	(1.23)	(0.74)	(-1.41)	(3.36)	(1.44)	(1.85)
DINT×π	0.021*	0.017*	0.002	0.006	0.004	0.010*	0.016*	-0.001	0.003
	(3.45)	(1.97)	(0.31)	(1.17)	(0.86)	(2.11)	(2.91)	(-0.17)	(0.85)
DCFA	0.018	0.017	0.024*	0.010	0.008	0.013	-0.006	-0.008	-0.004
	(1.75)	(1.58)	(2.19)	(0.81)	(0.74)	(1.01)	(-0.24)	(-0.32)	(-0.16)
DCUNR	-0.027*	-0.028*	-0.029*	-0.020*	-0.010	-0.021*	0.025	0.013	0.016
	(-2.32)	(-2.24)	(-2.30)	(-2.16)	(-1.33)	(-2.33)	(1.71)	(0.99)	(1.11)
DHINF	0.002	-0.002	-0.018	-0.058*	-0.064*	-0.082*	-0.011	-0.036*	-0.038*
	(0.21)	(-0.22)	(-1.79)	(-3.48)	(-5.32)	(-6.06)	(-0.96)	(-3.78)	(-3.94)
R^2 - overall	0.178	0.142	0.145	0.242	0.217	0.281	0.205	0.165	0.199
R^2 - between	0.253	0.072	0.090	0.334	0.312	0.323	0.345	0.390	0.217
R^2 - within	0.188	0.135	0.150	0.255	0.221	0.294	0.224	0.138	0.216
Overall significance	$_{11,426}=8.97^*$	$F_{11,444}=6.27^*$	$F_{11,446}=7.17^*$	$F_{11,630}=19.60^*$	$F_{11,630}=16.27^*$	$F_{11,635}=24.08^*$	$F_{11,525}=13.75^*$	$F_{11,532}=7.76^*$	$F_{11,541}=13.55^*$
Hausman test: $X^2(8)$	7.47	5.01	3.25	10.18	7.69	20.00*	6.17	13.87	10.86

Notes: R^2 values are calculated using all observations (R^2-overall); from a model using group means (R^2-between); and using deviations from the group mean (R^2-within). The Hausman misspecification tests test for systematic differences between fixed and random effects estimates. T-ratios are shown in parentheses. * indicates significance at the 5% level.

particular exchange rate regime on the relationship between inflation and economic growth. Although the choice of regime may have no direct effect on economic growth, the first important implication of our results is that the exchange rate regime does indeed matter when measuring the costs of inflation in terms of long term growth. These findings are consistent with the results obtained by Andrés *et al* (1996), though they are more informative as to the performance of intermediate regimes and in unveiling potential differences between industrialised and developing countries. Our conclusion that the negative impact of inflation on growth is higher for developing countries under a floating exchange rate regime has been rationalised with reference to the 'inflation threshold hypothesis', according to which only floating currency countries experiencing relatively high inflation rates are likely to incur significant costs in terms of economic growth. The policy implication stemming from these findings is clear. Developing countries, which often tend to be associated with weak monetary institutions, should seek the price stability that they could not otherwise secure through an external nominal anchor, fixing or pegging their currency. Significantly, our results suggest that, irrespective of the scheme employed to classify the exchange rate regime, such a policy option would not come at the cost of sacrificing growth. Although the real interest rate costs associated with the need to defend a peg in the event of a negative external shock and the consequent uncertainty as to the sustainability of such a regime are generally perceived to be deleterious to growth, 'credibility' gains associated with fixed or intermediate regimes point to a reduction of a country's vulnerability to speculative currency attacks and to greater stability as factors conducive to stronger growth performance (see also Mundell, 1995).

Our findings, and the policy implication that flows from them, align well to those by Bailliu *et al* (2003), who contend that flexible rates are more prone to exchange rate shocks, exacerbating business cycles and dampening growth compared to a fixed regime, especially in the context of developing countries with a weak financial system, and to the results obtained by Husain *et al* (2005), who find that in poorer developing countries more flexible regimes are associated with higher inflation without any gains in growth while in advanced economies flexible rates offer slightly higher growth without generating higher inflation.

5. Conclusion

Exploiting recent developments in the classification of exchange rate regimes, in this note we revisited, empirically, the relationship between inflation and growth under alternative exchange rate regimes. The results, based on a large panel of 125 industrialised and developing countries over the period 1980 to 2004, indicate that the costs of inflation for economic growth are significant only in the case of developing countries. Furthermore, such costs are higher for those developing countries that have a floating currency vis-à-vis those with a fixed or intermediate exchange rate regime arrangement.

Although in many developing countries the adoption of the exchange rate regime is heavily influenced by the underlying macroeconomic conditions rather than a free policy choice, the policy implication of our findings is apparent. Based exclusively on the moderating role of the exchange rate regime with respect to the costs of inflation for economic growth, fixed or intermediate exchange rate arrangements should be the preferred policy option for developing countries.

Accepted for publication: 31 August 2010

DATA APPENDIX

y	Log of GDP per capita	World Bank, World Development Indicators.
π	Inflation rate, annual percentage change in GDP deflator	World Bank, World Development Indicators.
Z	Includes both physical investment (gross fixed capital formation) as a percentage of GDP and the annual growth rate of total population.	World Bank, World Development Indicators.
DFIX	Dummy variable that equals one when the country adopts a fixed exchange rate policy	Calculated from classifications produced by Reinhart and Rogoff (2004), Shambaugh (2004) and various issues of the IMF's *Annual Report on Exchange Rate Arrangements and Restrictions*
DINT	Dummy variable that equals one when the country has an intermediate exchange rate regime.	
DCFA	Dummy variables that equals one for the CFA franc member countries post 1993, whose currency was devalued in 1994.	
DCUNR	Dummy variable that equals one for a period of civil unrest.	Fearon and Laitin (2003); Blattman and Miguel (2010)
DHINF	Dummy variables when a country has hyperinflation defined as inflation greater than 50%.	World Bank, World Development Indicators.

Endnotes

1. Corresponding author: Andrew Abbott, Professor of Economics, Business School, University of Hull, Cottingham Road, Hull, HU6 7RX, UK. Tel: +441482 463570, Fax: +441482 347500 E-mail: a.abbott@hull.ac.uk. Thanks to the referees and editors of this journal for helpful comments. Remaining errors are our own.

2. Rather than using regression analysis, Fernández Valdovinos (2003) examines the correlation between inflation and growth from a non structural, low frequency angle. Using data for eight developing countries over the period 1970-2000, he finds that after adopting the Baxter-King filter to extract the long-run components of the series, a strong negative association between inflation and growth emerges from the data.

3. Inevitably the model rests on rather stringent assumptions such as perfect competition and constant returns to scale technology, with the latter also implying that marginal productivity of labour is proportional to the average product of labour.

4. In 1994, there was a major devaluation of the CFA franc, with the rate changing from 1 CFA franc = 0.02 French franc to 1 CFA franc = 0.01 French franc.

5. As rightly suggested by an anonymous referee, accounting for the possibility of structural breaks that occurred in individual countries' macro-economies over the sample period is particularly important given that our sample includes many countries that experienced dips in growth rates over the period due to civil unrest (Liberia, Zimbabwe, Bosnia, etc.). A similar case can be made for breaks due to hyperinflation. For example Zimbabwe's inflation rate was between 113.3 per cent and 116.3 per cent in early 2002.

References

Andrés J, Hernando I and Krüger M (1996) 'Growth, Inflation and the Exchange Rate Regime', *Economics Letters*, 53, 61-65.

Balassa B (1964) 'The Purchasing Power Parity Doctrine: A Reappraisal', *Journal of Political Economy*, 72, 584-596.

Barro R (1991) 'Economic Growth in a Cross Section of Countries', *Quarterly Journal of Economics*, 104, 407-433.

Barro R (1995) 'Inflation and Economic Growth', *Bank of England Quarterly Bulletin*, May, 1-11.

Bailliu J, Lafrance R and Perrault J-F (2003) 'Does Exchange Rate Policy Matter for Growth?', *International Finance*, 6, 381-414.

Blattman C and Miguel E (2010) 'Civil War', *Journal of Economic Literature*, 48, 3-57.

Bleaney M and Francisco M (2007) 'Exchange Rate Regimes, Inflation and Growth in Developing Countries – An Assessment', *The B.E. Journal of Macroeconomics*, 7, 1-16.

Choi I (2001) 'Unit Root Tests for Panel Data' in Baltagi B H (ed) *Advances in Econometrics, Volume 15: Nonstationary Panels, Panel Cointegration, and Dynamic Panels*. Amsterdam: JAI Press.

De Gregorio J (1992) 'Economic Growth in Latin America', *Journal of Development Economics*, 39, 59-84.

De Gregorio J (1993) 'Inflation, Taxation and Long-run Growth', *Journal of Monetary Economics*, 31, 271-298.

Fearon J and Laitin D (2003) 'Ethnicity, Insurgency, and Civil War', *American Political Science Review*, 97, 75-90.

Fernández Valdovinos C G (2003) 'Inflation and Economic Growth in the Long Run', *Economics Letters*, 80, 67-173.

Fischer S (1993) 'The Role of Macroeconomic Factors in Growth', *NBER Working Paper No. 4565*.

Fischer S (2001) 'Exchange Rate Regimes: Is the Bipolar View Correct?', *Journal of Economic Perspectives*, 15, 3-24.

Genberg H and Swoboda K (2005) 'Exchange Rate Regimes: Does What Countries Say Matter?', *IMF Staff Papers, 52, Special Issue*.

Husain A M, Mody A and Rogoff K S (2005) 'Exchange Rate Regime Durability and Performance in Developing versus Advanced Economies', *Journal of Monetary Economics*, 52, 35-64.

International Monetary Fund. *Annual Reports on Exchange Rate Arrangements and Exchange Restrictions*. Washington, D.C., IMF, 1981-2007.

Jones L and Manuelli R (1995) 'Growth and the Effects of Inflation', *Journal of Economic Dynamics and Control*, 19, 1405-1428.

Khan M S and Senhadji A S (2001) 'Threshold Effects in the Relationship Between Inflation and Growth', IMF Staff Papers, 48:1.

Kormendi R L and Meguire P G (1985) 'Macroeconomic Determinants of Growth: Cross-Country Evidence', *Journal of Monetary Economics*, 16, 141-163.

Levy-Yeyati E and Sturzenegger F (2003) 'To Float or To Fix: Evidence on the Impact of Exchange Rate Regimes on Growth', *American Economic Review*, 93, 1173-1193.

Mundell R (1995) 'Exchange Rate Systems and Economic Growth', *Rivista di Politica Economica*, 85, 1-36.

Reinhart C and Rogoff K (2004) 'The Modern History of Exchange Rate Arrangements: A Reinterpretation', *Quarterly Journal of Economics*, 119, 1-48.

Roubini N and Sala-i-Martin X (1995) 'A Growth Model of Inflation, Tax Evasion and Financial Repression', *Journal of Monetary Economics*, 35, 275-301.

Samuelson P (1964) 'Theoretical Notes on Trade Problems', *Review of Economics and Statistics*, 46, 145-154.

Shambaugh J C (2004) 'The Effect of Fixed Exchange Rates on Monetary Policy', *Quarterly Journal of Economics*, 119, 300-351.

Williamson J (2000) *Exchange Rate Regimes for Emerging Markets: Reviving the Intermediate Option.* Washington, D.C., Institute for International Economics.

Wu Y and Zhang J (1998) 'Endogenous Growth and the Welfare Costs of Inflation: A Reconsideration', *Journal of Economic Dynamics and Control*, 22, 465-482.