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Abstract

In a rational expectations model, wages and prices should respond more to shocks in currency unions than in soft pegs because of the absence of exchange rate adjustment. Empirical evidence from three currency unions tends to support this hypothesis, but the rate of adjustment is slow.

Keywords: currency union, exchange rate, price.

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1. INTRODUCTION

As the Eurozone crisis has shown, currency unions, or individual member countries within a currency union, can experience problems of external competitiveness for a variety of reasons. The most obvious is a higher inflation rate than the anchor currency to which the currency is pegged, or (in the case of individual member countries) relative to the rest of the union. If the union's currency floats, it may experience significant volatility, and the same is true if a currency is pegged to a currency that floats.[1] For example, appreciation of the US dollar against the euro played a part in the 2001 collapse of Argentina's pegged regime, which is generally classified as a "hard" peg (as are customs unions) because of the degree of commitment not to devalue or revalue the exchange rate. Chen *et al*. (2012) identify the appreciation of the euro against other currencies as the most important component of real exchange rate appreciation in the peripheral Eurozone countries between 2000 and 2009.

Individual member countries of currency unions have different trade structures that affect their sensitivity to movements in the union's currency: for example Ireland's effective exchange rate is particularly sensitive to the euro-sterling rate because Ireland's geographical position gives the U.K. a particularly large weight in the country's trade. A further possibility is a sudden stop in capital flows to individual member countries that reduces their equilibrium real exchange rates, as happened to the peripheral Eurozone countries (Jaumotte and Sodsriwiboon, 2010; Shambaugh, 2012).

Because parity changes are ruled out, currency unions, like hard pegs to a single currency, may require significant price adjustment to correct a disequilibrium in the real exchange rate, whereas in soft pegs the nominal exchange rate is still available as an adjustment mechanism.

[1] This volatility can be avoided by pegging to an appropriate basket of currencies, but few countries do this, perhaps because pegs to a single currency are more transparent. Ghosh *et al.* (2014) provide some evidence of the advantages of transparency, in that *de facto* pegs that are also *de jure* pegs tend to have lower inflation than undeclared *de facto* pegs.

In a rational expectations model, as shown below, wage- and price-setters should be more willing to adjust wages and prices under hard pegs, because the nominal exchange rate is known to be fixed. On the other hand, nominal rigidities may obstruct this, at least in a downward direction, and the resulting output losses may precipitate a currency crisis along the lines of Obstfeld (1996), particularly if the banking system is also exposed to significant losses, as in the euro area.[2] This paper investigates price adjustment in three currency unions, and compares it with other exchange rate regimes.

The results show that, under floating or soft pegs, price adjustment is small, and adjustment works more or less exclusively through the nominal exchange rate. In currency unions, as the model predicts, price adjustment is statistically significant, but still slow: a 10% difference in the level of the real effective exchange rate is estimated to be associated with a relative price movement of less than 1% p.a.

2. THE THEORETICAL MODEL

The model is in the tradition of Barro and Gordon (1983). The deviation of (the log of) output (y) from its equilibrium level ($\bar{y}$) is an increasing function of the deviation of inflation (π) from its expected level (π^*), and a decreasing function of (the log of) the real wage (w). There is an additive zero-mean stochastic element (z), which we shall think of as a productivity shock, so ($w - z$) is effectively unit labour costs:

$$y = \bar{y} - \theta(w - z) + \beta(\pi - \pi *) \qquad \theta > 0, \beta > 0 \qquad (1)$$

For simplicity we shall assume that the real wage is set by workers who like both a higher real wage and higher output, and that their loss function is:

[2] For a model of the interaction between banking and currency crises, see Bleaney *et al*. (2008).

$$L_W = \frac{1}{2}(\tilde{y} - y)^2 + \frac{1}{2}(\widetilde{w} - w)^2 \qquad (2)$$

In equation (2) workers have a target level of output of $\tilde{y}$, which is assumed to be greater than $\bar{y}$, and a target real wage of $\widetilde{w} > 0$. From (1) it can be seen that, if $\pi = \pi^*$ and $z = 0$, y can only exceed $\bar{y}$ if w is negative, so in normal times (i.e. in the absence of an exceptionally favourable value of z) workers cannot attain their bliss point of $(\tilde{y}, \widetilde{w})$.[3]

The government cares about output and price stability, and has the same target level of output as the workers. It chooses the level of inflation to minimise its loss function, which is:

$$L_g = \frac{1}{2}(\tilde{y} - y)^2 + \frac{1}{2}\pi^2 \qquad (3)$$

Purchasing power parity is assumed to hold, with foreign inflation of zero, so the rate of inflation is also the rate of nominal exchange rate depreciation.

The model works as follows. In each period, the workers and the government observe z, and then choose w and π respectively to minimise their loss functions, taking full account of what the other is doing. The expected inflation rate π^* is a predetermined variable that is assumed to be zero for currency unions, whilst for soft pegs it reflects the rational expectations solution for inflation based on the assumption that $\pi = \pi^*$ and $z = 0$ (this is discussed further below).

Writing $k = (\tilde{y} - \bar{y}) > 0$ and substituting from (1) into (2) and (3) yields:

$$L_W = \frac{1}{2}[k + \theta(w - z) - \beta(\pi - \pi *)]^2 + \frac{1}{2}(\widetilde{w} - w)^2 \qquad (4)$$

[3] Since the price level is effectively determined by the exchange rate, workers can set the real wage by determining the nominal wage. One can think of (2) as reflecting the preferences of a union in centralised wage-bargaining, or alternatively of a series of identical worker-owned firms operating in a competitive market.

and

$$L_g = \frac{1}{2}[k + \theta(w - z) - \beta(\pi - \pi *)]^2 + \frac{1}{2}(\pi)^2 \quad (5)$$

The workers observe z and choose w to minimise L_W, and simultaneously the government also observes z and chooses π to minimise L_g. The two equations are:

$$\partial L_W / \partial w = \theta[k + \theta w - \theta z - \beta(\pi - \pi *)] + w - \widetilde{w} = 0 \quad (6)$$

and

$$\partial L_g / \partial \pi = -\beta[k + \theta w - \theta z - \beta(\pi - \pi *)] + \pi = 0 \quad (7)$$

From (6) we obtain

$$(1 + \theta^2)w = \widetilde{w} - \theta k + \theta^2 z + \theta\beta(\pi - \pi *) \quad (8)$$

and from (7) we get

$$(1 + \beta^2)\pi = \beta^2\pi * + \beta[k + \theta(w - z)] \quad (9)$$

Fixed exchange rates (currency union)

Under fixed exchange rates $\pi = \pi * = 0$, so from (8)

$$\frac{\partial w}{\partial z} = \frac{\theta^2}{1+\theta^2} \quad (10)$$

Equation (10) implies that, in order to insulate output somewhat from negative shocks, workers allow real wages to fall. The extent of the adjustment depends positively on the sensitivity of output to unit labour costs (θ).

In the case of output, partially differentiating (1) with respect to z yields:

$$\left(\frac{\partial y}{\partial z}\right) = \theta - \theta\left(\frac{\partial w}{\partial z}\right) + \beta\left(\frac{\partial \pi}{\partial z}\right) = \frac{\beta\theta^2}{1+\theta^2} - \beta = -\frac{\beta}{1+\theta^2} \quad (11)$$

For a hard peg, $\frac{\partial \pi}{\delta z} = 0$, so, using (10):

$$\left(\frac{\partial y}{\partial z}\right) = \theta - \frac{\theta^3}{1+\theta^2} = \frac{\theta}{1+\theta^2} \quad (12)$$

Soft pegs

Under soft pegs, the government is assumed to be free to adjust the nominal exchange rate so as to achieve its preferred level of π. Substituting from (8) into (9) yields the solution for π as:

$$(1+\beta^2+\theta^2)\pi = \beta^2\pi * + \beta k + \beta\theta(\widetilde{w} - z) \quad (13)$$

From (8) we have

$$(1+\theta^2)(\partial w/\partial z) = \theta^2 + \beta\theta(\partial\pi/\partial z) \quad (14)$$

From (13) we have

$$(1+\beta^2+\theta^2)(\partial\pi/\partial z) = -\beta\theta \quad (15)$$

This shows that a negative shock (a lower z) is partly absorbed in faster nominal exchange depreciation (a higher π). Substituting from (15) into (14) shows that, because of this, the real wage adjusts less than in the currency-union case shown in equation (10):

$$\frac{\partial w}{\partial z} = \frac{\theta^2}{1+\beta^2+\theta^2} \quad (16)$$

In short, the constraints of a fixed exchange rate give currency unions low inflation, but the cost is that the exchange rate cannot then be used to mitigate output shocks; this can be achieved only by adjusting internal prices (the real wage). In soft pegs, some degree of inflation is the norm, but the rate of devaluation can be adjusted to compensate for productivity shocks, with the consequence that internal prices adjust less than in the currency-union case. In the next section we test this prediction on empirical data.

Substituting from (15) and (16) into (11) yields the sensitivity of output to shocks in the soft-peg case, which is also less than in the hard-peg case:

$$\left(\frac{\partial y}{\partial z}\right) = \theta - \frac{\theta^3}{1+\beta^2+\theta^2} - \frac{\beta^3\theta}{1+\beta^2+\theta^2} = \frac{\theta}{1+\beta^2+\theta^2} \quad (17)$$

Finally, the value of $\pi*$ in the soft-peg case can be obtained by solving (8) and (9) for $\pi = \pi*$ and $z = 0$. This yields:

$$(1+\theta^2)w = \tilde{w} - \theta k \tag{18}$$

and, on substituting from (18) into (9):

$$\pi * = \frac{\beta(k+\theta\tilde{w})}{1+\theta^2} \tag{19}$$

3. DATA

There are three currency unions in our analysis: the euro area, the African Financial Community (CFA) and the East Caribbean Currency Authority (ECCA). The identification of other pegs and floats is drawn from the classification scheme of Bleaney and Tian (2014).

Annual data for 186 countries over the period 1980 to 2014 are used (1999 to 2014 for the euro area and the CFA zone), and are mostly drawn from IMF International Financial Statistics (IFS).[4] The GDP deflators are from the IMF World Economic Outlook (WEO) database, and price indices for the euro area from OECD Economic Outlook.

4. EMPIRICAL RESULTS

The model's three predictions are: comparing hard pegs with soft pegs, (1) inflation is lower; (2) output is more sensitive to shocks; and (3) there is more price adjustment to shocks. We concentrate on the third prediction, since the first is a well-known result (e.g. Bleaney and Francisco, 2005), and the second has been addressed elsewhere (e.g. Ghosh *et al*., 2015).

We estimate the following equation:

$$DlnP_{it} - DlnPA_{it} = a_i - bDlnRA_{it} - clnR_{it-1} + u_{it} \tag{20}$$

[4] Data before 1999 are not used for the CFA zone because of the large devaluation of the CFA franc in 1994.

where P_{it} is the consumer price index in country i in year t, PA_{it} is the same thing for country i's anchor currency, R is the real effective exchange rate index (an increase representing an appreciation), RA is the real effective exchange index of the anchor currency, D is the first-difference operator and u is a random error. Equation (1) expresses inflation relative to that in the anchor currency as a function of current real exchange rate appreciation of the anchor currency and the lagged level of the real exchange rate of country i. If $c > 0$, then there is price adjustment relative to the anchor currency in response to the lagged level of the country's real effective exchange rate. In an alternative formulation we replace the consumer price index by the GDP deflator.

It is useful to disaggregate the volatility of the real effective exchange rate of a member of a currency union into separate elements. Let R be the log of the real effective exchange rate of the country, N the log of its nominal effective exchange rate, and P and PF respectively the log of domestic prices and of the trade-weighted average of foreign prices (PA and PFA respectively for the anchor currency). By the definition of R,

$$R = N + P - PF \quad (21)$$

and for the anchor currency (A),

$$RA = NA + PA - PFA \quad (22)$$

Subtracting (22) from (21) and taking first differences yields:

$$DR = DRA + (DN - DNA) + (DP - DPA) - (DPF - DPFA) \quad (23)$$

So real exchange rate movements (DR) can be decomposed into (1) real effective exchange rate changes of the anchor currency (DRA); (2) nominal effective exchange rate changes relative to the anchor currency (DN – DNA), which can only happen (in the absence of a currency union devaluation) because of differences in trade weights; (3) inflation relative to the anchor currency (DP – DPA); and (4) differences in trade-weighted foreign inflation, which again is a matter of weights. The second and last terms are the effect of different trading partner weights between the member of the currency union and the anchor currency.

Table 1 shows that real exchange rate volatility of the anchor currency (DRA) has tended to be more important than inflation differentials (DP – DPA) to the real exchange rate volatility of currency union members. This suggests that the exogenous shocks assumed in the model have been a significant component of real exchange rate volatility in currency unions.

Table 1. Real Effective Exchange Rate Volatility in Currency Unions

Standard deviation	ECCA 1980-2014	CFA 1999-2014	Euro Area 1999-2014
DR	0.0414	0.0461	0.0268
DRA	0.0571	0.0579	0.0540
DN – DNA	0.0495	0.0273	0.0312
DP – DPA	0.0182	0.0297	0.0108
DPF – DPFA	0.0383	0.0104	0.0055
Observations	204	192	226
Anchor currency	US dollar	euro	euro

Notes. Data are annual. DR (DRA): change in log of real effective exchange rate of member countries (anchor currency). DN (DNA): change in log of nominal effective exchange rate of member countries (anchor currency). DP ((DPA): change in log of consumer price index of member countries (anchor currency). DPF (DPFA): trade-weighted average of change in log of trading partners' consumer price indices of member countries (anchor currency).

In the remainder of this paper we investigate whether the price level of member countries responds to the level of the lagged real effective exchange rate. The model in Section Two predicts that the response will be stronger in currency unions than in soft pegs.

Table 2 shows the results of estimating equation (20) separately for currency unions, other pegs and floats, and then for the three currency unions individually, using the price index and real effective exchange rate (REER) index of the euro area for the CFA and for individual euro-area countries, and of the US dollar for the ECCA. Where fixed country effects are not significant (as is the case for currency unions), the equation is estimated by OLS (the *p*-value of this test is given at the foot of Table 2). For currency unions the point estimate of the coefficient of the lagged REER is -0.0658, with a *t*-statistic of -7.42, whereas for other pegs the coefficient is only -0.0103, with a *t*-statistic of -1.62. Thus in currency unions there is a significant negative correlation between the lagged REER and consumer price inflation relative to the anchor currency. This is consistent with the predictions of the model, but it also implies that adjustment to real exchange rate shocks is slow, with a relative inflation effect of a 10 % difference in the real exchange rate of less than 0.7 % p.a.

In the individual currency unions the picture is fairly similar, with the lagged REER coefficient always negative and significant at the 1 % level, although the coefficient is biggest and most significant for the euro area.

In Table 3 we estimate a less parsimonious model of inflation as follows:

$$DlnP_{it} = a + bDlnPA_{it} - cDlnRA_{it} - elnR_{it-1} + fDlnP_{it-1} + gDlnR_{it-1} + u_{it} \tag{24}$$

In equation (24) the coefficient of the anchor country's inflation rate is no longer constrained to be equal to one, and lagged inflation and lagged real exchange rate movements are added to the equation. Because of the lagged dependent variable, the equation is estimated by OLS in every case, to avoid bias from the inclusion of fixed effects which, as in the case of Table 2, are insignificant for currency unions.

Table 3 shows the results of estimating equation (24). For currency unions, both as a whole and individually, anchor currency inflation is highly significant with a coefficient exceeding but not very far from one, which implies that the Table 2 model is not unreasonable. The lagged inflation coefficient is always positive and significant in almost every case, indicating some degree of inflation inertia. The lagged REER coefficients are similar to those in Table 2, with a point estimate of -0.0702 (and a *t*-statistic of-7.70) for currency unions, -0.0086 (-3.83) for other pegs and -0.0043 (-0.93) for floats. For individual currency unions the lagged REER coefficient always has a slightly lower *t*-statistic than in Table 2, but it is still significant at 1 % in each case.[5]

Table 4 looks at nominal exchange rate adjustment relative to the US dollar for soft pegs and floats, with the same explanatory variables as used for relative price adjustment in Table 2. The sample is confined to non-European countries, since European countries are more likely to be pegged to the euro, and also to observations with inflation in the range -10 % to +10 %. The estimated equation is:

$$DlnNUS_{it} = a_i - bDlnRA_{it} - clnR_{it-1} + u_{it} \qquad (25)$$

where *NUS* is the bilateral exchange rate against the U.S. dollar (U.S. dollars per unit of country i's currency).

For floats, the coefficient of the lagged REER in Table 4 is -0.164, with a *t*-statistic of -5.02, indicating significant exchange rate adjustment against the US dollar. For soft pegs, the coefficient is smaller, at -0.0577, and just significant at 10%, with a *t*-statistic of -1.71. Nevertheless the coefficient is more than five times as large as the equivalent coefficient for relative price adjustment for soft pegs in Table 2, which suggests that soft pegs rely mainly on exchange rate rather than price adjustment.

A common explanation for slow price adjustment is the existence of nominal rigidities, and particularly resistance to falls in prices and wages. If rigidities are particularly strong in a downward direction, then adjustment should be slower for negative shocks, which require price falls, than for positive ones. This suggests that nominal rigidities should be reflected in asymmetries in the adjustment process. To test this, the square of the lagged real

[5] If we ignore the bias issue and include country fixed effects where the test statistic shows them to be significant, the coefficients of the lagged REER are fairly similar: -0.00676 for other pegs and +0.00287 for floats.

effective exchange rate is added to equation (20). If nominal rigidities are significant, then adjustment should be slower (implying a less negative coefficient) when the lagged REER is high, so the coefficient of the square of the lagged REER should be positive.

Table 5 shows the results for all currency unions combined, and then for each one separately. For all currency unions together, the coefficient of the square of the lagged REER has the expected positive sign, but it has a *t*-statistic of only 1.11. Of the individual currency unions, only the ECCA has a positive sign for this coefficient, which is just significant at the 5 % level. For the Eurozone (where the results with country fixed effects are shown), the coefficient of the squared lagged REER is significant at the 1 % level but *negative*, in contradiction to the nominal rigidities hypothesis.

Table 6 repeats Table 2 using relative GDP deflators rather than consumer prices, because GDP deflators cover a wider range of goods and include exports rather than imports. The point estimate of the lagged REER coefficient for all currency unions combined is even slightly larger than in Table 2, at -0.0801, but it is significant at only 10 %, because the root mean square error of the regression is 0.0554, compared with 0.0201 in Table 2. This reflects the volatility of GDP deflators amongst commodity exporters in the CFA zone. The lagged REER coefficient for other pegs is rather larger and more significant than in Table 2, at -0.0337, with a *t*-statistic of -4.65. The individual currency unions present a very varied picture. For the euro area, the lagged REER coefficient is 40 % larger than in Table 2. This is consistent with Tressel and Wang's (2014) finding that different measures produce different estimates of the degree of REER adjustment in the euro area. For the ECCA, however, the lagged REER coefficient is unexpectedly positive, and for the CFA it is strongly negative, at -0.1965, but not statistically significant.

We have to acknowledge that there is always the possibility of some degree of endogeneity bias to these results: countries may differ in their degree of internal wage and price flexibility for institutional reasons, and those with greater flexibility may be more likely to opt for a currency union, knowing that they have the capacity to adjust to shocks. In other words, we may be observing self-selection of more flexible countries into currency unions rather than the effect of membership that is predicted by the theoretical model. The standard way to address such issues is to find a suitable instrument for the variable suspected of endogeneity; the instrument should not itself be correlated with the dependent variable other than through its correlation with the potentially endogenous variable. It is very difficult to think of an instrument for currency union membership that convincingly meets these criteria. An alternative approach might be to collect some measure of countries' institutional structure, in order to see whether currency unions have institutions that particularly favour price flexibility. Again, to find such a measure is difficult, because it is not just a matter of union membership but also of how centralised waged bargaining is (Bruno and Sachs, 1985; Freeman, 2007).

5. CONCLUSIONS

Floats rely exclusively on nominal exchange rate adjustment to correct real exchange rate misalignments. Soft pegs are like paler versions of floats, with slower nominal exchange rate adjustment and negligible relative price adjustment. In currency unions, where nominal exchange rate adjustment is ruled out, relative price adjustment is statistically significant but still quite slow in economic terms, with a 10 % higher real exchange rate being associated with a consumer price differential of less than 1 % in the subsequent year. For the euro area, the estimated rate of adjustment is faster using GDP deflators rather than consumer prices. The role of nominal rigidities remains unclear, because the evidence does not demonstrate that adjustment is any slower in the case of negative shocks.

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Appendix. Countries in the Sample

Table A1. Sample of Countries and Groups (listed by 2012exchange rate regime)	
Currency Unions (37)	
Euro area (17)	Austria, Belgium, France, Germany, Italy, Luxembourg, Netherlands, Finland, Greece (since 2001), Ireland, Malta (since 2008), Portugal, Spain, Cyprus (since 2008), Slovak Republic (since 2009), Estonia, Slovenia (since 2007);
CFA (14)	Cameroon, Central African Republic, Chad, Republic of Congo, Benin, Equatorial Guinea, Gabon, Guinea-Bissau, Côte d'Ivoire, Mali, Niger, Senegal, Togo, Burkina Faso;
East Caribbean (6)	Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines;
Soft Pegs (96)	Albania, Angola, Anguilla, Argentina, Aruba, Republic of Azerbaijan, Bahamas, Bahrain, Barbados, Belize, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brunei Darussalam, Bulgaria, Burundi, CEMAC, Cabo Verde, Cambodia, P.R. China: Hong Kong, P.R. China: Macao, P.R. China: Mainland, Comoros, Democratic Republic of Congo, Costa Rica, Croatia, Curaçao and St Maarten, Denmark, Djibouti, Dominican Republic, ECCU, Egypt, El Salvador, Eritrea, Ethiopia, Fiji, Georgia, Guinea, Guyana, Haiti, Honduras, Indonesia, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Kiribati, Kuwait, Lao People's Democratic Republic, Latvia, Lebanon, Lesotho, Libya, Lithuania, Macedonia, Malawi, Maldives, Micronesia, Montenegro, Montserrat, Morocco, Myanmar, Namibia, Nicaragua, Nigeria, Oman, Pakistan, Panama, Papua New Guinea, Peru, Qatar, Rwanda, São Tomé and Príncipe, Samoa, San Marino, Saudi Arabia, Sierra Leone, Solomon Islands, Sudan, Suriname, Swaziland, Tajikistan, Tanzania, Thailand, Tonga, Trinidad and Tobago, Tunisia, Ukraine, United Arab Emirates, Vanuatu, Venezuela, Vietnam, WAEMU, Republic of Yemen;
Floats (53)	Afghanistan, Algeria, Armenia, Australia, Bangladesh, Belarus, Brazil, Canada, Chile, Colombia, Czech Republic, Euro Area, Gambia, Ghana, Guatemala, Hungary, Iceland, India, Israel, Japan, Kenya, Republic of Korea, Kyrgyz Republic, Liberia, Madagascar, Malaysia, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Mozambique, Nepal, New Zealand, Norway, Paraguay, Philippines, Poland, Romania, Russian Federation, Republic of Serbia, Seychelles, Singapore, South Africa, Sri Lanka, Sweden, Switzerland, Turkey, Uganda, United Kingdom, United States, Uruguay, Zambia.

Table 2. Lagged Real Effective Exchange Rates and Consumer Price Inflation Relative to the Anchor Currency

	Exchange rate regime			Individual currency union		
	Currency union	Other peg	Float	CFA	Euro area	ECCA
Estimation method:	OLS	FE	FE	OLS	OLS	OLS
Constant	0.306*** (7.46)			0.299*** (3.55)	0.444*** (7.93)	0.279*** (3.53)
DRA	-0.0138 (-0.93)	-0.0311* (-1.89)	0.0034 (0.14)	-0.0242 (-0.69)	-0.0329*** (-2.31)	0.0129 (0.50)
R(-1)	-0.0658*** (-7.42)	-0.0103 (-1.62)	-0.0022 (-0.46)	-0.0642*** (-3.46)	-0.0963*** (-7.89)	-0.0599*** (-3.54)
Sample size	602	1234	601	190	226	186
No. countries	37	97	75	14	17	6
RMSE	0.0201	0.0247	0.0207	0.0296	0.0093	0.0175
R-squared	0.0864	0.0193	0.0005	0.0451	0.2687	0.0856
p-value of country fixed effects	0.850	0.000***	0.000***	0.769	0.098*	0.796

Notes. Dependent variable is change in log of consumer price index of member country relative to the anchor currency (DP – DPA). DRA: change in log of real effective exchange rate of anchor currency. R: log of real effective exchange rate of member country. Figures in parentheses are heteroscadisticity-robust t-statistics. *, **, ***: significantly different from zero at the 10, 5 and 1 % levels. Annual data 1980-2014 (1999-2014 for CFA and Euro area). For regimes other than currency unions, the sample excludes European countries and those with consumer price inflation of more than 10 % or less than -10 %, and the anchor currency is the US dollar. Regime classifications: Bleaney and Tian (2014).

Table 3. A Less Restrictive Model

	Exchange rate regime			Individual currency union		
	Currency union	Other peg	Float	CFA	Euro area	ECCA
Estimation method:	OLS	OLS	OLS	OLS	OLS	OLS
Constant	0.320*** (7.64)	0.0565*** (5.12)	0.0478** (2.39)	0.215** (2.46)	0.336*** (4.83)	0.279*** (3.41)
DPA	1.143*** (12.88)	0.539*** (7.74)	0.259** (2.09)	1.511*** (3.83)	1.218*** (13.3)	0.959*** (9.09)
DRA	-0.0326** (-2.06)	-0.0408** (-2.18)	-0.0230 (-0.88)	-0.0180 (-0.48)	-0.0521*** (-4.77)	-0.0424* (-1.68)
R(-1)	-0.0702*** (-7.70)	-0.0086*** (-3.83)	-0.0043 (-0.93)	-0.0487*** (-2.64)	-0.0750*** (-4.98)	-0.0607*** (-3.45)
DP(-1)	0.100* (1.81)	0.199** (2.51)	0.191*** (3.43)	0.146 (1.43)	0.233*** (2.97)	0.135** (2.40)
DR(-1)	-0.0268 (-1.06)	-0.0286* (-1.86)	-0.0057 (-0.72)	-0.1207** (-2.12)	0.0291 (1.47)	0.0117 (0.31)
Sample size	595	1207	589	189	226	180
No. countries	37	97	73	14	17	6
RMSE	0.0197	0.0275	0.0251	0.0294	0.0086	0.0162
R-squared	0.2865	0.1922	0.1867	0.1838	0.6621	0.3782
p-value of country fixed effects	0.921	0.000***	0.000***	0.429	0.708	0.906

Notes. Dependent variable is change in log of consumer price index of member country (DP). DRA: change in log of real effective exchange rate of anchor currency. R: log of real effective exchange rate of member country. DPA: change in log of consumer price index of anchor currency. Figures in parentheses are heteroscedasticity-robust t-statistics. *, **, ***: significantly different from zero at the 10, 5 and 1 % levels. Annual data 1980-2014 (1999-2014 for CFA and Euro area). For regimes other than currency unions, the sample excludes European countries and those with consumer price inflation of more than 10 % or less than -10 %, and the anchor currency is the US dollar. Regime classifications: Bleaney and Tian (2014).

Table 4. Nominal Exchange Rate Adjustment in Other Pegs and Floats

	Exchange rate regime	
	Other pegs	Floats
DRA	-0.445*** (-7.59)	-1.01*** (-7.86)
R(-1)	-0.0577* (-1.71)	-0.164*** (-5.02)
Sample size	1234	601
No. countries	97	75
RMSE	0.0662	0.0947
R-squared	0.1333	0.2307

Notes. Country fixed effects included. Dependent variable is change in the bilateral nominal exchange rate relative to the US dollar. DRA: change in log of real effective exchange rate of anchor currency. R: log of real effective exchange rate of member country. Figures in parentheses are heteroscedasticity-robust t-statistics. *, **, ***: significantly different from zero at the 10, 5 and 1 % levels. Annual data 1980-2014. The sample excludes European countries and those with consumer price inflation of more than 10 % or less than -10 %, and the anchor currency is the US dollar. Regime classifications: Bleaney and Tian (2014).

Table 5. Testing for Nominal Rigidities in Currency Unions

	All	CFA	Euro area	ECCA
Estimation method:	OLS	OLS	FE	OLS
Constant	1.03 (1.57)	1.13 (0.76)		6.09** (2.04)
DRA	-0.125 (-0.85)	-0.0210 (-0.58)	-0.0353*** (-3.01)	0.0205 (0.80)
R(-1)	-0.384 (-1.34)	-0.442 (-0.65)	3.64*** (3.14)	-2.53** (-2.01)
R(-1) squared	0.0350 (1.11)	0.0427 (-0.55)	-0.409*** (-3.21)	0.264** (1.97)
Sample size	602	190	226	186
No. countries	37	14	17	6
RMSE	0.0201	0.0297	0.0089	0.0173
R-squared	0.0881	0.0460	0.1813	0.1072
p-value of country fixed effects	0.832	0.779	0.015**	0.529

Notes. Dependent variable is change in log of consumer price index of member country relative to the anchor currency (DP – DPA). DRA: change in log of real effective exchange rate of anchor currency. R: log of real effective exchange rate of member country. Figures in parentheses are heteroscedasticity-robust t-statistics. *, **, ***: significantly different from zero at the 10, 5 and 1 % levels. Annual data 1980-2014 (1999-2014 for CFA and Euro area). Regime classifications: Bleaney and Tian (2014).

Table 6. Using GDP Deflators instead of Consumer Price Inflation

	Exchange rate regime			Individual currency union		
	Currency union	Other peg	Float	CFA	Euro area	ECCA
Estimation method:	OLS	FE	FE	OLS	FE	OLS
Constant	0.381* (1,82)			0.922 (1.51)		-0.179** (-2.02)
DRA	-0.205*** (-3.85)	-0.112*** (-5.16)	0.0092 (0.31)	-0.505*** (-3.72)	-0.0642*** (-3.85)	-0.0689 (-1.50)
R(-1)	-0.0801* (-1.77)	-0.0337*** (-4.65)	-0.0160 (-1.61)	-0.1965 (-1.48)	-0.1346*** (-7.24)	0.0396** (2.09)
Sample size	622	1336	614	192	226	186
No. countries	37	103	78	14	17	6
RMSE	0.0554	0.0340	0.0251	0.0893	0.0131	0.0297
R-squared	0.0563	0.0875	0.0118	0.1214	0.2155	0.0421
p-value of country fixed effects	0.3020	0.000***	0.000***	0.807	0.000***	0.194

Notes. Dependent variable is change in log of the GDP deflator of member country relative to the anchor currency. DRA: change in log of real effective exchange rate of anchor currency. R: log of real effective exchange rate of member country. Figures in parentheses are heteroscedasticity-robust t-statistics. *, **, ***: significantly different from zero at the 10, 5 and 1 % levels. Annual data 1980-2014 (1999-2014 for CFA and Euro area). For regimes other than currency unions, the sample excludes European countries and those with consumer price inflation of more than 10 % or less than -10 %, and the anchor currency is the US dollar. Regime classifications: Bleaney and Tian (2014).