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The Disappearing Openness-Inflation Relationship: A Cross-Country Analysis of Inflation Rates

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Abstract

The robust negative correlation between openness and inflation found in cross-country data for the 1970s and 1980s has disappeared in the 1990s. There is now a strong negative correlation of inflation with per capita GDP, as higher-income countries have achieved significant disinflation not emulated by lower-income countries. Since 1973, the most consistent finding is that floating exchange rate regimes are associated with inflation rates at least 10 percent a year higher than pegged exchange rate regimes, after allowing for other factors. There is also a consistent positive correlation between land area and inflation.

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I. Introduction

Are there systematic factors that determine the pattern of inflation rates across the world? Do larger, poorer countries tend to have higher inflation rates, for example?

A question of particular interest is whether a higher ratio of imports to GDP is associated with lower inflation. Empirical work by Romer (1993) and Lane (1997) suggests a robust relationship between openness and inflation in a sample of more than 100 countries based on 1973-88 averages. Does this relationship still exist using 1989-98 averages?

The results reported here show that the openness-inflation relationship has become very weak in recent years and is no longer robust. Once other structural factors (such as population and land area) or other important determinants of inflation such as the exchange rate regime are brought into the analysis, openness becomes insignificant. Moreover, a strong negative correlation between per capita GDP and inflation has developed in the recent period, because of the successful disinflation of the industrial countries. Some characteristics of cross-country inflation rates are, however, consistent over the whole period since 1973. One is that there is a strong exchange rate regime effect: floating the exchange rate is associated with an inflation rate at least 10 percent higher than pegging. Another feature is that inflation tends to be positively correlated with land area, for reasons which are rather unclear.

The paper also includes a simple analysis of the determinants of the exchange rate regime. Although there is still a tendency for smaller countries to be more likely to peg their exchange rates, the distribution of countries across exchange rate regimes is now much closer to being random than it was in the 1973-88 period.

II. Theory

The critical elements of the theory used by Romer and Lane can be highlighted very simply. The model consists of an expectations-augmented Phillips curve and a government objective function that incorporates a bias toward inflation. In order to introduce openness into this familiar set-up, the Phillips curve parameter is assumed to be decreasing in the share of imports in GDP, on the grounds that, with greater openness, a smaller proportion of any unanticipated increase in aggregate demand translates itself into an increase in domestic output, since a larger proportion leaks into imports.

Thus the model consists of three equations:

$$y = y^* + a(p - p^e) \quad (1)$$

$$Z = y - 0.5bp^2 \quad (2)$$

$$a = a_1 - a_2m \quad (3)$$

Here *y* represents output, y^* is the equilibrium level of output, *p* is inflation, p^e is the expected rate of inflation, *Z* is the government's utility, and *m* is the share of imports in output.[2] Both *a* and *b* are assumed to be positive.

As is well known, the Nash solution for the inflation rate, obtained by substituting from equations (1) and (3) into equation (2) and maximizing with respect to *p*, is

$$p = a/b = (a_1 - a_2m)/b \tag{4}$$

Equation (4) embodies the predicted negative relationship between inflation and openness. Two complications arise, however, in estimating equation (4) in a cross-country sample. One is that variations in *m* across countries might be swamped by variations in *b* (the inflation aversion parameter), which is difficult to measure. Hayo (1998) presents evidence of significant variations in inflation aversion across European countries.

The second complication is that countries may not choose the Nash solution, but instead elect to invest in a reputation for refusing to inflate, scoring higher values of *Z* in future periods by keeping inflationary expectations down. Given a choice between the reputational solution (playing p=0 in every period and also enjoying p^e=0 in all future periods) and the Nash solution (playing $p=a/b$ in the first period and having $p=p^e=a/b$ in all future periods), the latter will be chosen only for relatively high discount rates (r>1/2). The reputational strategy yields

$$V_R = [1+(1/r)]y^* \tag{5}$$

whereas the Nash strategy yields

$$V_N = [1+(1/r)]y^* + [2 - (1/r)](a_1 - a_2m)^2/b \tag{6}$$

where *V* is the present value of all future realizations of *Z*. The point here is that, although the returns to the Nash strategy are inversely related to openness (provided that $r > ½$), the relative attractiveness of this strategy depends only on the discount rate *r*, and if the reputational solution is chosen, then the openness-inflation correlation disappears. Thus, only

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[2] This is essentially the model presented by Romer, although he states equation (3) in verbal form only (1993, p. 873). Lane's equation (28) effectively embodies equation (3). Romer also suggests that *b* will be increasing in *m*, although his argument on this point is unclear.

if a significant proportion of the countries in any given sample prefer the Nash strategy does this model predict the openness-inflation relationship to appear in the data.

Lane's model is substantially more complex, but the elaboration largely consists of the derivation of inflation bias from the production side of the model, where imperfect competition is assumed to keep equilibrium output below its socially desirable level. Lane also assumes that the government can collect only seigniorage revenue; the inflation aversion parameter in his model directly reflects the collection costs of this revenue.

III. Empirical Results

This section reports inflation regressions for over 100 countries over two data periods: 1973-88 and 1989-98. The first of these periods is the same as that used by Romer (1993) and Lane (1997). In order to reduce the influence of outlying countries with particularly high inflation rates, Romer and Lane use the logarithm of the average percentage rate of inflation for 1973-88 as the dependent variable. This transformation risks creating the opposite problem, however, of outlying observations with inflation rates close to zero. This risk is particularly great for the second period, when there were more countries with very low average inflation rates. For this reason, the transformation of the dependent variable used here is

$$\pi = 100p/(100+p) \qquad (7)$$

where p is the average percentage change in the GDP deflator over the period. This transformation reduces the effect of outlying high values of p (since as p tends to infinity π tends to 100), whilst making very little difference to low or negative values (unlike the logarithmic transformation).[3]

Countries with exceptionally high openness (>90 percent for 1973-88 or >100 percent for 1989-98) were discarded from the sample to avoid outlier effects. An alternative would be to transform openness in the same way as inflation (in practice this yields similar results).

Table 1 presents the results of inflation regressions for 1973-88 and 1989-98 with openness and per capita GDP as regressors (regressions (1) and (2)), and then with population and area added as well (regressions (3) and (4)). In neither case is the explanation improved by allowing for interaction between openness and per capita GDP (results not

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[3] Equation (7) ensures that the difference between 10 percent and 20 percent inflation is still close to five times the difference between 2 percent and 4 percent inflation. The logarithmic transformation makes the difference between 10 percent and 20 percent the same as that between 2 percent and 4 percent (or 1 percent and 2 percent), which is distinctly unappealing.

shown). Data are taken from the *International Financial Statistics* data base (except in the case of per capita GDP, which comes from *World Development Indicators*).

With only openness and per capita GDP in the regression, the estimated effect of openness falls by about half between 1973-88 and 1989-98, and the significance level drops from 1 percent (*t*-statistic of -3.67) to 10 percent (*t*-statistic of -1.75). The most striking feature, however, is that per capita GDP becomes highly significant (*t*-statistic of -4.30) after playing no role at all in 1973-88 (*t*-statistic of -0.22).

Romer controlled for per capita GDP in all his regressions, usually obtaining a negative coefficient. Lane argued that GDP was a more persistently significant variable than per capita GDP and showed that regressions including GDP yielded more robust results. Regressions (3) and (4) therefore add two measures of country size (population and land area). Lane's point is reflected in the fact that population has a much more negative coefficient than per capita GDP for 1973-88. Otherwise, the results for 1973-88 are little changed: openness has a slightly lower *t*-statistic in regression (3) than regression (1) (-3.25 compared with -3.67) but a larger coefficient (-0.208 instead of -0.158). In regression (4), however, the main feature is that the openness coefficient drops to less than one-tenth of its regression (3) estimate, with a *t*-statistic of -0.31. There is again a large negative coefficient of population, and a substantial positive one for area. Per capita GDP remains highly significant.

The basic message of Table 1 is clear. In 1973-88 there is a significant negative correlation between openness and inflation. In 1989-98, the openness coefficient shrinks considerably, and is no longer statistically significant, and the (negative) coefficient of per capita GDP has a much higher *t*-statistic.

What about exchange rate regime effects? Previous authors have found strong correlations between the exchange rate regime and inflation (Fielding and Bleaney, forthcoming; Ghosh *et al.*, 1995). Accordingly, in Table 2 the exchange rate regime is included as a regressor. This variable uses an average score for each country over the relevant years, with three categories (pegged=1,intermediate=2 and floating=3), based on an updated version of the data set used by Ghosh *et al.* Note that a rise in the measure implies a shift toward floating, and that intermediate regimes are assumed to lie exactly half-way between pegged and floating rates as far as their effect on inflation is concerned.[4]

The strong correlation between the exchange rate regime and inflation found in previous research emerges in Table 2 also. In regressions (5) and (6), the exchange rate regime score is included instead of population and land area, and in regressions (7) and (8) in addition to these variables. Exchange rate regime score always has a positive coefficient,

[4] At a later stage the implications of identifying the effects of the three types of regime separately are considered.

implying that a shift towards flexibility is associated with a higher inflation rate. For 1973-88, its inclusion always leaves the openness coefficient highly significant and negative (*t*-statistics of -2.64 and -3.50 in regressions (5) and (7) respectively). For 1989-98, it also reinforces the basic picture from Table 1. Per capita GDP remains extremely significant, whilst openness is extremely insignificant (*t*-statistics of -0.52 and -0.25 in regressions (6) and (8) respectively).

Since the exchange rate regime score is such a significant variable, it needs to be considered in a little more depth. Would the results be very different if (a) it were differently specified, (b) if endogeneity were allowed for, and (c) if the correlations between exchange rate regime, openness and the other variables were removed?

The first two of these issues are addressed in Table 3. In regressions (9) and (10) in Table 3, an alternative specification of the exchange rate regime variable is used, in which there is no distinction between floating rates and intermediate regimes. The choice of this specification reflects the fact that, if each regime is allocated a separate dummy variable, intermediate regimes actually have a larger positive coefficient than floating rates. Not surprisingly, therefore, regressions (9) and (10) yield a better fit than regressions (7) and (8). The general effect of the respecification is to move coefficients further from zero without altering the broad picture. Most notably, the coefficient of per capita GDP becomes significant for the 1973-88 period for the first time (*t*-statistic of -2.30). Openness remains, however, highly insignificant in 1989-98 (*t*-statistic of -0.36) compared with 1973-88 (*t*-statistic of -3.81).

In regression (11) of Table 3, the issue of the possible endogeneity of the exchange rate regime to inflation is addressed by including the 1988 exchange rate regime score as an instrument for the average exchange rate regime score over 1989-98 in the regression for that period. Although the standard error increases, the coefficient remains almost as high as before, which suggests that endogeneity is not a major issue.[5]

How much are these results affected by collinearity between the variables? To investigate this issue, openness and the exchange rate regime score are regressed on the other explanatory variables. Table 4 shows the results for openness. What emerges is that measures of country size are very significant but per capita GDP is not. The population effect can be attributed to economies of scale. With a small population, a country cannot produce many varieties of goods efficiently, and so tends to trade more. Two arguments could be advanced for the area effect. One is transport costs: with a larger surface area, the average producer or consumer is further from the border, and the higher transport costs discourage trade. The other argument relates to trade in natural resources. If natural resources of different types are all distributed randomly across the globe (but in a largely uncorrelated way), then countries

[5] A Hausman test confirms the exogeneity of the exchange rate regime variable: the relevant *t*-statistic is 0.23.

with a larger area tend to have an endowment of these resources that is closer to the global average, and their trade in goods that are intensive in natural resources will be smaller.

In Table 5, regressions are shown for the exchange rate regime score in each period.[6] The results show that poor countries and those with small populations have a significantly lower regime score (i.e. are much more likely to have pegged exchange rate regimes), while openness and area make little difference. However, in 1989-98 the per capita GDP coefficient is less than half what it was in 1973-88, and the R-squared is far smaller. This reflects the increasing popularity of floating exchange rates amongst developing countries, whose exchange rates were almost universally pegged in the 1973-88 period (International Monetary Fund, 1997). Apart from the fact that countries with large populations continue to be more likely to have floating exchange rates, the distribution of exchange rate regimes across countries is now approaching randomness.

To purge openness and the exchange rate regime score of their collinearity with other variables, these variables are replaced in Table 6 by the residuals from the relevant regression in Tables 4 and 5. This ensures that the exchange rate regime measure is orthogonal to the other regressors, and means that the coefficient of population in regression (16), for example, captures both its direct effect and its indirect effect (by influencing openness and the choice of exchange rate regime), and not just its direct impact which might be offset or enhanced by its correlation with these other variables, as in regression (7). Only if the indirect effects are significant will there be much difference in the coefficients in the two regressions.

In the case of the 1973-88 period (regression (16)), three variables emerge as highly significant: openness (-), the exchange rate regime (+) and land area (+). Per capita GDP and population have coefficients very close to zero. Although all the other coefficients have moved by quite a lot compared with regression (7), the openness coefficient is remarkably similar, as is its *t*-statistic (-3.55). Regression (17) is similar to regression (16) except that Argentina is omitted from the sample, as very much the highest inflation observation. The openness coefficient falls by more than 10 percent, but is still highly significant, and the area coefficient falls by nearly 20 percent when Argentina is omitted.

Regressions (18) and (19) repeat the same exercise for 1989-98. As before, openness is highly insignificant, with a *t*-statistic of -0.19. Per capita GDP still has a highly significant negative coefficient, although somewhat smaller than in regression (8). Population is insignificant, but area has a significant positive coefficient, as in 1973-88. Residual exchange rate regime score is also highly significant. For both periods, the coefficients imply that

[6] If the purpose were to understand the choice of regime, rather than simply to ensure orthogonality, a probit model would have been appropriate. The results of the linear model presented in Table 5 may be regarded as an indication of what is likely to emerge from such a model.

floating rates are associated with inflation rates at least 10 percent higher than pegged rates.[7] Finally, regression (19) omits two outlying countries with exceptionally high inflation rates (Brazil and the Democratic Republic of Congo). As in the case of 1973-88, the main effect is to depress the coefficient of land area somewhat.

IV. Conclusions

The negative correlation between openness and inflation that appeared in cross-country data for the 1973-88 period has disappeared since 1989. The same conclusion is reached if we control for per capita income levels, population, area and exchange rate regime. As a result of successful disinflation by the industrial countries over recent years, the negative correlation between per capita GDP and inflation is very strong in 1989-98, whereas it was weak in 1973-88. In both periods, a shift from pegged to floating exchange rates is predicted to add at least 10 percent to a country's inflation rate. In both periods there is a positive correlation between land area and inflation. The reasons for this are unclear, and there is some suggestion that it may in part reflect the influence of outlying high-inflation observations. Nevertheless the consistency of this finding across time periods implies that it cannot be dismissed as a rogue result.

Can we expect the openness-inflation correlation to reappear? That depends on which of the two periods 1973-88 and 1989-98 is regarded as more "normal". On balance it seems more likely that the future will be more like 1989-98 than like 1973-88. The period 1973-88 was characterized by major commodity price shocks which, even if repeated, may take a very different form. In particular, such shocks may not cause such a persistent inflation shock to the developed countries as they did in 1973-88. Moreover, the globalization of international capital markets has increased the vulnerability of pegged exchange rate regimes to speculative attack, and this trend seems unlikely to be reversed. This suggests that many developing countries will continue to float their exchange rates, in marked contrast to 1973-88. The challenge of the future is clearly for developing countries to find ways to combine flexible exchange rates with low inflation.

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[7] Because of the transformation of the dependent variable, the effect is estimated to be higher at higher inflation rates.

Table 1. Cross-Country Inflation Regressions, 1973-88 and 1989-98

Dependent variable:	Inflation 1973-88 (1)	Inflation 1989-98 (2)	Inflation 1973-88 (3)	Inflation 1989-98 (4)
Independent variables				
Constant	18.12	39.75	32.89	23.57
	(3.45)	(6.36)	(2.39)	(1.50)
Openness	-0.158	-0.080	-0.208	-0.019
	(-3.67)	(-1.75)	(-3.25)	(-0.31)
ln (GDP pc)	-0.145	-3.18	-0.086	-2.94
	(-0.22)	(-4.30)	(-0.13)	(-3.96)
ln (population)			-1.38	-0.334
			(-1.95)	(-0.42)
ln (land area)			0.679	1.26
			(1.36)	(1.96)
Sample size	108	110	108	110
R-squared	0.115	0.180	0.150	0.211
Standard error	7.35	9.25	7.27	9.16

Notes: The dependent variable is π=100p/(100+p), where *p* is the average percentage inflation rate over the stated period. Figures in brackets are *t*-statistics.

Table 2. Inflation Regressions Including Exchange Rate Regime, 1973-88 and 1989-98

Dependent variable:	Inflation 1973-88 (5)	Inflation 1989-98 (6)	Inflation 1973-88 (7)	Inflation 1989-98 (8)
Independent variables				
Constant	17.27	31.01	52.45	36.60
	(3.28)	(5.04)	(3.58)	(2.68)
Openness	-0.123	-0.023	-0.217	-0.014
	(-2.64)	(-0.52)	(-3.50)	(-0.25)
ln (GDP pc)	-0.688	-3.61	-1.28	-3.46
	(-0.91)	(-5.17)	(-1.68)	(-4.95)
ln (population)			-2.49	-1.47
			(-3.15)	(-1.84)
ln (land area)			0.679	1.28
			(1.32)	(2.04)
Exchange rate regime score	2.62 (1.81)	4.83 (4.30)	4.98 (3.12)	5.24 (4.40)
Sample size	106	109	106	109
R-squared	0.145	0.300	0.222	0.333
Standard error	7.27	8.60	7.00	8.48

Notes: The dependent variable is π=100p/(100+p), where *p* is the average percentage inflation rate over the stated period. Figures in brackets are *t*-statistics. Exchange rate regime scores based on pegged rate = 1, intermediate = 2, floating rate = 3 for each year.

Table 3. Alternative Exchange Rate Regime Specifications

Dependent variable: Estimation method:	Inflation 1973-88 OLS (9)	Inflation 1989-98 OLS (10)	Inflation 1989-98 IV (11)
Independent variables			
Constant	59.69	43.43	35.84
	(4.10)	(3.17)	(2.50)
Openness	-0.230	-0.020	-0.017
	(-3.81)	(-0.36)	(-0.30)
Ln (per capita GDP)	-1.76	-3.99	-3.37
	(-2.30)	(-5.62)	(-4.63)
Ln (population)	-2.80	-1.78	-1.39
	(-3.62)	(-2.22)	(-1.53)
Ln (land area)	0.782	1.39	1.24
	(1.56)	(4.88)	(1.97)
Exchange rate regime score			4.88
			(2.13)
Binary ER regime score	4.84	5.53	
	(3,97)	(4.88)	
Sample size	106	109	108
R-squared	0.263	0.356	0.331
Standard error	6.82	8.33	8.51

Notes: The dependent variable is π=100p/(100+p), where *p* is the average percentage inflation rate over the stated period. Figures in brackets are *t*-statistics. Exchange rate regime scores based on pegged rate = 1, intermediate = 2, floating rate = 3 for each year. Binary exchange rate regime scores based on pegged rate =1 and intermediate and floating rates = 3 for each year. In regression (11) the instrument for the exchange rate regime score 1989-98 is the 1988 score. All other variables are instrumented by themselves.

Table 4. Openness Regressions, 1973-88 and 1989-98

Dependent variable:	Imports/GDP 1973-88 (12)	Imports/GDP 1989-98 (13)
Independent variables		
Constant	160.0	153.0
	(11.48)	(8.51)
ln (GDP pc)	-0.084	0.107
	(-0.08)	(0.09)
ln (population)	-6.41	-4.65
	(-7.30)	(-3.87)
ln (land area)	-1.92	-3.39
	(-2.63)	(-3.50)
Sample size	109	111
R-squared	0.562	0.444
Standard error	11.08	14.72

Notes: Dependent variable is imports as percent of GDP. Figures in brackets are *t*-statistics.

Table 5. Exchange Rate Regime Regressions, 1973-88 and 1989-98

Dependent variable:	Exchange rate regime score 1973-88 (14)	Exchange rate regime score 1989-98 (15)
Independent variables		
Constant	-3.65	-2.06
	(-4.59)	(-1.87)
Openness	-0.00087	-0.00140
	(-0.24)	(-0.31)
ln (GDP pc)	0.254	0.101
	(6.41)	(1.78)
ln (population)	0.215	0.214
	(5.30)	(3.42)
ln (land area)	-0.130	-0.004
	(-0.42)	(-0.09)
Sample size	108	110
R-squared	0.485	0.218
Standard error	0.437	0.697

Note: The dependent variable is the exchange rate regime score as explained in the text (more flexible rates score higher). Figures in brackets are *t*-statistics.

Table 6. Further Inflation Regressions, 1973-89 and 1989-98

Dependent variable	Inflation 1973-88 (16)	Inflation 1973-88 (Argentina omitted) (17)	Inflation 1989-98 (18)	Inflation 1989-98 (Brazil, Dem. Rep. of Congo omitted) (19)
Independent variables				
Constant	-1.29	2.33	22.46	29.42
	(-0.15)	(0.28)	(2.16)	(3.31)
Residual openness	-0.220	-0.193	-0.010	-0.004
	(-3.55)	(-3.27)	(-0.19)	(-0.10)
ln (GDP pc)	-0.007	-0.201	-2.90	-2.86
	(0.01)	(-0.33)	(-4.21)	(-4.89)
ln (population)	-0.067	-0.051	-0.307	-0.493
	(-0.12)	(-0.09)	(-0.43)	(-0.81)
ln (land area)	1.14	0.933	1.39	0.980
	(2.28)	(1.96)	(2.34)	(1.95)
Residual ER regime score	5.00	4.57	5.20	4.89
	(3.12)	(3.01)	(4.35)	(4.83)
Sample size	106	105	109	107
R-squared	0.223	0.195	0.330	0.357
Standard error	7.00	6.63	8.50	7.16

Notes: The dependent variable is π=100p/(100+p), where p is the average percentage inflation rate over the stated period. Figures in brackets are t-statistics. Residual openness is the residuals from the regression for the relevant period in Table 4, and residual exchange rate regime score is the residuals from the regression for the relevant period in Table 5.

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