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Testing Monetary Policy Intentions in Open Economies

Jim Granato,* Melody Lo,† and M. C. Sunny Wong‡

Temple (2002) argues that the inflation level used in Romer (1993) lacks power in revealing the policy intentions of monetary authorities. Temple also points out that Romer's use of the openness–inflation correlation cannot be explained by time consistency theory. In this article, we demonstrate that more open economies experience less inflation volatility and persistence. We attribute our findings to the hypothesis that monetary authorities in more open economies adopt more aggressive monetary policies. This pattern emerges strongly after 1990. Our results indicate that the near-universal regime shift in 1990 is not just a simple process of increased monetary policy aggressiveness, but an increased response to economic openness.

JEL classification: E31, E52, F41

> [T]he costs of high and variable inflation are potentially greater in open economies, and perhaps especially in those countries that seek to fix their exchange rate. This could explain why inflation is kept relatively low in more open economies. Although this argument is relatively simple, it is not easily tested.
>
> Jonathan Temple (2002, p. 465)

1. Introduction

This article examines the relationship between economic openness and inflation performance. Among the most prominent research on this topic is the work by Romer (1993). He demonstrates a negative relationship between economic openness and the inflation level. His finding has also been viewed as supportive, albeit indirectly, of time consistency theory (Kydland and Prescott 1977).[1] Romer (1993) argues that policymakers in more open economies have less incentive to adopt an expansionary monetary policy. His argument is based on the assumption that monetary surprises in more open economies result in higher inflation for a given increase in output. Romer's finding that

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[1] Romer (1993) finds a negative relationship between openness and the inflation level in a sample of 114 countries. However, the result is not significant in the OECD-country sample. Using the same sample, Lane (1997) extends Romer's (1993) study to control for the size of a country. After controlling for country size, Lane finds that openness and inflation have a robust negative relationship, even for OECD countries.

more open economies have lower inflation levels leads him to infer that this is evidence of time consistency in monetary policy practices.

However, Romer's work has not been generally accepted. Temple (2002) provides evidence that the openness–inflation correlation does not stem from time consistency theory because the inflation level may not properly reveal the monetary authorities' policy intentions. Temple questions this inference because it starts from a strong but unjustified assumption—more open economies possess a relatively steeper Phillips curve. Consequently, Temple proposes that the examination of the positive relationship between openness and the slope of the Phillips curve is a fundamental condition for Romer's argument. He, however, finds little support for the positive relationship between economic openness and the slope of the Phillips curve.

Further work on the relationship of openness and monetary policy intentions comes from Clarida, Gali, and Gertler (2001, 2002; hereafter CGG). In CGG (2001), the authors present a simple open-economy model with a Taylor-type interest rate policy rule (Taylor 1993). The article concludes that the optimal monetary policy in an open economy has the same solution as that in a closed economy derived in CGG (1999). The authors also suggest that there is a direct link between the degree of economic openness and the aggressiveness of monetary policy. They state that, "[O]penness does affect the parameters of the model, suggesting a quantitative implication. . . . [H]ow aggressively a central bank should adjust the interest rate in response to inflationary pressures depends on the degree of openness" (CGG 2001, p. 248).

In subsequent work, CGG (2002) revisit the issue based on a dynamic open-economy New Keynesian model and the role of monetary policy in open economies is refined. Consistent with the argument in CGG (2001), they find that the optimal monetary policy rule in an open economy is isomorphic to that in a closed economy in the Nash equilibrium. They also suggest that openness does not affect the optimality of a policy rule in such a scenario. On the other hand, economic openness does affect optimal monetary policy when the foreign optimal policy is endogenous in the domestic country's objective function. This effect, however, is ambiguous in direction because the relationship between the degree of economic openness and the aggressiveness of monetary policy is determined by the relative size of trade and wealth effects of changes in foreign output.

This line of theoretical literature is limited and does not offer a definitive conclusion on the relationship between economic openness and monetary policy intentions. Our article provides an alternative empirical evaluation of the relationship. Based on prior literature, we use inflation variability and persistence as the measures of monetary policy intentions. One branch of the literature, such as Taylor (1999), CGG (2000), and Owyang (2001), argues that aggressive monetary policy reduces the volatility of inflation. For instance, CGG (2000) estimate a forward-looking Taylor rule for the period between 1960:I and 1996:IV. They use Paul Volcker's appointment as Chairman of the Federal Reserve System as a regime shift to a more aggressive anti-inflation policy stance. Their results show that the policy rule is significantly more aggressive in the post-Volcker period, which reduced inflation volatility substantially. Another branch of the literature examines how monetary policy affects inflation persistence (Fuhrer 1995; Fuhrer and Moore 1995; Siklos 1999; Owyang 2001). For example, Siklos (1999) studies the effect of inflation-targeting policy on the persistence of inflation in a group of inflation-targeting countries in the period of 1958:I–1997:IV.

The issue of whether monetary authorities in more open economies are more aggressive about ensuring inflation stability remains unsettled. The focus of this article is to provide an empirical assessment of the openness–inflation relationship that is based on monetary-policy implementation. We demonstrate the relationship between economic openness and two new variables, inflation variability and inflation persistence. These two variables are used to potentially reveal monetary

policy making intentions. Using a sample of 102 countries for the period 1949–2001, our results show that economic openness is negatively associated with inflation volatility and persistence. In particular, we find that this relationship is most evident in the 1990s. This result is robust after controlling for various factors that may affect the policymakers' aggressiveness in stabilizing inflation. These factors include the size of an average supply shock an economy confronts, the status of economic development, the level of inflation, and the size of a country.

We also examine potential differences between developed and developing countries. We find that this negative relationship between openness and inflation performance is more pronounced in developed countries. The evidence further suggests that the developed and more economically open countries have experienced less inflation volatility and persistence since the 1990s. Our results suggest that the near-universal regime shift in 1990 is not just a simple process of increased policy aggressiveness. We note that the recent emphasis toward more aggressive monetary policies is, in part, a response to economic openness.

We organize the rest of our article in four sections. Section 2 presents the empirical results on the relationship between openness and inflation volatility. Section 3 provides the estimation procedure and examines the relationship between openness and inflation persistence, and Section 4 concludes the article.

2. Preliminary Evidence

Several studies show that aggressive monetary policy reduces both inflation and output volatility (Taylor 1999). We use the variance of inflation (σ_{π}^2) to measure inflation volatility. Our conjecture is that, if there exists a positive relationship between an aggressive inflation-stabilizing monetary policy and economic openness, we would expect to observe a negative relationship between openness and the variance of inflation. This relationship would serve as preliminary evidence of a positive relationship between an aggressive inflation-stabilizing monetary policy and economic openness.

Sample and Data

We use quarterly data from the International Monetary Fund's (IMF) *International Financial Statistics* (IFS). The percentage change in the Consumer Price Index (CPI) is used as the measure of inflation (π_t). For each country, we include the maximum data length available from IFS for the period 1949–2001.[2] We exclude any country whose data starts later than 1989. The average length of the data in our sample is approximately 39 years. The longest (shortest) duration is 53 (12) years. Overall, we have 102 countries to start our empirical analysis.[3]

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[2] For countries participating in the European Monetary Union, the definition of openness changed at the end of 1998. For this reason, their data ends in 1998.

[3] These 102 countries are Algeria, Argentina, Australia, Austria, Bahamas, Bahrain, Barbados, Belgium, Belize, Bolivia, Botswana, Brazil, Burkina Faso, Canada, Chile, Colombia, Costa Rica, Cote D'Ivoire, Denmark, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Fiji, Finland, France, Gabon, Germany, Greece, Grenada, Guatemala, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Kuwait, Lesotho, Luxembourg, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritius, Mexico, Morocco, Myanmar, Nepal, Netherlands, New Zealand, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Philippines, Poland, Portugal, Rwanda, Saudi Arabia, Senegal, Seychelles, Singapore, South Africa, South Korea, Spain, Sri Lanka, St. Lucia, St. Vincent and Grenadines, Sudan, Sweden, Switzerland, Syria, Tanzania, Thailand, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Uganda, United Kingdom, United States, Uruguay, Vanuatu, Venezuela, Zambia, and Zimbabwe.

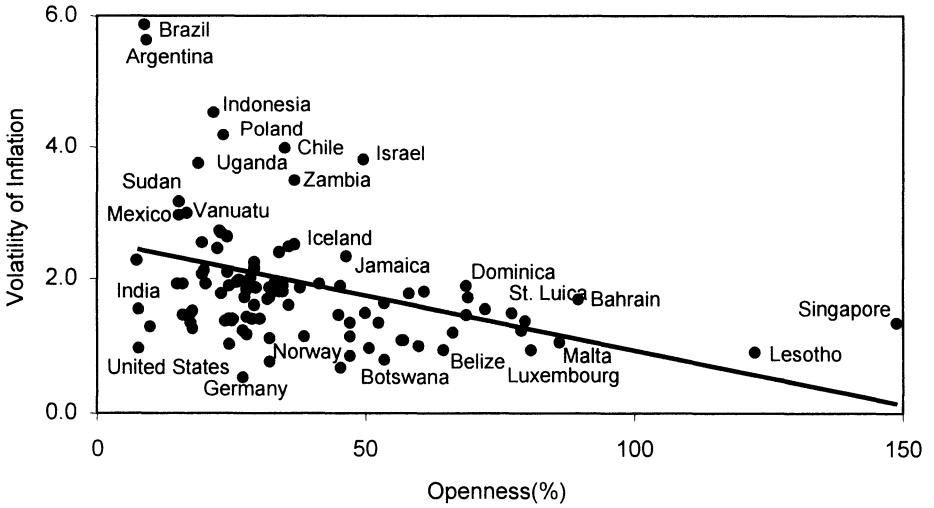

Figure 1. Openness and Volatility of Inflation of Full Sample and Whole Sample Period

Economic Openness and Inflation Volatility

To assess the relationship between openness and inflation volatility across countries, we estimate the following regression:

$$\log(\sigma^2_{\pi i}) = \alpha + \beta X_i + \varepsilon_i, \tag{2.1}$$

where $\sigma^2_{\pi i}$ represents the variance of country i's inflation rate; as used in Romer (1993) and Frankel and Rose (1996), X_i is the ratio of imports of goods and services to GDP (as a measure of the degree of openness); and ε_i is a stochastic term. As in Lane (1997), we take the logarithm of the inflation variance to reduce the effect of extreme observations on the results of regression 2.1.[4]

We start our analysis with the whole sample period (1949–2001). Figure 1 presents a scatter plot of the fitted values for the volatility of inflation against the level of economic openness for each country. The figure shows an overall negative relationship between openness and the volatility of inflation. We report the associated results in regression (1) of Table 1. The openness coefficient is negative (–0.015) and significant ($t = -3.493$) for the whole sample period.

The substantive implications of these findings are straightforward: Increasing economic openness generates less inflation volatility. Examining these results further, we see in relation to the sample average of inflation volatility of 1.920 (logarithmic scale), a 1 SD increase in economic openness (equivalent to 23 percentage points) decreases inflation volatility (on average) by almost 18%.[5] To put it differently, in an economy with a level of openness of 10%, one would expect its inflation volatility to be 2.327. If economic openness, over a period of time, increased to 50% and later to 100%, the inflation volatility would drop to 1.727 and 0.977, respectively.

How sensitive is this negative relationship to different time periods? The breakdown of the Bretton Woods system in 1973 provided a higher degree of domestic flexibility in monetary policy across countries, and researchers often acknowledge that the theoretical predictions of monetary

[4] Without taking the logarithm of the inflation variance, the largest value for the inflation variance in our sample is about 818,576 times the smallest one.

[5] This result comes from the following calculation: $(23.38 \times -0.015)/1.92 = 0.18$, where the standard deviation of openness is 23.38 and the mean of inflation volatility is 1.92.

Table 1. Openness and Volatility of Inflation for All Sample Countries

Time Period	Whole Sample	Whole Floating	1973–1990	1990s
Regression	(1)	(2)	(3)	(4)
Constant	2.477***	2.451***	2.215***	2.217***
	(11.093)	(10.470)	(9.358)	(8.210)
Openness	−0.015***	−0.014***	−0.010**	−0.021***
	(−3.493)	(−3.174)	(−2.398)	(−4.031)
R^2	0.114	0.107	0.058	0.180
Number of observations	102	102	102	102

Robustness check	Additional Regressors Added to (1)	Outliers Excluded from (5)	Additional Regressors Added to (2)	Outliers Excluded from (7)	Additional Regressors Added to (3)	Outliers Excluded from (9)	Additional Regressors Added to (4)	Outliers Excluded from (11)
Regression	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	2.127***	2.386***	2.061***	2.232***	1.464**	1.625**	4.171***	4.738***
	(3.102)	(3.598)	(3.272)	(3.593)	(2.158)	(2.376)	(7.476)	(10.064)
Openness	−0.010**	−0.017***	−0.007*	−0.012***	−0.005	−0.009**	−0.014***	−0.017***
	(−2.076)	(−4.778)	(−1.664)	(−3.549)	(−1.070)	(−2.085)	(−3.022)	(−3.632)
Real GDP volatility	0.412**	0.342**	0.342**	0.326**	0.385**	0.373**	0.482***	0.378***
	(2.368)	(2.145)	(2.585)	(2.508)	(2.590)	(2.501)	(3.929)	(4.216)
Real GDP per capita	−0.172	0.019	−0.157	−0.084	−0.162	−0.052	−0.860***	−0.864***
	(−0.838)	(0.123)	(−0.866)	(−0.525)	(−0.813)	(−0.270)	(−4.805)	(−4.719)
Inflation	0.011***	0.011***	0.010***	0.010***	0.008***	0.008***	0.009*	0.008**
	(3.235)	(3.112)	(6.645)	(7.888)	(8.107)	(7.924)	(1.677)	(2.057)
Total real GDP	−0.009	−0.155	−0.021	−0.074	0.068	−0.019	0.021	−0.063
	(−0.069)	(−1.506)	(−0.196)	(−0.802)	(0.646)	(−0.188)	(0.217)	(−0.691)
Land size	−2.5E-07**	−2.9E-07**	−8.5E-08	−2.0E-07	−1.8E-07***	−1.8E-07**	−1.8E-07*	−1.9E-07*
	(−2.080)	(−2.116)	(−0.727)	(−1.640)	(−2.715)	(−2.749)	(−1.792)	(−1.846)
R^2	0.698	0.677	0.732	0.748	0.716	0.723	0.710	0.740
Number of observations	99	95	99	97	98	97	99	95

Heteroskedasticity-consistent *t*-ratios in parentheses. ***, **, and * denote 1%, 5%, and 10% significance levels in two-tailed tests, respectively. We use Welsch distance test (Welsch, 1982) to identify outliers and excluded them from associated regressions. For regression (5), Bolivia, Canada, Indonesia, and Singapore are outliers. For regression (7), Uruguay and Singapore are outliers. For regression (9), Singapore is an outlier. For regression (11), Argentina, Canada, Poland, and Singapore are outliers. The real GDP per capita data is unavailable for Cote D'Ivoire, and total real GDP data is unavailable for Myanmar and Sudan. Also, data for Mali is available only after 1973. For these reasons, the sample size in regressions (5), (7), and (11) is reduced by three from (1), (2), and (4), while the sample size in regression (9) is reduced by four from regression (3).

models may have different results under the floating exchange-rate regime (post-1973). Further, the recent inflation-targeting literature suggests that there has been a seemingly universal regime shift in the practice of monetary policy since the 1990s. Monetary authorities have generally placed greater weight on reducing inflation instability during the past decade (Bernanke, et al. 1999; Cecchetti and Ehrmann 2002). Therefore, we examine if there is a structural change between monetary policy and economic openness during the entire period of analysis.

According to the argument mentioned above, we use 1973 and 1990 as the cutoff points. We examine regression 2.1 using the following subsamples: the floating exchange rate regime period of 1973–2001 (whole floating in the tables); the earlier floating period of 1973–1990 (1973–1990 in the tables); and the latter floating period of 1990–2001 (the 1990s in the tables). In panel A of Table 1, we summarize the regression results for the whole floating regime period, the 1973–1990 period, and the 1990s in regressions (2), (3), and (4), respectively.

The results show that the coefficients on openness are negative and significantly different from zero. The negative relationship between openness and inflation volatility is evident over all sample periods. When we contrast the 1990s coefficient(s) to the results in the sample period of 1973–1990, we see that the coefficient on openness in the sample of the 1990s ($\beta = -0.021$) is twice as large as the period 1973–1990 ($\beta = -0.010$).

The magnitude of the difference between the sample periods can be expressed in the following way. As the average of inflation volatility for the sample period of 1973–1990 is 1.812 and that for the period of the 1990s is 1.364, a 1 SD increase in economic openness drops inflation volatility by only 14% for the period 1973–1990. However, during the 1990s, a 1 SD increase in economic openness reduces inflation volatility by 36%.

The results suggest a potential positive relationship between openness and the aggressiveness of monetary policy occurred primarily in the 1990s. The literature recognizes that a major practical problem in testing monetary policy implications centers on the difficulty in isolating the exchange rate regime shift effect (Burdekin and Siklos 1999). We are aware that the effect of the exchange rate regime on the openness–aggressiveness relationship may not be adequately identified by simply dividing the sample at 1973.[6] The standard argument against dividing the sample this way is that not all central banks allowed their currencies to universally float freely in 1973. Various international monetary arrangements, such as currency blocs, could also have an effect on the openness–aggressiveness relationship. For example, when a currency bloc is imposed on a set of countries regardless of their degree of openness, openness and the policymakers' aggressiveness toward inflation would tend to have no relationship. Thus, we note that certain caution needs to be taken when interpreting our results.

Robustness Checks

We examine a set of additional factors to determine the sensitivity of our results. We consider several factors other than openness that could affect the policymaker's intention in policy making.

[6] Alogoskoufis and Smith (1991) show that the shift from a fixed to floating exchange rate regime leads to a more accommodative monetary policy and, thereby, increases inflation persistence. Yet they caution that this theoretical relation is not necessarily realized in practice because inflation persistence depends more on the central bankers' attitude toward inflation. This caveat is later empirically confirmed by Burdekin and Siklos (1999), where they examine in a sequential manner whether the imposition of a floating exchange rate regime is an important factor in the historical changes, that is, structural breaks in inflation persistence. They find no evidence that the shift in exchange rate regime plays a major role in changes in inflation persistence.

First, we argue that more severe supply shocks would generate a greater trade-off between inflation and output volatility. This larger trade-off influences policymakers to be less aggressive in controlling inflation. As a result, the economy will have more persistent inflation and greater inflation volatility. As large supply shocks would show up as increased volatility in real output, in addition to volatile inflation, we compute the variance of real output growth for each country to account for the size of supply shock.

The second robustness check is to assess if the link between openness and inflation is affected by the status of economic development. Romer (1993) notes that the openness–inflation correlation virtually holds for all types of countries except for most developed countries, as they may have overcome the dynamic inconsistency of optimal monetary policy. We use real GDP per capita (obtained from Penn World Tables) as the measure of economic development for an economy.

The third check is to include various independent variables that may serve as specification checks and rival arguments. Of prime importance is the inflation level because this is one of the key variables in the literature. In addition, to control for the potential impact from country size on the openness–inflation volatility relationship, we add data of total real GDP (Lane 1997) and of land size (Romer 1993) to the regressions. Results from regressions (5), (7), (9), and (11) in Table 1 indicate that the negative association between openness and inflation volatility remains highly significant for all sample periods, except for the period of 1973–1990, when the real GDP volatility, real GDP per capita, inflation level, total real GDP, and land size are included in the regression 2.1.

In the last robustness check, we use the Welsch distance measure (Welsch 1982) to formally identify outliers and exclude them from the associated regressions. We see a similar relationship between openness and inflation volatility from regressions (6), (8), (10), and (12) in Table 1. The exclusion of outliers does not alter the results statistically from what is reported earlier.

3. Economic Openness and Inflation Persistence

Aggressive monetary policy not only reduces the variance of inflation, but also lowers the persistence of inflation (Siklos 1999). If a more aggressive monetary policy is adopted in more open economies, we would expect inflation persistence to be smaller (a negative association between the openness and inflation persistence).

Specification and Estimation

The standard methodology used in the literature to estimate the size of inflation persistence is an autoregression (Alogoskoufis and Smith 1991). For purposes of comparison, we measure annual inflation persistence for each country in our sample. An AR(4) has the best fit on the quarterly inflation data:

$$\pi_{i,t} = a + b_{1,i}\pi_{i,t-1} + b_{2,i}\pi_{i,t-2} + b_{3,i}\pi_{i,t-3} + b_{4,i}\pi_{i,t-4} + \varepsilon_t, \tag{3.1}$$

where $\pi_{i,t}$ is country i's inflation rate at period t, measured by the log difference of *CPI*, and ε_t is a stochastic term. For each country, we calculate its inflation persistence (IP_i) as the sum of its significant coefficients on inflation lags from Equation 3.1. We then regress inflation persistence (IP_i) on the degree of openness (X_i),

$$IP_i = \gamma + \phi X_i + u_i, \tag{3.2}$$

where u_i is a stochastic term in our regression. We interpret a significant negative coefficient of openness (ϕ) as evidence of more aggressive monetary policy in more open economies.

While the use of autoregression is in line with the inflation persistence literature, it leaves a potential issue of assuming all countries face shocks coming from similar distributions. Indeed, the variation of shocks across countries could affect the validity of the inferences made from Equation 3.2. Therefore, we use an alternative measure of inflation persistence to allow the variation of shocks in the following regression:

$$\Delta\pi_{i,t} = c + d_{1,i}\pi_{i,t-1} + \sum_{j=1}^{4} d_{j+1,i}\Delta\pi_{i,t-j} + z_t, \tag{3.3}$$

where Δ denotes the first difference operator. This Equation 3.3 is similar to a traditional time series of augmented Dickey–Fuller regression. The size of coefficient $d_{1,i}$ indicates the average die-out rate of the inflation shock in country i.[7] If policymakers act more aggressively in response to inflationary shocks, we would observe $d_{1,i}$ to be negative and larger in absolute value. It indicates a higher speed of mean reversion in inflation. In what follows, we will mainly discuss empirical results where inflation persistence is estimated from Equation 3.1, but treat results from using Equation 3.3 as the robustness check.

We start the analysis with our initial sample of 102 countries. When a country's data spans less than 15 years, we drop it from the analysis due to the lack of degrees of freedom for different time specifications. This leads to the exclusion of 6 countries and leaves 96 countries in the final sample.

We next estimate the inflation persistence based on the autoregression of Equation 3.1. The autoregressive process of time-series variables must have an integration order of less than one, otherwise the ordinary least squares estimation provides nonstandard distributional results. Before performing the estimation of AR(4), we first examine the integration properties of inflation for each country using the unit root test (DF-GLS) proposed by Elliott, Rothenberg, and Stock (1996). It is generally acknowledged that the unit root test is deficient because too often it cannot decisively discriminate between traditional unit root processes that are integrated (I(1)) from fractionally integrated processes (of order $d < 1$) (Sowell 1990; Hassler and Wolters 1994). To distinguish unit root behavior from fractionally integrated behavior, we perform, along with the Elliott, Rothenberg, and Stock (1996) test, the modified Geweke and Porter–Hudak's (1983) fractional integration test proposed by Phillips (1999).[8] Among 96 countries left in the sample, we find 82 countries for which the inflation series are appropriate to estimate through an AR(4) process of Equation 3.1.[9]

We apply the same time period specifications as presented in section 2. However, some countries may have a monetary policy regime shift that is not identical to the cut-off points of 1973 and 1990. To resolve this problem, we apply a technique, developed by Andrews (1993), to see if there is a regime shift in the inflation series for each country, before we estimate Equation 3.1. When we find

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[7] We thank a referee for suggesting this alternative inflation persistence measurement.

[8] Whenever the DF-GLS test concludes that a country's inflation rate has a unit root, we will also perform the Phillips (1999) test before drawing our conclusions on the series' order of integration. When the Phillips test rejects the null hypothesis that the particular inflation series has a unit root, we conclude that the series has an integration order of less than one.

[9] We find 14 countries' inflation series to be I(1). For comparison purposes, we cannot include an inflation series with I(1) properties in our sample although it may indicate that it is very persistent. Results of DF-GLS and Phillips tests are available on request.

Table 2. Openness and Inflation Persistence for All Sample Countries

Panel A: Inflation persistence estimated from Equation 3.1				
Time Period	Whole Sample	Whole Floating	1973–1990	1990s
Regression	(13)	(14)	(15)	(16)
Constant	0.682***	0.643***	0.559***	0.635***
	(13.535)	(11.742)	(8.590)	(6.933)
Openness	−0.003**	−0.002	−0.0005	−0.002
	(−2.021)	(−1.336)	(−0.412)	(−0.640)
R^2	0.086	0.042	0.002	0.021
Number of observations	74	74	69	62

Robustness check	Additional Regressors Added to (13)	Outliers Excluded from (17)	Additional Regressors Added to (14)	Outliers Excluded from (19)	Additional Regressors Added to (15)	Outliers Excluded from (21)	Additional Regressors Added to (16)	Outliers Excluded from (23)
Regression	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Constant	0.020	0.109	0.001	0.048	−0.473	−0.339	0.266	0.416
	(0.083)	(0.459)	(0.003)	(0.227)	(−1.484)	(−1.127)	(0.993)	(1.606)
Openness	−0.002	−0.003**	−0.001	−0.002	0.001	0.001	−0.001	−0.005**
	(−1.355)	(−1.998)	(−0.708)	(−1.267)	(0.539)	(1.254)	(−0.478)	(−2.334)
Real GDP volatility	0.031	−0.012	0.032	0.027	0.135	0.072	0.020	0.021
	(0.518)	(−0.237)	(0.560)	(0.481)	(1.490)	(1.052)	(0.365)	(0.420)
Real GDP per capita	0.097	0.138	0.061	0.088	0.093	0.121*	0.018	0.045
	(1.279)	(1.799)	(0.922)	(1.263)	(1.212)	(1.696)	(0.200)	(0.515)
Inflation	0.001***	0.001***	0.001***	0.001***	0.0004**	0.0003**	0.002	0.001
	(2.819)	(2.941)	(3.036)	(2.922)	(2.296)	(2.245)	(0.891)	(0.847)
Total real GDP	0.055	0.022	0.082**	0.061	0.107*	0.060	0.059	0.032
	(1.265)	(0.491)	(2.331)	(1.597)	(1.737)	(1.563)	(1.117)	(0.662)
Land size	−4.4E-08	−1.6E-08	−1.4E-07	−1.4E-07	−5.8E-08	1.2E-07	−1.7E-07	−2.0E-07
	(−0.316)	(−0.124)	(−1.041)	(−1.058)	(−0.248)	(0.791)	(−0.817)	(−0.966)
R^2	0.289	0.368	0.267	0.274	0.181	0.243	0.149	0.197
Number of observations	74	72	74	73	69	68	62	61

Table 2. Continued

Panel B: Inflation persistence estimated from Equation 3.3 Time Period	Whole Sample	Whole Floating	1973–1990	1990s
Regression	(25)	(26)	(27)	(28)
Constant	−0.253***	−0.274***	−0.415***	−0.262***
	(−5.124)	(−6.402)	(−6.973)	(−3.058)
Openness	−0.003**	−0.003***	−0.002	−0.005**
	(−2.305)	(−3.142)	(−1.460)	(−2.217)
R^2	0.108	0.104	0.058	0.214
Number of observations	74	74	69	62

Robustness check	Additional Regressors Added to (25)	Outliers Excluded from (29)	Additional Regressors Added to (26)	Outliers Excluded from (31)	Additional Regressors Added to (27)	Outliers Excluded from (33)	Additional Regressors Added to (28)	Outliers Excluded from (35)
Regression	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)
Constant	−0.999***	−0.971***	−1.045***		−1.005***	−0.921**	−0.429	−0.289
	(−4.304)	(−4.069)	(−5.104)	–	(−5.244)	(−4.724)	(−1.562)	(−1.048)
Openness	−0.002**	−0.003*	−0.003***		−0.002	−0.003	−0.005*	−0.008***
	(−2.201)	(−1.911)	(−4.815)	–	(−1.244)	(−0.993)	(−1.970)	(−3.964)
Real GDP volatility	−0.006	−0.008	−0.045		−0.066	−0.060	−0.034	−0.033
	(−0.108)	(−0.150)	(−1.030)	–	(−1.317)	(−1.157)	(−0.513)	(−0.504)
Real GDP per capita	0.100	0.119*	0.165***		0.113	0.110	−0.029	−0.003
	(1.552)	(1.798)	(3.049)	–	(1.493)	(1.373)	(−0.372)	(−0.045)
Inflation	0.001*	0.001	0.001***		0.001***	0.001***	0.001	0.001
	(1.695)	(1.626)	(3.421)	–	(4.069)	(3.716)	(0.420)	(0.361)
Total real GDP	0.086**	0.072**	0.059**		0.066	0.059	0.064	0.038
	(2.604)	(2.018)	(2.082)	–	(1.625)	(1.263)	(0.970)	(0.611)
Land size	−1.2E-07	−1.2E-07	−1.8E-07		−1.9E-07	−3.3E-07*	−1.2E-07	−1.5E-07
	(−0.776)	(−0.784)	(−1.422)	–	(1.053)	(−1.988)	(−0.900)	(−1.077)
R^2	0.444	0.447	0.549	–	0.408	0.428	0.296	0.332
Number of observations	74	73	74	–	69	67	62	61

Heteroskedasticity-consistent *t*-ratios in parentheses. ***, **, and * denote 1%, 5%, and 10% significance levels in two-tailed tests, respectively. We use Welsch distance test (Welsch 1982) to identify outliers and exclude them from associated regressions. For regression (17), Zimbabwe and Singapore are outliers. For regressions (19), (23), (29), and (35), Singapore is an outlier. For regression (21), Poland is an outlier. For regression (33), Mexico and Singapore are outliers.

that country i's inflation series has a break point, we estimate its IP_i by modifying Equation 3.1 to include a proper shift dummy that is identified by the Andrews (1993) method.

In short, for country i, we estimate its IP_i that corresponds to a whole sample period and the subsample periods and we then assess Equation 3.2 to draw inferences on whether the monetary policy is more aggressive in more open economies.

We next determine if our statistical inferences on the relationship between openness and inflation persistence are robust to different inflation-persistence estimations procedures. We estimate inflation persistence from Equation 3.3 for the same set of countries identified in Equation 3.1 and reestimate Equation 3.2. When we estimate $d_{1,i}$ in Equation 3.3, the general-to-specific search strategy is applied to determine the number of lags of $\Delta\pi_{i,t}$ in each country (Hendry 1995).[10]

Results

Panel (A) of Table 2 reports the estimation results of regression (3.2), where IP_i is estimated from the autoregression of Equation 3.1, in different sample periods.[11] In regression (13) of Table 2, the coefficient on openness is –0.003, which is statistically significant at the 5% level. This result indicates that there is a significant, negative relationship between openness and inflation persistence for the whole sample period. In comparison with the sample average of inflation persistence (0.587), a 1 SD increase in economic openness decreases (on average) inflation persistence by about 11%. Figure 2 shows this negative relationship.

Robustness Checks

We also determine if the negative correlation between openness and inflation persistence is robust in the three subsample periods after additional regressors are added to the regressions and outliers are dropped from the sample. Regressions (20), (22), and (24) of Table 2 present results that correspond to the whole floating period of 1973–2001, the early floating period of 1973–1990, and the later floating period of the 1990s, respectively. Although the coefficient of openness is negative and significant for the 1990s, it is not significantly different from zero for the 1973–1990 period.

We interpret zero inflation persistence as evidence that a country has adopted an extremely aggressive inflation stabilization policy so that there is no autocorrelation in the inflation series. We find this to be the case for 5 countries in the early floating period of 1973–1990 and for 12 countries in the later floating period of the 1990s. This situation occurs particularly in countries with a relatively high degree of openness.[12]

These results indicate that the negative relationship between economic openness and inflation persistence occurs only in the 1990s. This finding is robust using the alternative measure of inflation

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[10] The maximum number of lags to be included is set at four. We selected the optimal lag structure based on when the Akaike (1974) information criterion was smallest and the model residuals were free of serial correlation.

[11] Among 82 countries in the sample, there are 7 countries (Colombia, Cote D'Ivoire, Dominica, India, Lesotho, Panama, and Seychelles) whose coefficients on the inflation lags of Equation 3.1 are negative. The negative coefficients indicate that the level of inflation in these countries tend to oscillate in sign. This finding, however, is not consistently observed in the existing inflation persistence literature. Therefore, we exclude these countries from our sample. We also exclude Kuwait from the sample because its inflation persistence appears to be zero across all sample periods.

[12] In the 1990s, the average openness for a group of 12 countries with zero inflation persistence is 56%, which is much higher than that for the full sample of 74 countries (37%). Countries with zero inflation persistence do not enter regressions. However, when we include these countries into regressions (22) and (24), the coefficient of openness is even stronger for the period of 1990s than reported in regression (24). Also, the coefficient of openness during the period 1973–1990 remains insignificant as reported in regression (22). Results can be obtained on request.

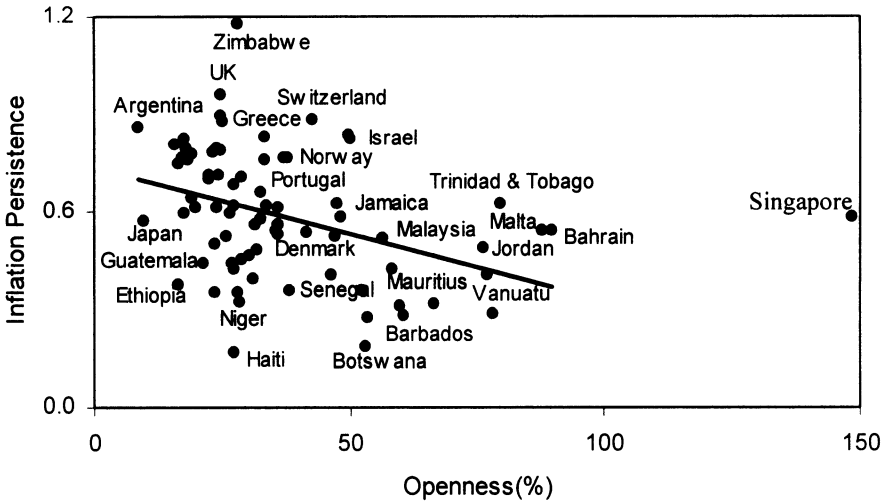

Figure 2. Openness and Inflation Persistence for Full Sample and Whole Sample Period

persistence (Eqn. 3.3). Associated results in panel (B) of Table 2 show that the findings on the relationship between openness and inflation persistence is not sensitive to which inflation persistence measure is used.

We also ask if the results of the 1990s reflect a change in monetary policy aggressiveness within a specific group of countries or for all sample countries. Recall that Romer (1993) shows that the link between openness and inflation can depend on a country's economic development. More economically developed countries are less prone to dynamic inconsistency in policy.

To see if policymakers behave differently in developed and developing countries during the sample periods 1973–1990 and the 1990s, we categorize (using IFS's definition) our full sample into developed and developing countries. Panel A of Table 3 reports associated regression results of Equation 3.2, where IP_i is estimated from autoregression 3.1. As seen in regressions (37) and (39), there is no significant relationship between openness and inflation persistence for both developed and developing countries in the sample period 1973–1990. Thus, there is no evidence that more open economies used more aggressive monetary policy during the period 1973–1990.

We note that, although the coefficient on openness for developed countries is not different from zero in the period of 1973–1990, regression (38) shows a significant negative relationship after 1990. Figure 3 presents an associated scatter plot, which shows a clear negative relationship between openness and inflation persistence.

For the group of developing countries, after adding additional regressors to the regression and removing outliers from the sample, regression (48) shows the coefficient on openness is negative and significant at the 5% level. Figure 4 presents an associated scatter plot that shows a negative relationship between openness and inflation persistence. Although the negative relationship emerges in both groups of countries in the 1990s, the relationship appears to be much stronger in developed countries ($\phi = -0.012$) than in developing countries ($\phi = -0.005$). (See results in regressions (43) and (48), respectively.)

Further examination of these results shows the difference between developing and developed countries is nontrivial. The average for inflation persistence in developing and developed countries is 0.538 and 0.587, respectively. Consequently, a 1 SD increase in economic openness reduces inflation

Table 3. Openness and Inflation Persistence for Developed and Developing Countries

Panel A: Inflation persistence estimated from Equation 3.1

	Developed Countries		Developing Countries	
Time period (Regression)	1973–1990 (37)	1990s (38)	1973–1990 (39)	1990s (40)
Constant	0.387**	0.993**	0.559***	0.586***
	(2.157)	(5.539)	(6.882)	(6.460)
Openness	0.006	−0.012**	−0.001	−0.001
	(1.024)	(−2.243)	(−0.454)	(−0.334)
R^2	0.060	0.254	0.003	0.006
Number of observations	17	17	52	45

Robustness check	Additional Regressors Added to (37)	Outliers Excluded from (41)	Additional Regressors Added to (38)	Outliers Excluded from (43)	Additional Regressors Added to (39)	Outliers Excluded from (45)	Additional Regressors Added to (40)	Outliers Excluded from (47)
Regression	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)
Constant	−2.320	−3.813	1.255	–	−0.973**	−0.627*	0.132	0.247
	(−0.589)	(−1.155)	(0.482)		(−2.067)	(−1.725)	(0.420)	(0.815)
Openness	−0.0001	0.003	−0.012*	–	−0.0003	0.001	−0.001	−0.005**
	(−0.011)	(0.414)	(−1.819)		(−0.185)	(0.616)	(−0.388)	(−2.067)
Real GDP volatility	0.119	0.495***	−0.003	–	0.156*	0.110	0.041	0.044
	(0.452)	(4.559)	(−0.037)		(1.805)	(1.411)	(0.609)	(0.711)
Real GDP per capita	0.474	0.676	−0.279	–	0.182*	0.172*	0.144	0.180
	(0.697)	(0.972)	(−0.466)		(1.923)	(1.892)	(1.036)	(1.392)
Inflation	−0.001	−0.026	0.046	–	0.0003**	0.0002	0.001	0.001
	(−0.055)	(−1.337)	(1.383)		(2.157)	(1.535)	(665)	(0.631)
Total real GDP	0.157	0.241	0.147***	–	0.170*	0.084**	−0.023	−0.045
	(0.856)	(1.542)	(3.801)		(1.756)	(2.388)	(0.279)	(−0.597)
Land size	2.9E-07	1.8E-07	−1.1E-0.6	–	−2.1E-07	5.5E-08	−8.4E-09	−06.4E-08
	(0.273)	(0.173)	(−1.610)		(−0.719)	(0.447)	(−0.037)	(−0.292)
R^2	0.322	0.485	0.711	–	0.290	0.352	0.162	0.218
Number of observations	17	15	17	–	52	51	45	44

Table 3. Continued

Panel B: Inflation persistence estimated from Equation 3.3

	Developed Countries		Developing Countries	
Time period (Regression)	1973–1990 (49)	1990s (50)	1973–1990 (51)	1990s (52)
Constant	0.020	0.019 (0.156)	−0.497***	−0.295***
	(0.137)		(−9.266)	(−3.543)
Openness	−0.012**	−0.014***	−0.001	−0.005*
	(−2.655)	(−3.279)	(−1.169)	(2.012)
R^2	0.367	0.232	0.027	0.232
Number of observations	17	17	52	45

Robustness check	Additional Regressors Added to (49)	Outliers Excluded from (53)	Additional Regressors Added to (50)	Outliers Excluded from (55)	Additional Regressors Added to (51)	Outliers Excluded from (57)	Additional Regressors Added to (52)	Outliers Excluded from (59)
Regression	(53)	(54)	(55)	(56)	(57)	(59)	(59)	(60)
Constant	−0.338	−3.650***	1.263	0.858	−1.081***	−0.953***	−0.855***	−0.740***
	(−0.178)	(−3.452)	(0.219)	(0.166)	(−3.909)	(−3.373)	(−4.399)	(−3.998)
Openness	0.0004	0.007**	−0.014*	−0.020*	−0.002	−0.004	−0.006**	−0.010***
	(0.106)	(2.726)	(−1.814)	(−1.941)	(−1.378)	(−1.102)	(−2.271)	(−5.367)
Real GDP volatility	−0.156	0.051	−0.285*	−0.317*	−0.072	−0.060	−0.016	−0.014
	(−0.954)	(0.615)	(−1.894)	(−2.342)	(−1.165)	(−0.952)	(−0.298)	(−0.262)
Real GDP per capita	−0.208	0.283	−0.239	−0.046	0.161	0.157	0.049	0.085
	(−0.646)	(1.455)	(−0.178)	(−0.041)	(1.607)	(1.495)	(0.583)	(1.109)
Inflation	0.006	0.011***	0.027	0.015	0.001***	0.001***	0.0003	0.0001
	(1.143)	(3.423)	(0.449)	(0.235)	(3.637)	(3.088)	(0.268)	(0.132)
Total real GDP	0.149	0.309***	−0.046	−0.072	0.056	0.037	0.125*	0.104*
	(1.511)	(6.956)	(−0.513)	(−1.153)	(0.939)	(0.499)	(1.931)	(1.835)
Land size	1.2E-06**	9.6E-07***	6.3E-07	5.2E-08	−2.5E-07	−3.8E-07*	−2.5E-07*	−3.0E-07**
	(2.442)	(3.872)	(0.538)	(0.47)	(−1.200)	(−1.905)	(−1.907)	(−2.500)
R^2	0.763	0.941	0.553	0.639	0.303	0.326	0.411	0.478
Number of observations	17	15	17	14	52	50	45	44

Heteroskedasticity-consistent t-ratios in parentheses. ***, **, and * denote 1%, 5%, and 10% significance levels in two-tailed tests, respectively. We use Welsch distance test (Welsch 1982) to identify outliers and exclude them from associated regressions. For regression (41), Iceland and Spain are outliers. For regression (45), Poland is an outlier. For regressions (47) and (59), Singapore is an outlier. For regression (53), Finland and Spain are outliers. For regression (55), Japan, Portugal, and Sweden are outliers. For regression (57), Mexico and Singapore are outliers.

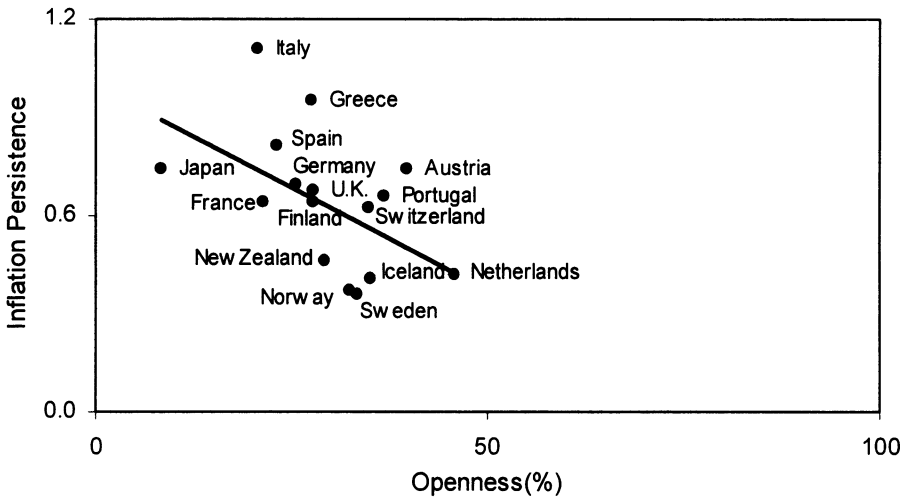

Figure 3. Openness and Inflation Persistence for Developed Countries in 1990s

persistence by 14% for developing countries, but it drops inflation persistence by 31% for developed countries.

Panel B of Table 3 shows that switching the inflation persistence estimation method from Equations 3.1 to 3.3 has little effect on our findings. Further, when we add proper group dummy variables, the *F*-test (not reported here) indicates there is a significant statistical difference in the economic openness coefficient between developed and developing countries in the 1973–1990 and 1990s sample periods.

Another issue is whether the negative relationship in the 1990s represents a change in relative degrees of openness among countries or, as we have been arguing, it represents a change in policy behavior. The rank correlations between the openness data in 1973–1990 and the 1990s for developed and developing countries are 0.953 and 0.728, respectively. This high correlation indicates that there is little change in the relative degree of openness among all countries before and after 1990. On the

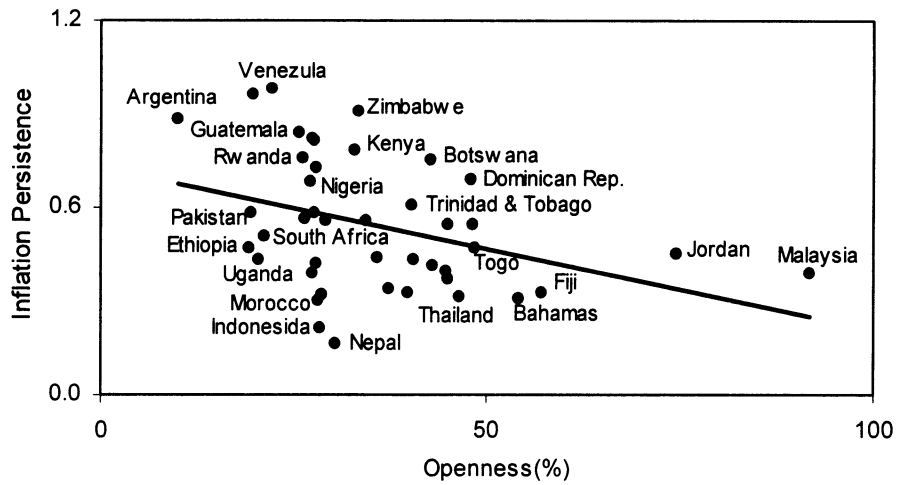

Figure 4. Openness and Inflation Persistence for Developing Countries in 1990s

other hand, the rank correlations between the inflation persistence estimation from Equation 3.1 in the 1973–1990 period and that of the 1990s (for developed and developing countries) are 0.066 and 0.279, respectively. These low correlations imply that monetary policy behavior has been changing dramatically among all countries since 1990.

The magnitude of rank correlation of inflation persistence also suggests this policy behavior is more pronounced in developed countries (0.066 vs. 0.279). This observation, along with the quantitative evidence (a much stronger negative relationship between openness and inflation persistence in developed countries during the 1990s), indicates that developed countries have adjusted their monetary or inflation stabilization policies in reaction to the degree of openness much more extensively than have the developing countries.

4. Conclusion

In this article, we document that, in a sample of 102 countries, the correlation between economic openness and inflation variability is negative. We also demonstrate that the correlation between economic openness and inflation persistence is negative. Our findings provide a possible connection between economic openness and aggressiveness in monetary policy toward inflation stabilization. This is consistent with the argument by CGG (2001). This stands in contrast with the time consistency theory of policy suggested in Romer (1993).

We note that this finding is plausible because the cost of inflation target deviations is larger in more open economies (Temple 2002). As a result, policymakers have a greater incentive to reduce deviations from the inflation target. We also find the relationship between economic openness and inflation volatility is strongest in the 1990s. There is also some evidence that this negative relationship between openness and the aggressiveness of monetary policy in the 1990s is more pronounced in developed countries than in developing countries. Also, our findings are consistent with the inflation-targeting literature, where many countries engaged in a regime shift in monetary policy after 1990. We would add this refinement to those findings. Regime shifts in the 1990s have been most pronounced in countries that are the most open.

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