Openness, inflation and the Phillips curve: a puzzle

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Abstract

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Abstract

Models of open economies with nominal rigidities are often thought to predict a correlation between openness to trade and the slope of the output-inflation trade-off, or Phillips curve. Using a variety of measures of the trade-off and a standard measure of openness, this paper argues that the direct evidence for a correlation is not strong. In turn, this calls into question the usual explanation for the negative correlation between openness and inflation that was documented by Romer (1993). The paper considers some alternative explanations for the Romer evidence.

1 Introduction

This paper investigates the possible link between openness to trade and the slope of the output-inflation trade-off or Phillips curve. Open economy macroeconomic models, and informal discussion, often suggest that the slope of the trade-off should be related to the extent of openness. Using a variety of measures of the trade-off and a standard measure of openness, this paper points out that the direct evidence for a correlation is not at all strong.

This is potentially interesting for several reasons. The evidence could be seen as contradicting the predictions of some standard open economy models. Less obviously, and closer to the main focus of this paper, the evidence is also relevant to influential work by Romer (1993). He pointed out that inflation is lower in more open economies, and explained this finding using the time consistency theory of inflation. The most plausible form of the argument ultimately relies on Phillips curves that are steeper in more open economies, and it is precisely this assumption that will be tested below.

The correlation between openness and inflation is of wider interest, since the Romer (1993) paper is often considered to be important support for time consistency theories of inflation. Other supportive evidence is lacking, and as Romer and Romer (1997, p.
point out, it is easy to question the generality of the time consistency arguments. The findings in the present paper contribute to this debate.

The paper ultimately argues that the time consistency theory is an unsatisfactory explanation of the openness-inflation correlation, and that alternative explanations should be considered. One possibility is that inflation may be relatively costly in more open economies, perhaps because inflation is associated with exchange rate variability, which could have more serious consequences for more open economies. This explanation for lower inflation in open economies is compatible with the time consistency hypothesis, but does not rely upon it.

The remainder of the paper will expand on these points, and has the following structure. Section 2 presents a brief discussion of the relevant theory. Sections 3 and 4 report on the empirical work, which draws on a variety of measures of the output-inflation trade-off to show that their sample correlations with openness are weak. Section 5 discusses some possible explanations for this finding, and for the apparent puzzle then represented by the Romer evidence on openness and inflation. Finally, section 6 rounds off with a summary and some conclusions.

2 Theoretical background

In this section, I first briefly discuss why one might expect to observe a correlation between the slope of the Phillips curve and the extent of openness to trade. The rest of the section discusses the relevance of this point to the evidence on openness and inflation compiled by Romer (1993).

The intuition that the slope of the Phillips curve is related to openness is based on models of small open economies with nominal rigidities. In such models, unanticipated monetary expansion typically leads to a real currency depreciation. There are potentially two effects on the trade-off. When inflation is measured in terms of a consumer price index, the effect of the depreciation on the domestic price of imports will add to the inflation cost of a monetary expansion. Meanwhile, if wages are partially indexed to a consumer price index, or if foreign goods are used as intermediate inputs in domestic production, the output gain to a given monetary expansion will be reduced. Both effects
mean that the Phillips curve is likely to be steeper in relatively open economies, but this hypothesis has rarely been tested.

Clearly the argument rests upon systematic exchange rate effects of monetary shocks. As discussed by Obstfeld and Rogoff (1996, p. 621-622) the conventional wisdom is that major policy shifts are indeed associated with exchange rate changes, exactly as predicted by influential models with nominal rigidities such as that of Dornbusch (1976). They cite as examples the Volcker deflation of the early 1980s in the United States, the Thatcher-Howe deflation in the United Kingdom at the same time, and the experiences of several Latin American countries in the 1990s.¹ That said, Obstfeld and Rogoff also point out that the ability of the Mundell-Fleming-Dornbusch model to predict exchange rate changes systematically is rather more controversial.

Investigating the correlation between openness and the output-inflation trade-off in a large sample of countries may shed some indirect light on this issue, although one should note at the outset an important maintained assumption. The argument that the slope of the trade-off will be greater in more open economies, as sketched above, is based on the effects of monetary shocks. In looking for such a relation in the cross-country data, I will assume that movements along short-run Phillips curves (and particularly disinflations) are predominantly driven by monetary shocks, rather than fiscal policy.

How plausible is this assumption? The time period for the empirical work below extends from the mid-1960s to the late 1980s. For much of this period, we could probably assume that models based on floating exchange rates and perfect capital mobility are quite good approximations, at least for developed countries. When these assumptions hold exactly, standard models imply that fiscal policy (or more generally an IS shock) will have no effect on output, as the policy change will be entirely offset by exchange rate movements. Thus it does seem quite likely that the majority of the disinflations in this period originated in monetary shocks, although this assumption should be borne in mind throughout.

¹Some formal econometric evidence for the United States can be found in Eichenbaum and Evans (1995).
economy models; there is another reason for finding the Phillips curve slope of some interest. Romer (1993) pointed out that a relation between openness and the slope of the Phillips curve can be used to help explain the international variation in rates of inflation. The reasoning is based on time consistency theories of inflation. Other things equal, these theories imply that equilibrium inflation will be lower, the steeper is the Phillips curve. Romer (1993) uses this argument to explain why inflation appears to be lower in relatively open economies. The evidence on this point is important because it provides indirect support for time consistency theories and, as discussed further below, these theories are otherwise very difficult to test.

To examine the elements of the argument in more detail, it is useful to first set out a simple model of equilibrium inflation, associated with Barro and Gordon (1983). At its heart is an expectations-augmented Phillips curve,

\[ \pi - \pi^e = -\gamma(u - u_n) \]

where \(\pi\) is inflation, \(\pi^e\) is expected inflation, \(u\) is unemployment, \(u_n\) is the natural rate of unemployment and \(\gamma > 0\) is the slope of the Phillips curve. Policy-makers have a quadratic loss function:

\[
L(\pi, u) = \frac{1}{2} \left[ (\pi - \pi^*)^2 + \lambda(u - u^*)^2 \right]
\]

(1)

where \(u^* < u_n\). If a credible commitment to targets is possible, the outcomes from the optimal policy are \(\pi = \pi^*\) and \(u = u_n\). Under the alternative discretionary outcome, the derivative of (1) with respect to inflation must be zero for equilibrium. Using the short-run Phillips curve, it can be shown that the equilibrium inflation rate under discretion, \(\pi^D\), is given by

\[ \pi^D = \pi^* + \frac{\lambda}{\gamma}(u_n - u^*) \]

Since it is assumed that \(u^* < u_n\), the equilibrium inflation rate is lower, the more costly is inflation (the lower is \(\lambda\)), the steeper is the short-run Phillips curve (the higher is \(\gamma\)) and the higher is the unemployment target relative to the natural rate (the higher is \(u^*\) relative to \(u_n\)).
A fundamental problem with this theory is that it is extremely difficult to refute empirically. The unemployment targets of policy-makers, their dislike for inflation, and the natural rate are all hard to measure with the necessary degree of accuracy. With this in mind, Hardouvelis (1992) argues that the correlation between openness and inflation may provide the best testing ground for the time consistency theory, since openness is both easily measured and (for present purposes) exogenous. Similarly, Romer identifies as a major contribution of his own paper “testing the central element of these models” (Romer, 1993, p. 893), namely the idea that inflation will be higher, the greater are the incentives to inflate.

Why might openness affect the incentives to inflate? Romer shows that openness matters because a domestic output expansion can be associated with a real depreciation, and this depreciation is more important in more open economies.2 Romer points out that the depreciation has consequences for the rise in output and inflation, and the welfare benefits of the increase in output, associated with a given monetary expansion. In terms of the simple model above, this means that both the $\lambda$ and $\gamma$ parameters, and hence the incentives to inflate, may depend on the extent of openness.

There is a drawback to the simple framework used by Romer. In his model, a domestic expansion generates a depreciation through its effect on world prices. Domestic expansion increases output at home relative to foreign output, and if domestic and foreign goods are imperfect substitutes, this reduces the international relative price of domestic goods: there is a real depreciation. The welfare loss from this decline in the terms of trade is greater for more open economies, and so the welfare benefits of a given monetary expansion are lower. In terms of the equations above, one might expect $\lambda$ to be lower in more open economies.

As pointed out by Lane (1997), a difficulty with this argument lies in its first step: most countries are simply not large enough to affect international relative prices simply by expanding domestic output. Many developing countries specialise in exporting primary goods, and domestic output is a negligible fraction of that abroad. In these countries, an expansion of domestic output is unlikely to affect the world price of domestic goods. Hence the mechanism in the Romer model that leads to a depreciation is

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2Romer’s theory builds on an earlier contribution of Rogoff (1985).
a little unsatisfactory.

An alternative framework is provided by models of small open economies with nominal rigidities, and Lane (1997) presents a theoretical analysis of openness and inflation along these lines. As discussed above, models with nominal rigidities often imply that an unanticipated monetary expansion will be associated with a real depreciation, even if world prices are unchanged. For a given monetary expansion, this depreciation will be reflected in a higher inflation cost and a reduced output gain, and these effects will be greater in more open economies. As a result, the slope of the Phillips curve will be steeper; in terms of the model above, the $\gamma$ parameter is higher in more open economies. According to the standard time consistency argument sketched above, the outcome will be a lower rate of inflation in equilibrium.

Given the argument that openness might affect the slope of the Phillips curve, it is interesting to ask whether inflation is indeed lower in more open economies. Romer (1993) found the correlation between openness and low inflation to be quite strong, using a variety of robustness tests. He also indicated that the correlation was relatively weak in samples of developed countries, perhaps because of differing institutional arrangements, such as independent central banks. Later papers, notably Lane (1997) and Campillo and Miron (1997), have argued that on controlling for other variables, the correlation is strong even in developed countries. Terra (1997, 1998) disputes the evidence, but does not always control for other variables (see also Romer 1998).

By combining standard models of open economies with the time consistency theory of inflation, the correlation identified by Romer (1993) has appeared comparatively easy to explain. As discussed above, the most appealing version of this argument rests on the assumption of a systematic relation between openness and the slope of the Phillips curve. One of the main contributions of the present paper, and in particular the next two sections, is to use direct evidence to question that basic assumption.

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3 In related work, Hardouvelis (1992) derives a link between the slope of the Phillips curve and the share of imported intermediate inputs in output. In his model, this measure of openness can be associated with more or less inflation, depending on how intermediate inputs substitute for other factors of production. This finding is related to an earlier contribution by Buiter (1979).

4 Iyoha (1973), Akhtar (1976) and Kirkpatrick and Nixson (1977) also discuss the relation between openness and inflation in less developed countries.
3 Openness and the sacrifice ratio

In this section, I turn to empirical evidence. The obvious difficulty here lies in measuring the slope of the Phillips curve. More precisely, we want to measure the slope of the Phillips curve when the economy is hit by a monetary shock. I start by noting that, if the slope of the Phillips curve is genuinely steeper in more open economies, then in particular one would expect to see greater openness associated with a lower “sacrifice ratio”. The latter is the ratio between total output losses and the change in trend inflation over the course of a disinflation. A relatively low figure (compared to disinflation episodes at other times or in other countries) corresponds to a relatively steep Phillips curve.

The sacrifice ratio provides an attractive way of identifying the output-inflation trade-off, since one would usually think that the shocks over the course of a disinflation are predominantly to demand rather than to supply. As noted earlier, in looking for the correlation between openness and the slope of the trade-off that is needed to explain the Romer (1993) evidence, I am also assuming that demand contractions are primarily monetary rather than fiscal in origin. For the majority of disinflationary episodes this assumption does not seem implausible.

Using annual output and inflation data from the 1960s onwards, Ball (1994) calculates sacrifice ratios for various disinflationary episodes in nineteen developed countries. For each country, the denominator of the sacrifice ratio is the change in trend inflation over the course of a disinflationary episode. The numerator is the sum of annual deviations between the log of trend output and that of actual output.

The calculations of trend output are clearly quite important here, and are based on three assumptions. The first two are that output is at its trend or natural level at the inflation peak, and again four quarters after the end of a disinflationary episode. Thirdly, the growth rate of trend output is assumed to be constant between the two points at which actual and trend output are equal. Further discussion of these assumptions can be found in Ball (1994). He argues that his measure of the sacrifice ratio is likely to be useful even in the presence of hysteresis. Importantly for the present paper, he notes that demand contractions appear to be the main cause of the disinflations he isolates in
the sample (Ball 1994, p. 161).

As a measure of openness, here and later in the paper, I use the Romer (1993) data on the post-1973 share of imports in GDP. This is a natural measure of openness to trade in this context. Note that the predictions of the theory are based on the importance of trade relative to GDP, and not on trade policy, so throughout this paper ‘openness’ should be interpreted in the former sense.\footnote{Romer (1993) shows that correcting for variations in openness driven by trade policies makes little difference to his results.}

The Ball sacrifice ratios, averaged for each country, are plotted against the import share in figure 1. There is some weak evidence for the negative relationship predicted by theory; but what evidence there is, depends on being prepared to overlook the three outlying observations Australia, France and Japan. Incidentally, although the evidence for a relationship is somewhat uncertain, it will turn out to be much the strongest in this paper.

The relation can be analysed in more detail using regressions based on Ball’s data, covering 65 disinflation episodes. The regressions seek to explain variation in the sacrifice ratio across the different episodes. Apart from openness, the other regressors are the initial inflation rate ($\pi$), the change in inflation ($\Delta\pi$), the length of the disinflation-ary period in years (called “Length”), and a measure of contract duration (“Duration”). The last variable is taken from Bruno and Sachs (1985), and takes the value of zero, one or two where higher values indicate relatively short contracts. The appendix lists the countries used in these and subsequent regressions. The group of countries is close to, but slightly smaller than, the OECD sample of Romer (1993).

It should be noted that Ball also briefly addresses openness and finds no effect on the sacrifice ratio (his Table 5.12). Here I am extending his results by trying a wider variety of different specifications, in particular ones which include initial inflation. Secondly, as well as using least squares, I use a robust estimator to check that these simple cross-section results are not being driven by a few outlying observations. Finally, another technical point to note is that the errors in measuring the sacrifice ratio are likely to vary in size across episodes, and particularly across countries. This means that the use of the sacrifice ratio as a dependent variable may introduce heteroscedasticity, and
I use heteroscedastic-consistent standard errors (HCSEs) to allow for this, based on MacKinnon and White (1985).

Table 1 reports results from a variety of specifications. Although it did not prove possible to replicate Ball’s regressions exactly, the results are qualitatively very similar. Overall, the findings confirm the message of Ball (1994). The sample correlation between openness and the sacrifice ratio is a weak one. If openness does have an effect, it appears to be negative, but it is very imprecisely estimated.

Figure 1 suggests that one reason for the high standard errors may be the presence of outliers, and so I have also re-estimated each equation using a robust estimator, least trimmed squares. These results, available on request, indicate that there is no strong correlation between openness and the sacrifice ratio even when one uses an estimator that downweights outliers. Another possibility, again indicated by figure 1, is that the relation may be non-linear. However, adding a quadratic term in openness makes little difference.

In thinking about the imprecision of the estimates, we can gauge the degree of uncertainty by calculating 95% confidence intervals, based on the HCSEs. One problem here is that it would be difficult to interpret the magnitude of an effect on the sacrifice ratio, and so I will report the size of the estimated effect relative to the sample standard deviation of the average sacrifice ratio. Using regression (1), consider the effect of a rise in the openness measure of one standard deviation, which is an increase in the share of imports in GDP of about 17 percentage points. The effect of this change on the sacrifice ratio is bounded, to a 95% level of confidence, between (-0.57, 0.28) of one standard deviation of the average sacrifice ratio.

The width of the 95% confidence interval suggests that there is considerable uncertainty in measuring the size of the openness effect. Against this, one could argue that here we are arguably looking at a population, namely that of developed countries, rather than a sample from a population. From this perspective, the confidence interval is less interesting than the point estimate of the effect of openness. According to the point estimate in regression (1), a change in openness of one standard deviation leads
to a change in the average sacrifice ratio smaller than 0.15 of its standard deviation.

The assumption that monetary shocks are chiefly responsible for disinflations is arguably more plausible after the collapse of Bretton Woods in the early 1970s. With this in mind, I have also used the Ball data to calculate an average sacrifice ratio which includes only the post-1973 disinflations. This has a correlation of 0.70 with the ratio based on all episodes, and the relationship with openness is similar to that shown in figure 1.

Overall, figure 1 and the results in Table 1 cast some doubt on the idea that the slope of the Phillips curve is strongly influenced by the degree of openness. This finding extends to the smaller quarterly data set used by Ball (1994). The regression results for that data set, not reported here, again indicate that openness and the sacrifice ratio are not strongly correlated. This result is robust to the exclusion of possible outliers.

As a further check on robustness, I use alternative measures of the sacrifice ratio taken from Jordan (1997). Although he uses a method quite similar to Ball’s, and considers roughly the same time period, there are enough differences in method to yield a different ranking of countries when ordered by the average sacrifice ratio. The rank correlation between Ball’s average sacrifice ratio and Jordan’s is just 0.46, some evidence of the uncertainty involved in estimating the trade-off.

I have carried out a regression analysis similar to that above for the Jordan measures. Following Jordan, the regressors include a dummy for the post-1972 period, initial inflation, the speed of disinflation, the change in inflation, and an index of nominal wage rigidity. Whether or not one controls for these variables, openness is again insignificant at conventional levels.

It is worth bearing in mind that the output-inflation trade-off may vary depending on the forces driving the change in output and employment. One possibility is that openness affects the output-inflation trade-off mainly during expansions, rather than during a disinflation. Jordan (1997) calculates “benefit ratios”, the gain in output over the course

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6 Ball notes that the correlation between the quarterly and annual sacrifice ratios is 0.81 for the twenty-five common episodes.

7 In these regressions I include a dummy for the post-1972 period to aid comparison with the results of Jordan (1997). I have also experimented with including a post-1972 dummy in the Table 1 regressions, but it is never significant at conventional levels.
of periods with increasing inflation. As measures of the output-inflation trade-off, these are less plausible than Ball’s. The procedure used by Ball assumes that disinflation is driven by demand shocks. It seems highly likely that supply shocks become more important outside recessions, in which case Jordan’s extension of the method to expansions is not wholly appropriate. In the presence of supply shocks, the procedure will not correctly identify the short-run trade-off (see Ball, Mankiw and Romer 1988 for more discussion). It is also worth noting that our maintained assumption, that monetary shocks predominate, may be less applicable in the case of expansions.

Even so, it is interesting to consider whether Jordan’s trade-off measures for expansions are correlated with openness. In figure 2, I plot the average benefit ratio against openness. Again, there is little evidence of a strong negative relation. This is borne out by the regressions reported in Table 2. It is worth noting that the weak relation observed between openness and the benefit ratio disappears completely when just two episodes are excluded: for both Japan 1966-70 and USA 1961-69, Jordan estimates a very high benefit ratio relative to other expansionary episodes. In the simplest specification that omits these two episodes, the t-ratio falls to just 0.41 for regressions estimated using the remaining 60 observations in the sample.

The point estimate suggests a small effect but, as in the earlier regressions based on the Ball data, it should be emphasised that there is a high degree of uncertainty in interpreting the results. The 95% confidence interval, when expressed in terms of standard deviations of openness and the average benefit ratio, is broadly similar to that calculated for the regressions based on the Ball data. Using regression (6), consider a one standard deviation increase in the measure of openness (in this sample, a change in the import share of around 14 percentage points). To a 95% degree of confidence, the effect of this increase on the benefit ratio is bounded between (-0.63, 0.41) of one standard deviation of the average benefit ratio.

With this uncertainty in mind, I end this section with some important caveats. The key caveat is that the evidence is ultimately ambiguous, since the 95% confidence intervals for the effect of openness are quite wide. Although it is difficult to reject the null
hypothesis of no effect, it would also be difficult to reject the hypothesis that openness matters. The next section will make some progress on this issue by considering a larger sample, in which the estimated effect of openness turns out to be more tightly bounded.

One important reason for high standard errors, besides the small sample, could be measurement errors in the dependent variable, the sacrifice ratio. Measuring the output-inflation trade-off is difficult and very sensitive to identifying assumptions, as King and Watson (1994) have recently emphasised. Their discussion is reinforced by the low rank correlation between the Ball measures of the sacrifice ratio and those constructed by Jordan. Yet the regressions in Table 1 do pick up effects of the change in inflation, episode length, and to a lesser extent contract duration. This is tentative evidence that there is some useful information in Ball’s trade-off measures.

Another concern is the range of possible control variables. For instance, I do not control for the exchange rate regime. This may be less problematic than it seems at first. Romer (1993) is sceptical that the exchange rate regime will matter to the basic argument, especially since ‘fixed’ rates are rarely set in stone. Similarly, Obstfeld and Rogoff (1996, p. 653) note that a flexible exchange rate is not essential to the openness-inflation argument.

It could be argued that disinflation may be accompanied by other reforms, and it is possible that open economies are more likely to choose particular disinflation strategies, such as exchange rate based stabilization programs, which could obscure the connection between openness and the trade-off. It is possible that controlling for these policies, or other determinants of the sacrifice ratio, could uncover a partial correlation with openness.

All of these arguments have some plausibility, but none quite overcome the main point, which is that the sample correlation between openness and the slope of the Phillips curve is not at all strong. Although many standard models predict the trade-off to be steeper in more open economies, and although this idea has been used to explain the Romer (1993) evidence, this relationship is not obviously present in the data. The next section will reinforce this claim, using evidence from a larger sample of countries.
4 Evidence from a larger sample

It is important to emphasise that the empirical work presented so far is relevant only to
developed countries. Romer (1993) argued that the link between openness and infla-
tion holds up best in large samples of developing countries, or samples that combine
developed and developing countries. When he confines attention to an OECD sample,
he finds little evidence for a correlation between openness and inflation. A number
of explanations are possible; one is that developed countries are more likely to have
found institutional means, such as independent central banks, to improve the inflation
outcome even in the presence of a short-run trade-off. Romer’s emphasis on this point
suggests that we should also cast the net further afield, and examine output-inflation
trade-offs in a wider sample of countries.

Fortunately, estimates of the trade-off for a large number of countries, developing
and developed, have been constructed by Ball, Mankiw and Romer (1988), henceforth
BMR. They provide estimates of the trade-off for a period before 1972, for post 1972,
and the whole period (roughly the 1960s to the mid-1980s, but varying by country).
It is worth noting that the necessary identifying assumptions are cruder than those of
Ball (1994). For the countries in common, the rank correlation between the post-1972
BMR measure and Ball’s average sacrifice ratio is just 0.34 in the cross-section. The
rank correlations are slightly higher for the Jordan measures, at 0.43 for the sacrifice
ratio and 0.42 for the benefit ratio, but remain low enough to highlight the uncertainty
involved in estimating output-inflation trade-offs.\footnote{Calculating average ratios for just the post-1972 period, using data in Ball (1994) and Jordan (1997), lowers these correlations.}

Figure 3 plots the post-1972 trade-off parameter against the Romer openness mea-
sure. The trade-off parameter estimated by BMR is lower, the steeper the Phillips curve,
and so once again we are looking for a downward sloping line in the figure. No such
pattern is apparent, and regressions only confirm this initial impression. Table 3 reports
results based on the specification used by BMR, using as the dependent variable the
trade-off parameter estimated from the whole period.\footnote{The trade-off parameters used as the dependent variable are estimates. Because the measurement errors in the estimates are of different sizes, they will cause heteroscedasticity in these cross-section regressions. BMR note that the measurement errors account for only a small part of the average variance of}
complete list of countries.

Regression (9) reproduces equation 5.6 from BMR. In the other regressions reported here, Singapore is excluded, since it has a very high share of imports in GDP. Regression (10) shows that the BMR results do not change much with the exclusion of Singapore. Regressions (11)-(13) combine the Romer openness measure with non-linear effects of inflation and a measure of nominal GNP uncertainty, variables that are emphasised as important in BMR’s theoretical framework.

Once again it is clear that a null hypothesis of no correlation between openness and the trade-off parameter is not rejected at conventional levels. Also of interest is that, in this larger sample of countries, the possible effect of openness is more tightly bounded. Based on regression (11), consider an increase in the openness measure of one standard deviation (in this sample, a rise in the import share of 13.3 percentage points). The effect of this increase on the trade-off parameter lies, to a 95% level of confidence, between (-0.19, 0.42) of one standard deviation of the trade-off parameter. We can now rule out large negative effects with a greater degree of certainty than was possible in the earlier results.

These findings are confirmed by two further sets of regressions. Replacing the full sample trade-off parameter with the post-1972 parameter makes little difference to the results. Estimating each equation using a robust estimator, least trimmed squares, again provides little evidence that the trade-off parameter is negatively associated with openness. Hence it seems unlikely that the results above could be explained by the presence of outliers.

Table 3 about here

5 The openness-inflation puzzle

Why is inflation lower in more open economies? The previous two sections have examined an assumption of the conventional explanation, namely that the Phillips curve the residuals, so correcting for this heteroscedasticity is unlikely to have much effect on the results. As a safeguard, I choose to use HCSEs throughout.

\footnote{BMR also briefly investigate this issue, and come to the same conclusion. See Ball, Mankiw and Romer (1988, p. 49).}
should be steeper in more open economies. As we have seen, the direct evidence for
this assumption is not strong. Although I have noted the high degree of uncertainty,
and the possibility that measurement error plays some role, the findings suggest that
it might be worth investigating other possible explanations for the openness-inflation

One argument is that the time consistency explanation does not necessarily depend
on a correlation between openness and the trade-off. If a monetary expansion is as-
sociated with a reduction in the relative price of domestic goods, this will reduce the
welfare gains from an expansion, and so temper the incentives to inflate. Although this
effect by itself could explain the openness-inflation correlation, international relative
prices are likely to be independent of domestic output for most countries, as discussed
earlier.\footnote{Lane (1997) presents an alternative model consistent with this view, in which domestically-produced traded goods are perfect substitutes for foreign goods, but which retains the Romer implication that the gains to a surprise monetary expansion are decreasing in openness. Barry (1998) has argued that this conclusion is unlikely to be a general one, however.}

That leaves the openness-inflation correlation as something of a puzzle. This point
is reinforced by a further consideration. Models of the optimal degree of central bank
independence suggest that openness might be associated with higher inflation. Eijffin-
ger and Schaling (1995) point out that in trading off credibility for flexibility in the
face of shocks, one should probably expect to observe a lower degree of central bank
independence in more open economies, and higher inflation.

In earlier research on openness and inflation, it was suggested that in more open
economies, inflation would be lower because inflationary pressure would spill over
onto the trade balance rather than domestic prices (Triffin and Grubel 1962, Whitman
1969). This view appears to take inflationary pressure as exogenous; more recent work
starts from the assumption that the government can set the inflation rate in the medium
run, in which case the older story is incomplete.

An alternative argument, more compatible with a modern time consistency frame-
work, is that the equilibrium rate of unemployment may be lower in more open economies.
There is indeed an effect of openness on the equilibrium rate of unemployment in stan-
dard frameworks (see for instance Harrigan et al. 1993). However, a first reading of
the evidence is that the relatively closed US economy has a lower equilibrium rate of unemployment than more open European countries, so this argument does not look particularly promising.

An alternative explanation may be more attractive, and have greater generality. It seems plausible that inflation is perceived as more costly in open economies, as will be the case if high inflation generates unwelcome variability in real exchange rates. With higher perceived costs of inflation, equilibrium inflation under discretion is lower.

This argument is consistent with some previous research. As noted earlier, effects of monetary shocks on the real exchange rate are found in standard models with price stickiness; recent contributions include Beaudry and Devereux (1995) and Gonzaga and Terra (1997) among others. Looking at case studies of individual countries, Little et al. (1993) cite real exchange rate variability as an important cost of inflation. Hau (2000) finds that real exchange rate variability is lower in more open economies; this may reflect lower inflation in these economies, although alternative explanations are possible.

Note that the models of both Romer (1993) and Lane (1997) have the property that the real exchange rate responds to monetary shocks, at least in the short run. In a sense the argument made here requires only one extra assumption to explain Romer’s evidence, namely that real exchange rate variability is costly in itself. Admittedly, the argument still has to explain why there is little direct evidence for a correlation between openness and the slope of the Phillips curve. Barry (1998) argues that this correlation is not necessarily a general implication of open economy models. In this respect, it is also worth pointing to wider evidence on the exchange rate effects of shocks. Obstfeld and Rogoff (1996, p. 621-622) note that empirical support for systematic effects of monetary shocks is not yet well established. It is probably easier to support the idea that inflation results in unwanted exchange rate variability, than it is to find evidence for the systematic effects of monetary policy that are needed to yield a correlation between openness and the slope of the Phillips curve.

Even were this not the case, the argument in terms of inflation costs retains two potential advantages over the original argument of Romer (1993). First, it can explain a second stylized fact: it appears that open economies are more likely to peg their
exchange rate (Lane 1995). This conflicts with the usual view that open economies will sometimes wish to insulate themselves against real shocks by maintaining a flexible exchange rate (see for instance Devarajan and Rodrik, 1992). This conflict suggests that flexibility considerations may be outweighed by a desire to reduce unwanted volatility in the real rate, and there is fairly general agreement that pegging the nominal rate reduces the variability of the real exchange rate. This will tend to increase the perceived costs of inflation; ultimately, the higher cost of monetary expansions is reflected in lower equilibrium inflation.

The second advantage of the argument given here is that, although it is compatible with the time consistency theory, it is not reliant upon it. After all, it is not clear that theories of time consistency will always provide a useful guide to the behaviour of governments in developing countries. Some autocratic regimes may have little incentive to generate output surprises. For some developing countries, the relatively frequent occasions on which the government loses control of inflation suggest that other forces are at work in the determination of inflation rates. It seems a little unlikely that the time consistency theory provides a general explanation of cross-country variation in inflation rates, applicable worldwide. In turn, this suggests that a satisfactory resolution to the openness-inflation puzzle may lie elsewhere.

To summarise, the argument advanced here is that the 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. One route would be to see whether the effect of openness on inflation is weakened when one controls for the exchange rate regime. One difficulty here is that the optimal exchange rate regime is likely to be determined simultaneously with the equilibrium inflation rate, since high inflation makes it harder to form a credible commitment to a peg. It is also possible that inflation is more costly in more open economies, regardless of the exchange rate regime.
6 Summary and conclusions

Standard models of small open economies with nominal rigidities are often thought to suggest that the slope of the Phillips curve should be related to the extent of openness to trade. When combined with the time consistency theory of inflation, this can explain the observed correlation between openness and low inflation in the cross-country data. As a result, this latter correlation has sometimes been used as indirect support for the time consistency theory, as in Romer (1993).

This paper directly addresses a key step in the argument. I find little support for the theoretical prediction of a correlation between openness and standard measures of the output-inflation trade-off, including sacrifice ratios. The sample correlations between openness and averages of the trade-off measures are weak, as indicated by the figures. Regressions that control for other variables, and that give less weight to outliers, only reinforce this finding. The result holds for two measures of the sacrifice ratio, and also for an alternative measure of the trade-off in a larger sample of developed and developing countries.

Such findings are interesting for at least two reasons. First, they perhaps call into question either the prevalence of unanticipated monetary shocks in the data, or the generality of some influential open economy models. Theoretical analysis based on more general assumptions, such as that of Barry (1998), may be worth pursuing. Second, the findings potentially turn the openness-inflation correlation into an interesting puzzle. It becomes a little harder to explain this correlation in terms of time consistency models, since the most plausible form of this argument ultimately rests on a correlation between openness and the slope of the trade-off for which the direct evidence is not strong.

As noted earlier in the paper, and as I have tried to emphasise throughout, there are some important caveats. Some of the cross-country evidence, properly interpreted, is essentially ambiguous. The strongest evidence for a correlation is found when using Ball’s measures of the trade-off, which are almost certainly the best considered here. And it may be simply that the trade-off is usually badly mismeasured or that other key variables are omitted. These issues are difficult to resolve, but the results in this paper do suggest that further theoretical work on openness and monetary shocks, and the
investigation of alternative explanations for the openness-inflation correlation, could both be fruitful.

7 Appendix: List of countries

The countries included in the Table 1 regressions (1) and (2) are:

Australia, Austria, Belgium, Canada, Denmark, Finland, France, West Germany, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Spain, Sweden, Switzerland, United Kingdom, United States.

The countries included in regressions (3) and (4) are as above, but excluding Ireland, Luxembourg and Spain, since the variable ‘Duration’ is not available for these countries.

The countries included in the Table 2 regressions (5)-(8) are:

Australia, Austria, Belgium, Canada, Denmark, Finland, France, West Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom, United States.

The countries included in the Table 3 regression (9) are:

Argentina, Australia, Austria, Belgium, Bolivia, Brazil, Canada, Colombia, Costa Rica, Denmark, Dominican Republic, Ecuador, El Salvador, Finland, France, West Germany, Greece, Guatemala, Iceland, Iran, Ireland, Israel, Italy, Jamaica, Japan, Mexico, the Netherlands, Nicaragua, Norway, Panama, Peru, Philippines, Portugal, Singapore, South Africa, Spain, Sweden, Switzerland, Tunisia, United Kingdom, United States, Venezuela, Zaire.

The countries included in regressions (10)-(13) are as above, but excluding Singapore.

References


8 Footnotes

1. Some formal econometric evidence for the United States can be found in Eichenbaum and Evans (1995).

2. Romer’s theory builds on an earlier contribution of Rogoff (1985).

3. In related work, Hardouvelis (1992) derives a link between the slope of the Phillips curve and the share of imported intermediate inputs in output. In his model, this measure of openness can be associated with more or less inflation, depending on how intermediate inputs substitute for other factors of production. This finding is related to an earlier contribution by Buiter (1979).

4. Iyoha (1973), Akhtar (1976) and Kirkpatrick and Nixson (1977) also discuss the relation between openness and inflation in less developed countries.

5. Romer (1993) shows that correcting for variations in openness driven by trade policies makes little difference to his results.

6. Ball notes that the correlation between the quarterly and annual sacrifice ratios is 0.81 for the twenty-five common episodes.

7. In these regressions I include a dummy for the post-1972 period to aid comparison with the results of Jordan (1997). I have also experimented with including a post-1972 dummy in the Table 1 regressions, but it is never significant at conventional levels.

8. Calculating average ratios for just the post-1972 period, using data in Ball (1994) and Jordan (1997), lowers these correlations.

9. The trade-off parameters used as the dependent variable are estimates. Because the measurement errors in the estimates are of different sizes, they will cause heteroscedasticity in these cross-section regressions. BMR note that the measurement errors account for only a small part of the average variance of the residuals, so correcting for this heteroscedasticity is unlikely to have much effect on the results. As a safeguard, I choose to use HCSEs throughout.

10. BMR also briefly investigate this issue, and come to the same conclusion. See Ball, Mankiw and Romer (1988, p. 49).

11. Lane (1997) presents an alternative model consistent with this view, in which
domestically-produced traded goods are perfect substitutes for foreign goods, but which retains the Romer implication that the gains to a surprise monetary expansion are decreasing in openness. Barry (1998) has argued that this conclusion is unlikely to be a general one, however.
## 9 Tables

Table 1

Openness and the sacrifice ratio

<table>
<thead>
<tr>
<th>Regression</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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<tr>
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<td>0.67</td>
<td>0.70</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>(2.83)</td>
<td>(1.39)</td>
<td>(1.36)</td>
<td>(0.84)</td>
</tr>
<tr>
<td>Openness</td>
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<td>-0.53</td>
<td>-0.22</td>
<td>-0.12</td>
</tr>
<tr>
<td></td>
<td>(0.69)</td>
<td>(0.62)</td>
<td>(0.19)</td>
<td>(0.11)</td>
</tr>
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<td>$\pi$</td>
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<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.90)</td>
<td>(0.99)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta \pi$</td>
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<td>-0.16</td>
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<tr>
<td></td>
<td>(1.68)</td>
<td>(2.09)</td>
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<td></td>
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<tr>
<td>Length</td>
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<td>0.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.62)</td>
<td>(2.73)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
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<td>-0.32</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(1.73)</td>
<td>(1.65)</td>
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</table>

$R^2$ | 0.01 | 0.02 | 0.25 | 0.26 |
N    | 65   | 65   | 58   | 58   |

Heteroscedasticity-consistent t-ratios in parentheses. See the appendix for a list of countries.
## Table 2
Openness and the benefit ratio

Dependent variable: the benefit ratio

<table>
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<th>(7)</th>
<th>(8)</th>
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<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<td>Constant</td>
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<td>6.33</td>
<td>4.09</td>
</tr>
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<td>(4.20)</td>
<td>(4.16)</td>
<td>(3.08)</td>
<td>(3.10)</td>
<td></td>
</tr>
<tr>
<td>Openness</td>
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<td>-3.76</td>
<td>-0.77</td>
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<tr>
<td>(1.39)</td>
<td>(0.41)</td>
<td>(1.16)</td>
<td>(0.31)</td>
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</tr>
<tr>
<td>Dummy for post-1972</td>
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<td>-3.07</td>
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<tr>
<td>(5.28)</td>
<td>(5.07)</td>
<td>(3.63)</td>
<td>(3.59)</td>
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<tr>
<td>$\pi$</td>
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<td>-0.12</td>
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<td></td>
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<tr>
<td>(0.59)</td>
<td>(0.87)</td>
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</tr>
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<td>$\Delta \pi$/length</td>
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<tr>
<td>(1.01)</td>
<td>(0.89)</td>
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<tr>
<td>$\Delta \pi$</td>
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<td></td>
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<tr>
<td>(0.60)</td>
<td>(1.38)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nominal wage rigidity</td>
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<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.53)</td>
<td>(0.07)</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

| $R^2$ | 0.43 | 0.40 | 0.46 | 0.44 |
| N | 62 | 60 | 62 | 60 |

Heteroscedasticity-consistent t-ratios in parentheses. See the appendix for a list of countries.
<table>
<thead>
<tr>
<th>Regression</th>
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<th>(10)</th>
<th>(11)</th>
<th>(12)</th>
<th>(13)</th>
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<td>0.58</td>
<td>0.16</td>
<td>0.56</td>
<td>0.55</td>
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<tr>
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<td>(4.06)</td>
<td>(1.61)</td>
<td>(5.50)</td>
<td>(3.48)</td>
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<tr>
<td>Mean inflation</td>
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<td>-5.42</td>
<td>-4.72</td>
<td>-5.46</td>
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</tr>
<tr>
<td></td>
<td>(3.03)</td>
<td>(2.84)</td>
<td>(4.44)</td>
<td>(2.83)</td>
<td></td>
</tr>
<tr>
<td>Square of mean inflation</td>
<td>8.40</td>
<td>7.90</td>
<td>7.00</td>
<td>8.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.16)</td>
<td>(2.02)</td>
<td>(2.60)</td>
<td>(2.03)</td>
<td></td>
</tr>
<tr>
<td>Standard deviation of nominal GNP growth</td>
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<td>0.98</td>
<td>1.03</td>
<td>1.03</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.38)</td>
<td>(0.30)</td>
<td>(0.32)</td>
<td>(0.32)</td>
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</tr>
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<td>Square of standard deviation of nominal GNP growth</td>
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<td>-1.79</td>
<td>-2.06</td>
<td>-2.06</td>
<td></td>
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<tr>
<td></td>
<td>(0.22)</td>
<td>(0.17)</td>
<td>(0.19)</td>
<td>(0.19)</td>
<td></td>
</tr>
<tr>
<td>Openness</td>
<td>0.24</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.75)</td>
<td>(0.45)</td>
<td>(0.44)</td>
<td>(0.44)</td>
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</tr>
<tr>
<td>$R^2$</td>
<td>0.42</td>
<td>0.40</td>
<td>0.01</td>
<td>0.40</td>
<td>0.41</td>
</tr>
<tr>
<td>N</td>
<td>43</td>
<td>42</td>
<td>42</td>
<td>42</td>
<td>42</td>
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</tbody>
</table>

Heteroscedasticity-consistent t-ratios in parentheses. See the appendix for a list of countries.
Figure 1 - Openness and the sacrifice ratio
Figure 2 - Openness and the benefit ratio

- USA
- Germany
- Austria
- Netherlands
- Japan
- Sweden
- Switzerland
- Australia
- Finland
- France
- United Kingdom
- Spain
- Italy
- Norway
- Denmark
Figure 3 - Openness and the output-inflation trade-off