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Comment   David Romer

This is an excellent chapter. The issue it addresses—whether globalization has the potential to reduce or even eliminate the ability of a domestic central bank to influence domestic economic developments—is already

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being debated, and is likely to become increasingly important as economic integration continues. Most previous analyses of this issue by both non-economists (e.g., Fisher 2006) and economists (e.g., Ball 2006; Rogoff 2006) have been relatively informal. This chapter's formal analysis is a significant step forward. The chapter's organization around the IS, LM, and AS relationships (and its clear separation of the issues involving each of those relationships) is sensible and insightful. The comprehensive discussion of a wide range of ways that globalization might affect the central bank's ability to influence the economy is very valuable, and the focus on extreme cases is a powerful way of clarifying the issues and of identifying problems with many earlier analyses. Finally, I agree with virtually all of Woodford's conclusions.

In my comments, I want to focus on one narrow area where I disagree with Woodford's conclusions, and where it appears that globalization does have the potential to significantly reduce the central bank's ability to influence the economy. In section 1.2.2 of his chapter, as part of his analysis of possible effects of globalization on the LM curve, Woodford discusses the possibility of multiple currencies circulating in a country. He concludes that unless the currencies are perfect substitutes, this development would not affect the domestic central bank's ability to control inflation. This seems counterintuitive. If many prices are not being quoted in units of domestic currency and many transactions are not being carried out using domestic currency, one would think the central bank's ability to affect how rapidly prices are rising would be reduced.

The reason Woodford reaches his conclusion is simple: he focuses on the central bank's ability to influence the price level *measured in units of domestic currency.* Because the central bank can control the value of domestic currency even in a highly globalized economy, it can continue to control this measure of inflation. But while there may be reasons to be interested in inflation measured this way, one might also be interested in inflation measured as an appropriate weighted average of the change in each price in units of whatever currency in which it is quoted. Because the central bank does not determine the values of foreign currencies, it is not clear it can control this measure of inflation in a highly globalized economy.

I therefore want to discuss how the circulation of multiple currencies affects the central bank's ability to influence this measure of inflation. The main thing I will do is present and analyze a simple model of this issue. At the end, I will briefly discuss the question of which measure of inflation is likely to be more important to the central bank. To preview, I find that if globalization really does proceed that far, central banks' ability to achieve their objectives may be substantially constrained. I also find that the constraint is asymmetric: the circulation of multiple currencies limits a central bank's ability to achieve higher inflation than other countries much more than it limits its ability to achieve lower inflation. As a result, whether the constraint

is good or bad depends largely on the reliability of central banks. To the extent they are prone to follow high-inflation policies when they should not, the constraint is potentially valuable. But to the extent they sometimes wish to achieve higher inflation than other countries for legitimate reasons, the constraint is harmful.

Assumptions

I am interested in the central bank's ability to control the average level of inflation. I therefore focus on the steady state of a flexible price model. The model is set in discrete time. Each period, households consume a continuum of differentiated goods. There is no international trade, so all goods that households consume are produced domestically, and domestic producers do not sell abroad.

Households' consumption preferences are described by the usual constant intertemporal elasticity of substitution form over time, and the usual constant elasticity of substitution (CES) form at a point in time. That is:

(1)
$$U = \sum_{t=0}^{\infty} e^{-\rho t} u(C_t),$$

$$u(C_t) = \frac{C_t^{(\sigma-1)/\sigma}}{(\sigma-1)/\sigma}, \quad \sigma > 0,$$

$$C_t = \left[\int_{i=0}^{1} C_t(i)^{(\theta-1)/\theta} \right]^{\theta/(\theta-1)}, \quad \theta > 1,$$

where $C_t(i)$ is the household's consumption of good i in period t. The real interest rate is exogenous, constant, and equal to households' rate of time preference: $r = \rho$.

Money enters the model because households face a cash-in-advance constraint on purchases of goods. There are two currencies in the economy, "pesos" and "dollars." Pesos are issued by the domestic central bank, while dollars are not. I therefore treat the rate of peso inflation (i.e., the rate at which prices quoted in pesos rise) as a choice variable of the central bank, and the rate of dollar inflation as exogenous. I denote the two inflation rates by π^P and $\pi^\$$, respectively. Because I focus on steady states, both are constant.

Each producer can post its price and accept payment in either pesos or dollars. To buy from a given producer, a household must hold the needed amount of the relevant currency one period in advance. If we let F denote the fraction of prices that are quoted in pesos, then the average rate at which prices are rising in this economy—which is the inflation measure I will focus on—is:

(2)
$$\pi = F\pi^P + (1 - F)\pi^\$.$$

We can rewrite this as

$$(3) \qquad\qquad \pi = \pi^\$ + F\Delta,$$

where Δ is the inflation differential, $\pi^P - \pi^\$$.

All firms produce using the same constant returns to scale technology. There are no cash-in-advance constraints for payments to factors of production, and factor payments and firm revenues can be used immediately in foreign exchange and asset markets. Thus in any period, all producers have the same marginal cost.

A key assumption is that each producer faces a cost of conducting business in dollars rather than pesos. This cost is heterogeneous across producers, and it may be negative. It is easiest to think of it as a direct utility cost. A highly patriotic producer may be very reluctant to do business in dollars; another producer may prefer to use dollars all else equal; and so on.

We will see that when peso inflation is greater relative to dollar inflation, the demand for goods priced in pesos relative to the demand for goods priced in dollars is lower. The heterogeneous cost of using dollars therefore causes the fraction of firms that price in pesos to be a decreasing function of the inflation differential. That is,

$$(4) \qquad\qquad F = F(\Delta), \, F'(\cdot) \leq 0.$$

Currency Competition, Inflation, and Distortions

With a cash-in-advance constraint, the effective price of a good to households depends on the inflation rate. With two currencies with differing inflation rates, the result is a distortion of households' choices toward goods sold in the lower inflation currency.

To see how the distortion operates, let P_t^P and $P_t^\$$ be the prices charged by the producer of a representative "peso good" and the producer of a representative "dollar good" in period t. If a household decides to buy one unit less of a peso good in period t, it needs P_t^P fewer pesos in period $t-1$. It can use those pesos to purchase P_t^P/ε_{t-1} dollars in period $t-1$, where ε is the exchange rate (i.e., the price of dollars in pesos), and then use those dollars to buy $P_t^P/(\varepsilon_{t-1}P_t^\$)$ units of a dollar good in period t. Because the producers of peso goods and dollar goods face the same marginal cost and the same elasticity of demand (and since they face no cash-in-advance constraint), they charge the same price. That is, P_t^P and $P_t^\$$ are related by

$$(5) \qquad\qquad P_t^P = \varepsilon_t P_t^\$.$$

Thus for households, the price of a peso good relative to a dollar good is $\varepsilon_t/\varepsilon_{(t-1)}$. And since (5) holds each period, $\varepsilon_t/\varepsilon_{(t-1)}$ is determined by the difference in the inflation rates.[1]

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1. Inflation rates are measured as changes in log prices.

(6)
$$\frac{\varepsilon_t}{\varepsilon_{t-1}} = e^{\Delta}.$$

Given the CES assumption about households' preferences, this implies that the representative household's consumptions of a generic peso good and a generic dollar good are related by

(7)
$$\frac{C_t^P}{C_t^{\$}} = e^{-\theta\Delta}.$$

This analysis shows that differences in inflation between the two currencies produce differences in the effective prices that households face for different goods, and thus differences in their purchases. These differences have no counterpart in the social opportunity costs of producing the goods. That is, differential inflation creates distortions.

The welfare cost of these distortions is approximately equal to a constant times the variance of (log) relative prices faced by households. With fraction F of goods priced in pesos and the remainder in dollars, this variance is

(8)
$$V = F(\Delta)[1 - F(\Delta)]\Delta^2.$$

It is useful to rewrite this as

(9)
$$V = [\Delta F(\Delta)]^2 \left[\frac{1 - F(\Delta)}{F(\Delta)} \right].$$

The distortions from different purchases of peso and dollar goods are zero if all goods are priced in dollars ($F = 0$), if all goods are priced in pesos ($F = 1$), or if the two inflation rates are the same ($\Delta = 0$). For a given Δ, they are greatest when $F = 1/2$; for a given F, they are increasing in the absolute value of Δ.

Currency Competition and Inflation Control

Recall that the measure of inflation I focus on—the average rate of increase of prices, in whatever currencies they are quoted in—is $\pi = \pi^{\$} + F(\Delta)\Delta$, where Δ is the inflation differential, $\pi^P - \pi^{\$}$ (see [3]). One can use this expression, together with equation (9) for the variance of relative prices caused by differential inflation, to establish the following results. Throughout, I assume that strictly positive amounts of both currencies circulate (i.e., $0 < F < 1$).

Result 1. There may be an upper bound to inflation. To see this, recall that $\pi = \pi^{\$} + F(\Delta)\Delta$. For $\Delta > 0$, raising Δ increases inflation by raising the Δ term, but lowers it by reducing the $F(\Delta)$ term. For many $F(\cdot)$'s, the second effect eventually dominates, so there is maximum inflation rate that can be attained. The numerical example presented later illustrates this possibility.

Result 2. Obtaining inflation different from foreign inflation introduces a distortion that is not present under a single currency. This follows from the

facts that $\pi \neq \pi^\$$ requires $\pi^P \neq \pi^\$$ and that when $\pi^P \neq \pi^\$$ and $0 < F < 1$, $V > 0$.

Result 3. A given departure of inflation above foreign inflation involves greater distortions than the same departure of inflation below foreign inflation. To see this, consider equation (9) for V. Since $\pi = \pi^\$ + F(\Delta)\Delta$, equal departures of inflation above and below $\pi^\$$ involve equal and opposite values of $F(\Delta)\Delta$, and thus the same value of $[F(\Delta)\Delta]^2$. But since $F'(\Delta) \leq 0$, $[1 - F(\Delta)]/F(\Delta)$ is greater for a positive value of Δ than for a negative value of Δ of equal magnitude.

Result 4. When inflation is above foreign inflation, if an increase in peso inflation raises overall inflation, it increases distortions. This follows immediately from (9) and the fact that $F'(\Delta) \leq 0$.

Thus, the only case where raising peso inflation further above dollar inflation could reduce distortions is when it reduces overall inflation. But the central bank would never put the economy in that situation: if the economy is at a point where $\Delta F(\Delta)$ is decreasing in Δ, then (as long as $F[\cdot]$ is smooth) there is some lower value of Δ that yields the same $\Delta F(\Delta)$, and so yields the same inflation rate with smaller distortions. Thus, result 4 says that the further inflation is increased above foreign inflation, the greater the distortions.

Result 5. When inflation is below foreign inflation, lowering inflation further can either raise or lower distortions. Lowering inflation further below foreign inflation requires increasing the magnitude of the difference between peso inflation and dollar inflation, which acts to raise distortions. But it increases the fraction of prices quoted in pesos. If most prices are already quoted in pesos, this acts to lower distortions. The numerical example shows that the overall effect can go in either direction.

Result 6. The lowest inflation rate that can be attained with a strictly positive nominal domestic interest rate is greater when foreign currency circulates than when only domestic currency is used. However, when currency competition is greater, that inflation rate is lower. The assumption that the real interest rate equals the rate of time preference, ρ, implies that the nominal interest rate on peso-denominated bonds is $i^p = \pi^p + \rho$. Thus the *peso* inflation rate must exceed $-\rho$ for i^p to be positive. This means that the overall inflation rate must exceed $\pi^\$ + F(-\rho - \pi^\$)(-\rho - \pi^\$)$, or $-\rho + [1 - F(-\rho - \pi^\$)](\pi^\$ + \rho)$. Unless $F(-\rho - \pi^\$)$ equals 1 (or $\pi^\$ \leq \rho$, which would imply a nominal dollar interest rate of zero), this exceeds the lower bound of $-\rho$ that occurs in the absence of multiple currencies. However, the more that households use pesos when peso inflation is low (i.e., the greater is $F[-\rho - \pi^\$]$), the lower is the lower bound.

Finally, result 3 suggests the following.

Result 7. With multiple currencies, there is likely to be deflationary bias. Addressing this issue formally would require extending the model. To see the intuition, however, suppose there are two countries in the world, and that one prefers lower inflation than the other. Result 3 suggests that it will be less

costly for the central bank that prefers low inflation to push overall inflation in its country down than for the central bank that prefers high inflation to push its overall inflation up. Thus, there is a force acting to make average inflation in the world closer to the level preferred by the low-inflation central bank than to that preferred by the high-inflation central bank.

Example

To illustrate these ideas (other than result 7), consider the case where $F(\cdot)$ is one minus a cumulative normal distribution with a mean of zero and a standard deviation of 5 percentage points. This implies that when the two inflation rates are the same, half of transactions are conducted in each currency, and that if the inflation differential is 5 percentage points, five-sixths of transactions are conducted in the lower inflation currency. Thus, it implies a high degree of substitutability between the currencies.

Figure 1C.1 plots overall inflation as a function of the inflation differential. For simplicity, I normalize dollar inflation to zero. Currency competition greatly constrains the ability of the domestic central bank to create inflation. Inflation can be raised only 0.85 percentage points above dollar inflation; this occurs when the inflation differential is 3.76 percentage points. In contrast, the presence of multiple currencies has little impact on the central bank's ability to achieve low inflation. As peso inflation falls, households
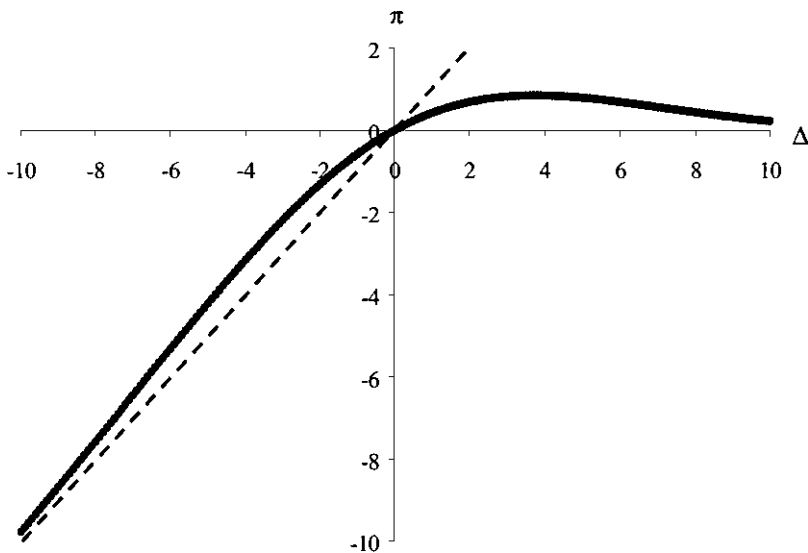

Fig. 1C.1   Overall inflation as a function of the difference between peso and dollar inflation (dollar inflation normalized to zero)
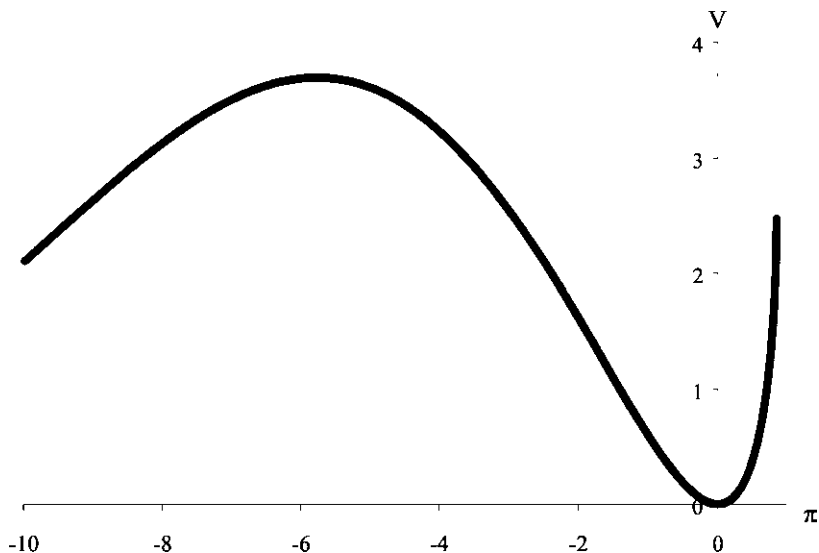
Fig. 1C.2   The variance of relative prices faced by households as a function of inflation (dollar inflation normalized to zero)

move rapidly out of dollars, and so overall inflation is determined mainly by peso inflation.[2]

Figure 1C.2 shows the variance of relative prices as a function of overall inflation (with dollar inflation again normalized to zero). For positive inflation (i.e., inflation above dollar inflation), the variance of relative prices is rising with inflation up to the maximum attainable inflation rate, as shown by result 4. For negative inflation, reductions in inflation first raise distortions (by increasing the difference in the opportunity cost to households of peso and dollar goods) and then lower them (by causing households to switch mainly into pesos).

An Extension

A natural extension of the model is to allow the fraction of prices posted in pesos and the fraction of goods purchased with pesos to differ. For example, some producers could post their prices in one currency but accept payment in either. One could model each fraction as a decreasing function

2. The figure can be reinterpreted to show the lower bound on inflation with and without currency competition. With multiple currencies (and $\pi^\$ = 0$), overall inflation must exceed $-\rho F(-\rho)$ for i^P to be nonnegative; with only domestic currency, it must exceed $-\rho$. Thus if we measure $-\rho$ on the horizontal axis, the solid line shows the lower bound on inflation with currency competition, and the dashed line shows the lower bound without currency competition.

of the inflation differential, with the functions now no longer necessarily the same. Redoing the analysis in this more complicated case is straight-forward.

An interesting special case of the extended model arises when all transactions are conducted in the lower inflation currency, but not all prices are necessarily posted in that currency. One situation where this would effectively occur is when households can trade in foreign exchange markets costlessly and instantaneously. In this case, households hold only the lower inflation currency, and buy the higher inflation currency only the instant before using it to make purchases.

In this case, inflation (the average rate at which posted prices are rising) continues to be given by $\pi = \pi^\$ + F(\Delta)\Delta$, where $F(\Delta)$ is now the fraction of prices quoted in pesos. However, because households no longer need to hold the high-inflation currency for a period to buy goods whose prices are posted in terms of that currency, they face the same effective price for all goods. Thus, differential inflation no longer produces distortions. However, result 1—the possibility of an upper bound to inflation—still holds, as does result 6 about the lower bound to inflation.

Which Measure of Inflation Is the Central Bank Likely to Care about?

Is control of peso inflation sufficient for the central bank to attain its objectives, or will it care about dollar inflation as well? A firm answer to this question requires a full understanding of the welfare effects of inflation, which we do not have. Thus, I will merely offer some preliminary comments about various forces that may affect the central bank's views about inflation.

I see only one consideration for which control of peso inflation is likely to be sufficient: nonindexation of the tax system. If the tax system is written in nominal terms, it is presumably in terms of domestic currency. Thus, to the extent the central bank is concerned about inflation because it is concerned about the distortions arising from this nonindexation, control over peso inflation is enough to allow it to achieve its objectives. In the model I have described, the central bank continues to have control over peso inflation, although this comes with some costs if it chooses a level that differs from dollar inflation.

For other factors that influence the welfare effects of inflation, the central bank will almost certainly care about both peso and dollar inflation. One cost of inflation is that it makes money costly to hold even though it is cost-less to produce, and so introduces inefficiency. In the model I have described, for example, inflation makes it more costly for households to obtain goods, and so could distort their labor-leisure choices. With foreign currency circulating in the country, some of these costs are determined by foreign central banks. Thus, the domestic central bank's control over peso inflation is not enough to give it full control over these costs.

A potentially more important consideration in the central bank's choice of inflation is that inflation can grease the wheels of labor and goods markets by making the need for nominal wage and price cuts less common. For wages and prices that are quoted in terms of foreign currency, inflation in terms of the domestic currency is not relevant. Thus, this is another case where the circulation of multiple currencies restricts the central bank's ability to achieve its objectives.

Another consideration in the determination of optimal inflation is that, since nominal prices are not continually adjusted, higher inflation increases the relative price variability that arises as different prices are adjusted at different times. Again, what affects welfare is not just inflation in terms of domestic currency, but the various inflation rates in terms of the different currencies in which prices are quoted. Thus again, control of inflation in terms of domestic currency is not enough.

Inflation also affects the chances that an adverse shock will put the central bank in a position where it wants to reduce the nominal interest rate to zero. Here I am not certain what to think, but my guess is that the news is mixed. On the one hand, if globalization proceeds to the point where multiple currencies are circulating in significant quantities in a country, goods and financial markets are likely to be so integrated that domestic monetary policy will have powerful effects via exchange rates rather than interest rates. Thus, the zero lower bound on the domestic interest rate is unlikely to matter much for the central bank's responses to domestic shocks. On the other hand, with this type of economic integration and the use of multiple currencies within a country, a worldwide shock that pushed foreign nominal interest rates to zero would likely affect the domestic economy, and the level of peso inflation would not affect the chances of this occurring. Thus, it appears that control of peso inflation does not give the central bank full control over the probability that a shock will push a nominal interest rate that matters to the economy to zero.

Finally, it has been suggested that high inflation in effect directly lowers utility, essentially because seeing prices rise makes people unhappy, or that inflation can cause people to make suboptimal financial plans because they have difficulty accounting for inflation. Here the relevant inflation rate is inflation in terms of whatever units people use to think about prices and financial plans. In an economy where many prices are quoted in units of foreign currency and many transactions are carried out using foreign currency, for at least some households those units are likely to be in foreign currency.

Conclusion

I have two main conclusions. First, I want to emphasize what I said at the outset, which is that this is an excellent chapter that should become the standard reference on globalization and monetary policy.

Second, there appears to be at least one important way that globalization

could severely limit a central bank's ability to achieve its goals. If globalization proceeds to the point where a significant fraction of prices are quoted in terms of foreign currency and a significant fraction of transactions are conducted in foreign currency, the central bank is likely to lose some of its influence over overall inflation, and this loss of influence is likely to matter for its ability to achieve its broader objectives.

This loss of influence is asymmetric: it is more costly for the central bank to raise inflation above foreign inflation than to lower it below, and raising it beyond some level may be impossible. Thus, the constraints that currency competition can create for central banks are not altogether bad: to the extent that some central banks' pursuit of higher inflation than their neighbors is undesirable (resulting from such factors as misguided views about the benefits of loose monetary policy, political pressures, and desires for seignorage), currency competition can impose useful discipline. But a country can also have legitimate reasons for wanting higher inflation than its neighbors. For example, its institutions or history may make nominal wage or price cuts particularly difficult, and so greasing-the-wheels considerations may make its optimal inflation rate higher than its neighbors'. My general point is that currency competition has the potential to prevent central banks from accomplishing some things they were previously able to. Whether this is good or bad depends on how well central banks were using the powers that become limited by globalization.

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