DOES ASYMMETRY OF INTERNATIONAL SHOCKS MATTER FOR THE U.S. BUSINESS CYCLE?

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This article proposes and investigates the asymmetry hypothesis, which predicts that an international asymmetric shock tends to have a stronger and longer effect on the U.S. business cycle than a symmetric shock. The hypothesis finds empirical support in the impulse responses of U.S. output and inflation to symmetric and asymmetric shocks; those responses are estimated in a four-variable structural vector autoregression. The hypothesis also finds support in stylized facts: The longest U.S. expansions have tended to occur when the rest of the world was growing below potential.(*JEL* E3, E5, E4)

I. INTRODUCTION

Economic expansions in the United States since World War II have tended to end with the same pattern: As the economy approaches capacity, wage and price inflation begins to rise. The Federal Reserve then tightens monetary policy to dampen inflationary pressures, thereby pushing the economy into a recession.[1] The expansion that ended in March 2001, however, appeared to deviate from this pattern: It was associated with little inflationary build-up, and consequently the Federal Reserve did not begin a string of uninterrupted tightening until late June 1999, when Consumer Price Index (CPI) inflation was running only slightly above the 2% rate. By comparison, consumer prices were rising at 6.2% at the end of the 1960s boom and over 5% at the end of the 1980s boom. Clearly, the monetary tightening of 1999 was enacted more in reaction to the threat of inflation, in light of the tight labor market, than to actual high inflation. What made the 1990s expansion different?

A number of explanations have been offered for the longevity of the latest expansion: that the credit markets have played an important role in sustaining the current expansion;[2] that greater fiscal discipline and enhanced central bank credibility have helped tame inflation expectations and sustain the boom; that the rise in the services component of gross domestic product (GDP) relative to manufacturing and more efficient inventory management have contributed to rendering the economy less susceptible to cyclical swings; that the increase in productivity growth caused by digital technology has helped meet increases in demand and labor shortages without driving up inflation; or that globalization per se has helped prolong the expansion.

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1. This pattern is a rough description of the empirical findings of Romer and Romer (1989). They show that most of the post–World War II economic expansions in the United States have ended with a tightening of monetary policy.

2. For example, Schlesinger of the *Wall Street Journal* (1 February 2000) writes: "A less-heralded but crucial force bolstering America's economic performance over the past nine years has been the evolution in the way money flows from those who have it to those who want it. This new economy, where financial risk is swapped, shared and spread through manifold channels, has more zip—witness the explosion in technology start-ups—and it enjoys new protection against the painful attacks that periodically afflicted the old one."

ABBREVIATIONS

CPI: Consumer Price Index
FX: Foreign Exchange
GDP: Gross Domestic Product
GMM: Generalized Method of Moments
PPP: Purchasing Power Parity
SVAR: Structural Vector Autoregression
VAR: Vector Autoregression

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This article considers another factor that is likely to have helped increase the longevity of the 1990s expansion. We call this factor the asymmetry hypothesis. The hypothesis maintains that in a flexible exchange rate regime, an asymmetric (that is, country-specific) shock will have a stronger and longer effect on output than will a shock that also hits the rest of the world. The hypothesis makes two assumptions: that the United States is sufficiently integrated with the rest of the world, or globalized, and that the Federal Reserve is forward-looking and (at least partly) effective in combating inflation and recessions. Under those assumptions, an expansion caused by a symmetric positive shock is accompanied by stronger inflationary pressures than an expansion caused by an equal-sized asymmetric shock, prompting quicker and stronger monetary tightening. Consequently, an expansion caused by a symmetric shock ends earlier than one caused by an asymmetric shock. Symmetrically, a contraction caused by a symmetric negative shock is potentially more devastating for the economy than one caused by an equal-sized asymmetric shock, prompting quicker and stronger monetary easing. Thus, a contraction caused by a symmetric shock ends earlier than a contraction caused by an asymmetric shock.

This article builds a two-country, open-economy model to illustrate why the hypothesis makes sense in an age of globalization and a forward-looking monetary regime. It then estimates a structural vector autoregression (SVAR) system using both long-run and short-run restrictions to investigate whether the hypothesis can stand the scrutiny of empirical study. Overall, we find evidence in favor of the asymmetry hypothesis. Estimating a structural vector autoregression and tracing the impulse responses of U.S. output growth to symmetric and asymmetric shocks, we find that asymmetric innovations have a greater and more sustained impact on the U.S. output gap than symmetric innovations do. We also find that the longest U.S. expansions have tended to occur when the rest of the world has been growing below potential.

Our work is related to the long line of research that investigates the relationship of business cycles among countries. Mitchell (1927) found that business cycles are positively correlated among countries and concluded that this correlation was growing over time because of growth in international financial linkages. Ahmed et al. (1993) developed and estimated a SVAR model to study the sources of international economic fluctuations in an open-economy setting. Curiously, contrary to this article's finding that the flexibility of the exchange rate plays a vital role in economic adjustment, those authors found no evidence of differences in the transmission properties of economic disturbances between the pre-1973 fixed exchange rate period and the post-1973 flexible exchange rate period.

The rest of this article is organized as follows. Section II introduces the theoretical framework of the asymmetry hypothesis. Section III proposes the hypothesis. Section IV presents the SVAR results. Section V provides other evidence in support of the hypothesis. Section VI draws conclusions.

II. THEORETICAL FRAMEWORK

This section describes the open-economy model that we use to propose the asymmetry hypothesis in section III. The model assumes that the world consists of two economies: United States and foreign. The U.S. currency is the dollar. Its exchange value relative to the foreign currency floats freely to clear the foreign exchange market.

In this model, positive (or negative) asymmetric shocks (ε^{AS}) are defined as shocks that boost (or lower) expected U.S. output growth relative to foreign output growth. Positive asymmetric shocks thus increase the expected risk-adjusted rate of return on U.S. assets relative to that on foreign assets, thereby increasing net capital inflows and causing the dollar to appreciate.[3] In contrast, positive (or negative) symmetric shocks (ε^{S}) are defined as shocks that boost (or lower) U.S. and foreign output growth contemporaneously and symmetrically, giving neither economy an advantage (or disadvantage) in the expected rate of return on its assets. Consequently, by definition symmetric shocks do not exert an additional impact on either economy through changes in net capital flows and the exchange rate.

3. We intentionally define asymmetric positive shocks narrowly here to simplify the analysis. For broader policy implications, one can conceivably relax the definition to include any shocks that result in increasing the expected rate of return on U.S. assets relative to that on foreign assets. Under this broader definition, an eruption of political unrest or a financial crisis in the foreign economy or enhanced fiscal/monetary policy credibility in the United States are examples of asymmetric demand shocks.

Asymmetric shocks (ε^{AS}) take the form of either demand shocks ($d\varepsilon^{AS}$) or supply shocks ($s\varepsilon^{AS}$). Likewise, symmetric shocks (ε^{S}) take the form of either demand shocks ($d\varepsilon^{S}$) or supply shocks ($s\varepsilon^{S}$). In each period, ε^{AS} equals 0, $d\varepsilon^{AS}$, or $s\varepsilon^{AS}$; and ε^{S} equals 0, $d\varepsilon^{S}$, or $s\varepsilon^{S}$.

The U.S. economy is summarized by eight equations described below. The foreign economy, though not explicitly depicted, is governed by the same market forces as described in these eight equations.

(1) Interest rate determination:

$$C^D(\overset{-}{r}) = C^s(\overset{+}{r}, \overset{+}{Y}) + NK(\overset{+}{r}, \overset{+}{E}, \overset{+}{\varepsilon^{AS}}) + NL(r^T \overset{-}{-} r^*),\ \varepsilon^{AS} = d\varepsilon^{AS} + s\varepsilon^{AS},$$

(2) Wage determination:

$$N^D(\overset{-}{w}, \overset{+}{Y}, \overset{-}{\varepsilon^{AS}}) = N^s(\overset{+}{w}, \overset{+}{\varepsilon^{As}}),$$

(3) Exchange rate determination:

$$NK(\overset{+}{r}, \overset{+}{E}, \overset{+}{\varepsilon^{As}}) + NX(\overset{-}{P/P^m(E)}, \overset{-}{Y_{-1}}, \overset{+}{Y^*_{-1}}) = 0,$$

(4) Import price: $P^m = \theta E P^*,\ 0 < \theta \leq 1$

(5) Price setting:

$$P = \alpha P^m + \beta P^D[\overset{+}{r}, P^m, \overset{+}{u}(w, P^m), \overset{+}{P^I}(Y/Y^p), \overset{+}{\lambda}(P^m, Y/Y^p)], \alpha + \beta = 1,\ u_1 > 0,\ u_2 \geq 0,\ P^{I'} > 0,\ \lambda_1 > 0,\ \lambda_2 > 0,$$

(6) Aggregate demand:

$$Y = I(\overset{-}{r}) + C(\overset{-}{r}, \overset{+}{Y_{-1}}, \overset{+}{W/P}) + G + NX(\overset{-}{P/P^m}, \overset{-}{Y/Y^*}) + d\varepsilon, d\varepsilon = d\varepsilon^{AS} + d\varepsilon^s,$$

(7) Potential output: $Y = Y^p(\overset{+}{N^p}, \overset{+}{K}, \overset{+}{s\varepsilon})$,

$$K = \delta K_{-1} + I, 1 > \delta > 0,$$
$$s\varepsilon = s\varepsilon^{AS} + s\varepsilon^s,$$

(8) Interest rate policy rule:

$$r^T = r^* + \phi(E[\pi] - \pi^*) + \gamma E[Y - Y^p],\ \phi > 0, \gamma > 0,$$

where C^D is domestic demand for financial capital, r is the real interest rate (the cost of capital), C^S is domestic supply of financial capital, Y is domestic output, NK is the net capital inflow, E is the nominal exchange rate (expressed as U.S./foreign currency, so that an increase in E represents dollar depreciation), NL is the net increase in liquidity resulting from the central bank's intervention in the credit market, r^T is the central bank's time-varying target real interest rate, r^* is the constant target interest rate under the desired economic conditions (that the actual inflation rate equals the target inflation rate and actual output equals potential output), N^D is labor demand, w is the real wage, N^S is domestic labor supply, NX is net exports, P is the U.S. consumer price, P^m is import price, Y^* is foreign output, θ is the exchange rate pass-through coefficient, P^* is foreign price, P^D is the price of domestically produced goods and services in the consumption basket, u is the unit labor cost, P^I is the price of nonimported inputs, Y^P is potential output, λ is the price markup, I is business investment, C is private consumption, W is nominal wealth, G is government spending, N^P is potential employment, K is the capital stock, δ is the depreciation rate, $E[\pi]$ is expected inflation, π^* is the target for inflation, and $E[Y - Y^P]$ is the expected output gap. In all of the equations, the time subscript for the current period is suppressed, with the subscript -1 referring to the last period.

Equation (1) says that the cost of capital is determined in the financial capital market. Demand for capital is a negative function of the real interest rate (the cost of capital). Supply of capital is the sum of the domestic supply of capital, the net capital inflow, and the net liquidity created by the central bank's intervention. Both the domestic supply of capital and the net capital inflow are positive functions of the cost of capital. The net capital inflow is also a positive function of asymmetric shocks (ε^{AS}), which increase the expected rate of return on U.S. assets. Net liquidity creation is a negative function of the gap between r^T and r^*.[4]

Equation (2) says that the real wage is determined in the labor market. Labor demand is a

4. In this framework, when the central bank increases the money supply by open-market purchase of Treasury securities, it injects liquidity to the banking system and increases the demand for new issuances of securities, thereby increasing the supply of capital.

negative function of the real wage and a positive function of output. It is also a negative function of ε^{AS} because a positive asymmetric shock renders wage–inflation pressure higher in the U.S. economy than in the foreign economy, giving U.S. firms—which can move their production abroad to take advantage of lower wages there—greater power in wage negotiations. Labor supply is a positive function of the real wage. It is also a positive function of ε^{AS} because a positive asymmetric shock causes U.S. wages to rise relative to foreign wages, thereby increasing the supply of immigrant workers.

Equation (3) says that the nominal exchange rate is determined by the supply of and demand for foreign exchange (FX). Net capital inflows (NK) represent excess supply of FX from financial account transactions and are a positive function of the price of foreign exchange in dollar terms (E). Net exports (NX), which are a negative function of the terms of trade[5] —and thus a positive function of E—represent excess supply of foreign exchange from current account transactions. Aggregate excess supply of FX thus equals NK plus NX. A positive excess supply of FX will exert downward pressure on the value of foreign currency until it clears the FX market.

Note that symmetric shocks do not enter into equations (1)–(3). This omission follows from our empirical definition of a symmetric shock. In the empirical section that follows, we define a symmetric shock as a shock that does not affect the real exchange rate. Thus, it is a shock that impacts both countries (or the United States and the rest of the world) in such a way as to cause no changes in the flows of capital or labor across borders. It therefore follows that wages, employment levels, capital flows, and interest rates are unaffected by symmetric shocks.

Equation (4) maintains that import prices are a positive function of the foreign price level and the nominal exchange rate. Holding the foreign price level constant, a 1% increase in E (i.e., a 1% dollar depreciation) will increase import prices by θ percent, where θ (the pass-through coefficient) is positive but bounded by 1.

Equation (5) says that the CPI is a consumption-share weighted average of the dollar price of imported goods and domestically produced goods and services. Domestic prices are determined by a markup over marginal cost, where marginal cost is a function of the real interest rate, the price of imports, the unit labor cost, and the price of other inputs. The unit labor cost is a positive function of real wages and a nonnegative function of import prices.[6] The price of other inputs is a function of the output gap as higher demand drives up the general price level. The markup is a positive function of both import prices and the output gap because an increase in either import prices or the output gap lowers the perceived price elasticity of demand.[7] This price equation will serve as the short-run aggregate supply schedule in our model.

Equation (6) says that aggregate demand is the sum of business investment, private consumption, government spending, and net exports. Investment is a negative function of the real interest rate. Consumption is also a negative function of that rate and a positive function of lagged domestic income (Y_{-1}) and real wealth (W/P). Net exports are a negative function of the terms of trade (P/P^m) and lagged relative output (Y_{-1}/Y^*_{-1}).

Equation (7) states that potential output is a function of potential employment, the capital stock, and productivity shocks. This equation can be considered the long-run supply curve.

Equation (8) says that the central bank adopts a forward-looking monetary policy stance similar to the one proposed in Clarida et al. (2000): The central bank will raise the target interest rate in anticipation of excess inflation or a positive output gap and lower the target rate in anticipation of recession.

Together, the equations constitute an open-economy macroeconomic model in which prices in the credit market, the labor market,

5. In calling P/P^m the terms of trade, we assume that export prices equal domestic prices (P).

6. This assumption makes sense because falling import prices increase competitive pressures on import-competing products, giving domestic firms stronger incentives to improve their productivity to prevent profit margins from being completely eroded.

7. In the standard pricing theory in monopolistic competition models, an increase (or decrease) in the perceived price elasticity will induce firms to lower (or increase) the profit margin. To see that firms' strategic markup is an inverse function of price elasticity, recall that a monopolistic firm will aim to maximize profits by producing and selling a target quantity Q^*. At Q^*, unit price (P) is equal to marginal cost plus the profit margin (λ), and λ is equal to $-P/\eta$, where η is the price elasticity of demand. An increase in P^m or $Y - Y^P$ thus will increase λ by lowering the perceived price elasticity for import-competing goods.

and the FX market are flexible; output can deviate from potential output in the short run because of sticky prices in the goods market; and the central bank pursues a policy objective of price and output stabilization.

III. THE ASYMMETRY HYPOTHESIS

The asymmetry hypothesis maintains that an asymmetric positive shock will result in a stronger and longer expansion than a symmetric positive shock will, because the former is associated with lower inflation than the latter, provoking slower and milder central bank intervention. Symmetrically, an asymmetric negative shock will result in a deeper and longer recession than a symmetric negative shock will, because the contractionary effect of the latter is more threatening, provoking a quicker and stronger central bank reaction to stimulate growth and end the recession. These predictions are not affected by whether a shock is originated from the demand side or supply side.

We illustrate the asymmetry hypothesis first by comparing the effects of positive symmetric and asymmetric shocks. We then argue for the symmetric property of the hypothesis: A negative asymmetric shock will result in a longer recession than an equal negative symmetric shock will. All the illustrations assume that before the shock hits, the initial economic conditions of both countries are symmetric.[8]

The Impact of Positive Shocks

This subsection illustrates that in a policy-neutral environment, an asymmetric positive shock will be accompanied by lower inflation than will the same strength of expansion spurred by a symmetric shock because of the differences in induced capital-flow and trade-flow effects. We first illustrate those capital-flow and trade-flow effects separately. We then combine those effects to compare the impacts of asymmetric and symmetric positive shocks. Our analysis will first be confined to a policy-neutral environment, bringing in the central bank reaction only in the conclusion.

8. This assumption is mainly for clarity of analysis. The assumption of symmetric initial conditions makes it easier to consider how an asymmetric shock spurs the capital- and trade-flow dynamics to interact with central bank reaction and the business cycle. In the appendix we argue that the validity of the asymmetry hypothesis does not depend on the initial degree of symmetry between the two countries.

The Capital-Flow Effects. The first type of capital-flow effect is the cost-of-capital effect. When the United States experiences an asymmetric shock, the inflow of capital in response to a positive ε^{AS} will increase the aggregate supply of financial capital. The resulting downward shift in the supply schedule will lower the cost of capital (or the real interest rate). In the case of a symmetric shock, ε^{AS} is zero and the added impact of a positive shock on the cost of capital is absent.

A lower cost of capital will generate the cost-of-capital effect on both the demand and the supply side. On the demand side, a lower cost of capital spurs business investment as well as consumption demand. Consequently, through that added boost to domestic demand, a positive asymmetric shock expands aggregate demand more strongly than does a symmetric shock—as indicated by equation (6)—thereby exerting additional inflationary pressure. On the supply side, equation (5) indicates that a lower cost of capital induced by net capital inflows exerts downward pressure on price inflation in the short run as well as in the long run. In the short run, a lower cost of capital could dampen inflationary pressure by lowering the marginal cost of production. Over time, the increase in investment spurred by a lower cost of capital will expand potential output by raising productive capacity, helping relieve inflationary pressure. In sum, through the differences in induced net capital inflows and thus the cost-of-capital effects, the expansion spurred by an asymmetric shock will tend to be larger, but the inflation/output trade-off generated by a positive asymmetric shock is smaller than that generated by a symmetric shock.

The second type of capital-flow effect is the real-wage effect. Equation (2) indicates that both asymmetric and symmetric positive shocks, by increasing output (Y), will push up the labor demand (N^d) schedule. The degree to which the N^d schedule moves up will differ, however, depending on whether the shock is symmetric. In response to an asymmetric shock, foreign wage pressures will be lower than U.S. wage pressures. That difference has two consequences. First, it reduces demand pressure on wage inflation because U.S. firms can move or threaten to move production abroad to take advantage of lower wages there. Second, it renders U.S. jobs more attractive to foreign workers. Both effects on the labor market dampen wage inflation pressures by increasing the bargaining power of employers while undercutting that of workers. In contrast, a symmetric shock will not significantly increase the bargaining power of employers relative to workers because wage pressures abroad will be high as well. Wage inflation pressures are thus lower in response to an asymmetric shock than to a symmetric shock. It is clear from equation (5) that lower wage inflation in turn will help dampen price inflation pressures during a U.S. expansion.

The Trade-Flow Effects. The first type of trade-flow effect is the net-export effect. Everything else being equal, an asymmetric shock results in an increase in the excess supply of foreign exchange, thereby pushing up the dollar (lowering E) to restore the equilibrium in the FX market (see equation [3]). This in turn will lower import prices, improving the terms of trade. The improvement in the terms of trade will render U.S. goods less competitive internationally, thus hurting net exports and output growth. In contrast, a symmetric shock will not disturb the FX market by pushing up net capital inflows; therefore, it will leave the exchange rate and the terms of trade unchanged. Moreover, an asymmetric shock increases Y/Y^*, whereas a symmetric shock leaves Y/Y^* unchanged. An asymmetric shock thus also hurts net exports more than a symmetric shock through the income effect. As a result, it exerts a larger net export drag through both the terms-of-trade effect and the income effect, resulting in more muted output growth and less inflationary pressure than does a symmetric shock.

The second type of trade-flow effect is the import-price effect. As the dollar appreciates in response to a positive asymmetric shock, import prices will fall. A symmetric shock, in contrast, will have no impact on import prices because it does not induce net capital inflows.

It is easy to see how lower import prices will help hold down domestic prices by taking the derivative of equation (5) with respect to P^m:

$$dP/dP^m = \alpha + \beta(dP^D/dP^m) + \beta(dP^D/du)(du/dP^m) + \beta(dP^D/d\lambda)(d\lambda/dP^m) > 0. \tag{9}$$

As import prices fall, U.S. consumer prices will fall *directly* in proportion to α (the share of imports in the consumption basket) plus $\beta(dP^D/dP^m)$. Because $\beta(dP^D/dP^m)$ is positive, the direct effect of changes in import prices on U.S. inflation is unambiguously greater than α. That point is worth emphasizing, because it clearly refutes the view held by many economists that the impact of import prices on U.S. inflation is limited to reflect the modest size of α.[9] Changes in import prices will directly affect consumer price inflation not only because imports are a component of the consumption basket but also because imports are used as inputs in the production of other consumption goods and services.[10]

Moreover, falling import prices can also lower U.S. prices *indirectly* through the competing-goods effect. As imports become more price-competitive, U.S. firms in import-competing industries will have to either enhance their productivity, lower their profit margins to stay competitive, or both. Either way, the total magnitude of the competing-goods effect is captured by $\beta(dP^D/du)(du/dP^m) + \beta(dP^D/d\lambda)(d\lambda/dP^m)$ in equation (9). Because $\beta > 0, (dP^D/du) > 0$, $du/dP^m \geq 0$, $(dP^D/d\lambda) > 0$, and $d\lambda/dP^m > 0$, the competing-goods effect is theoretically always positive.[11] Through the combination of those direct and indirect effects, a decrease in import prices will unambiguously dampen the inflationary pressure arising from an asymmetric shock.

Combining Capital-Flow and Trade-Flow Effects. Because net capital flows adjust more quickly to shocks than trade flows do, an asymmetric shock initially will have a stronger expansionary effect, but not necessarily a stronger inflationary effect, than a symmetric shock will. Over time, the stronger net-export drag from an asymmetric shock will kick in to dampen output growth, thereby prolonging the expansion at a more

9. It is not easy to have a precise measurement of α (imports/consumption of final goods). The imports/GDP ratio is usually used as a rough proxy for α. But because consumption of final goods is considerably smaller than GDP, the imports/GDP ratio significantly underestimates α. The imports/GDP ratio was around 13% in 1997.

10. Campa and Goldberg (1999) find that U.S. manufacturing industries have steadily increased their use of imported inputs in production, on average from about 4% in 1975 to more than 8% in 1995.

11. In Gamber and Hung (2001) we estimated panel data regressions to ascertain the sign and the degree of the competing goods effect. We found a significant and positive competing goods effect.

sustainable level. To illustrate, let us first use Figure 1 to analyze the impact of a positive *demand* shock on output and inflation, and Figure 2 the impact of a positive *supply* shock.

To simplify the analysis, we normalize the capital-flow and trade-flow effects already discussed to be zero in the case of a symmetric shock. In Figure 1, suppose that aggregate demand and aggregate supply intersect at

FIGURE 1
Impacts of Asymmetric versus Symmetric Demand Shocks

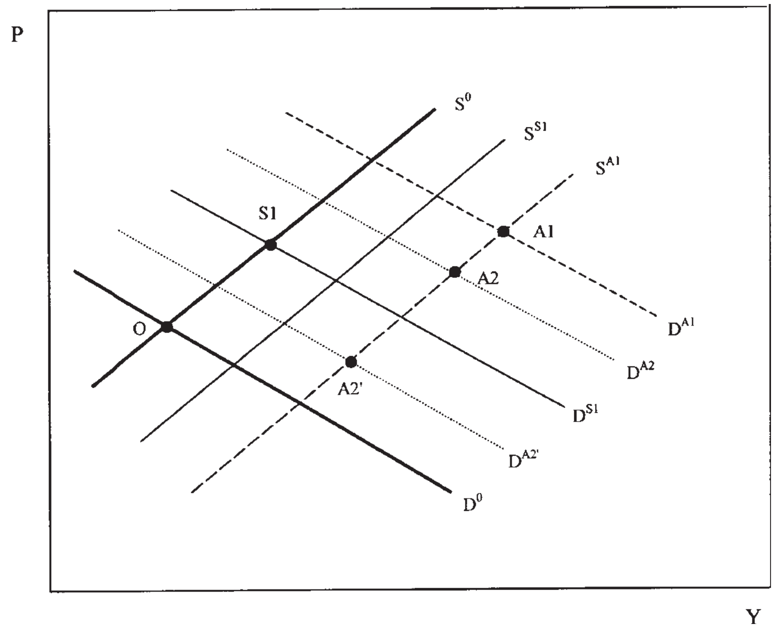
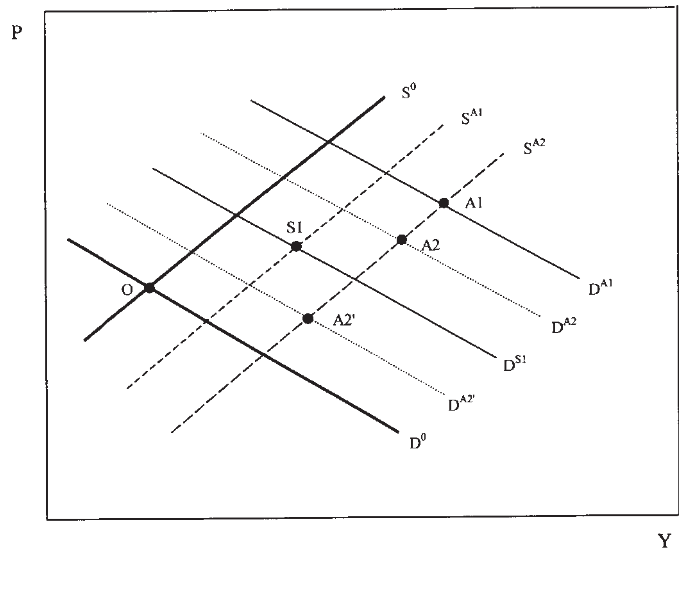


FIGURE 2
Impacts of Asymmetric versus Symmetric Supply Shocks



point O before a positive demand shock hits the economy. A symmetric demand shock moves the aggregate demand schedule upward, from D^0 to D^{S1}, and the new equilibrium point to S1. An asymmetric shock initially shifts aggregate demand upward by more than an equal-sized symmetric shock, because of the stimulative cost-of-capital effect, moving it from D^0 to D^{A1}. Meanwhile, however, an asymmetric shock will—through the cost-of-capital effect, the real-wage effect, and the import-price effect—also lower the marginal cost of production, exerting a negative impact on inflation and shifting S^0 downward to S^{A1}. The shift in both the aggregate supply and aggregate demand schedules following an asymmetric shock thus moves the new equilibrium to A1 initially. Over time, however, the negative net-exports effect will kick in and shift D^{A1} downward.

The extent to which D^{A1} will move downward, of course, depends on many factors, such as the price and income elasticities in the net-exports equation. For example, if the size of the contractionary net-export effect is smaller than that of the expansionary (demand-side) cost-of-capital effect, D^{A1} will shift downward to a location above D^{S1}—such as D^{A2}—and move the new equilibrium point to A2. Or, if the negative net-export effect more than offsets the positive cost-of-capital effect, D^{A1} may shift downward to a location below D^{S1}—such as $D^{A2'}$—and move the new equilibrium to A2′. Regardless of the extent to which D^{A1}shifts downward, however, the prediction of the asymmetry hypothesis remains intact: The inflation/output trade-off is smaller in response to an asymmetric shock than to a symmetric shock. That is clearly indicated by comparing either A2 or A2′ (the new equilibrium point following an asymmetric shock) with S1 (the new equilibrium point following a symmetric shock): Price is lower, and output is most likely higher, at either A2 or A2′ than at S1.

Now, let us analyze the impact of a positive supply shock using Figure 2. Suppose the shock is a symmetric one, taking the form of productivity shocks in both the U.S. and foreign economies. Initially, the shock would push the aggregate supply schedule downward from S^0 to S^{A1}. Over time, a positive ΔY also increases domestic demand, shifting aggregate demand upward to D^{S1} and moving the new equilibrium to S1.

An asymmetric supply shock initially shifts aggregate supply downward by more than an equal-sized symmetric shock does, because of the cost-of-capital effect, the real-wage effect, and the import-price effect on prices. The aggregate supply schedule thus moves from S^0 to S^{A1}. Meanwhile, the cost-of-capital effect also shifts D^0 upward to D^{A1}, moving the new equilibrium point to A1. At point A1, both price and output levels are higher than at S1. Over time, however, the net-export drag will shift aggregate demand downward.

Again, the extent to which D^{A1} will move downward depends on many factors. If the size of the negative net-export effect is smaller than that of the positive (demand-side) cost-of-capital effect, D^{A1} will shift downward to D^{A2}—a location well above D^{S1}—and move the new equilibrium point to A2. Alternatively, if the negative net-export effect more than offsets the positive cost-of-capital effect, D^{A1} will shift downward to $D^{A2'}$—a location below D^{S1}—and move the new equilibrium to A2′. One thing remains clear, however: Price is lower, and output is most likely higher, at either A2 or A2′ than at S1. Again, regardless of the extent to which D^{A1} shifts downward, the prediction of the asymmetry hypothesis remains intact: The inflation/output trade-off is smaller in response to an asymmetric shock than to a symmetric shock. A positive asymmetric supply shock results in lower inflationary pressure than does a symmetric shock, even if its expansionary effect may be higher initially.

Of course, the analyses are figurative, and the relative positions of S1 and A2 (or A2′) in both Figures 1 and 2 depend on (among many other factors) the slopes of the aggregate demand and aggregate supply schedules. Nevertheless, the main conclusion from those analyses is unambiguous: The inflation/output trade-off generated by an asymmetric shock is smaller than the one generated by a symmetric shock. Moreover, the differential impact of asymmetric and symmetric shocks does not depend on whether the shocks are demand shocks or supply shocks.[12]

It follows that even though the expansion caused by an asymmetric shock may tend to be greater initially than the one caused by a

12. This conclusion is made clear by comparing the effects of symmetric versus asymmetric demand shocks in Figure 1 and comparing the effects of symmetric versus asymmetric supply shocks in Figure 2.

symmetric shock, a forward-looking central bank will be slower to tighten monetary conditions in the case of an asymmetric shock—thereby allowing the expansion to last longer—than in the case of a symmetric shock.

The Impact of Negative Shocks

In this subsection, we propose that a negative asymmetric shock will result in a longer recession than an equal negative symmetric shock will. The reason is that a forward-looking central bank will take a negative symmetric shock more seriously and ease monetary conditions more quickly and aggressively to combat the possibility of a worldwide recession.

The hypothesis depends critically on the assumption that the central bank is forward-looking. In a policy-neutral environment, reasoning in reverse from the preceding subsection suggests that initially, an asymmetric shock will tend to have a greater contractionary impact than a symmetric shock because the former will result in a net capital outflow. Over time, however, a negative asymmetric shock will have a smaller contractionary impact because net exports will rise in response to a dollar depreciation—a result of a net capital outflow—and relatively higher foreign economic growth, helping end the recession. That reasoning suggests that a negative asymmetric shock will result in a shorter, though initially deeper, recession than a negative symmetric shock will; cumulatively, the contractionary effect of an asymmetric shock is smaller than that of a symmetric one.

Under our assumption about the central bank's reaction function, however, the relative size and duration of the contractionary effects of those two types of negative shocks are reversed. That is because the forward-looking central bank will lower the interest rate more quickly and aggressively when the expected recession is more severe. The recessionary impact of a negative symmetric shock is expected to be graver than that of an asymmetric shock because a countervailing net-export boost will be generated only by an asymmetric shock, not by a symmetric one. The central bank will thus act more quickly and aggressively in countering the contractionary effects of a negative symmetric shock than of an asymmetric shock. The different policy responses of the central bank cause the contractionary impact of a negative asymmetric shock to be deeper and longer than that of a negative symmetric shock.

IV. EMPIRICAL EVIDENCE FROM THE SVAR

In this section we use the SVAR approach to estimate the effects of asymmetric and symmetric shocks on U.S. output. To avoid dealing with the nonstationarity of output in the SVAR, we use the growth rate of output rather than the output level in the model. To find out whether the U.S. inflation and Federal funds rates actually respond to asymmetric versus symmetric shocks in the ways predicted by the asymmetry hypothesis, the model also includes inflation and the Federal funds rate. In addition, the model includes the real exchange rate, which is used to identify symmetric and asymmetric shocks. Sections II and III made clear that a positive (or negative) asymmetric shock would result in net capital inflows (or outflows) and a real dollar appreciation (or depreciation), whereas a symmetric shock would not. We thus define a positive asymmetric shock as one that has a contemporaneous and positive impact on the real dollar exchange rate, whereas a symmetric shock does not. Those definitions enable us to distinguish asymmetric shocks from symmetric shocks in a four-variable SVAR system that contains U.S. output, the real exchange rate, the Federal funds rate, and the inflation rate.

Estimation Procedure

Our SVAR estimation assumes that all four variables in our system are the cumulative result of four types of structural shocks: symmetric real shocks, asymmetric real shocks, monetary policy shocks, and inflation shocks, as summarized by equation (10):

$$Y_t = A(L)\varepsilon_t, \tag{10}$$

where $Y_t = [\Delta Y_t, ER_t, FF_t, \pi_t]'$, $\varepsilon_t = [\varepsilon_t^s, \varepsilon_t^{AS}, \varepsilon_t^{FF}, \varepsilon_t^{\pi}]'$, $A_{ij}(L)$ are polynomials in the lag operator L, ΔY is the growth rate of output, ER is the deviation of the real dollar exchange rate from its sample mean,[13] FF is the level of

13. We choose to use the deviation of the real exchange rate from its long-run mean, rather than the first difference in the real exchange rate, because we cannot impose the identification restriction on the latter to distinguish symmetric shocks from asymmetric shocks.

the Federal funds rate, π is the inflation rate, ε^S is the symmetric shock, ε^{AS} is the asymmetric shock, ε^{FF} is the monetary policy shock,[14] and ε^{π} is the inflation shock. Our unit-root tests indicate that the four time-series in the system can be reasonably assumed to be I(0) variables. All four types of shocks are assumed to have a zero mean and a constant variance.

To recover $A(L)$ so that we can trace the impulse responses of elements in Y with respect unit changes in elements in ε, we impose the following six identifying restrictions:

- A symmetric shock has no contemporaneous impact on the real exchange rate, that is, $A_{21}(0) = 0$. This restriction arises naturally from the definition and implication of symmetric versus asymmetric shocks.[15]
- Monetary policy has no long-run impact on output, that is, $\sum_{L=0}^{\infty} A_{13}(L) = 0$. In other words, money is neutral over the long run.
- Monetary policy has no long-run impact on the mean of the real exchange rate, i.e., $\sum_{L=0}^{\infty} A_{23}(L) = 0$. That is, purchasing power parity (PPP) holds in the long run, but monetary policy shocks may move the real exchange rate away from PPP in the short run.
- Inflation has no long-run impact on output, $\sum_{L=0}^{\infty} A_{14}(L) = 0$. That is, the natural rate hypothesis holds in the long run.
- Inflation has no long-run impact on the mean of the real exchange rate, $\sum_{L=0}^{\infty} A_{24}(L) = 0$. That is, PPP holds in the long run, though not in the short run.
- Monetary policy has no contemporaneous impact on the inflation rate, $A_{43}(0) = 0$. That is, there is at least a one-quarter lag between changes in the Federal funds rate and their affect on inflation.

With those structural restrictions, equation (10) can be expressed as follows:

$$(10') \quad \begin{bmatrix} \Delta Y_t \\ ER_t \\ FF_t \\ \pi_t \end{bmatrix} = \begin{bmatrix} X & X & 0_{LR} & 0_{LR} \\ 0 & X & 0_{LR} & 0_{LR} \\ X & X & X & X \\ X & X & 0 & X \end{bmatrix} \begin{bmatrix} \varepsilon_s \\ \varepsilon_{AS} \\ \varepsilon_{FF} \\ \varepsilon_{\pi} \end{bmatrix}$$

where 0_{LR} denotes a long-run restriction, and 0 denotes a contemporaneous restriction.[16]

SVAR Results

We employed the SVAR method to study the impulse responses of U.S. output, the real dollar exchange rate, the Federal funds rate, and the U.S. inflation rate. All data were obtained either from the Commerce Department's Bureau of Economic Analysis or the Board of Governors of the Federal Reserve System. The real exchange rate is a trade-weighted average of the price-adjusted dollar exchange rate relative to the currencies of the United States' 18 largest trading partners. The data are quarterly from 1974:1 to 2002:1, constituting 113 observations. Four lags of each variable were included in each regression. The impulse response functions are shown in Figures 3 through 6. Surrounding the impulse responses are one-standard-error bands computed from 1,000 bootstrap simulations.[17] Results of variance decompositions are shown in Table 1.

Impulse Responses. In general, the impulse responses are consistent with the asymmetry hypothesis. Figure 3 shows that the output level responds more strongly to an asymmetric shock than to a symmetric shock. According to the hypothesis, that occurs because a symmetric shock produces greater inflationary pressures and therefore a greater monetary tightening than an asymmetric shock does. The fact that output declines in response to a symmetric shock after quarter 4 is consistent

14. Following Bernanke and Blinder (1992) and Bernanke and Mihov (1998), we measure the stance of monetary policy with the actual Federal funds rate.

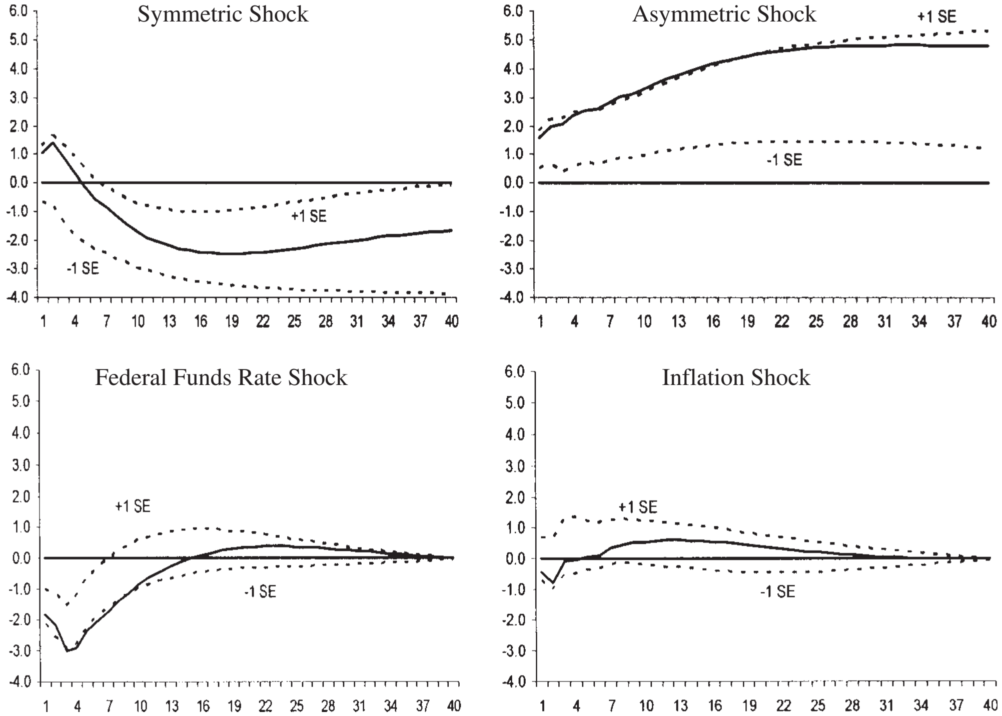
15. In this model, asymmetric shocks are defined as shocks that change the relative expected rate of return on U.S. assets relative to foreign assets, thereby changing net capital inflows and the nominal exchange rate contemporaneously. Because prices adjust more sluggishly than the nominal exchange rate, asymmetric shocks also affect the real exchange rate immediately. In contrast, symmetric shocks are defined as shocks that give neither economy an advantage in attracting net capital inflows. Consequently, by definition symmetric shocks do not change the exchange rate contemporaenously. See section II for details.

16. The remaining elements (the elements marked by Xs) are identified by the restriction that $A(0)A(0)'\Sigma = \Omega$ where Σ is the diagonal covariance matrix of the structural shocks (ε_t) and Ω is the covariance matrix of the estimated residuals from the unrestricted VAR. This relationship imposes 10 identifying restrictions on the four-variable VAR.

17. The standard error bands are not symmetrical because they are calculated relative to the mean of the impulse responses from 1,000 bootstrap simulations, not the reported point estimate of the impulse response, which is estimated using the actual data.

FIGURE 3

Impulse Responses of the **Output Level** to Four Types of Shocks (Over a 40-Quarter Forecast Horizon)



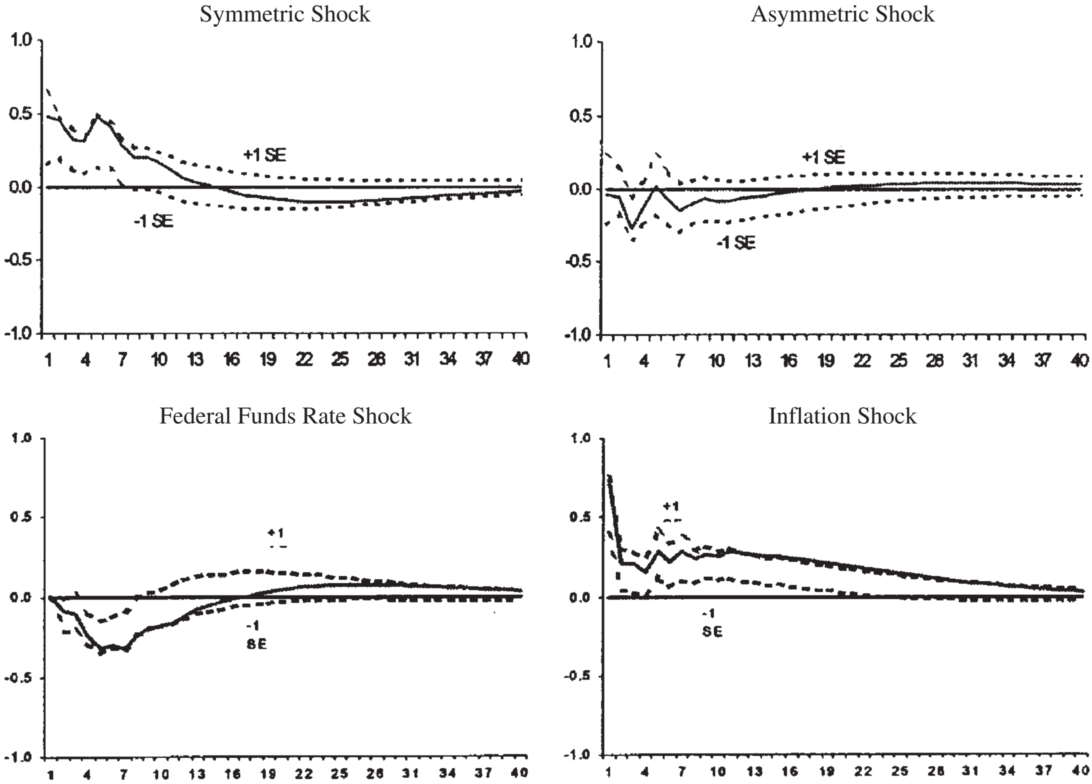
with the monetary tightening hypothesis. Those two assumptions are corroborated by Figures 4 and 5: Figure 4 shows that the inflation rate responds more strongly to a symmetric shock than to an asymmetric shock; Figure 5 shows that the Federal funds rate also responds more strongly to a symmetric shock than to an asymmetric shock.

The impulse responses of the real exchange rate are shown in Figure 6. The effect of a symmetric shock on the real exchange rate is zero in the first quarter as a result of the identification restriction. The real exchange rate then appreciates. That pattern suggests that the Federal Reserve has tended to be more forward-looking and proactive than foreign central banks, raising the interest rate in response to symmetric shocks by more than its foreign counterparts. An asymmetric shock causes the real exchange rate to appreciate immediately and then, after more than a year, gradually fall back toward its initial level. That pattern of response is consistent with our hypothesis. A positive shock to the U.S. economy that is not experienced elsewhere in the world will cause capital to flow into the United States. The rise in the demand for capital will cause the real exchange rate to appreciate. Over time, however, the increasing weight of the ensuing net-export drag will exert downward pressure on the real exchange rate until a new long-run equilibrium is achieved.

For the most part, the other impulse responses depicted in Figures 3 through 6 seem quite reasonable, lending credibility to our overall empirical findings. Figure 3 shows that an increase in the Federal funds rate lowers output immediately—though it has no long-run impact on output—and that an increase in inflation has no significant impact on output.[18] Figure 4 shows that

18. Note that VAR studies typically find that the output response to its own shock is significant and highly persistent, as in Leeper et al. (1996). In our identification scheme, the output shock is divided into two orthogonal shocks: a symmetric shock that is uncorrelated with real

FIGURE 4
Impulse Responses of the **Inflation Rate** to Four Types of Shocks (Over a 40-Quarter Forecast Horizon)



inflation responds negatively to Federal funds rate shocks. Figure 6 shows that as expected, Federal funds rate shocks cause the real exchange rate to appreciate, but inflation shocks have only a negligible impact on the real exchange rate. A somewhat puzzling result is that the Federal funds rate responds negatively to inflation, as shown in Figure 5. Recall, however, that the inflation shock in this analysis is orthogonal to the symmetric and asymmetric shock. Therefore, much of what we think of as demand-induced inflation shocks may already be included in those other shocks. On the whole, the impulse responses are supportive of our hypothesis. Asymmetric shocks lead to lower inflation, a smaller monetary tightening, and therefore a greater and more sustained output response than symmetric shocks do.

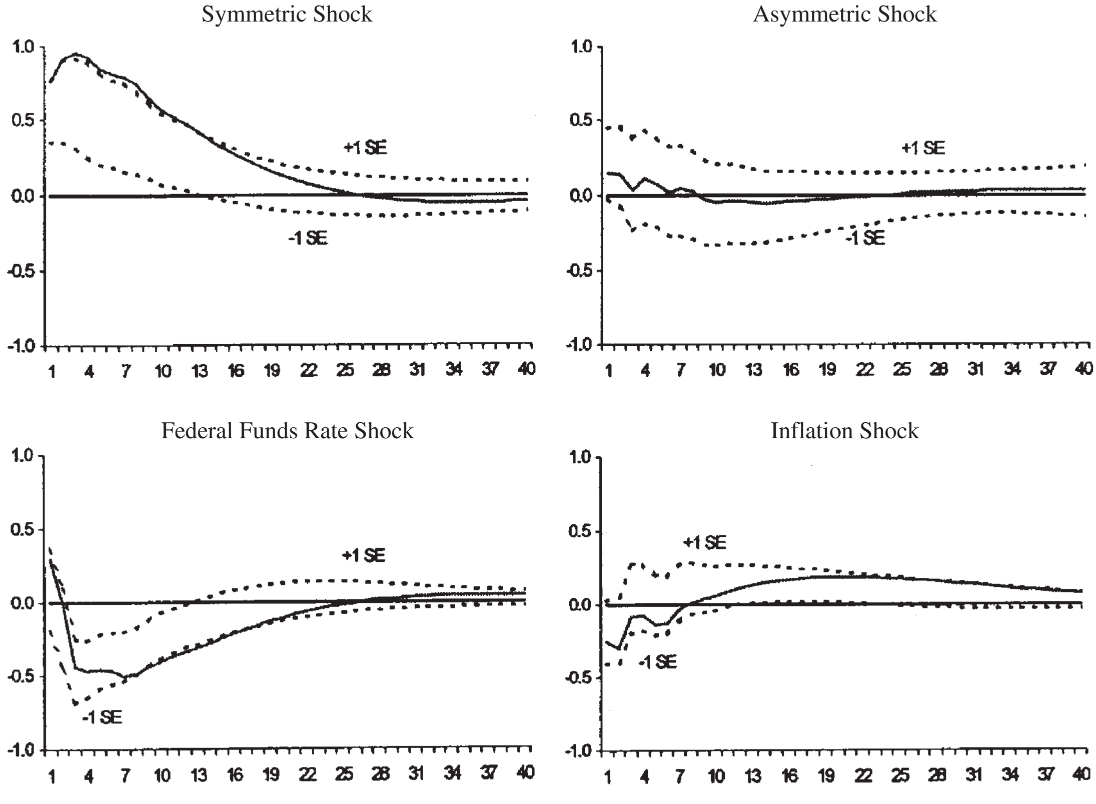
Variance Decomposition. Table 1 presents variance decompositions of the four variables included in our SVAR model. That is, it presents the percentage of the variance of the k-quarter-ahead forecast error of each variable that results from each of the four types of shocks studied in our model for $k = 1, 2, 3, 4, 8, 12$, and 40. Overall, the standard errors indicate that the confidence intervals surrounding the point estimates are not unreasonably wide.[19]

exchange rate movements and an asymmetric shock that is correlated with real exchange rate movements. Because other studies do not decompose the output shock in this way, our impulse responses are not directly comparable to theirs. In the context of our identification scheme, an output response to its own shock would be some combination of the top two panels in Figure 3. Moreover, the output response to its own shock would look more like the output response to the asymmetric shock because a significantly larger proportion of the variance of output is due to the asymmetric shock, and thus would be significant and highly persistent and consistent with other VAR studies.

19. The standard error bands are not symmetrical because they are calculated relative to the mean of the 1,000 bootstrap simulation results, not the point estimate.

FIGURE 5

Impulse Responses of the **Federal Funds Rate** to Four Types of Shocks (Over a 40-Quarter Forecast Horizon)



The variance decomposition results are generally consistent with our hypothesis. In particular, three patterns stand out in supporting the hypothesis. First, asymmetric shocks dominate other shocks in moving output and the real exchange rate. Second, symmetric shocks dwarf asymmetric shocks in explaining the variation in the Federal funds rate. Third, symmetric shocks are much more important than asymmetric shocks in driving inflation. That these three patterns remain unchanged throughout the forecast horizon also attests to the results' robustness.

V. SUPPLEMENTAL EVIDENCE

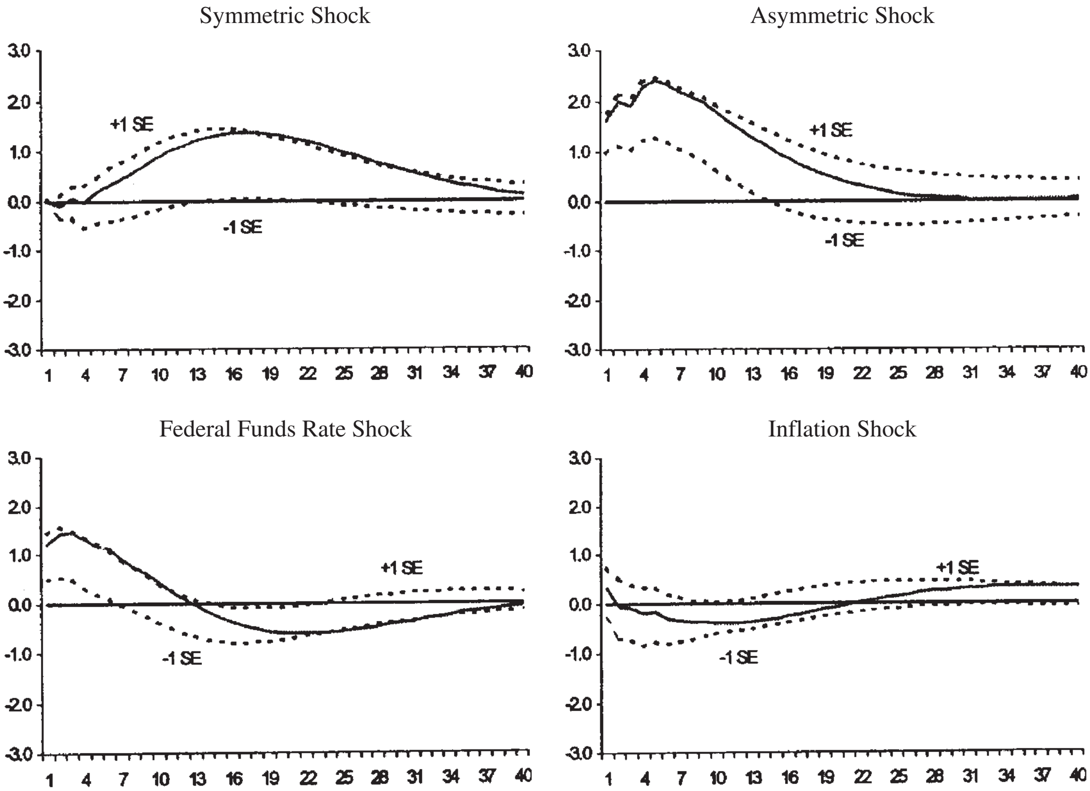
Overall, the impulse responses depicted in Figures 3 through 6 are supportive of the asymmetry hypothesis. This section provides supplemental evidence for that hypothesis.

The Validity of the Basic Premises

It is clear from section III that the asymmetry hypothesis builds on two critical premises that may be subject to debate. The first is the open economy assumption: that the U.S. economy is sufficiently open that the impact of an economic shock on U.S. economic conditions is necessarily complicated by international capital and trade flows. The second is the monetary policy assumption: that the central bank is forward-looking and effective in combating inflation and recession, tightening monetary conditions in response to rising inflationary expectations and easing monetary conditions in reaction to recessionary threats. This subsection presents evidence supporting the validity of those two premises.

The Open-Economy Premise. It is clear from the preceding theoretical analysis that as long as sufficient linkages exist between the U.S. and

FIGURE 6
Impulse Responses of the **Real Exchange Rate** to Four Types of Shocks (Over a 40-Quarter Forecast Horizon)



foreign economies to allow those capital and trade flows to adjust in response to shocks to the United States or abroad, the impacts of an asymmetric shock the U.S. economy would be complicated by those flows. Is there sufficient linkage between the U.S. and foreign economies?

It is true that despite the rapid rise in imports and exports in recent years, by the end of 2002 the imports/GDP ratio was only about 14%, and the exports/GDP ratio less than 10%. As argued in Gamber and Hung (2001), using trade flows exclusively as a measure of openness would surely miss the rise in breadth, or diversity, of U.S. trade with the rest of the world in terms of the number of industries that are faced with greater import competition. In 1970, over 84% of 431 manufacturing industries (at the four-digit SIC level) were faced with import penetration less than or equal to 10%, and only 7% were faced with import penetration greater than 20%. By 1996, the share of industries faced with import penetration less than or equal to 10% had halved to 42%, whereas those faced with import penetration greater than 20% had sextupled to 42% (see Table 2).[20] This increase in the breadth of U.S. trade means that changes in foreign economies and the exchange rate have significant implications for the U.S. economy. As discussed in section III, changes in import prices have not only a *direct* effect on U.S. consumer prices but also *indirect* effects by changing competitive pressures on domestic producers. The rise in the breadth of U.S. globalization implies that import prices will have a greater *indirect* impact on U.S. prices as more industries adjust their prices in response to changes in import prices.

20. This table is from Gamber and Hung (2001), Table 1, p. 64. The ratio in 1970 was based on 431 industries from Robert C. Feenstra, and the ratio in 1996 was based on 398 industries from the Census Bureau. The two sets of data are comparable despite the difference in the total number of manufacturing industries. See Table 2 for detailed documentation and comparison of those two sets of data.

TABLE 1
Variance Decomposition of Output, Real Exchange Rate, Federal Funds Rate, and Inflation Rate

	Symmetric Shock			Asymmetric Shock			Federal Funds Rate Shock			Inflation Shock		
Horizon	**−1SE**	**Point Estimate**	**+1SE**	**−1SE**	**Point Estimate**	**+1SE**	**−1SE**	**Point Estimate**	**+1SE**	**−1SE**	**Point Estimate**	**+1SE**
Percentage of Var(output)												
1	0.00	19.04	36.63	8.32	35.35	50.22	20.04	46.21	71.13	0.00	2.40	19.72
2	0.00	16.92	37.46	8.85	35.50	50.97	19.34	43.52	69.22	0.00	4.07	19.16
3	0.00	12.09	34.60	7.83	33.37	47.10	23.65	52.21	70.40	0.00	2.34	19.71
4	0.24	8.75	34.22	8.57	35.28	47.61	23.04	54.35	68.54	0.00	1.62	20.06
8	6.47	6.73	41.30	14.28	49.73	54.76	13.97	42.34	50.65	0.00	1.20	19.77
12	11.32	12.10	48.44	18.54	59.27	60.64	9.02	27.04	34.95	0.00	1.59	17.99
40	12.85	16.72	60.87	29.02	77.65	80.43	1.92	5.02	9.06	0.00	0.60	6.38
Percentage of Var(inflation rate)												
1	8.33	30.88	59.65	0.00	0.19	21.27	0.00	0.00	0.00	31.91	68.93	81.21
2	15.76	43.48	63.89	0.00	0.51	21.70	0.00	0.71	5.58	24.95	55.29	69.90
3	16.62	43.77	62.87	2.02	6.68	25.80	0.65	1.50	7.74	21.49	48.05	62.81
4	17.14	44.74	61.22	2.43	7.02	26.58	2.28	4.95	11.97	19.78	43.28	58.59
8	16.02	44.94	56.24	2.79	5.44	27.25	6.36	16.12	20.98	17.06	33.50	53.30
12	14.73	40.60	52.43	3.40	5.40	29.13	6.70	17.01	20.88	18.95	36.99	53.79
40	15.55	35.14	47.15	6.29	4.99	31.17	7.54	15.33	22.75	20.23	44.54	49.32
Percentage of Var(Federal funds rate)												
1	31.23	76.46	80.09	0.00	2.72	32.98	0.00	11.61	30.95	0.00	9.22	30.26
2	31.64	83.24	82.45	0.00	2.21	31.90	0.22	5.11	29.90	0.00	9.44	26.45
3	29.82	82.56	78.05	0.00	1.37	28.45	7.28	10.10	36.83	0.95	5.97	19.87
4	27.91	81.21	76.14	0.00	1.28	28.51	9.41	13.06	40.39	0.99	4.45	17.95
8	24.67	76.71	72.51	0.00	0.77	29.75	12.04	19.61	43.98	0.53	2.91	17.04
12	23.63	74.42	69.92	1.21	0.70	31.27	12.81	22.35	41.92	0.96	2.53	18.28
40	21.23	68.88	63.92	4.31	0.85	34.57	12.14	22.71	38.88	3.33	7.56	21.62
Percentage of Var(exchange rate)												
1	0.00	0.00	0.00	34.50	63.27	81.64	9.48	34.31	55.59	0.00	2.42	21.86
2	0.00	0.12	2.08	36.39	64.54	81.61	8.95	34.31	53.61	0.00	1.04	19.55
3	0.00	0.08	2.95	37.13	64.07	81.43	8.90	35.12	52.32	0.00	0.72	19.11
4	0.00	0.06	4.50	40.10	67.30	82.82	7.28	31.91	48.20	0.00	0.72	18.83
8	0.00	1.60	11.25	46.78	74.07	86.40	4.08	23.37	36.16	0.00	1.19	17.27
12	0.10	6.66	21.10	45.90	73.13	86.00	4.28	18.33	28.31	0.00	1.89	15.67
40	1.76	28.03	36.93	35.02	52.48	79.10	4.81	16.47	25.87	0.00	3.02	15.95

TABLE 2
The Share of Industries Faced with Import Competition Over Time (Percentage of Industries within Each Range of Import Penetration)

Import Penetration (IP)	1958	1970	1980	1990	1994	1996
$0 \leq IP \leq 10$	92	84	70	46	43	42
$10 < IP \leq 20$	4	10	17	22	20	18
$20 < IP \leq 30$	2	4	6	13	14	15
$30 < IP \leq 40$	0	1	3	6	8	9
$40 < IP \leq 50$	0	1	2	5	6	6
$50 < IP \leq 60$	0	1	1	3	4	3
$60 < IP \leq 70$	0	0	0	2	2	3
$70 < IP \leq 80$	0	0	0	1	2	2
$80 < IP \leq 90$	0	0	0	1	1	2
$90 < IP \leq 100$	0	0	0	1	1	2
Memorandum: total number of industries	431	431	431	346	398	398

Notes: $IPi = Mi/(Si - Xi + Mi)$, where Mi is imports, Si is shipments, Xi is exports, in industry i. Import and export before 1990 are from the Website (http://data.econ.ucdavis.edu/international/index.html) maintained by Robert Feenstra, presumably unrevised. Import and export data for 1990, 1994, and 1996 are revised data from the Census Bureau. Revised data are not available prior to 1989. Shipment data are from the *Annual Survey of Manufacturers* published by the Census Bureau.Observations in 1990 and 1994—the two years when both revised and unrevised data are available—indicate that the distribution of industries across the range of import penetration is not significantly affected by the revision of the data. For example, the share of industries with IP ≤ 10% in 1990 is 46% based on revised data and 44% based on unrevised data; in 1994, it is 43% based on revised data and 40% based on unrevised data. Gamber and Hung (2001), Table 1, p. 64.

In addition to broader and deeper exposures to trade with foreign countries, the United States has become more globalized in terms of capital flows across its borders. The removal of barriers to capital flows in many industrial as well as emerging countries has contributed greatly to the increase in both inflows and outflows of capital. Both outward and inward capital flows have soared relative to GDP since 1992. U.S. outflows of private capital, which averaged about 2% of GDP ($80 billion) per year during the 1980s, surged to nearly 6% of GDP (570 billion) by 2000. The surge in private-capital inflows is even more pronounced. After averaging roughly 3% of GDP ($140 billion) per year during the 1980s, private-capital inflows increased to over 10% of GDP ($1 trillion) by 2000.

A final and probably more conclusive piece of evidence that the United States is now sufficiently globalized is the finding by Gamber and Hung (2001) that foreign capacity utilization indeed plays a significant role in explaining and forecasting U.S. price inflation. They conclude that the rise in globalization has made foreign economic conditions an important factor to be reckoned with in constructing a model of price inflation for the U.S. economy.

The Monetary Policy Premise. Economists have long agreed that monetary policy plays an important role in macroeconomic fluctuations in the short run, even though it cannot affect aggregate output in the long run. There is no consensus, however, on whether active monetary policies on average have helped smooth or amplify cyclical economic swings. Differences in the policy rule as well as the credibility of the central bank over different periods have rendered the effect of monetary policies very uneven over time. We acknowledge that our assumption—that the U.S. central bank is not only forward-looking but also effective—is unlikely to be true throughout the entire post–World War II era. In light of the findings in papers by Clarida et al. (2000) and Mehra (1999), however, our assumption appears to be a reasonable characterization of U.S. monetary policy rules since 1979, the year Paul Volcker was appointed chairman of the Board of Governors of the Federal Reserve System.

Both papers find that the U.S. central bank has been forward-looking during the Volcker–Greenspan era: It has systematically raised (or lowered) real as well as nominal short-term interest rates in response to higher expected inflation (or output gap). Clarida et al. (2000) derive those findings by using the generalized method of moments (GMM) to estimate a monetary reaction function constructed from a simple forward-looking policy rule similar to that described in our equation (8). They find that the point estimate on the coefficient on the inflation gap (ϕ) is 2.15, significantly above unity during the 1979–96 Volcker–Greenspan period, even though it is only 0.83 for the pre-Volcker period. The estimates of γ—the coefficient measuring the sensitivity to the cyclical variable—are also significant in both periods. Mehra (1999) also uses GMM to estimate a forward-looking monetary reaction function for the post-1979 period—but assuming that the Federal funds rate responds to actual inflation in addition to expected inflation and expected output gap—and likewise finds that the Fed has responded aggressively to expected inflation.

Both studies claim that the target rates generated by their respective forward-looking reaction functions track the actual rates reasonably well. Both share the conclusion that the Fed during the Volcker–Greenspan regime has substantially raised target real rates in the wake of an anticipated increase in inflation. They also agree that to the extent that a rise in the real rate slows down economic activity and relieves inflationary pressures, the forward-looking policy rule provides a natural explanation for the inflation stability experienced by the U.S. economy since 1979.

Stylized Facts

The Federal Reserve's policy reactions in and the impacts of those reactions on the two most recent U.S. business cycles roughly fit the description of the hypothesis. The expansion of the 1980s, which began in November 1982, was more symmetric with foreign expansions than the expansion of the 1990s. The earlier expansion thus was accompanied by a stronger build-up of inflation than the later one. In response, the Federal Reserve began a string of uninterrupted tightening in March 1988, at a time when annual CPI inflation was slightly above 4%.[21] The target Federal funds rate rose by a total of 330 basis points to 9.81% by May 1989, when the tightening ended. The expansion subsequently ended in July 1990.[22] In comparison, the expansion of the 1990s, which began in April 1991, was more asymmetric and, not by coincidence, was associated with less inflationary build-up.[23] In response, the Federal Reserve did not begin a string of uninterrupted tightening until late June 1999. In fact, the tightening came in response to expected higher inflation—in light of a tight labor market, rapid domestic output growth, and strong foreign recoveries—rather than to actual high inflation, because inflation was only slightly above 2% at the time.[24] The course of tightening was reversed on 3 January 2001, when the Federal Reserve lowered the target Federal funds rate aggressively (by 50 basis points) in light of the confluence of weakening domestic indicators and faltering foreign economic recoveries. The target Federal funds rate, which was 4.75 percent in early June 1999, rose by a mere 175 basis points over the whole episode of the 1999–2000 tightening. To recap, the Federal Reserve raised the interest rate by a much smaller amount and at a much later time in the asymmetric expansion of the 1990s than in the (relatively) symmetric expansion of the 1980s.

Considering the pattern of U.S. expansions from a longer and broader perspective offers further support to the hypothesis. According to the National Bureau of Economic Research, five expansions have occurred in the United States since 1962. Table 3 presents the GDP

21. The tightening actually began about two years earlier, but it was interrupted briefly by easing in response to the 1987 stock market collapse.

22. That dating is based on the National Bureau of Economic Research's breakdown of U.S. business cycles. A legitimate question is, of course, whether the expansion might have lasted a bit longer if the Gulf War had not erupted following the Iraqi invasion of Kuwait on 2 August, 1990.

23. In 1992, Japan entered the slump from which it is still struggling to recover. During the current U.S. expansion, Europe has also been in a recession with double-digit unemployment for many years. The Asian crisis that erupted in July 1997 pushed emerging Asian economies into recession, reinforcing the asymmetry of economic conditions between the United States and the rest of the world. The influence of slow foreign growth on the current U.S. expansion is discussed in Congressional Budget Office (1999).

24. Instead of raising interest rates, the Fed actually lowered the target Federal fund rate three times, by a total of 75 basis points, from late September to mid-November 1998. Those rate cuts were aimed mainly at containing the fallout from the Asian crisis, including the imminent downward spiral of international financial markets following Russia's default on its debt and a looming domestic credit crunch following the near-bankruptcy of Long-Term Capital Management.

TABLE 3
GDP Gaps in Foreign Countries During U.S. Expansions (Percent)

	1962–69	1971–73	1976–79	1983–89	1992–2000
United States	1.07[a]	0.87	0.96	– 0.95	0.11
Australia		1.72	– 0.40	– 0.68	– 1.12
Belgium		1.25	0.99	– 1.66	– 0.69
Canada		2.09	1.53	0.02	– 1.31
France		1.58	1.18	– 2.61	– 1.65
Germany	– 0.36[a]	4.53	2.29	– 1.71	-0.98
Italy	– 1.12[a]	1.40	0.78	– 1.29	– 1.30
Japan		1.12	– 1.12	– 1.41	– 0.40
Netherlands		0.15	0.93	– 1.10	1.05
Sweden		1.01	0.29	1.95	– 2.45
United Kingdom		1.03	– 0.38	– 0.27	– 1.30
Rest of world (import-weighted)	– 0.10	0.82	0.50	– 0.90	– 1.00

Notes: U.S. expansions are based on NBER breakdown. GDP gap = [(Actual GDP – Potential GDP)/Potential GDP]*100.
[a]Data start in 1963.
Source: Main economic indicators by the OECD.

TABLE 4
U.S. and Foreign CPI Inflation Rates during U.S. Expansions (Percent)

	1962–69	1971–73	1976–79	1983–89	1992–2000
United States	2.4	4.5	7.1	3.8	2.6
Australia	2.3	7.1	10.7	7.6	2.1
Belgium	3.1	5.6	6.3	3.7	1.9
Canada	2.9	5.1	8.4	4.5	1.6
France	4.0	6.3	9.8	5.0	1.6
Germany	2.5	5.9	3.7	1.7	2.3
Italy	4.1	7.1	15.2	8.1	3.5
Japan	5.5	7.6	6.4	1.4	0.5
Netherlands	4.5	7.8	5.9	1.4	1.9
Sweden	3.9	7.3	1.9	2.4	1.6
United Kingdom	3.9	8.6	13.5	5.1	2.7
Rest of world (import-weighted)	3.7	6.6	7.4	3.3	1.5

Source: Main economic indicators by the OECD.

gap in the United States and 10 major foreign countries during those five expansions. Table 3 shows that of the five U.S. expansions since 1962, the three longest (1962–69, 1983–89, and 1992–99) were accompanied by negative GDP gaps in foreign countries, whereas the two shortest expansions (1971–73, 1976–79) were accompanied by positive foreign GDP gaps.

To be sure, Table 3 has an obvious shortcoming: Data on GDP gaps during the 1962–69 period were available only for Germany and Italy. It is thus comforting that Table 4 shows a picture consistent with that of Table 3: Price inflation was lower—averaging 2.5%—during the three longest U.S. expansions, and higher—averaging 7.0%—during the two shortest expansions. Capital flows have soared relative to GDP since 1992. U.S. outflows of private capital, which averaged about 2% of GDP ($80 billion) per year during the 1980s, surged to nearly 6% of GDP ($500 billion) by 1997. The surge in private-capital inflows is even more pronounced. After averaging roughly 3% of GDP ($140 billion) per year during the 1980s, private-capital inflows increased to over 9% of GDP ($700 billion) in 1997. Even though both inward and outward capital flows as a share of GDP dropped significantly in 1998 because of the Asian crisis, their quick rebound in 1999 and 2000 indicate that the trend toward greater capital flows is unlikely to be interrupted for long.

Even if we discard the data from the 1962–69 period, the broad-stroke picture presented by Tables 3 and 4 is still consistent with the asymmetry hypothesis. U.S. expansions that are not accompanied by foreign expansions are more likely to be attended by lower inflation, all else being equal. Because the Federal Reserve is less likely to raise the interest rate to end expansions that are accompanied by modest inflation, asymmetric expansions will tend to last longer than those symmetric with foreign expansions. Admittedly, our sample is small, and the table cannot pass as a formal test. Nevertheless, as stylized facts they are broadly consistent with the asymmetry hypothesis.

VI. CONCLUSIONS

This article argues the theoretical validity and investigates the empirical evidence of the asymmetry hypothesis. That hypothesis—under the assumptions of sufficient globalization and a forward-looking central bank—maintains that business cycles last longer when they are generated by shocks that are country-specific than when they are generated by symmetric shocks that occur not only in the home country but also abroad. We estimate a four-variable SVAR and examine stylized facts to see whether that hypothesis is corroborated by U.S. data. The results are affirmative.

Our analysis also indicates that the hypothesis's predictions could be reversed in an environment in which the central bank was inactive. In that setting, because of the absence of net-export drag and the benign neglect of high inflation, symmetric shocks could have deeper and longer effects on the business cycle in the home country than asymmetric shocks would. Such outcomes may be less desirable because they are likely to mean more extreme cyclical swings. Addressing such welfare issues, however, is a subject for future research.

APPENDIX: THE INFLUENCE OF ASYMMETRIC INITIAL CONDITIONS

The analyses in section III are based on the assumption that conditions in the U.S. and foreign economies are symmetric when a shock hits. Consequently, an asymmetric shock will result in asymmetric economic conditions, which in turn spur capital and trade flows in such a way that a positive (or negative) shock will have greater and longer expansionary (or contractionary) impact than a symmetric shock. This appendix proposes that the predicted impact of an asymmetric shock on the business cycle compared with the impact of a symmetric shock will continue to hold even if we relax the assumption on the initial symmetric conditions.

Assume that a *positive* asymmetric shock hits the United States when it is in an expansion while the foreign economy is in a recession. The capital and trade flows and their expansionary effects spurred by the asymmetric shock would still be larger and longer relative to those spurred by a symmetric shock. The reason is that the asymmetric positive shock would simply *increase* the degree of asymmetry between U.S. and foreign conditions but not affect the working of capital- and trade-flow channels that causes the asymmetric shock to have a stronger and longer expansionary effect than a symmetric shock.

What if the situation is reversed and the positive asymmetric shock hits when the United States is in a recession while the foreign economy is in an expansion? In that case, the shock hits when the foreign economy is receiving a net-capital-inflow boost and experiencing a net-export drag. Because the shock would boost U.S. but not foreign growth, it would reduce net capital outflows from the United States. The return of capital would help stimulate U.S. domestic demand and strengthen the U.S. currency, even though it would reduce net export growth over time. In comparison, a symmetric shock would boost both U.S. and foreign growth and do less to reduce net capital outflows from the United States. Thus, the expansionary effect of an asymmetric shock would still be stronger initially and more sustainable over time than that of a symmetric shock.

The relative contractionary effect of a *negative* asymmetric shock versus a symmetric shock will also continue to hold regardless of the initial condition. Assume that a negative asymmetric shock hits the United States when it is in a boom and the foreign economy is in a recession. The contractionary effect of the shock will still be deeper and longer than that of a symmetric negative shock because, even though the Federal Reserve will ease monetary conditions regardless of whether the shock is symmetric or asymmetric, the easing is likely to be more aggressive if the shock is symmetric than if it is asymmetric. The same logic and conclusions would apply if a negative asymmetric shock hit when the United States was in a recession and the foreign economy was in an expansion.

Of course, it is the asymmetry or symmetry of business cycle conditions at a given point in time that results in cross-border capital and trade flows, which in turn have bearings on domestic inflation and business cycle duration. The asymmetry of shocks, by either reinforcing or offsetting the existing asymmetric conditions, would simply either add to or subtract from the effect of initial asymmetry on the business cycle. Because the relative impact on inflation and the business cycle of asymmetric versus symmetric shocks does not depend on the initial conditions, however, such a realization does not invalidate the asymmetry hypothesis.

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