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ABSTRACT

This paper proposes and investigates the "asynchronization hypothesis," which predicts that an asynchronized shock tends to have a stronger and longer effect on the U.S. business cycle than an internationally synchronized shock. The hypothesis finds empirical support in the impulse responses of U.S. output and inflation to synchronized and asynchronized shocks; those responses are estimated in a system of four-variable structural vector autoregression. It also finds support in stylized facts: the longest U.S. expansions have tended to occur when the rest of the world is growing below potential.

Does International Asynchronization Matter for the U.S. Business Cycle?

Section 1: Introduction

Economic expansions in the U.S. 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 began in April 1991, however, appeared to deviate from this pattern: the expansion was associated with little inflationary buildup, and consequently, the Federal Reserve did not begin a string of uninterrupted tightening until late June 1999, when CPI inflation was running only slightly above the 2 percent rate. By comparison, consumer prices were rising at 6.2 percent at the end of the 1960s boom and over 5 percent 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 has 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 sustained the boom; that the rise in the

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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 U.S. have ended with a tightening of monetary policy.

2. For example, Schlesinger of the *Wall Street Journal* (February 1, 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."

services component of 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 prolonged the expansion.

This paper considers another factor that is likely to have helped increase the longevity of the 1990s expansion. We call this factor "the asynchronization hypothesis." The hypothesis maintains that in a flexible exchange rate regime, an asynchronized (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 U.S. 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 synchronized positive shock is accompanied by stronger inflationary pressures than an expansion caused by an equal-sized asynchronized shock, prompting quicker and stronger monetary tightening. Consequently, an expansion caused by a synchronized shock ends earlier than one caused by an asynchronized shock. Symmetrically, a contraction caused by a synchronized negative shock is potentially more devastating for the economy than one caused by an equal-sized asynchronized shock, prompting quicker and stronger monetary easing. Thus, a contraction caused by a synchronized shock ends earlier than a contraction caused by an asynchronized shock.

This paper 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 (VAR) 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 asynchronization hypothesis. Estimating a structural vector autoregression and tracing the impulse responses of U.S. output growth to synchronized and asynchronized shocks, we find that asynchronized innovations have a greater and more sustained impact on the U.S. output gap than synchronized 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. More recently, Ahmed et al. (1993) developed and estimated an SVAR model to study the sources of international economic fluctuations in an open-economy setting. Curiously, although the flexibility of the exchange rate plays a pivotal role in that paper, 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 paper is organized as follows. Section 2 introduces the theoretical framework of the asynchronization hypothesis. Section 3 proposes the hypothesis. Section 4 presents the SVAR results showing the effect of synchronized versus asynchronized shocks on U.S. output and inflation. Section 5 provides other evidence in support of the hypothesis. Section 6 draws conclusions.

Section 2: Theoretical Framework

This section describes the open-economy model that we use to propose the asynchronization hypothesis in section 3. The model assumes that the world consists of two economies: U.S. 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) asynchronized shocks ($\boldsymbol{\varepsilon}^{AS}$) are defined as shocks that boost (or lower) expected U.S. output growth relative to Foreign output growth. Positive asynchronized shocks thus increase the expected risk-adjusted rate of return on U.S. assets relative to that on Foreign assets.[3] Asynchronized shocks ($\boldsymbol{\varepsilon}^{AS}$) take the form of either demand shocks ($\boldsymbol{d\varepsilon}^{AS}$) or supply shocks ($\boldsymbol{s\varepsilon}^{AS}$). In each period, a demand shock equals either an asynchronized demand shock ($\boldsymbol{d\varepsilon}^{AS}$) or a synchronized demand shock ($\boldsymbol{d\varepsilon}^{S}$), where $\boldsymbol{d\varepsilon}^{AS}$ and $\boldsymbol{d\varepsilon}^{S}$ are mutually exclusive.

Positive (or negative) synchronized shocks ($\boldsymbol{\varepsilon}^{S}$) 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. A supply shock ($\boldsymbol{s\varepsilon}$) equals either asynchronized supply shocks ($\boldsymbol{s\varepsilon}^{AS}$) or synchronized supply shocks ($\boldsymbol{s\varepsilon}^{S}$), where $\boldsymbol{s\varepsilon}^{AS}$ and $\boldsymbol{s\varepsilon}^{S}$ are mutually exclusive. In each period, depending on whether there is a shock and what its nature is, $\boldsymbol{\varepsilon}^{AS}$ equals 0, $\boldsymbol{d\varepsilon}^{AS}$, or $\boldsymbol{s\varepsilon}^{AS}$; similarly, $\boldsymbol{\varepsilon}^{S}$ equals 0, $\mathbf{d\varepsilon}^{S}$, or $\boldsymbol{s\varepsilon}^{S}$ in each period.

3. We intentionally define asynchronized 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 U.S. are examples of asynchronized demand shocks.

The U.S. economy is summarized by the 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:

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

(4) Import price:

$$P^m = \theta E P^*,\ 0 < \theta \leq 1$$

(5) Price-Setting:

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

(6) Aggregate Demand:

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

(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 $\boldsymbol{C^D}$ is domestic demand for financial capital, $\boldsymbol{r}$ is the real interest rate (the cost of capital), $\boldsymbol{C^S}$ is domestic supply of financial capital, $\boldsymbol{Y}$ is domestic output, $\boldsymbol{NK}$ is the net capital inflow, $\boldsymbol{E}$ is the nominal exchange rate (expressed as *U.S./Foreign currency,* so that an increase in E represents a dollar depreciation), $\boldsymbol{NL}$ is the net increase in liquidity resulting from the central bank's intervention in the credit market, $\boldsymbol{r^T}$ is the central bank's time-varying target real interest rate, $\boldsymbol{r^*}$ 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), $\boldsymbol{N^D}$ is labor demand, $\boldsymbol{w}$ is the real wage, $\boldsymbol{N^S}$ is domestic labor supply, $\boldsymbol{NX}$ is net exports, $\boldsymbol{P}$ is the U.S. consumer price, $\boldsymbol{P^m}$ is import price, $\boldsymbol{Y^*}$ is Foreign output, θ is the exchange-rate-pass-through coefficient, $\boldsymbol{P^*}$ is Foreign price, $\boldsymbol{P^D}$ is the price of domestically produced goods and services in the consumption basket, $\boldsymbol{u}$ is the unit labor cost, $\boldsymbol{P^I}$ is the price of non-imported inputs, $\boldsymbol{Y^P}$ is potential output, λ is the price markup, $\boldsymbol{I}$ is business investment, $\boldsymbol{C}$ is private consumption, $\boldsymbol{W}$ is nominal wealth, $\boldsymbol{G}$ is government spending, $\boldsymbol{N^P}$ is potential employment, $\boldsymbol{K}$ is the capital stock, δ is the depreciation rate, $\boldsymbol{E[\pi]}$ is expected inflation, π^* is the target for inflation, and $\boldsymbol{E[Y-Y^P]}$ 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 asynchronized shocks (ε^{AS}), which increase the expected rate of return on U.S. assets. Net liquidity creation is a positive 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 negative function of the real wage and a positive function of output. It is also a negative function of ε^{AS} because a positive asynchronized 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 negotiation. Labor supply is a positive function of the real wage. It is also a positive function of ε^{AS} because a positive asynchronized 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

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.

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

downward pressure on the value of Foreign currency until it clears the FX market.

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 percent increase in E (i.e., a 1 percent 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 consumer price index 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 non-negative 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,

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6. This assumption makes sense since 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 (MC) 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.

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, Gali, and Gertler (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 above equations constitute an open-economy macroeconomic model in which prices in the credit market, the labor market, 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.

Section 3: The Asynchronization Hypothesis

The asynchronization hypothesis maintains that an asynchronized positive shock will result in a stronger and longer expansion than a synchronized positive shock will, because the former is associated with lower inflation than the latter, provoking slower and milder central bank intervention. Symmetrically, an asynchronized negative shock will result in a deeper and longer recession than a synchronized 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.

We illustrate the asynchronization hypothesis in the first subsection below by comparing the effects of positive synchronized and asynchronized shocks. The illustration is mainly to establish that an expansion spurred by a positive asynchronized shock is accompanied by lower inflation than the same strength of expansion spurred by a synchronized shock. We then conclude that the policy reaction of a forward-looking central bank in the case of an asynchronized shock will be slower and less aggressive, thereby allowing the expansion to last longer, than in the case of a synchronized shock. The second subsection below argues for the symmetric property of the hypothesis: a negative asynchronized shock will result in a longer recession than an equal-size negative synchronized shock will. All the illustrations assume that before the shock hits, the initial economic conditions of both countries are synchronized.[8]

8. This assumption is mainly for clarity of analysis. The assumption of synchronized initial conditions makes it easier to consider how an asynchronized shock spurs the capital- and trade-flow dynamics to interact with central bank reaction and the business cycle. In the appendix we will argue that the validity of the asynchronization hypothesis does not

The Impact of Positive Shocks

This subsection illustrates that in a policy-neutral environment, an asynchronized positive shock will be accompanied by lower inflation than will the same strength of expansion spurred by a synchronized 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 asynchronized and synchronized positive shocks. Our analysis will first be confined to a policy-neutral environment, bringing in the central bank reaction only in the conclusion.

The capital-flow effects

The cost-of-capital effect: When the U.S. experiences an asynchronized 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 synchronized 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 asynchronized shock expands aggregate demand more strongly than does a synchronized shock—as indicated by equation (6)—thereby

depend on the initial degree of synchronization between the two countries.

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 to 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 asynchronized shock will tend to be larger, but the inflation/output trade-off generated by a positive asynchronized shock is smaller than that generated by a synchronized shock.

The real-wage effect: Equation (2) indicates that both asynchronized and synchronized 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 synchronized. In response to an asynchronized 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 synchronized 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 asynchronized shock than to a synchronized 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 net-export effect: Everything else being equal, an asynchronized 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 synchronized 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 asynchronized shock increases Y/Y^*, whereas a synchronized shock leaves Y/Y^* unchanged. An asynchronized shock thus also hurts net exports more than a synchronized 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 synchronized shock.

The import-price effect: As the dollar appreciates in response to a positive asynchrozied shock, import prices will fall. A synchronized 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:

(9) $dp/dp^m = \alpha + \beta(dp^d/dp^m) + \beta(dp^d/du)\ (du/dp^m) + \beta(dp^d/d\lambda)\ (d\lambda/dp^m) > 0$

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, since 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 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). Since $\beta > 0$, $(dp^d/du) > 0$, $du/dp^m \geq 0$, $(dp^d/d\lambda) > 0$, and $d\lambda/dp^m > 0$,

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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 since consumption of final goods is considerably smaller than GDP, the imports/GDP ratio significantly underestimates α. The imports/GDP ratio was around 13 percent in 1997.

10. Campa and Goldberg (1997) find that U.S. manufacturing industries have steadily increased their use of imported inputs in production, on average from about 4 percent in 1975 to more than 8 percent in 1995.

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 asynchronized shock.

Combining capital-flow and trade-flow effects

Because net capital flows adjust more quickly to shocks than trade flows do, an asynchronized shock initially will have a stronger expansionary effect, but not necessarily a stronger inflationary effect, than a synchronized shock will. Over time, the stronger net-export drag from an asynchronized shock will kick in to dampen output growth, thereby prolonging the expansion at a more sustainable level. To illustrate, let us first analyze the impact of a positive *demand* shock on output and inflation using Figure 1 and then the impact of a positive *supply* shock using Figure 2. To simplify the analysis, we normalize the capital-flow and trade-flow effects discussed above to be zero in the case of a synchronized shock.

In Figure 1, suppose that aggregate demand and aggregate supply intersect at point O before a positive demand shock hits the economy. A synchronized demand shock moves the aggregate demand schedule upward, from D^0 to D^{S1}, and the new equilibrium point to S1. An asynchronized shock initially shifts aggregate demand upward by more than an equal-sized synchronized shock, because of the stimulative cost-of-capital effect, moving it from D^0 to D^{A1}. Meanwhile, however, an

11. Gamber and Hung (2001) estimate panel data regressions to ascertain the sign and the degree of the competing-goods effect. They find a significant and positive competing-goods effect.

Figure 1. Impacts of Asynchronized vs. Synchronized Demand Shocks

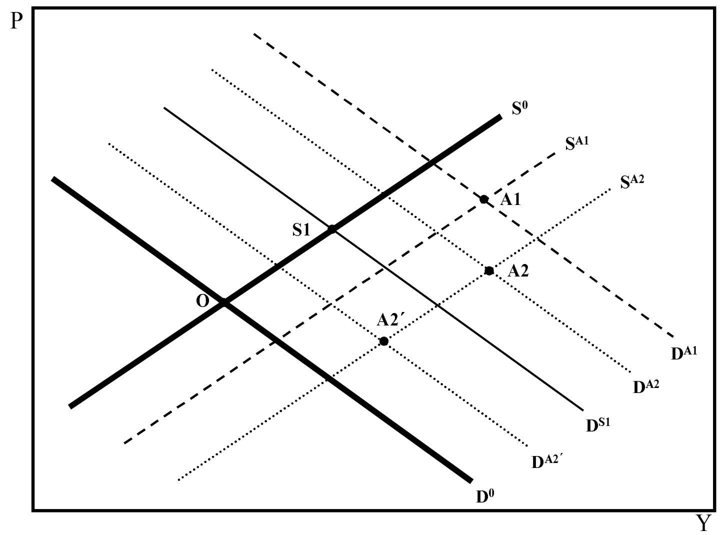
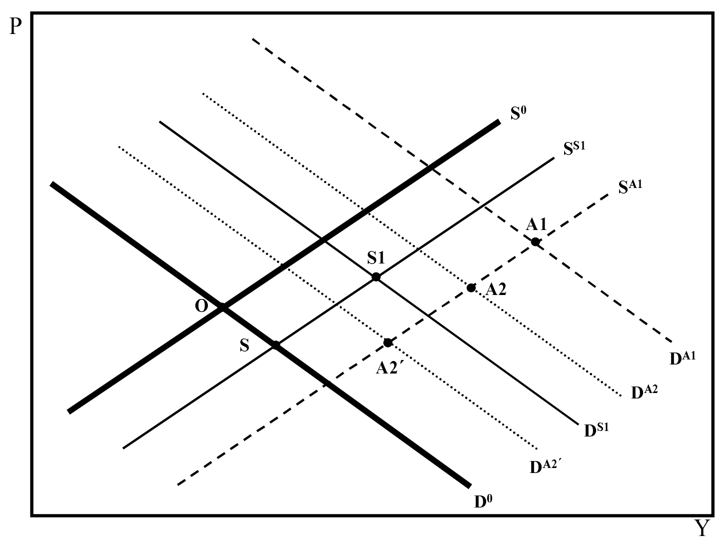


Figure 2. Impacts of Asynchronized vs. Synchronized Supply Shocks



asynchronized 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 asynchronized 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 asynchronization hypothesis remains intact: the inflation/output trade-off is smaller in response to an asynchronized shock than to a synchronized shock. That is clearly indicated by comparing either A2 or A2' (the new equilibrium point following an asynchronized shock) with S1 (the new equilibrium point following a synchronized 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 synchronized 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^{S1}, moving the new equilibrium to S1. Over time, a positive ΔY also increases domestic demand, shifting aggregate demand upward to D^{S1} and moving the new equilibrium to S1.

An asynchronized supply shock initially shifts aggregate supply downward by more than an equal-sized synchronized 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 asynchronization hypothesis remains intact: the inflation/output trade-off is smaller in response to an asynchronized shock than to a synchronized shock. A positive asynchronized supply shock results in lower inflationary pressure than does a synchronized shock, even if its expansionary effect may be higher initially.

Of course, the above 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 asynchronized shock is smaller than the one generated by a synchronized shock. It follows that even though the expansion caused by an asynchronized shock may tend to be greater initially than the one caused by a synchronized shock, a forward-looking central bank will be slower to tighten monetary conditions in the case of an asynchronized shock—thereby allowing the expansion to last longer—than in the case of a synchronized shock.

The Impact of Negative Shocks

In this subsection, we propose that a negative asynchronized shock will result in a longer recession than an equal-sized negative synchronized shock will. The reason is that a forward-looking central bank will take a negative synchronized 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 asynchronized shock will tend to have a greater contractionary impact than a synchronized shock because the former will result in a net capital outflow. Over time, however, a negative asynchronized 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 to end the recession. That reasoning suggests that a negative asynchronized shock will result in a shorter, though initially deeper, recession than a negative synchronized shock will; cumulatively, the contractionary effect of an asynchronized shock is smaller than that of a synchronized one.

Under our assumption about the central bank's reaction function, however, the relative scope 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 synchronized shock is expected to be graver than that of an asynchronized shock because a countervailing net-export boost will be generated only by an asynchronized shock, not by a synchronized one. The central bank will thus act more quickly and aggressively in countering the contractionary effects of a negative synchronized shock than of an asynchronized shock. The different policy responses of the central bank cause the contractionary impact of a negative asynchronized shock to be deeper and longer than that of a negative synchronized shock.

Section 4: Empirical Evidence from the SVAR

In this section we use the structural vector autoregression approach to estimate the effects of asynchronized and synchronized 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 asynchronized versus synchronized shocks in the ways assumed by the asynchronization 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 synchronized and asynchronized shocks. Sections 2 and 3 make clear that a positive (or negative) asynchronized shock would result in net capital inflows (or outflows) and a real dollar appreciation (or depreciation), whereas a synchronized shock would not. We thus define a positive asynchronized shock as one that has a contemporaneous and positive impact on the real dollar exchange rate, whereas a synchronized shock is one that does not. Those definitions enable us to distinguish asynchronized shocks from synchronized 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: synchronized real shocks, asynchronized real shocks, monetary policy shocks, and inflation shocks, as summarized by equation (10):

(10) $Y_t = A(L)\,\xi_t$

where $Y_t = [\Delta Y_t, ER_t, FF_t, \pi_t]'$, $\xi_t = [\varepsilon^S_t, \varepsilon^{AS}_{t,} \varepsilon^{FF}_t, \varepsilon^{\pi}_t]'$, $A_{ij}(L)$ 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,[12] FF is the level of the federal funds rate, π is the inflation rate, ε^S is the synchronized shock, ε^{AS} is the asynchronized shock, ε^{FF} is the monetary policy shock,[13] 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.

Our aim is to recover A(L), so that we can trace the impulse responses of elements in Y with respect to unit changes in elements in ξ. It is standard to recover A(L) by following the procedure below:

Step 1: Given that all four of the variables can be considered I(0) variables, we can estimate the following reduced-form vector autoregression:

(11) $Y_t = B(L)\,Y_{t-1} + U_t$

Step 2: Invert the autoregressive representation expressed in equation (11) to get a reduced-form vector moving average representation, where U_t's are composites of pure innovations ξ_t's:

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12. 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 synchronized shocks from asynchronized shocks.

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

(12) $Y_t = C(L)\ U_t$

Step 3: Invoke the mathematical relationship between U_t and ξ_t:

(13) $U_t = A(0)\ \xi_t$

Step 4: Substitute equation (13) into (12) to get:

(14) $Y_t = C(L)\ A(0)\ \xi_t$

Step 5: Substitute equation (10) into (14) to obtain the relationship between A(L) and C(L):

(15) $A(L) = C(L)\ A(0)$

Step 6: Solve for A(0) by using theoretical restrictions and the relationship between the variance/covariance matrix of ξ and U dictated by equation (13):

(16) $A(0)A(0)'\ Var(\xi) = Var(U)$

Since we already solve for C(L) in step 2, equation (15) suggests that all that is left to uncover A(L) is to solve for A(0), which has 16 elements. We thus need 16 restrictions to solve for A(0). Equation (16) gives rise to 10 restrictions toward our goal of solving A(0) because, although Var(U) is generally not a diagonal matrix, the standard assumptions about structural shocks mean that Var(ξ) can be normalized to be the identity matrix. We thus need to impose six structural restrictions to uncover A(L). In the context of this paper, it is appropriate to make the following six identifying restrictions:

- A synchronized shock has no contemporaneous impact on the real exchange rate, i.e., $A_{21}(0) = 0$. That restriction arises naturally from the definition and implication of synchronized versus asynchronized shocks.
- Monetary policy has no long-run impact on output, i.e., $\sum_{L=0}^{\infty} A_{13}(L) = 0$. That

restriction assumes that 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 restriction assumes that purchasing power parity (PPP) holds in the long run, but it allows monetary policy shocks to move the real exchange rate away from PPP in the short run.

- Inflation has no long-run impact on output, i.e., $\sum_{L=0}^{\infty} A_{14}(L) = 0$. That restriction assumes that the natural rate hypothesis holds in the long run.

- Inflation has no long-run impact on the mean of the real exchange rate, i.e., $\sum_{L=0}^{\infty} A_{24}(L) = 0$. That restriction assumes that PPP holds in the long run, but it allows inflation shocks to move the real exchange rate away from PPP in the short run.

- Monetary policy has no contemporaneous impact on the inflation rate, i.e., $A_{43}(0) = 0$. That restriction assumes that 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 X denotes no restrictions, 0_{LR} denotes a long-run restriction, and 0 denotes a contemporaneous restriction.

SVAR Results

We employed the SVAR method described above 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 1999:4, constituting 104 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 1-standard error bands computed from 1,000 bootstrap simulations.[14] Results of variance decompositions are shown in Table 1.

Impulse responses

In general, the impulse responses are consistent with the asynchronization hypothesis. Figure 3 shows that the output level responds more strongly to an asynchronized shock than to a synchronized shock. According to the hypothesis, that occurs because a synchronized shock produces greater inflationary pressures and

14. The standard error bands are not symetrical because they are calculated relative to the mean of the impulse responses from 1000 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)

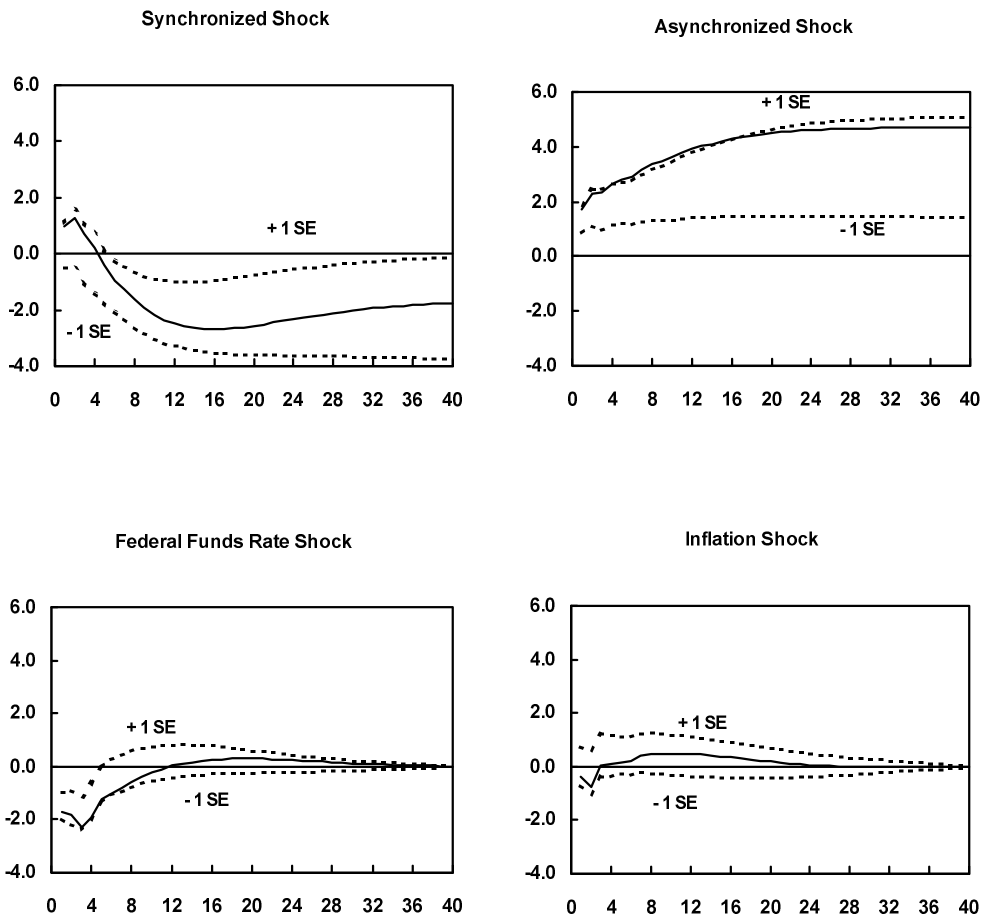


Figure 4. Impulse Responses of the Inflation Rate to Four Types of Shocks
(Over a 40-Quarter Forecast Horizon)

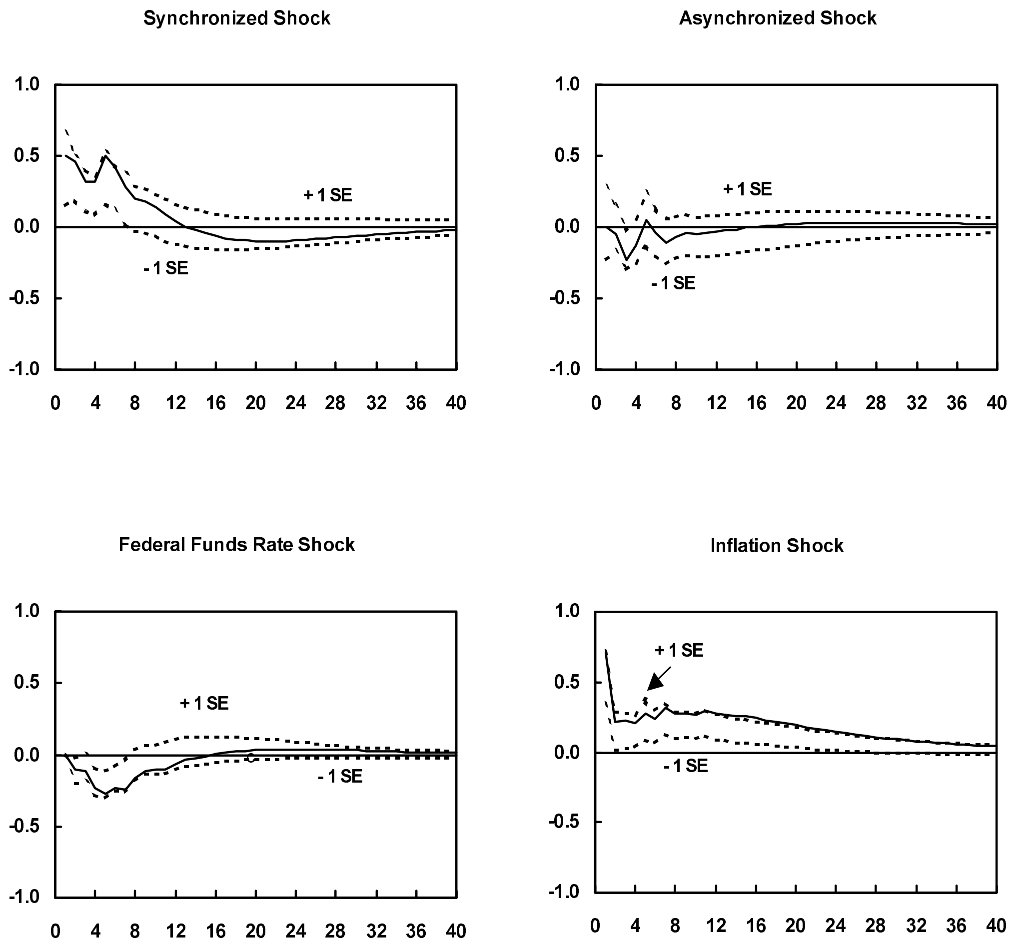


Figure 5. Impulse Responses of the Federal Funds Rate to Four Types of Shocks (Over a 40-Quarter Forecast Horizon)

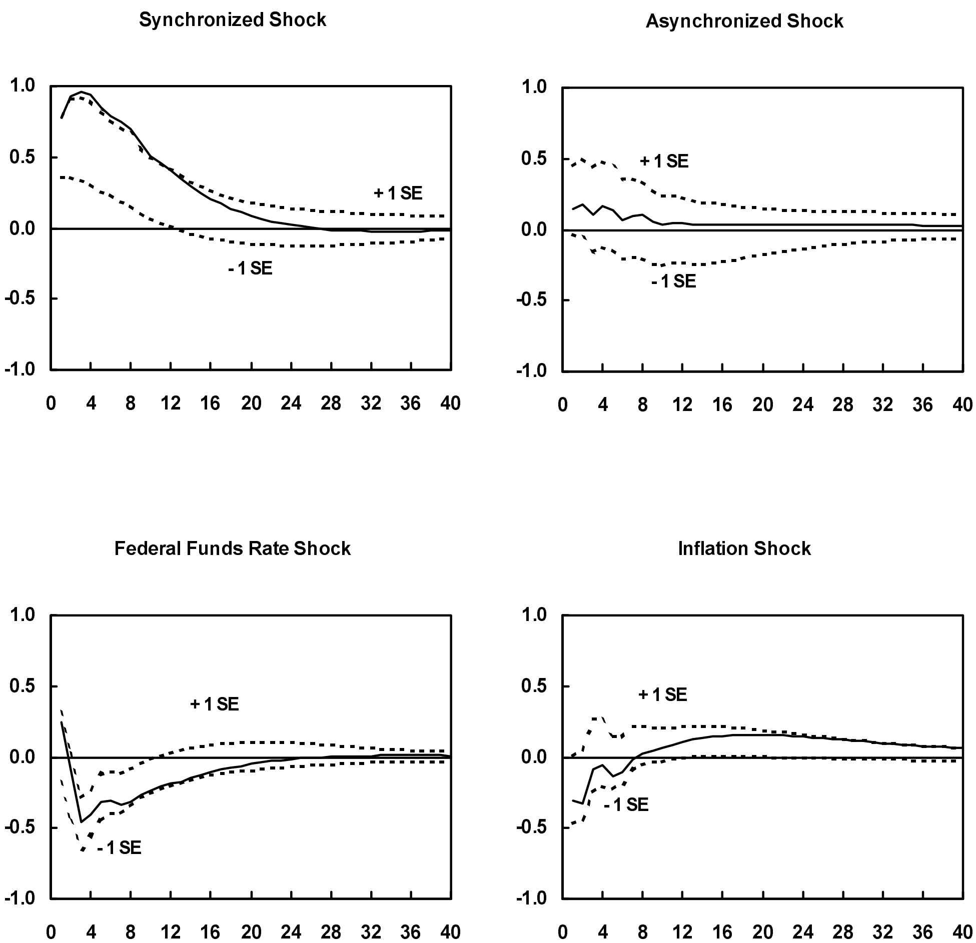
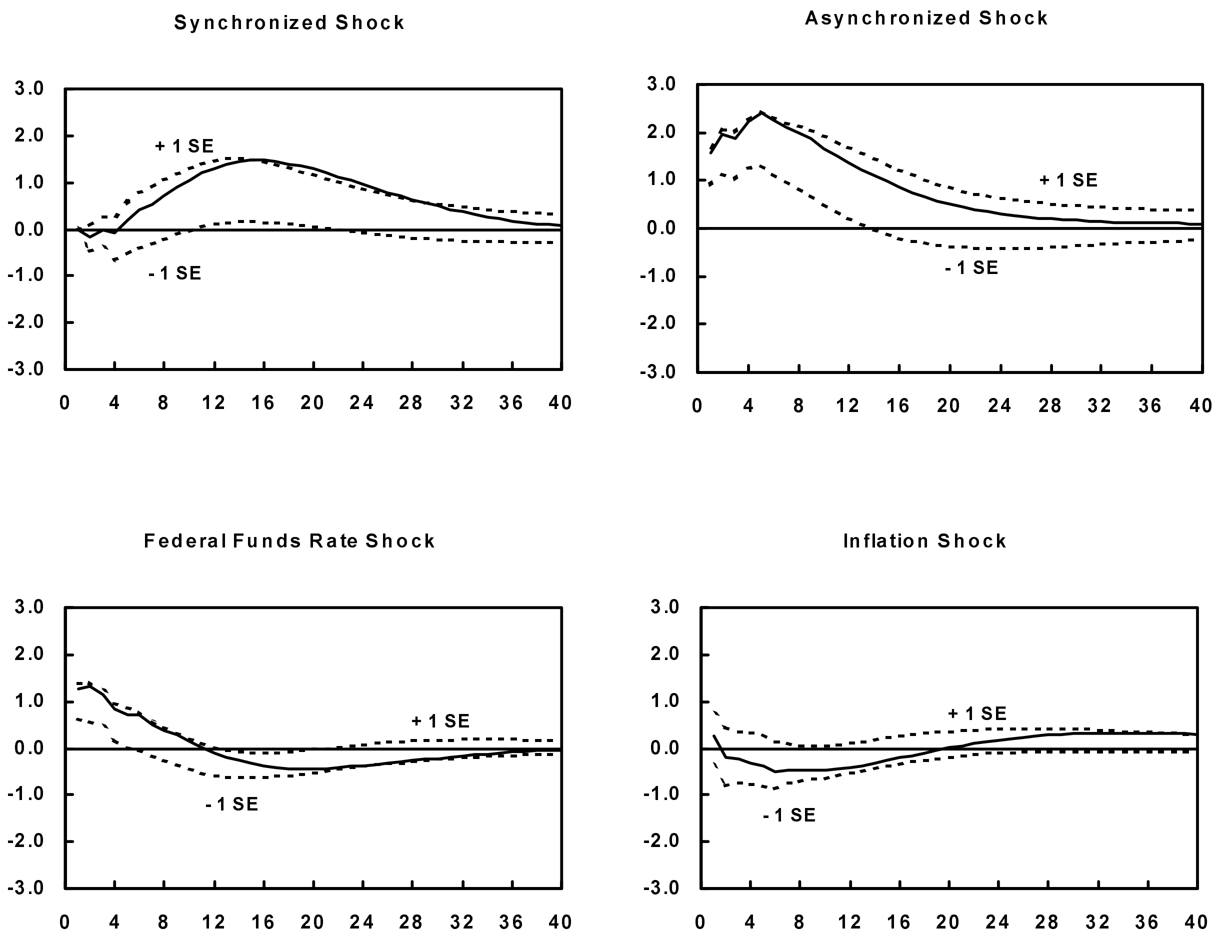


Figure 6. Impulse Responses of the Real Exchange Rate to Four Types of Shocks
(Over a 40-Quarter Forecast Horizon)



therefore a greater monetary tightening than an asynchronized shock does. The fact that output declines in response to a synchronized shock after quarter 4 is consistent 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 synchronized shock than to an asynchronized shock; Figure 5 shows that the federal funds rate also responds more strongly to a synchronized shock than to an asynchronized shock.

The impulse responses of the real exchange rate are shown in Figure 6. The effect of a synchronized 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 patten 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 synchronized shocks by more than its foreign counterparts. An asynchronized 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 U.S. 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. Figure 4 shows that 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 synchronized and asynchronized 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. Asynchronized shocks lead to lower inflation, a smaller monetary tightening, and therefore a greater and more sustained output response than synchronized 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. The associated standard errors are also reported in Table 1. Overall, the standard errors indicate that the confidence intervals surrounding the point estimates are not unreasonably wide.

In general, the variance decomposition results are consistent with the

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

Percentage of Var(output) Due to:

	Synchronized shock			Asynchronized shock			Federal funds rate shock			Inflation shock		
Horizon	-1SE	point estimate	+1SE	-1SE	point estimate	+1SE	-1SE	point estimate	+1SE	-1SE	point estimate	+1SE
1	0.00	13.42	29.82	16.00	43.34	56.16	19.41	41.28	64.37	0.00	1.96	21.26
2	0.00	14.83	31.61	18.53	46.30	60.06	15.63	34.98	59.08	0.00	3.89	20.79
3	0.00	10.90	29.10	18.75	47.34	58.99	17.68	39.38	58.88	0.00	2.38	20.18
4	0.00	8.08	28.54	21.25	52.14	61.47	15.82	38.03	54.97	0.00	1.75	19.83
8	7.62	9.78	37.08	28.69	67.33	67.10	8.17	21.57	33.45	0.00	1.32	18.03
12	12.64	17.62	46.32	29.36	69.51	69.85	5.07	11.60	21.33	0.00	1.27	15.91
40	11.60	19.05	60.59	32.22	78.38	84.09	0.98	2.24	5.54	0.00	0.34	5.42

Percentage of Var(Inflation Rate) Due to:

	Synchronized shock			Asynchronized shock			Federal funds rate shock			Inflation shock		
Horizon	-1SE	point estimate	+1SE	-1SE	point estimate	+1SE	-1SE	point estimate	+1SE	-1SE	point estimate	+1SE
1	10.37	33.26	64.97	0.00	0.00	23.54	0.00	0.00	0.00	25.45	66.74	78.27
2	17.87	45.25	68.49	0.00	0.22	23.45	0.00	1.03	5.29	19.80	53.50	66.96
3	18.32	45.48	67.60	1.00	4.34	25.97	0.66	1.94	7.33	17.75	48.24	61.38
4	18.34	45.62	65.60	1.58	4.88	26.47	2.46	5.57	11.65	16.62	43.93	57.28
8	18.40	47.52	62.43	1.77	3.71	27.29	4.80	11.42	17.05	15.52	37.34	52.75
12	17.55	42.75	57.75	2.49	3.41	29.03	5.02	11.08	16.85	18.36	42.76	52.95
40	18.76	36.73	51.53	5.73	3.16	31.95	4.78	9.22	17.80	19.93	50.89	49.51

Percentage of Var(Federal Funds Rate) Due to:

	Synchronized shock			Asynchronized shock			Federal funds rate shock			Inflation shock		
Horizon	-1SE	point estimate	+1SE	-1SE	point estimate	+1SE	-1SE	point estimate	+1SE	-1SE	point estimate	+1SE
1	30.33	77.55	81.98	0.00	2.75	31.29	0.00	7.98	25.29	0.24	11.73	36.50
2	30.71	82.28	82.58	0.00	2.83	31.90	0.00	3.89	25.75	0.13	11.00	31.73
3	30.34	81.31	78.00	0.00	2.14	29.08	6.14	9.58	32.62	0.91	6.98	24.49
4	30.02	81.36	77.32	0.00	2.25	29.62	7.29	11.18	34.52	0.77	5.21	21.81
8	30.12	82.20	77.16	0.00	1.91	32.01	7.46	12.43	34.40	0.88	3.46	18.44
12	29.65	81.92	75.52	1.02	1.73	33.56	7.80	13.10	32.54	1.71	3.26	18.20
40	27.07	77.58	70.38	4.17	1.89	36.33	7.36	12.82	30.35	3.32	7.71	21.02

Percentage of Var(Exchange Rate) Due to:

	Synchronized shock			Asynchronized shock			Federal funds rate shock			Inflation shock		
Horizon	-1SE	point estimate	+1SE	-1SE	point estimate	+1SE	-1SE	point estimate	+1SE	-1SE	point estimate	+1SE
1	0.00	0.00	0.00	32.33	59.91	77.23	13.34	38.49	57.47	0.00	1.61	23.29
2	0.00	0.29	3.35	37.03	64.57	78.47	10.68	34.00	51.37	0.00	1.13	21.39
3	0.00	0.20	4.66	39.66	67.02	79.89	9.31	31.68	47.72	0.00	1.11	20.67
4	0.00	0.18	6.98	44.15	72.26	82.43	6.90	26.24	41.30	0.00	1.32	19.91
8	0.00	2.42	15.36	50.71	79.24	86.74	3.72	15.78	26.82	0.00	2.55	17.86
12	0.10	10.33	25.91	47.51	74.87	85.54	3.73	11.59	20.71	0.50	3.22	15.99
40	4.26	31.79	39.60	37.54	54.39	79.01	3.49	9.77	19.07	0.88	4.05	16.16

NOTE: The SE (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.

asynchronization hypothesis. In particular, three patterns stand out in echoing the hypothesis. First, asynchronized shocks dominate other shocks in moving output and the real exchange rate. Second, synchronized shocks dwarf asynchronized shocks in explaining the variation in the federal funds rate. Third, synchronized shocks are significantly more important than asynchronized shocks in driving the inflation rate. The fact that all three of those patterns remain unchanged throughout the forecast horizon is all the more reassuring that these results are robust.

Section 5: Supplemental Evidence

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

The Validity of the Basic Premises

It is clear from section 3 that the asynchronization 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.

<u>The open-economy premise</u>

Is it valid to assume that the U.S. is sufficiently globalized? Protectionists in general certainly believe the U.S. has already become *too* globalized. There is much less consensus among economists, however. Although most economists would agree that the U.S. has become more globalized over the past few decades, they disagree about whether the U.S. is sufficiently globalized in the sense that foreign economic conditions significantly influence U.S. economic conditions. The Federal Reserve's response to the aftermath of the Asian crisis―lowering interest rates three times in less than two months by a total of 75 basis points despite a robust domestic economy―suggests that the Fed believes the U.S. cannot be an island of prosperity while tempest engulfs the sea around it. Some economists, however, maintain that the U.S. economy is still "effectively insulated" from foreign competition since imports and exports each represent only slightly more than 10 percent of U.S. gross domestic product (GDP).[15] Who is right?

It is our view that the acceptance of some economists' arguments that significant trade barriers―such as transaction costs and tariffs―still exist does not necessarily imply that those trade barriers would effectively insulate the U.S. economy from the influence of capital and trade flows. As long as sufficient linkages exist between the U.S. and foreign economies to allow those capital and trade flows to adjust in response to shocks to the U.S. or aborad, the impacts of an economic shock to the U.S. will probably be significantly complicated by those flows.

Is there sufficient linkage between the U.S. and foreign economies? It is true that despite the sharp rise in imports and exports in recent years, the imports/GDP ratio still stood at less than 14 percent by the end of 1999 and the exports/GDP ratio at less than 11 percent. However, 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

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15. For example, see Paul Krugman (1994, 1995)

import competition. In 1970, over 84 percent of 431 manufacturing industries (at the 4-digit SIC level) were faced with import penetration less than or equal to 10 percent, and only 7 percent were faced with import penetration greater than 20 percent. By 1996, the share of industries faced with import penetration less than or equal to 10 percent had halved to 42 percent, while those faced with import penetration greater than 20 percent had sextupled to 42 percent (see Table 2).[16] 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 4, 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.

In addition to broader and deeper exposures to trade with foreign countries, the U.S. 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 percent of GDP ($80 billion) per year during the 1980s, surged to nearly 6 percent of GDP ($500 billion) by 1997.

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16. 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 2. The Share of Industries Faced with Import Competition over Time (Percentage of industries within each range of import penetration in roughly 400 4-digit SIC industries)

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

NOTES: $IP_i = M_i/(S_i - X_i + M_i)$, where M_i is imports, S_i is shipments, X_i is exports, in industry i.

Import and export data for 1958, 1970, and 1980 are from Robert C. 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 $IP \le 10$ percent in 1990 is 46 percent based on revised data and 44 percent based on unrevised data; in 1994, it is 43 percent based on revised data and 40 percent based on unrevised data.

The surge in private-capital inflows is even more pronounced. After averaging roughly 3 percent of GDP ($140 billion) per year during the 1980s, private-capital inflows increased to over 9 percent 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.

A final and probably more conclusive piece of evidence that the U.S. 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. The authors conclude that although the traditional Phillips curve has been overpredicting inflation since 1995, an alternative Phillips curve that includes foreign capacity utilization as an explanatory variable has been able to substantially reduce the "missing inflation"—the gap between predicted and actual 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, Gali, and Gertler (2000) and Mehra (1999), howev+er, 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 equation (8). They find that the point estimate of ϕ is 2.15, significantly above unity during the 1979-1996 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 papers 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

This subsection presents stylized facts that lend broad support to the asynchronization hypothesis.

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 synchronized with foreign expansions than the expansion of the 1990s. The earlier expansion thus was accompanied by a stronger buildup 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 percent.[17] The target federal funds rate rose by a total of 330 basis points to 9.81 percent by May 1989, when the

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

tightening ended. The expansion subsequently ended in July 1990.[18] In comparison, the expansion of the 1990s, which began in April 1991, was more asynchronized and, not by coincidence, was associated with less inflationary buildup.[19] 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, since inflation was only slightly above 2 percent at the time.[20] The course of tightening was reversed on January 3, 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 asynchronized expansion of the 1990s than in the (relatively) synchronized expansion of the 1980s.

Considering the pattern of U.S. expansions from a longer and broader perspective

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18. 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 August 2, 1990.

19. In 1992, Japan entered the slump that it is still struggling to recover from. 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 asynchronization of economic conditions between the U.S. and the rest of the world. The influence of slow foreign growth on the current U.S. expansion is discussed in Congressional Budget Office, *The Economic and Budget Outlook: Fiscal Years 2000-2009* (January 1999).

20. 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.

offers further support to the hypothesis. According to the National Bureau of Economic Research, five expansions have occurred in the U.S. since 1962. Table 3 presents the GDP gap in the U.S. and 10 major foreign countries during those five expansions. (The GDP gap is defined as the percentage deviation of actual GDP from potential GDP.) Table 3 shows that of the five U.S. expansions since 1962, the three longest (1962-1969, 1983-1989, and 1992-1999) were accompanied by negative GDP gaps in foreign countries, whereas the two shortest expansions (1971-1973, 1976-1979) were accompanied by positive foreign GDP gaps. The average foreign GDP gap was -0.63 percent during the three longest expansions and 0.70 percent during the two shortest expansions.

To be sure, Table 3 has an obvious shortcoming: data on GDP gaps during the 1962-1969 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 2.8 percent—during the three longest U.S. expansions and higher—averaging 7.1 percent—during the two shortest expansions.

Even if we discard the data from the 1962-1969 period, the broad-stroke picture presented by Tables 3 and 4 is still consistent with the asynchronization 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, asynchronized expansions will tend to last longer than those synchronized with foreign expansions. Admittedly, our sample is small, and the table cannot pass

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

	1962-69	1971-73	1976-79	1983-89	1992-99
United States	1.07[a]	0.19	1.66	-0.18	0.20
Australia		1.72	-0.03	-0.02	-0.10
Belgium		1.74	0.56	-0.93	-1.57
Canada		0.31	1.75	0.48	-1.90
France		1.97	0.69	-1.52	-1.62
Germany	-0.36[a]	1.57	1.41	-1.32	-0.79
Italy	-1.12[a]	-0.56	0.26	-0.59	-1.94
Japan		1.21	-0.81	-1.26	-1.07
Netherlands		0.15	1.62	-0.62	0.32
Switzerland			-2.96	0.61	-2.19
United Kingdom		0.86	0.41	1.21	-0.40
Rest of World (Import-weighted)	-0.10	0.70	0.69	-0.49	-1.31

SOURCE: Main economic indicators by the OECD.

NOTES: U.S. expansions are based on NBER breakdown.
GDP gap = [(Actual GDP-Potential GDP)/Potential GDP]*100.

a. Data start in 1963.

Table 4. U.S. and Foreign CPI Inflation Rates During U.S. Expansions (Percent)

	1962-69	1971-73	1976-79	1983-89	1992-99
United States	2.4	4.5	7.1	3.8	2.6
Australia	2.3	7.1	10.7	7.6	1.8
Belgium	3.1	5.6	6.3	3.7	1.9
Canada	2.9	5.1	8.4	4.5	1.5
France	4.0	6.3	9.8	5.0	1.6
Germany	2.5	5.9	3.7	1.7	2.4
Italy	4.1	7.1	15.2	8.1	3.6
Japan	5.5	7.6	6.4	1.4	0.7
Netherlands	4.5	7.8	5.9	1.4	2.4
Switzerland	3.5	7.3	1.9	2.4	1.5
United Kingdom	3.9	8.6	13.5	5.1	2.7
Rest of World (Import-weighted)	3.6	6.3	7.9	3.3	1.5

SOURCE: Main economic indicators by the OECD.

as a formal test. Nevertheless, as stylized facts they are broadly consistent with the asynchronization hypothesis.

Section 6: Conclusions

This paper argues the theoretical validity, and investigates the empirical evidence, of the asynchronization 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 synchronized shocks that occur not only in the home country but also abroad. We estimate a four-variable structural vector autoregression 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, synchronized shocks could have deeper and longer effects on the business cycle in the home country than asynchronized 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 Asynchronized Initial Conditions

The analyses in section 3 are based on the assumption that conditions in the U.S. and Foreign economies are synchronized when a shock hits. Consequently, an asynchronized shock will result in asynchronized 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 synchronized shock. This appendix proposes that the predicted impact of an asynchronized shock on the business cycle compared with the impact of a synchronized shock will continue to hold even if we relax the assumption that existing U.S. and Foreign economic conditions are synchronized.

Assume that a *positive* asynchronized shock hits the U.S. 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 asynchronized shock would still be larger and longer relative to those spurred by a synchronized shock. The reason is that the asynchronized positive shock would simply *increase* the degree of asynchronization between U.S. and Foreign conditions but not affect the working of capital- and trade-flow channels that causes the asynchronized shock to have a stronger and longer expansionary effect than a synchronized shock.

What if the situation is in reverse and the positive asynchronized shock hits when the U.S. 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. Since the positive asynchronized shock would boost

U.S. but not Foreign growth, it would reduce net capital outflows from the U.S. 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 positive synchronized shock would boost both U.S. and Foreign growth and do less to reduce net capital outflows from the U.S. Thus, the expansionary effect of an asynchronized shock would still be stronger initially and more sustainable over time than that of a synchronized shock.

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

Of course, it is the asynchronization or synchronization 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 asynchronization of shocks, by either reinforcing or offsetting the existing asynchronized conditions, would simply either add to or subtract from the effect of initial asynchronization on the business cycle. Since the relative impact on inflation and the business cycle of asynchronized versus synchronized shocks does not depend on the initial conditions, however, such a realization does not invalidate the asynchronization hypothesis.

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