

Aggregate Shocks and the Relationship between U.S. Business Cycle Fluctuations and Export Performance

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Abstract

In contrast to the preceding literature, we study the relationship between domestic economic activity and export performance within the framework of vector autoregressive representations of the U.S. macroeconomy that explicitly recognize the potential importance of the type of shocks that initiate co-movements between aggregate activity and export volume. Our results verify that the relationship between aggregate activity and export volume depends upon the type of shock. If the initiating shock is an increase in the relative price of oil or a monetary shock (either contractionary or expansionary), the resulting correlation between export performance and domestic activity is positive. On the

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other hand, if the initiating shock is a change in government purchases, the correlation is negative. These results are fully consistent with a broad interpretation of the capacity pressure hypothesis that allows for the possibility that monetary and other shocks have important effects on the costs of committing resources to the export sector. Our results also suggest that far from being anomalous, the procyclical capacity pressure effect reported in earlier studies is fully consistent with the capacity pressure hypothesis in that it merely reflects the importance of oil price and monetary shocks during the sample periods considered in those studies. (JEL Classification: E32, F10)

I. Introduction

While a growing literature emphasizes the importance of export led growth, in recent years relatively little attention has been paid to the cyclical short-run behavior of exports. In light of the many advances in the empirical study of business cycle phenomena and the wide array of important policy issues that empirical examination of the relationship between fluctuations in aggregate economic activity and exports is likely to clarify, this relative neglect is surprising. Consider the following questions. Do U.S. exports rise during economic downturns and thereby attenuate recessions as was frequently asserted during the last recession? Does the answer to the foregoing question depend upon the type of shock that initiates the slowdown in economic activity? Given that policy makers frequently respond to falling output and employment with expansionary demand side policies, do these positive demand shocks encourage export performance? Some authors (see Brock [1991]) argue that export instability may have adverse effects on savings and investment, and thereby, have long-run consequences. Is export instability exacerbated under a policy regime in which policy makers respond to falling output with expansionary fiscal and/or monetary policies irrespective of the type of shock that initiated the slowdown? Our search of the literature yielded little recent evidence on these empirical questions.

Given the paucity of evidence on the relationship between cyclical fluctuations in output and export performance, the purpose of this paper is to present empirical evidence on the short-run relationship between export performance and domestic economic activity in the United States. In contrast to

previous empirical work on this issue, we employ vector autoregressive (VAR) models of the macroeconomy that emphasize the simultaneous determination and interdependence of aggregate activity and exports.

As illustrated in studies by Mintz [1961, 1967], Ball [1961], and others, the focal point for much of the earlier empirical research on the effects of domestic economic activity on export volume is the capacity pressure hypothesis (CPH). This hypothesis asserts that a *ceteris paribus* decrease in domestic economic activity leads to a decrease in domestic sales that reduces pressure on productive capacity and increases export volume by allowing for relatively low cost recommitment of excess capacity to the foreign market. Given the hypothesized inverse relationship between capacity pressure and export volume, tests of the CPH have typically focused on the empirical relation between some measure or proxy for capacity pressure and export volume. Since deviation-from-trend output is frequently used as a proxy for capacity pressure, the results of these tests are also considered to be informative about the relation between business cycle movements and exports.

Using single equation methods and British data, Ball, Eaton, and Steuer [1966], Artus [1970, 1973], and Winters [1974] report an inverse relationship between capacity pressure and export performance. However, their results require careful scrutiny since the empirical models they employed did not adequately account for the simultaneous nature of the relationship between export volume and relevant prices.

In recognition of these difficulties, Dunlevy [1980] employed a simultaneous equations, supply-demand framework of the export market to test the CPH for the United States and the United Kingdom. With capacity pressure viewed as an export supply phenomenon and measured as deviation-from-trend output, Dunlevy found that export supply moved, *ceteris paribus*, in a procyclical fashion. In response to this provocative result, Haynes and Stone [1983] argued that regression estimates based on a trend, deviation-from-trend decomposition of income are subject to bias if the response of export flows to income differs over cycles of varying lengths. Consequently, they used spectral analysis to directly isolate secular and business cycle components. However, like Dunlevy, they found a positive relationship between the domestic business cycle and export supply. In a recent examination of the importance of excess capacity as a determinant of export performance

in developing countries, Faini [1994] challenged the profession to provide both "theoretical and statistical explanation" (p 83 footnote 2) of the seemingly anomalous finding that capacity utilization has positive effects on exports.¹

Our review of the literature in this area lead us to the conclusion that it is dominated by the presumption that the shocks which typically buffet the macroeconomy affect domestic output and capacity pressure by changing aggregate demand. This presumption is well illustrated by the typical choice of proxies for capacity pressure. Dunlevy and Haynes and Stone, for instance, use transformations of domestic economic activity as proxies for capacity pressure. However, the efficacy of these transformations of industrial production and real GNP as proxies for capacity pressure depends upon the nature of the innovations that initiate business cycle fluctuations. If aggregate demand innovations are the primary source of business cycle fluctuations, variation in domestic economic activity will be consistently and positively related to capacity pressure and measures based on deviation-from-trend industrial production or real GNP will be effective proxies for capacity pressure. Under this scenario, evidence in support of the CPH may be interpreted as supportive of the view that there is an inverse relationship between domestic activity and export volume. However, if business cycle fluctuations are typically initiated by both aggregate demand and aggregate supply innovations, the direction of the relationship between capacity pressure and changes in domestic activity will not be consistently positive. In particular, unlike an increase in domestic activity due to a positive demand shock, a *ceteris paribus* favorable supply shock increases output but decreases the pressure on capacity. Consequently, if both demand and supply shocks are important explanators of business cycle fluctuations, measures of domestic activity such as deviation-from-trend industrial production or real GNP will fail to accurately and consistently reflect changes in capacity pressure.

The preceding arguments suggest that a "theoretical and statistical expla-

1. More recent applications of the capacity pressure hypothesis include Cushman [1987], Culem [1987], Das Gupta [1989] and Uhm and Koo [1990]. These studies illustrate the continued relevance of the issues addressed in this study. However, the applications are rather mechanical and do not contribute much to the particular issues analyzed in this paper.

nation" for the seemingly anomalous finding that capacity pressure has positive effects on exports is likely to be uncovered by closer examination of the nature of the shocks that initiate business cycle fluctuations and that generate correlations between exports and domestic activity. In pursuit of this explanation it is important to consider the conditions under which a given shock will generate the traditionally expected negative relationship between capacity utilization and exports. Under the capacity pressure hypothesis, in order for a shock to generate a negative relationship or correlation between domestic activity and the volume of exports, the shock must first alter the level of excess capacity. Second, given the change in the pressure on capacity, the volume of exports would move in the opposite direction if firms are able to recommit resources to the foreign market at relatively low costs. For example, an increase in the federal funds rate (*i.e.* a monetary tightening) is typically thought to affect domestic economic activity by reducing aggregate demand which leads to an increase in excess capacity. As a result, export volume increases as firms recommit resources to the export sector. However, if the increase in the federal funds rate also increases the costs of maintaining initial levels of exports and of recommitting resources to the foreign market, the increase in excess capacity could actually be associated with a decline in the volume of exports. More generally, a given shock will lead to the presumed negative relationship between exports and capacity utilization or domestic output if it affects capacity utilization through its effect on aggregate demand and if it does not have material adverse effects on the costs of recommitting resources to the foreign market.

This paper addresses the issues raised above by evaluating the relationship between the domestic business cycle and export volume within vector autoregressive representations of the U.S. macroeconomy. All variables are treated as jointly determined in order to capture the simultaneous nature of the relationship within the context in which it arises. In contrast to the preceding literature, our model recognizes the potential importance of both policy and nonpolicy shocks.² In particular, we consider innovations in govern-

2. With the exception of Haynes and Stone's spectral analysis, the empirical models employed in the studies cited above refrain from explicitly identifying the lag structure among the variables so that their results do not adequately capture the dynamic aspects of the relationship. In addition, they treat capacity pressure (or proxies for it)

ment purchases and in monetary policy – that are traditionally viewed as having their primary impact on aggregate demand – and changes in the relative price of oil that are frequently associated with aggregate supply.³ Our examination of the responses of domestic activity and export volume to these shocks indicates that, on average, increases in the relative price of oil and monetary policy innovations generate a positive relationship between U.S. exports and U.S. industrial production while changes in government purchases generate a negative relation. To the extent that monetary and oil price shocks were the principal initiators of business cycle fluctuations during the sample period considered in the Dunlevy and Haynes – Stone studies, our results suggest that the positive relationship they uncovered reflects the type of shocks that buffeted the economy during their sample period.

Our model also permits an evaluation of the impact of other variables on U.S. export performance. Virtually all commentators believe that foreign economic activity is a key determinant of foreign demand, and is therefore a primary explanator of U.S. export volume. (see Mintz [1961], p. 15 and Mintz [1967] *passim*). Similarly, many analysts believe that U.S. exports are inversely related to the price of U.S. exports and positively correlated with the level of foreign prices. While these relationships are not the focus of this study, it is instructive to note that the empirical regularities uncovered in this paper are consistent with these views.

The empirical models we employed are described in section II. Section III is devoted to a discussion of the empirical results and our conclusions are summarized in section IV.

II. Model Specification and Data

As indicated above, our primary purpose is to uncover and interpret empirical regularities between variation in domestic economic activity and

as exogenously determined and thereby ignore the possibility of feedback from exports to capacity pressure.

3. However, there is some debate about the exact mechanism(s) via which changes in the price of oil affect the macroeconomy. See Hamilton [1996b] for an examination of the possibility that changes in the price of oil affect the macroeconomy via both aggregate demand and supply.

the flow of U.S. exports. In pursuit of this objective, we specify and estimate a vector autoregressive (VAR) model using quarterly data from 1959:ii to 1987:iv.⁴ The VAR model treats all variables as jointly determined and is therefore consistent with Goldstein and Kahn ([1985], p. 1072) who note that

“simultaneity is not a problem that can be dealt with by assumption, particularly in relation to exports.”

and advocate use of vector autoregressive techniques to study the relations under consideration in this paper.

A. The Basic VAR Model

Let Z_t represent an $n \times 1$ vector of variables that adequately capture the macroeconomic context within which any relationship between aggregate economic activity and the volume of exports arises. Z_t is assumed to evolve according to the following vector autoregressive process.

$$Z_t = A_0 + A_1 Z_{t-1} + A_2 Z_{t-2} + A_3 Z_{t-3} + \dots + A_k Z_{t-k} + u_t, \quad (1)$$

in which the A_i 's for $i = 0, 1, 2, \dots, k$ are coefficient matrices and u_t is an $n \times 1$ vector of serially uncorrelated disturbances. Contemporaneous values of the variables in Z_t do not appear on the right hand side of (1); therefore, any contemporaneous correlation among the model's variables is reflected in the VAR residuals (*i.e.* u_t). Since this makes it difficult to attach economic interpretation to the effects of impulses to the elements of u_t on the model's variables, it is imperative that we work with orthogonalized innovations.

Under the assumption that the economy is driven by an $n \times 1$ vector of serially uncorrelated fundamental shocks (ε_t) with covariance matrix equal to the identity matrix, there is a matrix C that is a unique $n \times n$ lower triangular decomposition of the covariance matrix of u_t such that

4. Following 1987, the manner in which U.S. export prices were measured changed in at least two respects. First, in January 1989, the U.S. adopted the Harmonized System as the basis for reporting international trade data. This was followed in August 1989 by the introduction of a price index to replace the previously reported unit value series. Given these changes, we deemed it appropriate to truncate our sample in 1987 since data since 1988 might reflect difficulties associated with the transition to a new reporting system.

$$CC' = E[u_t u_t']. \quad (2)$$

Moreover, u_t may be specified as a linear function of the fundamental shocks, as follows:

$$u_t = C\varepsilon_t. \quad (3)$$

In general, estimates of the A_i 's are obtained by using ordinary least squares to estimate (1) equation by equation. Since C is uniquely determined by the relationship summarized in (2), (3) can be used to derive the economically meaningful fundamental shocks (ε_t). Consequently, (1) and (3) may be used to calculate the impulse responses of any variable in Z_t to a unit impulse in any of the elements in ε_t .

It is well known that the decomposition described above imposes a recursive structure on the contemporaneous relations among the model's variables. For example, placing our monetary policy indicator sixth in the ordering for the decomposition, imposes the restriction that impulses to the five variables that precede it, elicit contemporaneous or within-quarter effects from monetary policy but that monetary policy impulses have no within-quarter effects on these variables. As a consequence, the manner in which the elements of u_t are ordered for the decomposition is of substantial import.

The analysis that follows is based on two ten-variable VAR models. Four standard international trade variables are included in both models. These are; the volume of U.S. exports (*USEX*), a measure of world economic activity (*WEA*), a measure of the price of world exports (*PWEX*), and a measure of the price of U.S. exports (*PUEX*). To capture the state of the macroeconomy, U.S. economic activity as measured by the index of industrial production (*USIP*) and the producer price index for U.S. manufactured goods (*PPIUS*) are included in both models. Most authors explicitly consider measures of *WEA*, *PWEX*, *PUEX*, *PPIUS*, and *USIP* when constructing empirical models intended to evaluate the behavior of *USEX*.⁵ This approach is consistent with the view that shocks to these variables have important effects on *USEX* and that there are potentially substantial feedback effects from *USEX* to these variables.

5. See Goldstein and Khan [1985] for a review of the rationale for this approach.

In our view, examination of the empirical relation between domestic aggregate economic activity and *USEX* must be conducted within empirical models that explicitly account for the fundamental forces that generate this relationship. For example, if both policy and nonpolicy innovations have effects on exports that are independent of their effects on aggregate activity, failure to explicitly include measures of these variables in the VAR model would result in omitted variables problems of the type articulated in Lutkephol [1982]. Moreover, this problem is exacerbated if the effect of variation in economic activity on exports depends upon the nature of the shocks that generate movements in aggregate activity. In light of these considerations, we include an oil price measure (*POIL*), real government purchases (*GPUR*), and an indicator of monetary policy in both models.

Our inclusion of an oil price measure in both models is consistent with empirical regularities reported by Hamilton [1983] which show that major downturns in U.S. economic activity were typically preceded by exogenous increases in the price of oil. In addition, while there is some disagreement about the precise mechanism via which increases in the price of oil affect the real economy, oil price increases and monetary policy are widely believed to be strong competitors for the dubious distinction of being the key initiating factor in postwar U.S. recessions. Consideration of the mechanisms via which oil price shocks affect the real economy highlight the importance of including both an oil price measure and a monetary policy indicator in the model. In particular, Bernanke, Gertler, and Watson [1997] and Hamilton [1996b] show that increases in the price of oil typically induce the Federal Reserve to tighten monetary policy. In addition, Bernanke, Gertler, and Watson [1997] find that this endogenous response of monetary policy accounts for most of the contractionary effects of adverse oil price shocks on the real economy. Given the implications for the Federal Reserve's reaction function, the joint inclusion of both variables is important for the identification of exogenous monetary policy and for accurate measurement of the effects of oil price shocks.⁶

6. The distinct possibility that increases and decreases in the price of oil have asymmetric effects (see Mork [1989] and Hamilton [1988]) led us to consider including decreases in the relative price of oil as an additional variable. However, several considerations suggested we should not. First, given that our models already include

Given our interest in accounting for the effects of policy shocks on the relationship between U.S. exports and aggregate economic activity, we deemed it important to include *GPUR* as a fiscal measure that is potentially informative about the aforementioned relations. This is consistent with the many theoretical approaches that attribute an important role to real government purchases in the determination of aggregate economic activity.⁷

Monetary policy is the sum of an endogenous component that reflects the Federal Reserve's reaction function and an exogenous component that is independent of the state of the macroeconomy. Since the measured response of economic variables to endogenous monetary policy reflects both the effects of the policy response and the economic conditions to which the monetary authority is responding, economically meaningful interpretations can only be attached to the measured responses to the exogenous component of monetary policy. Consequently, the proper identification of exogenous monetary policy is of substantial import. For example, Gordon and Leeper [1994] and Strongin [1995] show that the well-known liquidity and price puzzles associated with monetary policy were largely the result of improperly identified monetary policy shocks. Given the importance of correctly identifying monetary policy shocks, we employ two different approaches to identifying monetary policy. While these approaches lead to important differences between the VAR models we specify, our results are largely robust to the manner in which we identify

a large number of variables (ten), our concerns about parsimony outweighed any concerns about lack of symmetry or omitted variable problems. Second, the failure of large reductions in the price of oil in the mid-1980's to lead an economic expansion raises important questions about the ability of decreases in the relative price of oil to explain economic activity. In fact, Mork [1989] examined the effects of both negative and positive changes in the price of oil and found that only positive changes have important effects on output. Finally, while there are some precedents for separate inclusion of both *POIL* and decreases in the relative price of oil in empirical macro-models, (see Dotsey and Ried [1992]) the more recent literature (see Bernanke, Gertler, and Watson [1997] and Hamilton [1996a, 1996b]) emphasizes increases in the price of oil without also including oil price decreases.

7. For example, Barro ([1989]; pp 51) notes that "The Ricardian approach to budget deficits amounts to the statement that the government's fiscal impact is summarized by the present value of its expenditures".

exogenous monetary policy.

B. Identifying Monetary Policy Shocks

In Model I, we follow Bernanke and Blinder [1992], Christiano, Eichenbaum, and Evans [1996, 1997] and use the federal funds rate as the indicator of monetary policy. However, given the distinct possibility that the Federal Reserve reacts within the quarter to changes in the state of the macroeconomy, the derivation of economically meaningful results dictates that we identify the portion of variation in FFR that is purely reflective of exogenous monetary policy. In pursuit of this objective, we employed the approach described in Christiano, Eichenbaum, and Evans [1996, 1997] and imbed an interest rate smoothing rule within the structure of the VAR model summarized in equations (1) and (3). The rule we employ is given by

$$FFR_t = \psi(X_t) + \varepsilon_{ft}; \quad (4)$$

where FFR is the federal funds rate, ψ is a linear function, and X_t is a vector of macrovariables that summarizes the information set available to the Federal Reserve at the time when it sets its policy instrument. X_t includes contemporaneous and lagged values of the subset of the variables in Z_t to which the monetary authority is assumed to react within the quarter and only lagged values of the remaining variables in Z_t . Christiano, Eichenbaum, and Evans [1996, 1997] assume that innovations in the contemporaneous variables in X_t elicit within quarter monetary policy responses but that these variables do not respond to monetary policy within the quarter. This recursiveness assumption implies that ε_{ft} is orthogonormal to the elements of X_t and justifies OLS estimation of (4) and interpreting ε_{ft} as the monetary policy shock. Consequently, the impulse responses of a variable to a monetary shock can be measured by the coefficients in the projection of the variable on current and lagged values of ε_{ft} .

As Christiano, Eichenbaum, and Evans [1995, 1997] point out, the foregoing procedure is asymptotically equivalent to incorporating (4) into the VAR structure described in (1) through (3). In particular, the recursiveness assumption implicit in (4) is imposed on the VAR structure by placing the contemporaneous variables in X_t ahead of the federal funds rate (FFR) for

the decomposition described in the previous section.

For the purposes of this paper, X_t includes the contemporaneous and lagged values of *POIL*, *GPUR*, *USIP*, *PPIUS*, and an index of sensitive commodity prices (*PCOM*) (in that order) and only the lagged values of *FFR*, *USEXP*, *WEA*, *PWEXP*, and *PUSEXP*. As noted earlier, the recursiveness assumption amounts to the restriction that the Federal Reserve responds to innovations in *POIL*, *GPUR*, *USIP*, *PPIUS*, and *PCOM* within the quarter but has no contemporaneous effect on these variables. Consistent with this specification, Z_t is comprised of the following variables in the order employed for the decomposition: *POIL*, *GPUR*, *USIP*, *PPIUS*, *PCOM*, *FFR*, *USEXP*, *WEA*, *PWEXP*, and *PUSEXP*.

Our inclusion of contemporaneous values of *POIL* in X_t is consistent with Hamilton [1983] who carefully demonstrates that oil price changes are largely exogenous events associated with political and other events. It is also consistent with Bernanke, Gertler, and Watson [1997] who also include contemporaneous values of an oil price variable in their version of X_t and demonstrate that the federal funds rate responds positively to increases in the price of oil. Hamilton [1996b] also reports a similar finding. Finally, *POIL* is ordered ahead of *USIP* and *PPIUS* under the reasonable presumption that increases in the relative price of oil affect these variables within the quarter.

To the extent that *GPUR* may be interpreted as an indicator of fiscal policy, our inclusion of contemporaneous values of *GPUR* in X_t reflects the view that monetary policy responds within the quarter to innovations in fiscal policy. However, given the relatively long lags that are typically associated with fiscal policy, it is very unlikely that *GPUR* responds to monetary policy within the quarter.

Our inclusion of contemporaneous values of *USIP*, *PPIUS*, and *PCOM* in X_t is consistent with Christiano, Eichenbaum, and Evans [1996, 1997] and with Bernanke, Gertler, and Watson [1997] who also include contemporaneous values of aggregate activity, the price level, and *PCOM* in their versions of X_t . It is now standard practice to include *PCOM* in *VAR* models in which identification of monetary policy is important in order to solve the so-called "price puzzle" in which an increase in the federal funds rate leads to an anomalous increase in the price level. Sims [1992] argues that *PCOM* con-

tains information that the Fed has about future inflation that is not captured by the other variables in the model.^{8,9}

To check the robustness of the results to our choice of the federal funds rate as the indicator of monetary policy, we estimate a second model in which nonborrowed reserves is taken to be the indicator of monetary policy. In addition, we use the approach described in Strongin [1995] to identify exogenous monetary policy.

Strongin's approach is based on the observation that forecast innovations in nonborrowed reserves reflect both independent monetary policy and the Federal Reserve's accommodation of innovations in the demand for total reserves. Strongin assumes that the level of total reserves is largely determined by the Federal Reserve's short-run accommodation of the demand for total reserves and that true monetary policy innovations do not have short run effects on total reserves. This leads him to the plausible conclusion that independent monetary policy is reflected in the mix of borrowed and nonborrowed reserves that the Federal Reserve uses to meet increases in the demand for total reserves. Given these assumptions, he argues that the contemporaneous relations among forecast innovations in nonborrowed reserves, forecast innovations in total reserves, and exogenous monetary policy are adequately captured by the following equation

$$nbr_t = \phi tr_t + v_{st}, \quad (5)$$

in which nbr_t is the forecast innovation in nonborrowed reserves, tr_t is the

8. Bernanke, Gertler, and Watson [1997] note that the commodity price index (*i.e.* *PCOM*) apparently excluded oil and other energy prices for most of its history. However, an oil price was added to the index in 1987. Since our sample ends in 1987, we do not expect that our results will be materially affected.

9. In general, confidence in the appropriateness of the assumption that *PCOM* does not respond to contemporaneous monetary policy actions should increase as the measurement interval gets smaller. For example, we are more comfortable with the use of this restriction in Bernanke, Gertler, and Watson [1997] who use monthly data than with its use in Christiano, Eichenbaum, and Evans [1996] who use quarterly data. However, since *PCOM* is not included in the second model described below, it does not employ this restriction. Since we find no material differences between the results based on this model and those based on Model I in which the aforementioned restriction is employed, we are inclined to conclude that it has little effect on our results.

forecast innovation in total reserves, and v_{st} is the fraction of the forecast innovation in nonborrowed reserves that is the pure policy shock.

The restrictions summarized in (5) imply that innovations in total reserves have important contemporaneous effects on nonborrowed reserves but that innovations in nonborrowed reserves have no contemporaneous effects on total reserves. Consequently, and as Strongin [1995] demonstrates, the restrictions implied in (5) are easily imposed on the VAR structure described in (1) and (2) by including total reserves and nonborrowed reserves in Z_t and placing total reserves ahead of nonborrowed reserves for the decomposition.

To implement the Strongin approach, we replace *PCOM* and *FFR* with total reserves (*TR*) and nonborrowed reserves (*NBR*) where we have normalized both variables with a 36-month moving average of total reserves. The resulting VAR model (Model II) is comprised of the following variables in the order employed for the decomposition. These are: *POIL*, *GPUR*, *USIP*, *PPIUS*, *TR*, *NBR*, *USEX*, *WEA*, *PWEX*, and *PUEX*.¹⁰

In choosing the number of variables that entered the VAR model, we were acutely aware of the tradeoff between parsimony on the one hand and the risk of omitted variables on the other. To some extent our decision to include ten variables in each of the VAR models specified above, suggests that we have attached greater weight to the risk of omitted variables. To examine the robustness of our results to model size, we estimated the following VAR models and calculated impulse responses, which we report in Figure 4. For these models Z_t is defined as: (variables are in the order employed for the decomposition) (1) *POIL*, *USIP*, *PPIUS*, *USEX*, *WEA*,

10. Throughout this paper the international variables (*i.e.* *USEX*, *WEA*, *PWEX*, and *PUEX*) are ordered after our measure of monetary policy. This ordering is equivalent to the restriction that monetary policy innovations have contemporaneous effects on the international variables but that the Federal Reserve does not alter its policy instrument in response to contemporaneous or within quarter innovations in the international variables. However, the Federal Reserve is free to respond to lagged innovations in the international variables. This recursiveness assumption is consistent with Cushman and Zha [1997] who argue that any monetary policy response to foreign shocks is likely to be relatively small given that the U.S. economy is large and relatively closed.

PWEX, PUEX; (2) *GPUR, USIP, PPIUS, USEX, WEA, PWEX, PUEX*; (3) *USIP PPIUS, PCOM, FFR, USEX, WEA, PWEX, PUEX*; (4) *USIP PPIUS, TR, NBR, USEX, WEA, PWEX, PUEX*.

C. Data

The empirical counterparts to the model's variables are as follows. *USEX* is measured by the quantum index of U.S. exports. Consistent with studies by Culem [1987], Dunlevy, and others, world economic activity is proxied by "effective" world purchasing power measured as the real value of world exports minus U.S. imports. Alternative measures of world activity such as trade weighted sums of national GDPs can be found in the literature. However, in contrast to these alternatives, the measure employed here reflects variations in openness of the world trading system. Industrial production is used to measure U.S. economic activity instead of real GNP since the trade data we employ is mostly reflective of trade in goods. *PUEX* and *PWEX* are, respectively, the unit values of U.S. and world exports. The data for *USEX*, *WEA*, *PUEX*, and *PWEX* come from the International Monetary Fund's *International Financial Statistics*.

In addition to these variables, we calculated changes in the relative price of oil as the difference between the rate of change of the producer price index for crude oil and the rate of change of the producer price index for all commodities. Following Mork [1989], Dotsey and Reid [1992], and Bernanke, Gertler, and Watson [1997] *POIL* is constructed by setting all negative values of the resulting series equal to zero. *PPIUS* is represented by the producer price index for manufactured goods.¹¹ Our choice of the PPI for manufactured goods over other measures such as the PPI for all commodities or the CPI reflects the view that the mix of goods measured in the trade data are primarily manufactured goods. Following Christiano, Eichenbaum, and Evans [1995, 1997] and Bernanke, Gertler, and Watson [1997], we use the Citibase series (*PSCCOM*) as our measure of sensitive

11. Note that homogeneity of degree zero in price is not imposed on the model. This reflects the view that for our current purposes little is gained from such a restriction. Additionally, there is evidence which suggests trade functions do not generally warrant such a restriction. (for example, see Murray and Ginman [1976])

commodity prices. Our measures of total reserves (*TR*) and nonborrowed reserves (*NBR*) are based, respectively, on the Citibase series *FMRRRA* and *FMRNBA* which are both adjusted for seasonality and for reserve requirement changes. Following Bernanke and Mihov [1995] both series are normalized with a 36-month moving average of total reserves. The federal funds rate, industrial production, the various producer price indices, and real government purchases come from Citibase. Finally, as noted previously, we employ quarterly data from 1959:II to 1987:IV.

Augmented Dickey-Fuller tests for first order unit roots together with Engle-Yoo [1987] and Hansen [1990] tests for cointegration suggested that with the exception *POIL*, the first differences of the variables of interest should be used in specifying and estimating the VAR models. Consequently, the models were specified and estimated with the first differences of *TR* and *NBR*, the first differences of the log of all other variables except *POIL* and *FFR* which are entered in their levels.¹²

Akaike's information criterion (AIC) was used to specify the VAR models' lag length and indicated a lag length of 8.¹³ After accounting for observations lost due to normalization of *TR* and *NBR*, differencing, and the maximum lag of eight used in the AIC test, the model was estimated for the period 1964:II to 1987:IV. Ljung-Box Q-statistics suggested no need for concern about serial correlation in the equations' residuals.

III. Empirical Results

Cumulative IRFs together with their one standard deviation confidence

12. While the Engle-Yoo and Johansen [1988] tests are widely used to test for cointegration, Hansen [1990] has shown that these tests suffer from substantial loss of power as the size of the system increases. Additionally, Hansen [1990] has proposed a two step procedure similar to the Engle-Yoo tests that circumvents this "curse of dimensionality". Both the Engle-Yoo and Hansen tests were used to test for cointegration, on balance the results indicate the absence of cointegrating vectors. Further details on these tests are available upon request.

13. Since the optimal lag length equaled the maximum lag of eight considered for the AIC tests, the model was estimated with ten lags. Examination of VDCs suggested no material departures from the results based on the optimal lag of eight. Consequently, only the results based on the eight-lag version of the model are reported.

bands are presented in Figures 1 through 4.¹⁴ In addition, variance decompositions (VDCs) of exports and industrial production together with their standard errors are presented in Tables 1A and 1B for Model I, and Tables 2A and 2B for Model II.

A. Variance Decompositions

Tables 1A and 1B indicate that the fraction of the forecast error variation in *USIP* explained by innovations in *POIL* is substantial, but significantly less than the percent of the variation in *USEX* explained by *POIL*. Examination of VDCs based on Model II reported in Tables 2A and 2B suggest that they are very consistent with the results based on Model I. These results are supportive of the view that increases in the relative price of oil have important effects on both *USIP* and *USEX*. In addition, they are not inconsistent with Hamilton [1983] and others who attribute an important role to oil price increases as an initiator of fluctuations in aggregate economic activity.

The VDCs based on both models indicate that *GPUR* explains a moderate percent of the *FEV* in *USIP*. In addition, the fraction of the *FEV* in *USEX* explained by *GPUR* at various horizons is moderate to small and the accompanying standard errors suggest that the point estimates are relatively imprecisely estimated. Overall, these results suggest that *GPUR* played a moderately important role as an explainer of business cycle fluctuations during our sample. This conclusion is not inconsistent with the views of many economists who attribute an important but not dominant role to innovations in government purchases.

As noted previously, the federal funds rate is taken to be the monetary policy indicator in Model I, and exogenous monetary policy is identified using the methods described in Christiano, Eichenbaum, and Evans [1996, 1997]. In Table 1A, the percent of the *FEV* in *USIP* attributable to monetary

14. Standard errors were calculated using the methods described in Doan [1990]. The solid lines in Figures 1-4 are the point estimates while the broken lines are plus- and minus- one standard deviation bands. Since *USEX* and *USIP* entered the model in first differences, the cumulative IRFs indicate the response of their levels to various shocks.

Table 1A
Variance Decomposition of U.S. Industrial Production (Model I)
 (Ordering: *POIL*, *GPUR*, *USIP*, *PPIUS*, *PCOM*, *FFR*, *USEX*, *WEA*, *PWEX*, *PUEX*)

FH	<i>POIL</i>	<i>GPUR</i>	<i>USIP</i>	<i>PPIUS</i>	<i>PCOM</i>	<i>FFR</i>	<i>USEX</i>	<i>WEA</i>	<i>PWEX</i>	<i>PUEX</i>
4	1.43	6.67	42.76	3.68	13	11.35	1.91	1.8	7.79	9.6
	2.14	2.66	5.48	2.63	6.56	4.34	2.07	2.47	1.92	0.98
8	4.93	4.85	24.54	7.93	30.01	9.13	3.18	1.12	8.7	5.63
	3.19	1.96	4.48	3.26	6.21	3.07	2.22	3.27	3.44	0.64
12	11.41	6.04	22.67	8.6	20.38	7.18	4.04	1.67	10.26	7.75
	4.58	2.84	3.87	3.09	5.19	3.23	2.64	3.46	4.25	0.87
16	11.46	7.83	19.24	7.67	20.32	5.97	6.55	3.64	10.49	6.81
	4.24	2.75	3.56	3	5.14	2.9	3.05	4.42	3.96	0.81

Notes: The column labeled FH is the forecast horizon in quarters. For each forecast horizon, the numbers in the upper row are the point estimates while those in smaller print in the lower rows are the corresponding standard errors.

Table 1B
Variance Decomposition of U.S. Exports (Model I)¹
 (Ordering: *POIL*, *GPUR*, *USIP*, *PPIUS*, *PCOM*, *FFR*, *USEX*, *WEA*, *PWEX*, *PUEX*)

FH	<i>POIL</i>	<i>GPUR</i>	<i>USIP</i>	<i>PPIUS</i>	<i>PCOM</i>	<i>FFR</i>	<i>USEX</i>	<i>WEA</i>	<i>PWEX</i>	<i>PUEX</i>
4	14.69	5.89	2.33	3.66	2.24	1.68	50.34	2.21	10	6.98
	4.27	2.99	4.51	2.98	5.36	1.76	6.17	4.01	4.5	0.74
8	21.24	6.01	2.64	5.66	2.39	2.61	33.79	5.35	8.52	11.79
	6.81	3.3	4.25	3.56	5.13	2.24	4.96	3.3	3.34	1.25
12	19.88	5.98	3.88	6.14	7.86	3.79	27.86	5.68	8.32	10.61
	5.68	3.44	3.69	4.03	6.68	1.95	5.01	3.1	3.92	1.02
16	17.45	7.29	6.58	5.5	8.15	3.61	26.21	5.56	10.04	9.62
	5.83	4.06	4.58	4.43	5.69	2	4.89	3.48	3.94	0.99

policy shocks peaks at 11.35 percent by the end of the first year and falls to about 6 percent by the end of the fourth year. In addition, the VDCs reported in Table 1B indicate that the percent of the *FEV* in *USEX* attributable to *FFR* shocks at any horizon is rather small. In fact, it reaches a maximum of 3.79 at the end of the third year with a standard error of 1.95. In interpreting these results it bears reemphasizing that our model measures the effects of monetary policy shocks and not systematic monetary policy. For example,

Table 2A**Variance Decomposition of U.S. Industrial Production (Model II)¹**(Ordering: *POIL*, *GPUR*, *USIP*, *PPIUS*, *PCOM*, *FFR*, *USEX*, *WEA*, *PWEX*, *PUEX*)

FH	<i>POIL</i>	<i>GPUR</i>	<i>USIP</i>	<i>PPIUS</i>	<i>PCOM</i>	<i>FFR</i>	<i>USEX</i>	<i>WEA</i>	<i>PWEX</i>	<i>PUEX</i>
4	7.1	2.89	59.32	6.29	4.87	1.84	2.94	5.2	4.04	5.5
	4.8	2.53	6.81	3.69	2.61	2.48	2.87	2.91	3.85	2.13
8	8.14	8.11	38.67	9.69	12.55	6.12	2.8	3.02	3.67	7.24
	5.47	3.83	5.27	3.3	5.92	3.45	2.27	1.78	2.64	1.56
12	10.08	8.09	31.01	8.08	10.77	13.93	3.09	2.16	4.56	8.24
	4.9	5.52	4.59	2.8	5.51	4.18	2.02	1.37	2.49	1.81
16	7.67	12.16	21.37	6	13.68	21.55	5.06	1.74	4.59	6.18
	5.15	4.93	4.96	3.54	6.01	4.36	2.73	1.5	2.84	1.65

Notes: 1. The column labeled FH is the forecast horizon in quarters. For each forecast horizon, the numbers in the upper row are the point estimates while those in smaller print in the lower rows are the corresponding standard errors.

Table 2B**Variance Decomposition of U.S. Exports (Model II)¹**(Ordering: *POIL*, *GPUR*, *USIP*, *PPIUS*, *PCOM*, *FFR*, *USEX*, *WEA*, *PWEX*, *PUEX*)

FH	<i>POIL</i>	<i>GPUR</i>	<i>USIP</i>	<i>PPIUS</i>	<i>PCOM</i>	<i>FFR</i>	<i>USEX</i>	<i>WEA</i>	<i>PWEX</i>	<i>PUEX</i>
4	3.1	6.32	6.28	9.59	3.19	7.54	50.52	1.99	3.13	8.34
	3.23	5.63	2.76	5.33	4.98	3.62	6.46	1.32	1.45	1.42
8	8.01	7.19	9.92	7.12	10.56	7.36	25.05	9.64	3.3	11.85
	5.68	4.19	4.07	4.95	5.84	3.19	4.6	3.26	1.29	1.82
12	12.11	6.9	10.2	8.68	15.95	6.23	18.89	7.65	4.12	9.27
	7.04	4.63	3.86	4.18	5.31	2.85	3.66	2.47	1.28	1.51
16	17.5	5.75	9.14	9.82	15.63	5.57	15.74	8.14	3.84	8.88
	7.12	4.29	3.99	4.08	5.23	3.17	3.21	2.33	1.32	1.33

under the assumption that some degree of price rigidity prevails, it seems likely that systematic monetary policy would have much greater explanatory power for *USEX*.¹⁵

15. See Bernanke, Gertler, and Watson [1997] who argue that the measured effects of monetary policy shocks are not sufficient to adequately explain the role of monetary policy in business cycle fluctuations and attempt to also measure the effects of systematic monetary policy.

Our indicator of monetary policy in Model II is nonborrowed reserves and monetary policy shocks are identified using the methods described in Strongin [1995]. The variance decompositions reported in Tables 2A and 2B show that *NBR* explained relatively more of the *FEV*s in both *USIP* and *USEX* than *FFR* did in Model I. However, the results are broadly similar in that both Models suggest that monetary policy shocks have relatively more important effects on *USIP* than on *USEX*.¹⁶

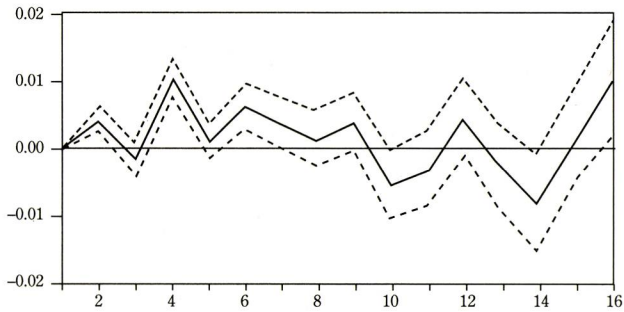
Finally, to evaluate the importance of including *WEA*, *PWEX*, and *PUEX* in the model, we examine their ability to explain variation in *USEX*. The VDCs based on Model I in Table 1B suggest that all three variables explain significant (*i.e.* as indicated by standard errors that are small relative to the point estimates) fractions of the *FEV* in *USEX*, although *PWEX* and *PUEX* explain relatively more of the *FEV* in *USEX* than *WEA*. In addition, the VDCs based on Model II in Table 2B are also consistent with the view that *PWEX*, *PUEX*, and *WEA* are important explanators of movements in *USEX*. Overall, these results bolster our confidence in the empirical model's ability to uncover the true economic relations embedded in the data.

B. Impulse Responses

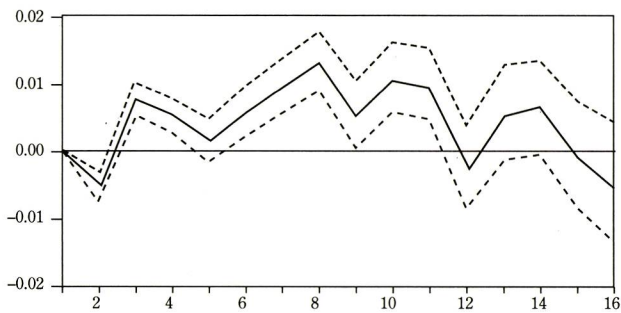
Panel A of Figure 1 (based on Model I) indicates that a one standard deviation shock to world economic activity (*WEA*) has an immediate, significantly positive effect on *USEX*. In addition, examination of Panel B indicates that (with the exception of an initial negative impact) a shock to the price of world exports (*PWEX*) elicits significantly positive effects from *USEX* for most horizons. Finally, panel C illustrates that U.S. export performance is negatively affected by a shock to the price of U.S. exports (*PUEX*). Overall, these results are consistent with widely held beliefs about the effects of

16. In comparing the percent of the forecast error variance in *USEX* and *USIP* explained by innovations in *FFR* and in *NBR*, it is important to recognize that an innovation in *FFR* is an unanticipated monetary contraction while an innovation in *NBR* represents an unanticipated monetary expansion. To the extent that monetary shocks have asymmetric effects these results may not be directly comparable. However, considering both unanticipated contractions and expansions is itself informative about the manner in which monetary policy affects the macroeconomy.

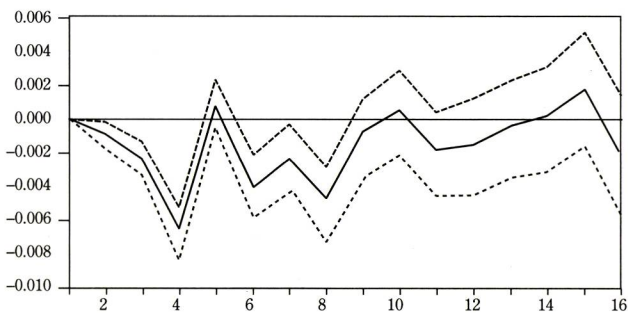
Figure 1
Impulse Responses of *USEX* to Int'l Variables



Panel A: Cumulative IR of *USEX* to *WEA*: Quarters



Panel B: Cumulative IR of *USEX* to *PWEX*: Quarters



Panel C: Cumulative IR of *USEX* to *PUEX*: Quarters

WEA, *PWEX*, and *PUEX* on U.S. export performance and encourage greater confidence in the empirical model's ability to uncover the economic relationships embedded in the data.

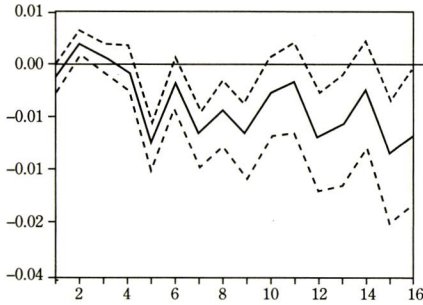
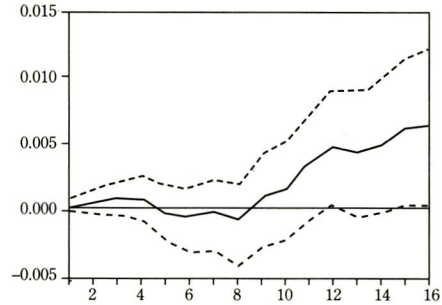
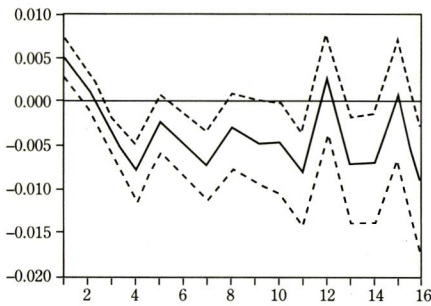
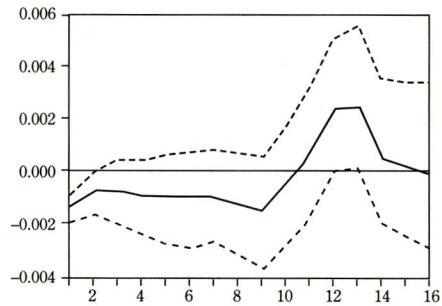
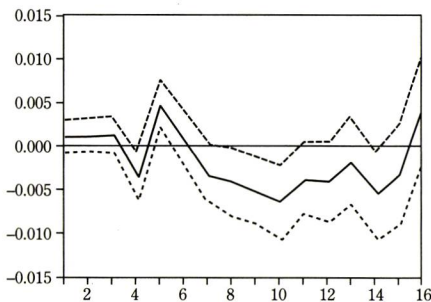
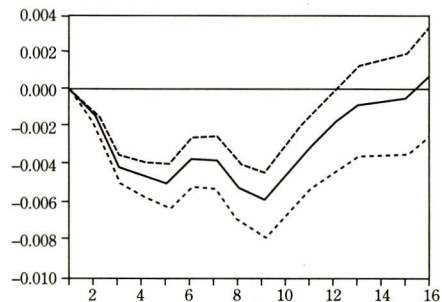
In evaluating the empirical relations between *USEX* and *USIP*, it is instructive to distinguish relations between *USEX* and *USIP* that arise

because of co-movements initiated by nonpolicy and/or policy shocks from those that reflect the response of *USEX* to shocks to *USIP* or vice versa. Co-movements between exports and domestic economic activity arise largely because nonpolicy and/or policy shocks elicit responses from both *USEX* and *USIP*. For example, if the direction of the effects of a monetary shock on *USIP* and *USEX* are of opposite sign, the implied relation between *USEX* and *USIP* is interpreted as negative. Such a relation is separate from the relation that arises because of a *USIP* shock that is fundamental in the sense that it is uncorrelated with any other shocks. To the extent that business cycle fluctuations are systematic responses to various exogenous shocks, we view the co-movements between *USEX* and *USIP* as more informative about the relationship between the domestic business cycle and export performance.

The impulse responses reported in panel A of Figure 2 indicate that a one standard deviation shock to *POIL* has significantly positive effects on *USEX* around the third quarter after the shock, followed by significantly negative effects over most of the next three years.¹⁷ In panel B, the shock to *POIL* elicits positive responses from *USIP* for the first 5 quarters followed by negative responses over the next 4 quarters and then by positive responses. The rather ambiguous sign of the responses and the fact that the point estimates fall within the one standard deviation bands make it difficult to interpret the overall direction of the implied correlation between *USEX* and *USIP*. However, the conclusion that the correlation is weakly positive seems reasonable. Examination of the impulse responses reported in panels A and B of Figure 3, (based on Model II) provide clearer indication that the implied relationship between *USEX* and *USIP* is positive. In addition, the impulse responses of *USEX* and *USIP* to a one standard deviation shock to *POIL* based on a seven-variable model comprised of *POIL*, *USIP*, *PPIUS*, *USEX*, *WEA*, *PWEX*, and *PUEX* are reported in panels A and B of Figure 4. These results provide the clearest indication that oil price shocks leads to a positive correlation between *USEX* and *USIP*. Overall, all three models, but

17. The initial positive effect of an increase in *POIL* on *USEXP* and to a lesser extent on *USIP* is not inconsistent with Dotsey and Reid [1992] and Hamilton [1988] who argue that an increase in the real price of oil could have either positive or negative effects on output.

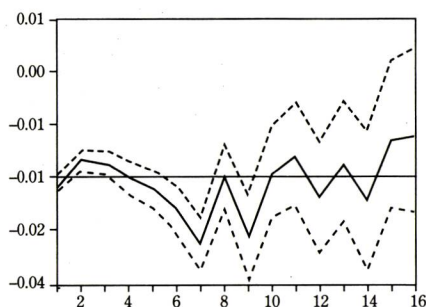
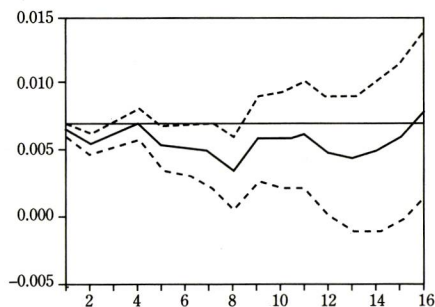
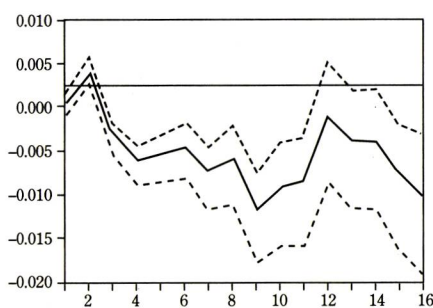
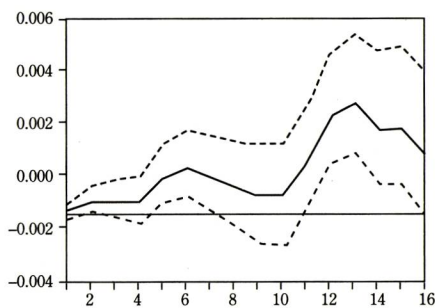
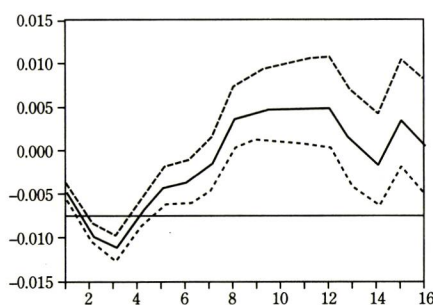
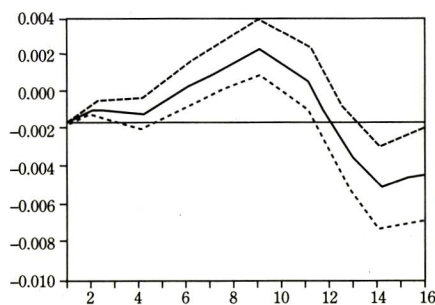
Figure 2
Impulse Responses of *USEX* and *USIP*

Panel A: Cumulative IR of *USEX* to *POIL*: QuartersPanel B: Cumulative IR of *USIP* to *POIL*: QuartersPanel C: Cumulative IR of *USEX* to *GPUR*: QuartersPanel D: Cumulative IR of *USIP* to *GPUR*: QuartersPanel E: Cumulative IR of *USEX* to *FFR*: QuartersPanel F: Cumulative IR of *USIP* to *FFR*: Quarters

particular Model II and the seven-variable model lead to the conclusion that business cycle fluctuations initiated by adverse oil price shocks generate a positive correlation between *USEX* and *USIP*.

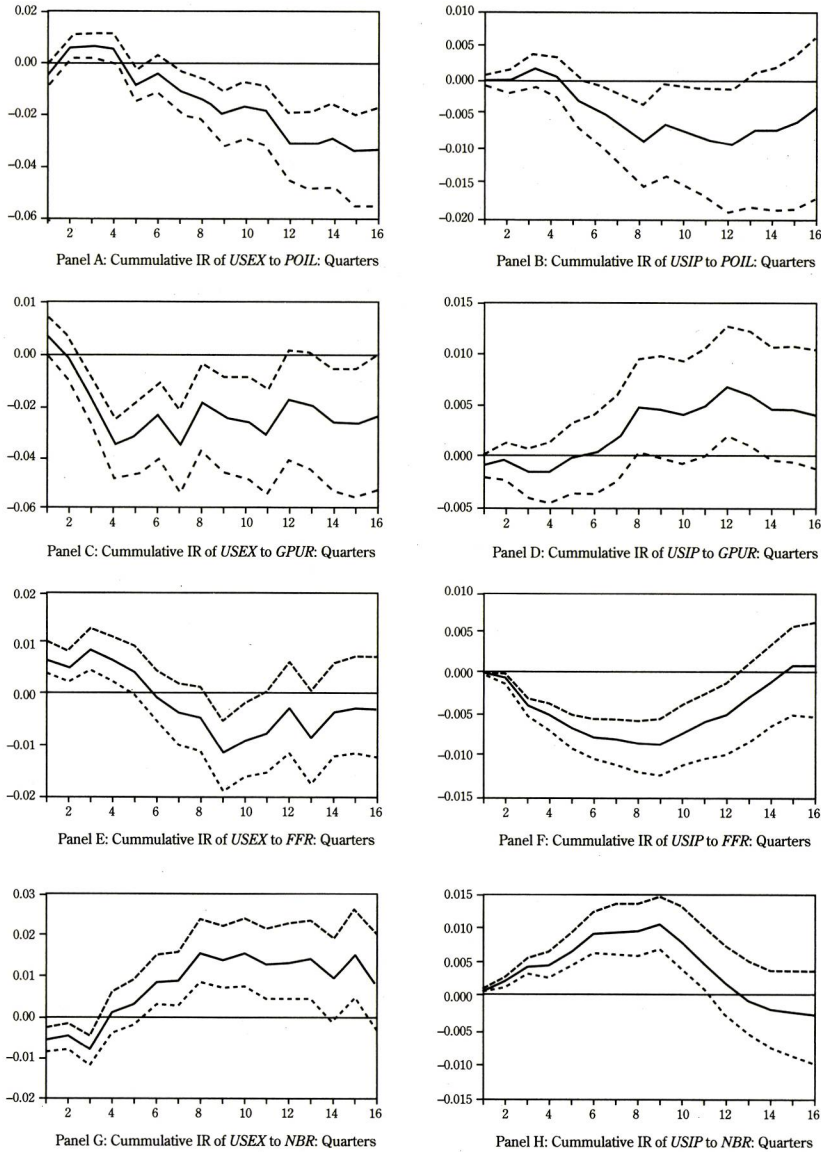
Panel C of Figure 2 illustrates that for the first 3 quarters after a one standard deviation shock to *GPUR*, *USEX* rises and subsequently its significant

Figure 3
Impulse Responses of *USEX* and *USIP*

Panel A: Cumulative IR of *USEX* to *POIL*: QuartersPanel B: Cumulative IR of *USIP* to *POIL*: QuartersPanel C: Cumulative IR of *USEX* to *GPUR*: QuartersPanel D: Cumulative IR of *USIP* to *GPUR*: QuartersPanel E: Cumulative IR of *USEX* to *FFR*: QuartersPanel F: Cumulative IR of *USIP* to *FFR*: Quarters

responses are negative. In contrast, the response of *USIP* to the *GPUR* shock is significantly negative for the first 3 quarters after the shock followed by significantly positive effects from the 11th through 13th quarters. Consequently, concentrating on the significant responses would lead to the conclusion that the *GPUR* shock leads to a weakly negative relationship

Figure 4
Impulse Responses Based on 7- and 8-Variable Models



between *USEX* and *USIP*. This conclusion is encouraged by examination of the impulse responses based on Model II. In particular, panels C and D of Figure 3 illustrate that the impulse responses of *USEX* and *USIP* to the *GPUR* shock clearly have opposite signs and indicate that *GPUR* shocks

lead to a negative correlation between *USEX* and *USIP*. We also examined this relationship within a seven-variable model comprised of *GPUR*, *USIP*, *PPIUS*, *USEX*, *WEA*, *PWEX*, and *PUEX*. These results (reported in panels C and D of Figure 4) are strongly supportive of the conclusion that fluctuations in aggregate economic activity generated by shocks to *GPUR* lead to a negative correlation between *USEX* and *USIP*.

Examination of panel E of Figure 2 indicates that an unanticipated monetary contraction (*i.e.* a one standard deviation shock to *FFR*) induces significantly negative responses from *USEX* for most horizons after the shock. In panel F, the unanticipated monetary contraction immediately reduces industrial production and has significantly negative effects on *USIP* lasting up to three years after the shock. We also examined the impulse responses of *USEX* and *USIP* to a *FFR* shock with an eight-variable model comprised of *USIP*, *PPIUS*, *PCOM*, *FFR*, *USEX*, *WEA*, *PWEX*, and *PUEX*. These results (reported in panels E and F of Figure 4) are very supportive of the conclusion that business cycle fluctuations initiated by contractionary monetary policy shocks lead to a positive correlation between *USEX* and *USIP*.

To evaluate the effects of an unanticipated monetary expansion we used Model II to calculate the impulse responses of *USEX* and *USIP* to a one standard deviation shock to *NBR*. The results are reported in panels E and F of Figure 3 and show that an unanticipated monetary expansion leads, with the exception of a brief period during which exports fall while output rises, to a clearly positive relationship between *USEX* and *USIP*. We also examined the impulse responses of *USEX* and *USIP* within an eight-variable model with the variables ordered as: *USIP*, *PPIUS*, *TR*, *NBR*, *USEX*, *WEA*, *PWEX*, and *PUEX*. The results reported in panels G and H of Figure 4 do not indicate any material departures from those based on the ten-variable model. Overall, these results are consistent with the view that unanticipated monetary expansions lead to increases in both domestic output and the volume of exports. More generally, the measured effects of *FFR* and of *NBR* on *USEX* and *USIP* lead to the conclusion that business cycle fluctuations initiated by exogenous monetary policy (both contractionary and expansionary) lead to a positive correlation between *USEX* and *USIP*. These results are robust to model size (*i.e.* eight *vs.* ten-variable models) and to

the method used to identify exogenous monetary policy.

C. Anomaly or Plausible Result? A Conjecture

Under the presumption that an unanticipated monetary contraction affects the economy primarily via its effects on aggregate demand, the capacity pressure hypothesis (CPH) suggests that it reduces the pressure on capacity and allows firms to engage in low cost recommitment of excess capacity to the export sector. Consequently, an unexpected monetary contraction leads to falling domestic activity and rising export volume. Given this relatively narrow interpretation of the CPH, the empirical result that monetary shocks lead to a positive correlation between the responses of *USIP* and *USEX* appears to be anomalous. Since this apparently anomalous result is robust to model size and to the method employed to identify exogenous monetary policy, we consider the conditions under which both contractionary and expansionary monetary policy shocks are likely to lead to a positive correlation between *USEX* and *USIP*. However, in the absence of a fully specified theoretical model, the opinions we express below are intended to be conjectures that appear to be consistent with our empirical results. Given that monetary policy shocks affect the economy primarily through their effects on aggregate demand, an unanticipated monetary contraction (*i.e.* a *FFR* shock in Model I) increases excess capacity. However, if a substantial fraction of exporting firms are only able to obtain external funds at significantly higher costs than the costs of internal funds, the reductions in cash flow and profits that are typically associated with a monetary contraction will increase their reliance on more costly external funds.¹⁸ Moreover, since monetary contractions are typically accompanied by tighter credit conditions and rising open market interest rates, the increased reliance on external funds comes at a time when such funds are relatively scarce and even more expensive. Overall, the higher costs and/or the reduced availability of operating capital may force exporting firms to decrease their sup-

18. See Christiano, Eichenbaum, and Evans [1997] for empirical evidence on the effects of monetary policy shocks on profits. In addition, Bernanke and Gertler [1995] provide an excellent summary of the effects of monetary policy innovations on the credit conditions faced by firms.

ply of exports at the same time that domestic demand conditions reduce their domestic sales.¹⁹

Similarly, an unanticipated monetary expansion, (represented by a one standard deviation shock to *NBR* in Model II) increases the pressure on capacity and would ordinarily lead firms to cut back on export activity. However, if a substantial fraction of exporting firms operate under the financing constraints described above, the opposite effect seems likely. In particular, the unanticipated monetary expansion increases cash flow and profits, reduces open market interest rates and the premium on external finance, while simultaneously increasing credit availability. In sum, these effects lead to substantial increases in exporting firms' financial capacity, a reduction in the costs of committing additional resources to the export sector, and thereby, to increases in both domestic output and export volume.

To assess the plausibility of the assertion that monetary policy shocks have important effects on the costs of recommitting resources to the export sector, we explore the consistency of this interpretation with our results on the responses of *USEX* and *USIP* to *POIL* and *GPUR* shocks. The effects of a given exogenous shock on excess capacity, depends on whether it affects the economy primarily via aggregate supply or primarily via aggregate demand. For example, if an adverse shock affects the real economy primarily via its effect on aggregate demand, excess capacity increases. On the other hand, if an adverse shock affects the real economy primarily via its effects on aggregate supply, excess capacity should fall. However, as is well illustrated by Hamilton's [1996b] discussion of the mechanism via which oil price increases affect the real economy, increases in the relative price of oil affect the economy through their effects on both aggregate demand and aggregate supply. For our current purposes this implies that it is difficult to determine whether a *POIL* shock increases or decreases excess capacity. Consequently, we examine the plausibility of our results under the assump-

19. The agricultural sector is an example of an exporting industry for which the scenario described here is likely to be relevant. In particular, high operating expenses, inadequate synchronization of cash flow with operating outlays, and relatively limited access to credit due to weak balance sheets makes the supply of agricultural exports relatively sensitive to the increase in interest rates and to the general tightening of credit conditions that accompany a rise in the federal funds rate.

tion that oil price shocks affect the real economy primarily via aggregate demand and under the alternative assumption that its effects operate primarily via aggregate supply.

To the extent that an increase in the relative price of oil affects the economy primarily via its effects on aggregate supply, a *POIL* shock reduces excess capacity. If the shock does not affect the costs of recommitting resources to the export sector, export volume would also fall. Since the effect on output would also be negative, the implied correlation between *USEX* and *USIP* would be positive. If the *POIL* shock also increases open market interest rates and reduces cash flow and profits it would also impair financial capacity and thereby magnify the effects described above. Consequently, the empirical observation that a shock to *POIL* shock generates a positive correlation between *USEX* and *USIP* is consistent with the view that *POIL* shocks affect the real economy primarily through their effects on aggregate supply. In addition, it is not inconsistent with the conjecture that increases in the relative price of oil exert important effects on the costs of recommitting resources to the export sector by affecting the financial capacity of exporting firms.

On the other hand, if an increase in the relative price of oil exerts most of its effects on the real economy via its effects on aggregate demand, excess capacity would increase and output would fall. Additionally, if the shock has negligible effects on the costs of recommitting resources to the export sector, firms would recommit resources to the export sector so that export volume would rise. However, if the increase in the relative price of oil increases exporting firms' reliance on relatively expensive external funds and decreases credit availability by inducing a "flight to quality", firms' financial capacity and therefore access to operating capital will be severely constricted. Under these circumstances exporting firms will be forced to reduce export volume. Consequently, our empirical regularities are consistent with the hypotheses that *POIL* shocks affect the real economy primarily through their effects on aggregate demand and with the conjecture that *POIL* shocks exert important effects on the costs of recommitting resources to the export sector by affecting the financial capacity of exporting firms.

To the extent that government expenditures are on productivity enhancing activities such as research and development and development of infrastruc-

ture, shocks to *GPUR* are expected to have important supply side effects in the long-run. However, in the short-run *GPUR* shocks affect the real economy primarily via aggregate demand. Since we are primarily concerned with the cyclical or short-run effects, we deemed it appropriate to assume that *GPUR* shocks affect the real economy primarily via aggregate demand. Under the preceding assumption, an increase in *GPUR* leads to a decrease in excess capacity. If the *GPUR* shock has negligible effects on the costs of recommitment, export volume falls and given that output rises, there is a negative correlation between *USEX* and *USIP*. On the other hand if the *GPUR* shock had important or material effects on financial capacity we would expect the improvement in financial conditions to allow firms to increase both foreign and domestic sales so that both *USEX* and *USIP* would rise. Therefore, our results are consistent with the view that in the short-run an increase in real government purchases affects the economy primarily via aggregate demand and that it does not have material effects on financial capacity and the costs of recommitting resources to and from the export sector.

A relatively modest and perhaps secondary goal of stabilization policy may be to attenuate the business cycle behavior of export volume. Our results suggest that a recession that is precipitated by tight monetary policy or by unanticipated increases in the relative price of oil will be characterized by falling exports. If policy makers respond by increasing the supply of money, both output and export volume will rise. However, if policy makers respond by increasing real government purchases, export volume would fall even further but output rises. Therefore, if a secondary objective of fiscal and monetary policies is to encourage export volume, our results clearly suggest that monetary expansion should be the preferred policy response to cyclically declining economic activity.

D. Capacity Pressure Hypothesis Revisited

Given the empirical regularities we have uncovered, it is instructive to consider the extent to which our results are informative about and consistent with the capacity pressure hypothesis (CPH). A clear implication of the preceding analysis is that the manner in which the effects of a given shock on *USIP* are related to the pressure on capacity depends on the channel(s) via

which the shock in question affects the real economy. For example, if an adverse shock affects aggregate economic activity primarily via its effect on aggregate supply, the resulting decline in *USIP* would indicate an increase in the pressure on capacity (*i.e.* a decrease in excess capacity). However, if the adverse shock affects the macroeconomy by reducing aggregate demand, the resulting fall in *USIP* should be associated with a decrease in the pressure on capacity (*i.e.* an increase in excess capacity). Consequently, in the absence of further information about the channel via which a shock affects the aggregate economy, a movement in *USIP* that should be linked to an increase in excess capacity may be observationally equivalent to a movement that should be linked to a decrease in excess capacity. Since our empirical model does not allow us to econometrically identify the precise channel(s) via which a shock affects the real economy, we have relied on theoretical arguments in the cases of monetary policy shocks and *GPUR* shocks to argue that they affect the economy primarily via aggregate demand. In the case of oil price shocks we refrained from making any such assumption because of our perception that there is a lack of theoretical and empirical consensus on exactly how oil price shocks affect the real economy.

The capacity pressure hypothesis is most frequently characterized as the assertion that an increase in excess capacity of whatever origin allows firms to recommit resources to the export sector at relatively low cost. As a result, export volume increases. Viewed in this narrow light, if oil price shocks affect the economy primarily via their effects on aggregate supply, the decrease in *USIP* associated with an unanticipated increase in the relative price of oil indicates a reduction in excess capacity. Since this naïve version of the CPH suggests that export volume falls when capacity pressure increases our results may be deemed consistent with the CPH subject to the accuracy of the assumption that oil price shocks affect the real economy primarily via aggregate supply. Similarly, since the short-run effects of *GPUR* shocks operate via aggregate demand, the increase in output associated with an increase in *GPUR* indicates an increase in excess capacity. Since the naïve version of the CPH suggests that export volume falls when capacity pressure increases our results may be deemed consistent with the CPH subject to the accuracy of the assumption that in the short-run *GPUR* shocks affect the real economy primarily via aggregate demand. Finally,

since monetary shocks are widely believed to affect the aggregate economy via their effects on aggregate demand, the decrease (increase) in *USIP* associated with an unanticipated monetary contraction (expansion) is interpreted as indicating an increase (decrease) in excess capacity. Since the naïve version of the CPH suggests that export volume falls (rises) when capacity pressure increases (decreases) our results are not consistent with the naïve version of the CPH.

The inconsistency described above encouraged us to consider a broader interpretation of the CPH that allows for the possibility that the exogenous shocks that cause changes in capacity pressure and generate co-movements between *USEX* and *USIP* also affect the costs of recommitting resources to the export sector. We find that all of our results are consistent with this broader interpretation of the CPH. In particular, while an unanticipated monetary contraction (expansion) decreases (increases) the pressure on capacity, export volume falls (rises) because the monetary contraction (expansion) increases (decreases) the costs of committing resources to the export sector. Consequently, the observation that monetary shocks (both contractionary and expansionary) lead to a positive correlation between *USEX* and *USIP* is not inconsistent with our broader interpretation of the capacity pressure hypothesis.

For many economists, monetary and/or oil price shocks are responsible for initiating most of the major fluctuations in aggregate economic activity in the postwar period. To the extent that this assessment is accurate, our results suggests that far from being anomalous, the “provocative” conclusions of Dunlevy and of Haynes and Stone [1983] that there is a procyclical relation between their measures of capacity pressure and export performance is exactly the result one would expect to find. In particular, the Dunlevy and Haynes-Stone results is merely a reflection of the type of shocks that were dominant in initiating movements in aggregate activity during their sample.

IV. Summary and Conclusions

Vector autoregressive representations of the U.S. macroeconomy were used to document the relationship between export performance and domes-

tic economic activity. In contrast to the preceding literature, our empirical models explicitly recognize the potential importance of both policy and non-policy shocks as important initiators of business cycle fluctuations and of variation in export volume. The empirical regularities we uncovered suggest that the relationship between business cycle fluctuations and export performance is dependent upon the type of shock that initiates movements in aggregate activity. If the initiating shock is an increase in the relative price of oil or a monetary shock (either contractionary or expansionary), the resulting correlation between export performance and domestic activity is positive. On the other hand, if the initiating shock is a change in government purchases, the correlation is negative.

These results are fully consistent with a broad interpretation of the CPH that allows for the possibility that monetary and other shocks have important effects on the costs of committing resources to the export sector. Overall, our results suggest that the procyclical capacity pressure effect reported in the Dunlevy and Haynes-Stone studies merely reflects the importance of oil price and monetary shocks during their sample periods. Finally, the consistency of our empirical results with the conjecture that monetary and oil price shocks have important effects on the costs of recommitting resources to the export sector highlight the need for further research on the precise mechanism(s) via which any such effects are exerted.

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