Empirical Estimates of the Short-Run Aggregate Supply and Demand Curves for the Post-War U.S. Economy*

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I. Introduction

This paper presents estimates of the short-run aggregate supply and demand curves for the post-war U.S. economy using a structural vector autoregression (SVAR). Following the work of Blanchard and Quah [4] (henceforth BQ) I assume that aggregate demand shocks have no long-run impact on the log of real output. In contrast to BQ I use aggregate output and prices while they use aggregate output and the unemployment rate. By replacing unemployment with prices I can estimate the slopes of the aggregate supply and demand curves for the U.S. economy.

My purpose in extending the work of BQ in this direction is threefold. First, to investigate whether the decomposition method proposed by BQ yields “textbook” aggregate demand and supply curves; second, to investigate whether the supply and demand shocks derived from this method correspond to historical demand and supply shocks; and third, to test the stability of the slope of the aggregate supply curve.

The once-well-accepted stylized characterization of prices as procyclical has recently been questioned (Kydland and Prescott [13] and Wolf [23]). Procyclical prices were previously thought to be evidence that the cycle was aggregate demand driven. The studies by Kydland and Prescott and Wolf show that prices are either acyclical or countercyclical thus indicating that aggregate supply shocks may play a role in business cycle fluctuations. In this paper I test whether, once output movements and prices are decomposed into demand and supply driven components, the aggregate demand induced movements in prices are procyclical and the aggregate supply induced movements in prices are countercyclical. I find that the aggregate supply curve does slope upward and the aggregate demand curve does slope downward. Thus, the evidence presented here is consistent with the notion that the lack of a consistent cyclical pattern in the price level is due to the fact that both demand and supply shocks generate business cycle fluctuations.

Secondly, I extend BQ by investigating whether the movements in output and prices due to aggregate demand and supply shocks correspond to specific episodes of demand and supply shocks during the post-war era as defined by independent sources. For example, does this estimation technique attribute movements in output due to oil price shocks to aggregate supply and

*I thank Frederick L. Joutz, David R. Hakes, Roderick Beck, Jenifer C. Gamber and an anonymous referee for helpful comments. The usual disclaimer applies.
the movement in output during the Volker-recession to aggregate demand? For the most part, oil price shocks and tight monetary policy regimes do correspond to aggregate supply and demand shocks respectively.

The third and final purpose of this extension is to test the stability of the aggregate supply curve. According to Lucas [14] the AS curve will steepen as the variance of absolute price shocks rises relative to the variance of relative price shocks. Over the post-war period the slope of the aggregate supply curve is not stable. I find that the aggregate supply curve was essentially flat in the mid-1960s, steepened throughout the 1970s and then flattened slightly in the 1980s.

This paper is organized as follows. Section II describes the evolution of the literature on decomposing movements in output into permanent and temporary components. Section III describes the Blanchard-Quah technique. Section IV presents the estimates of the supply and demand curves and the results of the stability tests. Section V concludes the paper.

II. Evolution of the Literature

The traditional, pre-1980, method of decomposing output movements into cycle and trend typically assumed that the trend followed a linear or smoothly evolving path. This trend line was assumed to be a function of growth factors such as labor, capital and technology while the remaining cycle was assumed to be a function of aggregate demand.

The work of Nelson and Plosser [15] showed that most macroeconomic time series contain a stochastic rather than deterministic trend. Their work cast doubt on the simple deterministic trend decomposition of output and suggested that at least part of the quarterly fluctuations in aggregate output are due to aggregate supply factors. Although this finding suggests that part of the quarterly change in aggregate output is determined by permanent aggregate supply factors it by no means suggests that all of the quarterly change is a function of these factors. In fact, the work by Nelson and Plosser gave no indication of the amount of output changes due to permanent and temporary shocks—they simply identified the fact that permanent shocks occur each time period. The question of the proportion of the variance in output growth due to each of the two factors was left to subsequent literature.

Figure 1 shows a scatter plot of quarterly growth rates of real GDP and the GDP deflator, 1949:2 through 1992:4. One would expect that if quarterly movements were dominated by aggregate demand the points would form a pattern from the southwest to the northeast thus tracing out an aggregate supply curve. If the movements were dominated by aggregate supply one would expect the points to form a pattern from the northwest to the southeast thus forming an aggregate demand curve. Neither pattern emerges from these points which leads one to conclude that either the model is wrong or both demand and supply shocks are important in determining the position of these points.

The literature on measuring the contribution of aggregate demand and supply can be roughly divided into two types: univariate and multivariate approaches. The univariate approaches typically estimate an ARIMA model for GDP and then assume either that permanent and temporary

1. Typically the AS-AD diagram plots the price level against the level of GDP. Throughout this paper, however, AS-AD refers to the first difference of the log of prices (the inflation rate) plotted against the first difference of the log of output (output growth).

disturbances are perfectly correlated [2] or orthogonal [22]. The multivariate approaches typically impose long-run restrictions on the impulse responses from a vector autoregression. Examples of this literature include Shapiro and Watson [18] who restrict the aggregate labor supply curve to be vertical in the long-run and BQ who restrict aggregate demand shocks to have no long-run impact on the log of real output. Estimates of the percent of the variation in quarterly GDP growth due to permanent shocks vary widely from a low of less than 1 percent (BQ) to a high of 93 percent (Stock and Watson, [21]).

III. The Blanchard-Quah Technique

The Blanchard-Quah decomposition method begins with the estimation of the following moving average representation of output growth (\(\Delta y\)) and the prime age male unemployment rate (\(u\)):

\[
\begin{bmatrix}
\Delta y \\
u
\end{bmatrix} =
\begin{bmatrix}
c_{11}(L) & c_{12}(L) \\
c_{21}(L) & c_{22}(L)
\end{bmatrix}
\begin{bmatrix}
\epsilon^{\Delta y} \\
\epsilon^u
\end{bmatrix}
\]  

(1)

where the \(\epsilon\)'s are mean zero innovations with covariance matrix \(\Omega\) (individual elements of this matrix are denoted by \(\omega_{ij}\)).

This representation is obtained by first estimating the unconstrained vector autoregression

3. Cochrane [6] describes the limitations of using these types of time series methods to identify the underlying sources of business cycle fluctuations.
and then inverting that representation by subjecting each equation to a one unit shock and tracing the effects of that shock through both equations. The resulting unconstrained impulse responses are represented by the polynomials in the lag operator \(c_y(L)\). \(C(L)\) denotes the entire matrix of polynomials. By construction, \(C(0)\), the matrix of contemporaneous responses, is the identity matrix.

The innovations (\(\varepsilon\)'s) are, in general, contemporaneously correlated. It follows that the impulse responses represented by the \(c_y\)'s do not show the responses to independent innovations. This is the problem with interpreting the innovations in a VAR as structural shocks as pointed out by Cooley and LeRoy [7]. In the absence of any identifying restrictions on this system of equations it is impossible to offer a structural interpretation of the innovations. Thus, we seek an alternative representation:

\[
\begin{bmatrix}
\Delta y
\end{bmatrix}
= \begin{bmatrix}
a_{11}(L) & a_{12}(L) \\
a_{21}(L) & a_{22}(L)
\end{bmatrix}
\begin{bmatrix}
\mu^\Delta y \\
\mu^\epsilon
\end{bmatrix}
\]  

(2)

where the \(\mu\)'s are orthogonal innovations with the diagonal covariance matrix \(\Sigma\) (again, individual elements of this matrix are denoted by \(\sigma_{ij}\)). The relationship between representations (1) and (2) is straightforward. Since \(C(0)\) is the identity matrix,

\[A(j) = C(j)A(0) \quad \text{for } j = 0, 1, \ldots,\]

(3)

where \(A(0)\) is a \(2 \times 2\) matrix of contemporaneous responses of \(\Delta y\) and \(u\) to the orthogonal innovations.

Thus, to construct this new representation we must identify the 4 elements of the \(A(0)\) matrix. Three of the 4 elements of this matrix are identified by the restriction that \(A(0)A(0)'\Sigma = \Omega\).

\[
(a_{11}^2 + a_{12}^2)\sigma_{11} = \omega_{11}
\]

(4)

\[
(a_{21}^2 + a_{22}^2)\sigma_{22} = \omega_{22}
\]

(5)

\[
(a_{11}a_{21} + a_{12}a_{22})\sigma_{22} = \omega_{12}
\]

(6)

It is clear from these three equations that some assumption must be made about the \(\sigma\)'s in order to proceed to solve for the \(a_y\)'s.\(^4\) Two obvious possibilities are to assume that \(\sigma_{11} = \omega_{11}\) and \(\sigma_{22} = \omega_{22}\) or alternatively to assume that \(\Sigma\) is the identity matrix, thus \(\sigma_{11} = \sigma_{22} = 1\). The latter assumption is imposed by BQ and has the convenient interpretation that the structural shocks have a variance (and therefore standard deviation) of 1; thus a one unit shock to the system of equations is also a one standard deviation shock.

There are several ways to identify the remaining element of the \(A(0)\) matrix. The early VAR literature [20] employed a Cholesky decomposition which amounts to setting one of the off-diagonal elements of the \(A(0)\) matrix equal to zero. Setting the \(a_{12}(0)\) element to zero amounts to assuming that innovations to the first equation are contemporaneously exogenous with respect to the second equation. Alternatively, setting \(a_{21}(0)\) (or reversing the order of the equations) assumes that innovations to the second equation are contemporaneously exogenous with respect to the first equation.

Although particular Cholesky decompositions can be justified based on economic theory the

\(^4\) The \(aij\)'s in these equations refer to the first elements in the polynomials. The \((0)\) is suppressed for clarity.
early VAR literature more often than not simply imposed them without justification. The litmus test for whether the restriction was reasonable was to see whether the results (variance decompositions and impulse responses) were invariant to the order the variables appeared in the VAR. In other words, in the context of the above example, the same results are obtained when \( a_{11}(0) = 0 \) as when \( a_{12}(0) = 0 \). This amounts to saying that there is very little contemporaneous correlation between the \( \epsilon \)'s.

These Cholesky restrictions were forcefully criticized by Cooley and LeRoy [7]. In response to their criticism structural VAR's were developed. These VAR's make explicit use of economic theory to identify the elements of the \( A(0) \) matrix. Two types of restrictions have been proposed: contemporaneous and long-run restrictions. Contemporaneous restrictions are similar to the zero restrictions described above for the Cholesky decomposition method. The main difference, however, is that the restrictions are drawn from economic theory. Blanchard [3] and Bernanke [1] present examples of this type of SVAR. The second type of restrictions are long-run restrictions. Examples of this in the literature are Blanchard and Quah [4], Shapiro and Watson [18] and Gamber and Joutz [11]. Gali [10] uses both contemporaneous and long-run restrictions to identify his model.

To illustrate how the long-run restrictions are used to identify the remaining element of the \( A(0) \) matrix, consider the restriction imposed by Blanchard and Quah that the long-run impact of an aggregate demand shock on the log of real output is zero.\(^5\)

Letting the \( \mu^{AD} \) be the aggregate demand shock, this restriction implies that the \((1,1)\) element of \( \sum C(L)A(0) = 0 \). Thus, the fourth equation becomes,

\[
\sum c_{11}(L)a_{11}(0) + \sum c_{12}(L)a_{12}(0) = 0. \tag{7}
\]

Solving these four equations (4–7) for the four elements of \( A(0) \) just identifies the two structural shocks of the system. The first shock in the system is interpreted as an aggregate demand shock and the second shock as an aggregate supply shock. Once the \( A(0) \) matrix is constructed equation (3) can be used to derive the structural impulse response functions and variance decompositions from the estimated \( C(L) \) matrix. The identifying restrictions used by BQ do not (directly) constrain the short-run dynamics of the system nor do they constrain the signs on the relationship between aggregate demand and aggregate supply shocks on output growth and the unemployment rate.

IV. Applying the Blanchard-Quah Technique to Price and Output Data

Blanchard and Quah estimate their model with the growth rate of real GDP and the prime age male unemployment rate. In this section I replace the unemployment rate with the inflation rate (\( \pi \)) as measured by the differenced log of the GDP implicit price deflator, base year 1987.\(^6\) The

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5. Note that labelling this shock "aggregate demand" imposes the restriction that the natural rate hypothesis holds in the long-run. As demonstrated by Durlauf [9] it is possible to generate highly persistent movements in output from aggregate demand shocks in a model where coordination failures are important. See Copper and John [8] for an example of such a model.

6. The augmented Dickey-Fuller (ADF) test applied to the inflation rate with 1 lagged dependent variable in the test regression yielded a \( t \)-statistic of \(-4.02 \) which is significant at the 5% level. Thus, using the sample from 1949.4–1992.4 the unit root null is rejected. The lag length for the ADF test was chosen using the highest significant lag method.
sample period is 1949.1–1992.4. GDP is billions of 1987 $'s. Both variables are in annual growth rate form. To begin, I estimate the following VAR with 4 lags of each variable on the right-hand side:

\[ \Delta y_t = b_0 + \sum_{i=1}^{4} b_1 \Delta y_{t-i} + \sum_{i=1}^{4} b_2 \pi_{t-i} + \epsilon_t^{\Delta y} \]  
\[ \pi_t = d_0 + \sum_{i=1}^{4} d_1 \Delta y_{t-i} + \sum_{i=1}^{4} d_2 \pi_{t-i} + \epsilon_t^\pi. \]  

(8a)  
(8b)  

The coefficient estimates are presented in the Appendix.

The next step is to estimate the covariance of the estimated residuals:

\[ \Omega = \begin{bmatrix} 14.05 & 1.65 \\ -1.65 & 4.67 \end{bmatrix}. \]

I then invert the autoregressive representation to get a moving average representation. For convenience I normalize the variance of the structural shocks to one. Further, I restrict aggregate demand shock to have no long-run impact on the log of real output. Together the normalization and the long run restriction yield equations (4)–(7) which can be solved for the 4 elements of the \( A(\theta) \) matrix:

\[ A(\theta) = \begin{bmatrix} 2.11 & 3.09 \\ 1.81 & -1.18 \end{bmatrix}. \]

Finally, the \( A(\theta) \) matrix can be used to construct the structural impulse responses from the relationship described by equation (3).

These impulse responses are presented in Figures 2–5. The middle line is the point estimate of the impulse response function. This is surrounded by the 95% confidence interval which is calculated from 1000 bootstrap simulations [17]. Note that, as predicted by theory, aggregate demand shocks have a positive impact on output and prices while aggregate supply shocks have a positive impact on output and a negative impact on prices.

Although the shapes of the aggregate supply and demand curves can be inferred from these impulse responses, a clearer representation of them can be obtained by reconstructing the output growth and inflation series using one shock at a time and then producing a scatter plot of the resulting series. This produces a graph which can be directly compared with the unconstrained scatter plot shown in Figure 1. To construct these series, first notice that the actual data on output growth and inflation can be reconstructed using the estimated structural impulse responses and the estimated structural shocks.

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as recommended by Campbell and Perron [5]. This result, however, is sensitive to the choice of sample period and lag length. Since the textbook aggregate demand and supply model specifies a relationship between the level of output and the price level I chose to difference both variables once. Thus, I used inflation in its level form in the regressions that follow. As pointed out in footnote 7, the estimated residuals from the vector autoregression were not serially correlated.

7. The Ljung-Box Q-statistics evaluated at 4, 8, 12 and 24 lags of the estimated residuals were .95, 4.9, 5.3 and 13.2. In each case I failed to reject the null hypothesis of no serial correlation in the estimated residuals. Similar results were obtained when 8 lags (as in BQ) of each variable were used in the vector autoregressions. The shorter lag length was used and reported throughout this paper because of the savings in degrees of freedom. This was an important consideration for some of the shorter sample estimates reported later in this section.
Figure 2. Output Response to Aggregate Demand

Horizontal axis label: periods
Vertical axis label: output response

Figure 3. Output Response to Aggregate Supply

Horizontal axis label: periods
Vertical axis label: output response
Figure 4. Price Level Response to Aggregate Demand
Horizontal axis label: periods
Vertical axis label: price level response

Figure 5. Price Level Response to Aggregate Supply
Horizontal axis label: periods
Vertical axis label: price level response
\[
\Delta y_{T+j} = \sum_{s=0}^{j-1} a_{11}(s) \hat{\mu}_{T+s-1} + \sum_{s=0}^{j-1} a_{12}(s) \hat{\mu}_{T+s-2} + \Delta \hat{y}_{T+j} \quad (9)
\]
\[
\pi_{T+j} = \sum_{s=0}^{j-1} a_{21}(s) \hat{\mu}_{T+s-1} + \sum_{s=0}^{j-1} a_{22}(s) \hat{\mu}_{T+s-2} + \hat{\pi}_{T+j} \quad (10)
\]

where the hatted variables denote the forecasts based on time \( T \) (first observation of the sample) information. To construct output growth due to aggregate demand shocks (denoted \( \Delta y^{AD} \)), I set \( \mu^T \) to zero in equation (9). Similarly, to generate output growth due to aggregate supply shocks (denoted \( \Delta y^{AS} \)) I set \( \mu^T \) to zero in equation (9). I repeated this procedure for the inflation rate due to aggregate demand (denoted \( \pi^{AD} \)) and the inflation rate due to aggregate supply (denoted \( \pi^{AS} \)).

The scatter plot of \( \Delta y^{AD} \) and \( \pi^{AD} \) along with the regression line is shown in Figure 6. The regression equation is as follows:

\[
\pi^{AD} = 0.147 + 0.646 \Delta y^{AD} \quad \text{adjusted } R^2 = 0.35,
\]

where standard errors are in parentheses.

The scatter plot of \( \Delta y^{AS} \) and \( \pi^{AS} \) along with its regression line is shown in Figure 7. The regression equation is as follows:

\[
\pi^{AS} = -0.02 - 0.36 \Delta y^{AS} \quad \text{adjusted } R^2 = 0.74.
\]

It is clear from these regression estimates and the scatter plots that the aggregate demand curve slopes downward and the aggregate supply curve slopes upward. The interpretation of these coefficients is as follows. First note that the values plotted in Figures 6 and 7 represent deviations from hatted (forecasted) values. Along the aggregate supply curve, a positive inflation innovation of 1% corresponds to a positive innovation in annual GDP growth of 1.55%. Similarly, along the aggregate demand curve, a positive inflation innovation of 1% corresponds to a negative innovation in annual real GDP growth of 2.78%.

Consider the following specific example from the sample. The forecasted values of GDP growth and inflation for the 2nd quarter of 1988 were 3.04% and 4.50% (annual rates). The actual growth rates were 4.32% for GDP and 4.38% for the deflator. Thus, growth was 1.28 percentage points higher than expected and inflation was .12 percentage points lower than expected. Of the 1.28 percentage points of unexpected growth 1.06 percentage points were due to aggregate supply while .22 percentage points was due to aggregate demand. Of the .12 unexpected shortfall in inflation .28 was due to aggregate demand while -.40 was due to aggregate supply.

The next question addressed in this paper is whether the values for aggregate demand and supply shocks identified above correspond to aggregate demand and supply shocks identified from other sources. To address this question I match the four constructed series \( \Delta y^{AD}, \Delta y^{AS}, \pi^{AD} \) and \( \pi^{AS} \) with three sets of dates identified using different methodologies. The first set of dates is the NBER-defined recession dates. The second set of dates is the series of oil price shock dates.

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8. In the estimates presented below I eliminated the hatted terms. This effectively sets the intercept term to zero, thus the resulting series are deviations from the forecasted values.
Figure 6. Scatter Plot of Output Growth and Inflation Due to Aggregate Demand

Horizontal axis label: $\Delta y^AD$
Vertical axis label: $\pi^AD$

Figure 7. Scatter Plot of Output Growth and Inflation Due to Aggregate Supply

Horizontal axis label: $\Delta y^AS$
Vertical axis label: $\pi^AS$
identified by Hamilton [12]. The final set of dates is the series of monetary contraction dates identified by Romer and Romer [16] using the narrative approach.10

Figures 8 and 9 show the time series plots of output due to aggregate supply.11 Figure 8 shows that each of the NBER-defined recessions occurs during a large negative supply shock. Figure 9 shows that each of the large negative movements in output due to aggregate supply occur during the periods of oil price increases identified by Hamilton [12]. The largest negative supply shock is clearly the 1973–74 oil price shock.

Figures 10 and 11 show the time series plots of output due to aggregate demand. These figures are constructed by subtracting the log of output due to aggregate supply (including the drift component) from the actual log of output. Figure 10 shows that each of the NBER-defined recessions occurs during a period of negative aggregate demand shocks. Note, however, that there are several episodes where aggregate demand shocks moved output down but no recession occurred (presumably because they were offset by positive aggregate supply shocks). Figure 11 shows the output due to aggregate demand with the Romer and Romer [16] dates superimposed on the graph. Again, output appears to move downward following each of these dates. However, as was the case with the NBER-defined dates, there are several other negative movements in output which do not directly follow these dates. Clearly, the largest negative movement in output due to aggregate demand followed the Volker-monetary contraction beginning October 1979.

Table I presents the estimated means of the four series $\Delta y^{AD}$, $\Delta y^{AS}$, $\pi^{AD}$ and $\pi^{AS}$ over the sub-samples identified by other sources. For example, the top line of the table shows the average of the 4 series during the NBER-defined recessions. These averages were estimated by regressing each of the series on a constant and a dummy variable equal to one during recession and zero otherwise. The regressions were corrected for first order serial correlation.

As expected from the graphical evidence output growth is lower during recessions due to both aggregate demand and aggregate supply. Inflation due to aggregate demand does not fall significantly during recessions. Inflation due to aggregate supply rises during recessions. Both the graphical evidence and the means presented in Table I indicate that aggregate demand and supply shocks are jointly responsible for the NBER-defined recessions.

The second set of numbers presented in Table I show the means of the four series during the oil price shock dates identified by Hamilton [12]. Note that output growth due to aggregate supply is significantly lower during these periods and inflation due to aggregate supply is (marginaly) significantly higher. Further, there are no differences in either the mean inflation rate or the mean growth in output due to aggregate demand during these periods. Thus, using the natural rate identifying restriction I find that movements in output growth and inflation during the Hamilton oil shock periods are solely due to aggregate supply shocks.

The final set of numbers presented in Table I show the means of the four series during the Romer and Romer [16] monetary contraction periods. The means presented in the row labeled "Romer" are based on the quarter containing the date identified by Romer and Romer and the three quarters following that date. The results show that there are no significant differences in either output growth or inflation due to aggregate demand during these periods. However, output


10. The monetary contraction periods identified by Romer and Romer [16] are: October 1947, September 1955, December 1968, April 1974, August 1978 and October 1979. The October 1947 episode was not included in the present analysis since it occurred prior to the start of the sample.

11. The drift is removed to make the fluctuations due to aggregate supply easier to identify.
Figure 8. Output Due to Aggregate Supply (drift removed) with NBER-defined Peaks and Troughs

Horizontal axis label: date
Vertical axis label: $y^A$ (percent deviation from drift)

Figure 9. Output Due to Aggregate Supply (drift removed) with Hamilton-defined Oil Shock Dates

Horizontal axis label: date
Vertical axis label: $y^A$ (percent deviation from drift)
Figure 10. Output Due to Aggregate Demand with NBER-defined Peaks and Troughs

Horizontal axis label: date
Vertical axis label: percent deviation from $y^{A5}$

Figure 11. Output Due to Aggregate Demand with Romer and Romer Defined Monetary Contraction Dates

Horizontal axis label: date
Vertical axis label: percent deviation from $y^{A5}$
Table I. Estimated Means of Output Growth and Inflation Due to Aggregate Demand and Supply

<table>
<thead>
<tr>
<th></th>
<th>$\Delta y^{AD}$</th>
<th>$\Delta y^{AS}$</th>
<th>$\pi^{AD}$</th>
<th>$\pi^{AS}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recession</td>
<td>-1.47**</td>
<td>-2.26**</td>
<td>-.42</td>
<td>.84**</td>
</tr>
<tr>
<td>Expansion</td>
<td>.34</td>
<td>.60**</td>
<td>.32</td>
<td>-.25**</td>
</tr>
<tr>
<td>Difference</td>
<td>-1.81**</td>
<td>-2.86**</td>
<td>-.74</td>
<td>1.09**</td>
</tr>
<tr>
<td>Hamilton</td>
<td>-.44</td>
<td>-1.25**</td>
<td>.29</td>
<td>.27</td>
</tr>
<tr>
<td>non-Hamilton</td>
<td>.16</td>
<td>.55**</td>
<td>.11</td>
<td>.15</td>
</tr>
<tr>
<td>Difference</td>
<td>-.60</td>
<td>-1.80**</td>
<td>.18</td>
<td>.42*</td>
</tr>
<tr>
<td>Romer</td>
<td>-.51</td>
<td>-2.34**</td>
<td>.22</td>
<td>.82**</td>
</tr>
<tr>
<td>non-Romer</td>
<td>.04</td>
<td>.32</td>
<td>.16</td>
<td>-.14</td>
</tr>
<tr>
<td>Difference</td>
<td>-.55</td>
<td>-2.66**</td>
<td>.06</td>
<td>.96**</td>
</tr>
</tbody>
</table>

Notes: These means were estimated by regressing the indicated series on a constant and a dummy variable equal to one during the indicated period and zero elsewhere. The regressions were corrected for first order serial correlation. * indicates significant at the 0.10 level, ** indicates significant at the 0.05 level.

Table II. Sums of Coefficients on Fiscal Policy and Supply Shock Proxies

<table>
<thead>
<tr>
<th>Proxy</th>
<th>$\Delta y^{AD}$</th>
<th>$\Delta y^{AS}$</th>
<th>$\pi^{AD}$</th>
<th>$\pi^{S}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiscal Policy</td>
<td>2.20**</td>
<td>-.92</td>
<td>1.60**</td>
<td>.28</td>
</tr>
<tr>
<td>Supply Shock</td>
<td>.52**</td>
<td>-.37**</td>
<td>.44**</td>
<td>.13**</td>
</tr>
</tbody>
</table>

Notes: ** indicates significant at the 0.05 level.

growth due to aggregate supply is significantly lower and inflation due to aggregate supply is significantly higher. These results are most likely due to the fact that two of the largest oil price shocks identified by Hamilton (1973–74 and 1978–79) are close to three of the five monetary contraction dates identified by Romer and Romer (April 1974, August 1978 and October 1979).

I next regressed each of the four constructed series on eight lags of itself and the contemporaneous value and eight lags of proxies for fiscal policy and supply shocks. Following Romer and Romer [16], I use the quarterly change in the ratio of the nominal budget surplus to nominal GDP to proxy fiscal policy and the quarterly percent change in the relative price of food and energy to proxy supply shocks. Table II presents the results from these regressions. Each cell presents the sums of the coefficients on the contemporaneous and lagged values of the indicated variable. The significance level is for the null that this sum is equal to zero.

As expected, the aggregate demand components of both inflation and output growth are positively correlated with contemporaneous and lagged fiscal policy. In addition, there is no significant relationship between the aggregate supply components of inflation and output growth and contemporaneous and lagged fiscal policy. The bottom row of Table II shows that all four constructed series are correlated with the contemporaneous and lagged measure of supply shocks. The positive correlation between the aggregate demand components of output growth and inflation and the supply shock proxy could be due to reverse causality.

As a final check on the reasonableness of the BQ technique for identifying aggregate shocks I tested for the stability of the slope of the aggregate supply curve. Lucas [14] showed that the

12. These variables are constructed the same as in Romer and Romer [16]. The government budget surplus includes federal, state and local surpluses. The relative price of food and energy is the weighted average of the producer price indexes for foodstuffs and feedstuffs, crude fuel and crude petroleum divided by the producer price index for finished products.
higher the variance of absolute price shocks relative to the variance of relative price shocks the steeper the slope of the aggregate supply curve. For the sample period considered here we should therefore see a steepening of the aggregate supply curve during the 1970s as inflation and inflation variability increased and a flattening during the 1980s as inflation subsided.

Figure 12 shows the recursive estimates of the aggregate supply curves slope. The point estimates are surrounded by the 95% confidence interval. The sample for each estimate is from 1949:2 to the point on the horizontal axis. The first point plotted is for the sample 1949:2 through 1968:4. The slope of the aggregate supply curve is clearly not stable over the entire period. As expected the slope of the aggregate supply curve was essentially zero in the sample through 1968, steepened throughout the 1970s and flattened slightly in the 1980s.

The estimated slope of the aggregate supply curve using the sample 1949:2 through 1968:4 is .23 with a standard error of .25. The estimated slope using the sample 1949:2 through 1978:4 is 1.5 with a standard error .18. The estimated slope using the sample 1983:1 through 1992:4 is .24 with a standard error of .06.

V. Summary and Conclusion

This paper presents estimates of the aggregate supply and demand curves for the post-war U.S. economy using the technique developed by Blanchard and Quah [4]. Using output growth and inflation instead of output growth and unemployment I obtain the following results: As expected, the aggregate supply curve is positively sloped and the aggregate demand curve is negatively sloped. The movements in inflation and output due to aggregate supply are closely related to iden-
tified oil price shocks. The movements in inflation and output growth due to aggregate demand are loosely related to identified contractionary monetary policy episodes. These results could be a reaffirmation of Friedman’s observation that monetary policy effects output and prices with long and variable lags. Finally, I find that the slope of the aggregate supply curve over the post-war period changed as predicted by Lucas [14]. Namely, it became steeper in the 1970s as the level and volatility of inflation increased and it flattened again in the 1980s as inflation subsided.

Appendix

Table AI. Regression Coefficients for Equations (8a) and (8b)

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>$\Delta y_t$</th>
<th>$\pi_t$</th>
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</thead>
<tbody>
<tr>
<td>$\Delta y_{t-1}$</td>
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<td>.06</td>
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<tr>
<td></td>
<td>(.08)</td>
<td>(.04)</td>
</tr>
<tr>
<td>$\Delta y_{t-2}$</td>
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<td>.03</td>
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<tr>
<td></td>
<td>(.08)</td>
<td>(.04)</td>
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<tr>
<td>$\Delta y_{t-3}$</td>
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<td>-.07</td>
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<tr>
<td></td>
<td>(.08)</td>
<td>(.04)</td>
</tr>
<tr>
<td>$\Delta y_{t-4}$</td>
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<td>-.20</td>
</tr>
<tr>
<td></td>
<td>(.07)</td>
<td>(.04)</td>
</tr>
<tr>
<td>$\pi_{t-1}$</td>
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<td>.34</td>
</tr>
<tr>
<td></td>
<td>(.14)</td>
<td>(.08)</td>
</tr>
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<td></td>
<td>(.14)</td>
<td>(.08)</td>
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<tr>
<td>$\pi_{t-4}$</td>
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<td>.10</td>
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<td></td>
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<td>(.08)</td>
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<td></td>
<td>(.71)</td>
<td>(.41)</td>
</tr>
</tbody>
</table>

Standard errors are in parentheses below the coefficient estimates. These estimates were obtained using the SHA-ZAM [19] statistical software package.

References


