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**Oil Prices and the Third District States\***

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With oil prices reaching an all-time high in mid-2008 and expectations that oil demand in emerging markets will continue to rise in the coming years, it would be helpful to view how high oil prices affect our local economy: our three-state region of Pennsylvania, New Jersey, and Delaware. Current thought suggests that increasing oil prices, and subsequently high gas prices, have a large and negative impact on economic growth. Increasing oil prices, as the story goes, divert a larger and larger share of consumer spending toward energy expenditures, decreasing the share available for other purchases, and the breadth of this spending diversion is sizable enough to stall output growth.

However, according to new research, the significance attributed to oil-price shocks is really based on anecdotal evidence from the 1970s, a time when supply was severely constrained by political factors and the economic conditions faced were far different from today's economic realities. Since the 1970s, oil-price shocks have become less of a burden on the overall economy. In a 2007 NBER working paper,<sup>1</sup> authors Olivier Blanchard and Jordi Gali use a variety of econometric tools to evaluate the impact of oil prices on national variables: real GDP, employment, and inflation, to name a few. Their conclusions follow two paths. First, oil-price shocks can only fuel the flames of concurrent economic stress, rather than being the sole driver of

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\* The views expressed here are those of the author and do not necessarily reflect those of the Federal Reserve Bank of Philadelphia or of the Federal Reserve System. Jason Novak is a senior economic analyst and can be contacted at [Jason.Novak@phil.frb.org](mailto:Jason.Novak@phil.frb.org).

<sup>1</sup> Olivier J. Blanchard and Jordi Gali. "The Macroeconomic Effects of Oil Shocks: Why Are the 2000s So Different from the 1970s?," NBER Working Paper 13368 (September 2007).

economic slowdown. Second, the negative impact of oil-price shocks has lessened over the past 30 years. They point to changes in monetary policy since 1980 (a stronger inflation-fighting stance), more flexible labor markets, and a declining share of oil in the economy as an explanation.

Given the limited amount of data available at the state level, I cannot replicate the entire Blanchard and Gali (2007) study. In this note, I adopt only one of their methodologies; this methodology, which is described in section four of their paper, is critical to their second claim that oil-price shocks have lessened over the past 30 years. I focus on two variables: real wages and salaries and total employment in each of the three states. The results are visual in nature and are suggestive of Blanchard and Gali's national results. However, for the three states, there are key differences in the relationships between oil prices and the state-level variables.

- State employment and real wages for our region are far more sensitive to oil-price shocks than the national variables.
- The relationships between oil-price shocks and three-state variables remained highly negative well into the 1990s, whereas the national relationship as a whole gradually improved from the mid-1980s on.

### **Application**

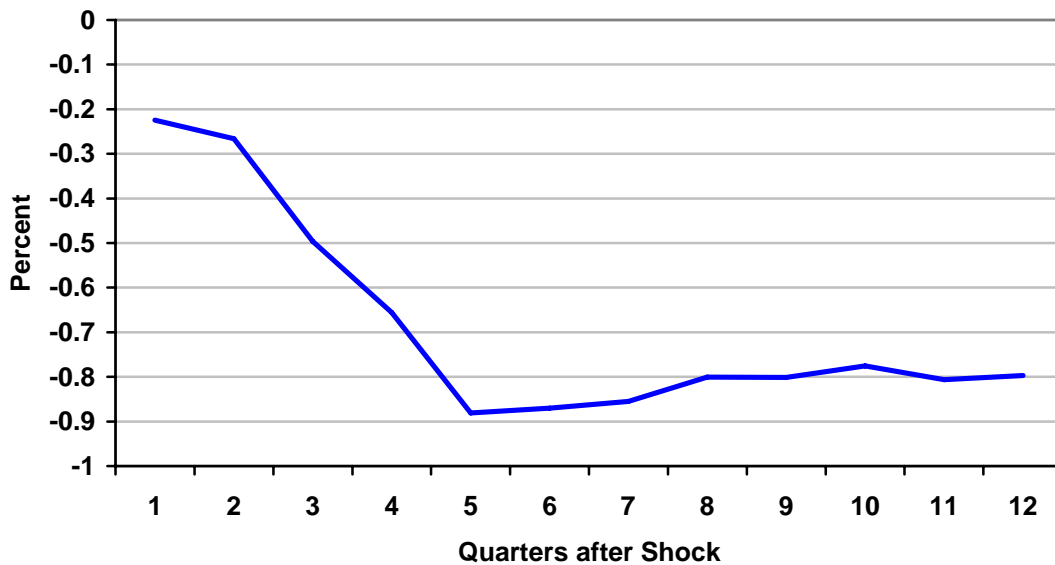
In their analysis, Blanchard and Gali simulated an oil-price shock, documented the responses in national variables, and mapped these responses in order to show how a variable's sensitivity has changed over time. Their method relies on a regression model between the variable of interest, past values of itself, and changes in the price of oil. The structure is as follows:

$$y_t = \alpha + \sum_{i=1}^4 \beta_i y_{t-i} + \sum_{j=0}^4 \gamma_j \Delta Oil_{t-j} + \varepsilon_t$$

where  $y_t$  is the variable of interest and  $\Delta Oil_t$  is the change in the price of oil.<sup>2</sup> In addition to the current change in the price of oil, there are also four lagged values each for  $y_t$  and  $\Delta Oil_t$ .

This model describing the relationship between oil prices and  $y_t$  is estimated using OLS. To simulate an oil-price shock, as Blanchard and Gali did, we can use the coefficient estimates from the model to create an impulse response function, which is essentially the difference between two simulations of the model: one with a shock to the oil price and one without a shock. This is best illustrated by example. We estimated the model where  $y_t$  is real GDP and  $\Delta Oil_t$  is the change in the price of West Texas Intermediate. The observation period spans the 40 quarters between 1965 and 1975. Using the estimated relationship between oil prices and real GDP, we can simulate a shock in the oil price, and plot the resulting impulse response function (Chart 1).

**Chart 1. Accumulated Response of GDP to an Oil-Price Shock  
(Observation Period 1965Q1-1974Q4)**



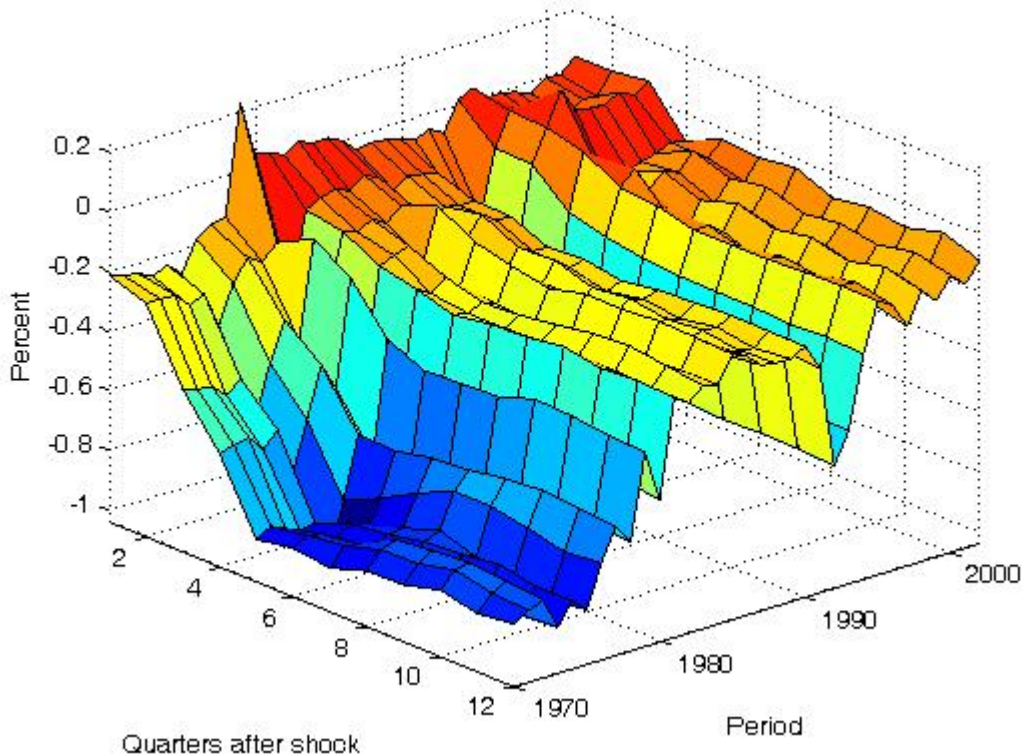
A one-time 10 percent (log) increase in oil price was simulated, and the associated response in real GDP, keeping all else equal, is plotted for 12 quarters after the shock. The

<sup>2</sup> All variables are in natural logarithmic scale. Oil price is the price of West Texas Intermediate.

response is accumulated over time. Initially, GDP declined at an increasing rate (compared to the baseline response), reaching -0.9 percent after five quarters. After that, GDP levels off and regains some of the losses by the end of the simulation. Therefore, during the 10-year period from 1965 to 1975, if there had been an increase in the price of oil, on average, the response from the level of real GDP was substantial and negative.

What is novel about the Blanchard and Gali method is that they repeated this process and gathered impulse response functions for each 10-year period between 1965 and 2007, incrementing one-year forward for each response function. In total, there were 32 separate impulse response functions describing how real GDP reacted to an oil-price shock. In the chart below, these results for real GDP are shown in three dimensions. The accumulated response to an oil shock is plotted on the vertical axis. On the left x-axis, we have the simulation period of 12 quarters after the oil-price shock. On the right x-axis, impulse response functions for each 10-year period are represented according to their centers; for example 1970, which corresponds to Chart 1, is the center of 1965 to 1975 period.

Chart 2. Response of GDP



Looking from left to right, we can see in the early years of the analysis that real GDP was highly responsive to an increase in the price of oil, in a negative way. From 1970 to 1978, the pattern was very similar to that in Chart 1 in that GDP reached its peak losses by the fifth quarter after the shock (dark blue represents a decline of  $-0.8$  to  $-1.0$  percent). After the fifth quarter, GDP did not decline further and was well below pre-shock levels for the remainder of the simulations.

In the 1980s and beyond, the relationship between oil-price shocks and real GDP was far different. For much of the 1980s, the simulations recorded minimal declines in GDP in response to an oil-price shock, around  $-0.2$  to  $-0.4$  percent (yellow). Outside of the decline in the early 1990s (the Iraq-Kuwait war), this low-response relationship remained in the 1990s and early 2000s, with accumulated declines ranging from  $0.0$  to  $-0.2$  percent by the end of the 12-quarter simulation.

### **Third District States and Oil Prices**

Applying this methodology to state-level data is straightforward. However, the choice of data sources has to be modified because GDP data at the state level are available only in annual estimates. This frequency of observations removes much of the short-term cyclicity necessary for this analysis. For example, in the estimates of the model for national GDP, much of the impact of the oil-price shock came during the first five quarters of the simulation. Using the annual state-level GDP data would be ineffective.<sup>3</sup> Personal income data, although they do not encompass the entirety of output, are measures of value as well and are quarterly in frequency. In fact, personal income data, and to a greater extent the wages and salaries component, map a similar cyclical pattern to GDP data over the past 40 years.

In this analysis, I use real wages and salaries at the state level as a value measure potentially affected by oil-price shocks. Following Blanchard and Gali, I also test the state employment series. The regression model is set up the same as for real GDP, where  $y_t$  is represented by our variable of interest. The models were run for both variables — real wages and salaries and employment — for each of the three states and the nation. Each model was simulated using a one-time 10 percent (log) change in the price of oil. The 3D graphs for real wages and salaries are below.

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<sup>3</sup> The Philadelphia Fed's state coincident indexes would serve as a proxy for state GDP. However, data for the indexes start in 1980, missing the 1970s, which is a critical period for this analysis.

Chart 3. Response of US Wages + Salaries

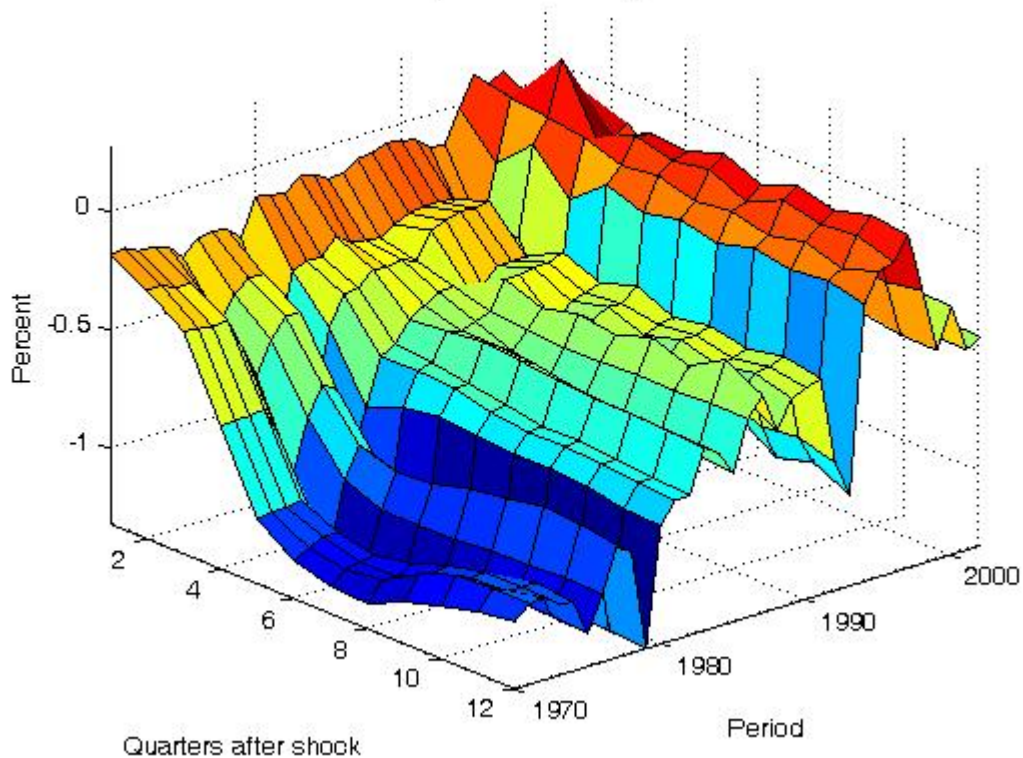


Chart 4. Response of DE Wages + Salaries

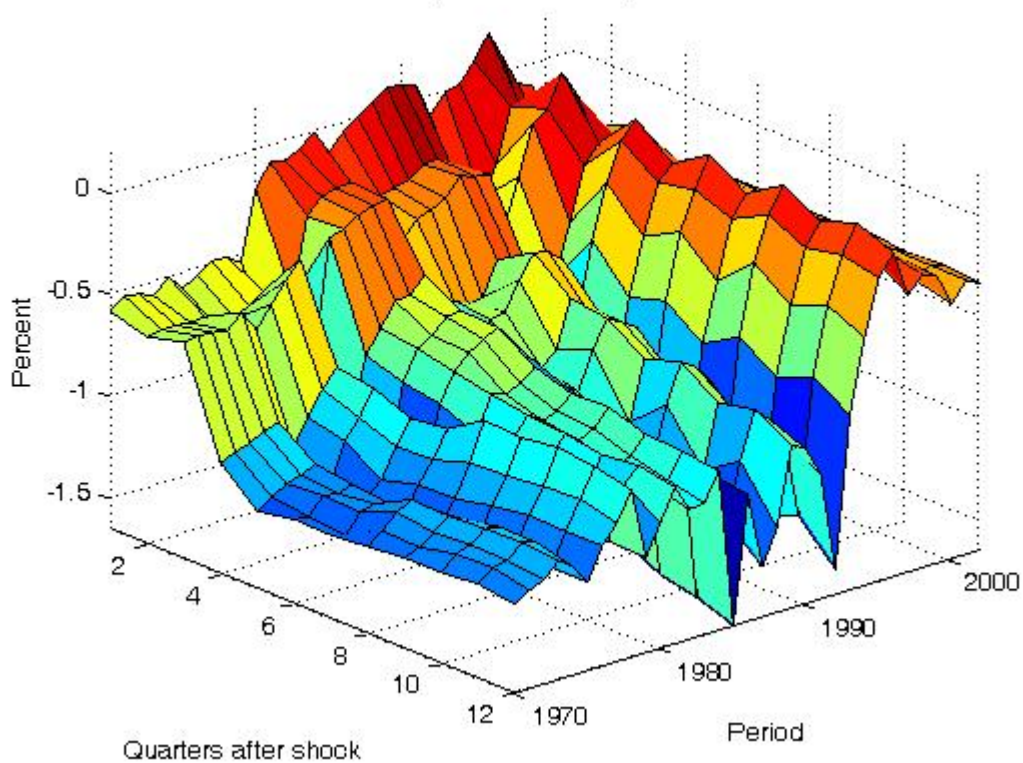


Chart 5. Response of NJ Wages + Salaries

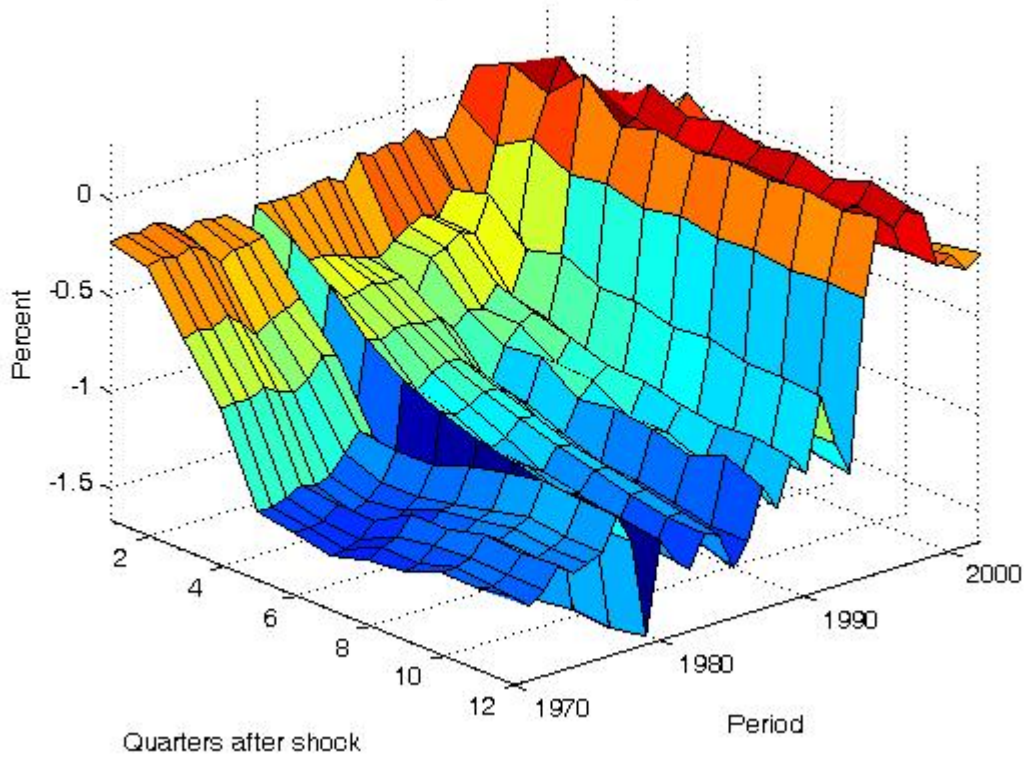
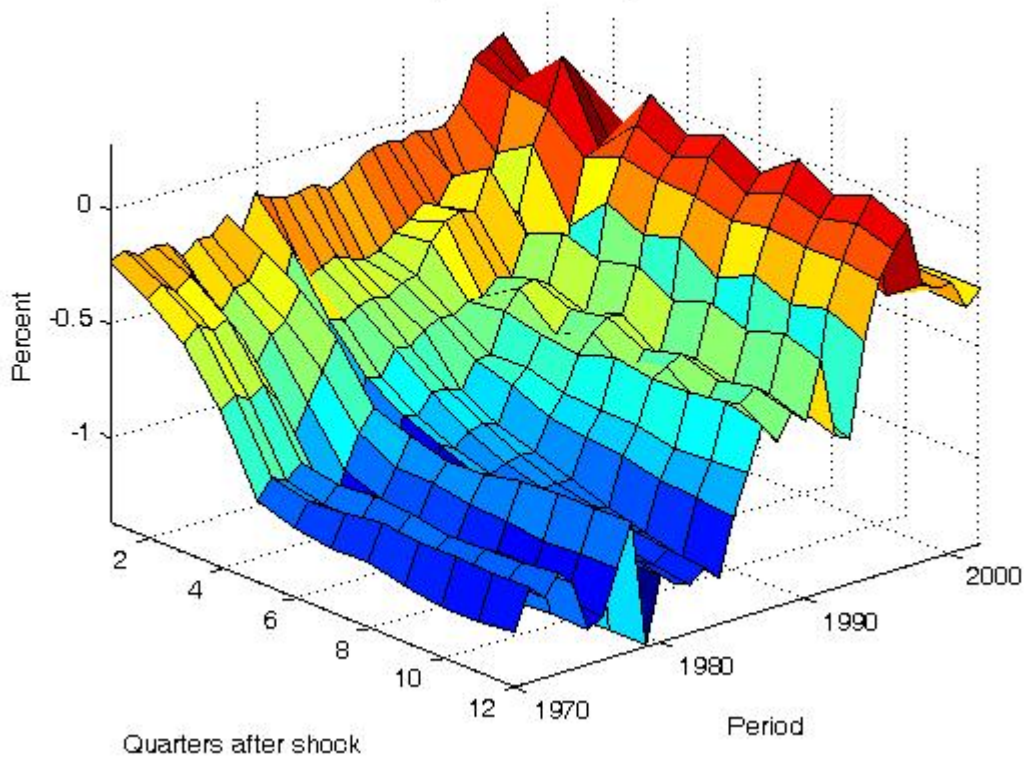


Chart 6. Response of PA Wages + Salaries





First of all, real wage and salary data are more volatile than GDP, especially at the state level, and this is transparent in the modeling results above. At the national level in the impulse response functions for the early 1970s, the declines in real wages were similar to the drop observed in the GDP level, though it is deeper in percentage terms (-1.2 percent) and it required seven quarters to reach its maximum loss rather than five. As in GDP, the period 1980-2004 looks much different from the 1970s in that the sensitivity to oil-price shocks is less dramatic.

At the state level, the declines in real wages and salaries remained into the 1980s and early 1990s, suggesting that oil-price shocks continued to be costly for our three-state region long after this relationship softened at the national level. Also, excluding the late 1990s and 2000s, the relationship did not gradually improve as it did in the nation. From the mid-1990s, the relationship between real wages and salaries and oil prices changed dramatically in that it was negligible if not positive in recent years for all three states, reversing the period of consistently negative responses.

The other variable of interest, employment, and its responses to an oil-price shock are plotted in the next series of 3D charts.<sup>4</sup>

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<sup>4</sup> In Blanchard and Gali (2007), employment was represented by total hours worked for each quarter. Since this metric is not available for the states, total number of employees was used for both the states and the national models presented here.

Chart 7. Response of US Employment

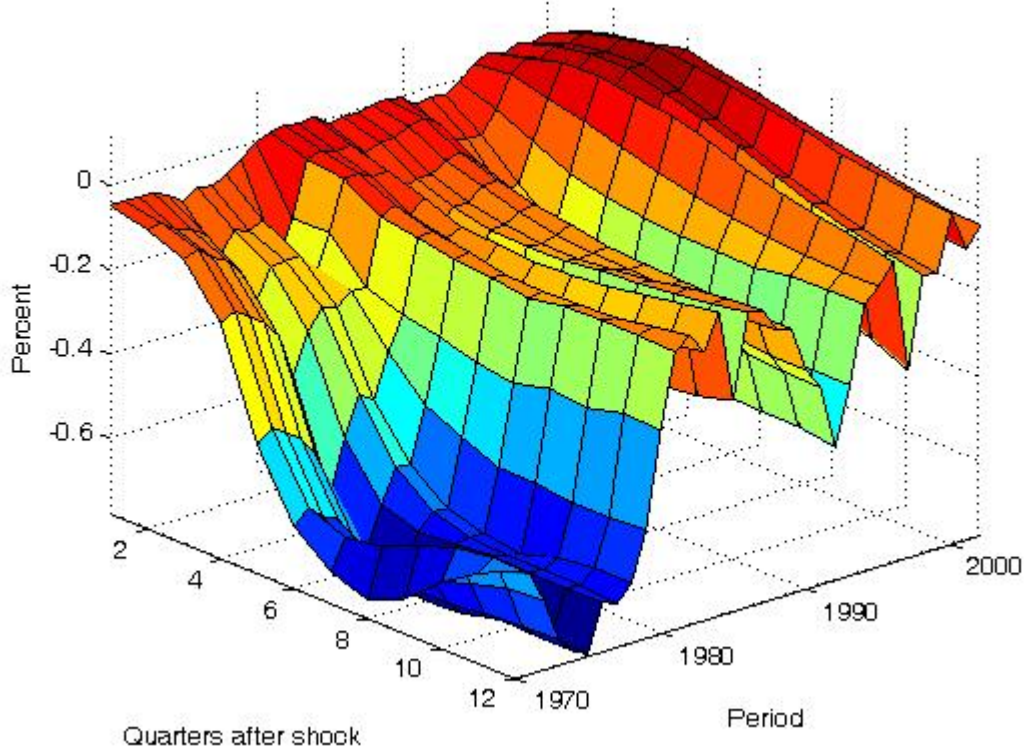


Chart 8. Response of DE Employment

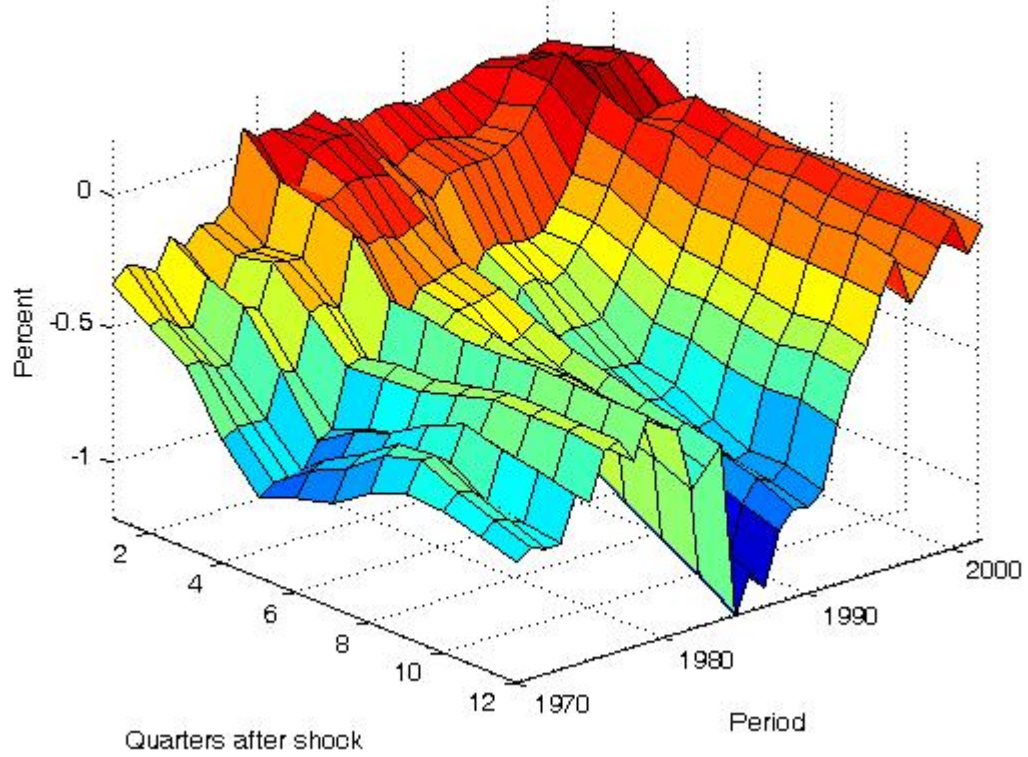
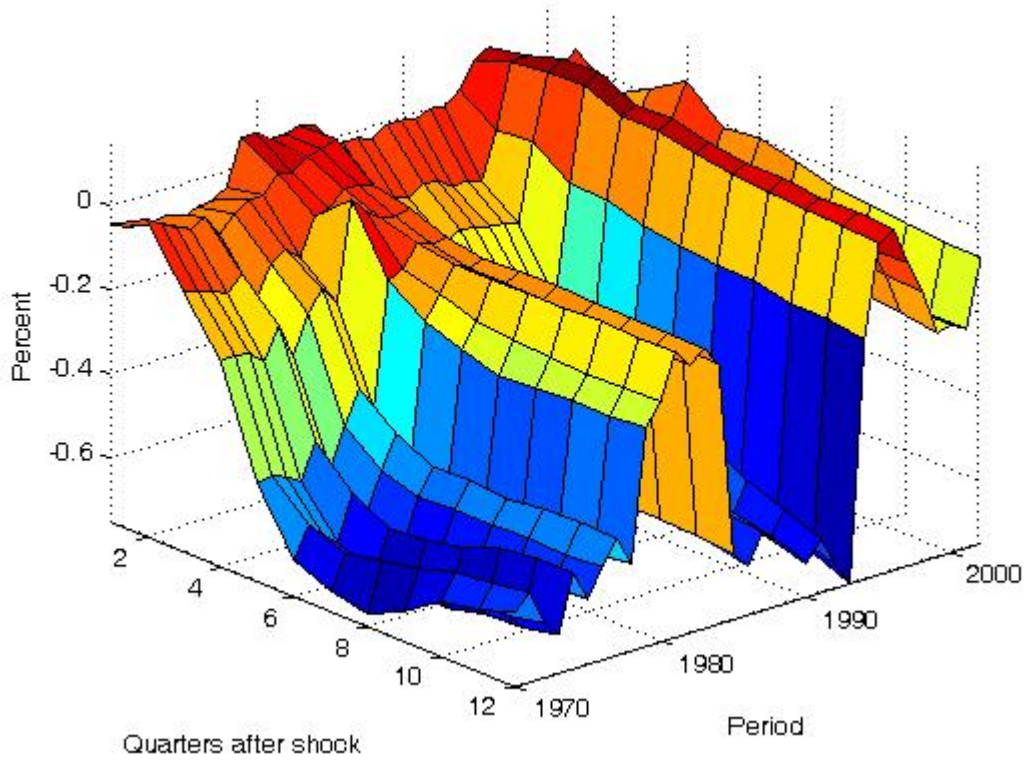
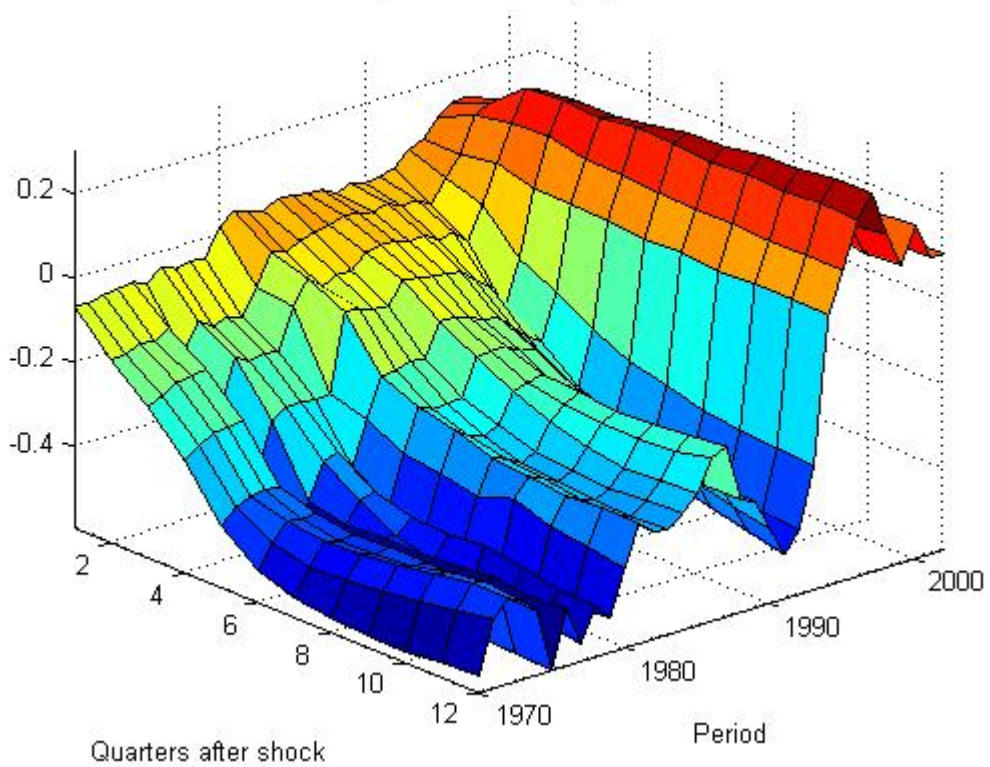


Chart 9. Response of NJ Employment



Response of PA Employment



The overall story from real wages and salaries applies to employment as well. Sensitivity to oil-price shocks in our three states remained far into the 1990s, while in the nation the pattern had changed by 1980. Volatility was much more pronounced in New Jersey, where declines were severe in the 1970s, late 1980s, and early 1990s.

### **Prolonged Relationship to Oil-Price Shocks in Third District States**

Over the past 30 years, national employment and real wages and salaries have become less sensitive to oil-price shocks. This is not the case for Pennsylvania, New Jersey, and Delaware. Estimation of Blanchard and Gali's models for the three-state region suggests that a sizable negative relationship with oil prices carried well into the early 1990s.

What might set the three states apart from the nation? It may be that a significant portion of national income is procyclical with oil prices; that is, earnings associated with domestic production and employment increase in response to increased oil prices. Pennsylvania, New Jersey, and Delaware are large consumers of oil products; however, their production levels are near zero. New Jersey and Pennsylvania rank among the top 10 oil-consuming states (Energy Information Administration, 2007). On a per capita basis, Delaware is in the top 20. Economies may not have lost their sensitivity to oil prices, and it is especially noticeable in states where oil production does not contribute to employment and income.

If we look at oil-producing states using the analysis set forth in this note, we find that the results look much like those for the nation during the past three decades; in some cases, oil-price shocks and economic activity are positively related. For example, employment and income data for Texas and Wyoming show largely positive responses to oil-price shocks during the 1980s, counter to the experience in Pennsylvania, New Jersey, and Delaware. While this result does not suggest causality or directly analyze the idea that domestic production has reduced or masked sensitivity to oil prices, it does support a need for more research in the differences between oil-producing and non-oil-producing states.