JRAP (2005)35:2

The Journal of
Regional
Analysis
& Policy

Macroeconomic Shocks and Regional Employment: The Case of Southern California

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Abstract. In this study, we specify a disaggregated vector autoregression model (VAR) to analyze the behavior of employment in three Southern California counties during two different types of aggregate economic downturns. Using this model, we estimate the impact of hypothetical, one-time shocks to macroeconomic variables, on employment levels by county. The two adverse shocks that we examine are a monetary (demand) shock, and an oil price (supply) shock. Our empirical framework allows us to examine, within a single model, the dynamic behavior of employment during these downturns. We provide evidence that even within regional economies in the United States, employment levels respond differentially to macroeconomic shocks. Our model also allows us to examine how the impact of these shocks on total county employment has changed over time. In particular, we find that, over the sample period, total employment across Southern California has become less sensitive to oil price shocks.

1. Introduction

Regional economies within the United States do not respond identically to macroeconomic shocks. Differences in industry structure, in the characteristics of regional labor markets, and many other factors may explain these differences in relative macroeconomic behavior. Recent studies have begun to examine these differences.[1] Our study focuses on the economy of three large counties in Southern California: Los Angeles, Orange and San Diego. The purpose of our study is twofold. First, we use a disaggregated vector autoregression model (VAR) to analyze the behavior of the three counties during two different types of aggregate economic downturns. The two adverse aggregate shocks that we examine are a monetary shock, and an oil price shock. We examine these responses at the aggregate- and sector-level. We analyze how regional employment in each county responds to each type of shock. We then compare the behavior of the counties to each other and to the national response to the same shock. Second, given the changing industrial composition of these counties, we examine whether the impact of these shocks on total county level employment has changed over time.

A better understanding of how regional economies differ in their response to shocks can be useful to policy-makers. For example, it may be easy at times for local policy-makers to guess the direction of Federal Reserve policy, since the Fed has become increasingly open about signaling its intentions regarding future open market operations. In an environment of rising interest rates, where the Fed is signaling an intention to keep raising rates in the near future, it may be useful for local policy-makers to know if their regional economy is more, or less sensitive to interest rate changes than the nation. In the case where a region is found to be more sensitive to rate changes than the nation as a whole, local policy-makers could anticipate these impacts and design policies designed to deal with the potential negative employment impacts of a Fed tightening.

Our study begins with an overview of macroeconomic conditions in the Southern California counties of Los Angeles, Orange, and San Diego over the pe-

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[1] See, for example, Carlino and Defina (1998, 1999). Papers by Coulson (2001), and Coulson and Rushen (1995) examine sources of fluctuations in the Boston economy.

riod 1983-2002.[2] We then introduce a disaggregated VAR model of the three regional economies in section 3. Section 4 highlights the econometric results of the model by first examining the effects of the two shocks on the regions, and then showing how the shocks have differential impacts on sectoral employment, even within a regional economy. Section 5 analyzes how the sensitivity of total employment in the Southern California counties to these shocks has changed over time. The last section of the study highlights our main results and conclusions.

2. Southern California Economy since 1983

2.1. Regional employment trends

In this study, we analyze the differential responses of employment, across ten industrial sectors in Southern California, to both demand and supply shocks. To represent the Southern California region, we analyze Los Angeles, Orange and San Diego counties. These are the largest counties in the region, with county employment levels ranging from 1.25 to 4 million. In spite of their large size, these counties are still inter-related in important ways. The counties are close enough geographically that households often live in one county and work and/or shop in another. Further, the counties are all influenced by developments at the state level, which affect funding of government in the region. For example, resulting from the recent California state budget crisis that erupted in 2002, all counties have seen a contraction in the rate of growth of state and local government employment.

The sectors we focus on are construction, durables, nondurables, transportation, communication and utilities (tcu), wholesale, retail, finance insurance & real estate (fire), services, federal government, and state & local government. The data, based on the SIC code, are available on a monthly basis from 1983 through the end of 2002.

Over this period, Southern California experienced significant volatility in employment growth rates. The region had a period of very strong economic growth from 1983-1989, followed by a very severe regional recession from 1990-1994, followed by a strong economic recovery.[3] The regional recession of the early 1990s was attributable to several factors. In part, the region's economy was sharing in the national recession that was occurring at that point in time, but the decline in federal defense expenditures[4] that took place also had a disproportionate impact on the economy of Southern California, due to the large number of defense contractors and military bases located in the region. In Los Angeles County alone, employment fell by 430,000 jobs from 1990-1994. The majority of the job losses occurred in the manufacturing sector, reflecting a permanent drop in the demand for defense-related hardware. From 1995-2000, economic growth accelerated, and then slowed again in 2001 due to the national economic recession that began in that year.

Orange County saw a similar pattern of employment declines during the early 1990s, but experienced a much stronger rate of employment growth during the second half of the decade than did Los Angeles County. The pattern of employment growth for San Diego County was very similar to that of Orange County. San Diego County has the smallest employment base of the three, with total nonfarm employment of 1.2 million in 2002. This compares to a base of 1.4 million in Orange County and 4.0 million in Los Angeles County.

2.2. Regional Employment by Industry

Table 1 shows employment by industry as a percent of total employment for the United States, and location quotients for Los Angeles County, Orange County and San Diego County, respectively, over the sample period.[5] For all regions, the service sector is by far the largest, comprising over 25 percent of total employment. The retail sector is the second largest sector in all regions, although there is a significant variation in the proportion of retail employment among the regions shown. The location quotient for retail employment exceeds 1.0 for San Diego and Orange Counties, but is only 0.88 for Los Angeles County.

Durable manufacturing is the third largest sector in both LA and Orange counties while it is the fourth largest, behind state and local government, in San Diego and in the nation. All Southern California counties have a higher percentage of employment in this sector than the nation (location quotients exceed 1.0). Over time, however, this sector's share of regional employment has been falling, as reported in Table 2.

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[2] In 2003, the Bureau of Labor Statistics began reporting employment statistics using the North American Industry Classification System (NAICS). Historical data based on NAICS are available only back to 1990. In order to ensure the largest sample size possible we chose to use the SIC-based time series.

[3] The final recovery lasted until the nation fell into recession in 2001.

[4] While it would be interesting to examine the employment effects of the decline in defense spending we were unable to obtain adequate data. Defense contract data would be ideal, but unfortunately, it is available on an annual basis only.

[5] We define total employment as the sum of employment in the ten industries: construction, durables, nondurables, tcu (transportation, communication and utilities), wholesale, retail, fire (finance, insurance and real estate), services, federal government and state and local government.

This long-term decline reflects the tremendous gains in productivity in this sector in recent decades, which have enabled manufacturers to produce a greater amount of output with fewer and fewer workers.

Table 1. Location Quotients by Industry

Employment by Industry:	U.S. (employment share)	L.A. (LQ)	O.C. (LQ)	S.D. (LQ)
Construction	4.7	0.64	1.02	1.11
Durable Mfg.	9.7	1.18	1.43	1.01
Nondurable Mfg.	6.8	1.09	0.86	0.43
TCU	5.3	1.04	0.64	0.75
Wholesale	5.5	1.29	1.24	0.78
Retail	17.8	0.88	1.02	1.08
FIRE	6.0	1.05	1.30	1.05
Services	27.1	1.10	1.03	1.09
Federal	2.5	0.65	0.46	1.81
State and Local	13.9	0.86	0.69	0.99

Note: We present average employment shares, as a percentage of nonfarm employment (1983-2002).

Table 2. Employment Share of Durable Manufacturing

	U.S.	L.A.	O.C.	S.D.
1983	12.1	15.8	18.6	12.8
2002	7.4	7.7	9.9	7.2

Note: We present the employment share of durable manufacturing, as a percentage of total employment, in 1983 and 2002.

Construction employment accounts for a relatively small share of employment in Los Angeles County, due to the relatively small amount of buildable land left in the county. Construction shares are similar to the national average for Orange and San Diego Counties. The location quotient for the finance, insurance and real estate sector is particularly large in Orange County, while the location quotient for federal government (1.8) in San Diego is more than double that of Orange County and Los Angeles Counties, due to the presence of a significant number of military bases in that county.

3. Regional Empirical Model

To analyze the behavior of regional employment in response to shocks to the U.S. economy we construct a log-linear vector autoregression (VAR) model[6] that includes employment (e_i^j) by industry in the three Southern California counties, total county-level employment ($\bar{e}^j$), the national price level (P),[7] national employment by industry (E_i), national employment ($\bar{E}$), national industrial production (IP), and the shock variables, s_t, where s_t is equal to the federal funds rate (f) when we analyze a monetary shock, and to the oil price (o) when we analyze an oil shock.[8] Thus, for each county ($j = 1$ to 3) and industry ($i = 1$ to 10) we estimate the following with least squares:[9]

[6] In practice, one typically uses log-linear systems to ensure that the effect of a shock expressed as a percentage change does not depend on the value of the variable.

[7] We use the consumer price index (CPI) as our measure of the price level.

[8] We use Hamilton's "net oil price" variable as our measure of oil prices. See Hamilton (1996) for more details.

[9] Although we believe some of the variables to be nonstationary, we estimate the system in levels for a few reasons. Estimating the system in levels is a more general specification then a differenced or vector error correction system. A differenced system is clearly misspecified if there are cointegrating relationships, as we would expect given national and regional employment, amongst the nonstationary variables. Correctly estimating an error correction system, however, given the number of variables in the system is extremely diffi-

$$\ln(e^{j}_{i,t}) = \sum_{k=1}^{q}\sum_{j=1}^{3}\sum_{i=1}^{10} B^{e^1}_{i,k} \begin{bmatrix} s_{t-k} \ln(P_{t-k}) \ln(IP_{t-k}) \ln(\overline{E}_{t-k}) \ln(E_{i,t-k}) \ln(\overline{e}^{\,j}_{t-k}) \\ \ln(e^{1}_{i,t-k}) \ln(e^{2}_{i,t-k}) \ln(e^{3}_{i,t-k}) \end{bmatrix} + u^{e^j}_{i,t} \quad (1)$$

Where k is the number of lags included in the estimation.

Depending on k, estimation of a standard VAR would necessitate estimating a large number of explanatory variables, relative to a sample size. To limit the number of coefficients to be estimated we assume that the regional employment variables do not appear in the national equations.[10] Therefore, none of the national variables (national employment, the price level, industrial production, and the shock variable) depend on the regional composition of employment. Thus, for each "national" variable (N) we estimate the following with least squares:[11]

$$\ln(N^{l}_{i,t}) = \sum_{k=1}^{q}\sum_{i=1}^{10} B^{N}_{i,k} \left[s_{t-k} \ln(P_{t-k}) \ln(IP_{t-k}) \overline{N}_{t-k} \right] + u^{N}_{i,t} \quad (2)$$

4. Demand Shocks, Supply Shocks and National and Regional Employment

In this section, we use our regional model to take a closer look at the driving forces behind Southern California employment. We do this by calculating an impulse response function for the estimated VAR described above. An impulse response function can estimate the impact of a single, hypothetical, one-time, one-standard-deviation shock to a macroeconomic variable, (such as the federal funds rate) on the other variables of the model (employment levels by sector) in subsequent future periods.

In our study, we examine the impact of two fundamentally different shocks to employment in Southern California. We compare the response of employment to an interest rate, or demand shock (federal funds),[12] and to an oil price, or supply shock. All variables are logged, except for the federal funds rate, which enters as a level. The VARs are estimated over the sample period from January of 1983 through December of 2002. All VARs include a half a year of lagged variables,[13] a constant, a linear trend and monthly dummies. The coefficients are estimated with ordinary least squares (OLS) and the significance levels are established using a Monte Carlo procedure with 2,500 replications in which data are generated by bootstrapping the estimated residuals. To avoid clutter we do not report confidence bands in the graphs but instead use ovals and squares to indicate that an estimate is significant at the 5 percent and 25 percent, respectively.[14]

4.1. Effect of the Shocks on National Variables

We start by analyzing the impact of both shocks on the national aggregate variables. Figure 1 displays the two shocks, plotting the response of the indicated variable to a one standard deviation shock to itself. In the case of the demand shock, the federal funds rate immediately increases, peaking three months after the initial shock, before decreasing over two years. We observe a similar pattern for the oil price shock, as oil prices immediately increase, peaking six months after the shock, before decreasing over three years. Figure 2 displays the responses of the national price level and U.S. industrial production levels to both shocks. The response of the price level to an oil price shock is as expected, the price level increases for over a year following the shock before slowly declining. In response to a federal funds rate shock, however, the response of the price level is surprising, although common in the literature. This sustained increase in prices, following a monetary contraction, is known as the "price puz-

cult. The levels system, while not efficient, is consistent, which allows us to correctly estimate the impulse responses.

[10] This assumption is not unreasonable as the regional employment measures are already a part of national employment. Moreover, if we consider a monetary shock, Fratantoni and Schuh (2003) point out that the Fed does not consider regional dispersion when setting policy, and therefore, it would make no sense to include the regional employment variables in the Fed policy function.

[11] Note that we define national employment and total county employment as the log of the sum of employment in each of the industries.

[12] It is important to note that, in the context of the federal funds rate shock, we are primarily interested in the behavior of interest rates and not that of the monetary policymaker. Thus, it is not crucial to our results that we have identified a "true" monetary policy shock, but rather that we have identified a pure interest rate shock. The results in the study are not affected if the shock to interest rates was the result of some other fundamental shock, whereas the literature on the effects of monetary policy is directly interested in identifying the responses to the actions of the monetary authority. We are interested in what happens when interest rates are unexpectedly high. In the remainder of the study, although we use the terms "interest rate shock" and "monetary contraction" interchangeably this is not meant to indicate that we have necessarily identified a "true" monetary policy shock.

[13] BIC selected a lag length of three, but since the results are robust to the number of lags, throughout the study, we present results for six lags.

[14] We also estimated 90% confidence intervals, but for clarity, we only present the 95% and 75% confidence levels in this study. Moreover, the 95th and 75th percentiles are approximately equivalent to two and one standard deviations, respectively.

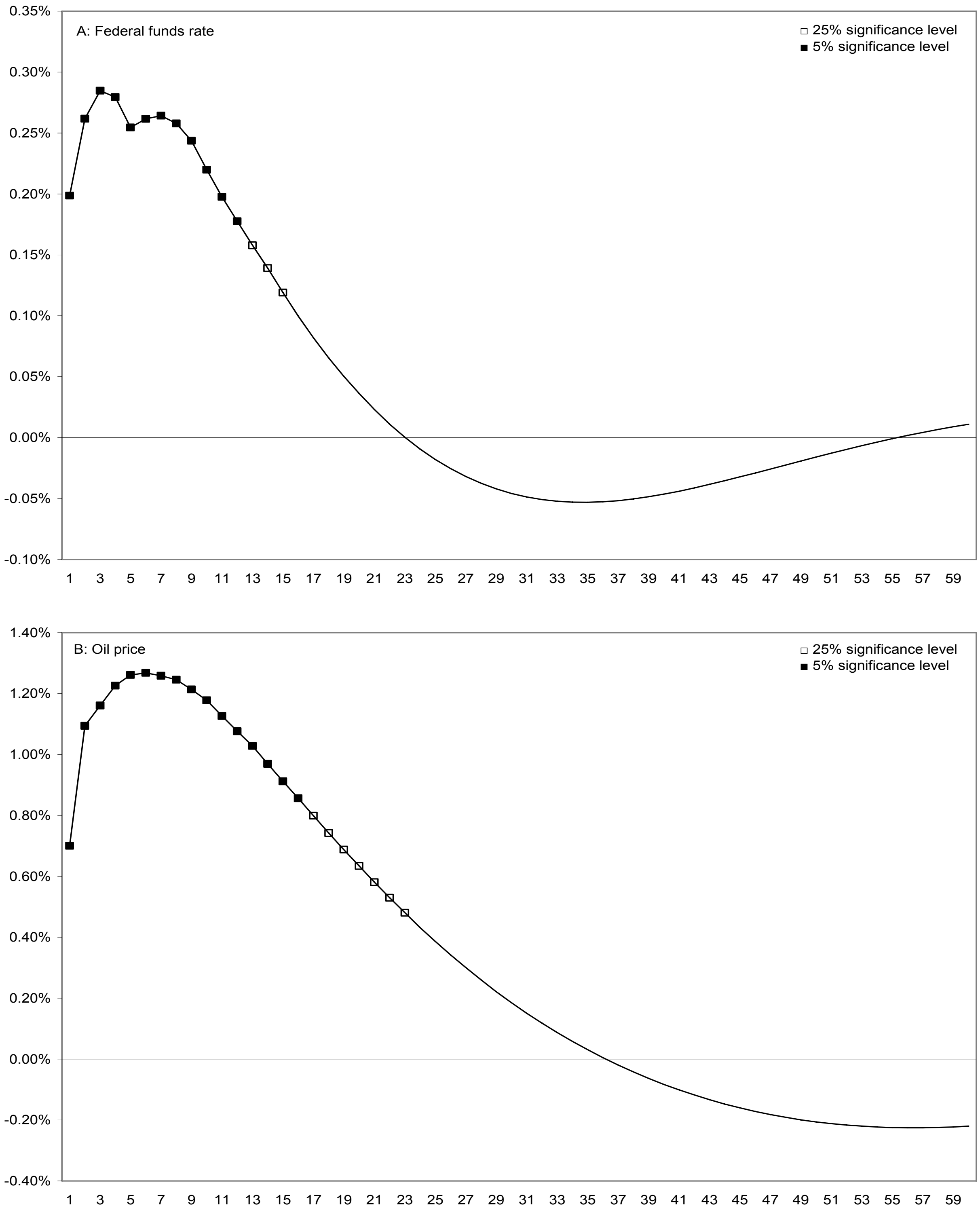

Figure 1. Two Aggregate Shocks [Note: These graphs plot the response of the indicated variable to a one standard deviation shock to itself. Open squares indicate a significant response at the 25% level and a solid square indicates a significant response at the 5% level (both two sided tests).]

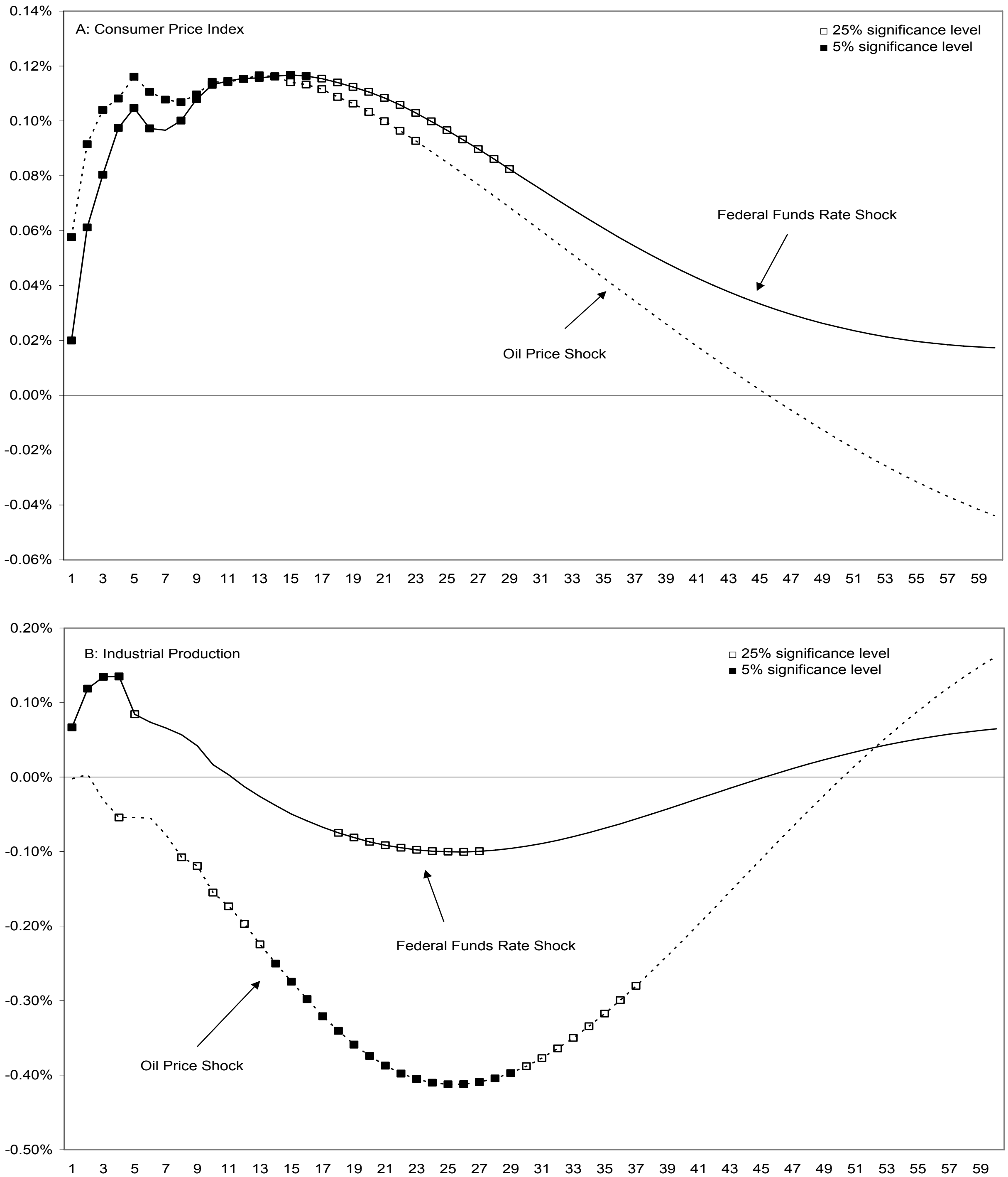

Figure 2. National Aggregate Variable Impulses [Note: These figures plot the responses of the indicated variables to a one standard deviation federal funds rate shock and a one standard deviation oil price shock, respectively. Open squares indicate a significant response at the 25% level and a solid square indicates a significant response at the 5% level (both two sided tests).]

zle" in the monetary transmission literature.[15] Finally, following an oil price shock industrial production falls immediately, declining over two years before slowly recovering. Following a monetary contraction, however, industrial production initially increases, over the first six months, before declining and then hovering near zero.

We next examine the impact of a federal funds rate shock and an oil shock on national employment. Our results are summarized in table 3. The table displays the cumulative employment responses, by sector, to a one standard deviation shock in the federal funds rate and the oil price at the 6th, 12th, 18th, 24th, 30th and 36th month horizons (months following shock).[16] Thus, for example, the table reports that 18 months after a one standard deviation shock to the federal funds rate, we would expect U.S. construction employment to fall 0.27 percent below its pre-shock level, and 30 months after the shock, construction employment would stand 0.37 percent below it pre-shock level. A federal funds shock defined as a one standard deviation shock over the sample period corresponds to a rate hike of 20 basis points, and a one standard deviation shock to oil prices corresponds to a 0.75 percent rise in oil prices. The effects of larger shocks could be estimated proportionately (e.g., to estimate the effect of a 100 basis point hike in funds rate we would multiply the impacts below by a factor of 5).

As the table reports, U.S. employment displays a delayed, negative response to a monetary contraction, which is consistent with the existing literature.[17] When we look across industries, we see a slightly different picture. While some industries display a similar delayed response, this is not true for all sectors of the economy. Construction, nondurables and fire employment all experience sharp, significant employment declines a year and a half to two years after the shock. These responses are not surprising, as these sectors are generally believed to be quite sensitive to changes in interest rates. What is surprising, however, is that durable manufacturing, which is generally believed to be highly procyclical does not respond much, other than an initial increase, to the monetary shock. Similarly, tcu, federal, retail and state and local employment are not impacted at all by the monetary shock.

These findings are, for the most part, consistent with those of Arnold (1999), although we analyze regional employment responses while he investigates the behavior of income across industries. Arnold estimates, over the period 1969:1-1998:3, a separate regional VAR for personal income and each of its components. Consistent across his study and our own is the finding that transportation and wholesale display the weakest downward responses to a monetary contraction. He also finds that construction and fire display the strongest declines in response to monetary contraction. The industry with the fourth strongest downward response in Arnold's study is durable goods manufacturing. We find durables to display a weak, delayed decline in activity following a monetary contraction. Barth and Ramey (2001) actually find that in an earlier sample (1959-1979) the response of durable manufacturing to a monetary contraction is quite strong (falling almost 1 percent six quarters after a shock), but when they calculate the response using the entire sample (1959-2000) the response for durables is, after 24 months, only about 60 percent of the response over the subsample. In light of this finding, our result for durables is not that surprising considering our sample covers only the second half of their sample.[18]

In response to the supply shock, the employment dynamics clearly differ. In addition to much stronger significance across all horizons, we observe a strong negative impact across nearly all the sectors. The only sectors that respond differently are federal employment and state and local employment. It is not surprising that employment levels in these sectors are not responsive to either shock. Employment in all other sectors, however, fall quite strongly, with construction, durables, wholesale and services experiencing the strongest declines. Thus, while for the monetary contraction we observe more dispersion across the sectors, in response to the oil price shock there is more uniformity across the sectors in their employment responses.

[15] See Christiano, Eichenbaum and Evans (1999) for more details. Previous researchers have shown that the inclusion of commodity prices often eliminates this price effect. In the case of our model, the inclusion of the commodity price index does reduce the positive response of prices, although it does not eliminate the price puzzle. More importantly, however, the inclusion of the commodity price index does not affect the responses of the remaining variables in the system. In addition, Barth and Ramey (2001) show that the price impulse response functions obtained in VARs that include the index for sensitive commodity prices display "sticky" behavior because the positive impulse response functions in some sectors cancel out the negative impulse response functions in other sectors. The sticky price impulses do not occur because of sticky prices at the two or three-digit industry level. They argue that a positive response of prices in response to a monetary policy shock may be due to an increase in costs, for example, because of an increase in the costs of obtaining financing.

[16] The complete impulses are available upon request.

[17] See Christiano, Eichenbaum and Evans (1999) for an excellent overview of the literature.

[18] Both Barth and Ramey (2001), like Arnold (1999), look at income across sectors.

Table 3. Temporal Employment Responses by Sector: United States (percentages)

	Federal funds rate shock						**Oil shock**					
	6	**12**	**18**	**24**	**30**	**36**	**6**	**12**	**18**	**24**	**30**	**36**
Total	0.040**	-0.003	-0.048*	-0.076*	-0.083*	-0.071	-0.049**	-0.109**	-0.170**	-0.210**	-0.221**	-0.205**
Con.	-0.033	-0.158*	-0.274*	-0.361*	-0.376*	-0.330*	-0.244**	-0.417**	-0.594**	-0.687**	-0.706**	-0.647**
Dur.	0.167**	0.149*	0.061	-0.016	-0.053	-0.051	-0.114*	-0.212*	-0.333**	-0.421**	-0.437**	-0.377*
Ndur.	0.065**	-0.005	-0.065*	-0.098*	-0.108*	-0.103*	-0.015	-0.043*	-0.087*	-0.115*	-0.112*	-0.087
TCU	-0.015	0.071	0.064	0.025	-0.008	-0.023	0.030	0.036	-0.050*	-0.150**	-0.214**	-0.226**
Whsl.	0.042*	0.033	0.006	-0.030	-0.064*	-0.081*	-0.089**	-0.184**	-0.278**	-0.326**	-0.323**	-0.283**
Ret.	0.079*	0.035	-0.007	-0.021	-0.010	0.016	-0.063	-0.108**	-0.139**	-0.150*	-0.143*	-0.116*
FIRE	-0.057	-0.172*	-0.264*	-0.278*	-0.229*	-0.157*	-0.083**	-0.148**	-0.186**	-0.200**	-0.197**	-0.184**
Serv.	0.036	-0.011	-0.065*	-0.097*	-0.106*	-0.097	-0.045	-0.136**	-0.207**	-0.252**	-0.267**	-0.256**
Fed.	0.038	-0.220**	-0.086	-0.031	-0.030	-0.039	0.229*	0.121	0.010	-0.043	-0.081*	-0.124*
St.&L.	-0.014	-0.023	-0.024	-0.026	-0.028*	-0.029*	0.008	0.032*	0.042*	0.034*	0.014	-0.009*

Note: * and ** indicate significance at the 25% and 5% (one-sided) levels, respectively.

4.2. Employment in Southern California

Tables 4, 5 and 6 display the cumulative employment responses, by sector, to a one standard deviation shock in the federal funds rate and the oil price, respectively, at the 6th, 12th, 18th, 24th, 30th and 36th horizons (months following shock) for Los Angeles, Orange County and San Diego.[19]

In Southern California, we find that Orange County is more sensitive than the nation to changes in the funds rate. We find that a federal funds shock causes a very large decline in interest-sensitive sectors in Orange County, such as construction, and fire. That Orange County is most sensitive to a funds rate shock is not surprising, since these interest-sensitive sectors have grown rapidly in that region in recent decades, fueled by a population and housing boom. In Orange County, the combined construction and fire sectors accounted, in 2002, for almost 14 percent of total nonfarm employment, compared with 12 percent in San Diego, 9 percent in Los Angeles, and 11 percent in the nation.

Responses in the other Southern California counties are smaller than the nation in the first 18 months, very similar to the nation 24 months after the shock, and slightly higher than the nation at 30 months after the shock. One notable difference between the responses in Southern California compared to those of the nation is the relative insensitivity of the service sector to a monetary shock. In the case of the nation, this is one of the sectors that experiences the strongest decline in response to a monetary shock. In the California counties, the response of employment in the service sector is quite small.

This difference may reflect a fundamental difference in the composition of the service sector in Southern California versus the nation, but may also be partly a function of the very strong underlying population growth rate in Southern California over the sample period. Over this period of time (1983-2002), the national population grew by 23.2 percent, while Los Angeles County saw its population increase by 25.1 percent, Orange County by 41.9 percent, and San Diego County by 46.8 percent. This strong underlying population growth trend in Southern California has led to a strong growth in demand for local services, causing this sector to grow even in adverse business cycle conditions. This strong underlying growth trend in services, therefore, cushions the blow that these regional economies experience in the event of a monetary shock.

Table 7 displays those sectors where employment falls more than total employment in that region, in response to the monetary shock. These are the sectors most strongly affected by the monetary shock. As the table indicates, certain sectors, like construction and fire, are most responsive to the monetary shock, both at the national and regional levels. The table indicates that certain other sectors experience a strong response to the monetary shock in some regions but not others. For example, employment in tcu responds sharply to the shock in Los Angeles and San Diego Counties, but not in the nation or in Orange County.

Finally, it is interesting to note that, while the demand shock has a delayed effect on county-level total

[19] The complete impulses are available upon request.

Table 4. Temporal Employment Responses by Sector: Los Angeles (percentages)

	Federal funds rate shock						**Oil shock**					
	6	**12**	**18**	**24**	**30**	**36**	**6**	**12**	**18**	**24**	**30**	**36**
Total	0.063**	0.040	-0.017	-0.078*	-0.122*	-0.145*	-0.081**	-0.106*	-0.172**	-0.242**	-0.298**	-0.336**
Con.	0.119*	-0.002	-0.192*	-0.453**	-0.639**	-0.682*	-0.061	-0.234*	-0.538**	-0.807**	-0.984**	-1.060**
Dur.	0.120*	0.104	0.110	0.040	-0.052	-0.130	-0.149**	-0.251*	-0.300*	-0.408*	-0.530**	-0.629**
Ndur.	0.048	-0.002	-0.058*	-0.079*	-0.096	-0.086	-0.038	-0.180**	-0.367**	-0.453**	-0.464**	-0.425
TCU	-0.085*	-0.060	-0.111*	-0.178*	-0.238*	-0.281*	-0.028	0.030	-0.108*	-0.252**	-0.354**	-0.419**
Whsl.	0.167**	0.091	-0.047*	-0.132*	-0.184*	-0.214*	-0.211**	-0.354**	-0.450**	-0.516**	-0.532**	-0.515**
Ret.	0.030	-0.006*	-0.086*	-0.170*	-0.236*	-0.274*	-0.110*	-0.063*	-0.135*	-0.221**	-0.290**	-0.335**
FIRE	-0.058*	-0.245**	-0.305**	-0.211*	-0.077	-0.003	-0.210**	-0.211**	-0.086	0.018	0.044	-0.011
Serv.	0.144**	0.154**	0.081	-0.004	-0.064*	-0.092*	-0.067*	-0.112*	-0.186**	-0.247**	-0.293**	-0.320**
Fed.	0.017	-0.177*	-0.165*	-0.114	-0.068	-0.045	0.301*	0.120	0.056	0.072	0.075	0.023
St.&L.	-0.074	-0.007	0.017	0.003	-0.020	-0.037	0.022	0.159**	0.181**	0.122	0.035	-0.052*

Note: * and ** indicate significance at the 25% and 5% (one-sided) levels, respectively.

Table 5. Temporal Employment Responses by Sector: Orange County (percentages)

	Federal funds rate shock						**Oil shock**					
	6	**12**	**18**	**24**	**30**	**36**	**6**	**12**	**18**	**24**	**30**	**36**
Total	-0.035*	-0.067*	-0.111*	-0.142*	-0.151*	-0.146*	-0.132**	-0.132**	-0.183**	-0.256**	-0.317**	-0.352**
Con.	-0.331**	-0.424*	-0.656**	-0.867**	-0.948**	-0.888*	-0.528**	-0.801**	-1.068**	-1.250**	-1.324**	-1.292**
Dur.	0.018	0.125*	0.059	-0.034	-0.098	-0.140	-0.264**	-0.244*	-0.332*	-0.501**	-0.630**	-0.678**
Ndur.	0.116**	-0.074*	-0.100*	-0.126*	-0.127*	-0.120*	0.003	-0.103*	-0.241**	-0.282**	-0.297**	-0.289**
TCU	-0.249**	-0.112	-0.085	-0.107*	-0.145*	-0.169*	-0.294*	-0.001	-0.128	-0.315**	-0.428**	-0.461**
Whsl.	-0.018	0.173*	0.240*	0.151	0.014	-0.086	-0.313**	-0.311*	-0.346*	-0.413*	-0.448*	-0.465*
Ret.	-0.079*	-0.197**	-0.240*	-0.257*	-0.244*	-0.203*	-0.151**	-0.174*	-0.184*	-0.213*	-0.242**	-0.248*
FIRE	-0.211**	-0.405**	-0.472**	-0.327*	-0.156	-0.071	-0.177*	-0.095	0.051	0.094	0.023	-0.113*
Serv.	0.057	0.016*	-0.053**	-0.092**	-0.107*	-0.108*	-0.035*	-0.035*	-0.131**	-0.225**	-0.301**	-0.346**
Fed.	0.152	-0.329*	-0.446**	-0.378**	-0.253*	-0.139*	0.241	0.023	0.043	0.084	0.109	0.092
St.&L.	-0.066	-0.022	0.047	0.060	0.056	0.045	0.099*	0.154**	0.181*	0.134*	0.061	-0.018*

Note: * and ** indicate significance at the 25% and 5% (one-sided) levels, respectively.

Table 6. Temporal Employment Responses by Sector: San Diego (percentages)

	Federal funds rate shock						**Oil shock**					
	6	**12**	**18**	**24**	**30**	**36**	**6**	**12**	**18**	**24**	**30**	**36**
Total	-0.001	-0.016	-0.045*	-0.078*	-0.111*	-0.136*	-0.012	-0.055*	-0.121**	-0.181**	-0.233**	-0.273**
Con.	0.132	0.224	-0.050	-0.347*	-0.556*	-0.642*	-0.281*	-0.410*	-0.618*	-0.893**	-1.102**	-1.199**
Dur.	0.337**	0.391**	0.376**	0.266*	0.109	-0.035	0.133*	0.102*	0.016	-0.131*	-0.324**	-0.510**
Ndur.	-0.238*	-0.241*	-0.131	-0.027	0.019	0.042	0.008	-0.008	-0.061	-0.060	-0.065	-0.039
TCU	-0.355*	-0.291*	-0.363*	-0.458*	-0.548*	-0.617*	-0.336**	-0.503**	-0.611**	-0.695**	-0.780**	-0.826**
Whsl.	-0.085	-0.110	-0.123*	-0.164*	-0.212*	-0.237*	-0.321**	-0.350**	-0.359*	-0.438**	-0.432*	-0.396*
Ret.	0.003	-0.062	-0.140*	-0.160*	-0.146*	-0.115	0.061	0.061	-0.032*	-0.051*	-0.043*	-0.040*
FIRE	-0.179**	-0.253*	-0.289*	-0.228	-0.167	-0.173	0.175*	0.251*	0.319*	0.276*	0.098	-0.152*
Serv.	-0.046	-0.072*	-0.041	-0.018	-0.017	-0.022	-0.033	-0.152**	-0.230**	-0.284**	-0.309**	-0.301*
Fed.	0.195**	0.164*	0.134	0.037	-0.046*	-0.087	0.096	-0.143**	-0.283**	-0.286*	-0.247*	-0.228*
St.&L.	0.007	0.025	0.022	-0.014	-0.056*	-0.094*	-0.001	0.119**	0.130**	0.085*	0.023	-0.046*

Note: * and ** indicate significance at the 25% and 5% (one-sided) levels, respectively.

Table 7. Strongest Negative Employment Declines to a Monetary Shock

U.S.	Los Angeles County	Orange County	San Diego County
Construction, Federal, FIRE, Nondurables, Services	Construction, Federal, FIRE, Retail, TCU, Wholesale	Construction, FIRE, Federal, Retail	Construction, FIRE Nondurables, Retail, TCU, Wholesale

Note: This table lists those sectors in which employment falls more than total employment, for that region, in response to a one standard deviation shock in the federal funds rate.

Table 8. Strongest Negative Employment Declines to an Oil Price Shock

U.S.	Los Angeles County	Orange County	San Diego County
Construction, Durables, Services, Wholesale	Construction, Durables, Nondurables, Wholesale TCU	Construction, Durables, TCU, Wholesale	Construction, Durables, Federal, Nondurables, Services, TCU, Wholesale

Note: This table lists those sectors in which employment falls more than total employment, for that region, in response to a one standard deviation shock in the oil price.

employment, it affects a few sectors quite quickly. This illustrates a danger with specifying a model that includes aggregate variables only. In doing so, there is a possibility of losing valuable information. In this case, by only observing the county-level total employment responses one could come to the conclusion that monetary shocks affect employment with a delay, while in reality, sectoral employment responds very quickly to the federal funds shock.

We next analyze the impact of an unexpected increase in the oil price. Even for the counties the impact of the oil shock, unlike that of the funds rate shock, is immediately negative. For the nation, the impacts build until the 30 month horizon, and then begins to diminish. In Southern California, the effects strengthen, so that the maximum impact is found 36 months after the shock.

During the first 30 months after the shock, the response of Los Angeles County is very similar to that of the nation. Orange County sees a slightly larger immediate response, but then follows a path similar to that of the nation. San Diego sees the smallest response to the oil shock, with declines following the shock that are smaller than that of the nation and of the other Southern California economies. One explanation for this is the relatively small share of manufacturing in San Diego's total employment base. In 2002, total manufacturing comprised only 10 percent of nonfarm employment in San Diego, compared with almost 13 percent in the nation, 14 percent in Los Angeles County and 15 percent in Orange County.

In contrast to a monetary shock, the declines in federal and nondurable employment are smaller than the decline in national employment. In addition, state and local employment is barely affected by the oil price shock. Conversely, construction, durables, wholesale and services are strongly affected by the unexpected increase in oil prices. In particular, construction employment falls nearly 5 percent. This is consistent with Davis and Haltiwanger (2001) in which they find the strongest employment declines to oil price shocks to be in the most energy- and capital-intensive industries.

Table 8 lists those sectors where employment falls more than total employment in the region, in response to the monetary shock. In Los Angeles County, construction, wholesale and manufacturing bear the brunt of the downturn in employment, but in contrast to national employment, nondurable rather than durable manufacturing accounts for the majority of the decline in manufacturing. We also see larger responses in construction, wholesale than we observe in the nation. In Orange County, four sectors fall more than total employment, and the construction sector is particularly hard hit by the shock, but the fire sector is less affected in Orange County than it is in the nation. In the case of San Diego, the brunt of the decline in employment in the county is borne by construction and wholesale, although the adverse impact of the oil shock is spread across the sectors. In contrast to the other counties services and federal employment are especially hard hit by the increase in oil prices.

5. Changes in Regional Sensitivity to Shocks Over Time

A further advantage of our model specification is that it allows us to examine the sensitivity of regional total employment to aggregate shocks over time. The estimation results depend on the initial conditions of the system due to the nonlinear nature of the model.[20] Because of this, we are able to generate an impulse response for each set of initial conditions, or, since our system includes six lags, 235 separate impulses. By then plotting the total regional employment responses as functions of time we are able to see how the effects of the shocks have evolved over the sample period.

Figure 3 displays the 24th period, cumulative impulse, in response to a federal funds rate shock, of total employment as a function of time for the United States, Los Angeles, Orange County and San Diego, respectively. The impact of the federal funds rate on U.S. employment has steadily increased over time (the decline in employment in response to the shock has become more negative over time). This is also the case for Los Angeles and San Diego Counties. In the case of Orange County, the observed pattern is very different. The sensitivity of employment to a federal funds shock has not changed much in Orange County over time. Orange County has also remained most sensitive to a funds rate shock of all the regions examined over the sample period.

Figure 4 displays the 24th period, cumulative impulse, in response to an oil price shock, of total employment as a function of time for the United States, Los Angeles, Orange County and San Diego, respectively. In contrast to the federal funds rate shock, the impact of oil prices on U.S. employment has decreased over the sample period. This trend toward decreasing sensitivity to oil price shocks is also evident in the Southern California counties, particularly in the case of Orange and San Diego Counties. The decreased sensitivity to oil price shocks is primarily due to the decline in the employment share of durable manufacturing and the increase in the employment share of services. Across all the regions, durable employment is highly sensitive to oil price shocks, experiencing strong, negative drops, while services is one of the least sensitive sectors. Thus, the increasing employment share of an oil price insensitive sector, at the expense of an oil price sensitive sector has resulted in the decreased sensitivity of total employment in Southern California to oil price shocks. In addition, factories and automobiles have become increasingly efficient in their use of oil over time, which also has served to decrease the sensitivity of the economy to changes in the price of oil.

The relatively strong economic performance we have seen in the national and regional economies over the last two years is consistent with the predictions of the model. Since 2003, the price of oil has more than doubled in nominal terms, rising by almost 90 percent in inflation-adjusted terms.[21] While similar real increases in oil prices in the past have been associated with economic recessions, U.S. real GDP growth has slowed only slightly, from a robust 4.2 percent rate of growth in 2004, to 3.5 percent in 2005. Moreover, regional employment growth actually accelerated in 2005.

Our results, however, do not imply that rising oil prices will have no effect on the macroeconomy. Most analysts are currently predicting that growth will slow in 2006. In addition, as we write in April of 2006, the oil market continues to spiral upwards, with spot prices topping $70 per barrel, and talk in the media of prices possibly reaching as high as $100 per barrel. Although though the elasticity of output with respect to oil prices has fallen over time, it is still negative, and if the price change is large enough, we would expect to see significant negative consequences on the national and regional economies.

6. Summary and Conclusions

This study analyzes the relative responses of three counties in Southern California to a monetary (federal funds rate) and real (oil price) shock, and compares these responses to those of the nation as a whole. Some key differences are seen in the behavior of the regions versus the nation and each other. In the case of the monetary shock, national employment is found to respond negatively to the shock, but with a significant delay. This pattern is also observed in Southern California, however, there are some important differences observed between the individual counties. The Orange County economy is found to be more sensitive overall than the nation and region to a monetary shock. The reason for this is that a monetary shock causes a very large decline in interest-sensitive sectors in Orange County, such as construction, and finance, insurance & real estate. Orange County also differs in its temporal response to the monetary shock. While Los Angeles and San Diego Counties respond much like the nation, in that employment declines with a significant lag af-

[20] Because of the log specification, the aggregate values are nonlinear combinations of the individual series.

[21] These percentages based on the price per barrel of the composite refiner's acquisition cost of crude oil (Source: US Energy Information Agency).

Figure 3. 24th Period Total Employment Response to a Federal Funds Rate Shock **[**Note: This graph plots the level of the 24th-period total employment response, for the United States, Los Angeles, Orange County and San Diego, to a one standard deviation funds rate shock in the regional model for each set of initial conditions.]

Figure 4. 24th Period Total Employment Response to an Oil Price Shock [Note: This graph plots the level of the 24th-period total employment response, for the United States, Los Angeles, Orange County and San Diego, to a one standard deviation oil price shock in the regional model for each set of initial conditions.]

ter the shock, the employment response in Orange County is immediate. One implication of this result is that policy-makers in Orange County should be aware that their economy may be particularly sensitive to rate hikes implemented by the Federal Reserve.

In the case of an oil price shock, we find that national employment responds immediately to the shock, and the declines are steepest in energy-intensive sectors such as durable goods manufacturing, and in the construction, wholesale and service sector. In the California regions we study, we find some similarities to the national effects. All of the California counties are found to exhibit an immediate decline in employment following the oil price shock, and these impacts are particularly concentrated in the manufacturing, construction, wholesale and service sectors, however, there are some interesting differences in the responses.

While Los Angeles and Orange Counties see similar declines in aggregate employment as the nation, San Diego County appears to be less sensitive to an oil price shock than the nation. Another important difference is that the effects of an oil price shock appear to linger longer in the Southern California counties compared to the nation. The most concentrated impacts of the oil price shock are felt at the national level after 30 months, after which time the effects diminish. In the Southern California counties we study, the impacts of the oil price shock continue to intensify through the 36th month after the shock.

Another key finding in our research concerns the changes in the sensitivity of national and regional employment to shocks over time. In the case of the nation, we find that the impact of a monetary shock has increased over time, while the impact of an oil shock has decreased as factories and automobiles have become increasingly efficient in their use of oil over time. In the case of the monetary shock, the sensitivity of the economies of Los Angeles and San Diego has increased over time, following the national trend. In contrast, Orange County's economy has actually become slightly less sensitive to monetary shocks in recent decades. In the case of the oil shock, all Southern California economies have become less sensitive over time, with the largest declines in sensitivity occurring in San Diego and Orange Counties. The fact that Southern California saw accelerated employment growth in 2005, in spite of a doubling of oil prices since 2003, is consistent with these results.

In summary, our study provides evidence that regional economies within the United States do not respond identically to macroeconomic shocks. Even within the three Southern California economies examined, we find a significant amount of variation in the way that these economies respond to a monetary and an oil price shock. This knowledge is useful, in that it may help to improve the ability of regional policy-makers to forecast the impact that future shocks may have on their local economies.

References

Arnold, I.J.M. 1999. "The Industry Effects of Monetary Policy and their Welfare Implications." Unpublished.

Barth, M.J. and V.A. Ramey 2000. "The Cost Channel of Monetary Transmission." NBER Working Paper 7675.

Bernanke, B.S. and A.S. Blinder 1992. "The Federal Funds Rate and the Channels of Monetary Transmission." *American Economic Review*. 82: 901-21.

Bernanke, B.S., M. Gertler, and M. Watson 1997. "Systematic Monetary Policy and the Effects of Oil Price Shocks." *Brookings Papers on Economic Activity*. 0: 91-157.

Carlino, G. and R. DeFina 1998. "The Differential Regional Effects of Monetary Policy," *Review of Economics and Statistics*. 80: 572-87.

Carlino, G. and R. DeFina 1999. "The Differential Regional Effects of Monetary Policy: Evidence from the U.S. States." *Journal of Regional Science*. 39: 339-58.

Christiano, L.J., M. Eichenbaum, and C.L. Evans 1999. "Monetary Policy Shocks: What Have We Learned and to What End?" *Handbook of Macroeconomics*. J.B. Taylor and M. Woodford eds. Amsterdam, New York, and Oxford: Elselvier Science, North Holland, Amsterdam.

Coulson, N.E. 2001. "Sectoral Sources of the Massachusetts Miracle and Other Turning Points." *Journal of Regional Science*. 41: 617-638.

Coulson, N.E. and S.F. Rushen 1995. "Sources of Fluctuation in the Boston Economy." *Journal of Urban Economics*. 38: 74-93.

Davis, S.J. and J. Haltiwanger 2001. "Sectoral Job Creation and Destruction Responses to Oil Price Changes." *Journal of Monetary Economics*. 48: 465-512.

Den Haan, W.J. 2000. "The Comovement between Output and Prices." *Journal of Monetary Economics*. 46: 3-30.

Den Haan, W.J., S.W. Sumner, G.M. Yamashiro (forthcoming). "Bank Loan Portfolios and the Monetary Transmission Mechanism." *Journal of Monetary Economics*.

Den Haan, W.J., S.W. Sumner, G.M. Yamashiro, 2005, "Bank Loan Components and The Time-varying Effects of Monetary Policy Shocks." Working Paper.

Fratantoni, M. and S. Schuh 2003. "Monetary Policy, Housing, and Heterogeneous Regional Markets." *Journal of Money, Credit, and Banking*. 35: 557-89.
Hamilton, J.D. 1996. "This Is What Happened to the Oil Price-Macroeconomy Relationship." *Journal of Monetary Economics*. 38: 215-20.
Hamilton, J.D. 1994. *Time-Series Analysis*. Princeton: Princeton University Press.
Hamilton, J.D. 1983. "Oil and the Macroeconomy since World War II." *Journal of Political Economy*. 91: 228-248.
Ravn, Morten O. and Harald Uhlig, 2002, "On Adjusting the Hodrick-Prescott Filter for the Frequency of Observations," *Review of Economics and Statistics* 84, 371-76.
Rudebusch, G.D. 1998. "Do Measures of Monetary Policy in a VAR Make Sense?" *International Economic Review*. 39: 907-31.
Rushen, S.F. 1998. "The Role of the Automotive Industry in Detroit's Employment Fluctuations: A Multiple Restriction Regime Approach." *Review of Regional Studies*. 28: 27-46.
Sims, C.A. 1992. "Interpreting the macroeconomic time series facts: The effects of monetary policy." *European Economic Review*. 36: 975-1011.