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Oil Shock Impacts on the Borderplex Regional Economy

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ABSTRACT: This study analyzes the effect of oil price shocks on the economies of El Paso, Texas and Ciudad Juarez, Chihuahua, jointly referred to as the "Borderplex". It employs a measure of the net oil price increase developed by Hamilton (1996) in a manner similar to that applied by Sill (2007) to the United States national economy. Impulse response functions are calculated to determine the impact of 10-percent oil price shocks on the Borderplex regional economy. The asymmetrical relationship between oil prices and economic performance is also examined using a net oil price decrease variable. Results found in this study are inconclusive. Negative and statistically significant relationships for the net oil price increase are obtained in the El Paso real personal income, El Paso non-agricultural employment, Ciudad Juarez retail sales, and Ciudad Juarez formal sector employment equations. Inconsistent results are reported for the El Paso retail sales equation, while there appears to be no relationship between net oil price increases and El Paso gross metropolitan product or between net oil price increases and El Paso median existing single family house prices. The results presented in this study do not find definitive evidence in support of an asymmetrical relationship between oil prices and metropolitan economic performance.

Keywords: Oil Price Shocks; Borderplex Regional Economy; Econometrics
JEL Classifications: M21; Q43; R15

1. Introduction

The effects of energy price fluctuations on economic performance have been extensively examined. It is widely accepted that economic conditions are impacted to some degree by energy price movements. Upward energy price movements increase a firm's cost of doing business through higher production and transportation costs. They also act as a drain on consumers' disposable income through increased utility and fuel costs. This has further ramifications throughout the economy as employment, retail sales, and the prices of other goods may be affected.

The impacts of higher energy prices are not always negative, however. Regions where energy production comprises a large share of the economy may observe a net positive effect despite losses in other sectors. Examples in North America include Campeche and Veracruz in Mexico; Texas and Alaska in the United States; and Alberta in Canada where oil extraction and refining form significant parts of the regional economies.

To date, although a significant amount of research has been conducted on energy price shocks, most of this research has been conducted at the national level. Relatively few studies have examined regional responses to energy shocks and none have been carried out for the El Paso-Ciudad Juarez Borderplex. There is no compelling reason to believe that responses observed at the regional level will be the same as at the national level. This is especially true in a region like the Borderplex where the impacts of two national business cycles are also felt.

The El Paso-Ciudad Juarez Borderplex is a major economic center along the U.S.-Mexico border. Total trade passing through the El Paso port of entry amounted to $64 billion in 2011 (Coronado, 2012). The maquiladora sector plays a central role in the regional economy. Since the inception of the Border Industrialization Program in the mid-1960s to provide employment opportunities to residents on the south side of the border following the end of the Bracero program, the maquiladora industry has evolved from the manufacturing of textiles, apparel, and other low-skill goods to the production or assembly of automobile and aircraft components, appliances, and medical instruments (Ayer and Layton, 1974; Gilmer and Coronado, 2012). The economy of El Paso is also responsive to the health of the maquiladora sector. Cañas et al. (2013) estimates that a 10 percent increase in maquiladora production in Ciudad Juarez leads to an increase of nearly 3 percent in employment in El Paso; the majority of which comes from transportation, financial, insurance, and real estate services.

The El Paso-Ciudad Juarez Borderplex is not an oil-producing region. There are no oil-extraction companies that can directly benefit from an increase in oil prices. However, oil-related activities do take place and form a significant part of the regional economy. On the north side of the international boundary, Western Refining owns and operates a 128,000 barrels per day (bpd) refinery which produces gasoline, diesel, and jet fuel (WR, 2012). It is one of three companies headquartered in El Paso listed on the New York Stock Exchange. Western Refining's consolidation in El Paso came after its acquisition of ChevronTexaco's refinery in 2003, which had purchased the bankrupt El Paso Refinery L.P. ten years earlier.

Pemex, Mexico's state-run oil company, operates a storage and distribution terminal (Terminal de Almacenamiento y Reparto) in Ciudad Juarez. According to Pemex figures, this terminal supplied almost 6 million barrels of fuel to the region in 2011. This terminal has the infrastructure necessary to provide fuel to all pumping stations in the city and surrounding communities (Pemex, 2012). Although rising oil prices suggest a negative impact in regions where oil extraction and production is not taking place, the presence of refining and distribution activities in the Borderplex makes their overall effect difficult to anticipate.

2. Literature Review

The impacts of oil price fluctuations on economic performance have long been examined. Hamilton (1983) finds that seven of the eight recessions after World War II were preceded by a significant increase in the price of oil. These upward movements in crude petroleum prices typically occur three to four quarters before a downturn in the economy. Hunt (1987) utilizes a transfer function methodology to estimate the impacts of energy price movements on the economic performance of energy producing states. The impacts of oil price movements are found to initially manifest themselves through their effects on the levels of activity in regional oil and gas industries and, subsequently, through their influences on personal income as a result of increases in the general price level.

Bohi and Powers (1993) estimate the effects of the oil shocks of 1978-80 and 1985-87 on output and employment of energy producing and non-energy producing states. The first shock is associated with a run-up in the price of oil, while the latter, as mentioned above, occurred because of a considerable decline in crude petroleum prices. The study uses the ratio of mining employment to total state employment as a measure of the importance of energy production in each state and the ratio of Industrial Energy Consumption to Gross State Product as a measure of the intensity of energy used in production. The results find that there exists a positive relationship between increases in oil prices and economic conditions in energy producing states during both periods, while the inverse relationship expected for energy use is only present in the 1978-80 shock.

Hoag and Wheeler (1996) estimate the impacts of energy price shocks on coal mining employment in Ohio. Utilizing a vector autoregression (VAR) model to construct variance decompositions, this study evaluates the extent to which changes in the prices of oil and coal and coal mining wages affect employment in the coal mining industry. Variance decompositions are useful because they describe the portion of the forecast error variance of a variable that is due to its own shocks and to shocks in the additional variables in the system. The findings of this paper indicate that over 25 percent of the forecast error variance in coal mining employment is attributable to a shock in the price of oil. In addition, oil price shocks are found to have a larger impact on coal mining employment than changes in coal prices or coal wages.

Bhattacharya (2003) employs a VAR methodology to explore the effects of oil price shocks and defense spending on the economic performance of a sample of energy producing states and states which are major beneficiaries of defense spending. The results indicate that an increase in the price of oil leads to a considerable positive impact on the economies of oil producing states. Variance decompositions for Texas indicate that, after five years, 18.44 percent of the forecast error variance of employment is attributable to a shock in the price of oil. The forecast error variance of employment attributable to oil shocks after five years is 34.7 percent in Louisiana, 23.07 percent in Oklahoma, and 21.01 percent in Wyoming. By calculating impulse response functions, that study also finds that the responses of national output to changes in the price of oil are always negative, but always insignificant.

Aguiar-Conraria and Wen (2007) contend that output follows a U-shaped path in the aftermath of a permanent increase in the price of oil. That study attributes the contraction and resurgence in economic activity to a multiplier-accelerator mechanism. This mechanism helps explain how production and investment decisions by firms reinforce each other, through externalities that exist among them, and transition the aggregate economy through the period of recession and expansion. The theoretical model is able to accurately predict the recession of 1974-75 and its eventual recovery. Standard models that do not account for the multiplier-accelerator mechanism, however, fail to match the timing of these movements in the business cycle effectively. Using a VAR to separate the effects on the U.S. economy of oil shocks and non-oil shocks, Aguiar-Conraria and Wen (2007) find that although non-oil shocks have a leading role in explaining movements in the economy prior to 1974, oil shocks become the most important factor in explaining economic conditions after this period.

An increase in the price of oil can have ramifications on economic performance through a variety of channels. Sill (2007) details several reasons why oil prices matter for an economy. Changes in oil prices have direct consequences on transportation costs and heating bills through changes in the price of fuel. Rapid increases in the price of oil can lead to increased uncertainty about the future which may lead firms and households to delay purchases and investment. Oil price movements also generate reallocations of labor and capital between energy-intensive industries and those that are not energy-intensive that may have distorting effects on employment levels.

Kliesen (2008) determines that \$100 per barrel oil prices in 2008 led to a decrease of 0.25 percentage points in real GDP growth that same year. At \$150 per barrel, the model employed predicts that real GDP growth can decrease by an additional 0.25 percentage points. The impacts of oil shocks on the aggregate economy are not perceived to be permanent, however. Kliesen (2008) argues that once oil prices stabilize, real GDP converges to normal growth patterns. The forecasts presented do not find any significant effects from higher oil prices in 2008 on real GDP growth in 2009.

Hamilton (2009) finds that the surge in oil prices in 2007-2008 significantly contributed to the U.S. recession that began in the last quarter of 2007. This oil shock, which was triggered by a low price elasticity of demand and the failure of physical production to increase in response to rising demand, is found to have had implications for total consumption, motor vehicle sales, and consumer sentiment. Using a VAR model, this study estimates that real GDP growth would have been 0.7 percent higher on average between the fourth quarter of 2007 and the third quarter of 2008 had the oil shock not occurred. Similar results are documented for Europe in Bayar and Kilic (2014).

3. Data and Methodology

This study employs a measure of the net oil price increase developed by Hamilton (1996) in a manner similar to that applied by Sill (2007) to the national economy. Hamilton (1996) argues that oil price increases that simply correct for previous price decreases are not strong determinants of changes in real output growth. In order to obtain a better assessment of pertinent oil price fluctuations, Hamilton (1996) develops an oil price measure, referred to as the net oil price increase, which compares the price of oil at time *t* with the price during the previous four quarters. If the price of oil at time *t* is greater than the maximum observed during the preceding year, the percentage change between the two values is calculated. If the price is lower than the previous year's maximum, the value of the net oil price increase for that time period is set to zero. Hamilton (2003) finds that observing the net oil price increase over a three year time frame, rather than one year, is a more appropriate computation. This measure isolates oil price increases which are relevant to changes in real output growth from those that merely reverse earlier price decreases.

Sill (2007) explains that while changes in the price of oil can influence the decisions of economic agents and affect economic conditions, the state of the economy can also have an effect on oil prices. Strong real output growth may lead to increased demand for oil and place upward pressure on prices. This feedback effect makes the direction of causality difficult to determine. Hamilton (2003) suggests looking at oil price shocks caused by military conflicts in the Middle East to control for the endogeneity between oil prices and United States macroeconomic conditions. These price shocks are found to accurately explain slowdowns in economic growth in the United States. However, similar results can be obtained using the 36-month net oil price increase (Hamilton, 2003). The net oil price increase controls for the feedback effect between oil prices and the economy, and accounts only for those prices increases which are relevant to changes in economic growth.

The idea that oil price increases lead to economic downturns may suggest that a decrease in the price of oil may lead to periods of faster economic growth. However, the relationship between oil prices and the economy is asymmetric. Higher oil prices lead to slower economic growth while a lower price does not necessarily increase the rate of output. Sill (2007) suggests that the structure of this relationship may be due to reallocation effects triggered by changes in oil prices. Lower oil prices are likely to increase the supply of goods due to lower costs of production. Demand is also expected to increase as a result of improved consumer sentiment following a decrease in oil prices. This would lead to a shift in resources across sectors in the economy. However, since the reallocation of resources is not immediate, the gains from increases in demand and supply may be offset by the slowdown in growth driven by this reallocation effect.

To test the asymmetric relationship between oil prices and the economy, this paper uses a net oil price decrease measure to estimate the effects of lower oil prices on economic conditions. If the price of oil at month *t* is less than the minimum observed price during the preceding 36 months, the percentage change between the two values is calculated. If the price is higher than the previous 36-month minimum, the value of the net oil price decrease for that time period is set to zero. The net oil price increase and net oil price decrease series for this paper are constructed using the monthly West Texas Intermediate spot price per barrel reported by the Federal Reserve Bank of St. Louis from January 1946 to December 2010.

This study examines the impacts of oil price shocks on the economies of El Paso and Ciudad Juarez. The monthly economic indicators for El Paso which are included in the analysis are total retail sales, gross metropolitan product, total personal income, median existing single-family home prices, and total non-agricultural employment. Total retail sales are obtained from Moody's Economy.com and span the period between January 1970 and December 2010. Real gross metropolitan product is also obtained from Moody's Economy.com and cover the period between January 1978 and December 2010. Real personal income is also obtained from Moody's Economy.com for the period from March 1969 to December 2010. Median existing single-family home prices are published by the National Association of Realtors from January 1975 to December 2010. Total non-agricultural employment data are obtained from the Bureau of Labor Statistics from January 1970 to December 2010.

Economic variables observed for Ciudad Juarez are retail sales and formal sector employment. The Ciudad Juarez real retail sales index, with base year 2003, is obtained from INEGI from January 1994 through December 2010. Formal sector employment, which is defined as the number of workers insured under the Mexican social security system, is obtained from IMSS from July 1997 to December 2010. Definitions of the variables used in this exercise are shown in Table 1.

Table 1. Mnemonics and Definitions

Variable	*Definition*
epsales	El Paso total retail sales growth rate
epgmp	El Paso Gross Metropolitan Product growth rate
epyp	El Paso total personal income growth rate
ephp	El Paso median existing single-family house price growth rate
epemp	El Paso total non-agricultural employment growth rate
cjsales	Ciudad Juarez retail sales growth rate
cjemp	Ciudad Juarez formal sector employment growth rate
oil	Net Oil Price Increase
dcrs	Net Oil Price Decrease

The effects of oil price changes on the growth rates of each El Paso variable are analyzed through an equation employing 12 autoregressive terms and 12 lags of the net oil price series as independent variables. These equations are estimated by an ordinary least squares approach. The regression equations are as follows:

$$epsales_t = \alpha_0 + \alpha_1 epsales_{t-1} + \alpha_2 epsales_{t-2} + \ldots + \alpha_{12} epsales_{t-12} + \beta_1 oil_{t-1} + \beta_2 oil_{t-2} + \ldots + \beta_{12} oil_{t-12} + \varepsilon_\tau \quad \textbf{(1)}$$

$$epgmp_t = \alpha_0 + \alpha_1 epgmp_{t-1} + \alpha_2 epgmp_{t-2} + \ldots + \alpha_{12} epgmp_{t-12} + \beta_1 oil_{t-1} + \beta_2 oil_{t-2} + \ldots + \beta_{12} oil_{t-12} + \varepsilon_\tau \quad \textbf{(2)}$$

$$epyp_t = \alpha_0 + \alpha_1 epyp_{t-1} + \alpha_2 epyp_{t-2} + \ldots + \alpha_{12} epyp_{t-12} + \beta_1 oil_{t-1} + \beta_2 oil_{t-2} + \ldots + \beta_{12} oil_{t-12} + \varepsilon_\tau \quad \textbf{(3)}$$

$$ephp_t = \alpha_0 + \alpha_1 ephp_{t-1} + \alpha_2 ephp_{t-2} + \ldots + \alpha_{12} ephp_{t-12} + \beta_1 oil_{t-1} + \beta_2 oil_{t-2} + \ldots + \beta_{12} oil_{t-12} + \varepsilon_\tau \quad \textbf{(4)}$$

$$epemp_t = \alpha_0 + \alpha_1 epemp_{t-1} + \alpha_2 epemp_{t-2} + \ldots + \alpha_{12} epemp_{t-12} + \beta_1 oil_{t-1} + \beta_2 oil_{t-2} + \ldots + \beta_{12} oil_{t-12} + \varepsilon_\tau \quad \textbf{(5)}$$

Given the linkages that exist between the economies on each side of the border, the impacts that oil prices have on economic conditions in Ciudad Juarez are also of interest. To measure these effects, the following two equations are estimated:

$$cjsales_t = \alpha_0 + \alpha_1 cjsales_{t-1} + \alpha_2 cjsales_{t-2} + \ldots + \alpha_{12} cjsales_{t-12} + \beta_1 oil_{t-1} + \beta_2 oil_{t-2} + \ldots + \beta_{12} oil_{t-12} + \varepsilon_\tau \quad \textbf{(6)}$$

$$cjemp_t = \alpha_0 + \alpha_1 cjemp_{t-1} + \alpha_2 cjemp_{t-2} + \ldots + \alpha_{12} cjemp_{t-12} + \beta_1 oil_{t-1} + \beta_2 oil_{t-2} + \ldots + \beta_{12} oil_{t-12} + \varepsilon_\tau \quad \textbf{(7)}$$

As is the case with the El Paso equations, the growth rates of formal sector employment and retail sales activity in Ciudad Juarez are regressed on twelve autoregressive terms and twelve lags of the net oil price series. In addition, all seven equations are also estimated using the net oil price decrease to examine if the asymmetric relationship between oil prices and the economy holds for El Paso and Ciudad Juarez.

In order to trace the effects that a shock in oil prices has on the simulated growth patterns of the El Paso and Ciudad Juarez economies, an impulse response function is calculated for each equation incorporating the net oil price increase. For this study, the simulated time period is from January 2011 to December 2015. Koop (1996) illustrates that impulse response functions are able to measure the impacts of a shock on future values of a time series relative to a benchmark. The benchmark for each variable used in this study is equal to the forecasted series using the net oil prince increase. Each equation is also simulated through the forecast sample period after a price shock is applied to the December 2010 value of the net oil price series. The spot price for West Texas Intermediate petroleum for this month is increased by 10 percent relative to the previous 36-month high. As Koop (1996) explains, the shock is only applied to one month because shocks of different sizes only serve to rescale the impulse response function. The difference between the shocked simulation and the benchmark series generates the impulse response function.

4. Results

Summary results for the ordinary least squares estimates of equations 1 through 7 are found in Table 2. All of the El Paso equations exhibit strong statistical fit, with coefficients of determination above 97 percent. The Ciudad Juarez retail sales and Ciudad Juarez employment equations have an R-squared of 23 percent and 73 percent, respectively. In order to correct for higher-order serial correlation, an ARMAX procedure (Pagan, 1974) is employed for the gross metropolitan product, personal income, and employment equations for El Paso, and the formal sector employment equation for Ciudad Juarez. Variance inflation factors are calculated and it is found that the issue of multicollinearity in the net oil price increase variables is only present in the Ciudad Juarez retail sales equation. Based on the regression results, the relationship between some of the economic variables and the net oil price increase is not clear. None of the coefficients for the lags of the net oil price increase in Equations 2 and 4 are statistically significant, suggesting that oil price increases do not explain movements in the gross metropolitan product and existing house prices in El Paso.

Table 2. Summary of Net Oil Price Increase OLS Results

	EPSALES	EPGMP	EPYP	EPHP	EPEMP	CJSALES	CJEMP
OIL lag 1	-0.000393	-0.00081	-0.0000346	0.003917	0.000192	-0.095439	0.036196*
	(0.5601)	*(0.4377)*	*(0.9423)*	*(0.2991)*	*(0.5534)*	*(0.28)*	*(0.0883)*
OIL lag 2	0.001122*	0.000298	0.000322	0.002852	0.000151	0.060768	-0.025545
	(0.0967)	*(0.7915)*	*(0.4952)*	*(0.4787)*	*(0.6424)*	*(0.5087)*	*(0.2517)*
OIL lag 3	0.000358	0.000159	-0.000156	-0.001898	0.000265	0.081836	0.03719*
	(0.597)	*(0.8881)*	*(0.7401)*	*(0.6378)*	*(0.4147)*	*(0.3798)*	*(0.0886)*
OIL lag 4	0.000131	-0.001028	0.000238	0.003202	-0.000815	-0.131649	-0.006511
	(0.8458)	*(0.3524)*	*(0.6102)*	*(0.4291)*	*(0.8031)*	*(0.1588)*	*(0.6979)*
OIL lag 5	0.000942	0.0000786	-0.000155	0.002623	0.0000314	-0.073751	0.004793
	(0.1627)	*(0.9433)*	*(0.7406)*	*(0.5181)*	*(0.9231)*	*(0.4311)*	*(0.7706)*
OIL lag 6	-0.0023***	-0.001413	-0.000562	0.000221	-0.000586*	0.130535	-0.04128**
	(0.0007)	*(0.2009)*	*(0.2328)*	*(0.9565)*	*(0.0723)*	*(0.1728)*	*(0.0112)*
OIL lag 7	-0.001193*	-0.001481	-0.00107**	-0.000546	-0.000386	-0.004051	-0.005336
	(0.0842)	*(0.1728)*	*(0.0232)*	*(0.8927)*	*(0.235)*	*(0.9663)*	*(0.7464)*
OIL lag 8	-0.00062	0.00067	0.000304	-0.003571	-0.000403	-0.1949**	-0.03677**
	(0.3648)	*(0.5405)*	*(0.5173)*	*(0.379)*	*(0.21)*	*(0.0382)*	*(0.0235)*
OIL lag 9	0.00140**	0.000687	0.000549	-0.00223	0.000339	0.026947	-0.03255**
	(0.0408)	*(0.5248)*	*(0.2404)*	*(0.5816)*	*(0.2931)*	*(0.7739)*	*(0.0475)*
OIL lag 10	-0.000979	-0.000654	-0.000546	0.004499	-0.000283	0.078066	-0.008854
	(0.1554)	*(0.5429)*	*(0.2453)*	*(0.265)*	*(0.38)*	*(0.4035)*	*(0.6785)*
OIL lag 11	0.000505	0.001428	0.000275	-0.004303	-0.0000284	-0.089958	-0.029459
	(0.4641)	*(0.1847)*	*(0.5579)*	*(0.2868)*	*(0.9297)*	*(0.3283)*	*(0.1815)*
OIL lag 12	-0.000373	-0.000314	0.000267	0.002571	-0.00073**	-0.126438	0.034078
	(0.5853)	*(0.7515)*	*(0.5732)*	*(0.4966)*	*(0.0237)*	*(0.1568)*	*(0.1209)*
R-squared	0.981827	0.985012	0.984761	0.977751	0.986458	0.23321	0.729263

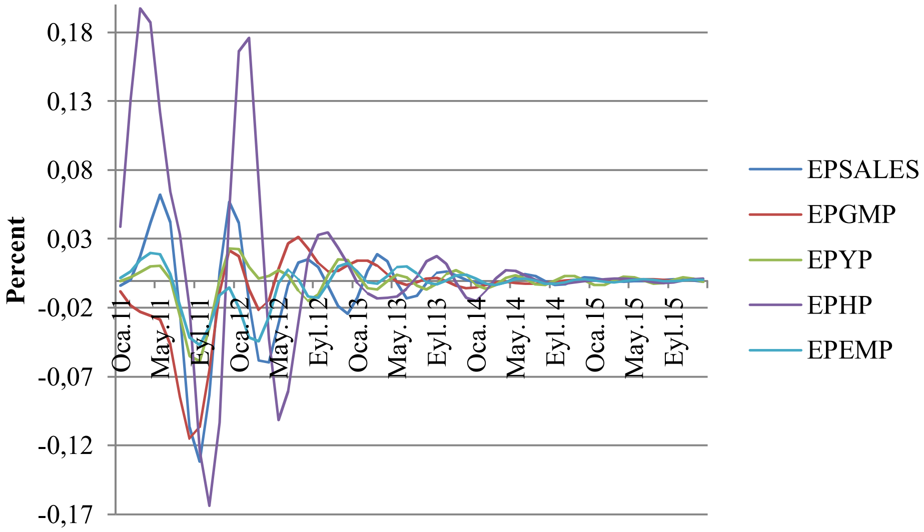
[a] *** indicates significance at the 1% level
[b] ** indicates significance at the 5% level
[c] * indicates significance at the 10% level

In the case of El Paso retail sales, two of the significant coefficients are positive while two are negative. The largest impact occurs six months after the increase in oil prices. According to the results, a one percent increase in oil prices relative to the previous 36-month high leads to a decrease of 0.0023 percent in retail sales. The impulse response function in Figure 1 shows the effect of a ten percent shock to the December 2010 value of the net oil price increase on the simulated growth rate of retail sales. It shows that the maximum impact of the oil shock occurs after nine months. Retail sales are predicted to decrease by 0.13 percent in September 2011. The growth rate slowly begins to recover and stabilizes back to its trend by the first quarter of 2015. Based on Figure 2, the total impact of the ten percent shock in the price of oil translates to a 0.24 percent permanent reduction, approximately $32 million, in the level of retail sales in El Paso.

Geographically, El Paso is highly fragmented. Traveling to different points in the city usually requires a substantial amount of driving. Access to public transit is limited, leaving residents with few alternatives when seeking transportation. Given that disposable incomes in El Paso are relatively low, a fraction of retail purchases tend to be forgone in response to higher gasoline prices. A substantial amount of retail purchases in El Paso are made by Mexican nationals whose budget constraints are also affected by rising oil prices. Higher fuel prices also imply an increase in the cost of waiting times at international ports of entry.

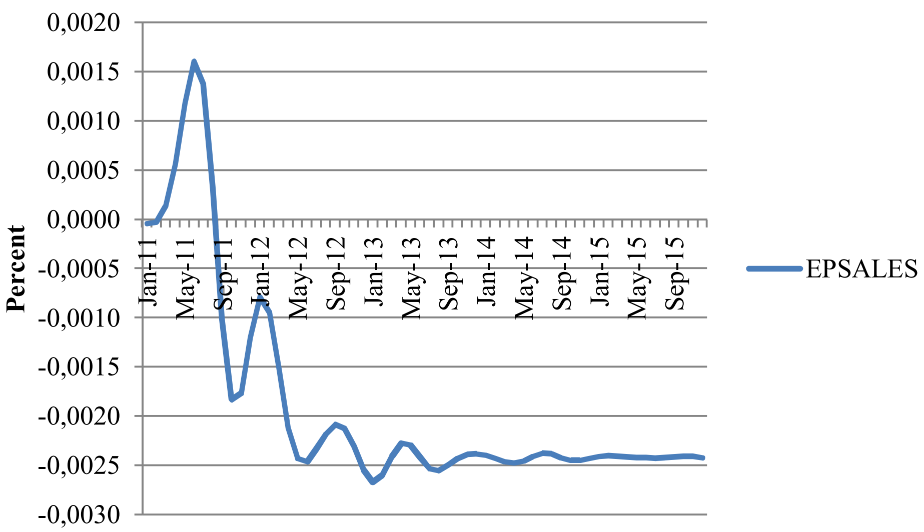
Table 2 shows that none of the coefficients for the lags of the net oil price increase are statistically significant in the El Paso gross metropolitan product equation. These results imply that increases in the price of oil are irrelevant towards movements in the GMP of El Paso. By analyzing Figure 1, however, it is possible to see how future values of this variable would react to a ten percent shock in oil prices. According to the impulse response function, GMP is expected to fall by over 0.1 percent at its maximum in August 2011. By late 2014 these effects will have largely dissipated. Figure 3 shows that an overall reduction of 0.39 percent, over $112 million, in the gross metropolitan product of El Paso is expected as a result of this shock.

Figure 1. El Paso Impulse Response Functions



The results in Table 2 show that the coefficient of the net oil price increase in the El Paso real personal income equation is negative and statistically significant at lag seven. These results state that a one percent increase in the net price of oil leads to a decrease in personal income of 0.0011 percent seven months later. The impulse response function presented in Figure 1 indicates that the largest impact of the ten percent shock to the December 2010 value of oil prices comes after nine months. Personal income is expected to decrease by 0.06 percent in September 2011. The effects of the shock lessen but do not completely disappear by the of the simulation period. As is shown in Figure 3, this denotes a permanent reduction in the total level of personal income of 0.075 percent, or over $23 million.

Figure 2. El Paso Retail Sales Total Impact Curve



The ordinary least squares estimation of the El Paso existing house prices equation fails to find any statistically significant t-statistics for the coefficients of the lags of the net oil price increase. The impulse response function presented in Figure 1 reveals wide fluctuations in the forecasted growth rate of existing house prices as a result of the ten percent oil price shock. The greatest impact is observed three months later when house prices are expected to increase by 0.2 percent. The largest negative outcome of the oil shock occurs in October 2011. House prices are predicted to fall 0.16 percent during this month. The effects of the oil shock slowly wear off by mid-2015. Figure 3 shows that the total impact of the oil shock results in a permanent increase of 0.66 percent, about $2,000, in existing house prices in El Paso.

Figure 3. El Paso Total Impact Curves

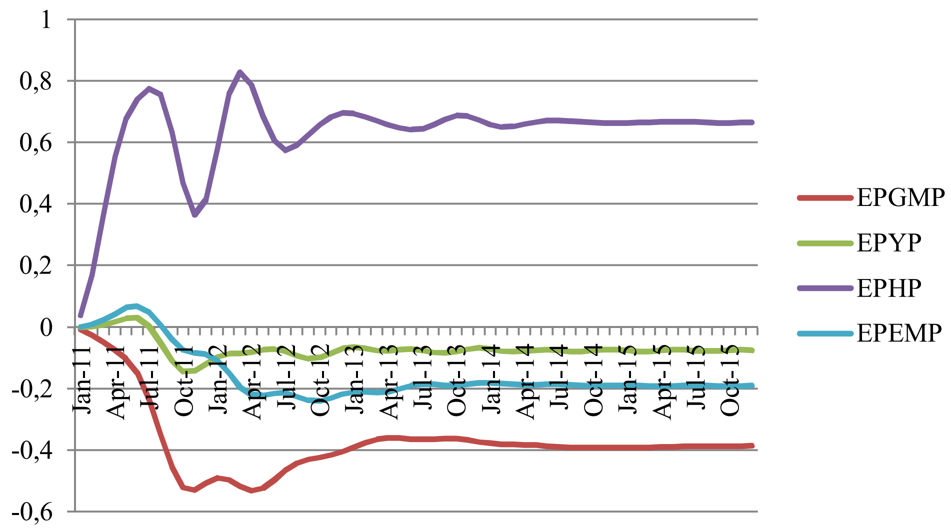


Table 2 shows that employment drops six and twelve months after an increase in the net oil price. According to the regression, a one percent increase in the net price of oil results in a decrease of 0.0006 percent six months later. After forecasting non-agricultural employment and applying the ten percent shock to oil prices, the impulse response function presented in Figure 1 shows that the largest impact resulting from such a change in the price of oil occurs after nine months. Employment is expected to drop by almost 0.05 percent in September 2011. The growth rate of employment is not expected to even out until about late 2015. The total impact of the oil shock on employment in El Paso appears in Figure 3. The oil shock is predicted to cause a permanent reduction in employment of about 0.19 percent. This means that over 560 jobs would be lost as a direct result of the one-time shock in the price of oil.

The only statistically significant coefficient of the lag of oil prices in the Ciudad Juarez retail sales equation occurs at lag eight. The results indicate that a one percent increase in oil prices relative to the previous 36-month high leads to an almost 0.2 percent decrease in retail sales eight months later. The magnitude of this coefficient is larger than that of the highest negative and statistically significant coefficient in the El Paso equation, revealing a higher retail sales sensitivity to increases in oil prices on the south side of the border. The impulse response function in Figure 4 shows sharp fluctuations in the growth rate of retail sales in Ciudad Juarez as a result of the ten percent shock to oil prices. Retail sales are anticipated to decrease by over 1.6 percent eight months later. This amounts to a permanent decrease of almost 3 percent in sales as is shown in Figure 5.

The results in Table 2 find statistically significant coefficients of the lags of the net oil price increase in the Ciudad Juarez formal sector employment equation at lags one, three, six, eight, and nine. The initial impact appears to be positive, as employment is expected to increase by almost 0.4 percent one and three months after a one percent increase in oil prices. These effects become negative, however, with the largest negative impact occurring six months after the rise in oil prices. Figure 4 presents the results of the impulse response function for Ciudad Juarez employment. The oscillations in the growth rate of employment shown in this graph are much sharper than those observed for the other variables. In fact, they do not appear to stabilize by the end of the forecast sample period. The largest impact occurs in February 2012 when employment is expected to fall by 0.59 percent. Overall, the oil shock is predicted to cause a reduction in the total level of formal sector employment of over 2.1 percent. This indicates a difference of over 7,200 fewer jobs in December 2015 than there would have been in the absence of the oil shock.

Figure 4. Ciudad Juarez Impulse Response Functions

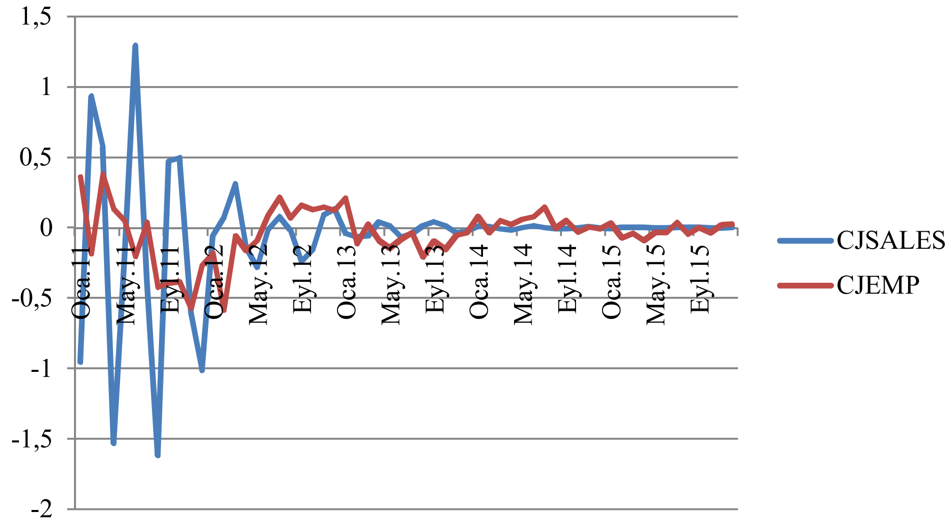
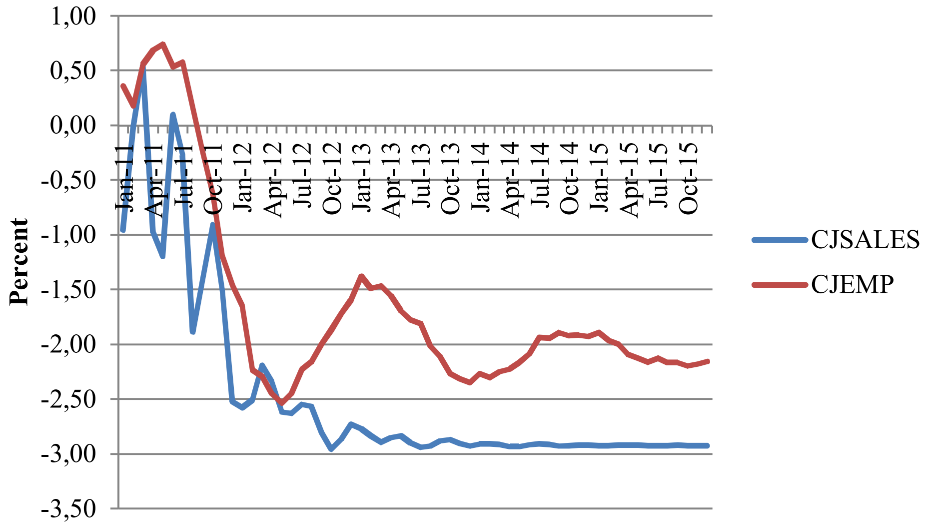


Figure 5. Ciudad Juarez Total Impact Curves



To test whether the lags of the net oil price increase are jointly significant, an F-test was calculated for each regression equation. The results for those tests are shown in Table 3.

Table 3 shows that the null hypothesis that all the lagged net oil price increase coefficients are jointly equal to zero is only rejected in the El Paso retail sales equation. The results indicate that the net oil price increase variables as a whole are not significant in equations 2 through 7. However, Pindyck and Rubinfeld (1998) explain that the F-test is a test of a group of variables, not of individual variables within that group. Therefore, as is shown in Table 2, there are statistically significant net oil price variables in all but two of the equations estimated.

The equations in Table 4 are estimated to test the asymmetric relationship between oil prices and the economy. Logic suggests that as the economy is expected to contract from an increase in the price of oil, a decrease in prices should lead to economic expansion. Sill (2007) describes that this is not necessarily the case. A drop in the price of oil may have reallocation effects on the economy which may offset any apparent gains from a lower oil price.

Table 3. Joint Significance Test

Equation	Calculated F-Statistic	Critical F-Statistic	Decision
EPSALES	2.33	1.75	Reject
EPGMP	0.83	1.75	Fail to Reject
EPYP	0.73	1.75	Fail to Reject
EPHP	0.65	1.75	Fail to Reject
EPEMP	1.13	1.75	Fail to Reject
CJSALES	0.93	1.75	Fail to Reject
CJEMP	1.29	1.83	Fail to Reject

$H_0 = \beta_1 \dots \beta_{12} = 0$
$H_A = \beta_1 \dots \beta_{12} \neq 0$

Table 4. Summary of Net Oil Price Decrease OLS Results

	EPSALES	EPGMP	EPYP	EPHP	EPEMP	CJSALES	CJEMP
DCRS lag 1	0.002156	0.001067	-0.000321	0.002402	0.000683	-0.048233	0.041332
	(0.2613)	*(0.2721)*	*(0.8210)*	*(0.5787)*	*(0.4590)*	*(0.6366)*	*(0.2371)*
DCRS lag 2	-0.00049	0.000473	-0.001228	-0.004942	-0.000167	0.141455	0.017055
	(0.8127)	*(0.6424)*	*(0.4065)*	*(0.2867)*	*(0.8664)*	*(0.1619)*	*(0.6080)*
DCRS lag 3	-0.00443**	-0.001659*	0.00336**	0.006374	0.000843	-0.073309	-0.01584
	(0.0313)	*(0.0950)*	*(0.0233)*	*(0.1691)*	*(0.3938)*	*(0.4742)*	*(0.6346)*
DCRS lag 4	0.001516	0.000137	-0.000171	-0.000311	0.000791	0.027828	-0.001729
	(0.4601)	*(0.8916)*	*(0.9083)*	*(0.9464)*	*(0.4193)*	*(0.7855)*	*(0.9584)*
DCRS lag 5	0.002525	0.001163	0.001221	0.002362	0.000118	0.000467	-0.0633*
	(0.2274)	*(0.2523)*	*(0.4115)*	*(0.6096)*	*(0.9046)*	*(0.9964)*	*(0.0520)*
DCRS lag 6	-0.00464**	-0.001161	0.0044***	0.008425*	0.001405	0.062709	-0.03208
	(0.0266)	*(0.2463)*	*(0.0035)*	*(0.0698)*	*(0.1561)*	*(0.5392)*	*(0.3185)*
DCRS lag 7	0.001403	-0.001311	-0.0018	-0.001991	-0.001482	0.002214	-0.042495
	(0.4967)	*(0.1910)*	*(0.2283)*	*(0.6678)*	*(0.1325)*	*(0.9827)*	*(0.1894)*
DCRS lag 8	0.001939	-0.000659	-0.000468	-0.000631	-0.000704	0.011029	-0.009851
	(0.3463)	*(0.5094)*	*(0.7541)*	*(0.8910)*	*(0.4738)*	*(0.9140)*	*(0.7583)*
DCRS lag 9	0.001634	-0.00221**	-0.00177	0.002497	-0.00225**	-0.038847	0.003324
	(0.4250)	*(0.0276)*	*(0.2344)*	*(0.5871)*	*(0.0226)*	*(0.7037)*	*(0.9169)*
DCRS lag 10	-0.002312	-0.00169*	-0.000957	0.002532	-0.000192	0.05125	-0.016355
	(0.2563)	*(0.0952)*	*(0.5196)*	*(0.5816)*	*(0.8464)*	*(0.6165)*	*(0.6095)*
DCRS lag 11	-0.000247	0.00216**	0.000776	0.000804	0.1485	0.031061	0.014709
	(0.9031)	*(0.0372)*	*(0.6021)*	*(0.8611)*	*(0.1339)*	*(0.7596)*	*(0.6456)*
DCRS lag 12	0.001418	0.001636	-0.000756	0.000433	0.00083	-0.039278	0.036951
	(0.4560)	*(0.1017)*	*(0.6005)*	*(0.9201)*	*(0.3732)*	*(0.6981)*	*(0.2475)*
R-squared	0.984925	0.985741	0.98507	0.977847	0.984322	0.200682	0.557533

[a] **** indicates significance at the 1% level*
[b] *** indicates significance at the 5% level*
[c] ** indicates significance at the 10% level*

The estimations presented in this study do not provide conclusive results in the case of El Paso. The equations for El Paso retail sales and non-agricultural employment contain negative and statistically significant coefficients of the lags of the net oil price decrease. These results provide evidence in favor of asymmetry. However, the equations for personal income and existing house prices have statistically significant coefficients which are purely positive. According to the results in Table 4, a one percent decrease in oil prices leads to an increase in personal income of 0.004 percent six months later. The equation for El Paso gross metropolitan product has statistically significant positive and negative coefficients. While the results for these equations make economic sense, they do not conform to the assumption of the asymmetric effect of oil prices on the economy.

This condition does hold in the case of Ciudad Juarez, however. The equation for Ciudad Juarez retail sales lacks any statistically significant coefficients of the lags of the net oil price decrease, indicating that decreases in the price of oil have no apparent effect on retail sales. The formal sector employment equation has a negative and statistically significant coefficient at lag 5. Based on this regression, a one percent decline in the net price of oil leads to a decrease of 0.06 percent in employment.

5. Conclusion

This study employs a measure of the net oil price increase developed by Hamilton (1996) in a manner similar to that applied by Sill (2007) to the national economy. This measure controls for feedback effects between oil prices and the economy, and accounts only for price increases which are relevant to economic growth. An impulse response function is calculated to examine the effects of a ten percent shock in oil prices on economic conditions. A net oil price decrease variable is also employed to examine the asymmetry hypothesis between oil prices and business cycle fluctuations.

The results found in this study are somewhat inconclusive. There are no statistically significant coefficients for the lags of the net oil price increase in both the El Paso gross metropolitan product and existing house prices equations. In the case of the El Paso retail sales estimation, the effects of the net oil price increase are both positive and negative. Given the negative effect that rising oil prices have on disposable incomes, it seems counter-intuitive that these would lead to increased retail purchases by consumers. However, the results do find a negative and statistically significant relationship between the net oil price increase and personal income and employment in El Paso, as well as retail sales and employment in Ciudad Juarez.

An impulse response function is generated for each variable in this study. A ten percent shock is applied to the December 2010 value of the net oil price increase and a five-year out of sample simulation is performed for each equation. The effect of this shock is found to lead to a reduction of 0.24 percent in retail sales in El Paso. Similarly, El Paso's gross metropolitan product drops by 0.39 percent as a result of the shock. This represents a permanent loss of over $112 million in local output. Personal income is predicted to fall by over 0.075 percent, or approximately $23 million, in response to the oil shock. The effects of the shock do not completely dissipate by the end of the simulation period, indicating the loss in personal income resulting from this oil price hike can be greater.

The value of existing house prices in El Paso is expected to increase by 0.66 percent after the oil shock. Higher production and transportation costs stemming from a shock to the price of oil lead to increased costs of doing business for firms across the economy. As a result, payroll cutbacks are not uncommon during these episodes. The impulse response function in this study estimates employment in El Paso to permanently decrease by 0.19 percent, or around 560 jobs, as a result of the ten percent jump in the price of oil.

The effects of the oil shock are amplified in the case of Ciudad Juarez. A permanent decrease of almost 3 percent in retail sales is expected. The impulse response function exhibits sharp fluctuations, making evident the higher retail sales sensitivity that exists on the south side of the border. The total level of formal sector employment is also expected to be negatively affected as a result of the oil shock. A decrease of over 2 percent in employment is attributed to the 10 percent rise in the price of oil. This represents over 7,200 fewer jobs in Ciudad Juarez.

The results presented in this study do not provide definitive evidence in support of an asymmetrical relationship between oil prices and the economy. Despite conventional thought which argues that lower oil prices should lead to periods of economic growth, research has found that this is not the case. A reduction in oil prices may have reallocation effects on the economy which may offset any gains attributed to a lower price of oil. The retail sales and employment equations for both El Paso and Ciudad Juarez provide evidence in favor of asymmetry. However, the equations for personal income, existing house prices, and gross metropolitan product reveal symmetrical relationships with respect to the net oil price decrease variable.

A considerable amount of research has been conducted examining the links between oil price fluctuations and macroeconomic conditions. To a lesser extent, studies have also focused on the impact of these price movements on regional economies. This examines the effects of oil price fluctuations on the economies of El Paso, Texas and Ciudad Juarez, Chihuahua. Given the disparities between the results found in this study with those obtained at the macroeconomic level, there is no reason to believe that similar results will be observed for other areas. Further testing may provide greater insight on the effects of oil prices and oil shocks on regional economies. In particular, data covering a longer time span would allow testing whether the effects of oil price shocks are weakening for regional economies in a manner similar to what has been documented at the national in at least one study for the United States (Farhani, 2012).

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