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The dynamic effects of aggregate supply and demand shocks in the Mexican economy

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Abstract

This paper studies if the supply shock derived from the Blanchard-Quah methodology contains a demand driven component in the Mexican economy during the period 1981Q1-2016Q2. We find that supply shocks are not contemporaneously correlated with demand shocks, so that 1) the anomaly in the inflation dynamics to a supply shock is not present if the standard Blanchard-Quah restrictions are employed; and 2) supply (demand) shocks represent the primary source of the long-run variation in output (inflation). The results show that it is possible to identify uncorrelated supply and demand shocks for the Mexican economy using the standard restrictions imposed by the Blanchard-Quah approach.

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1 Introduction

Applications of the Blanchard and Quah (1989) (BQ) methodology often find that aggregate supply (AS) shocks are the primary source of variations in real economic activity and that aggregate demand (AD) shocks are the primary source of variations in inflation. These findings have been questioned by Cover et al. (2006), who showed that AS and AD shocks are highly correlated in the USA. If it is assumed that supply shocks are affected by demand shocks, Cover et al. (2006) demonstrated that AD shocks are now the primary source of variations in real economic activity and that AS shocks represent the primary source of variations in inflation. Similar results have been obtained by other empirical studies for the G-7 and ASEAN countries. Bashar (2011; 2012) found that, if the standard BQ restrictions are employed and the correlation between AS and AD shocks is ignored, a positive supply shock causes the inflation rate to increase in the long-run (which is hard to justify by any macro theory). In the same vein, he also found that the anomaly in the inflation dynamics disappears if supply and demand shocks are allowed to be correlated —with causality running from the latter to the former.

The results obtained by Cover et al. (2006) and Bashar (2011; 2012) show that it may not possible to identify uncorrelated shocks using the BQ methodology since the AS shock derived from the latter can potentially contain a demand driven component. Therefore, if the possible correlation between AS and AD shocks is ignored, the BQ approach may downplay the role of AD shocks in explaining fluctuations in real economic activity and may lead to anomalies in the inflation dynamics.

The current paper studies if the supply shock identified by the BQ methodology contains a demand driven component in the Mexican economy during the period 1981Q1-2016Q2 by considering the sensitivity of AS shocks with respect to AD shocks. Previous studies for the Mexican economy have employed only the standard BQ model to identify the permanent and transitory components of GDP and unemployment rates (Estefan-Dávila , 2014) or modifications of the BQ methodology in order to study other macroeconomic phenomena, such as monetary policy and stagnation (Loría and Ramírez , 2011), the significance and potential dual-nature of oil-price shocks (pure technology and pure expenditure shocks) (Méndez-Marcano , 2014), and structural VAR (SVAR) models identified by sign restrictions to develop new indicators for monetary policy interventions (Pagliacci , 2016). Thus, our paper is the first research that explicitly considers the potential correlation between AS and AD shocks in the Mexican economy. As mentioned before, if such correlation is significant then role of AD and AS shocks discussed in previous studies can be highly misleading.

Contrary to the evidence reported in studies for the USA, G-7, and ASEAN countries, we find that AS shocks are not sensitive to AD shocks in the Mexican economy, so that the supply shock identified by the BQ methodology does not contain a demand driven component. Specifically, we find that: 1) the anomaly in the inflation dynamics to a supply shock is not present if the standard BQ restrictions are employed; 2) AS shocks are the primary source of the long-run variation in output; and 3) AD shocks are the primary source of the long-run variation in inflation.

Two main conclusions can be derived from our results. First, it is possible to identify uncorrelated AS and AD shocks for the Mexican economy using the standard restrictions imposed by the BQ methodology. In this regard, our findings are in line with Estefan-Dávila (2014), who found that demand shocks explain the majority of fluctuations in unemployment and that supply shocks explain the majority of fluctuations in GDP without considering the possible correlation between shocks.

Second, the findings that AS (AD) shocks are the primary source of the long-run variation in output (inflation) correspond to the viewpoint that negative fluctuations in production are caused by severe economic crises that impact the long-run performance of the economy and that fluctuations in inflation are a consequence of economic phenomena with transitory effects that do not represent structural changes in the goods and labour markets. The structure of the Mexican economy is different from that of industrialized economies and developing Southeast Asian countries in terms of the goods and services produced, the degree of oligopoly power in different industries, labour market flexibility, and levels of informal employment. Future research should try to implement new models in order to identify the relevant market structures that play a role in explaining the differences between the G-7 and ASEAN countries and Mexico.

The next section presents a description of the SVAR models, Section 3 reports the results obtained, and Section 4 concludes.

2 Methodologies

Consider a SVAR model that incorporates measures of real output (y_t) and the price level (p_t) that have been differenced sufficiently to achieve stationarity. Since the structural shocks are not directly observable, the usual practice is to retrieve the latter from the estimation of a reduced-form VAR:

$$y_t = \sum_{i=1}^{q} c_{11}^{i} y_{t-i} + \sum_{i=1}^{q} c_{12}^{i} p_{t-i} + e_t^{y} \tag{1}$$

$$p_t = \sum_{i=1}^{q} c_{21}^{i} y_{t-i} + \sum_{i=1}^{q} c_{22}^{i} p_{t-i} + e_t^{p} \tag{2}$$

where e_t^y and e_t^p are the residuals series.

The relation between the structural shocks and the reduced-form residuals can be expressed as:

$$\mathbf{e_t} = \mathbf{G_0} \boldsymbol{\varepsilon_t} \tag{3}$$

where $\mathbf{e_t} = (e_t^y, e_t^p)'$; $\boldsymbol{\varepsilon_t} = (\varepsilon_t^s, \varepsilon_t^d)'$, where ε_t^s and ε_t^d are one-standard deviation supply and demand shocks, respectively; and $\mathbf{G_0} = \mathbf{A_0^{-1}B} = \begin{pmatrix} g_{11}^0 & g_{12}^0 \\ g_{21}^0 & g_{22}^0 \end{pmatrix}$ represents the contemporaneous effects of the one-standard deviation shocks on each variable, where $\mathbf{A_0}$ is a 2X2 matrix of coefficients and $\mathbf{B}$ is the variance-covariance matrix of structural shocks.

The BQ methodology imposes two critical assumptions:

1. The long-run AS is vertical: the AD shock has no long-run effect on y_t and a shift in the AD curve will only increase p_t proportionately. This long-run restriction implies that $g_{12}^0 = -\frac{\sum_{i=1}^{q} c_{12}^{i}}{1-\sum_{i=1}^{q} c_{22}^{i}} g_{22}^0$.

2. The $\mathbf{B}$ matrix is diagonal: the structural shocks are contemporaneously uncorrelated.

Following a simple AS-AD model, Cover et al. (2006) and Bashar (2011; 2012) have employed a Modified SVAR model in which it is possible to relax the assumption that supply and demand shocks are uncorrelated[1]:

$$y_t = \alpha p_t + \sum_{i=1}^{q} \phi_{yi} y_{t-i} + \sum_{i=1}^{q} \phi_{pi} p_{t-i} + \gamma b_{22} \varepsilon^d + b_{11} \varepsilon^s \tag{4}$$

$$p_t = -y_t + \sum_{i=1}^{q} \theta_{yi} y_{t-i} + \sum_{i=1}^{q} \theta_{pi} p_{t-i} + b_{22} \varepsilon^d \tag{5}$$

where ε^s and ε^d are the unit variance structural supply and demand shocks, respectively; b_{11} and b_{22} represent the standard deviations of both shocks; and the supply shock in equation (4) has two components: $b_{11}\varepsilon^s$, which represents the independent AS shock; and $b_{22}\varepsilon^d$, which represents the AS shock induced by an independent AD shock. The coefficient γ measures the extent to which the AS shock is affected by the AD shock.[2]

Given the Modified SVAR in equations (4) and (5) and the reduced-form VAR in equations (1) and (2), we have the following relationship between the residuals from the latter and the structural shocks:

$$\begin{bmatrix} e_t^y \\ e_t^p \end{bmatrix} = \begin{bmatrix} 1 & -\alpha \\ 1 & 1 \end{bmatrix}^{-1} \begin{bmatrix} b_{11} & \gamma b_{22} \\ 0 & b_{22} \end{bmatrix} \begin{bmatrix} \varepsilon^s \\ \varepsilon^d \end{bmatrix} \tag{6}$$

so that the variance-covariance matrix of the reduced-form VAR residuals is defined as:

$$\begin{bmatrix} \mathrm{var}(e_t^y) & \mathrm{cov}(e_t^y, e_t^p) \\ \mathrm{cov}(e_t^p, e_t^y) & \mathrm{var}(e_t^p) \end{bmatrix} = \begin{bmatrix} \frac{b_{11}}{1+\alpha} & \frac{(\alpha+\gamma)b_{22}}{1+\alpha} \\ \frac{-b_{11}}{1+\alpha} & \frac{(1-\gamma)b_{22}}{1+\alpha} \end{bmatrix} \begin{bmatrix} \frac{b_{11}}{1+\alpha} & \frac{-b_{11}}{1+\alpha} \\ \frac{(\alpha+\gamma)b_{22}}{1+\alpha} & \frac{(1-\gamma)b_{22}}{1+\alpha} \end{bmatrix} \tag{7}$$

The final additional restriction required to provide exact identification of the system follows the BQ long-run restriction: $\alpha = -\frac{\sum_{i=1}^{q} c_{12}^i}{1-\sum_{i=1}^{q} c_{22}^i}$, which implies that the structural AD shock does not have any long-run effect on the output level as long as this does not induce the long-run AS to shift. Hence, α yields an estimate of the slope of the short-run AS curve; $1/(1+\alpha)$ represents an estimate of the immediate effect on output of a 1% structural supply shock; and $\alpha/(1+\alpha)$ represents an estimate of the immediate effect on output of a 1% structural demand shock.

3 Results

Data on real GDP and the Consumer Price Index (CPI) for the period 1981Q1-2016Q2 were obtained from the Economic Commission for Latin America and the Caribbean (ECLAC)

[1]The supply curve in this specification corresponds to a Lucas-type supply function (Lucas , 1972), where the AS function depends on its expected value, unanticipated inflation and a random supply shock. On the other hand, the demand curve corresponds to a nominal AD function, which is equal to its expected value plus a random demand disturbance (see Cover et al. (2006) for the derivation).

[2]We considered only the case in which supply shocks are affected by demand disturbances —so that the demand shock is causally prior to the supply shock— since, following Cover et al. (2006), the other alternative specification —which consists in assuming that demand shocks can be affected by supply disturbances, so that the supply shock is causally prior to the demand shock— is mathematically equivalent to the standard BQ model (up to a scalar).

database.[3] We first tested the order of integration of the logarithms of both series using different unit root tests, finding that real GDP was difference stationary and that the CPI had to differenced twice to become stationary. We then tested for cointegration between the log of real GDP and the log-first difference of the CPI using the Johansen methodology, finding no evidence of cointegration between the variables.[4]

The VAR model included the annualised growth rate of real GDP, calculated as $g_t = 100 * [\ln(\text{GDP})_t - \ln(\text{GDP})_{t-4}]$; and the first difference of the annualised inflation rate, calculated as $\Delta\pi_t = \pi_t - \pi_{t-1}$, where $\pi_t = 100 * [\ln(\text{CPI})_t - \ln(\text{CPI})_{t-4}]$.[5] The Likelihood Ratio test indicated that the optimal lag length for the VAR model was 8; however, the latter presented serial correlation problems at the 5% according to the Lagrange Multiplier tests. Thus, we considered a VAR model with 9 lags, which did not present problems of autocorrelation.

Table 1 reports the estimated coefficients obtained from the Modified SVAR model. Since α is less than one (0.21), it is possible to conclude that the AS in the Mexican economy is not very sensitive to changes in the inflation rate; the immediate effect of a 1% supply shock on output $(1/(1+\alpha) = 0.83)$ is greater than the respective effect of a 1% demand shock $(\alpha/(1+\alpha) = 0.17)$; and $\gamma = 0.14$ is statistically non-significant, which suggests that AS shocks are not sensitive to AD shocks.

Table 1. Estimated coefficients using the Modified model

α	0.210
$1/(1+\alpha)$	0.827
$\alpha/(1+\alpha)$	0.173
γ[a]	0.139
	(0.984)
b_{11}[a]	1.958
	(0.122)
b_{22}[a]	2.841
	(0.178)

Notes: [a]Standard errors are shown in parenthesis.

[3]To the best of our knowledge, the ECLAC database is the most comprehensive source of quarterly data for Mexico. Both time series start in 1981Q1, so that the estimation sample was selected according to this constraint. Moreover, the GDP series for Mexico extracted from the ECLAC database uses two different base years: 1993 (for the period 1981Q1-1998Q4) and 2008 (for the period 1993Q1-2016Q2). The series were spliced together using 2008 as the base year. We used the CPI (2008=100) in order to consider the most common measure of inflation (Bashar , 2011; 2012). The CPI measures the change in cost on a bundle of households' representative basket of goods and services, so that we assume that changes in the latter reflect demand fluctuations more accurately than changes in the GDP deflator —which measures changes in the level of prices of all new, domestically produced, final goods and services in the economy. Both the real GDP and the CPI series for the Mexican economy are shown in Figure A.1 in Appendix A. Finally, as a robustness check we also estimated the models using the GDP deflator (2008=100) as the measure of inflation, finding fairly similar results (the latter are available from the author on request).

[4]The results for the different unit root tests and the Johansen tests for cointegration are available from the author upon request.

[5]We also considered the log-first difference of real GDP and the log-second difference of the CPI. The results obtained remained qualitatively the same.

From Figure 1 it is possible to observe that the impulse response functions (IRFs) for the structural AS and AD shocks as identified by the BQ decomposition and by the Modified model are fairly similar[6]:

1. The responses of g_t to a 1% supply shock and of $\Delta\pi_t$ to a 1% demand shock are (on average) 1.71% and 2.16%, respectively.

2. The responses of g_t to a 1% demand shock and of $\Delta\pi_t$ to a 1% supply shock are (on average) 0.65% and -1.40%, respectively.

3. According to the BQ decomposition, the response of g_t to a 1% demand shock is statistically non-significant for all periods and the response of $\Delta\pi_t$ to a 1% supply shock is significant only for the impact period. On the other hand, according to the Modified model the response of g_t to a 1% demand shock is statistically significant one quarter after the initial shock and the response of $\Delta\pi_t$ to a 1% supply shock is significant three quarters after the initial shock.

The long-run effects on the aggregate output level and on the inflation rate of the AS and AD shocks are presented in Figure 2. Both the BQ and the Modified models show that a positive supply shock has a permanent effect on output and that a positive demand shock has a permanent effect on the inflation rate. Both methodologies also show that there is a negative response of the inflation rate to a positive supply shock, which is significant over a longer time horizon when the Modified model was employed. As expected, a positive demand shock has no permanent effects on output using the BQ model; and the Modified model shows evidence of a slight, permanent increase in the output level, although the effect is statistically significant only for two quarters after the initial shock.[7]

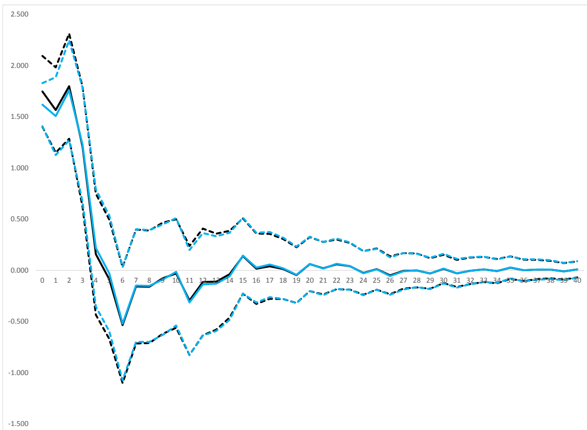
Finally, the variance decomposition analyses are presented in Table 2. The BQ model shows that around 93% (79%) of the short-run variation in output (inflation) and around 95% (76%) of the long-run variation in output (inflation) have been the result of structural supply (demand) shocks. According to the Modified model, the supply (demand) shock accounts for approximately 80% (61%) of the short-run variation in output (inflation) and for approximately 89% (62%) of the long-run variation in output (inflation).

4 Conclusions

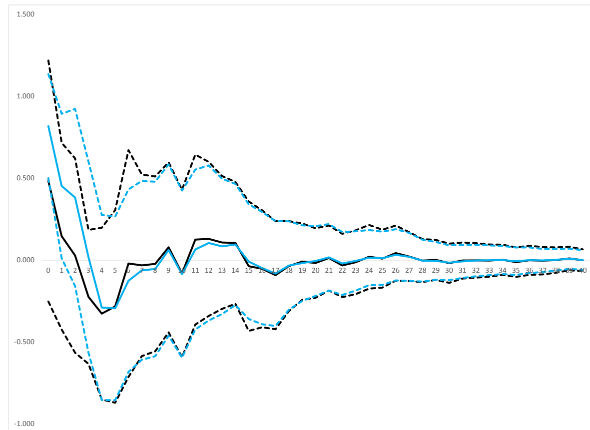
Previous studies for the USA, G-7, and ASEAN countries have shown that the Blanchard-Quah approach can lead to anomalies in the inflation dynamics and can downplay the role of demand shocks in explaining fluctuations in real economic activity if the potential correlation between supply and demand shocks is ignored. The latter means that it may not be possible to derive independent supply and demand shocks using the Blanchard-Quah methodology since both can be contemporaneously correlated.

[6] In Figures 1 and 2 the horizontal axis shows the time horizon (quarters); and we plot the responses up to 40 quarters. Bootstrapped standard errors were generated via 2000 replications.

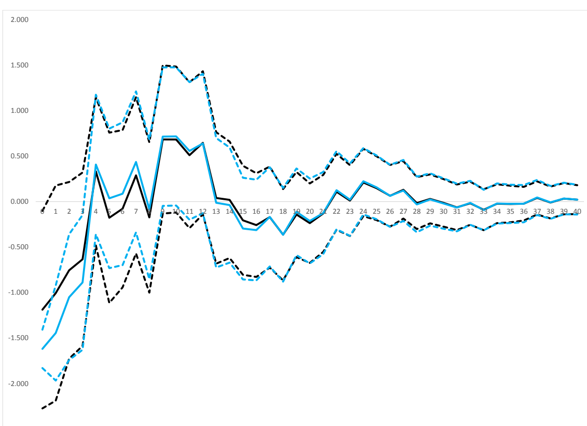
[7] The estimated structural AS and AD shocks derived from both models are presented in Figure B.1 in Appendix B. The correlation between the AS shocks derived from the BQ decomposition and from the Modified model is 0.97; whereas the respective correlation between the AD shocks is 0.89. This also shows that the AS and AD shocks obtained from both specifications were fairly similar.



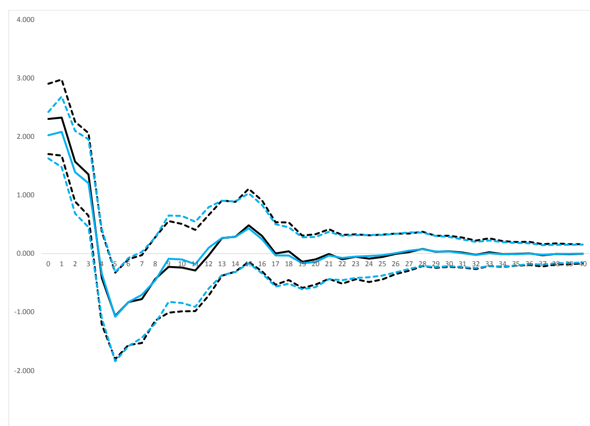
(a) Response of g_t to a 1% supply shock



(b) Response of g_t to a 1% demand shock

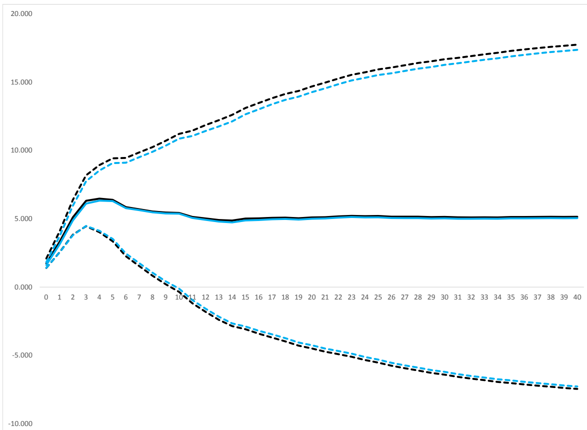


(c) Response of $\Delta\pi_t$ to a 1% supply shock

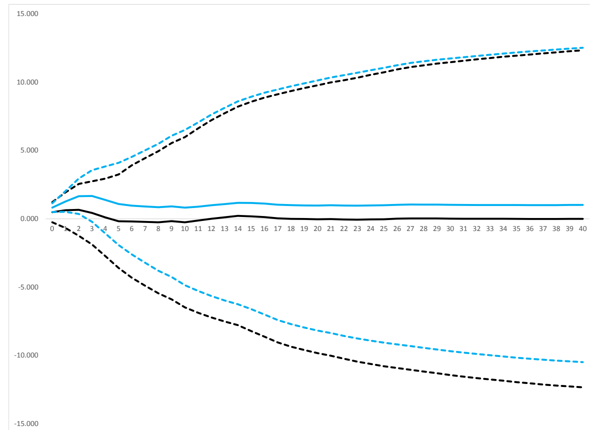


(d) Response of $\Delta\pi_t$ to a 1% demand shock

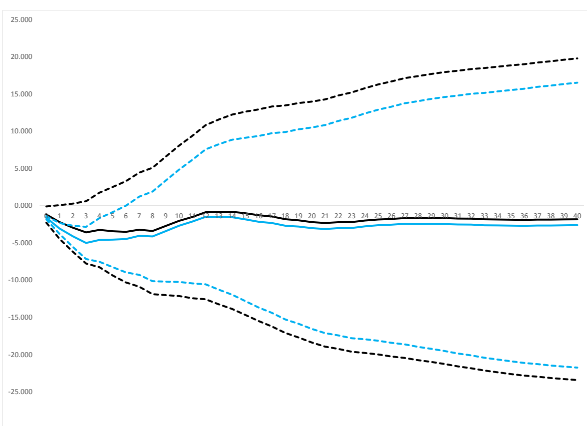
Figure 1. Dynamic responses of g_t (output growth rate) and $\Delta\pi_t$ (first difference of the inflation rate) to a 1% supply and demand shocks, with bootstrapped 95% confidence intervals (shown by dotted lines). Impulse responses were obtained from the SVAR models based on the Blanchard-Quah decomposition (shown in black) and on the Modified model (shown in blue)



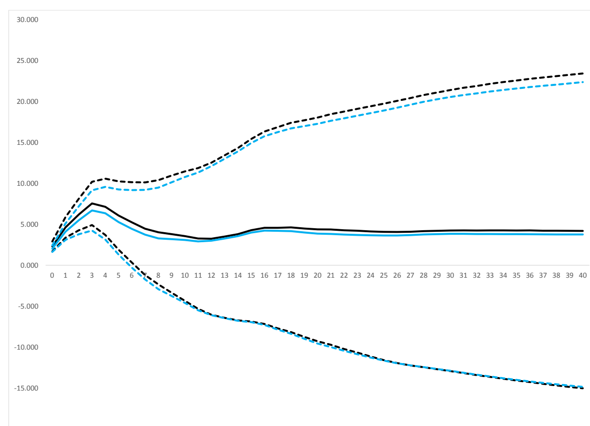
(a) Accumulated response of output to a 1% supply shock



(b) Accumulated response of output to a 1% demand shock



(c) Accumulated response of inflation to a 1% supply shock



(d) Accumulated response of inflation to a 1% demand shock

Figure 2. Responses of aggregate output level and inflation rate to a 1% supply and demand shocks, with bootstrapped 95% confidence intervals (shown by dotted lines). These figures are the cumulative impulse responses of the figures presented in Figure 1, obtained from the SVAR models based on the Blanchard-Quah decomposition (shown in black) and on the Modified model (shown in blue)

Table 2. Variance decompositions for the Blanchard-Quah and the Modified models

Horizon (quarters)	Variance in the output growth rate due to		Variance in the change in the inflation rate due to	
Blanchard-Quah model				
	Supply shock (%)	Demand shock (%)	Supply shock (%)	Demand shock (%)
1	92.91	7.09	21.03	78.97
2	95.58	4.42	18.47	81.54
10	95.48	4.52	18.77	81.23
40	94.86	5.14	23.67	76.33
Modified model				
	Supply shock (%)	Demand shock (%)	Supply shock (%)	Demand shock (%)
1	79.65	20.35	39.03	60.97
2	84.84	15.16	35.85	64.15
10	89.02	10.98	34.05	65.96
40	88.78	11.22	38.15	61.85

The present paper has explored if the supply shock identified by the Blanchard-Quah methodology contains a demand driven component in the Mexican economy during the period 1981Q1-2016Q2. We do not find evidence that supply shocks are correlated with demand shocks in Mexico, so that: 1) the inflation rate decreases when there is a positive supply shock if the standard Blanchard-Quah restrictions are employed; 2) supply shocks account for approximately 95% of the long-run variation in output; and 3) demand shocks account for approximately 76% of the long-run variation in inflation.

The results show that it is possible derive uncorrelated supply and demand shocks for the Mexican economy using the standard restrictions imposed by the Blanchard-Quah methodology. Given that the structure of the Mexican economy is different from that of industrialized economies and developing Southeast Asian countries, future research should try to implement new models in order to identify the relevant market structures that play a role in explaining the differences between the G-7 and ASEAN countries and Mexico.

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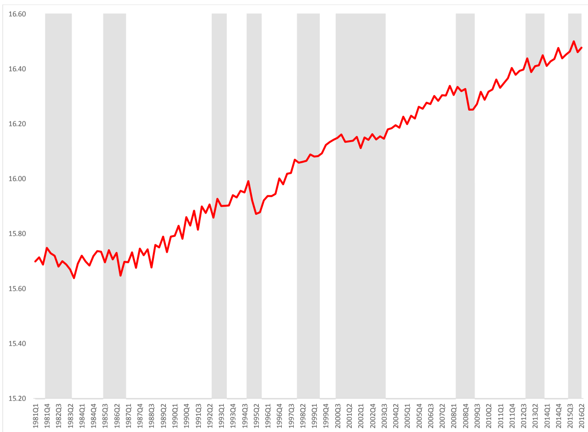
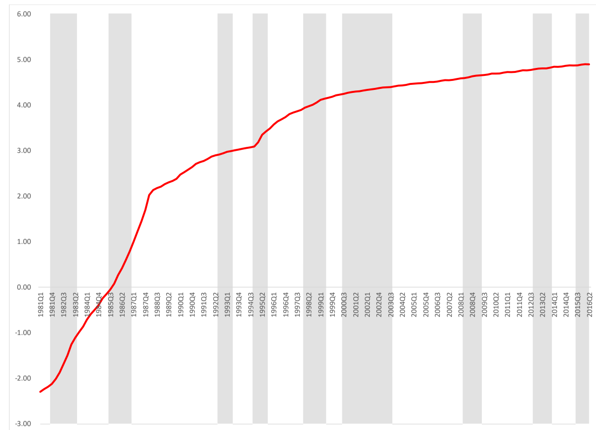
A Data



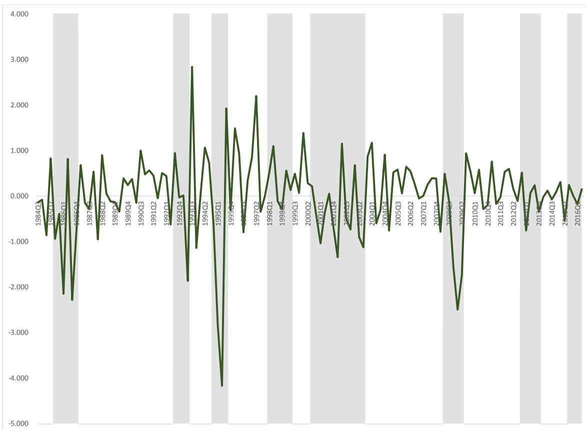
(a) Natural log of real GDP



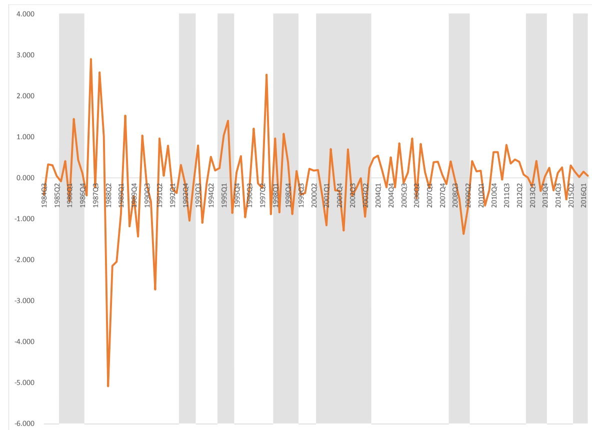
(b) Natural log of CPI

Figure A.1. Mexico: Natural log of real GDP and of CPI; quarterly, 1981Q1-2016Q2 (base year: 2008). Shaded areas indicate OECD based recession indicators from the period following the peak through the trough (extracted from the FRED database, series: MEXRECD).

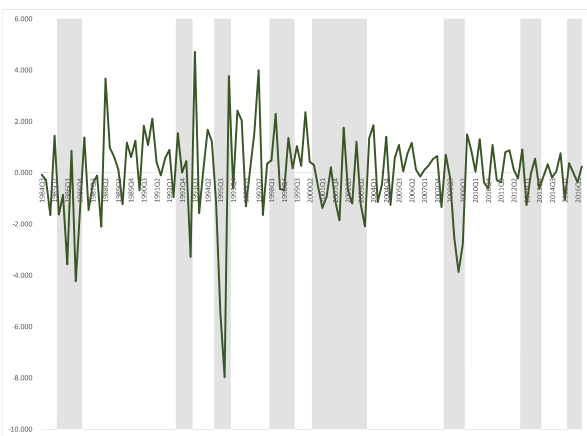
B Estimated structural shocks



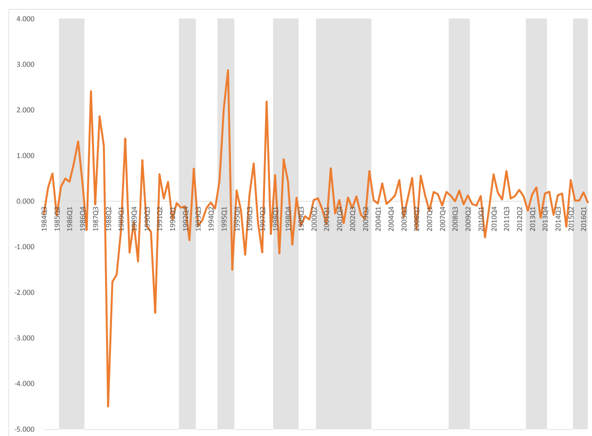
(a) Aggregate supply shock derived from the Blanchard-Quah decomposition



(b) Aggregate demand shock derived from the Blanchard-Quah decomposition



(c) Aggregate supply shock derived from the Modified model



(d) Aggregate demand shock derived from the Modified model

Figure B.1. Structural shocks obtained from the SVAR models based on the Blanchard-Quah decomposition and on the Modified model; quarterly, 1984Q3-2016Q2. Shaded areas indicate OECD based recession indicators from the period following the peak through the trough (extracted from the FRED database, series: MEXRECD).