Fear of Floating or Monetary Policy as Usual? A Structural Analysis to Mexico's Monetary Policy

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November 22, 2006

Abstract

In this paper I analyze monetetary policy for the Mexican economy before and after the financial and balance of payments crisis. I estimate a small open economy DSGE model using Bayesian methods. I address how monetary policy was conducted over time as an initial approach to evaluate if Mexico observes real inflation targeting or fear of floating. In my empirical analysis I conclude that the central bank of Mexico did not respond strongly to movements in the exchange rate during the floating exchange rate regime, especially compared to the high degree of exchange rate targeting observed in the managed exchange rate regime. Thus I do not find strong evidence that monetary policy in Mexico posses fear of floating. In addition, I observe that inflation has become the nominal anchor in the economy in the years after the 1994 crisis

*I thank Professor Milani for his advise and help with many aspects of the paper. I also thank professor Branch for his helpful comments.

Introduction

Fear of floating has been an endemic problem in emerging market countries for the last decade. This epidemic developed after the contagion of financial and balance of payments crisis around the emerging markets such as in Mexico. Before the crises, most of these countries had as a common characteristic pegged or managed exchange rate policies. As part of their recovery, several of these countries allowed the exchange rate to float. In Mexico's case, low international reserves, a large current account deficit, and lack of credibility drove the policy authorities to have a floating exchange rate regime. However, Calvo and Reinhart (2000) concluded that most emerging markets are not true floaters characterized by having fear of floating[1]. In this paper I look at the Mexican economy experience before and after the financial and balance of payments crisis. I will address how monetary policy was conducted over time as an initial approach to evaluate if Mexico observes inflation targeting or fear of floating.

Mexican monetary policy observed a significant regime change after the financial and balance of payments crisis of 1994. Policy shifted from having a predetermined exchange rate to a floating exchange rate making monetary policy the nominal anchor of the economy after the crisis. There are several reasons why emerging markets and in this case Mexico have sought a predetermined exchange rate apart from the desire to stabilize inflation through the exchange rate, as addressed by Calvo and Reinhart (2000). Predetermined exchange rates have been adopeted by emeging markets due in part by the association of devaluations with recessions. In addition, a large portion of these type of countries debt is denominated in dollars which make defaults and general debt servicing more pervasive if there are large swings in the exchange rate. If large depreciations occur, adjustments in the current account are more pronounced in emerging markets. Moreover, large swings to the exchange rate have a larger impact on trade mostly because trade is invoiced in US dollars in these countries. In this paper I compare the two monetary policy regimes to study if Mexico is still targeting the exchange rate after the crisis, namely if it observes fear of floating. Moreover, I study to what extent the central bank of Mexico targets inflation before and after the crisis to corroborate if monetary policy has become the nominal anchor of the economy in the second regime. Calvo and Reinhart (2000) compare the behavior of the volatility of the interest rate, the exchange rate, and the international reserves from different countries that are suspected to observe fear of floating to the behavior of such variables in true floater countries, namely Japan and the US. In my study I compare

[1]By fear of floating I mean that policy authorities take "deliberate policy actions to stabilize the exchange rate," Calvo and Reinhart (2000)

the model estimation for the Mexican economy under two different regimes, one that stands for a control that is known for having a fixed exchange rate, and the second one that targets inflation but where fear of floating might be present.

In order to attain my goal I estimate a New Keynesian small open economy model for Mexico before and after the crisis of December 1994 using Bayesian methods. The small open economy model framework, derived from micro-foundations, offers a structural channel for the study of monetary policy. The model is derived from the optimization problems of the households and monopolistically competitive firms. The New Keynesian dynamic stochastic general equilibrium (DSGE) model has become a widely used tool for the study of monetary policy by researchers and policy makers. Large New Keynesian DSGE models have been estimated for the US and Europe and small open economy models have been estimated for countries such as Australia, Canada, and New Zeeland. In this paper I estimate a small open economy DSGE model for an emerging market economy such as Mexico. The estimated model is based on a simplification of the Galí and Monacelli (2005) small open economy model by Lubik and Schorfheide (2005) using likelihood based Bayesian methods. Within the small open economy framework most countries must be analyzed using the rest of the world and its effect on the small open economy; however, Mexico may be analyzed by simply using the influence of the US economy. This is because the shocks that emanate from the US business cycle have the greatest impact on the Mexican economy Del Negro and Obiols-Homs (2000). This remark was reached after computing the forecast variance decomposition for the Mexican output and prices, and they conclude that the percentage of the forecast errors explained by the US business cycles varies between 30-97%.

Monetary policy is represented by a Taylor type rule that uses the short term interest rate as the instrument of monetary policy. The monetary rule I estimate provides useful insight on how the central bank of Mexico adjusted the interest rate in response to changes in the output gap, exchange rate, and inflation. The use of a Taylor type of rule for the study of monetary policy in Mexico is consistent with the analysis of authors such as Martinez, Sanchez and Werner (2000). These authors concluded that the behavior of the interest rate in Mexico is determined by the "traditional variables that guide discretionary actions of monetary policy in any central bank". Moreover, the model allows for the study of the impact that a monetary policy shock has on inflation, output gap, the terms of trade and that exchange rate. A more thorough analysis of the differences between Martinez, Sanchez and Werner (2000) and my paper can be found in the literature review.

In my empirical analysis I conclude that the central bank of Mexico did not respond

strongly to movements in the exchange rate during the floating exchange rate regime, especially compared to the high degree of exchange rate targeting observed in the managed exchange rate regime. Thus there is no strong evidence that monetary policy in Mexico poses fear of floating. In addition I perceive that inflation has become the nominal anchor in the economy in the years after the 1994 crisis. In my monetary policy rule analysis, the response of the interest rate to inflation in the floating exchange rate regime is more than one to one which compares to the reaction behavior addressed by the Taylor principle. Moreover, I perceive much less concern by the monetary policy authorities to control inflation during the managed exchange rate regime.

Brief History of Mexico's Monetary Policy (1976-2006)

From September 1976 to February 1982, Mexico observed a fixed exchange rate regime pegged with the dollar at an almost constant rate. By February 1982, Mexico suffered an inflation rate growing at 31% and dangerously low reserves. In addition, the country experienced a 28% overvaluation of the peso. All these factors led to a large devaluation in February 1982.

On February 17th, 1982 the peso devaluated 85% followed by the adoption of a flexible exchange rate regime that lasted until August of the same year. The economy was suffering from inflationary pressures that came from a large deficit financed by money creation and foreign borrowing, and an emergency wage increase. Moreover, Mexico was unable to meet its foreign obligations due to a critical currency shortage. The shortage was caused by the outflow of foreign capital, the coming to term of loans acquired in 1981, and the fall in oil prices. These events unleashed the August 1982 debt crisis that resulted in the nationalization of the banking system and the adoption of tighter capital controls. In addition, the monetary policy authorities adopted a pegged rate of depreciation of the peso to the dollar that lasted until 1988. By the end of this monetary policy regime yearly inflation was at an all time high of 150% caused in part by constant wage revision. Mexico underwent a devaluation of its currency in September and October of 1988.

The devaluations of September and October 1988 indicate the beginning of a new monetary policy regime that would gradually liberalize the exchange rate. The purpose of this regime was to abandon the exchange rate as the nominal anchor of the economy. In December, 1987 Mexico adopted an anti-inflationary program that put an end to the constant wage revisions, privatized the banking system and fixed the exchange rate to the dollar. The fixed exchange rate regime lasted from March to December 1988 changing into a "Tablita" type regime that prevailed until October, 1991. The

"Tablita" regime let the peso's exchange rate adjust at a slow fixed pace that went from a daily devaluation of 1 peso per dollar, to .40 pesos per dollar. The exchange rate was further liberalized into a "limited flexibility" regime that used a "widening exchange rate band" to control the depreciation of the currency. From October 1992 to the balance of payment crisis of December 1994, the band width reached 15% of the peso exchange rate with the dollar. The predetermined exchange rate bands helped anchoring inflation expectations in the economy during this regime. In December 22nd, 1994, the beginning of the Tequila crises, the monetary authorities adopted a floating exchange rate regime.

After the adoption of a flexible exchange rate, the economy experienced two types of regimes that intended to target inflation in the economy. The tool used as the anchor in the economy shifted from a controlled exchange rate in the previous regimes to a regime that controls monetary policy. In recent years, monetary policy oriented to target inflation has used the interest rate as the policy instrument. Policy has evolved from a borrowed reserves regime to a regime that used "discretionary actions of monetary policy" as concluded by Martinez, Sanchez and Werner (2002). Monetary policy authorities in Mexico have taken into consideration the output gap, expected inflation and shocks originating in the foreign sector to formulate a discretionary monetary rule. The evolution of monetary policy led to a rule that uses explicit inflation targeting as a preemptive source of stability.

Literature Review

There has been extensive literature that treats the empirical study of monetary policy in Mexico. Most of the papers focus on the period leading to the financial and balance of payment crises or the period directly after the crises. The period leading to the crisis can be divided according to Santaella and Vela (1996) by an inflation pre-stabilization (1985-1987) period and by an inflation stabilization period (1988-1994). The authors conclude that the stabilization period, as opposed to what is perceived during the pre-stabilization period, observes a nominal anchor and was able to decrease the degree of nominal instability in the economy. This conclusion was reached through the estimation of a bivariate VAR model for the inflation rate and either the exchange rate or the money supply. In addition, variance decomposition was performed in order to pin down if the monetary authorities used an exchange rate stabilization program (ERBS) or a money based stabilization program (MBS) to contain inflation during the stabilization program. During the 1988-1991 or tablita regime the exchange rate contributes more

to explained inflation variance, while during the 1991-1994 band regime money supply further explains inflation variance than the exchange rate. The greater money supply contributed to the inflation variance during the band regime is consistent with the intention of monetary authorities to loosen up the exchange rate as a nominal anchor of the economy toward the end of the inflation stabilization regime.

A parallel line of work that uses a single equation approach to study the ERBS period leading to the balance of payments crisis was developed by Kamin and Rogers and (1996) and Calvo and Mendoza (1996). The two papers study the growth in money supply leading to the 1994 crisis. However, Kamin and Rogers conclude that the increase in the monetary base was due to a strong positive shock to the money demand while Calvo and Mendoza attribute it to a shock to capital inflows.

Monetary policy authorities have been criticized for not responding with adequate strength to various shocks that caused the decline in reserves, and pressures on the peso, leading to the 1994 crisis. Kamin and Rogers (1996) estimate two error-correction equations- one for money demand and a second for a monetary policy reaction function. The two models predict the behavior of the data for Mexico from 1983 to1994, except for the later stages of the ERBS period. The money demand equation shows that the growth of the monetary base in 1994 was not due to a loosening monetary policy but as a response to strong positive shocks to money demand.

The monetary policy reaction function estimates relates the interest rate to the lagged interest rates, GDP, inflation, exchange rate and the international reserves. In light of the monetary policy reaction function specification, the authors conclude that a rise in the exchange rate leads to a rise in the interest rate while a rise in international reserves causes a decline in the interest rate; while monetary policy authorities were not concerned about targeting output and inflation. Thus, in order to maintain the exchange-rate based stabilization strategy the monetary policy authorities should have had to further increase the interest rate, which was not consistent with the estimated reaction function. However, the increase in the interest rate would have required a change in the policy reaction function which would not have been recommended given the weak level of economic activity at the time leading to the crisis.

Calvo and Mendoza (1996) perform granger causality tests to corroborate the transmission mechanism of monetary policy in Mexico. They find that the rapid cyclical expansion of real balances leading to the balance of payment crisis was not due to GDP growth but instead to capital inflows, while the increase in real balances granger causes the growth in GDP. However, capital inflows predict the behavior of the interest rates that converlsy predict the behavior of real balances.

After the financial and balance of payments crisis, the monetary authorities aban-

doned the managed exchange rate regime as the nominal anchor of the economy in favor of a regime that targets inflation. Martinez, Sanchez and Werner (2000) and Carstens and Werner (1999) have studied the mechanism of monetary transmission in Mexico under this paradigm. The monetary authorities opted for a rule that "limited domestic credit growth during the year" called borrowed reserves to stabilize the economy as addressed in Mexico's central bank Monetary Program for 1995. Monetary authorities, during the borrowed reserves regime, revealed their involvement in the money market by announcing the amount to auction by the central bank. In that fashion, the announced level of borrowed reserves became the level of borrowed reserves for the opening of the following period. The central bank would determine if it aimed to satisfy the money demand at market interest rate. If the purpose of the central bank was to increase interest rates, then the central bank would fall short in its supply of funds for private banks. Thus, banks had to either incur overdrafts in their current accounts or borrow at a penalty rate set by the central bank; either measure increased interest rates.

In 1998, the monetary authorities evolved from the borrowed reserves regime to an explicit medium and short run inflation targeting. The central bank gradually abandoned the money aggregate's growth targeting for a quarterly inflation report that discusses the central bank's internal forecasts of inflation. Thus, the central bank sends a signal and allows short term interest rates to gradually adjust distributing external shocks between changes in the interest rates and the exchange rate. In that light, a volatile interest rate would not be totally related to changes in monetary stance avoiding agents' misinterpretations of policy.

Martinez, Sanchez and Werner study different aspects that characterize the period of monetary policy after the crisis such as the high degree of pass-through of exchange rate movements to inflation. The authors found that a depreciation of the exchange rate of 10% would have 82% of its effect in prices during the first year; however, they acknowledged that the pass-through has diminished in later years. They attribute this phenomenon to the effect that exchange rates have on tradable goods and on the effect that the above mentioned have in inflation expectations.

In addition, the authors estimate a Taylor rule to determine if the interest rate behavior has aided in reducing inflationary pressures. The Taylor rule includes inflation expectations deviation form the central bank's target, the output gap, the depreciation in the exchange rate from the previous year and the gross yield of public sector's debt denominated in foreign currency. Martinez, Sanchez and Werner find that under the borrowed reserves regime the yield of bonds placed in the external market and the exchange rate depreciation determined the interest rate. However, after 1998, when

the inflation targeting regime was more established, inflation and the output gap are more important determinants of the interest rate.

Martinez, Sanchez and Werner estimate a VAR of the real exchange rate, inflation and the interest rate as an approach to characterize Mexico's small open economy. The estimation is an approximation to a model composed by an accelerating Phillips curve, an output gap equation and monetary policy reaction function. The authors report impulse response functions to show the monetary policy transmission mechanisms and how disturbances to the different variables of the system affect the interest rate. They found that an increase of 1.4 percentage points in the ex-ante real interest rate causes a real appreciation of the exchange rate, a drop in the output gap, and a drop in inflation. Moreover, the monetary policy authorities will raise interest rate as a response to devaluation and a rise in the output gap. Lastly, variance decomposition was performed to conclude that movements in the real interest rate are the main source of variation to the output gap, exchange rate and inflation.

Moreover, the authors address the main determinants of inflation for tradable and non-tradable goods. They find that shocks to the real interest rate are the most important source of variations in the goods described above. Thus, in the author's words "interest rates behavior can be explained by using the traditional variables that guide the discretionary actions of monetary policy of every central bank."

The sources of inflationary pressures have been a topic of study addressed by authors in the period prior to the 1994 crisis. Two views on this topic are the traditional monetary expansion explanation and the view of the advocates of the models with price rigidities. Carstens and Werner (1999) study if an increase in the money supply is what leads to inflationary pressures or if shocks to key prices meaning wages, exchange rates and public sector prices directly affect inflation. After the estimation of a vector error correction model, they concluded that key prices are the main driving forces of inflation and not the money supply.

To fill in the gap of the study of monetary policy in Mexico with regime changes before and after the crisis, Del Negro and Obiols-Homs(2001) estimate a small open economy VAR for Mexico. Their main finding is that exogenous shocks to monetary policy have had a small impact in the economy while shocks that originate in the US business cycle have the strongest impact on the Mexican economy. The authors display the responses of domestic variables to an expansionary monetary shock. They find that the interest rate has no immediate response to the monetary shock; the output response is positive but insignificant, while prices increase significantly a few months after the shock but their response is also small. Moreover, they conclude that the US business cycle has the most impact in output.

The initial goal of this paper is to estimate a monetary policy rule for Mexico that comprehends the periods before and after the 1994 crisis. In that setting this paper builds on Kamin and Rogers (1996) and Martinez, Sanchez and Werner (2000), that estimate a Taylor type of policy rules for the periods before and after the crisis respectively. Furthermore, multiple equation models have been estimated by Martinez, Sanchez and Werner (2000) for the period after the crisis and Del Negro and Obiols-Homs (2000) for the periods before and after the crisis, that portrait the characteristics of a small open economy. The estimating procedure used in both cases is a VAR that has as objective to study the mechanisms of monetary policy transmission in Mexico. My estimation is closer to the model structure approximated by a VAR by Martinez, Sanchez and Werner, however I estimate a small open economy structural model. Del-Negro and Obiols-Homs use a money supply equation as monetary policy reaction function while my estimation uses a Taylor type of rule to study monetary policy in Mexico.

A Simple Small Open Economy Model

The New Keynesian model has been extended to include the characteristics of small open economies (Galí and Monacelli (2005)). The small open economy model differs from the closed economy model in that the former assumes that the economy observes a higher degree of trade openness, higher substitutability across foreign goods, and a higher response of their main macroeconomic variables to outside shocks. The model essentially consists of a dynamic IS-type equation and a New Keynesian Phillips curve. The dynamic IS-type equation is derived from the "conventional" Euler equation that includes the consumption of goods produced at home and in the foreign economy taking into consideration the effective terms of trade. As described by Galí and Monacelli (2005) the wedge between consumption and output, and domestic and consumer prices changes the specifications of the New Keynesian Phillips curve. In this setting, terms of trade and foreign output affect wage through their effect on consumption[2]. The New Keynesian Phillips curve is also modified by the effects that trade openness has in the slope of the curve[3]. An additional assumption of the model is that the economy observes complete international financial markets, which is a shortcoming of the model used for the Mexican economy setting.

[2]For a more detailed explanation on the transmission mechanism of terms of trade and foreign output on marginal cost and the real wage see Galí and Monacelli 2005.

[3]As addressed by Galí and Monacelli (2005) an increase in trade openness diminishes the impact that domestic output exerts on inflation through the openness impact on the terms of trade needs

The model specification follows Lubik and Schorfheide (2005) developed through a simplification of Galí and Monacelli (2005). The small economy model is log-linearized around a steady state and is composed by a New Keynesian Phillips curve (1), a dynamic IS-type equation (2), a CPI equation that introduces the exchange rate in the model (3), a policy rule(4), and a terms of trade equation (5)[4] . The open economy Phillips curve is given by:

$$\pi_t = \beta\ E_t\pi_{t+1} + \alpha\beta\ E_t\Delta q_{t+1} - \alpha\Delta q_t + \frac{\kappa}{[\tau + \alpha(2-\alpha)(1-\tau)]}(y_t - \bar{y_t}) \tag{1}$$

where $\bar{y_t} = -\alpha(2-\alpha)\frac{1-\tau}{\tau}y_t*$ "is potential output in the absence of nominal rigidities" Lubik and Schorfheide (2005). The structural parameters presented in the model are $\alpha \in [0,1]$ that is a natural index of trade openness, τ that is the intertemporal elasticity of substitution, and $\kappa > 0$ that is a function of price stickiness. The endogenous variables are output gap y_t, CPI inflation rate π_t, first difference of the terms of trade Δq_t, and the US output y_t*. The dynamic IS-type equation is described by:

$$y_t = E_t y_{t+1} - [\tau + \alpha(2-\alpha)(1-\tau)]\,(R_t - E_t\pi_{t+1}) \tag{2}$$

$$-\alpha[\tau + \alpha(2-\alpha)(1-\tau)]E_t\Delta q_{t+1} + \alpha(2-\alpha)\frac{1-\tau}{\tau}E_t\Delta y_{t+1}$$

Assuming relative purchasing power parity, the nominal exchange rate enters the model as:

$$\pi_t = \Delta e_t + (1-\alpha)\Delta q_t + \pi_t* \tag{3}$$

Monetary policy is represented by a Taylor-type rule that responds to inflation, the output gap, and the exchange rate. The monetary policy parameters are denoted by ψ_π, ψ_y and ψ_e. The utilization of a Taylor type of rule for the study of the regime after the 1994 balance of payments crisis has been widely justified in previus literature for Mexico. Moreover, for the first regime, Adolfson, (Lasseén, (Lindé and Villani (2005) and Curdia and Finocchiaro (2005), offer further explanation on the relavance of this type of rule for the study of fixed exchange rates in emerging markets. An alternative specification, would be to estimate a Taylor type rule where the interest rate responds only to movements in the exchange rate, however, in this paper I will let the data speak and I will estimate the same monetary policy rules for both periods.

$$R_t = \rho_R R_{t-1} + (1-\rho_R)[\psi_\pi\pi_t + \psi_y y_t + \psi_e\Delta e_t] + \epsilon_t^R \tag{4}$$

[4]For detailed discussion on the specification and derivation of the model see Lubik and Schorfheide (2005) and Galí and Monacelli (2005)

The terms of trade equation is represented by "the relative price that clears the international goods market" Lubik and Schorfheide (2005).

$$[\tau + \alpha(2-\alpha)(1-\tau)]\Delta q_t = \Delta y_t* - \Delta y_t \tag{5}$$

The structural model composed by equation (1)-(5) is a linear Rational Expectations model[5]. I assume that the disturbances of π_t, y_t, y_t*, π_t*,and Δq_t follow an AR(1) processes with coefficients ρ_g, ρ_u, ρ_{y*}, $\rho_{\pi*}$, and ρ_q. Initially, I estimated the full set of structural, non-structural and policy parameters along with the standard deviations of the shocks. However, I struggled to obtain the desired convergence of the standard deviations of the shocks. This shortcoming was overcome by fixing the AR(1) process coefficients to the initial values reached after the estimation of the full set of equations. In order to deal with the non-existent or multiple equilibria solution to the linear rational expectations model estimated I discarded the paremter values that fall into the indeterminacy region of the parameter space. Thus the parameter values reported are within the determinacy region. Although the issue of determinacy for the Mexican economy is beyond the scope of this paper, plots of the determinacy regions of the parameter space are reported in figures 1-6 of the Apendix.

Bayesian Estimation Strategy

The estimation performed for this model is a Bayesian estimation following An and Schorfheide(2005). I estimate the set of structural and non-structural parameters, policy parameters, and corresponding standard deviations of the shocks jointly in the model and these are represented in a vector of 13 x 1 parameters denoted θ. The vector θ is composed by:

$$\theta = [\sigma, \alpha, \kappa, \rho, \psi_\pi, \psi_y, \psi_e, \sigma_R\sigma_{y*}, \sigma_g, \sigma_u, \sigma_{\pi*}, \sigma_q]' \tag{6}$$

The vector of observed variables is composed by the output gap, CPI inflation rate, nominal interest rate, depreciation rate, first difference of the terms of trade, and US output gap and can be written as: Y_T=[π_t, y_t, Δe_t, R_t, Δq_t, y_t*].

A prior distribution is assigned to the parameters of the model and is represented by p(θ). The Kalman filter is used to evaluate the likelihood function given by $p(Y^T|\theta)$, where $Y^T = [Y_1, ..., Y_T]$. Lastly, the posterior distribution is obtained by updating

[5]The rational expectations model was solved using Sims (2002)

prior beliefs through Bayes' rule taking into consideration the data reflected in the likelihood. Bayes' rule is represented by:

$$p(\theta|Y^T) = \frac{p(Y^T|\theta)p(\theta)}{p(Y^T)} \tag{7}$$

I estimate the posterior distribution through a Metropolis Hastings algorithm[6]. The specific simulation method that I use is random walk Metropolis Hastings for which I ran 300,000 iterations, discarding the initial 20% as burn-in.

Data

The estimation for Mexico was done using quarterly data from the second quarter of 1981 to the fourth quarter of 2005. The first monetary policy regime comprehends data from 1981:2 to 1994:4 which marked the beginning of the Tequila crisis. The estimation for the second regime used data from 1995:1, when the monetary policy authorities were forced to let the exchange rate float, to 2005:4. The inflation measure was derived by using log differences of the CPI or INPC (Indice Nacional de Precios as Consumidor) multiplied by 400 to yield annualized percentage rates of change. The output gap growth rate was calculated by using a log difference between the GDP or PIB (Producto Interno Bruto),seasonally adjusted, and the potential GDP, scaled by a 100 to transform them into quarter-to-quarter percentages. As a measure of the interest rate I used the 91 days cetes, which is considered the Mexican equivalent of the federal funds rate. The nominal exchange rates of the peso to the dollar, and the terms of trade changes are also measured in log differences scaled by a 100 to transform them into depreciation rates, and percentage changes in the terms of trade. Lastly, I use US output gap as the the log difference between GDP and potential GDP. The CPI series, nominal exchange rate of the peso to the dollar, and terms of trade were obtained from DRI Webstract, while the values for GDP and cetes were obtained from the Banco de Mexico website in the section of Indicadores Economicos y Financieros. The US output gap was obtained from the database of the Federal Reserve Bank of St. Louis.

Priors

The prior for the Bayesian estimation of the small open economy model for Mexico, along with 95%prior probability intervals can be found in Table 1. The choice of priors

[6]For details on the specification of the Metropolis Hastings algorithm refer to Chib and Greenberg (1995)

for the estimation of the small open economy model for Mexico takes into consideration various characteristics of estimations for small open economy models for different countries and estimates from the previous literature for Mexico. The priors for the monetary policy rules ψ_π and ψ_y were adopted from values concluded by the Taylor principle. In order to gauge the effect that the exchange rate produces in the interest rate in the two regimes, I chose a fairly high value of prior mean set at 1 which I allow to vary widely. The prior means for the interest rate smoothing parameter ρ, and κ, take values chosen by Lubik and Schorfheide (2005) for Canada, New Zeeland, Australia and Great Britain that are set at 0.5. However, the choice of prior for the measure of trade openess α has a higher mean than in the previous literature for Australia, for example. This is because the proportion of total trade to GDP has increased from 15% in 1990 to 58% in 1999 in Mexico, while the same measure in Australia has increased from 26% to 31%. Thus, I center the prior for α at 0.5, as opposed to the estimate used by the Lubik and Schorfheide (2000) centered at 0.2. The prior means for the standard deviations to the shocks are not too informtive, and they are allowed to vary widely.

Table 1: Prior Distributions

Name	Density	Mean	Standard Deviation	95% Prior Prob. Interval
σ	Gamma	1.00	0.50	[0.27,2.19]
α	Beta	0.50	0.20	[0.13,0.87]
κ	Gamma	0.50	0.20	[0.19,0.96]
ρ	Beta	0.80	0.10	[0.57,0.95]
ψ_π	Normal	1.50	0.25	[1.01,1.99]
ψ_y	Normal	0.50	0.25	[0.01,0.99]
ψ_e	Normal	1.00	0.50	[0.02,1.98]
σ_R	InvGamma	8.00	6.00	[0.80,23.37]
σ_y*	InvGamma	1.00	0.70	[0.12,2.78]
σ_g	InvGamma	7.00	4.89	[0.86,19.51]
σ_u	InvGamma	7.00	4.89	[0.86,19.51]
$\sigma_\pi*$	InvGamma	10.00	6.00	[1.88,24.68]
σ_q	InvGamma	7.00	4.89	[0.85,19.48]

Results

The parameter estimates for the Bayesian estimation of the small open economy model for Mexico can be found in Table 2. I report posterior means as point estimates and

95% posterior probability intervals. For the analysis of my results I will refer to the first regime as the regime with managed exchange rate and the second regime will denote the regime with a floating exchange rate. The parameters of interest in this model are the parameters of the Taylor type of rule that describe the conduction of monetary policy.

The Taylor type rule shows that the response to output did not change much during the two regimes, for the first regime ψ_y=.666 and for the second regime ψ_y=.798. These measures confirm that the central bank of Mexico was concerned with targeting output in their determination of the interest rates during both regimes, and these values are consistent with the response suggested by Taylor (1993). Kamin and Rogers (1996) report that the central bank of Mexico was not concerned with controlling output as part of their monetary policy in the first regime, while their purpose was to control the exchange rate. However Martinez Sanchez and Werner (1999) conclude that during the second regime the monetary authorities were concerned mostly with controlling the output gap and inflation in their conduction of monetary policy.

Table 2: Parameter Estimation Results

Posterior

	Regime 1		**Regime 2**	
Name	Mean	95% Posterior Prob. Interval	Mean	95 % Posterior Prob. Interval
σ	0.65	[0.29, 1.38]	0.82	[0.32, 1.87]
α	0.70	[0.23, 0.95]	0.74	[0.44, 0.95]
κ	2.01	[1.32, 2.78]	1.05	[0.51, 1.70]
ρ	0.47	[0.35, 0.58]	0.40	[0.27, 0.53]
ψ_π	0.79	[0.58, 1.00]	1.12	[0.95, 1.32]
ψ_y	0.67	[0.20, 1.14]	0.80	[0.41, 1.20]
ψ_e	1.87	[1.23, 2.50]	0.43	[0.15, 0.77]
σ_R	12.86	[10.12, 16.71]	4.35	[3.31, 5.71]
σ_y*	0.75	[0.62, 0.91]	0.53	[0.43, 0.65]
σ_g	8.47	[5.38, 10.78]	3.68	[2.63, 5.11]
σ_u	7.45	[5.84, 9.34]	5.05	[3.61, 6.92]
$\sigma_\pi*$	14.70	[12.06, 18.10]	12.34	[10.04, 15.27]
σ_q	6.88	[4.78, 8.66]	2.96	[2.39, 3.71]

The parameter value for inflation in the first regime is ψ_π=.786, which is consistent with the notion that monetary authorities did not use inflation targeting as the nominal

anchor of the economy. The inflation parameter in the second regime is ψ_π=1.118 which implies that the response of interest rates to inflation is greater than 1. This estimate is consistent with the Taylor principle, however, it is still a much less moderate anti-inflationary policy than what I observe for the US economy where the same measure is close to 1.5.

In order to complete my analysis, and determine if the Mexican economy observes fear of floating, I take a closer look at the parameter value of the exchange rate. First, it is worth noting that I fixed the prior mean for the exchange rate policy parameter to 1, so that this value would not bias my estimates toward a low value of the exchange rate parameter in the second regime. I observe a strong concern from the monetary policy authorities to target the exchange rate in the conduction of monetary policy during the first regime. The interest rate responds by moving 1.835 times for each unit change in the exchange rate. This measure is consistent with Mexico's history of managed exchange rate policies during the fist regime and with parameter values reported by the previous literature. For the second regime I perceive that Mexican authorities are much less concerned with targeting the exchange rate in their conduction of monetary policy. The measure for this period is ψ_e=.434 so the estimation of a small structural model does not yield strong evidence that Mexico observes fear of floating. In addition, when calculating the 95% posterior probability interval, I find that the estimate for the interest rate response to the exchange rate falls between 0.15 and 0.77 with 95% probability. These values confirm that the interest rate does not repond one to one to a change in the exchange rate. Moreover, when I compare this interval with the 95% posterior probability interval of the first regime, where I find that the same measure will observe values between 1.23 to 2.50 with 95% probability, I conclude that the second regime measures are much higher than values for the first regime.

My estimation of structural parameters for the inter-temporal elasticity of substitution is higher in the second regime σ=0.82 than in the first regime σ=0.65. My measures of trade openness α are .70 and .74 for the first and second regimes respectively, which do not show a significant difference among regimes. However, this measure shows that Mexico observes a great degree of trade openness, and this result is consistent with the observable high degree of integration of the economy through trade experienced in the last decades. Moreover, α in previous estimations of small open economy models, such as Lubik and Schorfheide (2005), has been lower than the observable for the Canadian import share,a characteristic that I do not perceive for the Mexican economy. In addition I observe a ρ, the interest rate smoothing term, much lower for the Mexican economy than what has been reported in previous estimations of small open economy models for other countries.

The sensitivity of inflation to movements in the output gap, κ, is larger in the first regime than in the second regime. As addressed in previous sections, κ is a function of the Calvo parameter that denotes price stickiness in the economy, thus a lower kappa is representative of prices that do not change for longer periods of time. Therefore, in the second regime I observe a lower κ, which indicates stickier prices. This parameter value for the second regime is consistent with the lower inflation levels reported by the Mexican economy that could be attributed to the monetary policy measures adopted by the central bank, namely inflation targeting. By contrast the monetary authorities in the first regime intended to target exchange rate and not inflation, so I detect greater sensitivity of inflation to movements in the output gap in the first regime than in the second regime. However, the measure for κ in both periods for Mexico is much higher than in the US. Thus the model shows that prices in Mexico are fixed for shorter periods and inflation is a much more sensitive to movements in the output gap than in the US. The measure κ for Mexico also shows that slighter changes on the interest rate yields a greater response from inflation.

Lastly, Calvo and Reinhart (2000) analyze the behavior of the volatility of interest rates to determine if an economy shows fear of floating. The authors conclude, due to the lack of credibility that market agents have in monetary authorities in the presence of fear of floating, interest rate volatility is likely to be higher than when policies are credible. Hence the likelihood of observing relatively large fluctuations in interest rates will depend on both- the lack of credibility of the exchange rate regime and on the willingness of the monetary authorities to use interest rate policies as means of stabilizing the exchange rate. For my analysis, the standard deviation of the interest rate shocks is much higher in the fist regime 12.863 than in the second regime 4.347. In general, the standard deviations of the different shocks to the economy are more accentuated in the first regime than in the second regime. The volatility of the shocks to monetary policy shows that Mexico's monetary policy has taken steps toward having a credible free floating monetary policy that targets inflation.

Impulse Response Functions

In order to understand the monetary transmission mechanism in the Mexican economy during the two regimes, I used my small open economy estimates to analyze the impulse responses to a one unit monetary shock presented in Figure 7-9. In addition, in order to gauge the different dynamics present in the model I also study the reaction of the different variables to various other structural shocks (Figures 2 and 3). A contrac-

tionary monetary policy shock produces a decline in inflation, the output gap, and an appreciation of the currency. Furthermore, I observe an increase followed by a sudden decline in the terms of trade. The dynamics observed after a shock to monetary policy in this model are close to the impulse responses reported by Martinez, Sanchez and Werner(1999) that result from an estimation of a VAR. In my estimation, the effect of each one of the shocks to monetary policy dies out before 5 periods have past, while in Martinez, Sanchez and Werner's estimation, the shocks do not seem to die out before 8 periods which shows that shocks to monetary policy do not persist in the economy for long periods of time.

The second graph shows how a shock to the US output affects the different variables in the model. A shock to US output decreases inflation, increases the output gap, decreases the interest rates and causes an appreciation of the currency, as well as an increase in the terms of trade. A relevant feature of the dynamics observed after this shock is that the shock stays in the economy for longer than 25 periods.

A domestic output shock causes an increases in inflation and the interest rate and a depreciation of the exchange rate. Moreover a domestic output shock stays in the economy for over 10 periods. In addition, a shock to inflation causes a decline in the output gap, an increase in the interest rates and a devaluation of the currency, and I perceive an increase in the terms of trade. The effect of this type of shock remains in the economy for over 15 periods.

A shock to foreign inflation decreases inflation and output. After a foreign inflation shock, the interest rate decreases but only in the first regime while the in the first regime it poses no change. The effect of this shock has an ambiguous and almost negligible effect in the exchange rate and terms of trade.

In sum, a contractionary monetary policy in Mexico portrays the traditional moderate dynamics observed in small open economy models that were addressed in the previous literature for Mexico. The US output shocks show the most persistence in the variables of the model, staying in the economy for over 25 periods.

Conclusion

I estimate a small open economy model for Mexico in order to study how monetary policy was conducted. In particular, I address the question of whether or not the period after the balance of payments and the financial crisis shows fear of floating. I conclude that fear of floating is not strongly present in the Mexican economy after the crisis. Moreover, through the estimation of the DSGE model we find that the exchange rate

has been the nominal anchor of the economy before the crisis while inflation rate has become the nominal anchor of the economy after the crisis.

Additionally, the monetary policy transmission observed in the model denotes that a contractionary monetary policy shock produces a decline in inflation, the output gap, and an appreciation of the currency. Furthermore, I observe an increase followed by a sudden decline in the terms of trade. However, the shocks to monetary policy do not persist in the model for longer than 5 periods. By contrast, shocks to the US business cycle cause dynamics in the variables of the model that persist over 25 periods in the economy.

The structural parameters of the models show that the model can fit the high degree of trade openness observed in Mexico and could be extended to study the behavior of this characteristic in other emerging markets. Also, when compared with estimates for other small open economies, the value for the sacrifice ratio between inflation and the output gap in Mexico is extremely large, nevertheless consistent with the characteristics of the Mexican economy. Even though fear of floating is not strongly present in this paper, I still observe a low degree of exchange rate targeting in the period after the 1994 crisis. However, I suspect that this feature is due to the high pass-through of exchange rate movements to inflation in Mexico. Thus, the inclusion and study of pass-through in Mexico and its link to fear of floating is a topic that requires further research.

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Appendix

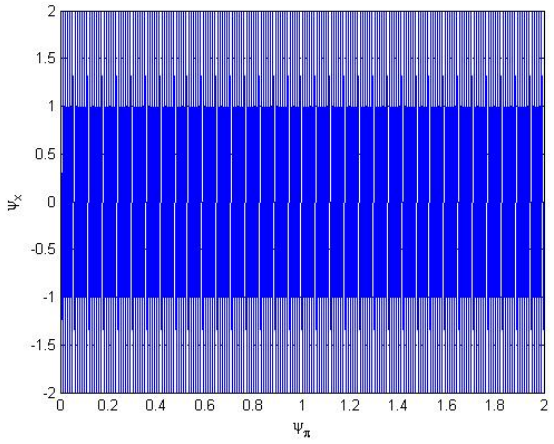

Figure 1: Determinacy Region for Regime 1

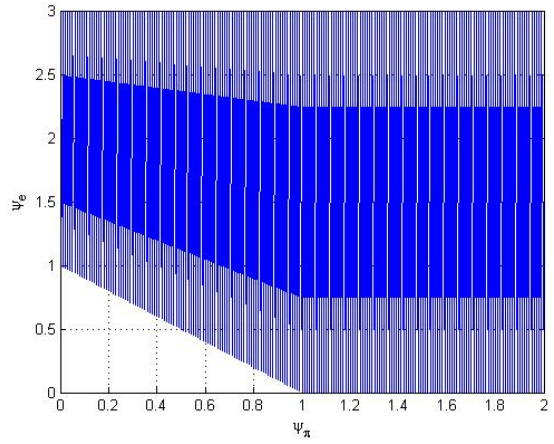

Figure 2: Determinacy Region for Regime 1

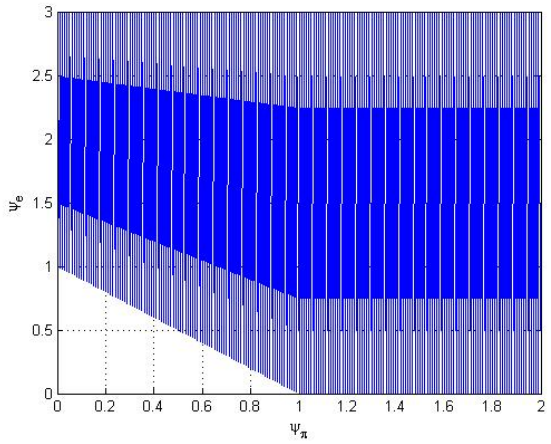

Figure 3: Determinacy Region for Regime 1

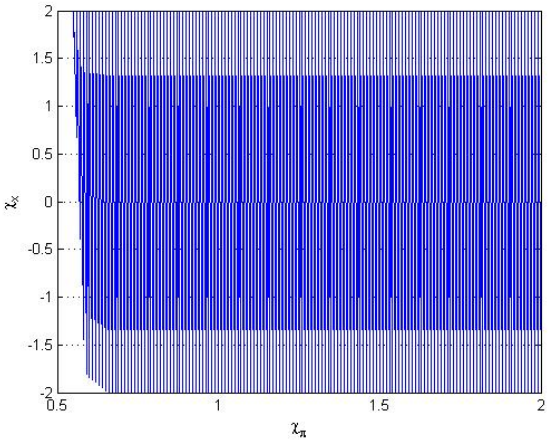

Figure 4: Determinacy Region for Regime 2

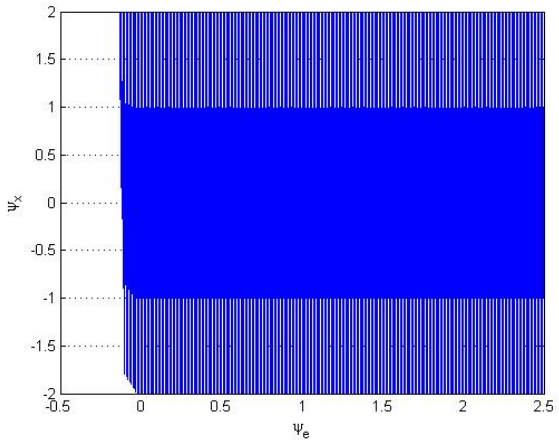

Figure 5: Determinacy Region for Regime 2

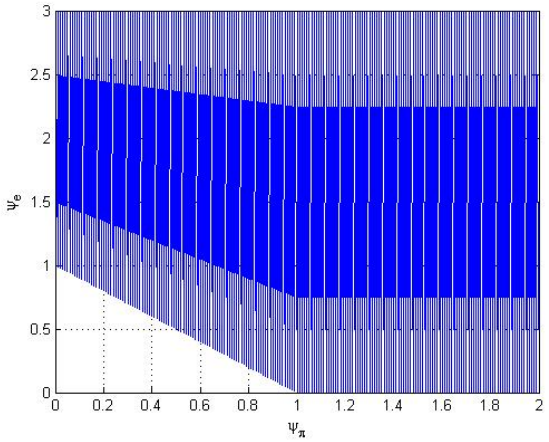

Figure 6: Determinacy Region for Regime 2

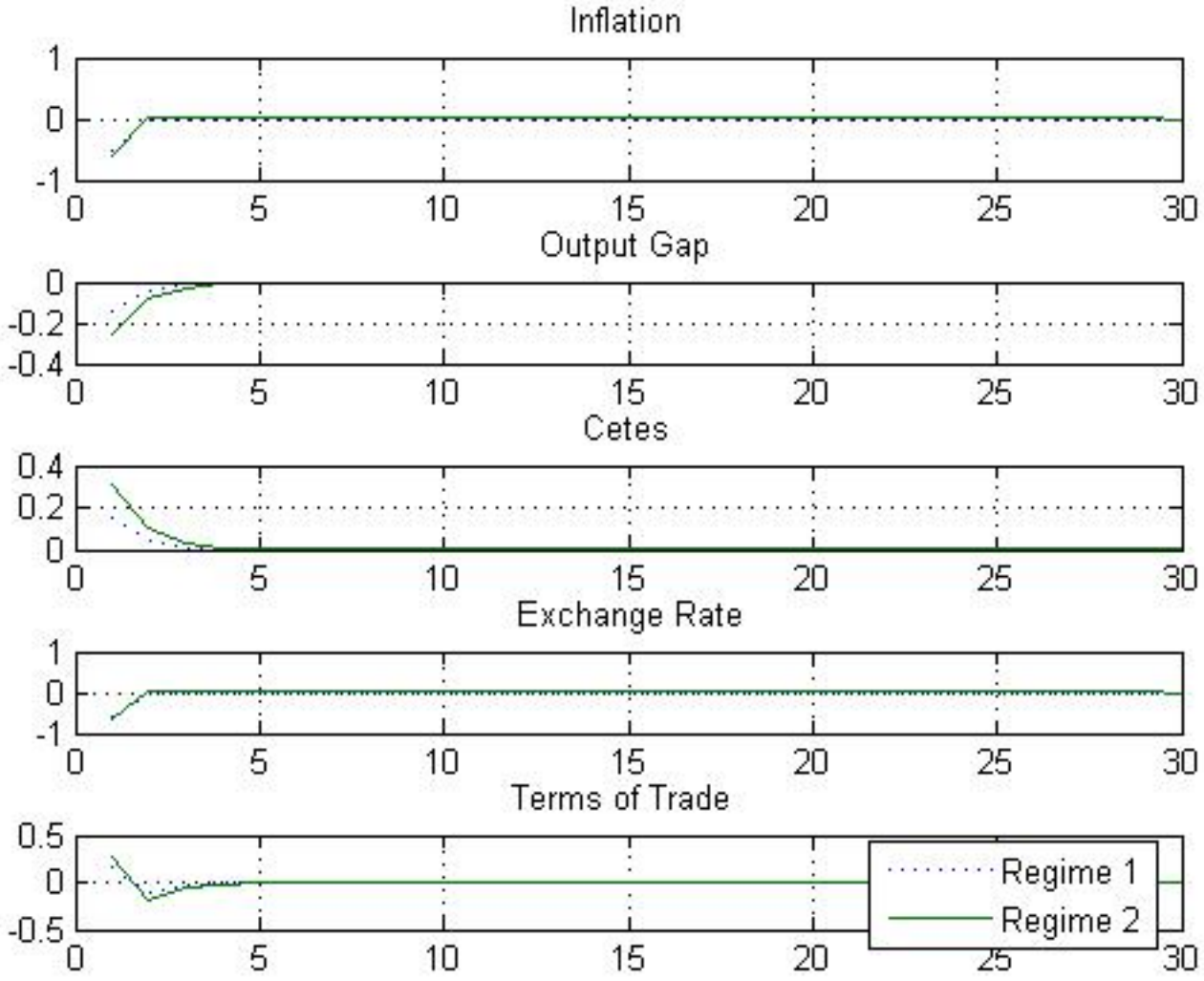

Figure 7: Impulse Responses to a Monetary Policy Shock

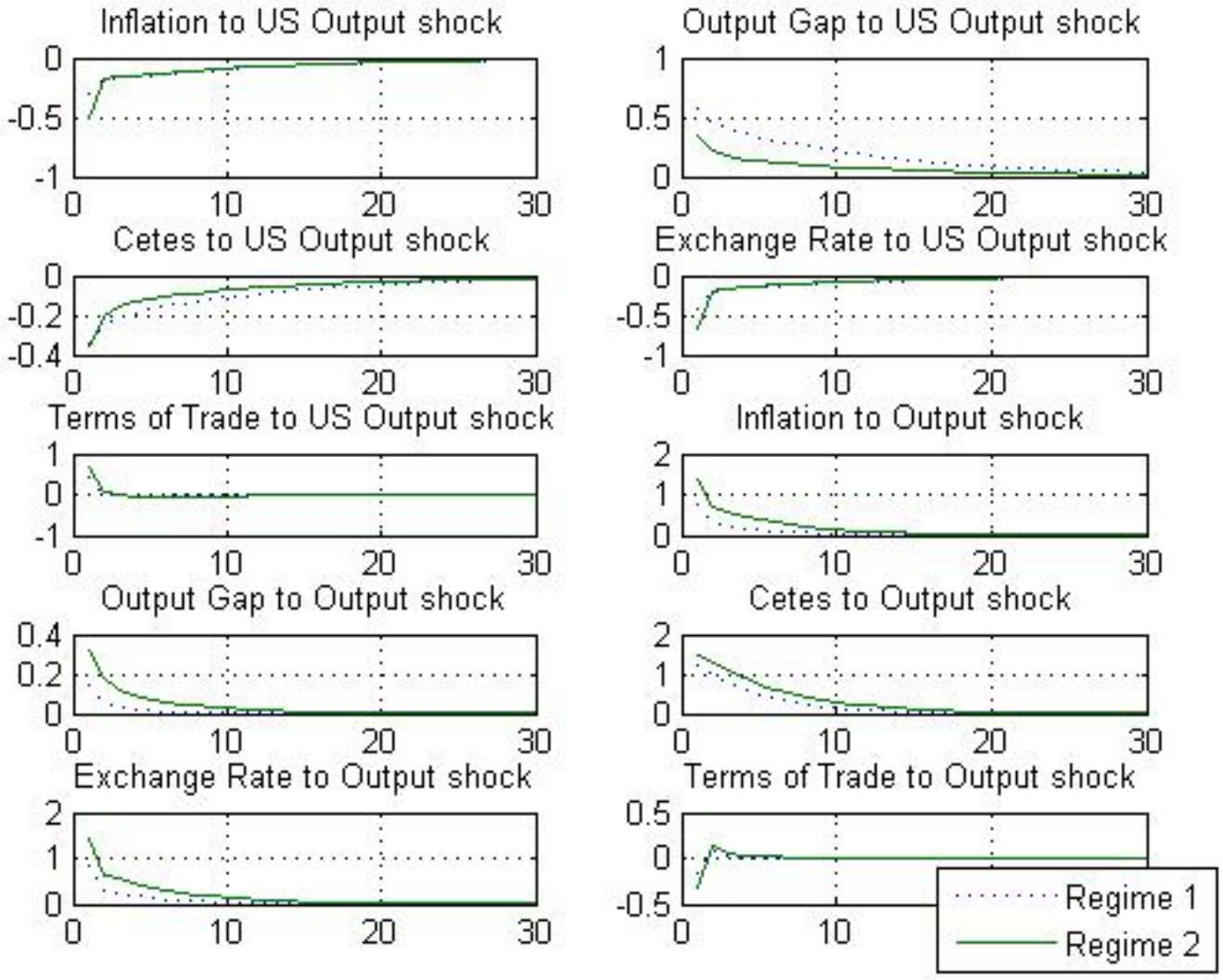

Figure 8: Impulse Reponses to a Shock to U.S. and Domestic Output

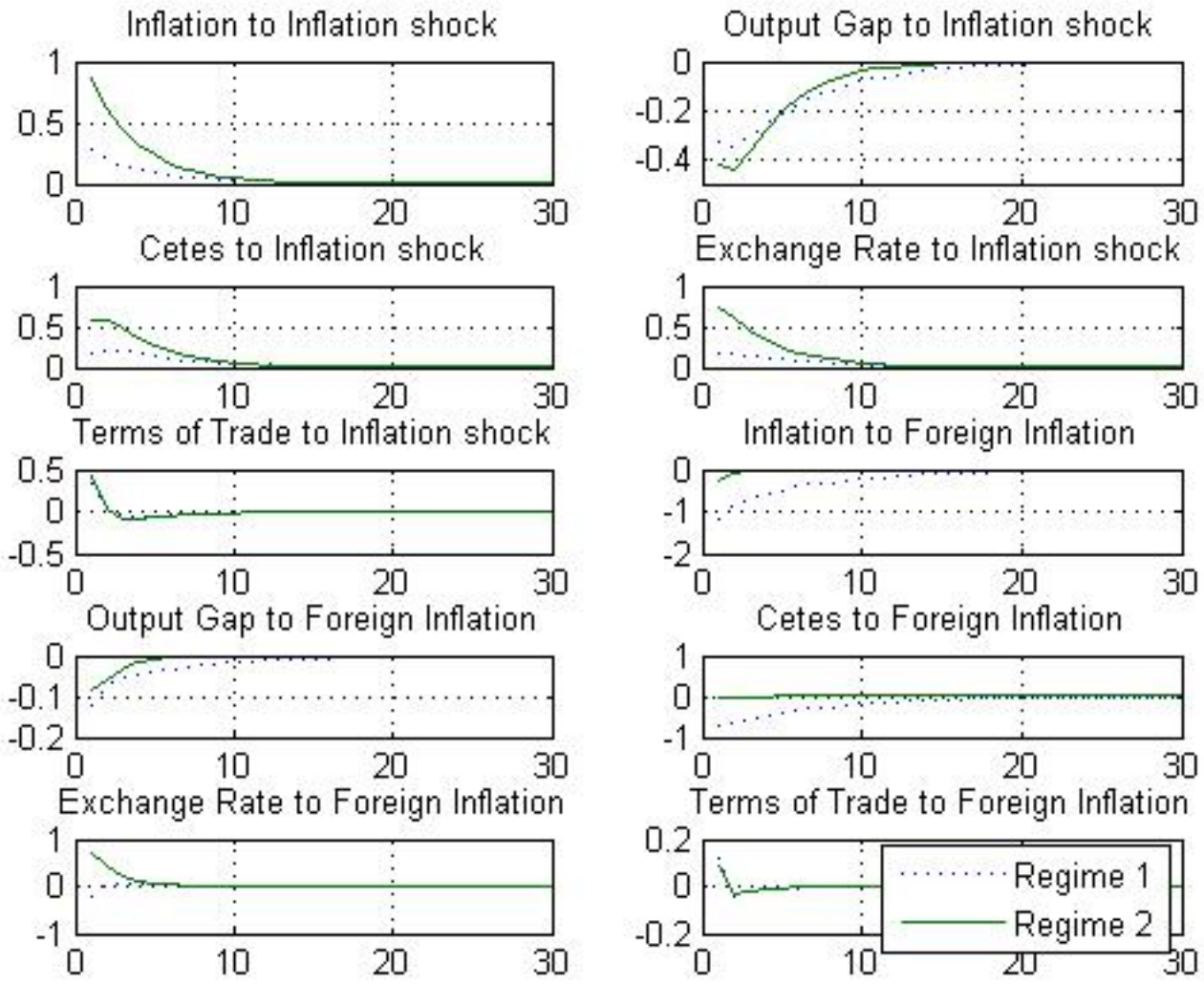

Figure 9: Impulse Responses to a Shock to Foreign and Domestic Inflation

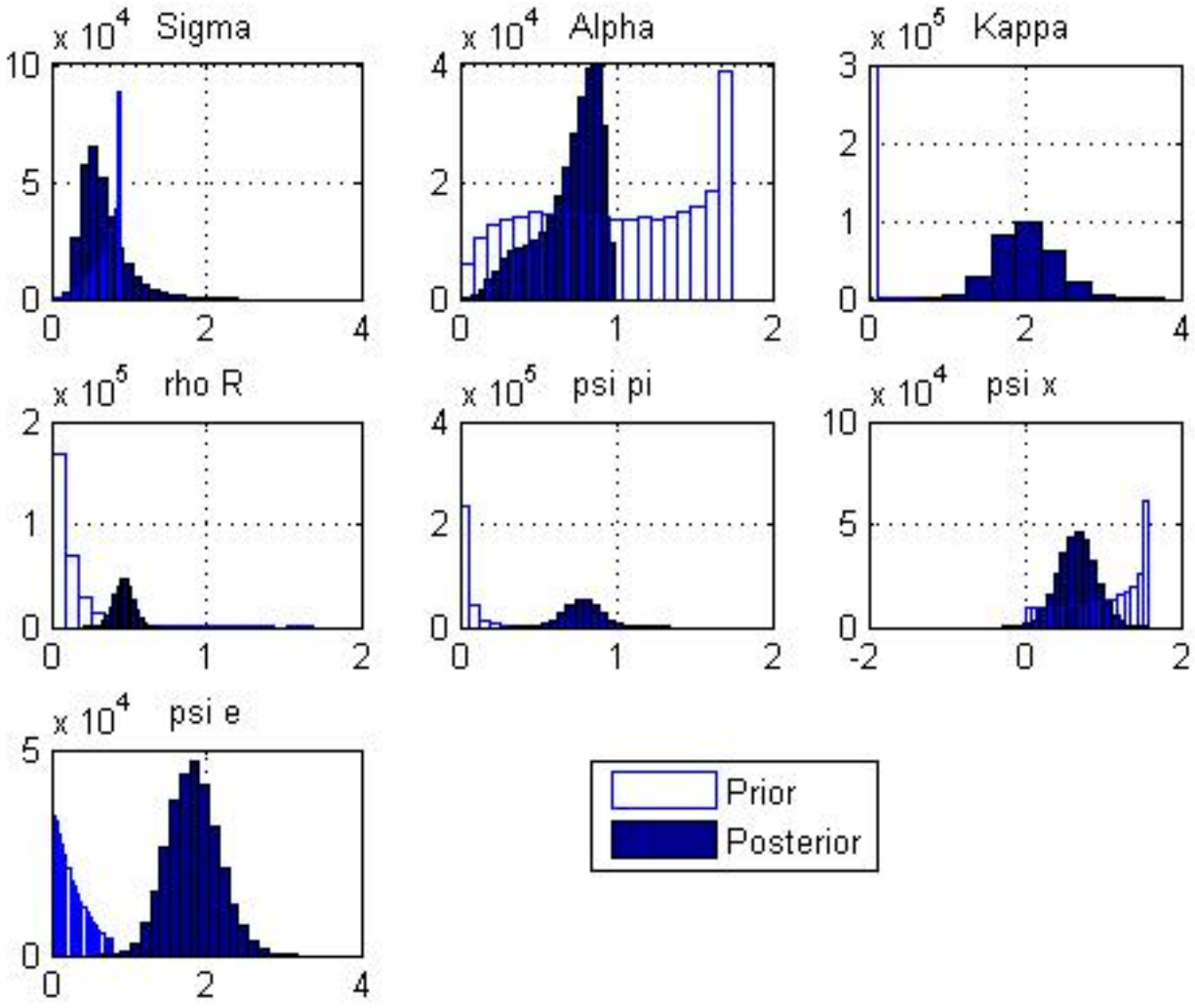

Figure 10: Estimated Parameter Distribution for Regime 1

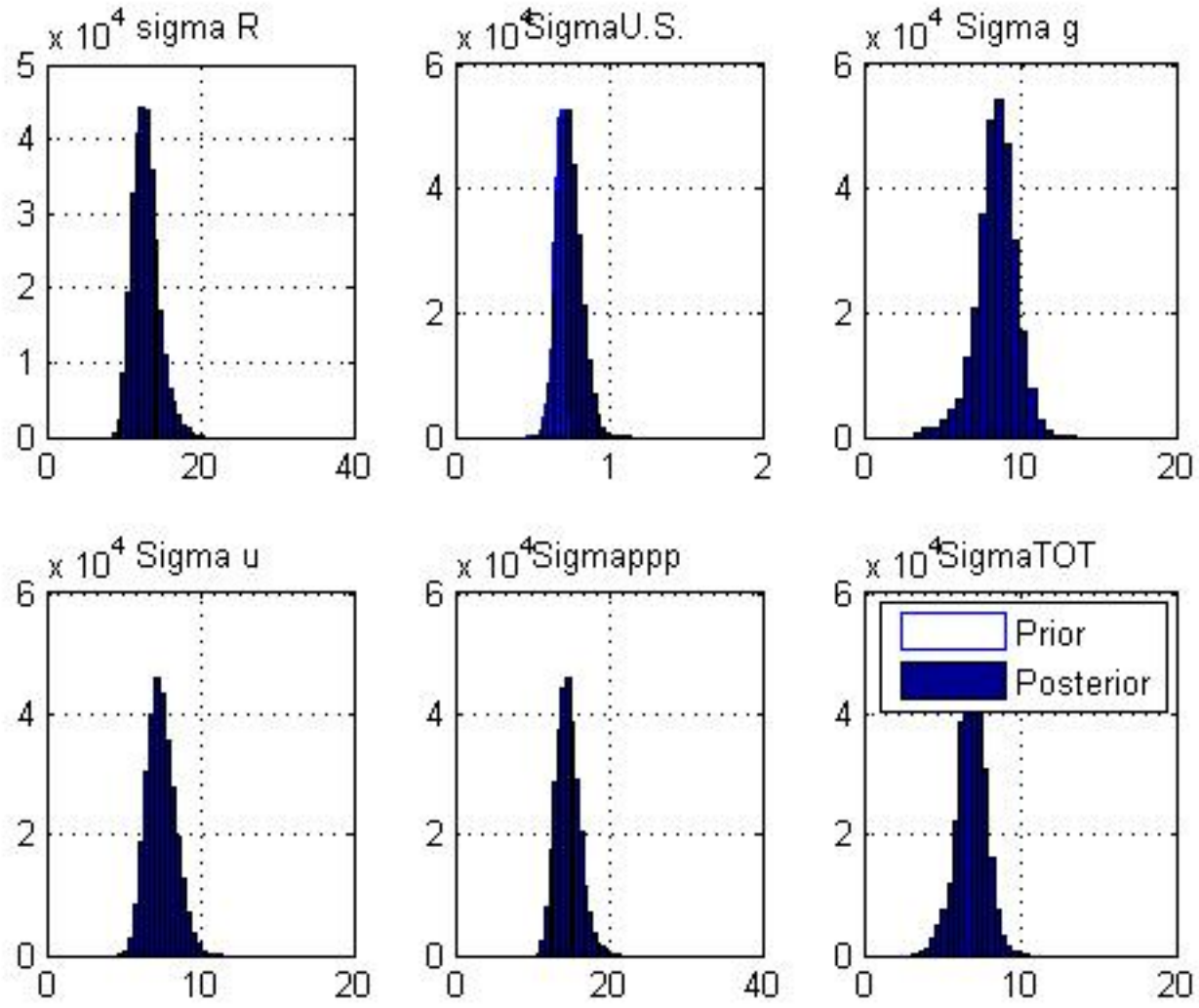

Figure 11: Estimated Parameter Distribution Regime 1

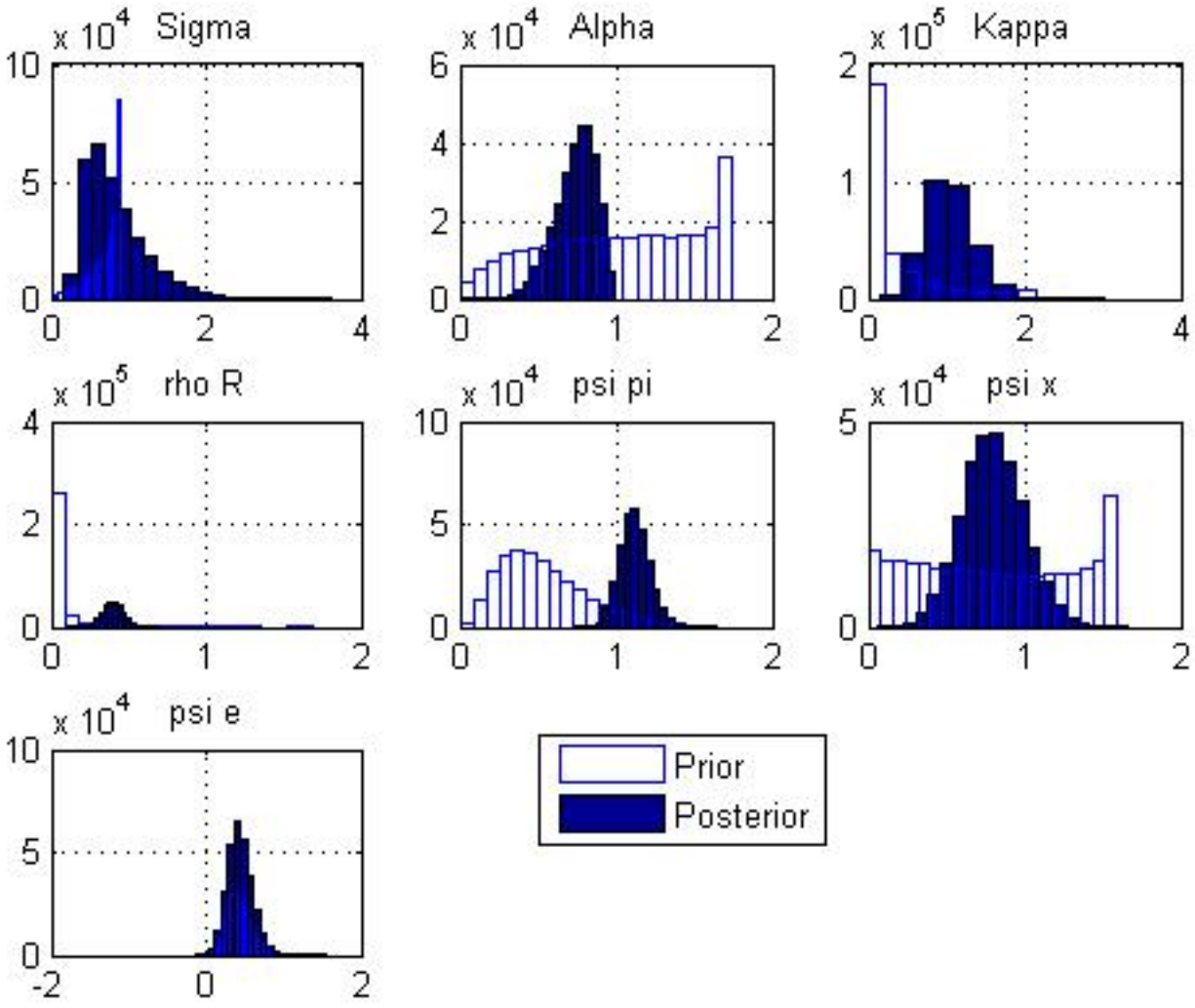

Figure 12: Estimated Parameter Distribution for Regime 2

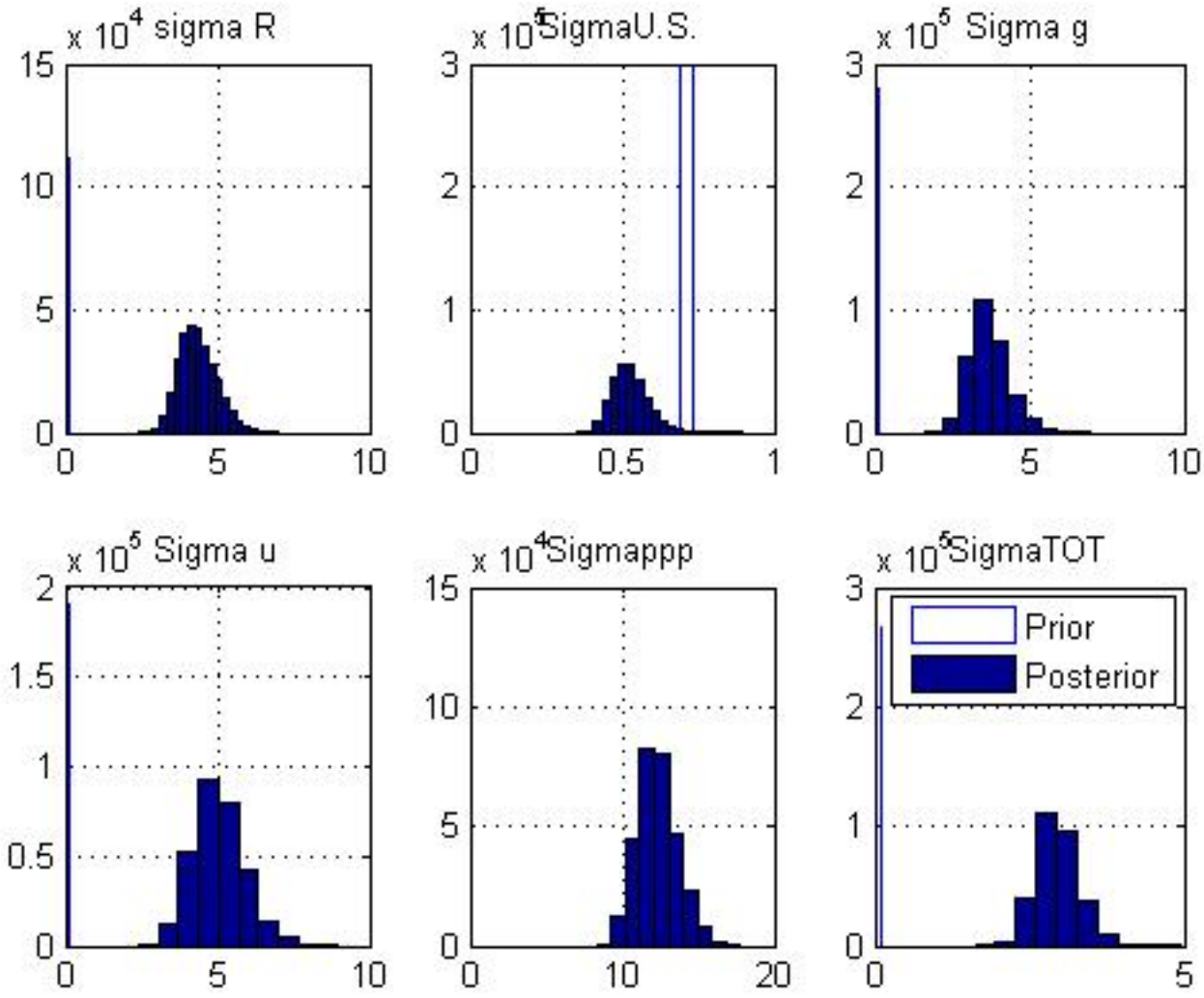

Figure 13: Estimated Parameter Distribution for Regime 2

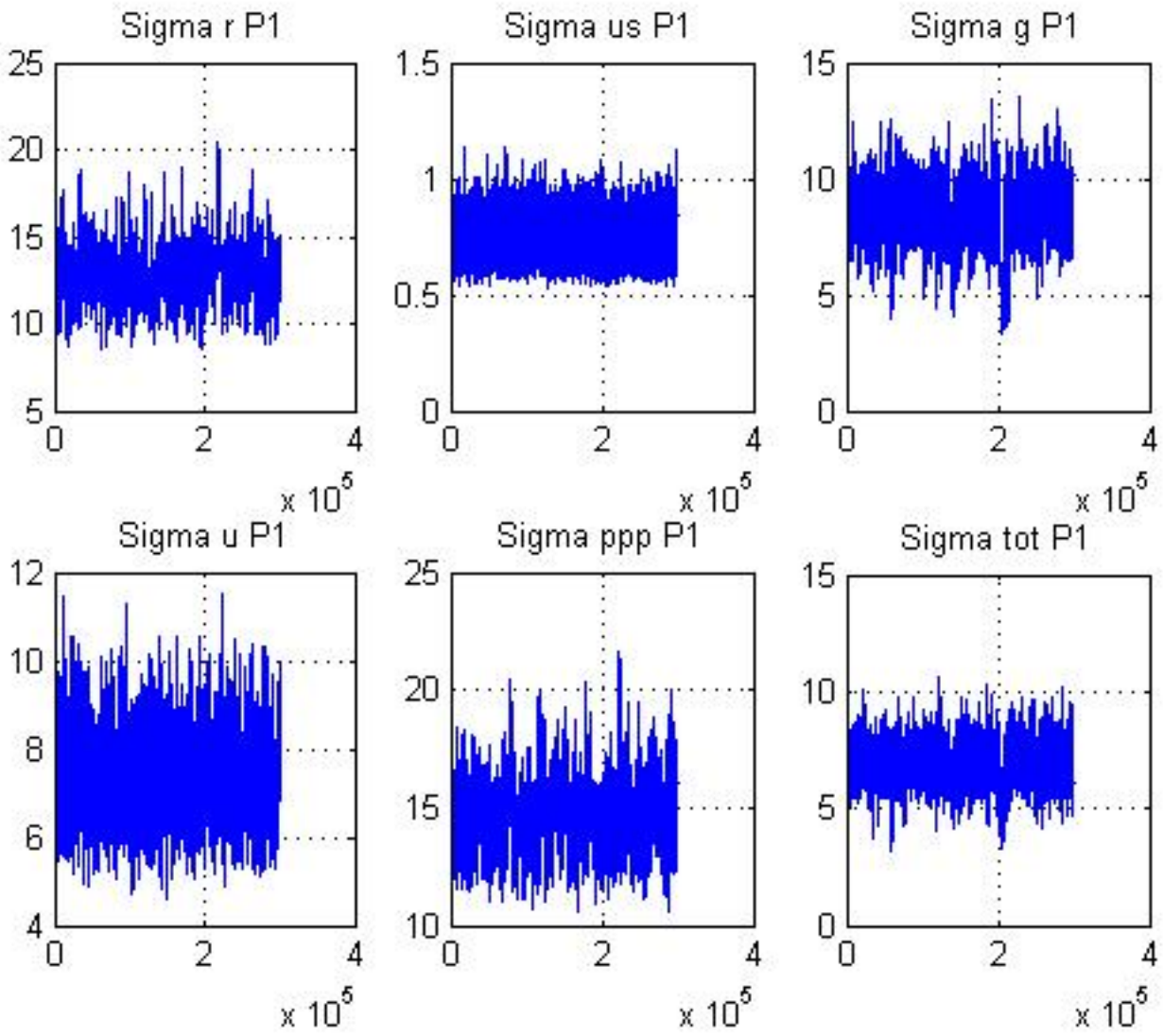

Figure 14: Draws from Posterior Distribution Regime 1

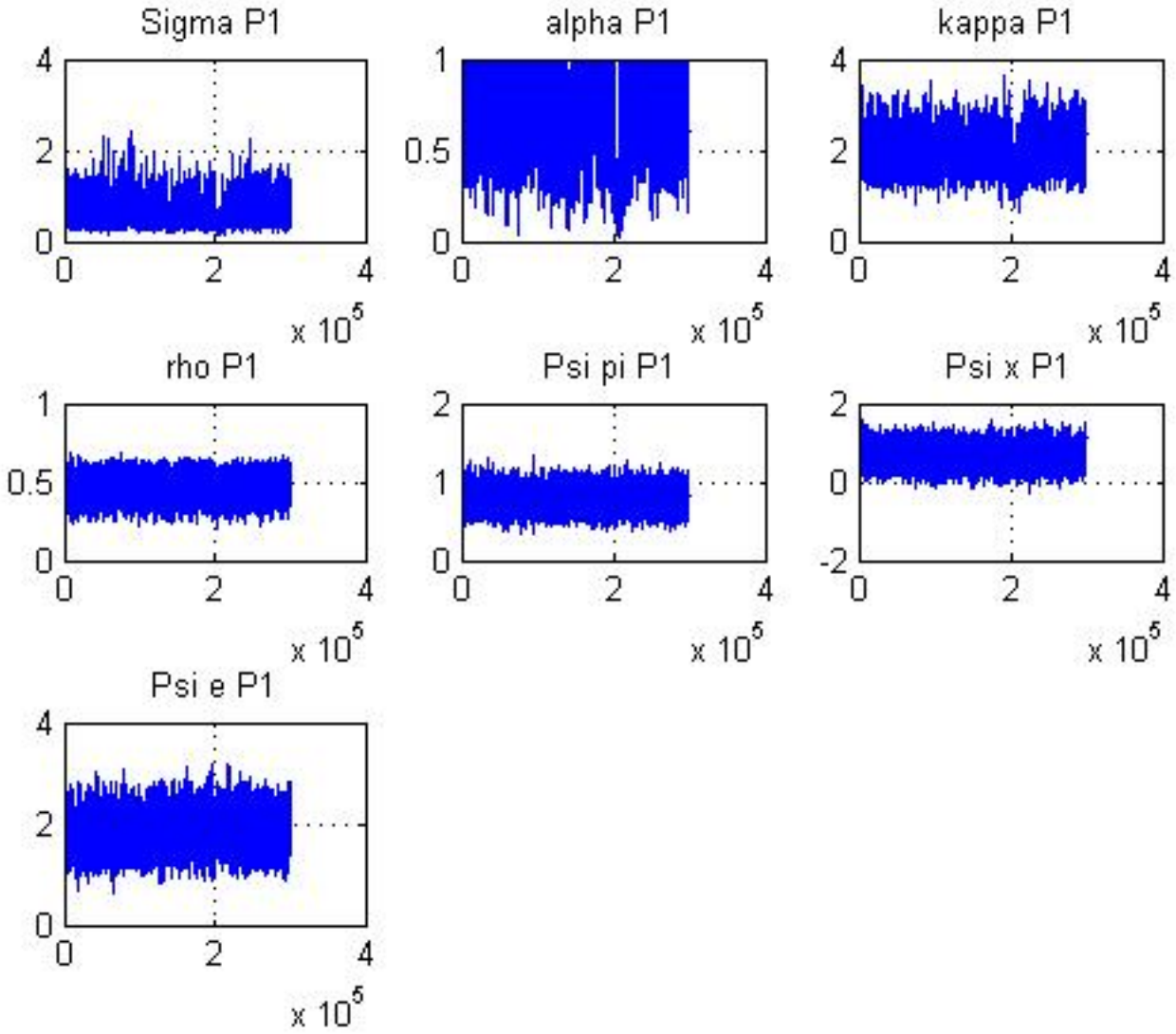

Figure 15: Draws from Posterior Distribution Regime 1

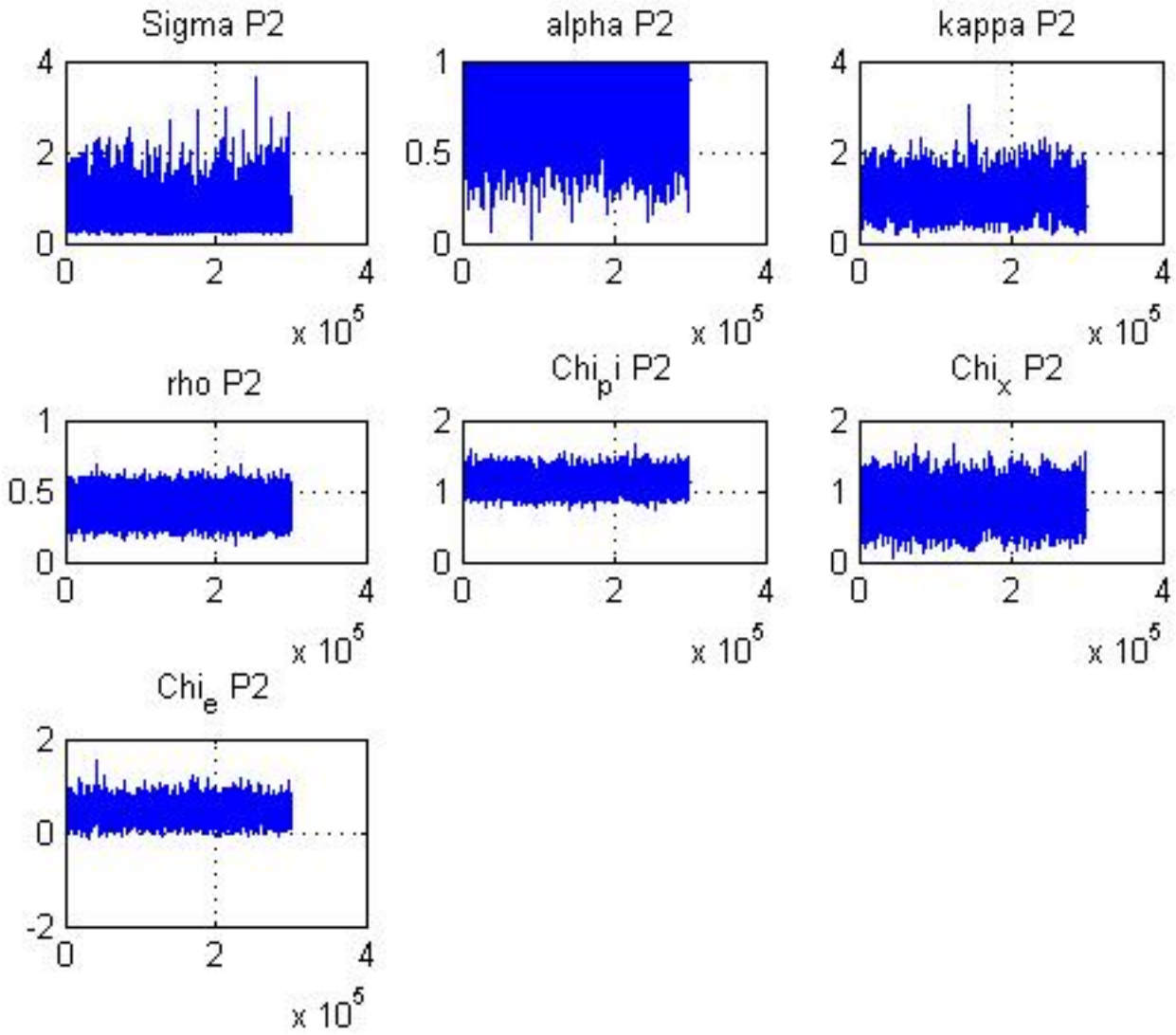

Figure 16: Draws from Posterior Distribution Regime 2

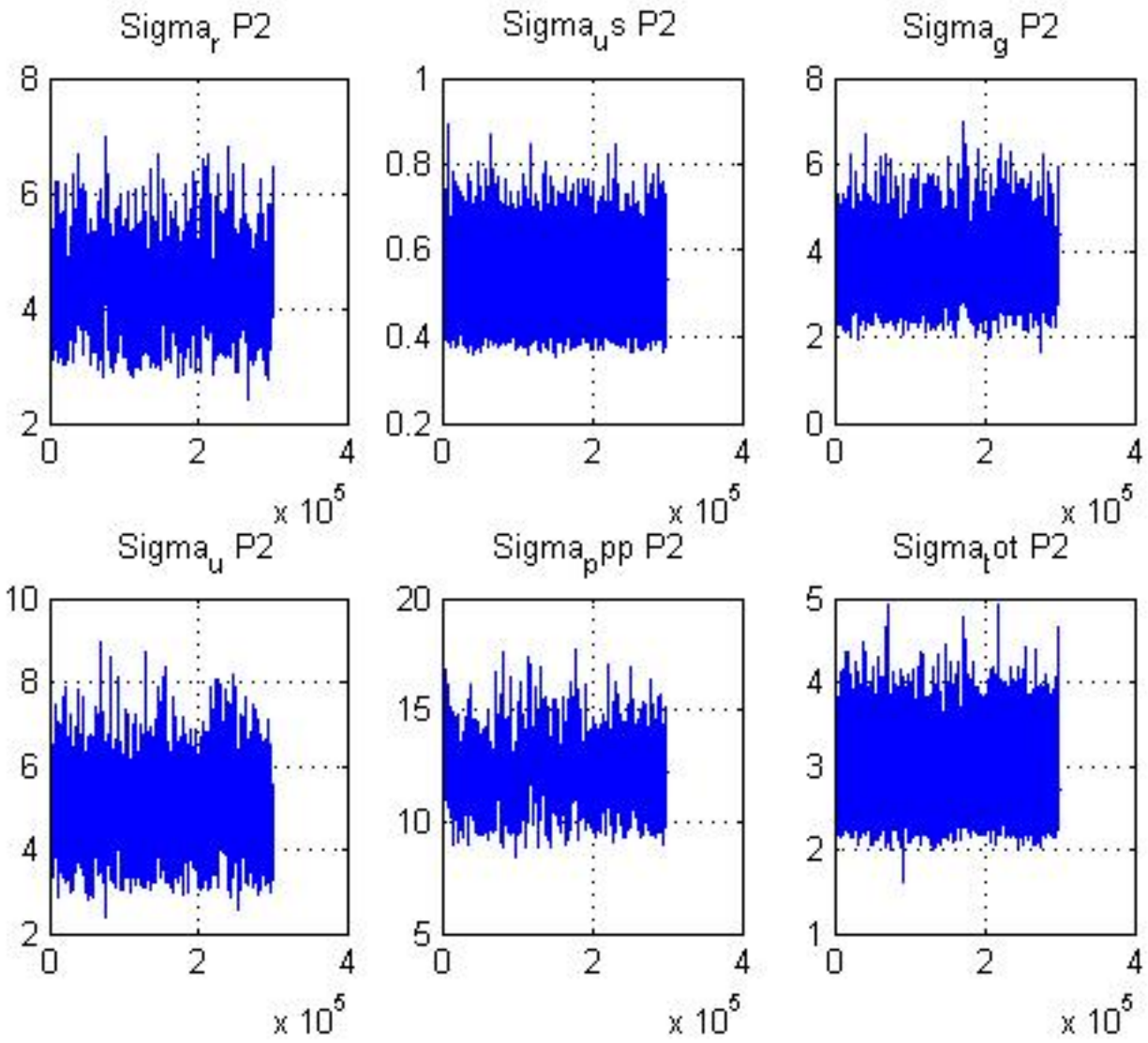

Figure 17: Draws from Posterior Distribution Regime 2