Remittances, Relative Price Variability and Inflation in Mexico*

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Abstract: Using generalized impulse responses derived from a vector autoregression (VAR) model this paper examines the effects of remittances on inflation and the distribution of relative price changes in Mexico for the period between 1980 and 2005. While we find little evidence of any significant impact of remittances on inflation and relative price variability for the entire sample period, remittances seem to have significant positive effects after 1994. Furthermore, we find that a positive relationship between inflation and relative price variability holds for Mexico irrespective of our model specification and choice of sample period.

Key words: Remittances, relative price variability, generalized impulse response

JEL Classification: E61, E62, E65

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"..There were approximately 1.3 million households in Mexico receiving remittances in 2000. Over 10% of households in rural areas receive remittances, and for these households remittances represent almost 48.9% of their total current monetary income. In urban areas, over 4% of households receive remittances that account for almost 50% of their current monetary income. In sum, remittances directly contribute to sustaining the livelihood of a significant number of urban and rural households in Mexico..."

Zarate-Hoyos, 2004

1. Introduction

The remittances into Mexico have increased manifold in recent years and are expected to have multitude of effects in the economy. [1] The growth enhancing effects may work through various direct and indirect channels. For example, the flow of remittances eases constraints on capital and foreign exchange. If a portion of these funds is devoted to productive investment it directly contributes to growth. They may also facilitate international trade by replenishing the foreign exchange reserves and thereby indirectly affect growth. Even though these funds are spent on consumption, they may have important multiplier effects. Higher consumption demand leads to expansion of production and higher level of employment in Mexico.[2]

As the above quote suggests, a sizeable part of the total population receives remittances that augment their household incomes. The expenditure patterns that result from these flows of remittances may have differential effects in various markets and they are likely to have some consequences for relative prices. Although the existing literature discusses various economic effects of remittances, it does not explicitly examine the

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[1] According to official estimates, total remittances have increased from about $0.7 billion in 1980 to $13.6 billion in 2004 – by more than 19 times. In recent years this amount has more than doubled from $6.6 billion in 2000 to $16.6 billion in 2004 (based on authors' estimates from Banco de Mexico data).
[2] Adelman and Taylor (1992) find that when all direct and indirect effects are taken into account, each dollar of remittances spent on consumption increases the Mexican Gross Domestic Product by $2.90.

effects on relative prices. This paper is an attempt to investigate how remittances affect the distribution of relative consumer price changes and the overall inflation.

There are two strands of literature that are relevant for our current study. The first category focuses on the effects of remittances on expenditure patterns. Included in this group is a study by Durand et al (1996) who using data for 30 communities in Mexico find that 10 percent of total reported remittances are spent on productive investment, 14 percent on housing and an overwhelming 76 percent on consumption. In a recent study Zarate-Hoyos (2004) uses data from the Mexican Income and Expenditure Survey for 1989 to compare the consumption patterns of remittance receiving households (RRHs) with those of the households that do not receive any remittances. This study shows that even though RRHs have lower average expenditures in most spending categories, they devote a relatively higher proportion of current expenditures to equipment and housing purchases, and home improvements. These expenditures, as the author suggests, may benefit the national economy through labor and goods markets across Mexico.

The second strand of literature examines, in general, the relationship between inflation and distribution of relative prices. Beginning with the influential papers by Vining and Elwertowski (1976) and Parks (1978), it has grown into a voluminous literature. The robust empirical observation of a positive relationship between inflation and relative price variability (RPV hereafter) across countries and over time has provoked substantial interests among economists. The direction of causality in this relationship has been the issue of contention. In addition to theories that establishes the causal link one way or the other there have been suggestions that some extraneous factor may cause both inflation and RPV simultaneously. In Mexican context there have been a few studies on

determinants of inflation and RPV. In an early article, Blejer and Leiderman (1982) show that RPV is significantly affected by the external variability within traded goods, expected changes in the traded/non-traded price ratio, real money growth and unexpected inflation.

Viquerira(1991) attributes the positive relationship between inflation and RPV to the price setting behavior of the firms, which depends on the characteristics of commodities, the markets in which they are traded, and the industries that supply them. On a slightly different vein, Kalter and Armando (1999) blame expanding government expenditures and exchange rate policy for widening gap between relative prices of traded versus nontraded goods before the 1994 Mexican economic crisis. Rogers and Wang (1995) find evidence of inflation being influenced by fiscal, real money growth, exchange rate, and asset market disturbances. Fiscal and money growth shocks turn out to be the most influential.

These previous studies have neither examined the effects of remittances on prices nor included remittances as a determinant of RPV or inflation. The fact that these funds are spent mostly on consumption may suggest that there are some significant effects on prices of consumer goods and services. Moreover, the pattern of expenditures by consumption categories that results from augmentation of household incomes may have implications for the distribution of relative prices. Using generalized impulse responses derived from a vector autoregression (VAR) model this paper examines the effects of remittances on inflation and the distribution of relative price changes in Mexico for the period between 1980 and 2005. We find little evidence of any significant impact of remittances on inflation and relative price variability for the entire sample period.

However, remittances seem to have significant positive effects after 1994. These findings may have important policy implications. Given that high inflation and RPV involve welfare cost, these results may suggest that the government should encourage use of remittances for productive investment rather than for consumption.

The rest of the paper is organized as follows. In section 2, we discuss the theoretical intuition about the effects of remittances on relative consumer prices and inflation that provides the basis for our empirical investigation. Section 3 describes our data and empirical methodology. In section 4, we present the results and their analysis. The next section includes our concluding remarks.

2. Theoretical Conjecture

In Mexico, remittances evidently augment household income. According to Zarate-Hoyos (2004), remittance receiving households receive an average amount of $476 per month and this amount is used mostly for current consumption. Since most 'families of modest means do not have access to credit, either to finance large consumer expenditures such as furniture, appliances, housing, and medical care or to underwrite productive investments such as education, farming, cattle raising, manufacturing, or retail sales', it is reasonable to assume that demand for such items will increase relatively more than will for other items as a result of this augmentation of household income.[3] These shifts in demand combined with price elasticities of supply then may imply disproportionate changes in relative prices. This is likely to increase the dispersion of relative price

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[3] See Durand et al (1996). Zarate-Hoyos (2004) finds that remittance receiving households spend significantly higher amounts on equipment and machinery than do the households that receive no remittances.

changes. Furthermore, remittances may raise overall inflation through their direct and indirect effects on aggregate demand.

This theoretical possibility may be linked to another literature that documents a positive relationship between inflation and the dispersion of relative price changes. The theoretical exposition of this empirical regularity has not been conclusive in regards to the causal mechanism that generates the observed relationship. Theories that have been proposed fall into one of three categories. The first category of theory shows that the causation runs from inflation to RPV.[4] The second category, on the other hand, takes RPV as exogenous, and shows that inflation is caused by the distribution of relative price changes. The third category of theory propounds that both inflation and RPV are generated by some exogenous factor.

Remittances may fit well into the first or the third line of these theoretical explanations. As we have explained above, if remittances have implications for distribution of relative prices (or price changes) then we would expect a positive relationship of RPV not only with inflation but also with remittances. Fundamentally, however, these two potential driving forces of RPV belong to two different categories. While inflation, more accurately unanticipated inflation, creates misperceptions of absolute and relative price changes among the producers and thus influence their supply behavior, remittances influence the consumer behavior and demand by shifting the budget constraint.

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[4] In most empirical studies, RPV essentially means the dispersion of price changes across commodity groups.

Furthermore, it is plausible that remittances are an 'exogenous factor' that drives both inflation and RPV. If increase in remittances raises both inflation and RPV then it might provide an additional explanation for positive relationship between the two.

3. Data and Empirical Methods

Data

The main source of data for this study is the *Banco de México*'s database on the Economic and Financial Indicators.[5] We use monthly data on remittances and consumer price indices (CPI) for a period from January 1980 to June 2005. The choice of the sample period is dictated by the availability of data. The remittances data are available in millions of US dollars, and have been converted into millions of pesos using the nominal exchange rate (*pesos* per dollar). We use the consumer price indices for a total of 77 categories of goods and services.[6] We also obtain monthly data on industrial production index as a measure of output, and on M1 as a measure money supply. Additionally, we retrieve monthly data on the government expenditures from the National Accounts System published by Mexican Bureau of Statistics (*INEGI).*[7,8]

In order to examine the effects of remittances on inflation and RPV we first calculate measures of inflation and relative price dispersion using the CPI data. Let P_t be the aggregate CPI in period *t*, then aggregate inflation is defined as

$$\pi_t = 100 \times (ln\ P_t - ln\ P_{t-1}) \tag{1}$$

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[5] Available at http://www.banxico.org.mx/siteBanxicoINGLES/eInfoFinanciera/FSinfoFinanciera.html
[6] A list of these items is included in the appendix.
[7] Available at http://www.inegi.gob.mx/inegi/default.asp
[8] The data series have been adjusted for seasonal movements, wherever necessary, using the U.S. Census Bureau's X12 seasonal adjustment program. For details, see the *X12-ARIMA Reference Manual*. For a brief description, you may consult the *EViews User Guide*.

Furthermore, let $P_{i,t}$ be the CPI of commodity category i in period t. Then the change in price of i in period t is defined as

$$\pi_{i,t} = 100 \times (ln\, P_{i,t} - ln\, P_{i,t-1}) \tag{2}$$

RPV in period t is defined as

$$V_t = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(\pi_{i,t} - \overline{\pi}_t\right)^2} \tag{3}$$

where $\overline{\pi}_t = \dfrac{1}{n}\sum_{i=1}^{n}\pi_{i,t}$ is the mean price changes (averaged across commodities) in period t.

[9] Also, note that i indexes product or service categories and n is the number of these categories. We also calculate the percentage growth rates of remittances, money supply, government expenditures, nominal exchange rate and industrial production as 100 times the log first differences of the relevant variables.

Table 1 provides summary statistics on the key variables in the data set. There is substantial variation in monthly remittance growth rates over time. Also, the monthly inflation rate widely varies between -0.09 percent and 12.31 percent. RPV is relatively less volatile. Government expenditures growth displays considerable variation. Money growth and changes in the exchange rate have similar variability. Industrial production during this period grows at an average monthly rate of 0.21 percent with an average variation of 1.22.

The first step in any investigation of time series involves examination of the stochastic trending properties of the relevant variables. Table 2 reports the results of the conventional Augmented Dickey-Fuller (ADF) test for the presence of a unit root. As we

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[9] Note that P_t is constructed as a weighted index of all underlying prices and therefore it is desirable that both V_t and $\overline{\pi}_t$ are calculated as weighted standard deviation and mean respectively. However, we find that the results do not change. Moreover, some prominent studies for the U.S. (e.g. Vining and Elwertowski, 1976) use unweighted measures.

can see from the table, we reject the null hypothesis of unit root for all series. In other words, all these variables are I(0) processes.

Empirical Methods

We use a vector autoregression (VAR) methodology to model the dynamic relationships between remittances, inflation and RPV. We derive generalized impulse responses from the estimates of various specifications of the following unrestricted VAR model:

$$Y_t = A_0 + \sum_{j=1}^{p} A_j Y_{t-j} + \varepsilon_t \tag{4}$$

where Y_t is an $m \times 1$ vector of variables; A_0 is an $m \times 1$ vector of constants; A_j is an $m \times m$ matrix of auto-regressive coefficients at lag j. p is the maximum lag of the variables chosen by using a 'pare down' method based on Schwarz Information Criterion (SIC).[10] ε_t is an $m \times 1$ vector of innovations that are assumed to be serially uncorrelated but can be correlated with each other. Unlike 'orthogonalized' impulse responses that had been commonly used to conduct dynamic analysis of VAR models, the generalized impulse responses approach is invariant to the ordering of the variables in the VAR (see Pesaran and Shin, 1998).

We estimate two specifications of the model described by equation (4). The most parsimonious specification includes only three variables: remittance growth, inflation and RPV. The idea behind this specification is to focus on the dynamic interactions among the three variables of interest. The more general specification, however, includes four additional variables: money growth, government expenditure growth, nominal exchange

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[10] See Enders (1995)

rate growth, and industrial production growth. The first two variables are included to capture and control for effects of monetary and fiscal policies on relative prices and inflation. The changes in nominal exchange rate may affect inflation and RPV through their effects on international trade that influence aggregate demand. Inclusion of growth of industrial production allows for the possibility that real shock influences the rate of inflation through a "Phillips curve" type relationship.[11]

4. Results

The estimated generalized impulse responses (along with two standard error bands) of inflation and RPV derived from our parsimonious specification of the model are shown in Figure 1. The first row shows the responses of inflation and RPV to a one standard deviation innovation in remittance growth. An innovation in remittance growth does not seem to have any significant impact either on inflation or on RPV. The second row shows responses of inflation to a one standard deviation innovation in RPV, and of RPV to a one standard deviation innovation in inflation. An innovation in RPV leads to a positive and fairly persistent increase in inflation and vice versa. These responses are consistent with the empirical observation of a positive relationship between inflation and RPV.

We now include money growth, government expenditure growth, exchange rate growth and industrial production growth in addition to the three variables of interest and estimate the more general specification of our VAR model. Note that except for money growth, all other growth rates have been adjusted for CPI inflation. The impulse

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[11] In a 'somewhat related' study, Rogers and Wang (1993) find that output, monetary and exchange rate shocks are the most important sources of fluctuations in relative prices in Mexico. They, however, use the ratio of the wholesale price index (WPI) to the consumer price index (CPI) as the measure of relative prices.

responses are presented in Figure 2. The responses of inflation and RPV to a one standard deviation innovation in remittance growth are not different from our previous results: there is no significant impact. Interestingly, innovations in monetary growth and in government expenditure growth do not have any significant effect either on inflation or on RPV. This does not accord well with the results of Rogers and Wang (1993, 1995). However, they use the ratio of wholesale and consumer price index as a measure of relative price (Rogers and Wang, 1993) and they consider the time period from 1977 to 1990 (Rogers and Wang, 1995).[12]

A shock to the industrial production growth has significant negative effects on inflation and RPV. Thus a real output not only lower the inflation rate but also reduces variability of price changes. In contrast, a one standard deviation innovation in exchange rate has significant positive and persistent effects on inflation as well as on RPV though the magnitudes of these effects are different. Innovations in inflation and RPV have significant positive effects on each other, which demonstrate once again the positive correlation between the two.

Sensitivity Analysis: 1995 - 2005

Remittances to Mexico have increased substantially only in recent years. The government has recognized the potential economy-wide benefits of remittances and has provided incentives to the Mexican emigrants to transfer money back to their home country. Along with these initiatives, the data collection has also improved in recent years. Given these developments, we would like to conduct a sensitivity analysis using the most recent data on remittances.

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[12] A re-estimation of our model for period 1980 to 1990, however, reveals that money growth has somewhat larger effects on inflation for that sample period.

We now truncate the sample period and re-estimate the models using data for the sub-period from 1995 to 2005: the period after the economic crisis of 1994. Figure 3 presents the estimated generalized impulse responses of inflation and RPV. A one standard deviation innovation in remittance growth leads to a statistically significant positive increase in inflation, that peaks in period 2 (about 0.2 percentage points) and then this positive effect gradually tapers off. The effects on RPV have very similar pattern though the magnitudes of these positive effects are much smaller. We still observe the positive correlation between inflation and RPV.

We then estimate the more general specification of the VAR model that includes money growth, government expenditure growth, exchange rate and industrial production growth. The impulse responses are presented in Figure 4. The responses of inflation and RPV to remittances are very similar to those in Figure 3 though the magnitudes are slightly smaller. Additionally, we find that inflation and RPV decrease in response to monetary growth. These negative effects die down within a year. These 'surprising' results may have demonstrated the famous "price puzzle" observed in the U.S. This may also explain the neutrality of monetary growth for inflation and RPV for the entire sample period. In fact, estimation of our model with data for the period 1980 – 1994 reveals that money growth has relatively larger positive – though not strongly statistically significant - effects on both inflation and RPV which accord well with previous studies.[13] Furthermore, a one standard deviation innovation in real exchange rate growth leads to significant positive increase in both inflation and RPV though the effects are much larger on inflation. The effects of an innovation in industrial production growth are, as expected, negative and statistically significant.

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[13] The results of this experiment have not been reported in the paper but can be obtained from the authors.

Monthly data on remittances are likely to have substantial amount of measurement error particularly during the early part of the sample period. In order to smooth out some of the month to month variations arising out of such error, we convert them into quarterly data and re-estimate the model for the entire sample period as well as for the sub-period between 1995 and 2005. The results are qualitatively similar and we do not find any significant impact of remittances either on inflation or on RPV for the entire period. However, they have significant positive impact on inflation and RPV since 1995. We do not report the results in the paper.

5. Concluding Remarks

Using generalized impulse responses derived from the estimation of a vector autoregression (VAR) model this paper examines the effects of remittances on the distribution of relative price changes in Mexico for the period between 1980 and 2005. While we find little evidence of any significant impact of remittances on inflation and RPV for the entire sample period, remittances seem to have significant positive effect after 1994. Furthermore, we find that the positive relationship between inflation and RPV holds for Mexico irrespective of our model specification and choice of sample period.

We must mention a few caveats that remain in this study. *First*, the remittances data for the earlier years of the sample period under consideration are not very reliable. The data collection process was not centralized and much of the remittance flow may have been under-reported. *Second*, a part of the remittances may have been in the form of gifts (goods) and its extent and effects are hard to measure. *Third*, remittances are distributed unevenly across the Mexican states. Some states and communities receive more

remittances than others and it will be a useful exercise to use community and/or state level data. But regional data on remittances are not available for a long enough sample period to conduct a worthwhile analysis.

Since it is by now a part of the conventional wisdom that high inflation and relative price variability involve welfare costs, these findings may suggest policy actions for better uses of remittances. The government in Mexico should formulate policies to channel these remittances for productive investments rather than for consumption.

Table 1: Summary Statistics

	Remittances growth	M1 growth	Government expenditures growth	Exchange rate growth	Industrial production growth	Inflation	Relative price variability
Mean	3.12	2.59	2.58	2.02	0.21	2.31	2.59
Maximum	41.49	28.81	81.33	36.32	4.89	12.31	9.89
Minimum	-49.18	-5.69	-94.98	-5.13	-4.18	-0.09	0.54
Std. Dev.	9.07	3.10	16.52	4.62	1.22	2.25	1.77
Observations	305	305	305	305	305	305	305

Table 2: Augmented Dickey-Fuller Test Results for Remittances, Consumer Price Index, Money Supply, Exchange Rate, Industrial Production Index and Relative Price Variability (Sample Period: January 1980 – June 2006)

Statistics	Remittances	CPI	Money Supply (M1)	Government expenditure growth	Exchange Rate	Industrial Production	Relative Price Variability
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ADF test statistics	-15.66	-4.76	-8.60	-21.93	-4.59	-7.27	-7.86
Lag length of the augmented terms	1	0	1	1	4	2	1
Is a time trend included in the test equation?	Yes	Yes	Yes	Yes	Yes	No	Yes
Is an intercept term included in the test equation?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dickey-Fuller 5% critical value	-3.42	-3.42	-3.42	-3.99	-3.42	-2.87	-3.42
MacKinnon approximate p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Number of obs. used in the test equation	303	304	303	298	300	302	303

Notes: To select the lag length of the augmented terms in the test equation, we start with a maximum lag length of 12 and pare it down by looking at the Schwartz Information Criterion (SIC).

Figure 1: Response to Generalized One S.D. Innovations ± 2 S.E.
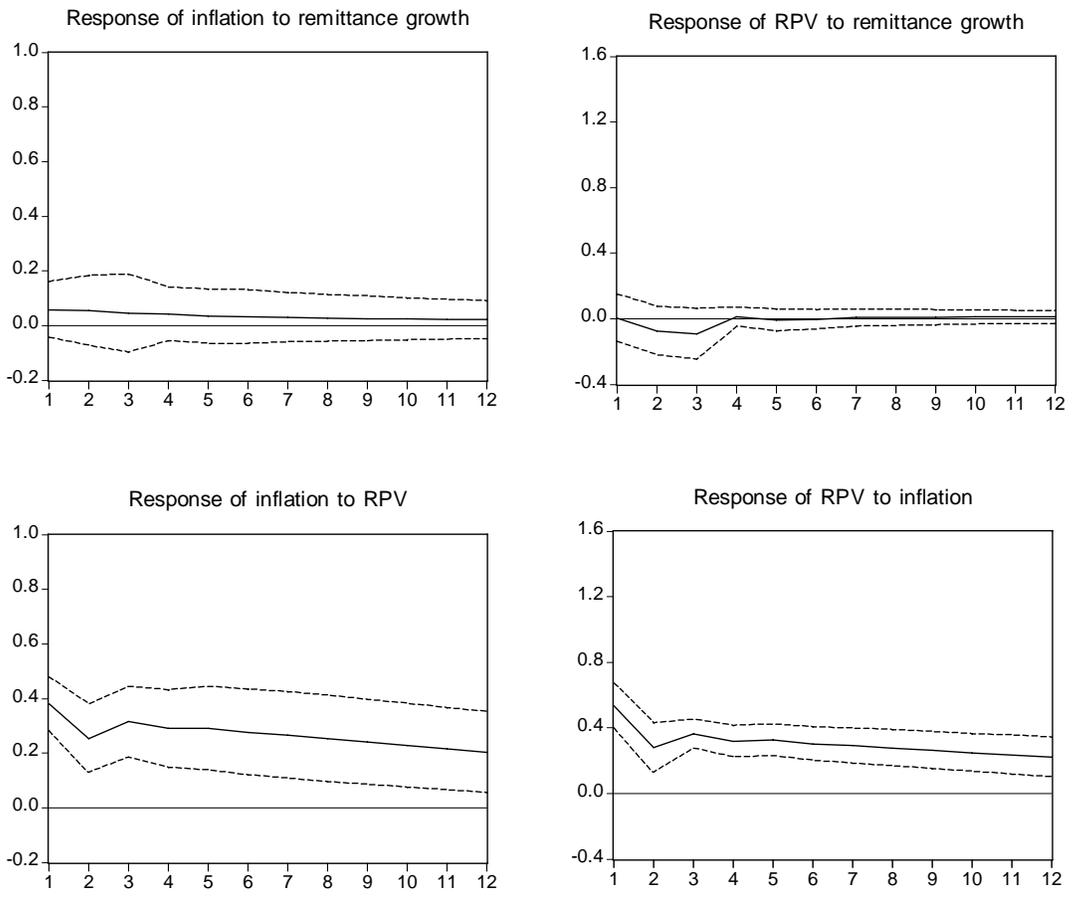
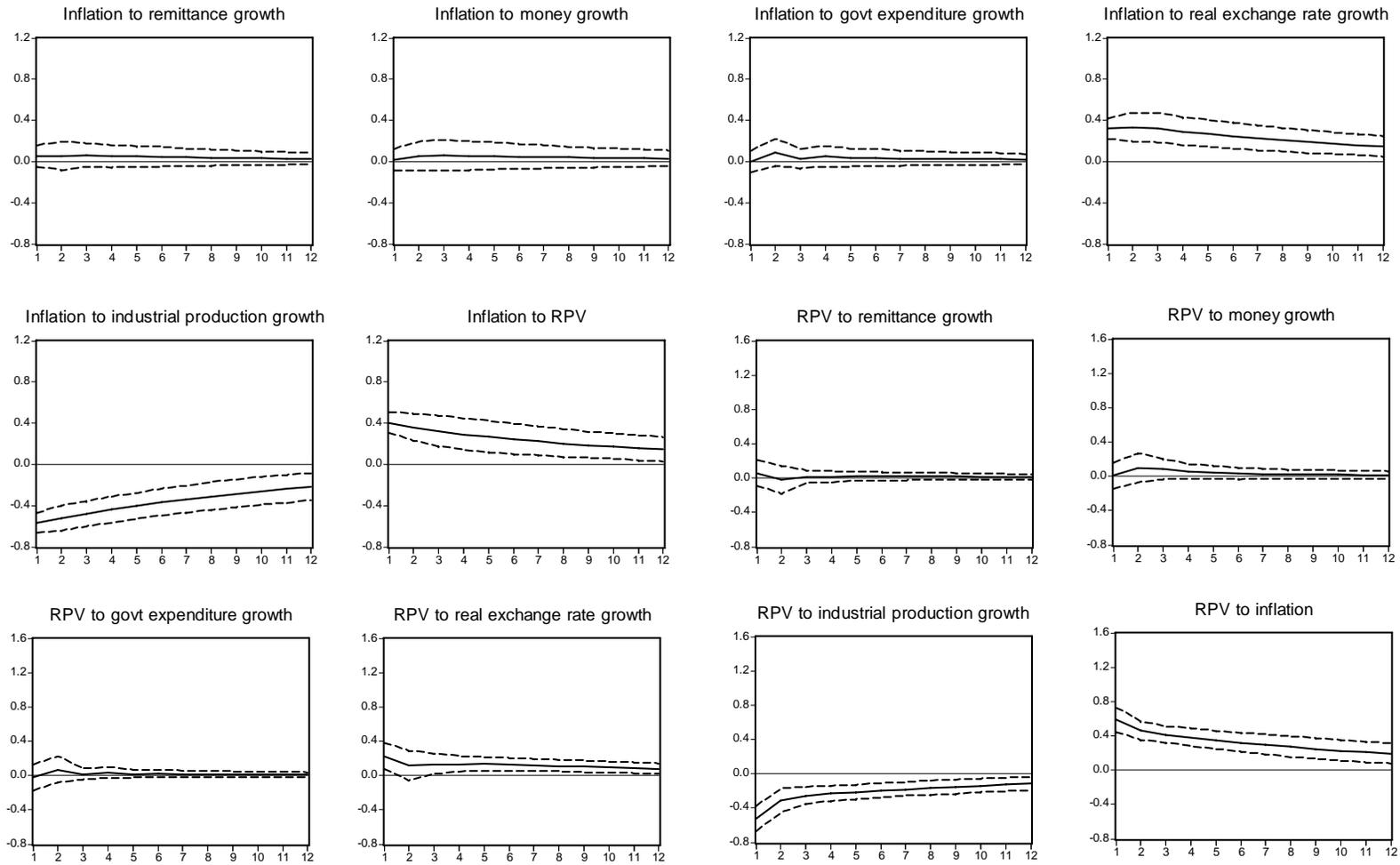Figure 2: Response to Generalized One S.D. Innovations ± 2 S.E.

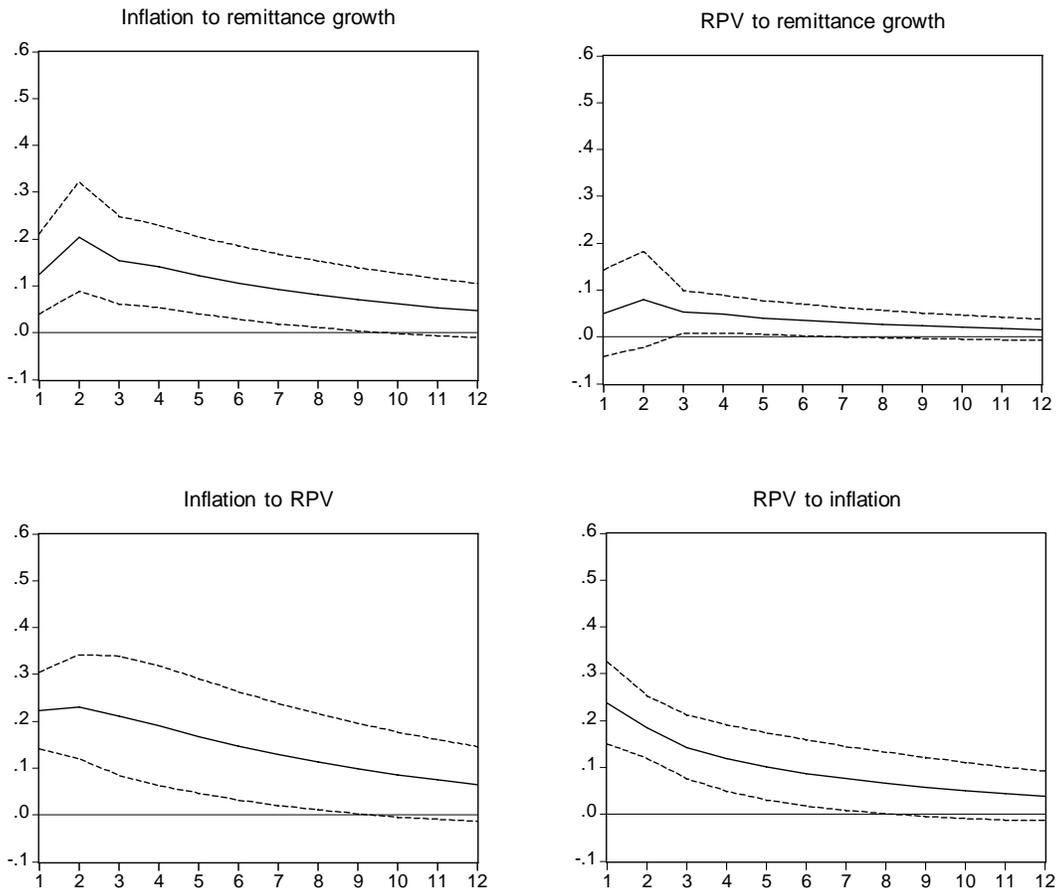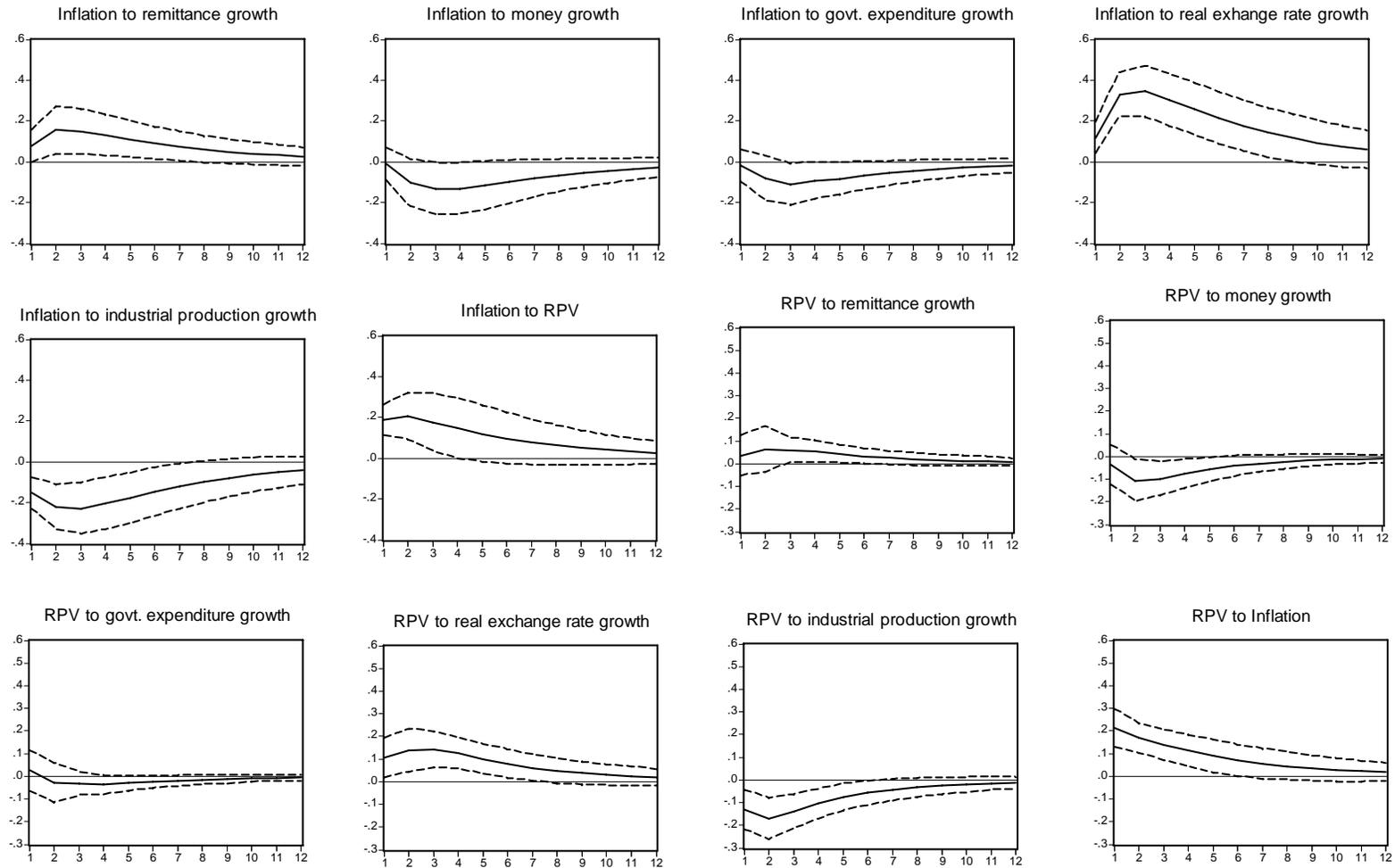Figure 3: Response to Generalized One S.D. Innovations ± 2 S.E.

Figure 4: Response to Generalized One S.D. Innovations ± 2 S.E.

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Appendix

List of CPI Items

1) Tortillas and corn products, 2) Bread, 3) Crackers, pasta and flour, 4) Rice and cereals, 5) Poultry, 6) Pork, 7) Beef, 8) Others, 9) Ham and sausages, 10) Fish and seafood, 11) Canned fish and seafood, 12) Fresh milk, 13) Processed milk, 14) Milk products, 15) Eggs, 16) Oil and vegetable oil, 17) Fruits, 18) Fresh vegetables, 19) Dry vegetables, 20) Processed fruits and vegetables, 21) Sugar, 22) Coffee, 23) Soft drinks, 24) Spices, 25) Candy and chocolate, 26) Meals cooked outside, 27) Beer, 28) Wine and liquor, 29) Cigarettes, 30) Men's shirts and underwear, 31) Men's pants and suits, 32) Women's blouses and underwear, 33) Women's pants, 34) Dresses and skirts, 35) Children's clothing, 36) Baby's clothing, 37) Heavy clothing, 38) School uniform, 39) Footwear, 40) Clothing care and footwear maintenance, 41) Personal accessories, 42) Rent, 43) Owner occupied housing, 44) Electricity, 45) Gas, 46) Telephone, 47) Other services, 48) Kitchen furniture, 49) Wood furniture, 50) Electric appliances, 51) Electronic appliances, 52) Domestic utensils, 54) Textile accessories, 55) Soap and other cleaning, 56) Medicines, 57) Medical equipment, 58) Medical services, 59) Personal care services, 60) Personal care articles, 61) Personal cleaning articles, 62) Urban public transportation, 63) Extended transportation, 64) Automotive vehicles, 65) Gas and oil, 66) Auto parts, 67) Automobile services, 68) Private education, 69) Textbooks, 70) Material, 71) Hotels and tourism activities, 72) Other recreational services, 73) Newspapers and magazines, 74) Other recreational articles, 75) Bars and restaurants, 76) Professional services, 77) Diverse services.