

# A view from above: Macroeconomic determinants of Mexican remittances\*

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## Abstract

Conventional wisdom in the economics of migration holds that remittance receipts may be a more stable source of capital for developing countries than Official Development Assistance or private financial capital. We use national accounts data to analyze movements in remittance flows to Mexico from 1980-2006 against these series, as well as US GNI and Mexican GDP. We find some evidence that remittances are acyclical, meaning that they neither driven by movements in the Mexican nor the US economy. A vector autoregression (VAR) model is estimated using de-trended series of several economic indicators. Impulse response functions indicate that a positive shock to US GNI leads to an increase in remittance receipts, whereas remittances decrease with positive movements in Mexican GDP, however both these shocks are neither persistent nor significant.

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## 1 Introduction

In a global economy there is cause for worry that the movements of international capital, subject as they are to the animal spirits of the market, may have profound negative effects on poorer countries and their inhabitants. As proof of this vulnerability, one needs only to recall a recent example in 1997 when the economies of the so-called Asian “Tigers” suffered great losses despite being in sound fiscal condition, with low inflation and low unemployment (Krugman, 1998). The East Asian crisis began when Thailand let the baht float against the dollar, but the crisis was not contained; the capital flight that accompanied speculation in the currency market spread to other areas throughout the region, destabilizing Malaysia, Indonesia and South Korea in its wake.

Similarly in Mexico when the peso was devalued during the 1994 “Tequila” crisis Mexico’s international debt, which was typically dollar denominated, suddenly became a much bigger burden than before. The devaluation and subsequent economic turmoil cast doubt on the long term viability of the Mexican economy, deterring new investments and putting downward pressure on foreign direct investment (FDI). Thus the cyclical nature of capital flows with regard to income, i.e., the direction that capital moves, has important implications for the strength and success of a national economy.

As with capital flows more generally, there is some understanding to be gained by determining whether remittance flows move with or against the business cycle; if remittances are pro-cyclical with respect to the home country’s income they flow

more freely when the home economy is doing well.<sup>1</sup> But if they are countercyclical to home country income, they flow more freely when the economy is doing poorly, possibly lessening the burden of the economic contraction on the migrant sending country. Most private capital flows, such as FDI, are considered pro-cyclical because there is more to be gained by a foreign investor when the economy is doing well. A remittance, however, is a horse of a different color. Figure C of Appendix C juxtaposes four macroeconomic series over the period 1980-2006: US GNI, Mexican GDP, remittance receipts to Mexico and Official Development Assistance to Mexico. All series are represented in real 2000 values, denominated in US Dollars. The bottom panel shows that while ODA fluctuates over the period, remittance receipts remain fairly stable, increase gradually at first, and then rise steeply but with little variation. In contrast, ODA inflows to Mexico show a lot of variance, and do not show a consistent trend. Similarly, Figure C of Appendix C juxtaposes the same four macroeconomic series with respect to Mexico. However, Figure C of Appendix C includes the cyclical components of the four series, obtained by using the Hodrick-Prescott filter, the Baxter and King filter and polynomial detrending. Again, the bottom panel of the figure highlights the stability of the remittance series relative to the ODA series.

Why would remittances show this stability relative to other capital flows? To begin, remittances do not create an interest liability or an obligation to repay, so a devaluation of the currency would not render the remittance receiver in bigger debt as a result of a negative shock. A second consideration is the very personal nature of

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<sup>1</sup>N.B. Throughout the paper we use home and host country interchangeably with sending and receiving migrant country, respectively.

remittances; whereas foreign direct investment involves contracts between financial intermediaries and a transnational capitalist class — both of which may have only short-term interest in any given investment — a remittance is a disbursement paid by a family member who has migrated to his or her loved-ones back home. Compared to the capitalist, the remitter has greater concern for the overall welfare of the family left behind.

It is this familial tie, in part, that makes it unclear, a priori, whether remittances will move with or against the business cycle. It is possible that a Mexican migrant living in the United States will send more money home when news of the “Tequila” crisis travels north. Similarly, if income falls in the United States, a Mexican migrant might be compelled to send less money back home.

In sum, the import of the relationship between the business cycle in both the migrant sending and receiving countries and remittances must not be under-stated, as shocks to the national economy may be ameliorated or exacerbated depending on the timing of remittance receipts. The hypothesis motivating this paper is that remittances from migrants in the United States to Mexico will depend more on the macroeconomic conditions in the US than in Mexico, as a migrant’s ability to send transfers will depend on conditions where he or she is based. There is some microeconomic literature that considers the motivations to remit, but this paper will not delve into these considerations. Instead, it will take a macro perspective on the issue.

## 2 Literature

A growing literature on migration and remittances, evaluated at both the international and national levels, provides some insight into the relationship between remittances and shifts in the global macro-economy. Looking solely at developing countries, Kapur (2004) plots net and gross remittances against other private and public capital flows. His study shows that while other capital flows (such as FDI) exhibit notable fluctuations over time, remittances were the most stable capital flow during the period 1990-2001. Another study by Ratha (2003) complements that of Kapur. Ratha argues that remittances are generally a less volatile, more dependable, source of funding than private capital flows and foreign direct investment. Sayan (2006) looks at remittance and output data for 12 lower and middle income countries from 1976-2003. He finds that, although the aggregate country data exhibits counter-cyclicality vis-à-vis GDP, within countries the result is ambiguous as remittances can be pro-, counter-, or even a-cyclical.

Other papers consider the impact that migrant-hosting economies have on remittance flows. A recent working paper by Roache and Gradzka (2007) evaluates the impact of the US business cycle on remittances to Latin America. Looking at data from 1990-2007, the authors use three approaches – simple correlations, cointegration tests, distributed lag tests, and dynamic factor modeling – to estimate the relationship between 19 US economic indicators and remittances to various Latin American countries. They find, on average, no correlation between US economic indicators and remittances to the LAC. However, the results from Engle-Granger and Johanson cointegration tests provide some evidence that GDP is the most likely to

have a long run relationship to remittances. Of import to our study here is that when using a dynamic factor model methodology to estimate the US-LAC relationship, the authors find that Mexico is the sole country which shows some relationship between remittances and the US business cycle. This is especially pronounced for the more recent years.

Much work has been done on the remittance flows from Turkish workers living in Germany. Akkoyunlu and Kholodilin (2006) use data from 1962-2004 to see whether Turkish or German income has greater significance on remittances sent back to Turkey. The authors employ cross-correlations, tests of cointegration, and vector auto regression models. They find that the GDP of the host country (Germany) is a pro-cyclical determinant of remittances, whereas income in the home country (Turkey) is relatively unimportant. Oddly, the results in Akkoyunlu and Kholodilin contrast those of Sayan (2004) and Sayan and Tekin-Koru (2007), who find that remittances to Turkey are indeed pro-cyclical to Turkish income. This could be due to the fact that income is conceptualized differently in each study. Sayan points out that Gross National Product includes GDP and NFI (net foreign investments), which includes net remittance receipts; thus the relevant series to test against is GDP in the home country (which excludes remittances) and GNP in the host country.

Sayan and Tekin-Koru (2007) look at remittance flows to Mexico vis-a-vis US and Mexican GDP from 1990-2005. The authors find that Mexican remittances are countercyclical to Mexican GDP and pro-cyclical with respect to US GNP. This is the opposite relationship that the same authors found with respect to Turkey. Finally, in a recent paper discussing the business-cycle properties of Mexican remittances,

Vargas-Silva (2008) finds evidence that the cyclical (de-trended) component of Mexican output and remittances have a negative correlation. However, the results were not robust to different definitions of remittances, which suffer from measurement error more generally. Vargas-Silva's strongest result, which is insensitive to different remittance measures, is that there is a strong correlation between the cyclical component of US output and remittances to Mexico. He indicates that a further decomposition of US income into specific industrial components that focuses, for example, on construction, might give a clearer indication of the response of remittances to output shocks.

We will draw on the aforementioned literature as we investigate the empirical relationship between remittance flows to Mexico and the Mexican and US business cycles.

### **3 Data and Methodology**

#### **3.1 Data**

In order to glean a broad understanding of Mexico's remittance cycle vis-à-vis the business cycles of both Mexico and the US, we have gathered annual data for the period 1980-2006. The data are denominated in dollars and come from the World Development Indicators (WDI) database of the World Bank (See Appendix A). All values have been adjusted to base year 2000 in real terms. The decision to use series from the WDI instead of those available from the Banco de Mexico is based on two considerations. First, the WDI series have longer coverage, allowing us to observe more than one business cycle in the data. Second, and perhaps more pertinent, is

that the Banco de Mexico data is peso-denominated, meaning that when the “Peso Crisis” took hold in the mid 1990s, the peso value of remittances jumped, while this is in fact an artifact of the steeply depreciating currency. It seems, also, that what is relevant from a migrant perspective is the dollar value that he or she sends, rather than the current value in terms of pesos. We have included summary statistics of each series in Appendix B.

Following the convention used by Sayan and Tekin-Koru (2006), we use Gross Domestic Product for the home country and Gross National Product for the host country as measures of output. According to national accounting conventions, GNP equals GDP plus net factor income from abroad (NFI). As NFI includes net remittance receipts, this figure should be excluded from any analysis of the home country’s output (Sayan and Tekin-Koru 5).

One way in which our analysis would benefit is if it were to include the United States income series in comparison to Mexican income. It is likely that there are strong linkages between remittances and the US economy. Anecdotal evidence supporting this point can be seen in that the recent U.S. economic slowdown since 2007 has sparked substantial media coverage on the effect that migrants could be sending less money home than before the crisis. Our data would not be able to capture these recent events at such an early date, and there are other considerations to keep in mind, such as immigration laws that make undocumented workers resort to “black” market measures to send money home. Given these stylized facts and despite the limitations in our analysis, it seems important to take into consideration the factors that may be driving international remittances.

Two important caveats about the data need to be noted here. First, the remittances variable included in the dataset only captures transfers made by documented migrants and sent via official channels. Since a substantial portion of remittances is sent through informal channels, the remittances data may not be fully representative of actual remittances and may be an underestimate. (Vargas-Silva 295). Second, the remittance receipt values for Mexico represent the total remittances received by Mexico from all other countries its workers are employed in. Although the US is the top source country for Mexican immigrants, with 10.3 million of its 11.5 million emigrants in the US in 2005, it is important to add that the remittances included in the dataset may not solely come from the US (Migration and Remittances Factbook 2008, World Bank).

### **3.2 Methodology**

Much of the literature on capital flows emphasizes that data in long time series must be de-trended so that the estimated coefficients are not confounded by structural shifts in the economy, or by a general (upward or downward) trend in the series. A trend in a time-series is a slow, gradual change in some property across time which must be removed in order to evaluate the fluctuations in the series. When trying to evaluate cyclicity between two time-series vectors it can be useful to detrend them to ensure that the results we get are not due to similar or opposing trends in the variables in the long term. In a word, de-trending removes the noise so that we can see the underlying signal.

Several approaches are relevant for de-trending national accounts data. The tra-

ditional form of de-trending is the polynomial filter, which estimates the unknown time trend of the series by regressing dummies of time on each variable of interest, and fitting a polynomial of degree  $k$  to the series. The result of polynomial de-trending is that once the estimated trend is removed, the remaining series (the cyclical component) is stationary.

There are some theoretical issues with the polynomial de-trending that have caused much of the literature to move away from this method in search of a new technology. The Hodrick-Prescott filter is used almost ubiquitously in papers dealing with remittances and cyclicity (Sayan (2006), Akkoyunlu and Kholodilin (2006), Roache and Gradzka (2007) and others).<sup>2</sup> Harvey and Jaeger acknowledge the danger of the introduction of spurious correlation in the series with the use of the HP filter (Harvey and Jaeger 1993). In some cases (Sayan and Tekin-Koru 2007), the authors use both techniques to detrend their data. They compute all results using both techniques and subsequently present both sets of results. Surprisingly, in many of the cases, both methods yield similar results. In some cases (such as the relationship between remittances and consumption patterns), the two methods give different results.

On a general level, by using polynomial detrending, the smoothness of the derived trend and thus the frequency content of the detrended series can be controlled by changing the highest order of fitted the polynomial  $t$  (Turhan-Sayan and Sayan 2002). In addition to the HP filter and polynomial detrending, a band-pass filter known as the Baxter and King (BK) filter could also be used for our purposes (Baxter and

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<sup>2</sup>For a detailed description of the Hodrick-Prescott filter, consult Appendix D

King 1995). The BK filter is considered an alternative to the HP filter (Woitek 1998). It is used in similar analyses due to its ability to remove high frequency components (irregular or fast-moving components) in addition to the low frequency components that the HP filter removes (Vargas Silva 2008). After considering three detrending approaches we found that for the purposes of the present analysis the BK filter is superior. After looking at the three filters, the polynomial, the HP, and the BK filters, we determined that in many cases the first two actually introduced a unit-root into the series, or made the autocorrelation worse than it was originally. For a look at these results please consult Appendix E.

Before employing the Baxter King Filter on the data, we need to determine whether or not a given series contains a unit root. The Polynomial Filter only needs to be used or the detrending carried out in case a unit root is present. In order to detect the presence of a unit root, we conducted a series of Phillips-Perron (PP) tests for all the variables in the dataset (Table 2). The results of the PP tests indicate that a null hypothesis of the presence of a unit root could not be rejected for the following variables: Mexican GDP, US GNI, Official Development Assistance and Foreign Direct Investment in Mexico. Thus, the cyclical part of the data for these variables needs to be calculated using the Baxter King Filter. The series which possessed a unit root were thus detrended using the BK filter.

We carried out PP tests for the detrended series to check whether the unit root had been removed. For every series except the US GNI, the p-values for the polynomial detrended series show that we can reject the null hypothesis that the detrended series exhibits a unit root.

## 4 Results

After isolating the cyclical components of the series, we conducted pair-wise correlations between each series and Mexican remittances. Since the cyclical components could also be related to lags in the series rather than the value of the series in the current period, we included lags of each variable of up to five years. The number of lags was selected on an ad-hoc basis and we observed no significant differences in the results if we added additional lags or used fewer lags. The p-values for the pair-wise correlations between The p-values for Mexican GDP, US GNI, ODA and Foreign Direct Investment in Mexico and Portfolio Investment for bonds and Portfolio Investment and remittances are shown in Table 4 in Appendix F.<sup>3</sup> As noted above, Table 4 shows that the p-values for Mexican GDP and US GNI are not significant with respect to remittances, and that this relationship does not appear to be sensitive to the lags.

Looking solely at the results from the pair-wise correlations in Table 4, we may be inclined to report that Mexican remittances appear to be acyclical with respect to Mexican GDP and acyclical with respect to US GNI. However, the bi-variate nature of the pair-wise correlations does not allow us to control for additional factors and thus we cannot accept that conclusion. In order to make more robust inferences about the relationship between Mexican and US income and Mexican remittances, we conduct two additional statistical tests. We first test for Granger Causality between

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<sup>3</sup>Portfolio Investment for bonds consists of bond issues purchased by foreign investors. Portfolio investment flows are net and consist of non-debt-creating portfolio equity flows (the sum of country funds, depository receipts, and direct purchases of shares by foreign investors.) (World Development Indicators, World Bank)

output and remittances and then estimate a vector autoregression model (VAR) that includes additional variables such as US GNI (Mexican GDP), FDI, ODA and Portfolio Investment in detecting a relationship between Mexican GDP (US GNI) and remittances.

The Granger Causality test should tell us whether the analysis indicates more than just correlations, and may imply the presence of causation. Appendix G shows the Granger Causality tests, with two sets of relationships: between Mexican GDP and remittances and between US GNI and remittances. For both sets of relationships, the test checks whether income causes remittances or whether remittances cause the particular income. The F and p-values for the relationship between Mexican output and remittances are not statistically significant and we cannot prove the presence of Granger Causality in either direction (refer Appendix G, Table 5). The p-values for the null hypotheses that test the relationship between US output and Mexican remittances are also not statistically significant, and we fail to reject the null hypotheses in Appendix G, Table 6. Thus, the tests do not allow us to establish Granger Causality between Mexican output and Mexican GDP or between US GNP and Mexican remittances. While Granger Causality is not the same as true causality, these results reinforce the results obtained in Table 4 and indicate that there is no causal relationship between either Mexican or US income and the remittances received by Mexico.

Though the pairwise correlations and Granger Causality tests do not provide conclusive results regarding the relationship between remittances and Mexican and US income, we are still interested in the direction of these relationships. To give an idea

of directional relationships, we estimated a VAR model and used the coefficients to graph Impulse Response Functions depicted in Appendix H. The impulse response functions (IRFs) included in the appendix show how remittances respond to macroeconomic shocks. Figure H consists of a solid line in the gray area, representing a 95 percent confidence interval. The IRFs display the response of the cyclical components of remittances to a one standard deviation shock to the cyclical components of Mexican income and US income. Panel A of Figure H shows that remittances responds negatively to shocks to Mexican GDP in the first year. After the first period, remittances recover from the shocks to Mexican income and rise, but only reach their initial level (value before the shock) after about ten years. In contrast, Panel B of Figure H shows that remittances rise in response to positive shocks to the US GNI in the first year. The rise in remittances due to shocks to US income is larger than the decline experienced by remittances caused by positive shocks to Mexican income. However, the initial increase in remittances is not sustained beyond the first year and remittances experience a sharp decline in the next two periods before eventually stabilizing at their original level after about ten years.

Overall, shocks to US GNI seem to explain a larger share of variance in remittance receipts than shocks to Mexican GNI. However, remittances tend to eventually stabilize at their original levels after a period of time in both cases and, in this respect, macroeconomic shocks do not appear to have a persistent effect.

## 4.1 Conclusions and Future Work

In this paper we have aimed to study the empirical relationship between remittances received by Mexico and the business cycles of Mexico and the US. After using a number of statistical tests, we found almost no statistical relationship between either Mexican income and remittances or US income and remittances. Although the results obtained from the IRFs (See Figure H) suggest that remittances are countercyclical with respect to Mexican income and procyclical with respect to US income, the effect is not significant or persistent. The results suggest that remittances do not respond to changes in home or host country income, i.e., Mexican GDP and US GNI respectively. This acyclicity of Mexican remittances is a surprising result, as it differs from our hypothesis that the US economy would be a strong driver of remittances.

Our conclusion that remittances are acyclical to both Mexican and US output directly contradicts Sayan and Tekin-Koru's (2007) and Vargas-Silva's finding that remittances are countercyclical to Mexican GDP and Sayan and Tekin-Koru's result that they are pro-cyclical with US GNP. One possible explanation for this discrepancy may be that we use annual instead of quarterly data, meaning that we have fewer opportunities to observe variation in the series, as well as a smaller sample. Further, Mexican migrants in the US may be concentrated in certain sectors or may be engaged in specific economic activities, for example, the construction, agricultural or service sectors (Vargas-Silva). According to this argument, Mexican remittances would show a counter or pro-cyclical relationship with income solely from fluctuations in those sectors and not from the economy as a whole. Therefore, looking at data from

particular sectors may yield better results.

Other ways in which the results could be strengthened would be the addition of other statistical tests and selection of the appropriate parameters for the existing tests. Despite the contradictory results from the literature concerning Mexican remittances from the US, our findings fit in with Roache and Gradzka's generalized findings that remittances can be acyclical to host country income levels. Roache and Gradzka attribute the absence of any relationship between US economic indicators and remittance receipts in Latin American countries to a "remittance smoothing hypothesis", arguing that "remittances would be less volatile than income" (14). This explanation seems to fit our results. The authors claim that "access to financial services" is a prerequisite for stable remittances and this would be more probable for established migrants. Since the Mexico-US corridor is ranked as the "Top Migration Corridor", the quality and quantity of financial services for migrants is likely to be well-developed, thus facilitating stable remittances.

Further, our results support the generally optimistic outlook for remittance flows in times of economic adversity. The World Bank's "Outlook for Remittance Flows 2008-2010" claims that remittances "will exhibit resilience compared to private capital flows and development aid" and that they have declined only slightly thus far this year as a consequence of the economic downturn (Ratha, Mohapatra and Xu 2008). The relative stability of remittances during difficult economic times could only be possible if remittances exhibit acyclical behavior with respect to both home and host country income.

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## A Data Sources

Table 1: List of Variables, Coverage and Sources

Variables	Variable Name	Years	Data Source
Workers' remittances, receipts for Mexico (BoP, deflated to constant 1993 US\$)	remit	1980-2006	WDI
Mexican GDP (constant 2000 US\$)	mxgdp	1980-2006	WDI
Portfolio investment in Mexico, bonds (PPG + PNG) (NFL, deflated to constant 1993 US\$)	pinv1	1980-2006	WDI
Portfolio investment in Mexico excluding LCFAR (BoP, deflated to constant 1993 US\$)	pinv2	1980-2006	WDI
Foreign direct investment, net (BoP, deflated to constant 1993 US\$)	fdi	1980-2006	WDI
Official development assistance (deflated to constant 1993 US\$)	oda	1980-2006	WDI
GDP deflator for Mexico (1993 = base year)	mxdf	1980-2006	WDI
U.S. GNI, Atlas method (deflated to constant 2000 US\$)	usgni	1980-2006	WDI
U.S. GDP deflator (2000 = base year)	usdf	1980-2006	WDI

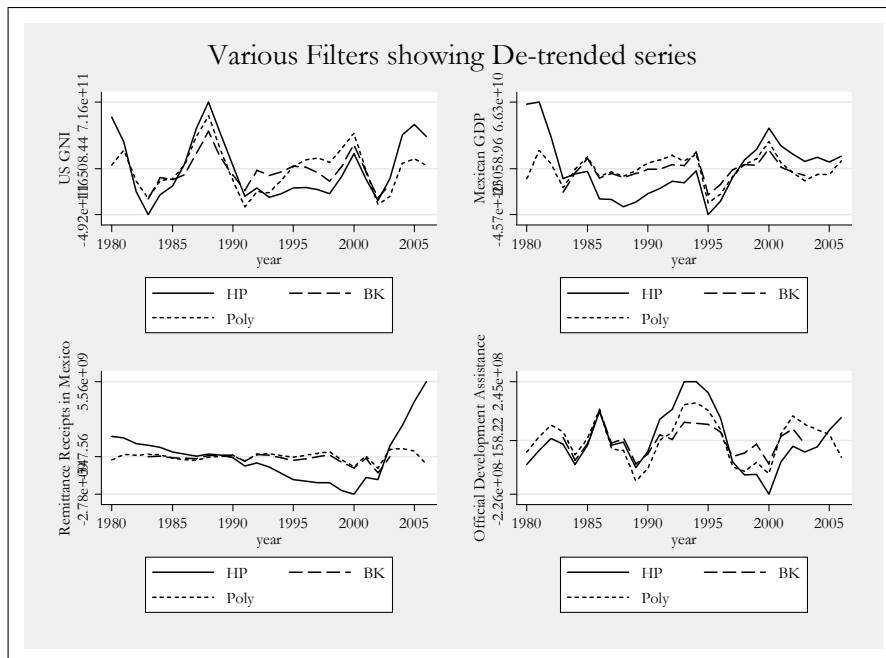
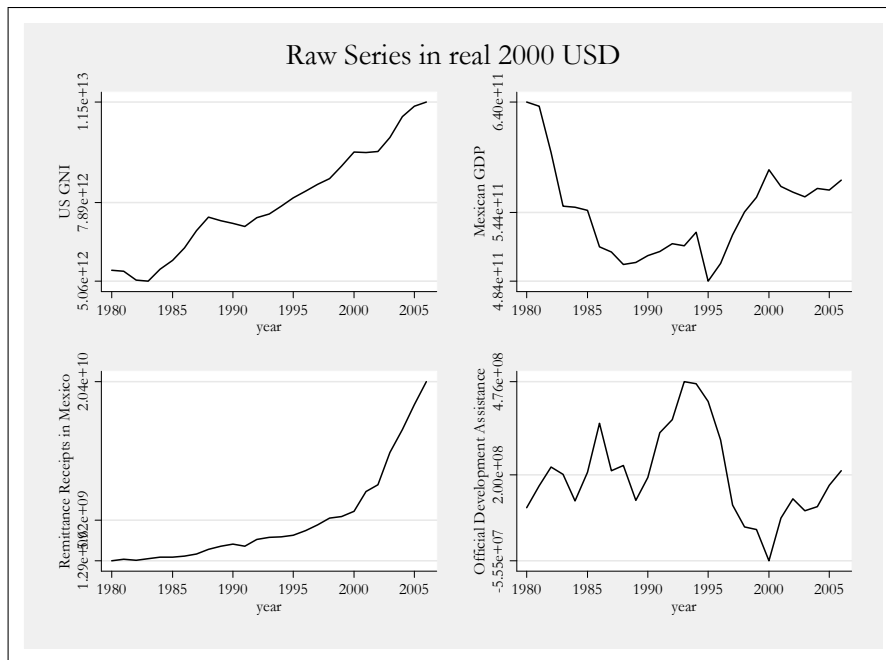
## B Summary of Data

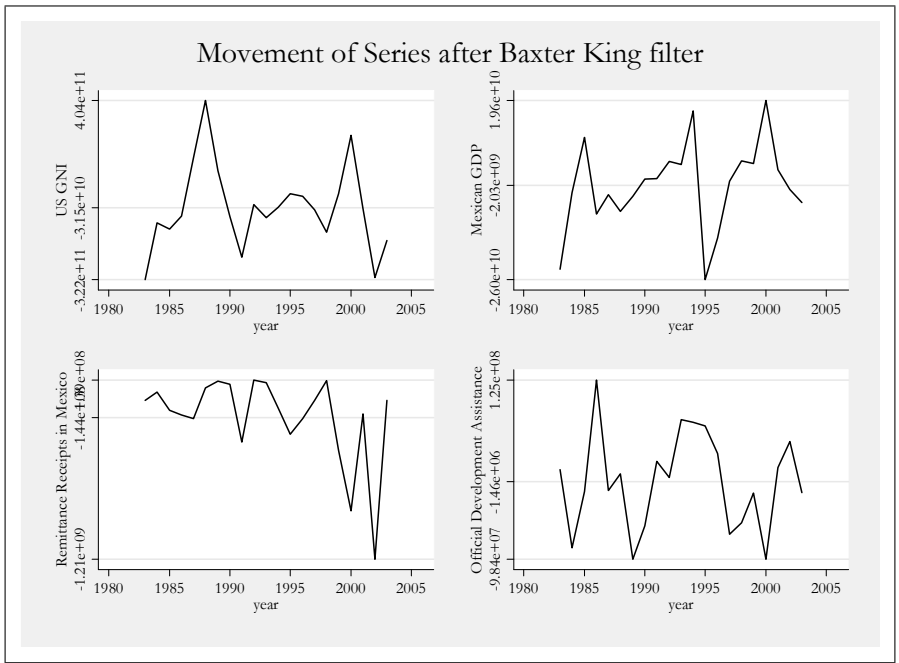
Table 2: Summary of Data, 1980-2006

<b>Variable</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>N</b>
year	1993	7.9373	27
Mexican GDP	544147666666.6668	39761029057.2604	27
US GNI	7888947407407.407	1934418405962.793	27
Remittance Receipts in Mexico	5622869415.7407	5257877821.7315	27
Foreign Direct Investment in Mexico	9062129628.7778	6183784739.4496	27
Official Development Assistance	199913223.8519	133554088.0538	27
Portfolio Invesment, Bonds	898268207.1519	4275168616.9871	27
Portfolio Invesment	4371059798.8419	8761915156.7210	27

*All values are real, constant 2000 USD*

## C Graphs of Data





## D Equations of de-trending filters

### Polynomial detrending approach

The equations described below follow Sayan (2006).

- The objective is to estimate the (unknown) trend of GDP

$$y_t^T = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + \dots + \alpha_k t^k$$

- and remittances by fitting a polynomial of degree  $j$  of the form

$$r_t^T = \beta_0 + \beta_1 t + \beta_2 t^2 + \dots + \beta_k t^k$$

- to the remittance series ( $r_t^T$ ) such that all estimated  $\alpha$  and  $\beta$  coefficients would be statistically significant. Further, once the estimated trend is removed, the remaining series (cyclical component) would be stationary, i.e. would reject the null hypothesis of a unit root.

### Hodrick-Prescott detrending approach (HP Filter)

- The objective is to minimize the following:

$$\sum_{t=1}^T (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2$$

- Where  $y = \log$  of series e.g. GDP

- $\tau$  = trend component of the series

The first term of the equation is the sum of the squared deviations  $d_t = y_t - \tau_t$  which penalizes the cyclical component. The second term is a multiple  $\lambda$  of the sum of the squares of the trend component's second difference. This second term penalizes variations in the growth rate of the trend component. The larger the value of  $\lambda$ , which is also called the "smoothing weight", the higher is the penalty. A smoothing weights of 100 is standard for annual data, 1600 for quarterly data.

For the HP Filter, the smoothing parameter can take on different values. Hodrick and Prescott linked the smoothing parameter or constant to a ratio of variances for use in the H-P filter (1997). They estimated a variance ratio of 1600 for quarterly data and this estimation led to the widespread adoption of 1600 as a default smoothing parameter for quarterly data (Schlicht 99). However, there is no consensus on a parameter for annual data and different authors have employed different values (Backus and Kehoe (1992), Correia, Neves, and Rebelo (1992), Baxter and King (1999), Ravn and Uhlig (1999)). In applied work, scholars have used linear, quadratic or power of four adjustments from the default value of 1600 to derive the smoothing parameter for annual data (Ahumada and Garegnani 263). For the purposes of this paper, we detrended the data using a smoothing parameter of 6.25 as ascertained by Ravn and Uhlig, which is also the default value for the smoothing parameter in the statistical program Stata (Ravn and Uhlig).

## E Unit Root Tests

Table 3: P-values for multiple tests of the unit root, before and after de-trending. (lags=2), detrended using a 5th order polynomial

	Unfiltered	Poly	HP	BK
Mexican GDP	0.31	0.02	0.28	0.01
US GNI	0.39	0.23	0.28	0.13
Remittance Receipts in Mexico	1.00	0.00	1.00	0.00
Official Development Assistance	0.52	0.23	0.50	0.06
Foreign Direct Investment in Mexico	0.60	0.00	0.57	0.01
Portfolio Investment, Bonds	0.26	0.00	0.05	0.00
Portfolio Investment	0.03	0.00	0.02	0.00

The Phillips-Perron test of the unit root calls for a rejection of the null hypothesis of a unit root (stationarity) when the p-value is below a chosen significance level. In this study we have chosen the 95% level. The first column shows the unfiltered data (in real 2000 USD); we can see that we fail to reject the hypothesis of the unit root for every series except the second portfolio investment variable. A glance at this unfiltered variable shows that there is a lot of variation during the time interval, with a steep drop right before 1995, probably corresponding to the Mexican currency crisis. The first column shows that every series except portfolio investment needs to be de-trended. .

Columns 2, 3 and 4 show the p-values of the Phillips-Perron unit-root test for Polynomial Filter (to the 5th order), the Hodrick-Prescott filter, and the Baxter-King Filter respectively. The Baxter-King series, which has been estimated using a lead-lag specification of 3, allows us to reject the null of stationarity in a majority of cases, thus we will use this in our analysis.

Note, however, that none of the de-trending methods are able to rid US GNI of its unit root. We are unsure of what to do about this, perhaps using a higher order polynomial in subsequent iterations of this paper will be necessary.

## F Pairwise Correlations

Table 4: Pairwise correlations and p-values in parentheses for Remittances with five lags. The first six variables are de-trended using the Baxter-King filter

	(t-5)	(t-4)	(t-3)	(t-2)	(t-1)	(t)
Mexican GDP	0.24 (0.41)	0.24 (0.39)	-0.09 (0.74)	-0.57 (0.07)	-0.15 (0.56)	-0.06 (0.82)
US GNI	0.21 (0.48)	0.22 (0.44)	-0.14 (0.60)	-0.16 (0.54)	0.20 (0.43)	0.19 (0.43)
Official Development Assistance	-0.05 (0.86)	0.05 (0.85)	0.17 (0.52)	0.51 (0.04)	-0.13 (0.62)	-0.14 (0.56)
Foreign Direct Investment in Mexico	-0.44 (0.19)	0.31 (0.25)	0.30 (0.27)	-0.05 (0.86)	-0.43 (0.13)	-0.12 (0.63)
Portfolio Investment, Bonds	0.44 (0.11)	-0.14 (0.63)	-0.15 (0.59)	0.28 (0.28)	-0.24 (0.36)	0.12 (0.61)
Portfolio Investment	0.28 (0.25)	-0.02 (0.93)	-0.39 (0.16)	0.04 (0.86)	0.03 (0.90)	0.20 (0.41)

Note that Mexican GDP, US GNI, ODA and FDI have been de-trended using the Baxter-King filter. The second portfolio series has not been de-trended because they don't exhibit unit roots.

## G Granger Causality

Table 5: Granger Causality: Mexican GDP and Mexican Remittances

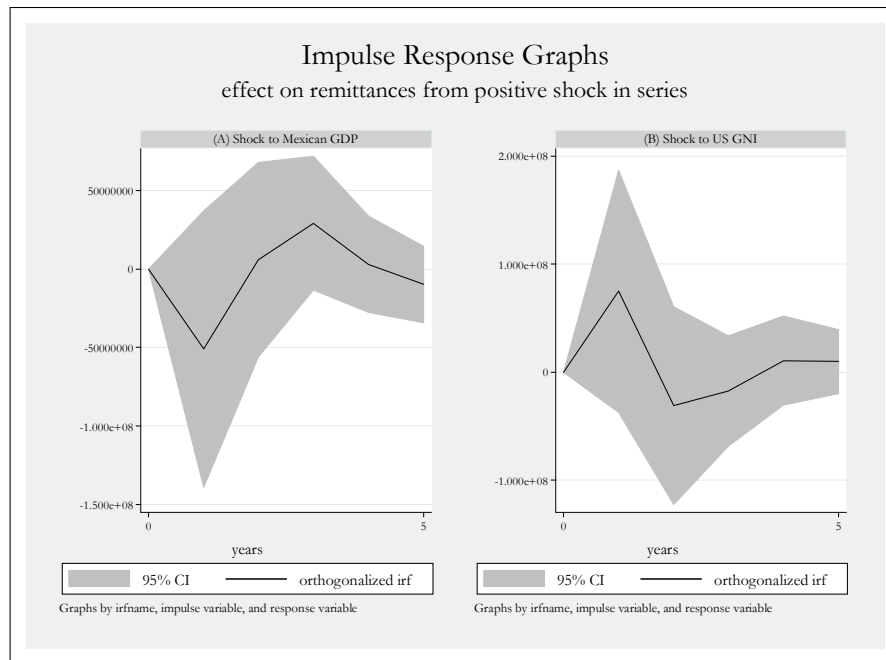
	1984-2006	1984-2006
Null Hypothesis	F-stat (2,12)	p-value
Mexican GDP does not granger cause Mexican Remittances	3.16	0.0792
Mexican Remittances do not granger cause Mexican GDP	0.03	0.9681

Table 6: Granger Causality: US GNI and Mexican Remittances

	1984-2006	1984-2006
Null Hypothesis	F-stat	p-value
US GNI does not granger cause Mexican Remittances	1.09	0.3665
Mexican Remittances do not granger cause US GNI	2.00	0.1780

Note: we have used the F-statistic and the p-value that goes along with that. None of the p-values are significant at the 95% confidence interval, meaning that there appears to be no granger causality in our series. However, we do come close to rejecting the null that Mexican GDP does not granger cause remittances, as is noted in the second row of the first table.

## H Impulse Response Graphs from VAR



The impulse response graphs above come from running a vector auto regression model (VAR) and plotting the response of remittances to a shock in Mexican GDP (on the left hand side) and US GNI (on the right hand side). The x-axis of each of the graphs represents years, and the y-axis represents the magnitude of the shock's response.