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Remittances and the Dutch Disease

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Abstract: Using data for El Salvador and Bayesian techniques, we develop and estimate a two-sector dynamic stochastic general equilibrium model to analyze the effects of remittances in emerging market economies. We find that, whether altruistically motivated or otherwise, an increase in remittance flows leads to a decline in labor supply and an increase in consumption demand that is biased toward nontradables. The higher nontradable prices serve as incentive for an expansion of that sector, culminating in reallocation of labor away from the tradable sector; a phenomenon known as the Dutch disease. Quantitative results also indicate that remittances improve households' welfare as they smooth income flows and increase consumption and leisure levels. A Bayesian vector autoregression analysis provides results that are consistent with the dynamics of the model.

JEL classification: F40 F41 O10

Key words: Dutch disease, real exchange rate, remittances

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Remittances and the Dutch Disease

1 Introduction

The magnitude, as well as the growth rate, of remittances received by several developing countries has exceeded the inflow of official aid and private capital in recent years. In fact, the amount of remittances in 2007 was estimated at about 2.1% of GDP in the developing world. Although they have helped to reduce absolute poverty, improve human capital indicators and reduce inequality (Fajnzylber and López, 2008), the magnitude of remittance flows has raised critical questions with respect to their undesirable effects on the recipient economies. These issues are similar to those that emerged during periods of massive capital inflows to the region. In particular, there is a concern about whether remittances could cause Dutch disease effects in these countries. The massive inflow of foreign currency could be associated with a real exchange rate appreciation and loss of international competitiveness, which in turn could lead to a decline in the production of manufactures and other tradable goods.

The existing research on remittances has predominantly centered on the microeconomic aspects, with a scanty treatment of their macroeconomic implications. In this paper, we use a dynamic stochastic general equilibrium (DSGE) model of a small open economy to analyze the effect of remittances on resource reallocation and the real exchange rate. On the estimation side, we take the Bayesian approach and use macroeconomic data for El Salvador, a country for which remittances amounted to 18.4% of GDP in 2008. We consider the scenario where remittances are strictly independent of conditions in the domestic economy, as well the case where remittances are countercyclical, and hence endogenously determined. Here, a novel microfounded optimizing framework justifies such a countercyclical pattern. These together represent the case where remittances are altruistically motivated. We also examine the case where remittances act like capital inflows, driven by the remitter's desire to invest in the domestic economy. The intuition here is that domestic households are just intermediaries that channel funds from home-born foreign residents. Although the results are quantitatively different depending on the motivation to remit, they generally suggest that remittance inflows lead to the realization of the Dutch disease phenomenon under each of the cases considered.

Furthermore, we evaluate the welfare implications of remittances within the confines of the model. The optimization framework indicates that the decline in the labor supply and the increase in consumption that leads to the reallocation of resources towards the nontradable sector is the household's optimal response to the increase in disposable income. In addition, we show that the countercyclical nature of altruistic remittances improves welfare as they may serve as a substitute for contingent claims in smoothing consumption.

As a second stage of this study, we consider a Bayesian Vector Autoregression (BVAR) analysis using the well-known Minnesota prior. The aim is to see whether the observed dynamics derived from the estimated theoretical model are consistent with the ones from a non-theoretical VAR model estimated from the same data. Our preferred econometric technique addresses the issue of small sample size and does not a priori impose a particular structure on the remittance generation process i.e. whether they are exogenous, countercyclical or self-interested. We show that the VAR evidence matches well with the implications of the theoretical model.

2 Dutch Disease and Related Literature

Theoretical analyses of Dutch disease effects of capital inflows in small open economies have largely been based on the dependent economy model, also known as the 'Salter-Swan-Corden-Dornbusch model'.[1] Within this framework, the higher disposable income triggers an expansion in aggregate demand, which for exogenously given prices of tradable goods, culminates in higher relative prices of nontradable goods (spending effect) that corresponds to a real exchange rate appreciation. The higher nontradable price leads to an expansion of the nontradable sector causing a further reallocation of resources toward the nontradables (resource movement effect). In this context, we also consider an additional transmission mechanism: remittances tend to increase household income and thus result in a decrease in the labor supply. A shrinking labor supply is associated with higher wages (in terms of the price of tradable output), that in turn leads to higher production costs and a further contraction of the tradable sector.

Figure 1 shows the evolution of the real exchange rate and the tradable-nontradable ratio for a group of high remittance-recipient countries.[2] In these countries, there seems to be a positive relationship between remittance flows and real exchange rate appreciation, as well as a negative relationship between remittances and tradable-nontradable output ratio. Due to limitations on the availability of high frequency and time series data for majority of countries, we focus on a business cycle analysis of El Salvador.

There are differences in views on the motivation to remit; one group argues that remittances are altruistically motivated whereas others argue that they are mostly driven by selfish reasons including the exploitation of investment opportunities (Lucas and Stark, 1985). Self-interested will thus tend to be procyclical (Giuliano and Ruiz-Arranz, 2006). From a macroeconomic perspective, Chami et al (2006) use

[1] See Corden and Neary (1982) for details. Lartey (2008) models 'Dutch Disease' effects in a real business cycle framework.

[2] Countries included are El Salvador, Barbados (remittances representing 4.3% of GDP in 2003), Jordan (22.3%), Lesotho (25.3%), Mauritius (4.1%), and Sri Lanka (7.8%). The real exchange rate is the real effective exchange rate index provided by the International Financial Statistics. Base year is1995. Tradable/ Nontradable ratio is the sum of agriculture and manufacturing output over services' output (as a share of GDP).

a general equilibrium framework to study the impact of countercyclical remittances on government policy in a one-sector closed economy context. Loser et al (2006) present a discussion of remittances and Dutch disease using a descriptive IS-LM-BP textbook model. Durdu and Sayan (2007) show that countercyclical (procyclical) remittances mitigate (deepen) sudden stops.[3]

Empirical studies that are related to this study include Amuedo-Dorantes and Pozo (2004), Rajan and Subramanian (2005), and Winters and Martins (2005), all of which use cross-country data to document that real exchange appreciation follows remittance flows. Lartey et al (2008) also show that these flows lead to a resource reallocation towards nontradables. Finally, Acosta (2006), Fajnzylber and López (2008), Funkhouser (1992), and Hanson (2007) in Mexico report that remittances reduce households' labor supply.[4]

3 The Model

3.1 Households

The description of the household is conventional; there is a continuum of households of unit mass. The household has preferences over real consumption C_t and labor effort L_t supplied in a competitive market. It decides on bonds and shares to take into the next period, amount of tradable and nontradable goods to consume, and labor effort to supply.

Consumption composites The household's consumption index, C_t, is given by the composite: $C_t = \left[(\gamma_c)^{\frac{1}{\rho_c}}(C_{N,t})^{\frac{\rho_c-1}{\rho_c}} + (1-\gamma_c)^{\frac{1}{\rho_c}}(C_{T,t})^{\frac{\rho_c-1}{\rho_c}}\right]^{\frac{\rho_c}{\rho_c-1}}$ which comprises nontradable consumption, $C_{N,t}$ and tradable consumption, $C_{T,t}$. $\gamma_c \in [0,1]$ is the share of nontradables in total consumption, and $\rho_c > 0$ denotes the elasticity of substitution.

The consumer price index is $P_t = \left[\gamma_c (P_{N,t})^{1-\rho_c} + (1-\gamma_c)(P_{CT,t})^{1-\rho_c}\right]^{\frac{1}{1-\rho_c}}$ where $P_{N,t}$ is the price of the nontradable good, and $P_{CT,t}$ is the price of the tradable consumption good, all expressed in units of the domestic currency.

The tradable consumption good is a composite of home, $C_{H,t}$, and foreign, $C_{F,t}$, tradable goods, $C_{T,t} = \left[(\gamma_h)^{\frac{1}{\rho_h}}(C_{H,t})^{\frac{\rho_h-1}{\rho_h}} + (1-\gamma_h)^{\frac{1}{\rho_h}}(C_{F,t})^{\frac{\rho_h-1}{\rho_h}}\right]^{\frac{\rho_h}{\rho_h-1}}$, where $\gamma_h \in [0,1]$ is the share of home goods in tradable consumption. The elasticity of substitution is $\rho_h > 0$. The corresponding price index is $P_{CT,t} = \left[\gamma_h + (1-\gamma_h)(P_{CF,t})^{1-\rho_h}\right]^{\frac{1}{1-\rho_h}}$, where $P_{CF,t}$ is the price of the foreign tradable consumption good. The price of the domestic tradable good serves as the numeraire. Since we are conducting the analysis in terms

[3] Remittances could also promote entrepreneurial activities by relaxing liquidity constraints. See Funkhouser (1992) and Yang (2008).

[4] Yang (2008) shows shocks resulting in real exchange rate depreciation increase remittances but do not significantly affect the labor supply of recipient households.

of real variables only, we normalize the nominal exchange rate to a value of unity.

The Household's Problem The household's utility function is represented by Cobb-Douglas preferences featuring an endogenous subjective rate of time preference, and given by:

$$E_0 \left\{ \sum_{t=0}^{\infty} \exp\left[-\sum_{\tau=0}^{t-1} \kappa \log(1 + C_t^{(1-\omega)}(1-L_t)^{\omega}) \right] u(C_t, L_t) \right\}, \; u(C_t, L_t) = \frac{\left[C_t^{(1-\omega)}(1-L_t)^{\omega} \right]^{1-\gamma} - 1}{1-\gamma}. \quad (1)$$

The budget constraint is:

$$P_t C_t + v_t x_{t+1} \leq (v_t + d_t) x_t + w_t L_t + P_{CF,t}(\Xi_t^c + \Xi_t^d) - B_t + q B_{t+1}. \quad (2)$$

The representative household enters each time period t with shares x_t of the production unit of the tradable sector purchased from the previous period, all denominated in units of the domestic tradable good. The household earns a return $(v_t + d_t)$ on shares held from the previous period; v_t is the period t price of a claim to the tradable sector firm's entire future profit, and d_t is period t dividends issued by the firm. Ξ_t^c are altruistic remittances received from home-born foreign residents that have close family ties with the domestic household, Ξ_t^d are altruistic remittances received from individuals with distant family ties, and w_t are wages in terms of the domestic tradable output.[5] We assume that international financial transactions are restricted to one period, risk-free bonds. The level of debt due in period t is denoted B_t, and $q = 1/(1+r)$ is the time t price of debt due in period $t+1$. r is the world interest rate, which in this model is assumed to be a constant. With these preferences, the lifetime marginal utility includes an "impatience effect", by which an increase in consumption alters the subjective discount rate applied to the entire future utility stream.[6]

The optimality conditions for bonds, shares, consumption and labor supply respectively are:

$$1 = \exp\left[-\kappa \log(1 + C_t^{(1-\omega)}(1-L_t)^{\omega}) \right] E_t \left[\frac{\lambda_{t+1}}{\lambda_t}(1+r)\frac{P_t}{P_{t+1}} \right], \quad (3)$$

$$v_t = \exp\left[-\kappa \log(1 + C_t^{(1-\omega)}(1-L_t)^{\omega}) \right] E_t \left[\frac{\lambda_{t+1}}{\lambda_t}(v_{t+1} + d_{t+1})\frac{P_t}{P_{t+1}} \right], \quad (4)$$

[5] A detailed description of the two types of altruistic remittances is provided in section 3.3.

[6] This type of preferences where introduced by Mendoza (1991) and play a determinant role in small open economies that feature incomplete insurance markets, since foreign asset holdings diverge to infinity with the standard assumption of an exogenous rate of time preference. Other methods include transaction costs in foreign assets and ad-hoc interest rates that depend on the stock of foreign debt. Although these alternatives are suitable in log-linear applications, this equivalence is unlikely to hold in models that aim to capture non-linear adjustments (Arellano and Mendoza, 2002). We assume that the endogenous discount factor does not depend on the agent's own consumption and effort, but on the average per-capita level of these variables.

$$\frac{C_{N,t}}{C_{T,t}} = \frac{\gamma_c}{1-\gamma_c}\left(\frac{P_{N,t}}{P_{CT,t}}\right)^{-\rho_c}, \frac{C_{H,t}}{C_{F,t}} = \frac{\gamma_h}{1-\gamma_h}\left(\frac{1}{P_{CF,t}}\right)^{-\rho_h}, \tag{5}$$

$$\frac{\omega}{1-\omega}\frac{C_t}{(1-L_t)} = \frac{w_t}{P_t}; \tag{6}$$

where the marginal utility of the consumption index is: $\lambda_t = (1-\omega)C_t^{(\gamma-1)(\omega-1)-1}(1-L_t)^{\omega(1-\gamma)}$.

GHH preference specification The utility function described in the previous section implies that labor supply is affected by changes in household wealth. As a variant, we also consider a Greenwood, Hercowitz and Huffman (GHH) quasi-linear preference specification as in Mendoza (1991):

$$E_0\left\{\sum_{t=0}^{\infty}\exp\left[-\sum_{\tau=0}^{t-1}\kappa\log(1+C_t-\tau\frac{{L_t}^{\nu}}{\nu})\right]u(C_t,L_t)\right\}, \text{ where } u(C_t,L_t) = \frac{\left[C_t-\tau\frac{{L_t}^{\nu}}{\nu}\right]^{1-\gamma}-1}{1-\gamma}.$$

This specification enables us to examine a key transmission mechanism documented in the literature, that remittances tend to increase household income and result in a decrease in the labor supply that in turn amplifies the Dutch disease effects. GHH style preferences mute the income effect governing labor supply decisions in that higher levels of consumption do not reduce the incentive to work. We abstract from the derivation of the entire solution of the household's behavior with these preferences here, and highlight the key implication: that the interjection of this preference specification results in a modification of the equation describing the marginal rate of substitution between consumption and leisure, resulting in the following optimality condition: $\tau {L_t}^{\nu-1} = \frac{w_t}{P_t}$ that replaces equation (6) in the original formulation.

3.2 Firms

Both the tradable and nontradable goods are supplied in competitive domestic markets. Factor demands are determined in a perfectly competitive fashion as well. The investment unit solves a cost minimization problem to determine demands for raw domestic and specific foreign investment inputs, whereas the optimal level of total final investment is determined by the production unit. Capital acquisition is subject to adjustment costs and hence implies a forward-looking behavior. The capital stock K_t changes according to $K_{t+1} = I_t + (1-\delta)K_t$, where δ is the depreciation rate. Labor can migrate instantaneously between sectors within the economy. This ensures the household faces the same wage w_t in each sector. The total domestic labor supply is $L_t = L_{T,t} + L_{N,t}$, where $L_{T,t}$ is labor devoted to the tradable sector and $L_{N,t}$ denotes labor in the nontradable sector. We assume a unit of tradable good can be transformed into a unit of raw investment without incurring any costs.

3.2.1 Tradable Sector

Investment Unit The investment unit combines domestic raw investment $I_{H,t}$, and the specific foreign investment good $I_{F,t}$ to produce investment I_t. In order to associate self-interested remittances with capital inflows, we assume without loss of generality, that firms in the investment unit can be managed by home-born foreign residents.[7] Constant returns to scale technology allows us to express the production function in aggregate terms as follows: $I_t = \left[(\gamma_i)^{\frac{1}{\rho_i}} (I_{H,t})^{\frac{\rho_i-1}{\rho_i}} + (1-\gamma_i)^{\frac{1}{\rho_i}} (I_{F,t})^{\frac{\rho_i-1}{\rho_i}}\right]^{\frac{\rho_i}{\rho_i-1}}$, where $\rho_i > 0$, and $0 < \gamma_i < 1$. Associated with this investment technology is a minimized unit-cost function denoted $P_{I,t}$, the replacement cost of capital which depends on $P_{IF,t}$, which is the price of the imported investment good in units of domestic currency. For any given rate of investment, I_t, the firm's minimization problem is as follows:

$$\min_{\{I_H, I_F\}} I_{H,t} + P_{IF,t} I_{F,t} \;\; s.t. \;\; \left[(\gamma_i)^{\frac{1}{\rho_i}} (I_{H,t})^{\frac{\rho-1}{\rho}} + (1-\gamma_i)^{\frac{1}{\rho_i}} (I_{F,t})^{\frac{\rho_i-1}{\rho_i}}\right]^{\frac{\rho_i}{\rho_i-1}} \geq I_t.$$

The optimization yields demands for home and foreign investment as: $I_{H,t} = \gamma_i \left(\frac{1}{P_{I,t}}\right)^{-\rho_i} I_t$, $I_{F,t} = (1-\gamma_i)\left(\frac{P_{IF,t}}{P_{I,t}}\right)^{-\rho_i} I_t$, where γ_i is the share of investment expenditure on the domestic component of investment, ρ_i is the elasticity of substitution between home and foreign investment, and $P_{I,t}$ is the minimum unit cost function for I_t, which is expressed as $P_{I,t} = \left[\gamma_i + (1-\gamma_i)(P_{IF,t})^{1-\rho_i}\right]^{\frac{1}{1-\rho_i}}$.

Production Unit The production unit produces a tradable good $Y_{T,t}$ according to the following constant returns to scale technology, $Y_{T,t} = a_t^T K_t^{\alpha} L_{T,t}^{1-\alpha}$, where a_t^T is an exogenous productivity shock in the tradable sector.[8] The unit solves the maximization problem by which total final investment is determined. The installation cost of capital, measured in terms of the tradable good, is given by: $\frac{\phi}{2}\left(\frac{I_t}{K_t} - \delta\right)^2 K_t$, where ϕ governs the size of the installation cost. The installation cost is applicable only to net investment I_t^n, which is defined as: $I_t^n = K_{t+1} - K_t = I_t - \delta K_t$. It maximizes the present discounted value of dividends:[9]

$$E_t \sum_{s=t}^{\infty} \Omega_s \left[Y_{T,s} - P_{I,s}\left(I_s + \frac{\phi}{2}(\frac{I_s}{K_s} - \delta)^2 K_s\right) - w_s L_{T,s}\right], \tag{7}$$

subject to, $K_{t+1} = I_t + (1-\delta)K_t$.

[7] Since input and output markets for the investment unit are perfectly competitive, and production of the aggregate investment good takes place according to constant returns to scale; the equilibrium allocations are the same regardless of the ownership status.

[8] Yang and Choi (2007) present evidence on how agricultural shocks affecting the tradable sector (in their case, rainfall) are good predictors of migration and remittances' volatility in rural areas in Philippines.

[9] The value of the production unit is obtained by deriving equation (7) from (4): $v_t = E_t \sum_{s=t}^{\infty} \exp\left[-\kappa \log(1 + C_t^{\omega}(1-L_t)^{\omega})\right]^{s-t} \frac{\lambda_{t+1}}{\lambda_t} \frac{P_t}{P_{t+1}} d_s$, where $\exp\left[-\kappa \log(1 + C_t^{\omega}(1-L_t)^{\omega})\right]^{s-t} \frac{\lambda_{t+1}}{\lambda_t} \frac{P_t}{P_{t+1}} = \Omega_s$ for $s = t, t+1, t+2, ...$ is the stochastic discount factor; and $d_s = Y_{T,s} - P_{I,s}\left(I_s + \frac{\phi}{2}(\frac{I_s}{K_s} - \delta)^2 K_s\right) - w_s L_{T,s}$ is dividends. In the case of GHH style preferences, the discount factor is adjusted to reflect that specification.

The optimality conditions for $K_{t+1,}$ I_t and $L_{T,t}$ respectively are:

$$E_t\Omega_{t+1}\left(\alpha\frac{Y_{T,t+1}}{K_{t+1}}-P_{I,t+1}\left[\frac{\phi}{2}(\frac{I_{t+1}}{K_{t+1}}-\delta)^2-\phi(\frac{I_{t+1}}{K_{t+1}}-\delta)\frac{I_{t+1}}{K_{t+1}}\right]+\lambda_{I,t+1}(1-\delta)\right)=\lambda_{I,t}, \tag{8}$$

$$P_{I,t}\left(1+\phi(\frac{I_t}{K_t}-\delta)\right)=\lambda_{I,t}, \tag{9}$$

$$(1-\alpha)\frac{Y_{T,t}}{L_{T,t}}=w_t. \tag{10}$$

The Euler equation (8) describes the evolution of $\lambda_{I,t}$, the shadow price of a unit of capital. Equation (9) shows that net investment equals zero when the shadow value of a unit of capital, $\lambda_{I,t}$ equals its replacement cost (i.e. the price of new uninstalled capital, $P_{I,t}$).

3.2.2 Nontradable Sector

The nontradable good firm produces output with a simple technology linear in labor and described by: $Y_{N,t}=a_t^{NT}L_{N,t}$, where a_t^{NT} is a technology innovation in the nontradable sector. The static efficiency condition for the choice of labor demand is: $P_{N,t}\frac{Y_{N,t}}{L_{N,t}}=w_t$.

3.3 Remittances

Altruistic Remittances Foremost, we assume that home-born foreign residents with close family ties in the domestic economy regularly send transfers of tradable consumption goods to domestic households, the remittances being independent of domestic economic conditions. Several reasons can account for fluctuations in remittances flows over time. An example would be a productivity improvements in a sector of the foreign economy where a migrant is employed. The variation in the value of asset holdings or changes in the legal and administrative requirements regarding transfer of funds from abroad could also be plausible explanations. However, since this is a small open economy model, variables that are determined abroad are taken as given. In steady state, altruistic remittances represent a percentage of total output, and we specify close ties remittances as following an exogenous stochastic process, $\tilde{\Xi}_t^c$.

Distant ties remittances are instead countercyclical. The intuition is as follows: we assume that a fraction of the home-born foreign residents have distant ties with their families, hence they send resources only if they consider that these households are about to face severe economic hardship. We show that the evolution of this macroeconomic variable may be characterized by: $\tilde{\Xi}_t^d=(Y_t)^\eta$, where $\eta<0$ is the elasticity of aggregate remittances with respect to aggregate output, which depends on the uncertainty remitters with distant ties face.[10]

Self-Interested Self-interested remittances behave as any other capital inflow, driven by selfish reasons and reflecting the remitters' desire to invest in the home country. Domestic households could therefore be viewed as merely intermediaries that just channel funds from home-born foreign residents who use their savings to take advantage of local opportunities. We assume that a fraction μ of the finance of the foreign investment good $I_{F,t}$, is categorized as self-interested remittances ($\Xi_t^{si} = \mu I_{F,t}$).

3.4 Resource Constraints, The Foreign Economy and Shock Processes

The following equations characterize the resource constraints of the economy: $Y_{T,t} = C_{T,t} + I_{H,t} + X_t$, $Y_{N,t} = C_{N,t}$, and $Y_t = Y_{T,t} + P_{N,t}Y_{N,t}$, where X_t is the component of tradable sector output that is exported and Y_t is aggregate output.

The small open economy can neither affect foreign prices nor foreign output, and thus takes these variables as given. The real exchange rate e_t, is defined as the ratio of the price of foreign consumption basket to the domestic one: $e_t = \frac{P_{F,t}}{P_t}$, where $P_{F,t}$ is the foreign consumer price index in units of foreign currency. From the description of the consumption composites, it can be observed that a rise in the relative price of domestic nontradables leads to an appreciation of the real exchange rate (e_t decreases).[11] The price of the foreign investment good, $P_{IF,t}$, serves to pin down the evolution of foreign capital inflow (and therefore self-interested remittances). It follows a exogenous stochastic process. [12] Following Gertler et al (2006), we postulate an empirically reasonable reduced-form export demand curve: $X_t = e_t^{\xi} Y_t^F$; $\xi > 0$, where Y_t^F is aggregate output in the foreign economy. The current account equation for the domestic economy in real terms is: $CA_t = -rB_t + \Xi_t + X_t - P_{CF,t}C_{F,t} - P_{IF,t}I_{F,t}$. Aggregate Remittances, $\Xi_t = P_{CF,t}(\Xi_t^c + \Xi_t^d) + P_{IF,t}\Xi_t^{si}$ are direct transfers that positively enter in the current account. We impose a balanced current account in steady-state ($CA = 0$).

The structural shocks are assumed to follow a first-order autoregressive, $AR(1)$, process with an i.i.d. normal error term: $\hat{\imath}_{t+1} = \epsilon_0(\hat{\imath}_t)^{\eta_i} \exp(\epsilon_{\hat{\imath},t+1})$, $0 < \eta_{\hat{\imath}} < 0$, $\epsilon_{\hat{\imath}} \sim N(0, \sigma_{\hat{\imath}})$ where $\hat{\imath} = \left\{ a^T, a^{NT}_{,} P_{IF,} \tilde{\Xi}_t^c \right\}$

[10] See appendix A for the derivation.

[11] By definition, the real exchange is $e_t = \frac{\varepsilon_t P_{F,t}}{P_t}$, where ε_t is the nominal exchange rate, which is equal to one.

[12] The evolution of the price of the foreign tradable composite is assumed to be as follows $P_{TF,t} = \left[\gamma_F \left(P_{IF,t}\right)^{1-\rho_F} + (1-\gamma_F)\left(P_{CF,t}\right)^{1-\rho_F}\right]^{\frac{1}{1-\rho_F}}$, such that $\gamma_F \in [0,1]$ and $\rho_F > 0$. $P_{F,t}$ is a composite of this price and the price of foreign nontradable consumption that we assume given. An increase in the availability of foreign consumption goods (for instance, following an inflow of remittances), will necessarily lead to a decline in the price of foreign tradable consumption in terms of the home tradable (which serves as the numeraire). That is, $P_{CF,t}$ is endogenously determined.

4 The Bayesian Estimation

The Bayesian estimation technique uses a general equilibrium approach that addresses the identification problems of reduced-form models (see An and Schorfheide, 2007, for a survey), and outperforms GMM and maximum likelihood methods in small samples (Fernández-Villaverde and Rubio-Ramírez, 2004). This last argument is of particular importance in this case, as the number of available observations for El Salvador is 62 (using quarterly data, from 1991Q1 to 2006Q2).[13] The data we use features key macroeconomic variables including real output, nontradable output, remittances, and the real exchange rate. Variables are linearly detrended and transformed in $\Delta \ln$ to express them in growth rates.[14]

Calibration Some parameters are kept fixed from the start of the calculations to address identification issues; others can be linked to steady-state values and are calibrated to roughly match sample means. We set the international real interest rate to 4 percent annually. We assign the conventional values of 0.33 and 0.03 to the capital share, α, and depreciation rate, δ, respectively. When considering the case of GHH style preferences, we follow Mendoza (1991) and fix ν at 1.455. We cannot disaggregate the final demand for tradable output. Consequently, we rely on standard values observed in the small open economy literature. As in Devereux et al (2006), the share of nontradable good in the consumption basket, γ_c, is fixed at 0.55. The share of employment in the nontradable sector is 60 percent. We follow Gertler et al (2006) and set the value for the share of raw home investment in the investment good composite, γ_i, at 0.5. Remittances expressed as a share of total output is 16 percent in steady-state; and we fix γ_F and ρ_F, at 0.7 and 0.1, respectively. Finally, we assume that the share of home tradables in tradable consumption, γ_h, is set to 0.4 and κ is fixed at 0.0248 so that in steady-state the current account is balanced. [15] It is not possible to identify μ, the fraction of foreign direct investment financed with self-interested remittances. If we calibrate μ to be relatively large, a sizable fraction of the remittances will be procyclical by construction, and therefore we will probably force the model to deliver a relatively large value for η (in absolute terms). That is, we may force the model to overestimate the countercylicality of distant ties remittances (and the insurance they provide) to better match the data. Since we want to emphasize this insurance mechanism, we are cautious

[13] Refer to Acosta et al (2009) for a comprehensive discussion of the estimation methodology.

[14] The real exchange rate is defined as nominal exchange rate * US CPI / El Salvador CPI. For robustness, we used alternative measures of this variable in the computations (such as the nominal exchange rate*PPI / CPI) . Since results are similar we choose not to report them. Output is real GDP; and nontradable output = utilities + real state + retail + transport + banking + other services (each sector is a different component of total GDP). Remittances are expressed in millions of USD (1991) and are seasonally adjusted using TRAMO-SEATS with outlier detection and correction. Variables are expressed in growth rates. Since the number of observables has to be the same than the number of shocks we include the terms of trade in the observables.

[15] In order to achieve identification, in the baseline estimation we assume that total altruistic remittances are equally split between distant and close ties. For robustness, we later proceed with an impulse response analysis where remittances shocks are have either a distant or close ties specification.

and choose a relative low value for μ, which equal to 0.05.[16]

Prior distributions The shapes of the densities are selected to match the domain of the structural parameters, and we deduct mean and distribution priors from a certain range of parameter estimates that can be found in the literature. All the variances of the shocks are assumed to possess an Inverse Gamma distribution with a degree of freedom equal to 2. This distribution delivers a positive variance with a rather large domain. The distribution of the autoregressive parameters in the shocks is assumed to follow a Beta distribution that covers the range between 0 and 1. However, we select a rather strict standard error, and thus precise prior mean in order to obtain a clear separation between persistent and non-persistent shocks (Smets and Wouters, 2003). The stochastic processes are harmonized (Smets and Wouters, 2007). For the rest we consider either a Normal distribution or a Gamma distribution when the support is restricted to positive real numbers. Table 1 presents the summary statistics.

As argued above, in order to get more reliable estimates of η, the parameter that characterizes the cyclical pattern of the remittances with distant ties, on the one hand we establish a flat prior across a wide range of possible values and on the other hand, a relative precise prior for the persistence of close ties remittances that are exogenously determined. There are no priors in the literature that can serve as a starting point. Given these circumstances, the mean for the prior of η is the result of trials with a very weak prior (Smets and Wouters, 2003). We choose a rather loose prior for the elasticity of substitution between tradable and nontradable consumption, ρ_c, foreign and home tradable, ρ_h and home and foreign investment, ρ_i. The values reflect the thought that consumption goods have a higher degree of substitution than intermediates, and that home and foreign tradables have a relative higher degree of substitution than do tradables with nontradables.

Estimation results (posterior distributions) The last five columns of Table 1 report the posterior mean, mode, and standard deviation obtained from the Hessian, along with the 90 % probability interval of the structural parameters. The specified priors are in general pretty informative. The posterior means of $\rho_c, \xi, \gamma, \phi, \rho_h, \rho_i$ are $0.39, 1.12, 2.06, 2.25, 0.55,$ and 0.20, respectively. We obtain a sizeable and relatively precise negative estimate for $\eta = -2.253$ in spite of the loose prior, confirming our countercyclical remittances prior. Regarding the shocks, we find that the shock to the foreign investment price is relatively persistent and that the volatility of exogenous remittances is particularly high. The estimate for $\sigma_{\tilde{\Xi}_c}$ is 0.078, which is significantly larger than the prior (0.01). Table 2 reports the estimates of the posterior mode and standard deviation for the model with GHH preferences. The results, in general, are similar. However, we find that

[16] As discussed later, with this benchmark, the posterior mode for η is -2.253 . If, for instance, we had fix $\mu = 0.50$, the posterior mode for η would be -2.5604.

technology shocks in the nontradable sector are significantly more persistent, and therefore more relevant in driving the business cycle when we use the GHH specification. One possible interpretation is that since nontradable output is linear in labor effort, when we supress the income effect of the labor supply, we force the model to overestimate the exogenous innovation to nontradable output in order to better match such data series.

5 Impulse Response Analysis

5.1 Exogenous altruistic Remittances (close ties)

Figure 2 reports the impulse response functions (median and confidence sets) following a one standard deviation shock to exogenous remittances. The increase in household's disposable income results in a decrease in the amount of labor supplied. A shrinking labor supply is associated with relatively higher real wages. Households' income increases as a result of remittances and higher wages, which leads to an increase in consumption demand. In response to that, the relative price of nontradable output, which is labor-intensive and has final consumption as its sole destination, significantly increases due to higher production costs and an increase in consumption demand. This in turn leads to an expansion in nontradable output, reallocating labor away from the tradable sector into the nontradable sector. The increase in the relative price of nontradables represents an appreciation of the real exchange rate. This real appreciation negatively impacts foreign demand for the home tradable, contributing to a further deterioration in the demand for tradables.

The behavior of investment is determined by two offsetting effects. First, a shrinking labor supply, higher wages and an appreciated real exchange rate negatively affect the productivity of capital. Second, an increase in households' consumption demand increases the demand for the home tradable. This, along with the possibility of substituting the relatively expensive labor with capital, positively affect investment demand. The net effect of these counteracting pressures is a slight increase in the capital accumulation on impact. For robustness, the responses of some key variables to a permanent shock to the level of remittances are presented in Figure 3. Fundamentally, the results indicate the same dutch-disease effects explained previously, with the distinction that, in this scenario, such effects are persistent through time.[17]

GHH Specification A key factor underlying the mechanism that propagates the Dutch Disease phenomenon is the negative labor supply effect following an increase in remittances. The GHH style preferences mute the income effect governing the labor supply decision. In Figure 4, we plot the model's response to a

[17] The long-lasting nature of the increase in remittances has slightly different implications. The permanent nature of the shock results in a persistent decrease in the labor supply which leads to a substantial decrease in the capital stock accumulation as its productivity declines.

temporary increase in remittances under the baseline preferences and the GHH style preferences. As household consumption increases, wages also increase; and GHH-type specification implies that the increase in wages is associated with an increase in the labor supply. In effect, increasing employment reduces wage-induced inflationary pressures on impact and the fall in productivity of the tradable sector and appreciation of the real exchange rate is moderate. The spending effect and the resource movement effect that characterize the Dutch Disease phenomenon are therefore robust to GHH style preferences, but in comparison to the baseline specification, the resource movement is such that the eventual decline in employment in the tradable sector is smaller, while the expansion of nontradables sector labor is larger. Although the labor employed in the tradable sector contracts, tradable output slightly increases, as a result of the more capital intensive production structure that eventually also supports higher wages.

To assess the quantitative relevance of the labor supply effect, we consider the difference between the log marginal likelihood of the GHH model with respect to the baseline Cobb-Douglas specification that includes the wealth effect of the labor supply. The difference between the Cobb Douglas and the GHH specification is 15.60, a difference that can be regarded as weak evidence in favor of the first model over the latter.[18] The evidence here suggests that in the particular case of El Salvador where the income shocks provided by the remittances seem to be very large, the baseline utility specification that includes the wealth effect of the labor supply seems to provide a relatively better fit to the data.[19]

5.2 Endogenous altruistic Remittances (distant ties)

Figure 5 shows the impulse responses to a negative technology shock in the tradable sector at the posterior median of the estimated parameters. We consider two counterfactual scenarios; one in which all the altruistic remittances are countercyclical and another where they are exogenous. With exogenous remittances, we observe that the income effect weakly dominates the substitution effect, and lower wages lead to a modest increase in the labor supply. Nonetheless, overall households' labor income falls, resulting in lower consumption. Lower consumption generates a deflationary pressure on the relative price of the nontradable output, leading to a real exchange rate depreciation. The tradable sector benefits from lower production costs due to the low wages, and higher exports. As a result, the variation in tradable output and investment is relatively modest. There is a reverse resource movement with the tradable sector gaining labor share on the nontradable sector.

The dynamics change once we account for the presence of countercyclical remittances. A negative shock

[18] The (log) Bayes Factor is directly related to the predicted density of each model. Here we consider the Laplace approximation (Gaussian) based on the numerical optimization of the posterior model. For robustness, we also report the Modified Harmonic Mean estimator which nonetheless provides similar outcomes.

[19] The unavailability of quaterly data on wages and employment hours prevents us from reaching a more decisive conclusion.

to technology is followed by an increase in remittances. The increase in households' income dampens the increase in the labor supply, which diminishes the deflationary pressure on wages. Additionally, the real exchange rate tends to appreciate as the price of nontradables increase. Exports decline contrary to the no-remittances case. The Dutch-disease type resource reallocation process is clear in this instance: the employment in the nontradable sector expands, and when compared to the case with no remittances, the tradable sector experiences a relatively larger decline.

5.3 Self-Interested Remittances

Figure 6 reports the impulse response functions (median and confidence set) to a negative one standard deviation shock to the price of foreign investment which is associated with an increase in the level of foreign direct investment and self-interested remittances. This shock can also be interpreted as a terms of trade shock that leads to real exchange rate appreciation. Despite a dampening effect of this appreciation on exports, the shock expands output, characterizing self-interested remittances as procyclical. The primary effect of the shock is an increase in capital accumulation, which results in a more capital intensive production process that positively impacts the productivity of labor, the level of wages, and consequently consumption. As real wage increases, coupled with rising returns on shares, there is an increase in demand for nontradables which leads to a further expansion of the nontradable sector. Thus, even in the extreme case in which remittances are channeled exclusively to investment in the tradable sector, the spending and resource movement effects typical of the Dutch Disease are observed.

6 Variance and Historical decomposition

Table 3 displays the forecast error variance decomposition at various horizons based on the mode of the benchmark model's posterior distribution. We observe that in the very short run, movements in total remittances are primarily driven by exogenous remittance shocks which account for more than 70 percent of the forecast error variance. Productivity and the price of foreign investment (terms of trade) shocks instead account for most of the remittance variation in the long run. Tradable shocks account for most of the variation in distant ties remittances. However, remittance shocks have a non-trivial role in driving the dynamics of distant ties (countercyclical) remittances in the very short run, suggesting that exogenous remittances, which are sizable and volatile, are a significant source of output fluctuation at shorter horizons.

Variations in self-interested remittances are mostly explained by tradable technology innovations and terms of trade. Similarly, at shorter horizons, remittances explain almost 40 percent of the volatility of the real exchange rate. At longer horizons, terms of trade appears to be preponderant, accounting for 67 percent of the asymptotic forecast error variance. Consistent with the impulse response analysis above, remittance shocks seem to change the composition of output between tradable and nontradables rather than total output per se. While remittance shocks are the main force driving the variability of nontradable output at all horizons, aggregate output is mostly explained by technological innovations in the tradable sector at all horizons. For completeness, Figure 7 shows the historical contribution of the different shocks to detrended growth over the sample period. We include the observables and only depict self interested remittances, since by construction, distant ties remittances mimic output decomposition and close ties remittances are exclusively explained by exogenous remittance shocks. Exogenous innovations to remittances seem to explain the real exchange rate appreciation and the expansion in nontradable output in the early nineties. Regarding self interested remittances, we find that while productivity innovations are more relevant in the first part of the sample, changes in the relative price of investment become relatively more important in the latter years.

7 Volatility and Welfare

Moments Table 4 reports unconditional moments for the actual data and Table 5 reports the median and confidence sets from the simulated distribution of moments, using artificial time series samples generated with parameter draws from the posterior distribution. Notably, the standard deviation of total output is very low, while its components, tradables and nontradables, fluctuate significantly over the sample period. The model matches the volatility of output particularly well, as well as the relative standard deviation of tradables, nontradables and remittances. However, it overestimates the volatility of the real exchange rate and fails to generate persistent series which is consistent with the data.

Table 6 reports moments obtained using the posterior median of the estimated parameters, with relative standard deviations shown in parentheses. We include estimates for two variables, consumption and labor supply, for which data is unavailable. We compare the baseline model with three counterfactual scenarios: a) same model forcing close ties (exogenous) remittances to have zero standard deviation, b) same model forcing distant ties (countercyclical) remittances to be acyclical and thus not reactive to aggregate output, and c) the same model considering both cases (a) and (b).

As expected when we compare all four cases, we observe that the standard deviations of tradables, nontradables and the real exchange rate significantly increase as remittances vary over the business cycle. It should be noted however that the volatility of aggregate output is not significantly altered. Interestingly, we observe that the volatility of consumption significantly increases when exogenous remittances shocks are included. On the contrary, consumption volatility decreases if we only consider countercyclical remittances. Hence, exogenously driven remittances increase the volatility of household consumption, whereas countercyclical remittances dampen this effect. As countercyclical remittances smooth consumption, it also serves to reduce labor supply volatility.[20]

Welfare Remittances improve welfare. The welfare improvement is derived from two different sources. First, remittances improve the welfare stance in terms of average levels of consumption, i.e. remittances represent 24.2 percent of consumption in steady state. Second, the preceding discussion highlights the potential insurance role of endogenous countercyclical remittances as a substitute for contingent claims in smoothing income flows. We compare the welfare level associated with the benchmark (evaluated at the estimated median of the parameters) and compare that with a) same model setup with the additional assumption that all altruistic remittances are characterized by the estimated stochastic process, and b) same model setup with the assumption that all altruistic remittances fluctuation are driven by the countercyclical pattern estimated for distant ties remittances.

Under the baseline model, the household welfare, W_0 is defined as:

$$W_0 = E_0 \left\{ \sum_{t=0}^{\infty} \exp \left[- \sum_{\tau=0}^{t-1} \kappa \log(1 + (C_t)^{(1-\omega)}(1 - L_t)^{\omega}) \right] u(C_t, L_t) \right\}. \tag{11}$$

We measure the welfare cost (or gain) relative to our baseline setup, as the fraction of the expected consumption stream we should add (or extract) so that the household is indifferent across the alternative scenarios. This fraction is computed from the solution of the second-order-approximation to the model equilibrium relationships around the deterministic steady state following the methods in Schmitt-Grohé and Uribe (2004).[21] We find that a transition from the baseline model to that in which all altruistic remittances are exogenous results in a loss of 2.25 percent of the consumption stream. In contrast, moving to the case where all remittances are countercyclical results in a gain of 0.34 percent of the consumption stream.[22]

8 BVAR Evidence for El Salvador

We conduct a VAR analysis using macroeconomic data for El Salvador to test whether the model is consistent with the facts typically observed in a small open economy for which remittances flows are important. Instead of applying traditional VAR techniques, we prefer to use a Bayesian VAR (BVAR) with a stan-

[20] Note that remittances will vary over the cycle even if $\eta = \sigma_{\Xi} = 0$, due to fluctuations in self interested remittances and $P_{CF,t}$.

[21] Conventional linearization can generate approximation errors that may cause welfare reversals. In particular, the first-order approximation to the unconditional mean of endogenous variables coincides with their non-stochastic steady state values.

[22] These relatively large welfare gains are in line with Arellano et al (2009) who calculate the welfare effects of volatile foreign aid in African economies. For instance, they find that if aid could be delivered in such a way as to insure fully against productivity shocks, donors could reduce average aid inflows by 64% without reducing the level of welfare, which represents about 3% of CES consumption. As shown in Kim et al (2006), the welfare costs of incomplete markets can be very large if agents are relatively impatient and shocks are highly persistent.

dard Minnesota prior specification for two reasons. BVARs perform better when sample sizes are small and keep the traditional advantage of the VAR analysis by not imposing behavioral equations based on a specific economic theory (Litterman, 1986). The last point is also relevant as we would not like to impose a particular structure on the remittances generation process i.e. whether they are exogenous, altruistic, or self-interested.[23]

Figure 8 presents impulse responses with 90-percent confidence bands. In the Cholesky decomposition, the shocks are orthogonalized in the following order: ratio of tradable-nontradable output (TNT), log of GDP (LY), log of real exchange rate (LRER), log of remittances (LREM), log of CPI (LCPI).[24] It should be noted that in our nomenclature an increase in LRER depicts a real exchange rate depreciation. The ordering does not affect the results substantially, and as shown below such an ordering also renders the BVAR and the model more directly comparable[25]. The results closely reflect the predictions of the theoretical model as we observe the following: (a) An increase (decrease) in total output seems to be driven by productivity innovations that change the shares of tradable and nontradable output in favor of tradables (nontradables). On impact, this scenario results in depreciation (appreciation) of the real exchange rate (first row of Figure 8). (b) Following the argument above, a positive (negative) disturbance in income results in real exchange rate depreciation (appreciation). However, the response is hump-shaped (second row). (c) Remittances are countercyclical: when we have a positive (negative) innovation in output, remittances significantly decrease (increase) on impact (second row). (d) Although macroeconomic disturbances that result in exchange rate depreciation seem to co-move with remittances (third row), a shock to remittances results in a sizeable and significant real exchange rate appreciation (fourth row). (e) Either a "J-curve" puzzle[26] or some other mechanism in place drives the initial hump-shaped response of the tradable-nontradable ratio to a shock in remittances. Nonetheless, in the medium-run this shock results in a resource reallocation that jeopardizes the performance of the tradable sector i.e. Dutch disease phenomenon (fourth row). (f) The CPI, which mostly reflects the evolution of the price of nontradables in the data, immediately reacts to an increase in remittance flows (fourth row).

The observations in (a), (b), (c), and (d) match well with the theoretical implications derived from the

[23] See Acosta et al. (2009) for a comprehensive discussion of the estimation methodology.

[24] Most of the series are trend stationary according to the Augmented Dickey-Fuller (ADF) test, except the log of remittances, which is difference stationary. Each BVAR equation includes two lags, a constant, and the following exogenous variables: a linear trend, an indicator variable for the dollarization period that takes the value of 1 starting in 2001Q1.

[25] Results are available upon request. One caveat: The impulse responses from the VAR and those from the structural model are not strictly comparable since the restrictions implied by the two frameworks are different.

[26] We have to take into account two facts in order to interpret the "J-curve"puzzle in this context. First, in the data, tradable and non-tradable output composition would not change much immediately after a depreciation since contracts and production decisions are usually made several months in advance. For empirical evidence and related literature, see Backus et al (1994). Second, the event of a real depreciation is likely to be the result of an ongoing productive structure that is severely biased towards nontradables in detriment of tradable output. In other words, the real depreciation occurs in anticipation of an international position that is unsustainable given the pattern of the productive structure. To conclude, these two events seem to explain why on impact TNT falls following real exchange rate depreciation shock to slowly recover afterwards. See third row, first column.

case of productivity disturbances biased towards tradables and countercyclical remittances. Moreover, when we consider an isolated shock to remittances as in (d), the evidence coincides with the theoretical results in the exogenous remittances case. Evidence in (d) is in conformity with the model predictions, in the sense that innovations to the terms of trade that result in real exchange rate depreciation, lead to a decline in output, and thus in an increase of altruistic remittances. The observed Dutch disease phenomenon in (e) is clearly consistent with all the theoretical specifications included in the model. In addition, evidence in (f) is consistent with dynamics in both altruistic remittances specifications.

9 Conclusion

Using Bayesian methods and Salvadorian data, we develop and estimate a general equilibrium model of a small open economy to examine whether an increase in remittances causes Dutch disease effects. We also test the welfare implications, and finally conduct an empirical analysis using data from El Salvador to determine how well the estimated model does in matching empirically observed facts in an economy that receives large amounts of remittances. For the theoretical model, we consider three cases: one where remittances are exogenously determined; another where remittances are countercyclical; and finally the case where remittances act like capital inflows. The results generally suggest that remittance inflows leads to the realization of the Dutch disease phenomenon under each of the cases considered. This is because whether altruistically motivated or otherwise, an increase in remittances ultimately culminates in a rise in household income and consequently an increase in consumption that is biased toward nontradables. In addition, remittances result in a decrease in the labor supply which leads to increase in production costs of the nontradable sector, which is relatively labor intensive. This in turn results in rising nontradable prices which is consistent with real exchange rate appreciation, and consequently creates an expansion of the nontradable sector at the expense of the tradable sector. We also show that these conclusions hold even in a scenario where remittances are not channeled to household consumption but to investment. We further obtain results from empirical analysis that provide support for the findings in the theoretical model, with respect to the behavior of the macroeconomic variables that are key to the Dutch disease phenomenon. In particular, the qualitative implications of an increase in remittances for nontradable output and the real exchange rate in the theoretical model matches the evidence remarkably well.

In the absence of market failures, the decline in the labor supply and the increase in consumption that leads to the reallocation of resources towards the nontradable sector is the household's optimal response to the increase in disposable income. The welfare optimization framework used in this study suggests in principle, that remittances contribute to higher consumption, leisure, as well as lower disposable income volatility and a smoother path for households' consumption expenditures.

A Appendix-The Countercyclicality of Altruistic Remittances

In order to justify the countercyclicality of altruistic remittances we assume that residents with distant ties do not send resources on regular basis; they only send resources home in case of severe economic hardship. In this case, the decision to send remittances or not is taken one period in advance. For instance, we could imagine that these infrequent remitters may have to search for the most convenient channel to send remittances, fulfill administrative steps or satisfy legal requirements before actually sending funds.

We will assume that given the distant ties with the domestic households, the remitters neither interfere nor have information on households decisions regarding asset holdings, participation in the labor market and predicted pattern of wages. The decision to remit instead depends on a forecast of total output at period t formed at the time of taking the decision to remit at period $t-1$, so that if, $E_{t-1}\left\{Y_t\right\} \leq \varpi \bar{Y}$, they will remit a lump-sum amount $\Xi_{it}^{d} = \zeta$, and if $E_{t-1}\left\{Y_t\right\} > \varpi \bar{Y}$, no remittances will be sent (i.e. $\Xi_{it}^{d} = 0$); $\varpi < 1$ is a threshold value and $\bar{Y}$ is the steady-state value of total output. This implies that a level of aggregate output below $\varpi \bar{Y}$ signals severe economic hardship and triggers the decision to remit home lump-sump funds ζ.[27]

As a result, all remitters have is a noisy signal: $E_{t-1}\left\{Y_t\right\} = \vartheta_{i,t-1} Y_t$. Where $\vartheta_{i,t-1}$ is assumed to be a random variable drawn from a common uniform distribution, $U(\vartheta_{i,t-1})$, with support on $\left[1-\Omega_t^f, 1+\Omega_t^f\right]$, such that $0 < \Omega_t^f < 1$. From this specification, we have that $E\left\{\vartheta_{i,t-1}\right\} = 1$, hence on average, rational home-born foreign residents correctly predict the value of future output. Letting $\tilde{\vartheta}_{i,t-1}$ be the random variable threshold maximum realization that triggers a remitter's decision to send funds, we obtain $\tilde{\vartheta}_{i,t-1} Y_t = \varpi \bar{Y}$. In other words, remittances will be positive for any remitter that gets a realization such that $\vartheta_{i,t-1} \leq \tilde{\vartheta}_{i,t-1}$. This establishes a monotonically decreasing relationship between this threshold realization and the actual output at the time remittances are received: $\tilde{\vartheta}_{i,t-1} = \tilde{\vartheta}_{i,t-1}(Y_t)$ where $\tilde{\vartheta}'(Y_t) < 0$. Additionally, the proportion of home-born foreign residents with distant ties that choose to remit to the domestic households in every single period is given by: $\Pr\left\{(\vartheta_{i,t-1} < \tilde{\vartheta}_{i,t-1})\right\} = \frac{\tilde{\vartheta}_{i,t-1} - 1 + \Omega_t^f}{2\Omega_t^f}$, which establishes an increasing monotonic relationship between aggregate remittances and the threshold realization $\tilde{\vartheta}_{i,t-1}$: $\int_0^1 \Xi_{it}^d di = \Xi_t^d = \Xi_t^d(\tilde{\vartheta}_{i,t-1})$, where $\Xi_t^{d\prime}(\tilde{\vartheta}) > 0$. Using the equations above, we can express total remittances as a decreasing function of aggregate output for any given exogenous value of $\Omega_t^f = \Omega^f : \Xi_t^d = \psi(Y_t)$, $\psi'(Y_t) < 0$, which may be expressed as: $\Xi_t^d = (Y_t)^{\eta}$. Where $\eta < 0$ is the elasticity of aggregate remittances with respect to aggregate output. Which is the expression characterizing distant ties remittances. It should be noted that in the model we assume that domestic households are identical. This assumption allows us to express the budget constraint

[27] Severe economic hardship that may result in local households cutting back basic services like schooling or health care. For references, see World Bank (2006).

in aggregate terms. The elasticity η depends on the value of Ω_t^f, which could be interpreted as a measure of uncertainty. This link between η and Ω_t^f is underpinned by the second differential, $\frac{\partial \Pr\{\}}{\partial\tilde{\vartheta}\partial\Omega_t^f} = -\frac{(1-a)}{2(\Omega_t^f)^2} < 0$. The intuition is that aggregate remittances will be less sensitive to changes in output given a higher uncertainty about the reliability of the forecast $E_{t-1}\{Y_t\}$.

B Appendix-Estimation Methodology

In this section we explain very briefly the estimation approach used in this paper. Let's define Θ as the parameter space of the DSGE model, and $Z^T = \{z_t\}_{t=1}^T$ as the data observed. From their joint probability distribution $P(Z^T, \Theta)$ we can derive a relationship between their marginal $P(\Theta)$ and conditional distributions $P(Z^T/\Theta)$ known as the Bayes theorem: $P(\Theta/Z^T) \propto P(Z^T/\Theta)P(\Theta)$

The method updates the *a priori* distribution using the likelihood contained in the data to obtain the conditional posterior distribution of the structural parameters. The posterior density $P(\Theta/Z^T)$ is used to draw statistical inference on the parameter space Θ. Combining the state-form representation implied by the solution of the linear rational expectation model and the Kalman filter we can compute the likelihood function. The likelihood and the prior permit a computation of the posterior, that can be used as the starting value of the random walk version of the Metropolis algorithm, which is a Monte Carlo method used to generate draws from the posterior distribution of the parameters. In this case, the results reported are based on 20,000 draws of such algorithm. The jump distribution is chosen to be a normal one with covariance matrix equal to the Hessian of the posterior density evaluated at the maximum. The scale factor is chosen in order to deliver an acceptance rate between 20 and 30 percent depending on the run of the algorithm. Convergence of the algorithm is assessed by observing the plots of the moment draws (mean, standard deviation, skewness and kurtosis). Measures of uncertainty follow from the percentiles of the draws.

B.2. Empirical Performance Define the marginal likelihood of a model A as follows: $M_A = \int_\Theta P(\Theta|A)P(Z^T|\Theta, A)d\Theta$. Where $P(\Theta|A)$ is the prior density for model A, and $P(Z^T|\Theta, A)$ is the likelihood function of the observable data, conditional on the parameter space Θ and the model A. The Bayes factor between two models A and B is the defined as: $\mathcal{F}_{AB} = M_A/M_B$. The marginal likelihood of a model (or the Bayes factor) is directly related to the predicted density of the model given by: $\hat{p}_{T+1}^{T+m} = \int_\Theta P(\Theta|Z^T, A) \prod_{t=T+1}^{T+m} P(z_t|Z^T, \Theta, A)d\Theta$. Where $\hat{p}_0^T = M_T$. Therefore the marginal likelihood of a model also reflects its prediction performance.

C Appendix-Bayesian VAR Specification

Bayesian statistics presupposes a set of prior probabilities about the underlying parameters to be estimated, which will be revised accordingly in the light of the evidence. Litterman (1986) suggests specifying a "flat prior" or diffuse restrictions on the coefficients by placing independent Normal prior distributions with means of zero for all lags except for the first one (which has a prior mean of one) and standard deviations decreasing the further back they are in the lag distributions. This procedure is usually called the "Litterman prior" or "Minnesota prior"), and it presupposes that coefficients on higher order lags are more likely to be zero than lower order lags. More formally, the "Litterman prior" originally suggested in Doan, Litterman and Sims (1984) and Litterman (1986) for an n-dimensional VAR of non-stationary variables consists on the specification of the following prior distribution on the VAR coefficients $(b_{ijk}) : b_{ijk} \sim N(b_{ijk}, \Psi^2_{ijk})$ where i is the equation, j the variable, and k the lag considered and $\Psi_{ijk} = \pi g(k) \varsigma_{ij} \frac{\breve{\sigma}_i}{\breve{\sigma}_j}$. With $\tilde{b}_{ijk} = 1$, if $i = j$, $k = 1$ and $\tilde{b}_{ijk} = 0$, otherwise. Additionally, ς_{ij}, $g(k)$ if $i = j$, $k = 1$, and $0 < \varsigma_{ij}$, $g(k) < 1$, otherwise. $\breve{\sigma}_i$ is the standard error of a univariate autoregression on equation i (to scale for the different magnitudes of the variables in the system), π is the overall "tightness" of the system, $g(k)$ is the tightness function for lag k relative to lag 1, and ς_{ij} represents the tightness of variable j in equation i relative to variable i. We follow the "Litterman prior", and use a mean of zero for the prior on all coefficients except the first own lag in each equation, $\pi = 0.2$, a symmetric relative tightness ς_{ij} equal to a constant $\breve{\imath} = 0.5$ for all off-diagonal variables in the system (a practical suggestion for small systems, with five or fewer equations), and an harmonic decaying-lag tightness function $g(k)$ with a decay parameter of 2, $g(k) = 1/(k^2)$.

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Table 1. Summary statistics for the prior and posterior distribution of the parameters

Prior Distribution					Posterior Distribution				
Description	Name	Density	Mean	Std Dev	Sd (Hess)	Mode	Mean	5%	95%
Elast Subs T/NT	ρ_c	Gamma	0.4	0.05	0.051	0.3905	0.3945	0.3103	0.4770
Exports Elasticity	ξ	Normal	1	0.35	0.282	0.8684	1.1212	0.6181	1.5949
Inv Elast Intertemp	γ	Gamma	2	0.20	0.202	2.0598	2.0684	1.7256	2.3946
Invest Adjust Costs	ϕ	Gamma	2.2	0.40	0.398	2.1499	2.2504	1.5724	2.8995
Elast Subs Foreign/Dom	ρ_h	Gamma	0.7	0.10	0.067	0.5549	0.5522	0.4460	0.6569
Elast Subs Invest Comp	ρ_i	Gamma	0.2	0.025	0.025	0.1977	0.2007	0.1592	0.2408
Elast Remittances	η	Normal	-2.5	0.25	0.257	-2.253	-2.3269	-2.7541	-1.8961
Tech Shock T	η_{a^T}	Beta	0.8	0.1	0.026	0.9569	0.9302	0.8722	0.9886
Remittances Shock	$\eta_{\tilde{\Xi}_c}$	Beta	0.8	0.1	0.016	0.9533	0.9477	0.9222	0.9727
P Foreign Inv Shock	$\eta_{p_{IF}}$	Beta	0.8	0.1	0.021	0.9738	0.9399	0.8836	0.9945
Tech Shock NT	$\eta_{a^{NT}}$	Beta	0.8	0.1	0.064	0.8230	0.8084	0.7112	0.9094
Tech Shock T sd	σ_{a^T}	Inv gamma	0.01	2*	0.001	0.0077	0.0078	0.0066	0.0090
Remittances Shock sd	$\sigma_{\tilde{\Xi}_c}$	Inv gamma	0.01	2*	0.010	0.0688	0.0776	0.0576	0.961
P Foreign Inv Shock sd	$\sigma_{p_{IF}}$	Inv gamma	0.01	2*	0.003	0.0209	0.0209	0.0156	0.0259
Tech Shock NT sd	$\sigma_{a^{NT}}$	Inv gamma	0.01	2*	0.001	0.0086	0.0094	0.0078	0.0108

Note: For the Inverted Gamma function the degrees of freedom are indicated. Results are based on 500,000 draws of the Metropolis Algorithm.

Table 2. Summary statistics for the prior and posterior distribution of the parameters

Prior Distribution					Posterior Distribution			
					Cobb-Douglas		GHH	
Description	Name	Density	Mean	Std Dev	Mode	Sd (Hess)	Mode	Sd (Hess)
Elast Subs T/NT	ρ_c	Gamma	0.4	0.05	0.3905	0.051	0.2589	0.032
Exports Elasticity	ξ	Normal	1	0.35	0.8684	0.282	0.9228	0.197
Inv Elast Intertemp	γ	Gamma	2	0.20	2.0598	0.202	2.0011	0.199
Invest Adjust Costs	ϕ	Gamma	2.2	0.40	2.1499	0.398	2.1254	0.393
Elast Subs Foreign/Dom	ρ_h	Gamma	0.7	0.10	0.5549	0.067	0.4021	0.055
Elast Subs Invest Comp	ρ_i	Gamma	0.2	0.025	0.1977	0.025	0.1977	0.025
Elast Remittances	η	Normal	-2.5	0.25	-2.253	0.257	-2.5523	0.247
Tech Shock T	η_{a^T}	Beta	0.8	0.1	0.9569	0.026	0.9516	0.039
Remittances Shock	$\eta_{\tilde{\Xi}_c}$	Beta	0.8	0.1	0.9533	0.016	0.9525	0.017
P Foreign Inv Shock	$\eta_{p_{IF}}$	Beta	0.8	0.1	0.9738	0.021	0.9805	0.015
Tech Shock NT	$\eta_{a^{NT}}$	Beta	0.8	0.1	0.8230	0.064	0.9684	0.018
Tech Shock T sd	σ_{a^T}	Inv gamma	0.01	2*	0.0077	0.001	0.0063	0.001
Remittances Shock sd	$\sigma_{\tilde{\Xi}_c}$	Inv gamma	0.01	2*	0.0688	0.010	0.0524	0.007
P Foreign Inv Shock sd	$\sigma_{p_{IF}}$	Inv gamma	0.01	2*	0.0209	0.003	0.0184	0.002
Tech Shock NT sd	$\sigma_{a^{NT}}$	Inv gamma	0.01	2*	0.0086	0.001	0.0085	0.001
$\Delta\log(\hat{L})$ (Laplace)					–	–	–	15.60
$\Delta\log(\hat{L})$ (Mod.Harmonic)					–	–	–	16.23

Table 3. Forecast Error Variance Decomposition

	NT output	Real exch rate	Output	Total remitt	Distant ties	Close ties	Self-interested
t=1							
T tech shock	1.00	1.23	91.17	24.19	91.17	0.00	47.49
Remitt shock	66.55	39.41	7.89	73.73	7.89	100.00	2.10
Invest price shock	7.13	46.95	0.85	1.96	0.85	0.00	46.98
NT tech shock	25.32	12.42	0.09	0.12	0.09	0.00	3.43
t=4							
T tech shock	1.31	1.37	91.78	26.08	91.78	0.00	46.79
Remitt shock	71.31	39.42	7.70	71.19	7.70	100.00	2.05
Invest price shock	8.61	50.45	0.41	2.67	0.41	0.00	48.81
NT tech shock	18.77	8.76	0.11	0.06	0.11	0.00	2.35
t=8							
T tech shock	1.69	1.53	92.16	28.29	92.16	0.00	45.64
Remitt shock	74.15	38.54	7.45	67.94	7.45	100.00	1.97
Invest price shock	10.33	53.76	0.28	3.73	0.28	0.00	50.74
NT tech shock	13.83	6.18	0.12	0.04	0.12	0.00	1.65
t=16							
T tech shock	2.36	1.74	91.91	31.68	91.91	0.00	43.41
Remitt shock	74.72	36.05	7.01	62.26	7.01	100.00	1.84
Invest price shock	13.15	58.09	0.96	6.03	0.96	0.00	53.59
NT tech shock	9.77	4.12	0.12	0.03	0.12	0.00	1.15
t=40							
T tech shock	3.52	2.01	88.68	35.76	88.68	0.00	39.77
Remitt shock	70.59	30.98	6.19	52.28	6.19	100.00	1.65
Invest price shock	18.59	64.19	5.03	11.92	5.03	0.00	57.66
NT tech shock	7.30	2.81	0.11	0.04	0.11	0.00	0.92
t=Asympt.							
T tech shock	3.94	2.04	84.31	35.77	84.31	0.00	38.59
Remitt shock	67.13	28.31	5.68	47.34	5.68	100.00	1.60
Invest price shock	22.16	67.14	9.91	16.85	9.91	0.00	58.93
NT tech shock	6.77	2.51	0.09	0.03	0.09	0.00	0.89

Note: Forecast error variance decomposition is at the posterior mode. Forecast horizon: Q1, Q4, Q8, Q16, Q40, asymptotic. Shocks: tradables technology, exogenous remittances, price of foreign investment good, nontradables technology.

Table 4: Unconditional moments for El Salvador. Data: 1991Q2–2006Q2

Variable (Growth Rate)	St. Dev	Relative St. Dev	Autocorr
Output	0.82 0.70/1.00	1.00	−0.03 −0.29/0.23
Tradable Output	1.49 1.26/1.81	1.82	−0.03 −0.29/0.23
Non Tradable Output	1.06 0.90/1.30	1.29	0.25 0.00/0.47
Real Exchange Rate	1.67 1.41/2.03	2.04	0.20 −0.05/0.43
Remittances	4.66 3.95/5.67	5.69	0.13 −0.13/0.38

Note: Variables were transformed in $\Delta \ln$ (expressing everything in growth rates). The 95 percent confidence interval is reported in smaller font.

Table 5: Unconditional moments for the estimated benchmark model

Variable (Growth Rate)	St. Dev	Relative St. Dev	Autocorr
Output	0.76 0.65/0.88	1.00	−0.01 −0.03/0.01
Tradable Output	1.52 0.86/2.18	2.00	−0.03 −0.05/−0.02
Non Tradable Output	1.17 1.05/1.27	1.54	−0.04 −0.05/−0.02
Real Exchange Rate	2.54 2.25/2.77	3.34	−0.03 −0.05/−0.02
Remittances	5.77 5.04/6.57	7.59	−0.02 −0.03/−0.01

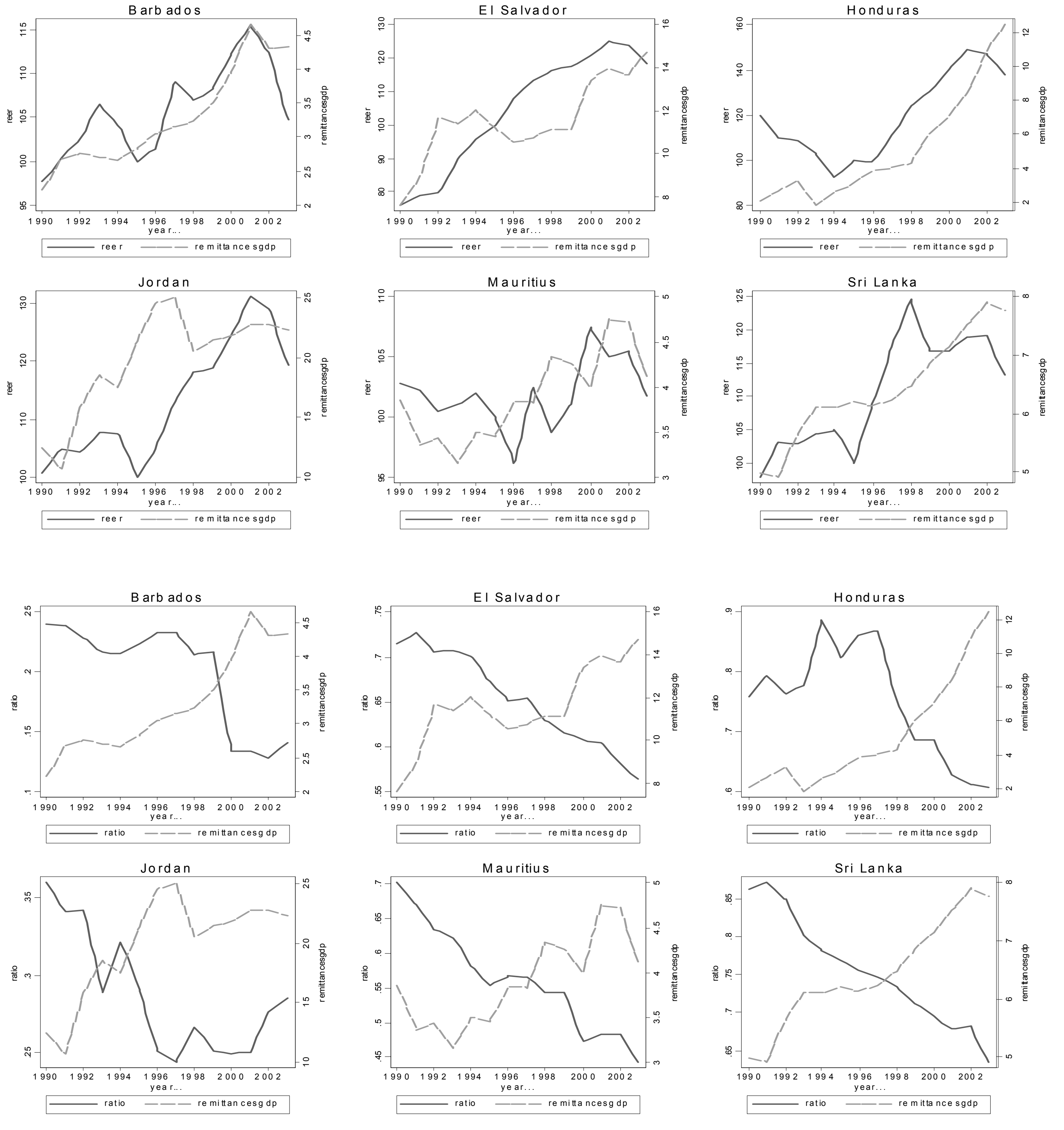
Note: We report the median from the simulated distribution of moments using the samples generated with parameter draws from the posterior distribution. The confidence intervals are in smaller font.

Table 6: Counterfactual moments (standard deviation)

Variable (Growth Rate)	Baseline	(a) $\sigma_{\tilde{\Xi}} = 0$	(b) $\eta = 0$	(c) $\eta = \sigma_{\tilde{\Xi}} = 0$
Output	0.72(1.00)	0.69(1.00)	0.77(1.00)	0.74(1.00)
Tradable Output	1.52(2.11)	1.09(1.58)	1.58(2.05)	1.08(1.46)
Non Tradable Output	1.19(1.65)	0.69(1.00)	1.28(1.66)	0.74(1.00)
Real Exchange Rate	2.51(3.49)	1.95(2.83)	2.63(3.42)	2.02(2.73)
Remittances	5.73(7.96)	2.92(4.23)	5.63(7.31)	1.99(2.69)
Consumption	1.66(2.31)	0.55(0.80)	1.79(2.32)	0.63(0.85)
Labor Supply	0.45(0.63)	0.45(0.65)	0.47(0.61)	0.47(0.64)

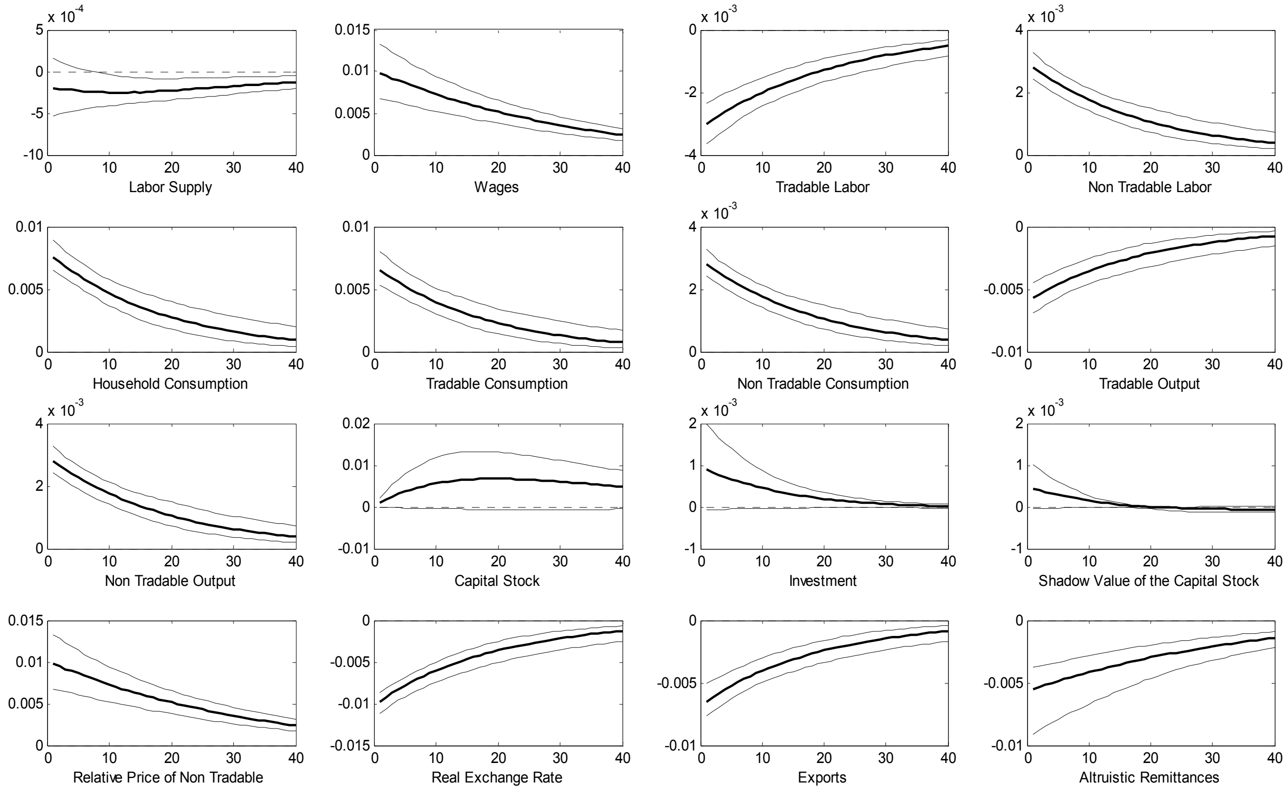
Note: We simulate the model using the posterior median of the estimated parameters; (a) assumes that the standard deviation of the stochastic process of the exogenous remittances is zero; (b) assumes that distant ties remittances are not countercyclical; (c) assumes that both (a) and (b) hold; relative standard deviation with respect to output is in parenthesis.

Figure 1. Remittances, Real Effective Exchange Rate, and Tradable-Non-Tradable Output Ratio



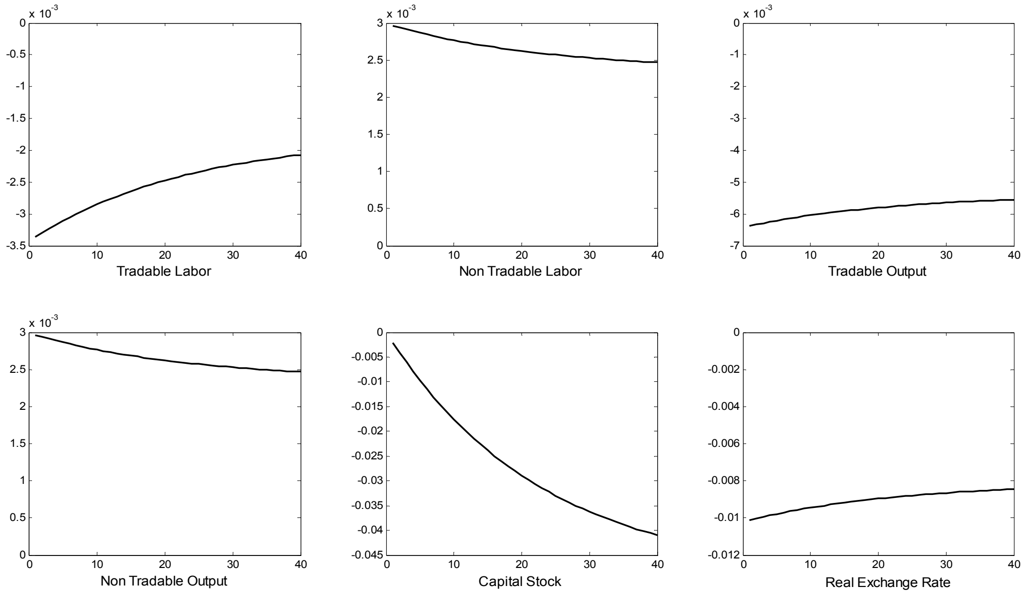
Note: Annual frequency data; Source - International Financial Statistics (International Monetary Fund) and World Development Indicators (World Bank). Top panel: solid line-Real exchange rate; Dotted line-Remittances/GDP. Bottom Panel: solid line-Tradable-Non-Tradable ratio; Dotted line-Remittances/GDP.

Figure 2. Exogenous Altruistic Remittances (close ties)



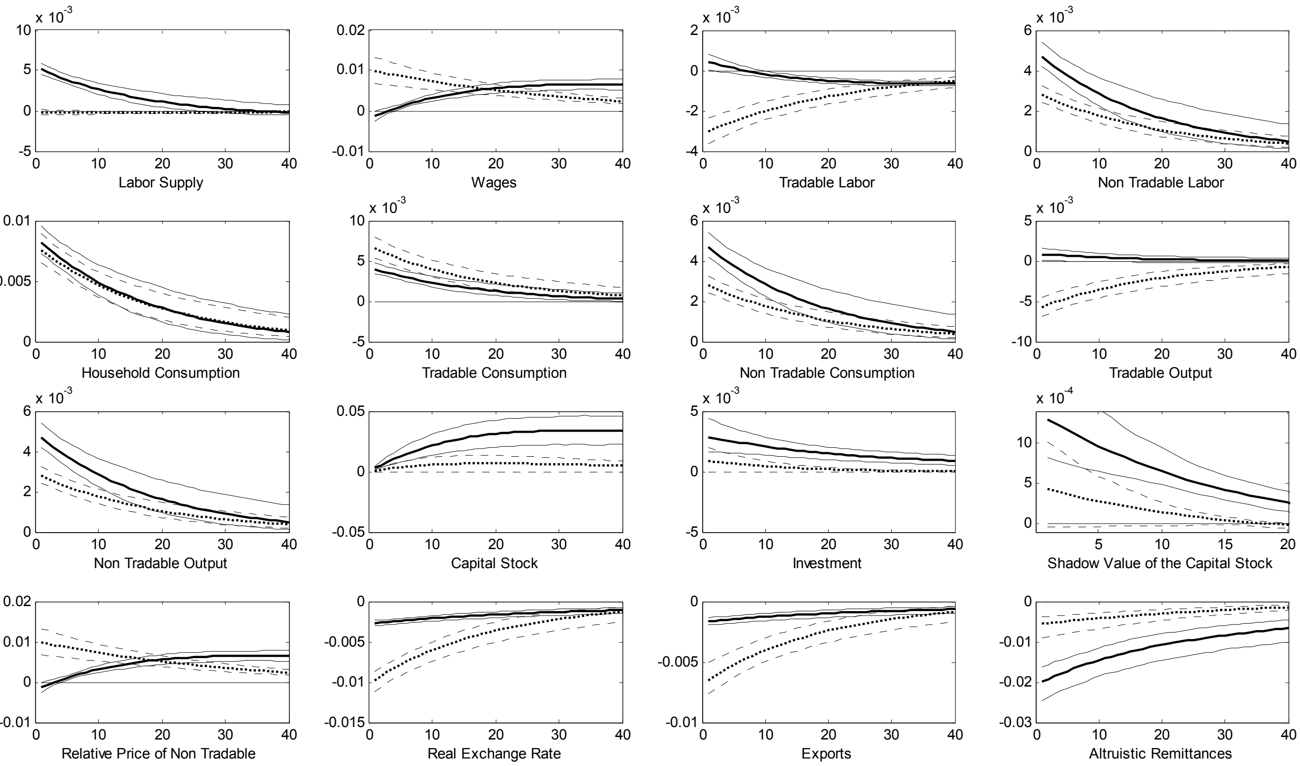
Note: The thick line is the median impulse response to an exogenous remittance shock (one standard deviation). The thin lines are the 10 and 90 percent posterior intervals.

Figure 3. Exogenous Altruistic Remittances (close ties) - Permanent Shock



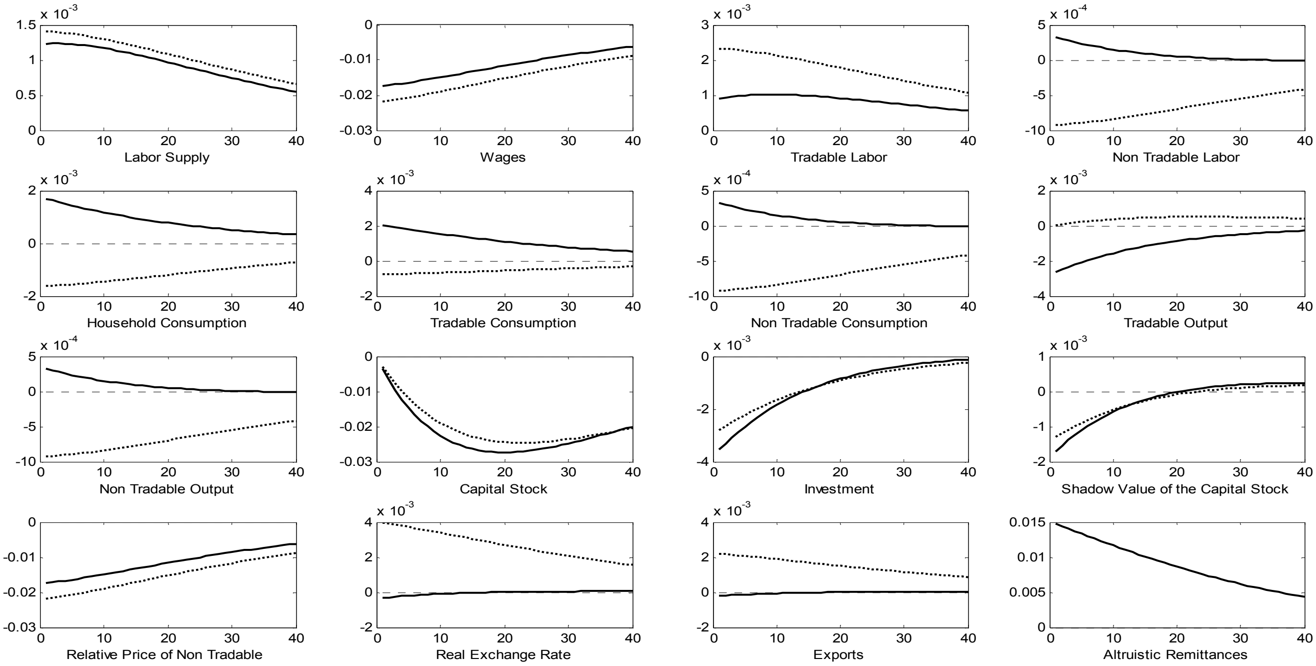
Note: Response to a permanent increase in altruistic (close ties) remittances. Impulse responses are based on the median of the posterior distribution of the parameters.

Figure 4. Exogenous Altruistic Remittances (close ties) - GHH and Cobb-Douglas Utility Specification



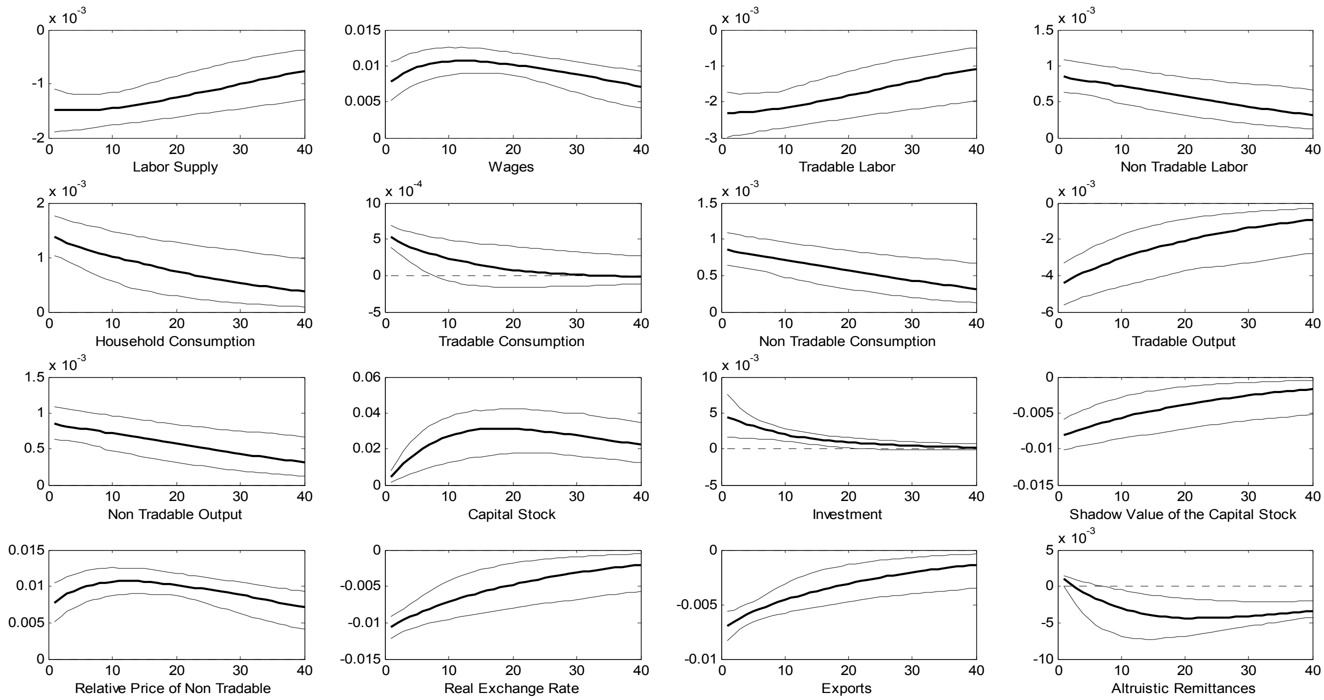
Note: The solid line displays GHH preferences. The dotted line displays baseline Cobb-Douglas preferences. The thin lines are the 10 and 90 percent posterior intervals.

Figure 5. Countercyclical Altruistic Remittances (distant ties)



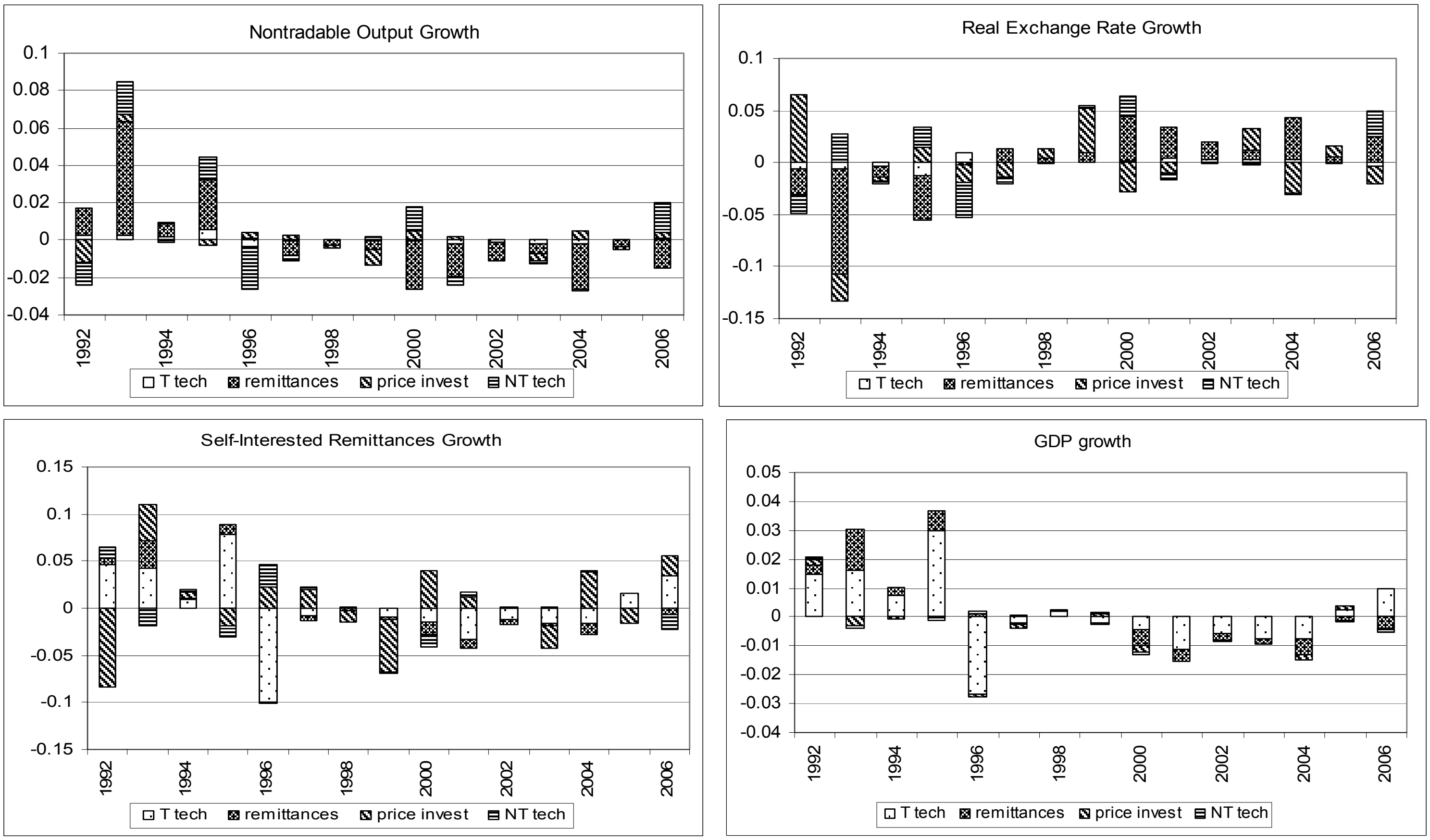
Note: Response to a decrease in tradable sector productivity (one standard deviation). Impulse responses are based on the median of the posterior distribution of the parameters. The dotted line is the counterfactual scenario with no countercyclical remittances.

Figure 6. Self-Interested Remittances



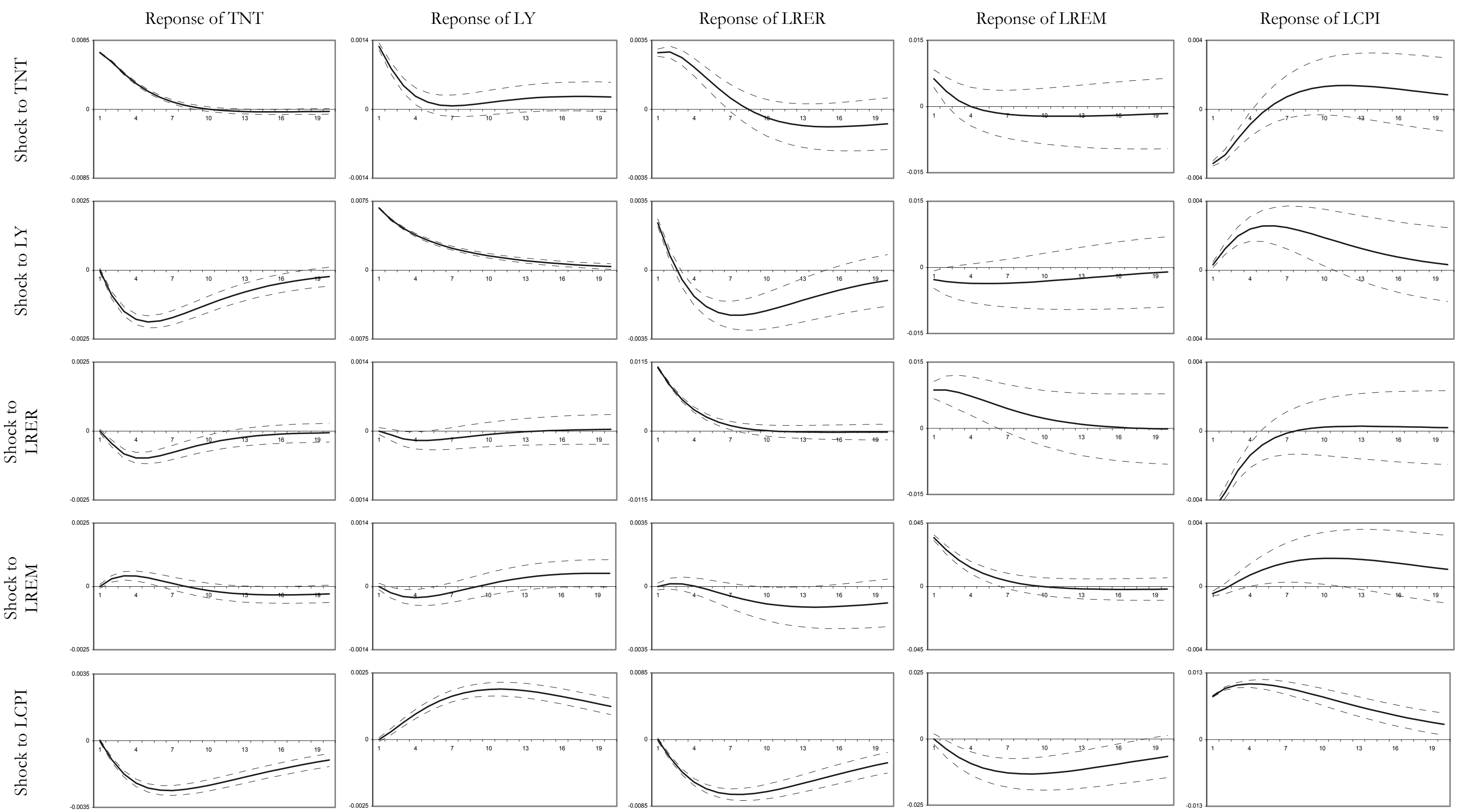
Note: The thick line is the median impulse response to a decrease in the price of the foreign investment good (one standard deviation). The thin lines are the 10 and 90 percent posterior intervals.

Figure 7. Historical Decomposition



Note: Historical Decomposition, Annual Growth (deviation from trend).

Figure 8: Bayesian VAR Evidence, El Salvador 1991-2006, quarterly data.



Note: The BVAR is estimated using quarterly data from 1991Q1 to 2006Q2. Dashed lines indicate 90-percent confidence bands. The Choleski ordering of the impulse responses is TNT, LY, LRER, LREM and LCPI. Each equation contains 2 lags per variable, a constant, a quarterly trend, and a dollarization dummy after 2001Q1. Coordinate: Deviation from the baseline.