# A small open economy DSGE model with workers' remittances

Muhammad Rehman and Sajawal Khan
*State Bank of Pakistan, Karachi, Pakistan*
Zafar Hayat
*Department of Research, State Bank of Pakistan, Karachi, Pakistan and Senior Economist, IMF, Islamabad, Pakistan, and*
Faruk Balli
*School of Economics and Finance, Massey University, Albany, New Zealand and Higher School of Economics and Business, Al-Farabi Kazakh National University, Almaty, Kazakhstan*

Received 4 January 2019
Revised 9 August 2019
21 November 2019
Accepted 23 November 2019

## Abstract

**Purpose** – In this paper, the authors develop and estimate a small open economy dynamic stochastic general equilibrium (DSGE) model with an enriched micro-founded specification to account for foreign remittances, an important source that helps bridge the trade gap in many developing and emerging market economies.
**Design/methodology/approach** – Although the authors' specification provides a general frame for the analysis of the role of workers' remittances, they motivate and calibrate the model with specific focus on Pakistan, where most of the trade deficit is met through the remittance channel.
**Findings** – The results indicate that a negative shock to workers' remittances hampers real growth via decreased consumption and imported investment goods, while it builds pressure on exchange rate and hence worsens current account balance. These results indicate that too much dependence on workers' remittances to help meet foreign exchange deficits may potentially leave the economy in doldrums in case sizable negative shocks occur to the flow of foreign remittances.
**Originality/value** – The authors develop and estimate a small open economy DSGE model with an enriched micro-founded specification to account for foreign remittances, an important source that helps bridge the trade gap in many developing and emerging market economies.

**Keywords** Business cycles, Workers remittances, Open economy
**Paper type** Research paper

## 1. Introduction

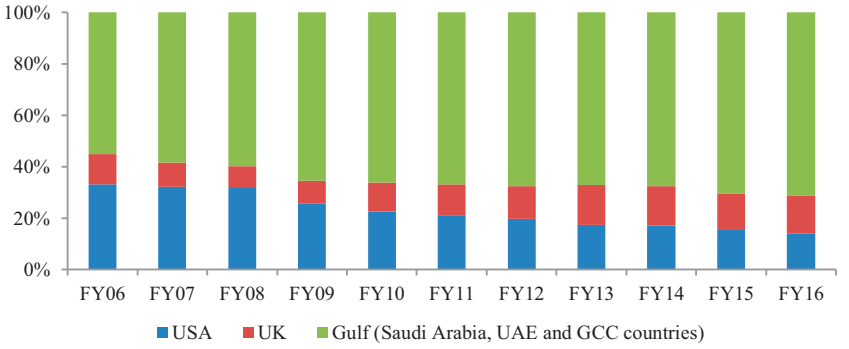
In this paper, we develop a dynamic stochastic general equilibrium (DSGE) model for a small open economy with an enriched micro-founded specification, which allows analyzing the role of foreign remittances [1]. Although the purpose is to provide a general frame for such analysis in an open economy setting, we specifically focus on Pakistan's case as an analogue to highlight the importance of the remittance channel for a small open developing economy, with a long history of trade deficits [2]. Although the bulk of this deficit is met by remittances from Pakistanis working abroad, this dependency potentially renders Pakistan's economy vulnerable to external shocks. Since Pakistan's debt levels have already been critical – approximately 145% of the overall trade, that is, exports plus imports – to help the economy out of relatively bigger negative external shocks to the remittances sector may put nontrivial dents into the balance of payment and in the income and consumption smoothing patterns of the country.

For example, the recent international slowdown and the vulnerability (due to the depleting fiscal space) of gulf countries – major destination to Pakistani workers abroad (Figure 1) – may build economic pressures, thereby leading to foreign workers' layoffs, which, in turn, may cause at least twofold problems for Pakistan's economy. First, the absorption of the

**JEL Classification** — E32, F24, F43.

Journal of Economic Studies
Vol. 47 No. 6, 2020
pp. 1339-1361

0144-3585
DOI 10.1108/JES-01-2019-0009

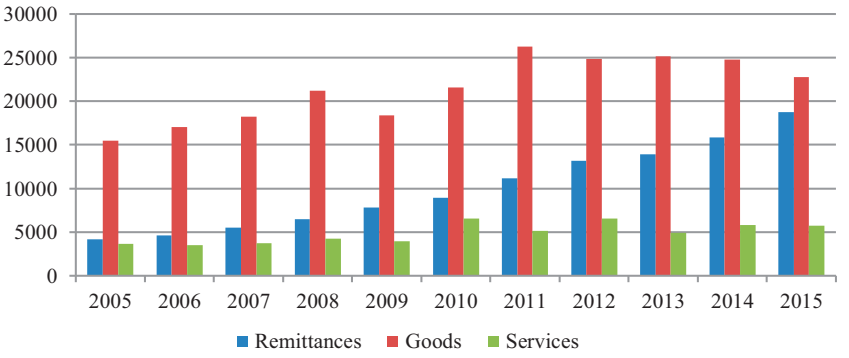



**Source(s)**: Haver; (Units: Mil. USD)

**Figure 1.**
Source country/region share of Pakistani workers' remittances (%)

potentially laid off workers abroad into the domestic labor force would be a giant task, given the already high unemployment rates in the country. Second, a fall in remittances would lead to further worsening of the trade deficit, thereby forcing the economic managers of the country to resort to international sources for debt, which tends to be expensive in bad times; Pakistan has already accumulated high levels of debt, that is, 68% of GDP, with external debt being 24.5% of GDP, and is paying a big toll servicing it [22% of total export proceeds from goods and services in 2015] [3].

Given the historically high levels of military spending due to geo-strategic location and long-standing Kashmir issue with the neighboring country, this drain essentially leaves little cushion for spending on education (2.47% of the total government expenditures in 2014), research and development (0.293% as percent of GDP in 2013) and health (2.6% of GDP in 2014) – [Source; World Bank Development Indicators] – which are crucial areas for Pakistan to focus on, given the fact that majority of the population in the country is poor [4]. Amid the stagnant nature of foreign exchange proceeds from goods and services sectors, the increasing level of dependence on workers' remittances for Pakistan (Figure 2), any sizable shock(s) to the remittances sector is associated with huge risks to get into traps of economic problems on macroeconomic and social fronts with nontrivial consequences [5].




**Source(s)**: Haver; (Units: Mil. USD)

**Figure 2.**
FX proceeds from goods and services exports and remittances

With this brief background, we focus on examining the role of workers' remittances, an area which hardly seems to have drawn attention under a DSGE setting [6]. For example, Smets and Wouters (2002) attempted to explore the implications of sticky import prices and imperfect exchange rate pass-through for optimal monetary policy through a micro-founded open economy DSGE model with sticky domestic and import prices. The influential studies of Smets and Wouters (2003, 2004) and Adolfson (2007a) showed that the new generation DSGE models performs well in terms of forecasting as against the standard as well as the Bayesian VAR models in closed and open economy settings, respectively. In the tradition of Christiano *et al.* (2005) and Smets and Wouters (2003), Adolfson *et al.* (2008) estimated and tested small open economy model on Swedish data to examine the consequences of modifying the uncovered interest rate parity (UIP) condition by altering the structural open economy DSGE model of Adolfson *et al.* (2007b), [7]. Gali and Monacelli (2005) laid out a small open economy version of the Calvo sticky price model to analyze the properties and macroeconomic implications of alternative monetary policy regimes.

In contrast to the aforementioned literature focusing on areas other than remittances channel, Acosta *et al.*'s (2009) study – to the best of our knowledge, is the only influential study – attempted to analyze the effect of remittances on resource allocation and the real exchange rate for El Salvador in a two-sector open economy DSGE model [8]. They introduced remittances into their model in two ways. First, they assume that remitters are home-born foreign residents and send consumption tradable goods to the domestic economy due to their close ties with home country residents. Second, their model assumes that self-interested remitters invest in the home country, which is realized in the form of foreign direct investment (FDI). In the first case, remittances are shortened after purely (i.e. sort of a helicopter drop), which are incorporated in households' budget constraint as additional income only. While in the second case, they endogenize remittances through FDI, thereby affecting firms' optimization decisions. Their study, however, did not take into account the remitters in the households' utility function as member of the domestic family. In their first case, the remittances therefore impact the household optimization decisions via income effect only.

In contrast, we introduce two categories of labor: the labor working domestically (within the country) and the labor working abroad (in foreign countries) in each household. Here, we assume that since the workers working abroad are low-skilled (and hence low-paid), they therefore cannot afford to take their families along. Naturally, their families reside permanently in the home country. Here, it is important to mention that unlike Chami *et al.* (2006) and Acosta *et al.* (2009), our worker is neither an "emigrant" nor an "immigrant" as their objective is to earn livelihood and not to settle in the host country. This assumption is more realistic given the absence of policies granting immigration on permanent basis in Gulf countries and that the labor at any point in time, or at least at the end of the day, is bound to come back to the home country. Therefore, their treatment in our model comes through the total labor, that is, the labor working within the country and the labor working abroad. In our model, while maximizing the overall utility, each household in the home country takes into account consumption and leisure of the remitters as well. In this way, changes in the relative wages have impact on labor leisure and saving-consumption choices not only through the income effect but also through the substitution effect [9].

Furthermore, we do not consider the second case of Acosta *et al.* (2009) where the remitters remit as FDI, because in this case the remitters are low-paid and do not save much that they can use as FDI in the home country. This assumption is not realistic because the overall FDI is very low in Pakistan (0.83% of GDP for the period 2014–2015). Furthermore, specific data are not available where the distinction in country's Balance of Payment (BOP) accounts – that whether the FDI is originated from workers working abroad or other sources – is made for ease of computation. We therefore introduced FDI directly into our model.

The main findings of our research indicate that a decrease in foreign remittances dampens domestic consumption as well as imported-investment goods, puts pressure on exchange rate, worsens the current account balance and hampers the real growth. The rest of the paper is structured as follows. In Section 2,we present the theoretical model. Section 3 is advocated to describe the calibration of model parameters. Section 4 explains the impulse response functions obtained from the model, while Section 5 concludes the paper.

## 2. The model

Our main vehicle is a new Keynesian-type small open economy DSGE model with three domestic agents: households, firms and a government. The latter constitutes both fiscal and monetary authorities. The household's preferences are the function of consumption and leisure, whereas agents consume the goods produced not only by the domestic economy but also imported goods as the final consumption good. The households supply a proportion of their labor to foreign firms, while the remaining differentiated labor is provided to labor packers. These labor packers in turn supply labor to domestic intermediate firms under a perfectly competitive environment. Households accumulate capital both through domestic investment and foreign investments, and rent it out to intermediate firms. They also hold domestic and foreign bonds, the choice for which depends upon UIP. The model has three layers in production: intermediate goods, final goods and exports. For the production of intermediate goods, capital and labor are used, which, in turn, are used to produce homogenous final goods. Part of the homogenous final goods is consumed domestically, while the remaining is acquired by the exporters to be sold out to the rest of the world.

Broadly, the model contains three categories of firms: domestic, exporting and importing firms. Domestic firms are of two types: intermediate goods producing firms and final goods producing firms. For the production of intermediate goods, capital and labor are used, which, in turn, are used to produce homogenous final goods. Part of the homogenous final goods is consumed domestically, while the remaining is acquired by the exporters. They, in turn, package the final good as per the international standards for export purposes. Importing firms buy two types of homogenous good: consumption goods and investment goods in the world market. They package them and sell them to domestic households.

The fiscal authority accounts for the impact of the shocks originating from government expenditures. It issues domestic bonds and imposes taxes to generate funds for the purchase consumption goods. Furthermore, the fiscal authority may take external debt to balance the payments. The monetary authority, on the other hand, sets the nominal interest rate, which – for the sake of convenience – is accounted for through a simple Taylor rule [10]. The choice of the nominal interest rate is primarily driven by the fact that the State bank of Pakistan (SBP) uses this rate as the policy rate, which constitutes signaling effect as all the economic agents may not necessarily work out their decisions through real interest rate.

### *2.1 Households*

There is a continuum of households of measure one. We posit that the representative households' preferences may be expressed by the following function:

$$E_{j,0}\sum_{t=0}^{\infty}\beta^{t}\left(\log(C_t - hC_{t-1}) - \varphi_L\frac{(L_t)^{1+\sigma_L}}{1+\sigma_L}\right) \tag{1}$$

Where the parameter $\beta \in (0,1)$ is a discount factor and the parameter $\sigma_L$ is the elasticity of work effort with respect to real wage. The variable $C_t$ is a composite consumption index of both domestically produced and imported goods denoted by $C_t^d$ and $C_t^m$, respectively, while $h$

is habit persistent parameter. The $C_t$ can be expressed as:

$$C_t = \left[ (1-\gamma_c)^{\frac{1}{\varepsilon_c}} \left( C_t^d \right)^{\frac{\varepsilon_c - 1}{\varepsilon_c}} + \gamma_c^{\frac{1}{\varepsilon_c}} \left( C_t^m \right)^{\frac{\varepsilon_c - 1}{\varepsilon_c}} \right]^{\frac{\varepsilon_c}{\varepsilon_c - 1}} \tag{2}$$

Where $P_t$ is CPI index representing weighted average of both the domestic and imported price indices denoted by $P_t^d$ and $P_t^m$, respectively. The parameter $\varepsilon_c > 1$ is the elasticity of substitution between domestic and imported consumption goods, while the parameter $\gamma_c$ determines the share of import price index in CPI as:

$$P_t = \left[ (1-\gamma_c) \left( P_t^d \right)^{1-\varepsilon_c} + \gamma_c \left( P_t^m \right)^{1-\varepsilon_c} \right]^{\frac{1}{1-\varepsilon_c}} \tag{3}$$

Given the composite demand function in Equation (2), households maximize their consumption subject to their budget constraint as:

$$C_t^d = (1-\gamma_c) \left( \frac{P_t^d}{P_t} \right)^{-\varepsilon_c} C_t \tag{4}$$

$$C_t^m = \gamma_c \left( \frac{P_t^m}{P_t} \right)^{-\varepsilon_c} C_t \tag{5}$$

Equations (5) and (6) show that consumption of domestic and imported goods changes with their relative prices and aggregate consumption level. Since the households provide capital services to intermediate firms, they can therefore increase their capital stock by investing $I_t$ in additional physical capital. The law of motion for the household's physical capital stock $K_t$ is given by:

$$K_t = (1-\delta) K_{t-1} + I_t \tag{6}$$

Here, $\delta$ is the rate of depreciation of capital. As with consumption, total investment is assumed to be given by a constant elasticity of substitution (CES), which is an aggregate of the domestic $I_t^d$ and foreign investment $I_t^m$ goods such that:

$$I_t = \left[ (1-\gamma_i)^{\frac{1}{\varepsilon_i}} \left( I_t^d \right)^{\frac{\varepsilon_i - 1}{\varepsilon_i}} + \gamma_i^{\frac{1}{\varepsilon_i}} \left( I_t^m \right)^{\frac{\varepsilon_i - 1}{\varepsilon_i}} \right]^{\frac{\varepsilon_i}{\varepsilon_i - 1}} \tag{7}$$

Where $\gamma_i$ is the share of imports in investment, and $\varepsilon_i$ is the elasticity of substitution between domestic and imported investment goods. Assuming that prices of investment goods and consumption goods are the same, optimal allocation of investment between domestic and imported investment goods is given by:

$$I_t^d = (1-\gamma_i) \left( \frac{P_t^d}{P_t} \right)^{-\varepsilon_i} I_t \tag{8}$$

$$I_t^m = \gamma_i \left(\frac{P_t^m}{P_t}\right)^{-\epsilon_i} I_t \tag{9}$$

Equation (9) and (10) show that investment of domestic and imported goods changes with their relative prices and aggregate investment level.

*2.1.1 Labor supply and wage decisions for domestic and migrated labor sectors* [11]. The households supply a proportion of their labor to foreign firms, depending upon the demand. Since wages are assumed to be already higher in host countries and the households make a small portion of the total wage earners abroad, they therefore do not have bargaining power to set wages abroad. The remaining differentiated labor $L_t^d$ is provided to labor packers – who, in turn, supply them to domestic intermediate firms, presumably under a perfectly competitive environment – especially after packing/equipping the labor as per the firms' demand. Given the aforementioned, the aggregate labor supply can be given by the following:

$$L_t^d = \left(\int_0^1 \left(L_{l,t}^d\right)^{\frac{\theta_L - 1}{\theta_L}} dl\right)^{\frac{\theta_L}{\theta_L - 1}}, \quad L_t^{mig} = \left(\int_0^1 \left(L_{l,t}^{mig}\right)^{\frac{\theta_L^* - 1}{\theta_L^*}} dl\right)^{\frac{\theta_L^*}{\theta_L^* - 1}}$$

Where $\theta_L$ and $\theta_L^*$ are elasticities of substitution between different labor types in the domestic labor supply $L_t^d$ and foreign labor supply $L_t^{mig}$ sectors. The conditional demand for domestic and migrated labor from households is given as:

$$L_{l,t}^d = \left(\frac{W_{l,t}^d}{W_t^d}\right)^{-\theta_L} L_t^d \ldots L_{l,t}^{mig} = \left(\frac{W_{l,t}^{mig}}{W_t^{mig}}\right)^{-\theta_L^*} L_t^{mig}$$

and given that the total labor demand from households is:

$$L_t = L_t^d + L_t^{mig}$$

the wage cost for the domestic goods producers would be:

$$W_t^d = \left(\int_0^1 \left[W_{l,t}^d\right]^{1-\theta_L} dl\right)^{\frac{1}{1-\theta_L}} \tag{11}$$

The households $i$ set their domestic wages following a Calvo setting. In each period, households face $(1 - \xi_w^d)$ probability to re-optimize wages. All other households that provide labor for domestic firms can only partially index their wages by past inflation.

$$W_{t+k}^d(i) = X_{t+w}^w W_t^d(i)$$

where $X_{t+w}^w = \pi_t.\pi_{t+1} \ldots\ldots \pi_{t+k}, if\ k > 0$, otherwise $X_{t+k}^w = 1$.

Therefore, the relevant part of the Lagrangian for the household $i$ is then:

$$\Gamma^d(i) = E_t \sum_{k=0}^{\infty} \left(\beta \xi_W^d\right)^k \left[X_{t+w}^w \widehat{W}_t^d - MRS_{t+k}^d(i)\right] L_{l,t+k}^d$$

Here, $MRS_t^d(i)$ is a marginal rate of substitution for $i$th domestic household. The households will optimize with respect to $\widehat{W}_t^d$. The maximized function as a result is as follows:

$$\widehat{W}_t^d = \frac{\theta_L}{(\theta_L - 1)} \frac{E_t \sum_{k=0}^{\infty} (\beta \xi_W^d)^k L_{l,t+k}^d MRS_{l,t+k}^d}{E_t \sum_{k=0}^{\infty} (\beta \xi_W^d)^k L_{l,t+k}^d \frac{P_{t+k-1}}{P_{t-1}}}$$

The aggregate wage expression therefore can be expressed as:

$$W_t^d = \left[ (1 - \xi_w^d) \widehat{W_t^d}^{1-\theta_L} + \xi_w^d \left( \pi_{t-1}^d W_{t-1}^d \right)^{1-\theta_L} \right]^{1-\theta_L} \tag{12}$$

The foreign wage $W_t^{mig}$ is set abroad and is therefore treated as exogenous for domestic households:

$$\log\left(\frac{W_t^{mig}}{W_{t-1}^{mig}}\right) = (1 - \rho_{W^{mig}}) \log(SW^{mig}) + \rho_{W^{mig}} \log\left(\frac{W_{t-1}^{mig}}{W_{t-2}^{mig}}\right) + \omega_{W^{mig}t},$$

where $\rho_{W^{mig}}$ is autocorrelation coefficient and $\omega_{W^{mig}t}$ is a zero-mean, serially uncorrelated shock with standard errors $\sigma_{W^{mig}t}$.

*2.1.2 Intertemporal optimizing households.* The households' total income constitutes five major components. First is the labors' disposable income $(1 - \tau_{inc,t}) W_t L_t$, where $\tau_{inc,t}$ is the income tax rate. Second is the rental income denoted by $R_{K,t} K_{j,t}$. The third is the return both on domestic and foreign bonds denoted by $B_{t-1}$, and $e_t F_{j,t-1}$, respectively. Fourth are the profits of domestic final firms $Div_t^D$, and fifth are the exporting and importing firms denoted by $Div_t^X$ and $Div_t^m$, respectively. It may be noted that $e_t$ represents the nominal exchange rate.

Here, it is important to mention that we introduce remittances, which are the focus of this research via households' budget constraint. Here, we assume that the household labor income is the sum of domestic labor income $W_t^D L_{j,t}^D$ as well as remittances, which enters the model through the term $\gamma_{t,j}^{mig} e_t W_t^{mig} L_{j,t}^{mig}$. It is important to mention that here we assume that some of the household members work within the country, and the others from the same household work abroad. We further assume that the household members that work abroad send part $\gamma_{t,j}^{mig}$ of their earnings $W_t^{mig} L_{j,t}^{mig}$ to their families in Pakistan, while the rest is presumably consumed by them.

The households maximize Equation 1 subject to the following intertemporal budget constraint:

$$\frac{e_t F_t}{(1 + R_t^*)} + \frac{B_t}{(1 + R_t)} + (1 + \tau_{c,t}) P_t C_t + P_t I_t$$

$$= e_t F_{t-1} + B_{t-1} + (1 - \tau_{inc,t}) W_t^D L_{j,t}^D + \gamma_t^{mig} e_t W_t^{mig} L_{j,t}^{mig} + R_{K,t} K_t + Div_t^D + Div_t^X + GT_t \tag{13}$$

The household's first-order conditions are as follows:

$$\frac{W_t^D}{P_t} = \frac{(1 + \tau_{c,t})}{(1 - \tau_{inc,t})} \frac{\varphi_L (L_t^D)^{\sigma_L}}{\left( (C_t - hC_{t-1})^{-1} - \beta h E_0 (C_{t+1} - hC_t)^{-1} \right)} \tag{14}$$

$$\frac{e_t}{e_{t+1}} = \frac{(1+R_t^*)}{(1+R_t)} \tag{15}$$

$$1 = \frac{1}{(1+R_t)}\left(\pi_{t+1}(1-\delta) + \frac{R_{K,t}}{P_t}\right) \tag{16}$$

Equation (14) is the labor supply equation, Equation (15) explains exchange rate parity and Equation (16) ) equates rate of return on bonds and capital.

*2.2 Firms*

At firms' level, we suppose three layers in domestic production, that is, the firms that produce the final goods, the firms that produce intermediate goods and finally the exporting firms.

*2.2.1 The final goods sector.* The final homogeneous goods $Y_t^d$ are produced presumably using a CES technology with a continuum of domestic intermediate goods $Y_{i,t}^d$ as inputs such that:

$$Y_t^d = \left(\int_0^1 \left(Y_{i,t}^d\right)^{\frac{\theta-1}{\theta}} di\right)^{\frac{\theta}{\theta-1}} \tag{17}$$

Here, $\theta$ is the elasticity of substitution among differentiated intermediate goods, as well as input and output prices of the firms – denoted by $P_{i,t}^d$ and $P_t^d$, respectively – that produce final goods are conditional as given. Profit maximization on their part thus leads to the following first-order condition:

$$\frac{Y_{i,t}^d}{Y_t^d} = \left(\frac{P_{i,t}^d}{P_t^d}\right)^{-\theta} \tag{18}$$

Equation (18) represents domestic demand of $i^{th}$ good which depends upon its relative price and aggregate domestic demand. By integrating (18) and using (17), we obtain the following relation between the prices of the final goods and the prices of intermediate goods:

$$P_t^d = \left(\int_0^1 \left(P_{i,t}^d\right)^{1-\theta} di\right)^{\frac{1}{1-\theta}} \tag{19}$$

Here, it may be noted that some of these good are consumed and invested domestically, while others are exported, such that:

$$Y_t^D = I_t^D + C_t^D + G_t \tag{20}$$

*2.2.2 Intermediate goods sector.* We assume that there is a continuum of domestic intermediate firms of measure one. Production is carried out by means of two major input factors, namely, labor and capital, expressed as:

$$Y_{i,t}^d = A_t K_{i,t}^{\alpha} L_{i,t}^{d(1-\alpha)} \tag{21}$$

The parameter $\alpha$ is the share of capital in intermediate production. $A_t$ is an aggregate technology shock that follows a stochastic process given by:

$$\log A_t = (1-\rho_A)A + \rho_A \log(A_{t-1}) + \omega_{A,t}$$

Where $\rho_A$ technology is shock persistence and $\omega_{A,t}$ is a normally distributed, serially uncorrelated shock with zero mean and standard deviation $\sigma_{A,t}$. The firms that produce intermediate goods maximize their profits subject to the available production technology, thereby setting demand for labor and capital, given as:

$$\frac{K_{i,t}}{L_{i,t}} = \frac{\alpha \quad w_t^d}{(1-\alpha) r_{K,t}} \tag{22}$$

Equation (22) connects capital to labor ratio with their relative prices. It is important to observe that:

$$w_t^d = \frac{W_t^d}{P_t}, \text{ and } r_{K,t} = \frac{R_{k,t}}{P_t}$$

The firm's real marginal cost is given by:

$$mc_{i,t}^d = \frac{1}{A_t} \alpha^{-\alpha} (1-\alpha)^{-(1-\alpha)} w_t^{d1-\alpha} r_{K,t}^{\alpha} \tag{23}$$

Each firm $i$ produces differentiated goods and therefore has a market power in price-setting decisions. As in Calvo (1983), formal firms are not allowed to change their prices unless they receive a random "price-change signal." We assume that in each period, there is a probability $\xi_{p^d}$ that formal intermediate producers will not be able to re-optimize their price and therefore index it according to:

$$P_{i,t+k}^d = N_{t+k}^d P_{i,t}^d$$

where, $N_{t+k}^d = \pi_t^d . \pi_{t+1}^d \ldots\ldots \pi_{t+k}^d$, *if* $k$>0, otherwise $\pi_t = 1$

$$\pi_t^d = \frac{P_t^d}{P_{t-1}^d}$$

The probability that a given price can be re-optimized in any particular period is constant and equal to $1 - \xi_{p^d}$. Profit optimization by producers that are "allowed" to re-optimize their prices at time $t$ maximizes their profit function subject to price $\check{P}_{i,t}^d$. Formal firm $i$ optimizes following profit function:

$$\max_{\substack{d \\ P_{i,t}}} \Omega p = E_t \sum_{s=0}^{\infty} \left(\beta \xi_{p^d}\right)^s \left[ N_{t+s}^d \check{P}_{i,t}^d - MC_{i,t+s}^d \right] Y_{i,t+s}^d,$$

which results in:

$$\check{P}_{i,t}^d = \left(\frac{\theta}{\theta - 1}\right) \left( \frac{E_t \sum_{s=0}^{\infty} \left(\beta \xi_{p^d}\right)^s MC_{i,t+s}^d Y_{i,t+s}^d}{E_t \sum_{s=0}^{\infty} \left(\beta \xi_{p^d}\right)^s Y_{i,t+s}^d \pi_{t+s}^d} \right) \tag{24}$$

The aggregate formal price level is given by:

$$P_t^d = \left[ \left(1 - \xi_{p^d}\right) \left( \check{P}_{i,t}^d \right)^{1-\theta} + \xi_{p^d} \left( \pi_{t-1}^d P_{t-1}^d \right)^{1-\theta} \right]^{\frac{1}{1-\theta}} \tag{25}$$

Log-linearizing and combining Equations (21) and (22) yield the following aggregate Phillips curve relationship:

$$\tilde{\pi}_t^d == \frac{1}{(1+\beta)} \tilde{\pi}_{t-1}^d + \frac{\beta}{(1+\beta)} \tilde{\pi}_{t+1}^d + \frac{\left(1 - \xi_{p^d}\right)\left(1 - \beta\xi_{p^d}\right)}{\xi_{p^d}(1+\beta)} \widetilde{mc}_t^d \tag{26}$$

*2.2.3 The exporting firms sector.* Here, we suppose that there is a continuum of exporting firms indexed by s ∈ [01]. Each exporting firm buys a homogeneous final good and sells it to the rest of the world. The demand for these goods comes from the households of foreign economy, who decide whether to consume or invest the goods they import. We assume that their total consumption and investment basket follows a CES. Therefore, their total demand for the goods of the exporting firms can be written as:

$$Y_t^X = \left( \frac{P_t^x}{P_t^*} \right)^{-\theta^{mx}} Y_t^* \tag{27}$$

Where $\theta^{\text{mx}}$ is the elasticity of substitution between domestic and foreign goods in a foreign economy. $P_t^X$ is export price index, and $Y_t^*$ and $P_t^*$ are the output prices and the prices in the rest of the world, respectively. We assume that all the macroeconomic variables in a foreign country are exogenous and follow an AR(1) process, such that:

$$\log\left( \frac{P_t^*}{P_{t-1}^*} \right) = (1 - \rho_{\pi^*}) \log\left(\pi^*\right) + \rho_{\pi^*} \log\left( \frac{P_{t-1}^*}{P_{t-2}^*} \right) + \omega_{\pi^*,t},$$

and,

$$\log\left(Y_t^*\right) = (1 - \rho_{Y^*}) \log\left(Y^*\right) + \rho_{Y^*} \log\left(Y_{t-1}^*\right) + \omega_{Y^*,t}.$$

Where $\pi^*$ is the steady-state rate of foreign inflation, and$\rho_{\pi^*}$ and $\rho_{Y^*}$ are the autocorrelation coefficients. $\omega_{\pi^*,t}$ and $\omega_{Yw,t}$ are zero-mean and serially uncorrelated shocks with standard errors $\sigma_{\pi^*,t}$ and $\sigma_{Y^*,t}$, respectively. Just like the case with domestic prices, we assume that export prices also follow a Calvo process. The log-linearized aggregate export price inflation thus is given by:

$$(1+\beta)\tilde{\pi}_t^x = \tilde{\pi}_{t-1}^x + \beta\tilde{\pi}_{t+1}^x + \frac{\left(1 - \xi_{p^x}\right)\left(1 - \beta\xi_{p^x}\right)}{\xi_{p^x}} \widetilde{mc}_t^x \tag{28}$$

where,

$$\widetilde{mc}_t^x = \tilde{P}_t + \tilde{e}_t - \tilde{P}_t^x \tag{29}$$

*2.3 Imports*

The import sector consists of foreign firms that buy homogenous good in the world market at price $P_t^*$. We presume that there are two different types of these importing firms; one, that

turns the imported product into a differentiated consumption good $C_t^{m1}$, and the other that turns it into a differentiated investment good $I_t^m$. In each of these two categories, there is a continuum of importing firms that sell their differentiated consumption goods to households $C_t^m$ and the government $G_t^m$, whereas the investment goods are being sold to the households $I_t^m$.

$$Y_t^m = C_t^m + I_t^m + G_t^m \tag{30}$$

Let the private and public consumptions be expressed as:

$$C_t^{m1} = C_t^m + G_t^m.$$

The different importing firms buy the homogenous good at price $P_t^*$ in the world market. The final import consumption and investment goods are a composite of a continuum of $i$ and $r$ differentiated imported consumption and investment goods, each supplied by a different firm, which we assume to follow the CES function:

$$C_t^{m1} = \left( \int_0^1 \left( C_{i,t}^{m1} \right)^{\frac{\theta^{mc}-1}{\theta^{mc}}} di \right)^{\frac{\theta^{mc}}{\theta^{mc}-1}} \tag{31}$$

and,

$$I_t^m = \left( \int_0^1 \left( I_{r,t}^m \right)^{\frac{\theta^{mi}-1}{\theta^{mi}}} dr \right)^{\frac{\theta^{mi}}{\theta^{mi}-1}} \tag{32}$$

The demand for the respective differentiated imported consumption and investment goods is given by:

$$C_{i,t}^{m1} = \left( \frac{P_{i,t}^m}{P_t^m} \right)^{-\theta^{mc}} C_t^m \tag{33}$$

and,

$$I_{r,t}^m = \left( \frac{P_{r,t}^m}{P_t^m} \right)^{-\theta^{mi}} I_t^m \tag{34}$$

Where, for the sake of computational convenience, we assume that $\theta^{mc} = \theta^{mi}$. In order to allow for incomplete exchange rate pass-through to the consumption and investment import prices, we assume local currency price stickiness. Phillips curve relations for the imported consumption and investment good can be expressed as:

$$(1+\beta)\tilde{\pi}_t^m = \tilde{\pi}_{t-1}^m + \beta\tilde{\pi}_{t+1}^m + \frac{\left(1-\xi_{p^m}\right)\left(1-\beta\xi_{p^m}\right)}{\xi_{p^d}} \widetilde{mc}_t^m \tag{35}$$

where,

$$\widetilde{mc}_t^m = \tilde{P}_t^* + \tilde{e}_t - \tilde{P}_t^m.$$

*2.4 The fiscal sector (authorities)*

The fiscal authority purchases the composite consumption good $G_t$, issue bonds $B_t$ and raises taxes $\tau_c$ and $\tau_{inc}$. Like private consumption, we also assume that the government consumption $G_t$ is a CES index of domestically produced goods as well as imported goods such that:

$$G_t = \left[ (1-\gamma_{cg})^{\frac{1}{\varepsilon_c}} \left(G_t^d\right)^{\frac{\varepsilon_c-1}{\varepsilon_c}} + \gamma_{cg}^{\frac{1}{\varepsilon_c}} \left(G_t^m\right)^{\frac{\varepsilon_c-1}{\varepsilon_c}} \right]^{\frac{\varepsilon_c}{\varepsilon_c-1}} \tag{36}$$

As was the case with private consumption, here we posit that the government purchases have the same intra-temporal elasticity of substitution, that is, $\varepsilon_c$>1. The parameter $\gamma_{cg}$ in Equation 36 determines the share of imports in public consumption goods. The government demand for these goods can be expressed as:

$$G_t^d = (1-\gamma_{cg}) \left(\frac{P_t^d}{P_t}\right)^{-\varepsilon_c} G_t \tag{37}$$

$$G_t^m = \gamma_{cg} \left(\frac{P_t^m}{P_t}\right)^{-\varepsilon_c} G_t \tag{38}$$

*2.4.1 Government budget and deficit.* The government revenues $GR_t$ are defined as follows:

$$GR_t = \tau_{c,t} P_t^c C_{j,t} + \tau_{inc,t} W_t L_{j,t} \tag{39}$$

$$G_t = \tau_{c,t} P_t^c C_{j,t} + \tau_{inc,t} W_t L_{j,t} + B_t - (1+R_{t-1}) B_{t-1} + e_t D_t^* + \left(1+R_{t-1}^*\right) e_t D_{t-1}^*.$$

Where income from taxes is the essential revenue of the state budget. Personal income tax revenues are dependent on wages, employment ($W_t L_{j,t}$) and the tax rate imposed, which are represented by implicit personal income tax rate $\tau_{inc,t}$. The excise taxes are modeled by one implicit tax rate on consumption $\tau_{c,t}$, which is imposed on nominal consumption $P_t^c C_{j,t}$. By subtracting revenues from expenditures, we may easily derive a primary government deficit:

$$DF_t = G_t - GR_t, \tag{40}$$

which is accumulated into debt, such that:

$$\frac{B_t}{(1+R_t)} = DF_t + B_{t-1} - e_t D_t^* + \left(1+R_t^*\right) e_t D_{t-1}^* \tag{41}$$

The variable $D_t^*$ represents external debt at time $t$, and the government consumption $G_t = \overline{g}^* g_t$ while the tax rates follow an AR(1) process, such that:

$$g_t = (1-\rho_{1,g}) g + \rho_{1,g} g_t + \omega_{g,t}$$

$$\tau_{c,t} = \left(1-\rho_{\tau_c}\right) \tau_c + \rho_{\tau_c} \tau_{c,t} + \omega_{\tau_c,t}$$

$$\tau_{inc,t} = \left(1 - \rho_{\tau_{inc}}\right)\tau_{inc} + \rho_{\tau_{inc}}\tau_{inc,t} + \omega_{\tau_{inc},t}$$

Where $\omega_{g,t}$, $\omega_{\tau_c,t}$ and $\omega_{\tau_{inc},t}$ are normally distributed, serially uncorrelated shocks with zero mean and standard deviation, that is, $\sigma_{g,t}$, $\sigma_{\tau_c,t}$ and $\sigma_{\tau_{inc},t}$, respectively. Since the variable $D_t^*$ represents external debt at time $t$, the government therefore faces the following budget constraint [12]:

$$G_t = \tau_{c,t}P_t^c C_{j,t} + \tau_{inc,t}W_t L_{j,t} + \frac{B_t}{(1+R_t)} - B_{t-1} + e_t D_t^* - \left(1 + R_{t-1}^*\right)e_t D_{t-1}^* \tag{42}$$

*2.5 Monetary sector (authorities)*

Consistent with Smets and Wouter (2003), we assume that the monetary authority sets the nominal interest rate according to a simple Taylor rule, such that:

$$\frac{R_t}{R} = \varepsilon_{R,t}\left(\frac{R_{t-1}}{R}\right)^{\rho_R}\left(\left(\frac{\pi_t}{\pi}\right)^{\psi_1}\left(\frac{Y_t}{Y^p}\right)^{\psi_2}\right)^{1-\rho_R} \tag{43}$$

Where $R$ and $\pi$ are steady-state real interest rate and inflation, respectively, whereas $Y^p$ is potential output at time $t$. The parameter $\rho_R$ is the degree of interest rate smoothing in interest rate rule, and $\varepsilon_{R,t}$ denotes nominal interest rate shocks.

*2.6 Aggregate equilibrium conditions*

Broadly, the current account equation can be expressed as:

$$CA_{t=}P_t^x Y_t^x - \frac{P_t^m Y_t^m}{e_t} + \gamma_t^{mig} W_t^{mig} L_{j,t}^{mig} \tag{44}$$

also,

$$Y_t = Y_t^D + Y_t^X \tag{45}$$

## 3. Calibrations

Since calibration requires a number of values for the parameters – 22 in our model – utmost care has been taken to adopt values from comprehensive and latest possible available studies/sources. In case where the parameter values are not available from relevant research studies on Pakistan, we rely on international studies. Table 1 summarizes the parameter values for the purpose of calibration. The discount factor $\beta$ is given a standard value 0.978 [13]. The weight on leisure in the utility function $\varphi_L$ is calibrated at 1.27 (see Ahmad, 2016) so that the representative household spends about one-third of its total working time in the steady state [14].

We assume perfect elasticity of work effort with respect to real wage. The consumption habit persistence parameter $h$ is calibrated from quarterly consumption series from Hanif *et al.* (2013) and set at 0.63. The share of imports in aggregate consumption $\gamma_c$ is calibrated, using the expression

$$\frac{C_t^m}{C_t^d} = \frac{\gamma_c}{(1-\gamma_c)}\left(\frac{P_t^m}{P_t^d}\right)^{-\varepsilon_c}$$

and assuming that $\frac{P_t^m}{P_t^d} = 1$ in steady state.

| Parameter definition | Value | Parameter definition | Value |
|---|---|---|---|
| 1. Discount factor($\beta$) | 0.978 | 12. Calvo parameter (Domestic) ($\xi$pd ) | 0.25 |
| 2. weight of leisure in the utility function ($\phi$L) | 1.27 | 13. Calvo parameter (imported) ($\xi$pm ) | 0.25 |
| 3. Elasticity of work effort with respect to real wage ($\sigma$L) | 1 | 14. Calvo parameter (export) ($\xi$px ) | 0.6 |
| 4. Consumption habit persistence ($h$) | 0.63 | 15. Steady-state consumption tax rate ($\tau$c ) | 0.10 |
| 5. Substitute elasticity $b/w$ domestic/ imported consumption goods ($\varepsilon$c) | 2 | 16. Steady-state income tax rate ($\tau$inc ) | 0.05 |
| 6. Substitute elasticity b/w domestic/ imported investment goods ($\varepsilon$i) | 6 | 17. Interest rate smoothing parameter ($\rho$R) | 0.59 |
| 7. Share of import prices in CPI index ($\gamma$c) | 0.091 | 18. Weight assigned to inflation in Taylor rule ($\psi$1) | 2.845 |
| 8. The share of imports in aggregate investment ($\gamma$i) | 0.27 | 19. Weight assigned to output gap in Taylor rule ($\psi$2) | 0.25 |
| 9. Share of imports in real government consumption($\gamma$cg) | 0.15 | 20. Capital share in intermediate domestic production ($\alpha$) | 0.6 |
| 10. Capital depreciation rate($\delta$) | 0.016 | 21. Substitute elasticity b/w in domestic/imported consumption goods in foreign economy ($\theta$mx) | 5 |
| 11. Wage Calvo parameter ($\xi$Wd) | 0.34 | 22. The elasticity of the derived demand for the imported good ($\theta^{\text{mc}}$) | 0.98 |

**Table 1.**
Parameter values for calibrations

Where $C_t^d$ = total private consumption –0.7422 × total imports, and $C_t^m = 0.7422 \times$ total imports [15]. The results imply that $\gamma_c = 0.22$. The share of imports in aggregate investment $\gamma_i$ is calibrated in a similar fashion:

$$\frac{I_t^m}{I_t^d} = \frac{\gamma_i}{(1-\gamma_i)}\left(\frac{P_t^m}{P_t^d}\right)^{-\varepsilon_i}$$

while assuming that $\frac{P_t^m}{P_t^d} = 1$ in steady state. Where $I_t^d$ = total private investment –0.1837 × total Imports, and $I_t^{mt} = 0.1837 \times$ total Imports [16]. The substitution elasticity between domestic and imported consumption/investment goods $\varepsilon_c/\varepsilon_i$ is set at 2 to balance composite consumption/investment index equation. Consistent with Ali (2014), we set the share of imports in aggregate investment $\gamma_i$ and the share of imports in real government consumption $\gamma_{cg}$ equal to 0.27 and 0.15, respectively. We set the share of import prices $\gamma_i$ equal to 0.091 based on the share of the imported items in the CPI basket. The substitution elasticity between domestic and imported investment goods $\varepsilon_i$ is set at 6 to balance composite investment index equation.

Following Ahmad *et al.* (2012), we set the parameter of depreciation rate $\delta$ at 0.016. Based on the study of Choudhary *et al* (2014),the domestic price and wage stickiness parameters are set at 0.34 and 0.25, respectively. Consistent with Smets and Wouter (2003), we assume Calvo parameter for imported goods is same as domestic Calvo parameter. Similarly, we also assume the price stickiness $\xi_{p^x}$ parameter for exports at 0.6. The price stickiness $\xi_{p^x}$ parameter for exports is assumed to be 0.6. This is domestic Calvo parameter usually used for USA . Consistent with the data collected by the Federal Board of Revenue, the steady-state taxes on consumption and labor are chosen, so that $\tau_c = 0.10$ and $\tau_{\text{inc}} = 0.05$, respectively. We estimated log-linearized version of Taylor rule using quarterly data of 3-month Treasury bill rate. We have estimated Taylor rule and used its coefficients $l$ for setting the values of weights assigned to inflation and output ($\psi$1, $\psi$2) and interest rate smoothing parameter $\rho R$. We fix $\alpha = 0.6$ to replicate the capital share in real GDP. The elasticity of the derived demand for the imported/exported good $\theta^{\text{mc}}/\theta^{\text{mx}}$ is set at 0.98/5, as in Beltran and Draper (2008).

## 4. Impulse response functions

### *4.1 Small positive shocks to remittances*

Although our main focus is on the effects of negative shocks to remittances, we first highlight whether small positive shocks to remittances in case of Pakistan does any good as is generally believed. We therefore present the impulse responses obtained on the basis of calibrated estimations in Figure 3.

As expected, a positive shock to remittances increases the demand for domestic as well as foreign consumption goods due to increase in households' disposable income. As a result of higher consumption, the demand for labor and investment spending also increases. This finding is consistent not only with cross-country evidence in the context of developing countries (see Combes and Ebeke, 2011) but also in Pakistan-specific context. For example, Gillani *et al.* (1981) noted that most of the remittances are spent on consumption (62%), whereas 35% are either invested or saved by the recipient families. Similarly, Amjad (1986),while examining Pakistan's data, found that significant portions of consumption and investment were financed by remittances.

The results also indicate that since increased remittances relax the restraint on imported consumption and investment goods, the aggregate demand increases, which, in turn, boosts the real output. Thus, in effect, an increase in remittances helps both in income and consumption smoothing. This result is consistent with Iqbal and Sattar (2005) who investigated the role of remittances in explaining output growth in Pakistan and found not only a positive relationship between the two but that the former is the third major source of capital for economic growth [17].

On external front, our results reveal that initially the exchange rate appreciates due to the increase in remittances, but later it seems to come under pressure. This phenomenon in part may be explained by the notion that, although with a certain lag, the increase in imports (due to increase in domestic aggregate consumption and aggregate demand) is more than the increase in exports, thereby putting downward pressure on exchange rate [18]. This may be the case because the export sector of Pakistan has been stagnating historically due to multifaceted structural and entrepreneurial problems (State Bank of Pakistan, 2015), which might not allow a catch-up in growth in exports to the extent to more than off-set the increase in import demand, thereby causing the current account balance to deteriorate. Furthermore, on the other hand, an increase in interest rate may also appreciate the currency, thereby making imports increase and current account balance to deteriorate. Thus, here it is evident that positive shocks to remittances can only help in the form of a temporary relief, which is not sustainable unless the structural issues in the export sector are resolved and other sources of foreign exchange are revamped.

On the downside, with an increase in foreign remittances, initially the inflation increases up to 3 quarters, but then slightly falls below its steady-state level for up to 7–8 quarters. The initial increase in inflation seems to be explained by an increase in aggregate consumption, investment, labor demand and output. Further explanation for inflation may come from the increase in demand for imported goods, which considerably exceeds the exports, thereby putting pressure on exchange rate and hence the prices of imported goods. Yet another explanation may also follow from the fact that from the flow of remittances, the recipient households tend to engage in conspicuous rather than productive consumption (Airola, 2007), which would rather tend to be inflationary, at least in the short-term.

### *4.2 Small- and large-size negative shocks to remittances*

In the previous subsection, we highlighted that a small positive shock to remittances helps smoothen consumption and income, increase investment and temporarily relieve exchange rate pressures. On the other side, these results imply that there may be dents in all these

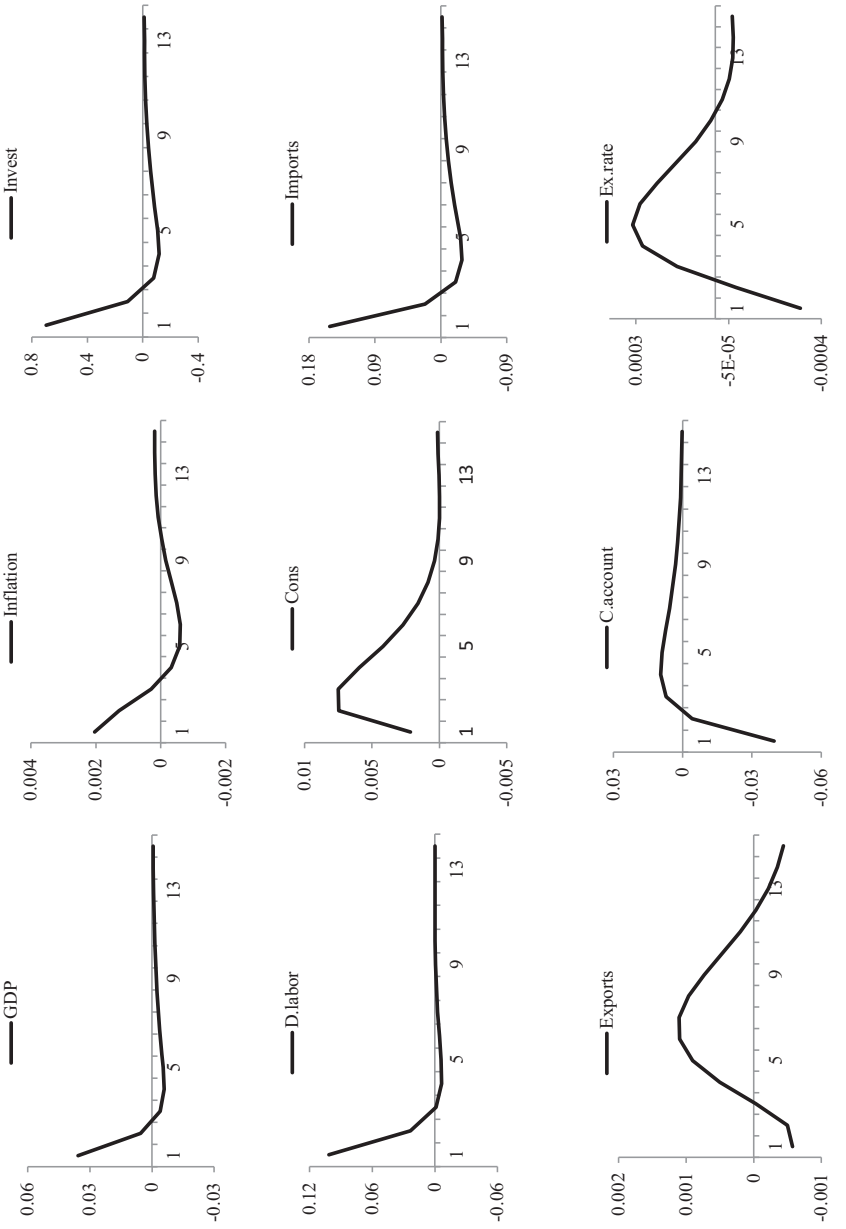



**Figure 3.**
Impulse response functions (IRFS) for 0.01 SD positive shock to remittances

sectors in case of negative shocks to remittances. For the sake of ready reference, we report the IRFS obtained from small- and slightly large-size negative shocks to the flow of remittances to Pakistan (Figure 4). A small negative shock of one standard deviation to the remittances leads to a decrease in demand for domestic and foreign consumption goods due to a decrease in disposable income. Labor demand, investment as well as the output go down, and an increased pressure on exchange rate is witnessed, which deteriorates the current account balance [19]. This deterioration of the current account balance is extremely crucial given the historical and increasing degree of dependence on the remittances channel in Pakistan to bridge the gap (Figure 5).

A relatively large-size negative shock magnifies the adverse effects. Here, it is important to mention that although our DSGE neither is meant to nor accounts for the nonlinearity in effects of remittances across various macroeconomic indicators as the underlying framework assumes linearity, further research on these lines may add different perspectives to our understanding. The chances of occurrence of large-size negative shocks to the remittances sector may not be precluded, which, in fact, may originate both internally and externally (e.g. potential layoffs of workers in Gulf countries due to their depleting fiscal space and international economic slowdown).

A rough historical analysis of the shocks (both positive and negative in terms of standards deviation – Figure 6) to remittances shows that not only extended but high levels of negative shocks are possible. For example, the average flow of remittances (as % GDP) from 1975 to 2013 is 5%, with the worst shock to remittances sector (−0.8 SD) that occurred in 1999, where the flow of workers' remittances stood at 1.6% of GDP mainly due to atomic bomb blasts, which was an internal geo-political decision. This level of negative shock to remittances is way bigger in size than the 0.5% we applied in our analysis, as is shown in Figure 4. During the period of positive shocks to remittances from FY1976 to FY1988 (Figure 6), on average, the level of external debt (flow) remained low at 854.1 million USD, as compared to higher average level of 1645.1 million USD during FY1990–FY2008, which led to a rise in external debt by 93%. It is nevertheless important to mention that this rise could have been even higher had Pakistan not retired its external debts by historically high levels until then during FY2000–2001 and FY2004–2005 in the aftermath of September 11, 1999 attacks in the USA, and the following financial by the USA and international donor agencies, which enabled Pakistan to retire and reschedule its expensive external debts on soft terms and low rates.

## 5. Conclusion

In this paper, we develop a small open economy DSGE model with an enriched micro-founded specification to provide a general frame for the analysis of remittances, one of the main sources of external finance for many – if not all – developing and emerging market economies. We focus on and calibrate the model parameters for Pakistan, a country highly vulnerable to workers' remittances shocks due to historically high levels of trade deficits. We found that a negative shock to remittances hampers growth in consumption, investment, labor demand, demand for imported goods and aggregate output; depreciates the exchange rate; and worsens both the current account balance. Given the higher and increasing degree of dependence of the country on remittances for external finance, occurrence of any sizable negative shocks to the flow of remittances poses nontrivial risks to Pakistan's economy and by association to the economic managers on how well prepared the economy is to cope with such shocks. In light of the historical stalemate in the export sector performance of the country, high levels of external debts and too much dependence on exogenous foreign remittances call for structural reforms to fix the external sector imbalance.

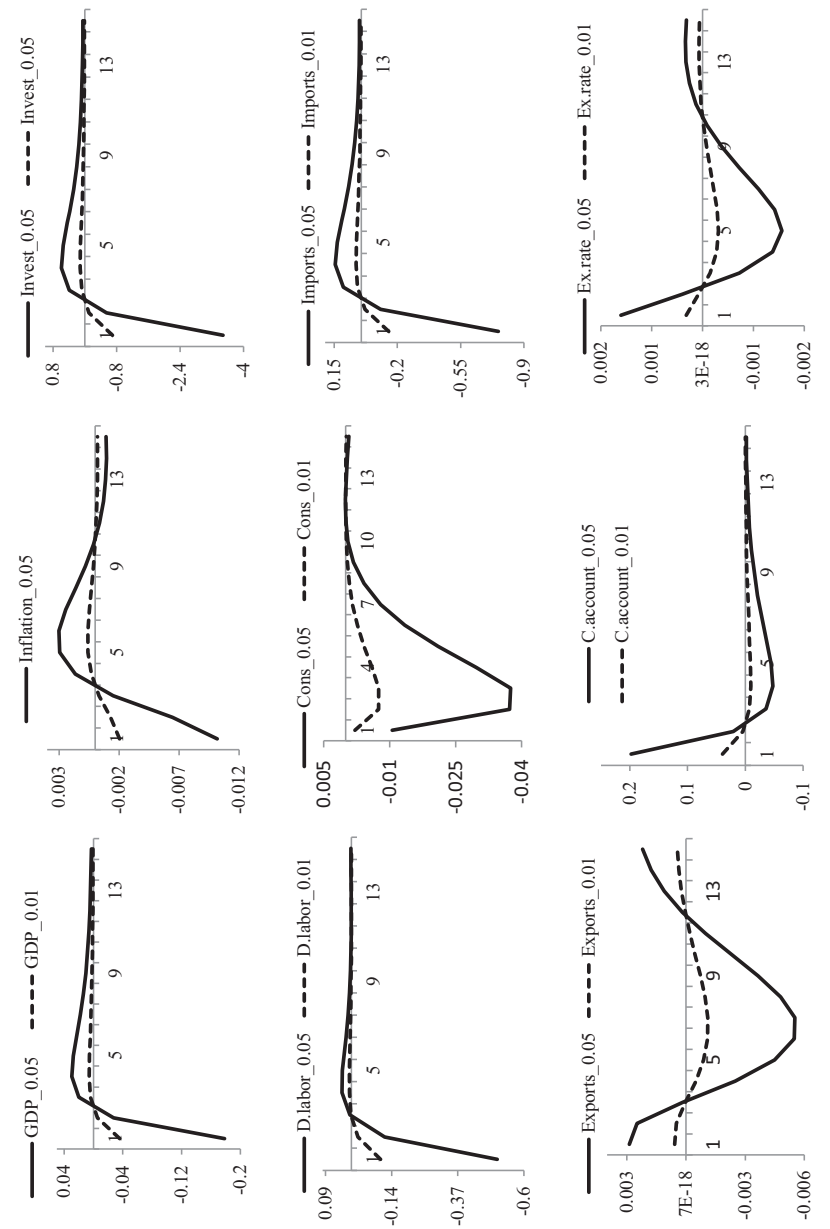



**Figure 4.**
IRFS representing negative shocks of different magnitude to remittances

## Notes

1. The role of foreign remittances is duly acknowledged and well established in the literature. See, for example, Catrinescu *et al.* (2009) and references therein for the impact of remittances on economic growth; Bugamelli and Paterno (2011) and Ebeke and Combes (2013) for its relationship with volatility in output; Mundaca (2009) and Aggarwal *et al.* (2011) for financial development; Amuedo-Dorantes and Pozo (2004) for its relationship with exchange rate; Adams and Page (2005) for significant role of remittances in reducing poverty; Abdih *et al.* (2012) for institutional quality and Balli and Rana (2015) for its role as a significant determinant of risk sharing (income smoothing), among others.
2. Acosta *et al.* (2009) examined the role of remittances with respect to the possibility of Dutch disease for El-Salvador. Pakistan, though a developing country, is distinct in nature. Here, the problem is not appreciation of the currency, but rather the maintenance of exchange rate at certain desirable levels due to the continuing high levels of trade gap.
3. Source: Economic Survey of Pakistan 2015–2016.
4. As per the latest official estimates for 2015, nearly 39% of Pakistanis live in multidimensional poverty, with asymmetric distribution of poverty across urban (9.3%) and rural (54.6%) areas [Source: Economic Survey of Pakistan 2015–2016]. Majority of the country's population (61.242% of total population in 2015) lives in the rural areas of the country [Source: World Bank Development Indicators]. It is important to mention that workers' remittances in Pakistan have been found to significantly reduce poverty (Siddiqui and Kemal (2002), Arif (2004), Jamal (2004), Irfan (2011) and Javed *et al.* (2012)).
5. See Burki (1991), Mansuri (2006), Muhammad *et al.* (2010), Arif and Chaudhary (2015) and Awan (2015) for social benefits of remittances such as better education, health, well-being and good behaviors of relatives and friends with the remitters' recipient families.
6. Although DSGE models are widely used by central banks of advanced and emerging market economies, especially due to their usefulness in terms of scenario and policy analysis, like any other

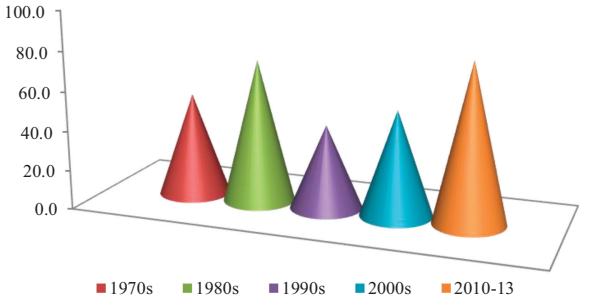



**Figure 5.**
Share of the net current account balance bridged by workers' remittances in Pakistan

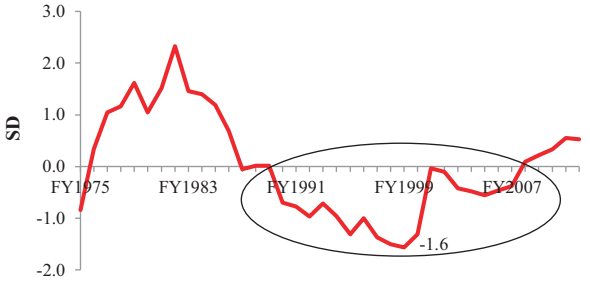



**Figure 6.**
Pakistan's workers' remittances as % GDP (normalized)

models they are not perfect tools of analysis and have limitations. An infinite living representative household (no heterogeneity in household) and stationarity assumptions are some of the key limitations of DSGE model available at: http://www.crei.cat/wp-content/uploads/2016/07/gali_dsge_2017.pdf

7. Also see Adolfson *et al.* (2007b) who extended the closed-economy DSGE model of Christiano *et al.* (2005) by incorporating open economy aspects and other related literature referred therein, including Corsetti and Pesenti (2001), Kolman (2001) and Lubik and Schorfheide (2005).
8. Another relevant study is Chami *et al.* (2006) that investigated the influence of countercyclical remittances on economic variables and the conduct of fiscal and monetary policy in a business cycle setting.
9. We believe that non-inclusion of the substitution effect into the micro-foundations of the model may have implications for the results such models would produce.
10. It is important to acknowledge that the assumption of Taylor rule may not be realistic (Malik and Ahmed, 2010) in closely mimicking the actual monetary policy because the true preference of SBP's monetary policy is not known. Its preference keeps shifting between the dual objectives of inflation and growth (Hayat *et al.*, 2016), depending on the state of the business cycle. The assumption, however, offers convenience and ease of computation. Despite this limitation, we have some confidence in the results of our analysis, as in the recent past, the SBP has been using Forecasting and Policy Analysis System (FPAS) as well DSGE models to provide input for policy formulation while using Taylor's type rule, with specific weights on both objectives.
11. Here, it may be noted that the word "migrated" merely means part of the labor working abroad without having the intention for or the status of "immigrant" or "emigrant."
12. Consistent with the literature, this representation is a simplifying assumption (see, e.g. Adolfson *et al.*, 2007, Equation 4.1), and our focus is not on the fiscal side but on remittances. However, even if fixed, the direction in the movement of different variables would remain the same, with slight difference in magnitude. Adolfson, M., Laseén, S. and Lindé, J., C. (2007b). Bayesian estimation of an open economy DSGE model with incomplete pass-through. *Journal of International Economics 72,* 481–511.
13. The steady-state discount factor is estimated by $\beta = \frac{1}{1+R}$. Where $R$ is the long-run average real interest rate. In Pakistan, average of 3-months T-bills rate from July–1998 to October–2014 is 8.922. Corresponding to this value, quarterly $\beta$ would be 0.978.
14. Standard working time in Pakistan is 8 h.
15. Note that 0.7422 is the ratio of consumption goods in total imports. This number is calculated by Ali (2014).
16. Note that 0.1837 is the ratio of investment goods in total imports. This number is calculated by Ali (2014).
17. Nishat and Bilgrami (1991) also found that remittances positively impact on consumption, investment and imports, and hence GNP in Pakistan.
18. While examining the association between remittances and imports in case of Pakistan, Raheem *et al.* (2014) found the former to be an important long-term determinant of the latter.
19. A supporting evidence to our finding can be referred to in Burney (1987) that an increase in remittances reduces current account deficit, the extent of external debt burden and the need for additional loans.

## References

Abdih, Y., Chami, R., Dagher, J. and Montiel, P. (2012), "Remittances and institutions: are remittances a curse?", *World Development*, Vol. 40, pp. 657-666.

Acosta, P.A., Lartey, E.K.K. and Mandelman, F.S. (2009), "Remittances and the Dutch disease", *Journal of International Economics*, Vol. 79, pp. 102-116.

Adams, R.H. Jr and Page, J. (2005), "Do international migration and remittances reduce poverty in developing countries?", *World Development*, Vol. 33, pp. 1645-1669.

Adolfson, M., Linde, J. and Villani, M. (2007a), "Forecasting performance of an open economy DSGE model for the Euro area", *Econometric Reviews*, Vol. 26 No. 4, pp. 289-328.

Adolfson, M., Laseén, S. and Lindeʹ, J.C. (2007b), "Bayesian estimation of an open economy DSGE model with incomplete pass-through", *Journal of International Economics*, Vol. 72, pp. 481-511.

Adolfson, M., Laseen, S., Linde, J. and Villani, M. (2008), "Evaluating an estimated New Keynesian Small open economy model", *Journal of Economic Dynamics and Control*, Vol. 32, pp. 2690-2721.

Aggarwal, R., Demirgüç-Kunt, A. and Martínez Pería, M.S. (2011), "Do remittances promote financial development?, *Journal of Development Economics*, Vol. 96, pp. 255-264.

Ahmad, S., Pasha, F. and Rehman, M. (2016), "The role of money in explaining business cycles for a developing economy: the case of Pakistan", SBP Working Paper No. 74.

Ahmed, W., Haider, A. and Iqbal, J. (2012), "Estimation of discount factor β and coefficient of relative risk aversion γ in selected countries", State Bank of Pakistan Working Paper No. 53.

Airola, J. (2007), "The use of remittance income in Mexico", *International Migration Review*, Vol. 41 No. 4, pp. 850-859.

Ali, A. (2014), "Share of imported goods in consumption of Pakistan", *SBP Research Bulletin*, Vol. 10 No. 1, pp. 59-61.

Amjad, R. (1986), "Impact of workers' remittances from the Middle East on Pakistan's economy: some selected issues", *Pakistan Development Review*, Vol. 25 No. 4, pp. 757-782.

Amuedo-Dorantes, C. and Pozo, S. (2004), "Workers' remittances and the real exchange rate: a paradox of gifts", *World Development*, Vol. 32, pp. 1407-1417.

Arif, R. and Chaudhry, A. (2015), "The effects of external migration on enrolments, accumulated schooling and dropouts in Punjab", *Applied Economics*, Vol. 47 No. 16, pp. 1607-1632.

Arif, G.M. (2004), "Effects of overseas migration on household consumption, education, health and labour supply", in Oda, H (Ed.), *International Labour Migration from South Asia*, Institute of Development Economics, Japan External Trade Organisation.

Awan, M.S., Javed, M. and Waqas, M. (2015), "Migration, remittances, and household welfare: evidence from Pakistan", *The Lahore Journal of Economics*, Vol. 20 No. 1, pp. 47-69.

Balli, F. and Rana, F. (2015), "Determinants of risk sharing through remittances", *Journal of Banking and Finance*, Vol. 55, pp. 107-116.

Beltran, D.O. and Draper, D. (2008), "Estimating the parameters of a small open economy dsge model: indentifiability and inferential validity", International Finance Discussion Paper No. 955.

Bugamelli, M. and Paternò, F. (2011), "Output growth volatility and remittances", *Economica*, Vol. 78, pp. 480-500.

Burki, S.J. (1991), "Migration from Pakistan to the Middle East", in Papademetriou, D.G. and Martin, P.L. (Eds), *The Unsettled Relationship: Labour Migration and Economic Development*, Greenwood Press, London.

Burney, N. (1987), "Workers' remittances from the Middle East and their effect on Pakistan's economy", *Pakistan Development Review*, Vol. 26 No. 4, pp. 745-763.

Calvo, G.A. (1983), "Staggered prices in a utility-maximizing framework", *Journal of Monetary Economics*, Vol. 12, pp. 383-398.

Catrinescu, N., Leon-Ledesma, M., Piracha, M. and Quillin, B. (2009), "Remittances, institutions, and economic growth", *World Development*, Vol. 37, pp. 81-92.

Chami, R., Thomas, F.C. and Michael, T.G. (2006), "Beware of emigrants bearing gifts: optimal fiscal and monetary policy in the presence of remittances", IMF Working Paper 06/61.

Choudhary, M.A., Ahmed, W., Khan, S., Naeem, S. and Zoega, G. (2014), "Determinants of wage stickiness in a developing economy", *Economic Modelling*, Vol. 3, pp. 296-304.

Christiano, L., Eichenbaum, M. and Evans, C. (2005), "Nominal rigidities and the dynamic effects of a shock to monetary policy", *Journal of Political Economy*, Vol. 113 No. 1, pp. 1-45.

Combes, J.L. and Ebeke, C. (2011), "Remittances and household consumption instability in developing countries", *World Development*, Vol. 39, pp. 1076-1089.

Corsetti, G. and Pesenti, P. (2001), "Welfare and macroeconomic interdependence", *Quarterly Journal of Economics*, Vol. 116 No. 2, pp. 421-445.

Ebeke, C. and Combes, J.-L. (2013), "Do remittances dampen the effect of natural disasters on output growth volatility in developing countries?", *Applied Economics*, Vol. 45, pp. 2241-2254.

Galí, J. and Monacelli, T. (2005), "Monetary policy and exchange rate volatility in a small open economy", *The Review of Economic Studies*, Vol. 72 No. 3, pp. 707-734.

Gilani, I., Khan, M.F. and Iqbal, M. (1981), "Labour migration from pakistan to the middle east and its impact on the domestic economy", Part 1, Pakistan Institute of Development Economics, Islamabad, Research Report Series 126.

Hanif, M.N., Iqbal, J. and Malik, M.J. (2013), "Quarterisation of national income accounts of Pakistan", *SBP Research Bulletin*, Vol. 9 No. 1, pp. 1-61.

Hayat, Z., Balli, F., Obben, J. and Shakur, S. (2016). An empirical assessment of monetary discretion: the case of Pakistan, *Journal of Policy Modeling*, Vol. 38 No. 5, pp. 954-970.

Iqbal, Z. and Sattar, A. (2005), "The contribution of workers' remittances to economic growth in Pakistan", Research Report No. 187, available at: http://www.pide.org.pk/Research/Report187.pdf.

Irfan, M. (2011), "Remittances and poverty linkages in Pakistan: evidence and some suggestions for further analysis", PIDE Working Papers 2011:78.

Jamal, H. (2004), "Remittances inflows, growth and poverty: the case of Pakistan", in Oda, H. (Ed.), *International Labour Migration from South Asia*, Institute of Developing Economics, Japan, External Trade Organisation, Tokyo.

Javid, M., Arif, U. and Qayyum, A. (2012), "Impact of remittances on economic growth and poverty", *Academic Research International*, Vol. 2 No. 1, pp. 433-447.

Kollmann, R. (2001), "The exchange rate in a dynamic-optimizing business cycle model with nominal rigidities: a quantitative investigation", *Journal of International Economics*, Vol. 55, pp. 243-262.

Lubik, T. and Schorfheide, F. (2005), "A Bayesian look at new open economy macroeconomics", in Gertler, M. and Rogoff, K. (Eds), *NBER Macroeconomics Annual*, MIT Press.

Malik, W.S. and Ahmed, A.M. (2010), "Taylor rule and the macroeconomic performance in Pakistan", *Pakistan Development Review*, Vol. 49 No. 1, pp. 37-55.

Mansuri, G. (2006), "Migration, school attainment, and child labor: evidence from rural Pakistan". Policy Research Working Paper No. 3945, World Bank, Washington, DC.

Muhammad, N., Ahmad, M., Ahmad, N., Shah, M., Alam, I. and Jawad, M. (2010), "The impact of foreign remittances on the socio-economic conditions of households (A case study of rural areas in Dir Lower, NWFP)", *Sarhad Journal of Agriculture*, Vol. 26 No. 1, pp. 141-145.

Mundaca, B.G. (2009), "Remittances, financial market development and economic growth: the case of Latin America and the Caribbean", *Review of Development Economics*, Vol. 13, pp. 288-303.

Nishat, M. and Bilgrami, N. (1991), "The impact of migrant workers' remittances on Pakistan's economy", *Pakistan Economic and Social Review*, Vol. 29, pp. 21-41.

Raheem, A.R., Vishnu, P. and Nawaz, A. (2014), "Causal relationship between worker's remittances and imports in Pakistan", *European Journal of Scientific Research*, Vol. 119 No. 3, pp. 327-336.

Siddiqui, R. and Kemal, A.R. (2002), "Remittances, trade liberalisation, and poverty in Pakistan: the role of excluded variables in Poverty change analysis", *Pakistan Development Review*, Vol. 45 No. 3, pp. 383-415.

Smets, F. and Wouters, R. (2002), "Openness, imperfect exchange rate pass-through and monetary policy", *Journal of Monetary Economics*, Vol. 49 No. 5, pp. 913-940.

Smets, F. and Wouters, R. (2003), "An estimated dynamic stochastic general equilibrium model of the Euro area", *Journal of the European Economic Association*, Vol. 1 No. 5, pp. 1123-1175.

State Bank of Pakistan (2015), "What has caused stagnation in Pakistan's exports?" in , *Annual Report 2014-15 (State of the Economy)*, available at: http://www.sbp.org.pk/reports/annual/arFY15/Special-Section3.pdf.

## Further reading

Ahmed, W., Malik, M.J. and Rehman, M. (2014), "Quarterly bayesian DSGE model of Pakistan economy with informality", SBP Working Paper No. 68.

Ali, H. and Ahmad, E.. (2014), "Choice of monetary policy instrument under targeting regimes in a simple stochastic macro model", PIDE Working Papers 2014; 102.

Choudhary, M.A., Khan, S., Pasha, F. and Rehman, M. (2016), "The dominant-borrower syndrome", *Applied Economics*, Vol. 48 No. 49, pp. 4773-4782.

Durdu, C.B. and Sayan, S. (2008), "Emerging market business cycles with remittance fluctuations", International Finance Discussion Papers 946.

Giuliano, P. and Ruiz-Arranz, M. (2009), "Remittances, financial development, and growth", *Journal of Development Economics*, Vol. 90, pp. 144-152.

Haider, A., Din, M. and Ghani, E. (2013), "Monetary policy, informality and business cycle fluctuations in a developing economy vulnerable to external shocks", *Pakistan Development Review*, Part II, pp. 609-681.

Mandelman, F.S. and Zlate, A. (2008), "Immigration and the macro economy", Federal Reserve Bank of Atlanta Working Paper, 2008-25.

Nishat, M. and Bilgrami, N. (1993), "The determinants of workers' remittances in Pakistan", *Pakistan Development Review*, Vol. 32 No. 4, pp. 1235-1245.

Smets, F. and Wouters, R. (2005), "Comparing shocks and frictions in US and Euro area Business cycles: a Bayesian DSGE approach", *Journal of Applied Econometrics*, Vol. 20 No. 2, pp. 161-183.

**Corresponding author**
Faruk Balli can be contacted at: f.balli@massey.ac.nz