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MACROECONOMIC IMPACTS OF REMITTANCES: A TWO-COUNTRY, TWO-SECTOR MODEL

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ABSTRACT

We examine the impacts of remittances on foreign direct investment and the development of emerging countries using a macro-dynamic model of two small open economies designated as advanced and developing country. Specifically, we incorporate a two-sector framework for the latter: traditional non-traded and foreign capital dependent traded sector while introducing collateral effects of remittances. The results from extensive calibration exercises show that remittances in the presence of labor migration hurts the traded sector of the developing economy, leading to a contraction in aggregate output in the long run. Albeit to a lesser extent, the contraction persists even with the expansionary impacts of remittances through a collateral effect, giving rise to a phenomenon known as a migration-remittance trap.

Keywords: cross-border labor migration; remittances; foreign direct investment; economic development; migration-remittance trap.

JEL Classifications: E13; F21; F22; O11

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1 Introduction

In a seminal work on economic development, Lewis (1954) argues that industrialization is feasible when there is unlimited supply of labor from subsistence sectors. In low-income countries where population exceedingly outnumbers capital, there exists sectors including agriculture, petty retail trading, domestic service and the like where the supply of labor far exceeds the demand at a subsistence wage. Thus, new industries can be created or old industries expanded without experiencing labor shortage. Once capital accumulation catches up with labor, the capitalists can avoid the bottleneck by either importing labor or exporting capital to countries with abundant labor. Today, the relevancy of this postulation could not be overstated given the fact that millions of workers have migrated across national borders and economic impacts of cross-border labor mobility have been front and center in policy debates in many developing countries.

For host countries, cross-border labor mobility evidently brings about unlimited supply of labor as put forth by Lewis (1954). In return, wages earned by migrant workers generate remittance inflows to home countries, resulting in substantial accumulation of foreign exchange reserves. Between 1980 and 2019, the World Bank estimated that migrant remittance inflows to low and middle income countries have increased from around 18 billion USD to approximately 548 billion USD. They account for well over a third of GDP in countries such as Haiti, Lebanon, South Sudan, and Tonga. The growth in foreign currency reserves has helped improve the countries' credit rating and expanded their borrowing capacity in the international market (Bugamelli and Paterno, 2009; Chatterjee and Turnovsky, 2018; IMF and World Bank, 2009). In this respect, promoting labor mobility and remittance inflows make economic sense for low-income, labor abundant countries. After all, one of the United Nation's Sustainable Development Goals is to facilitate safe, responsible labor migration and to reduce transaction costs of remittances.

From the existing literature, the evidence of remittance impact on home economies is mixed. While some studies find a positive relationship between remittances and economic

growth (Faini, 2007; Lim and Basnet, 2017; Ramirez and Sharma, 2008; Ziesemer, 2009), others find a negative or no relationship (Chami et al., 2005; Donou-Adonsou and Lim, 2016; Gupta, 2005; IMF, 2005; Lim and Simmons, 2015). Using a stochastic general equilibrium framework, Bahadir et al. (2018) show that remittances are contractionary when they go to wage earners but expansionary when they are funneled to credit-constrained entrepreneurs. Chatterjee and Turnovsky (2018), on the other hand, utilize a two-sector small open economy model to demonstrate that remittances can be growth-enhancing through collateral effect. The improvement in the borrowing capacity of a country enables it to expand the formal sector and thus the aggregate output. However, these studies have treated remittances as an exogenous inflow of funds, abstracting the effect of cross-border labor movement from the models. As evidenced in a study by Lim and Morshed (2015), the increased flow of remittances in recent decades comes from the surge in migration. In addition, based on a simple one-sector model capturing the link between labor migration and remittances, Lim (2021a) argues that despite the positive effect of remittances through the collateral channel, labor migration causes a decrease in domestic capital accumulation leading to economic contraction in the long run.[1] Lim (2021b) extends the model to include a two-sector economy with a traded sector using foreign capital and a non-traded sector employing only labor. He shows that a poor country should promote foreign direct investment rather than encouraging labor migration as a policy for its economic development.

Moreover, there is a compelling evidence indicating that countries that have actively promoted overseas migrant work have received a significantly smaller amount of foreign direct investment (FDI) than remittances. For instance, Asian countries such as India, Bangladesh, Pakistan, and the Philippines have, for decades, sent a huge number of migrant workers abroad. By 2017, there were over 16 million, 7.5 million, 6 million, and 5.7 million of migrant workers originating from India, Bangladesh, Pakistan and the Philippines respectively (UN Migrant Stock Database). These migrant workers accounted for approximately 3%, 11%,

[1]This endogenous migrationn is first introduced in Lim and Morshed's (2017) one-sector, two-country, small open economy model. They focus more on fiscal policy including a tax on remittances.

8.5%, and 13% of their respective labor force. In Figure 1, we present their average annual inflows of FDI and remittances as a percentage of GDP. Markedly, within the last decade remittance inflows were 2 times, 7 times, 9 times, and 5 times the size of their respective FDI. This diverging trend can reasonably be expected to persist over the coming years.

Against the backdrop of possible counteractive effect between remittances and FDI, the paper sets out to contribute to the understanding of the role of remittances in the presence of labor migration. While many empirical studies suggest various channels through which remittances influence economic growth, we contend that a rather comprehensive study entails accounting for the role of migrant workers. To that end, we build upon the work of Lim (2021b). First, Lim (2021b) assumes that the non-traded sector employs only labor. Without domestic capital, remittances are only directed toward consumption, abstracting from the fact that they have been invested in acquiring assets and in small businesses. In contrast, we incorporate domestic capital into the non-traded sector and allow remittances to be allocated between investment and consumption according to households' preferences (utility maximization). Second, this study differs from the earlier study in its focus. While Lim (2021b) compares and contrasts between the policy to promote foreign direct investment and the policy to encourage labor migration, we examine exogenous remittances vs endogenous remittances, the latter of which is driven by either push or pull factors. Finally, we tighten the calibration of the model by choosing more relevant small open economies for the host country, thus more reasonable parameters.

The cornerstone of our analysis is rested on the framework of two-country, two sector model: advanced and developing country, and traded and non-traded sector. The advanced economy employs migrant workers from developing country while wages earned are sent back as remittances. The non-traded sector can be considered as a traditional agricultural sector or petty retail trading that uses domestic capital and labor for its production whereas the traded sector represents a manufacturing sector that employs foreign capital and domestic labor. Labor migration is chosen optimally based on wage differential between the two

countries. These characteristics are consistent with current economic structure in many developing nations. The model is then calibrated to four representative developing economies including India, Bangladesh, Pakistan, and the Philippines and nine representative advanced economies, namely Hong Kong, Japan, South Korea, Kuwait, Malaysia, Qatar, Saudi Arabia, Singapore, and United Arab Emirates. In 2010, the four Asian countries sent a combined 13 million migrant workers to those developed nations. In addition, the former also accumulated approximately $55 billion in FDI from the latter in 2012.[2]

We find that although remittances boost consumption, they have a contractionary effect on the home economy as a whole. The economic reduction is even greater after accounting for labor migration. That is, the negative effect of labor loss due to migration outstrip the positive collateral effect resulting from greater accumulation of foreign reserves, thereby suppressing aggregate output in the long run. In the presence of diminishing return, labor migration reduces the marginal product of capital leading to shrinkage in the traded sector. The non-traded sector benefits from remittance inflows; however, the traded sector suffers from the outflow of labor and the reduction in FDI. The study lends supports to a paradox in international finance which noted that FDI does not appear to flow to developing countries and the constant outflow of migrant workers can be one of the contributing factors. The findings underscore the importance in attracting foreign capital while retaining workers for economic development.

This paper contributes to the literature, especially in development economics, in some important ways. First, we add more understanding of the relationship between remittances and economic development in the presence of labor migration. While many empirical studies show that there are important channels that remittances can have a growth impact on the economy, this study shows that we cannot understand the full impact without taking into account migrant workers that are the source for the inflow of these remittances. Second, we also shed more lights onto the understanding of the relationship among international

[2]The data for migrant workers are taken from the UN Department of Economic and Social Affairs and the data for FDI from UNCTAD Bilateral FDI Statistics.

migration, remittances, and foreign direct investment. This could explain the empirical evidence in Figure 1 that many of the labor-exporting countries receive a huge amount of remittances that is many times the size of FDI. Third, we also provide interesting results related to the capital accumulation in the non-traded sector which complement many of the findings in the literature.

The remainders of the paper proceed as follows. Section 2 details the model while Section 3 derives the macroeconomic equilibrium. Section 4 discusses the calibration exercises together with the sensitivity analyses. Finally, Section 5 concludes the findings and provides policy implications.

2 Model

We construct a simple macro-dynamic model of two small open economies consisting of an advanced, labor-importing country and a developing, labor-exporting country. The residents of the developing country are allowed to move to work as migrant workers in the advanced economy, but they face some migration frictions. For simplicity, we assume that the advanced economy produces only traded goods. The developing economy produces both non-traded and traded goods. Both economies are small in that they take the price of the traded goods as given. In the advanced economy, the traded good is produced using both capital and labor. In the developing country, goods in the non-traded sector are produced by domestic capital and labor whereas goods in the traded sector are produced by labor and foreign capital, the latter of which is provided by the advanced economy in the form of foreign direct investment. Both countries also have access to the world financial market, but are subject to a borrowing premium, which reflects their associated risk. The two countries are described as follows:

2.1 Advanced economy

2.1.1 Firms

Firms in the advanced country use capital (K_h), native labor (N_h) and migrant workers (N_m) to produce traded output (Y_h). The price of the traded goods is assumed to be numeraire. The country's production technology is given by the neoclassical function

$$Y_h = f(K_h, N_h, N_m) \tag{1}$$

where $f_{K_h} > 0,\ f_{N_h} > 0, f_{N_m} > 0,\ f_{K_hK_h} < 0,\ f_{N_hN_h} < 0, f_{N_mN_m} < 0,\ f_{K_hN_h} > 0,\ f_{K_hN_m} > 0$ and $f_{N_hN_m} > 0$. These are conventional assumptions under imperfect substitution of the inputs.

The profit maximizing behavior of firms yields the conventional demand functions for capital, native labor and migrant workers as follows

$$r_h = f_{K_h}(K_h, N_h, N_m) \tag{2}$$

$$w_h = f_{N_h}(K_h, N_h, N_m) \tag{3}$$

$$w_m = f_{N_m}(K_h, N_h, N_m) \tag{4}$$

where $r_h,\ w_h$ and w_m are the real return on capital, the real wage rate for natives and the real wage rate for migrant workers, respectively. Equation (2) is the advanced country's demand for capital which equates the marginal product of capital to the return on capital; equation (3) is the advanced country's demand for native labor which equates their marginal product to the natives' wage rate; and equation (4) is the advanced country's demand for migrant workers which equates migrants' marginal product to the migrants' wage rate.

The firms in this economy invest domestically an amount, I_h, but also transfer an amount, $\Phi_f(I_f, K_f)$ out of domestic capital for outward investment in the developing econ-

omy. The accumulation of domestic capital (K_h) is given by

$$\dot{K}_h = I_h - \Phi_f\left(I_f, K_f\right) \tag{5}$$

where I_f is outward investment flow and K_f is the stock of capital abroad (foreign capital stock or outward FDI stock).

For simplicity, it is assumed that there is no depreciation cost for both domestic and foreign capitals, but converting traded goods into domestic investment incurs an adjustment cost and outward foreign investment also incurs a cross-border mobility cost. The cost functions are assumed to be convex and homogenous of degree one. The gross investment costs for domestic and foreign investments can be, respectively, expressed as

$$\Phi_h\left(I_h, K_h\right) = I_h\left(1 + \frac{hI_h}{2K_h}\right) \tag{6}$$

$$\Phi_f\left(I_f, K_f\right) = I_f\left(1 + \frac{\eta I_f}{2K_f}\right) \tag{7}$$

where $h, \eta \geq 0$ is the unit-free cost parameters. These cost specifications follow Hayashi (1982). Without the depreciation cost, the foreign capital accumulation for a representative household can be written as

$$\dot{K}_f = I_f \tag{8}$$

2.1.2 Households

Each household in the advanced country is endowed with one unit of time and allocates it between leisure (L_h) and work (N_h). Native labor supply is subject to the constraint

$$N_h = 1 - L_h \tag{9}$$

Households in the advanced economy choose consumption (C_h) and leisure (L_h) to maximize the concave utility function

$$W_h = \int_0^\infty H\left(C_h, L_h\right) e^{-\beta t} dt \tag{10}$$

where β is the rate of time preference, subject to their accumulation of foreign debt

$$\dot{B}_h = rB_h + C_h + \Phi_h\left(I_h, K_h\right) + T_h - \left(1-\tau\right) r_f K_f - r_h K_h - w_h N_h \tag{11}$$

where r denotes unit borrowing costs, and B_h is the advanced country's stock of debt. τ is the tax rate imposed by the government of the developing country on foreign capital income, r_f is the return on foreign capital, and T_h is the lump-sum tax imposed by the government of the advanced economy.

The households in the advanced economy have access to the international financial markets; however, they are subject to a borrowing premium, which reflects their associated risk. This borrowing premium is assumed to be strictly increasing and convex in the nation's aggregate debt (B_h), relative to its ability to service the debt, as reflected by GDP, Y_h. The cost of borrowing is thus specified by[3]

$$r = r^* + \Omega_h\left(\frac{B_h}{Y_h}\right); \qquad \Omega_h' > 0,\ \Omega_h'' > 0 \tag{12}$$

where r^* is the exogenous real world interest rate, and $\Omega_h\left(B_h/Y_h\right)$ is the borrowing premium. In the decision process, the household, in a decentralized economy, takes the borrowing cost as given. This is because it is a function of the economy's *aggregate* debt to output ratio which in a small open economy an individual household is too small to influence.

The household in the advanced economy maximizes (10), subject to (5), (8), (9) and

[3]Foreign borrowing constraint of equation (12) has long been used in macro-dynamic models and form a convenient way of closing the "small economy model"; see Turnovsky (1997). Empirical evidence supporting functions of this form is provided by Edwards (1984) and more recently by Chung and Turnovsky (2010).

(11). The optimality conditions are given by

$$H_{C_h}(C_h, L_h) = \pi \tag{13}$$

$$H_{L_h}(C_h, L_h) = \pi w_h \tag{14}$$

$$\beta - \frac{\dot{\pi}}{\pi} = r \tag{15}$$

$$q_h - 1 = h\frac{I_h}{K_h} \tag{16}$$

$$\frac{q_f}{q_h} - 1 = \eta\frac{I_f}{K_f} \tag{17}$$

$$\frac{\dot{q}_h}{q_h} + \frac{1}{q_h}\left[r_h + \frac{(q_h - 1)^2}{2h}\right] = r \tag{18}$$

$$\frac{\dot{q}_f}{q_f} + \frac{1}{q_f}\left[(1-\tau)\, r_f + \frac{q_h}{2\eta}\left(\frac{q_f}{q_h} - 1\right)^2\right] = r \tag{19}$$

where π is the shadow price of wealth in the form of foreign bonds. q_h and q_f denote the shadow prices of domestic capital stock and foreign capital stock, respectively, relative to that of foreign bonds.

Equation (13) equates the marginal utility of consumption to the shadow price of wealth. Equation (14) is the native labor supply equation which implies that the marginal utility of leisure is equal to the utility-adjusted return to labor. Equation (15) is the Keynes-Ramsey rule which describes the intertemporal allocation of consumption which equates the rate of return on consumption to the borrowing cost. Equations (16) and (17) are the optimum decision for domestic and foreign investment, respectively, while equations (18) and (19) are the no-arbitrage condition, equating the returns on domestic and foreign capital to the cost of borrowing.

The transversality conditions require that

$$\lim_{t\to\infty} \pi_h K_h e^{-\beta t} = 0; \;\; \lim_{t\to\infty} \pi_f K_f e^{-\beta t} = 0; \;\; \lim_{t\to\infty} \pi B_h e^{-\beta t} = 0 \tag{20}$$

where $\pi_h = q_h\pi$ and $\pi_f = q_f\pi$ are the shadow prices of both capital stocks, K_h and K_f,

respectively.

2.1.3 Government

We assume a very simple form of government budget in the advanced economy. This government balances the budget at all times by spending all the tax revenue. Thus,

$$G_h = T_h \tag{21}$$

2.2 Developing economy

2.2.1 Output

There are two sectors in this economy. The non-traded sector employs domestic capital and labor while the traded sector employs foreign capital and domestic labor in its production. The non-traded sector can also be viewed as the traditional sector which includes agriculture, petty retail trading, domestic service and the like. At the same time, the traded sector is largely operated by foreign firms to serve either the domestic market or exports, or both. These assumptions seem consistent with the characteristics of many developing countries today. Both production functions are specified as

$$Y_N = F^N(K_N, N_N) \tag{22}$$

$$Y_T = F^T(K_f, N_T) \tag{23}$$

where Y_N and Y_T are the economy's non-traded and traded outputs, respectively. K_N is domestic capital. N_N and N_T are domestic labor employed in non-traded and traded sectors, respectively. We assume that both production functions exhibit constant returns to scale. The profit-maximization behavior of firms in the developing country yields the following demand functions for labor in the non-traded sector, labor in the traded sector, and foreign

capital

$$F^N_{N_N}(K_N, N_N) = w_N \tag{24}$$

$$F^N_{K_N}(K_N, N_N) = r_N \tag{25}$$

$$F^T_{N_T}(K_f, N_T) = w_T \tag{26}$$

$$F^T_{K_f}(K_f, N_T) = r_f \tag{27}$$

where w_N and w_T are the real wage rate in the non-traded sector and the traded sector, respectively. r_N is the return on domestic capital. The aggregate output or Gross Domestic Product (GDP) is defined as

$$Y = pY_N + Y_T \tag{28}$$

where p is the price of non-traded output relative to that of traded output, the latter of which is assumed to be numeraire. In a two-sector dependent economy model, this relative price is also defined as the real exchange rate (see Morshed and Turnovsky, 2004). Domestic capital can be converted from the non-traded output with an adjustment cost. The gross investment cost for domestic investments can be written as

$$\Phi_N(I_N, K_N) = I_N\left(1 + \frac{zI_N}{2K_N}\right) \tag{29}$$

where $z \geq 0$ is the unit-free cost parameter. The accumulation of domestic capital is

$$\dot{K}_N = I_N \tag{30}$$

2.2.2 Households

Each household is endowed with one unit of time and allocates it among non-traded production (N_N), traded production (N_T), temporary migrant work abroad (N_m), permanent immigration $\left(\bar{I}_m\right)$ and leisure (L). Here we define two types of migrants, short-term workers

who migrate to work on temporary contracts and permanent immigrants who emigrate to live in a third country and never return. In other words, temporary migration is endogenous while permanent immigration is exogenous in the model. This set up is in line with the observation in many South Asian countries where those who migrate to work in the Middle East are generally short-term migrant workers and those who emigrate to the U.S. and European countries always seek residence there and never return. Some forms of this formulation are also employed by Lim et al. (2021). The labor market equilibrium condition is then given by

$$N_N + N_T + N_m + \bar{I}_m + L = 1 \tag{31}$$

Migrant workers remit a fraction of income after consumption (C_m) back to their family in the home country. We include both remittances from temporary migrant workers and permanent immigrants, again the latter of which is fixed. The equation for remittances (R_m) can be written as[4]

$$R_m = \xi_m w_m N_m - C_m + \bar{r}_m \tag{32}$$

where $\bar{r}_m$ is exogenous remittances received from permanent immigrants, $\bar{I}_m$ and the term $(\xi_m w_m N_m - C_m)$ is remittances received from temporary migrant workers, N_m. C_m is the consumption of migrant workers in the advanced economy, but jointly chosen by the household in this economy. $0 < 1 - \xi_m < 1$ is the migration friction or cost associated with migration. This cost includes expenses such as job search, work permits, and transportation. This cost could be high for an informal migrant labor market where migrant workers have to go through many hurdles including time spent on the immigration process of the host country to obtain the work permits. While migrant workers are paid with their marginal product (see equation 4), the loss of migrant income due to the friction is treated as a deadweight loss which disappears from the model. In this paper, we use ξ_m as a policy variable that induces migration (or a push factor). In an effort to promote labor migra-

[4]This specification draws upon the empirical work of Lim and Morshed (2015) who empirically show that the increased remittances to developing countries is the result of migration.

tion, the governments of developing countries such as Bangladesh, India, Pakistan, and the Philippines have established formal institutions to facilitate and govern this migrant work process (Lim, 2021a). The efforts put forward by the governments of these Asian developing countries to ease the process for migrant workers seeking and taking jobs overseas can be seen as a reduction in migration cost ($\xi_m \to 1$ or $1 - \xi_m \to 0$).

We assume that the household in the developing country also has access to the international financial markets. Similar to the advanced economy, the household faces an upward-sloping supply curve for debt. As noted in Chatterjee and Turnovsky (2018), remittances have become important for some developing countries, especially those with high remittance-to-GDP ratio, to use as collateral in securing borrowing. Thus, we explicitly allow for some portion, κ, where $0 \leq \kappa \leq 1$, of the flow of remittances to serve as a component of repayment capacity. Thus, the interest rate function is specified as

$$r_d = r^* + \Omega_d \left(\frac{B_d}{Y + \kappa R_m} \right); \qquad \Omega_d' > 0, \ \Omega_d'' > 0 \tag{33}$$

where B_d is the country's stock of debt; r_d is the interest rate faced by the household in the developing country; and $\Omega_d \left(B / \left(Y + \kappa R_m \right) \right)$ is the borrowing premium. As κ increases, the country's ability to service the debt improves and its unit borrowing cost declines. Similar to the advanced economy, the assumption of a small open economy implies that individual household cannot influence the interest rate and so takes it as given in the decision process.

The developing economy household's instantaneous budget constraint can be written as

$$\dot{B}_d = r_d B_d + C_T + T - w_T N_T + p \left[C_N + \Phi_N \left(I_N, K_N \right) - w_N N_N - r_N K_N \right] - \left(\xi_m w_m N_m - C_m + \bar{r}_m \right) \tag{34}$$

where C_N and C_T are the consumption of traded and non-traded goods, respectively, of the representative household (located in the developing country). T represents the lump-sum tax.

The representative household derives utility from domestic consumption of both traded and non-traded goods, migrant consumption abroad, and leisure. The utility function is

$$W_d = \int_0^\infty \left[U\left(C_T, C_N\right) + M\left(C_m\right) + \Gamma\left(L\right)\right] e^{-\beta t} dt \tag{35}$$

where $U_{C_T} > 0,\ U_{C_N} > 0,\ U_{C_T C_T} < 0$, and $U_{C_N C_N} < 0$. $M\left(C_m\right)$ is the utility of migrants from consuming while working abroad, with $M_{C_m} > 0$ and $M_{C_m C_m} < 0$. $\Gamma\left(L\right)$ is the utility derived from leisure, with $\Gamma_L > 0$ and $\Gamma_{LL} < 0$. For simplicity, $M\left(C_m\right)$ and $\Gamma\left(L\right)$ are assumed to be additively separable from $U\left(C_T, C_N\right)$.

The household in the developing country maximizes (35), subject to (30), (31), and (34). The optimality conditions are given by

$$\begin{aligned}
U_{C_T}\left(C_T, C_N\right) &= \lambda && (36)\\
U_{C_N}\left(C_T, C_N\right) &= \lambda p && (37)\\
M_{C_m}\left(C_m\right) &= \lambda && (38)\\
\Gamma_L\left(L\right) &= \lambda p w_N = \lambda w_T = \lambda \xi_m w_m && (39)\\
\beta - \frac{\dot{\lambda}}{\lambda} &= r_d && (40)\\
\frac{\dot{q}_N}{q_N} + \frac{p}{q_N}\left[r_N + \frac{\left(q_N - 1\right)^2}{2z}\right] &= r_d && (41)\\
q_N - 1 &= z\frac{I_N}{K_N} && (42)
\end{aligned}$$

where λ is the shadow price of wealth in the form of foreign bonds.

Equations (36) and (37) equate the marginal utility of consumption for traded and non-traded goods to its respective shadow price of wealth and equation (38) also equates the marginal utility of migrant consumption to the shadow price of wealth. Equation (39) is the labor supply equations for all three labor markets including non-traded sector, traded sector, and the migrant labor market. That is, the marginal utility of leisure is equated

to the utility-adjusted return to work in all three labor markets. These equations are in line with Harris and Todaro (1970)'s rural-urban migration model and as it is extended to international migration. Equation (40) is the Keynes-Ramsey rule which describes the intertemporal allocation of consumption which equates the return on consumption to the cost of borrowing. Finally, (41) is the no-arbitrage condition, equating the return on capital to the cost of borrowing and (42) is the optimum decision for investment.

The transversality condition requires that the private agent satisfies the intertemporal budget constraint

$$\lim_{t\to\infty} \lambda q_N K_N e^{-\beta t} = 0; \quad \lim_{t\to\infty} \lambda B e^{-\beta t} = 0 \tag{43}$$

2.2.3 Government

Finally, the government of the developing country collects its revenue from a tax on foreign capital income and a lump-sum tax from the domestic household. The total tax revenue is used for public consumption. For simplicity, it is assumed that public consumption yields no utility. The government budget constraint is

$$\tau r_f K_f + T = G \tag{44}$$

where τ represents the foreign income tax rate with $0 < \tau < 1$ and $G = pG_N + G_T$ is total public consumption of both non-traded and traded goods.

3 Macroeconomic equilibrium

In this section, we combine the two economies to derive their macroeconomic equilibrium. There are two important features, labor migration and stock of foreign capital, that link the two economies. The advanced economy's consumption and native labor supply can be

derived by combining (3) and (9) together with (13) and (14)

$$C_h = C_h(\pi, K_h, N_m) \tag{45}$$

$$N_h = N_h(\pi, K_h, N_m) \tag{46}$$

For the developing country, the equilibrium sectoral consumption can be derived from equations (36) and (37) as

$$C_T = C_T(p, \lambda) \tag{47}$$

$$C_N = C_N(p, \lambda) \tag{48}$$

and the equilibrium labor supplies ($N_T, N_N,$ and N_m) can be derived by plugging equations (4), (24), and (26) into (39) and using (31). This yields

$$N_j = N_j(p, \lambda, N_h, K_h, K_f, K_N) \tag{49}$$

where $j = T, N, m$.

The market-clearing condition for the non-traded sector can be expressed as

$$Y_N = C_N + \Phi_N(q_N, K_N) + G_N \tag{50}$$

where $\Phi_N(q_N, K_N) = \frac{K_N}{2z}(q_N^2 - 1)$

Plugging equations (22) and (48) into the market-clearing condition (50), we can derive the short-run equilibrium real exchange rate (p).

$$p = p(q_N, K_N, N_N, \lambda) \tag{51}$$

3.1 Equilibrium dynamics

Using equations (45)–(51), we can write $C_h, N_h, C_T, C_N, N_T, N_N, N_m$, and p as a function of $\pi, \lambda, q_N, K_N, K_f$, and K_h. This suggests that once the time paths of all capital stocks (K_N, K_h, K_f), the price of non-traded capital (q_N), the shadow price of wealth of the developing economy (λ), and that of the advanced economy (π) are determined, we can derive the time paths of both consumption quantities (C_T, C_N) of the developing economy and consumption quantity (C_h) of the advanced economy, labor supplies (N_h, N_T, N_N, N_m), and the real exchange rate (p). These time paths of $K_N, K_h, K_f, \lambda,$ and π, together with q_N, q_h, q_f, B_d, and B_h can be determined from the following equilibrium dynamics of the model

$$\dot{K}_N = \frac{K_N}{z}(q_N - 1) \tag{52}$$

$$\dot{q}_N = r_d q_N - p\left[F^N_{K_N} + \frac{(q_N-1)^2}{2z}\right] \tag{53}$$

$$\dot{\lambda} = \lambda(\beta - r_d) \tag{54}$$

$$\dot{B}_d = r_d B_d + C_T + G_T - \tau F^T_{K_f} K_f - F^T_{N_T} N_T - (\xi_m f_{N_m} N_m - C_m + \bar{r}_m) \tag{55}$$

$$\dot{\pi} = \pi(\beta - r) \tag{56}$$

$$\dot{B}_h = rB_h + C_h + \frac{K_h}{2h}\left(q_h^2 - 1\right) + G_h - (1-\tau) F^T_{K_f} K_f - f_{K_h} K_h - f_{N_h} N_h \tag{57}$$

$$\dot{q}_h = rq_h - \left[f_{K_h} + \frac{(q_h-1)^2}{2h}\right] \tag{58}$$

$$\dot{K}_h = \frac{K_h}{h}(q_h - 1) - \frac{K_f}{2\eta}\left[\left(\frac{q_f}{q_h}\right)^2 - 1\right] \tag{59}$$

$$\dot{q}_f = rq_f - \left[(1-\tau) F^T_{K_f} + \frac{q_h}{2\eta}\left(\frac{q_f}{q_h} - 1\right)^2\right] \tag{60}$$

$$\dot{K}_f = \frac{K_f}{\eta}\left(\frac{q_f}{q_h} - 1\right) \tag{61}$$

where equations (55) and (57) describe the evolutions of debt for the developing and advanced economies, respectively. r and r_d are given by equations (12) and (33), respectively.

The equilibrium is characterized by an autonomous system of ten differential equations. The advanced country's capital stock (K_h), its stock of capital abroad (K_f), its foreign debt (B_h), the capital stock of the developing country (K_N) and its debt (B_d), are assumed to move sluggishly, while the shadow prices of wealth, λ and π, and and the capital prices, q_N, q_f and q_h, are free to jump instantaneously. The numerical simulations (in the

next section) confirm that there is an existence of a saddle-point equilibrium, characterized by five stable (negative) and five unstable (positive) eigenvalues, ensuring a unique stable transitional path.

3.2 Steady state

In the long run, the model economies progress to a steady-state position in which $\dot{\lambda} = \dot{B}_d = \dot{q}_N = \dot{K}_N = \dot{\pi} = \dot{B}_h = \dot{q}_h = \dot{K}_h = \dot{q}_f = \dot{K}_f = 0$. Imposing these conditions on equations (52)–(61) and using equations, (9), (31), (32), (38) and (45)–(51), we can solve for the steady-state values of $\tilde{\lambda}, \tilde{B}_d, \tilde{q}_N, \tilde{K}_N, \tilde{\pi}, \tilde{B}_h, \tilde{q}_h, \tilde{K}_h, \tilde{q}_f, \tilde{K}_f, \tilde{C}_T, \tilde{C}_N, \tilde{C}_m, \tilde{p}, \tilde{N}_N, \tilde{N}_T, \tilde{N}_m, \tilde{L}, \tilde{C}_h, \tilde{N}_h, \tilde{L}_h$ and $\tilde{R}_m$ where the "~" denotes a steady-state value for an endogenous variable. The steady-state equilibrium can be summarized by the following set of relationship, applicable to the advanced and developing countries, respectively. See the set of steady-state equations in Appendix.

4 Numerical analyses

4.1 Functional forms

Because the dynamic system comprises highly non-linear equations, further insights can be obtained by calibrating the model to reflect the real-world data and characteristics of the advanced and developing economies, respectively. The following functional forms are used in the subsequent calibration analyses.

The advanced economy's utility function is of the form

$$H\left(C_h, L_h\right) = \frac{1}{\gamma}\left(C_h L_h^{\varphi}\right)^{\gamma} \tag{62}$$

where φ represents the relative importance of leisure in households' utility and $1/\left(1-\gamma\right)$ is the intertemporal elasticity of substitution.

The advanced economy's production is expressed by the three-input nested constant-elasticity-of-substitution (CES) function

$$Y_h = A_h \left[\alpha_k K_h^{\rho} + (1 - \alpha_k) \left[\alpha_n N_h^{\delta} + (1 - \alpha_n) N_m^{\delta} \right]^{\frac{\rho}{\delta}} \right]^{\frac{1}{\rho}} \tag{63}$$

In the first stage native and migrant workers combine via a CES aggregator to yield total labor, which is then combined with capital to produce final output. $1/(1-\rho)$ and $1/(1-\delta)$, where $-\infty < \rho, \delta < 1$, are the CES between capital stock and labor, and between native and migrant workers, respectively. In addition, $0 < \alpha_k, \alpha_n < 1$ are the relative intensities of capital and native labor, respectively. A_h is the level of technology of the advanced economy.

The interest rate faced by the residents of the advanced economy is given by

$$r = r^* + e^{a \frac{B_h}{Y_h}} - 1 \tag{64}$$

where r^* is the world interest rate. a parameterizes the rate at which the borrowing premium increases with its debt position. In the case of a perfect world capital market $a = 0$, the interest rate reduces to r^*.

The developing economy's utility functions for domestic households' consumption of both goods, leisure, and migrant workers' consumption are given, respectively, by

$$U(C_T, C_N) = \frac{1}{\gamma} \left(C_T^{\sigma} C_N^{1-\sigma} \right)^{\gamma} \tag{65}$$

$$\Gamma(L) = \varsigma_l \frac{L^{1+1/\delta_l}}{1 + 1/\delta_l} \tag{66}$$

$$M(C_m) = \varsigma_m \frac{C_m^{1+1/\delta_m}}{1 + 1/\delta_m} \tag{67}$$

where σ is the relative weight of consumption of traded goods. ς_l and ς_m are the weights of utility from leisure and migrant consumption, respectively, and δ_l and δ_m are the elasticities of leisure and migrant consumption, respectively.

The production functions for both traded and non-traded sectors of the developing country is specified, respectively, by

$$Y_T = A_T \left[\theta_T K_f^{\zeta_T} + (1-\theta_T) N_T^{\zeta_T}\right]^{\frac{1}{\zeta_T}} \tag{68}$$

$$Y_N = A_N \left[\theta_N K_N^{\zeta_N} + (1-\theta_N) N_N^{\zeta_N}\right]^{\frac{1}{\zeta_N}} \tag{69}$$

where θ_T and θ_N, with $0 < \theta_{T,}\theta_N < 1$, are the relative capital intensity in the traded and non-traded sector; $1/(1-\zeta_T)$ and $1/(1-\zeta_N)$, with $-\infty < \zeta_T, \zeta_N < 1$, are the CES between capital and labor; and A_T and A_N are the levels of technology in both sectors, respectively.

The interest rate faced by the residents of the developing economy is expressed by

$$r_d = r^* + e^{b\frac{B_d}{Y+\kappa R_m}} - 1 \tag{70}$$

where b is the rate at which the borrowing premium increases with the debt ratio.

4.2 Benchmark economies

We calibrate the model to fit the characteristics of the benchmark economies. For the reference sample, we choose nine advanced economies – Hong Kong, Japan, South Korea, Kuwait, Malaysia, Qatar, Saudi Arabia, Singapore, and United Arab Emirates – with large presence of migrant workers and four developing Asian economies – Bangladesh, India, Pakistan, and the Philippines – which are long known for sending migrant workers overseas. In 2010, these developing countries sent a combined 13 million migrant workers to the nine advanced economies in the sample and in 2012 they recorded an instock of FDI of approximately $55 billion from those advanced economies.

Table 1 describes the parameters and steady-state values. The parameter values chosen are reasonable in light of the extant literature and consistent with the data of the reference sample. The choice of $\gamma = -1.5$ yields an intertemporal elasticity of substitution

of 0.4 which is well within the range of empirical evidence provided by Guvenen (2006). For the advanced economy, the elasticity on leisure, $\varphi = 1.75$, is standard and yields consistent labor supply, $\tilde{N}_h = 0.349$, which is well documented in the real business cycle literature (see Cooley, 1995; Turnovsky, 2004). The rate of time preference is set at $\beta = 5\%$, which is conventional in the general equilibrium model. The world interest rate is set at $r^* = 3.5\%$. With $\beta > r^*$, this ensures that both economies are the net debtors in the equilibrium. The borrowing premium $a = 0.03$ is chosen to yield an aggregate debt-output ratio $\left(\tilde{B}_h/\tilde{Y}_h\right)$ of about 50% for the advanced economy and $b = 0.05$ to yield an aggregate debt-output ratio $\left(\tilde{B}_d/\tilde{Y}\right)$ of 30%, both of which are consistent with the data. For these benchmark values, we set the collateral parameter pertaining to remittances at $\kappa = 0$ and will examine the full collateral effect of remittances ($\kappa = 1$) in the following analyses.

For the production function of the advanced economy, the choice of $\rho = 0.08$ yields an elasticity of substitution between capital and labor equal to 1.087, slightly above unity, which is close to Duffy and Papageorgiou's (2000) estimate for a sample of rich countries and the choice of $\delta = 0.5$ yields an elasticity of substitution between migrants and natives equal to 2, which is consistent with Cortes' (2008) estimate for low-skilled workers in the U.S. The level of technology in the production of the advanced economy is set at $A_h = 10$. The relative capital intensity is set at $\alpha_k = 0.17$ to yield a capital-output ratio $\left(\tilde{K}_h/\tilde{Y}_h\right)$ of 4.62 and the relative migrant labor intensity is set at 0.08 (or relative native labor intensity, $\alpha_n = 0.92$) to yield a migrant-native labor ratio $\left(\tilde{N}_m/\tilde{N}_h\right)$ of 15%, both of which is consistent with the data of the reference sample. The government spending, G_h, in the advanced economy is set at 1.3, which is equivalent to 16% of output, which is also consistent with the data. This produces native consumption-output ratio, $\tilde{C}_h/\tilde{Y}_h = 79\%$, which is also reasonable for an advanced economy. Given these parameter values, the model produces the natives' real wage in the advanced economy ($\tilde{w}_h = 17.47$) and that of migrant workers ($\tilde{w}_m = 3.916$), indicating that native workers are more productive than migrant workers, which is plausible in the case of low skilled Asian migrants. Plus, the relative wage of natives to migrants, $\tilde{w}_h/\tilde{w}_m = 4.6$,

is also reasonable. The relative wage of workers in the Middle East to that of South Asian workers ranges from 3 to 6 times (ILO, 2020).

For the developing economy, the relative weight of consumption of traded goods in the utility function is set at $\sigma = 0.46$, which is standard (see Morshed and Turnovsky, 2004; Chatterjee and Turnovsky, 2018). We choose the weight of migrant utility, $\varsigma_m = 0.2$, to achieve plausible migrant consumption and thus remittance flows from the advanced economy. With the exogenous portion of remittances, $\bar{r}_m = 0.03$, we obtain a remittance-output ratio, $\tilde{R}_m/\tilde{Y} = 7.1\%$, which is consistent with the data of the sample countries. In addition, the share of remittances sent by permanent immigrants, $\bar{r}_m/\tilde{R}_m = 44\%$, is also in line with the data for South Asian countries (see Lim and Basnet, 2017). We also choose the weight of leisure in the utility function, $\varsigma_l = 0.22$, to obtain a reasonable labor force participation rate $\left(1 - \tilde{L} - \bar{I}_m\right)$ and thus migrant-labor force ratio $\left(\tilde{N}_m/1 - \tilde{L} - \bar{I}_m\right)$ equal to 10%, the share of employment in non-traded sector$(\tilde{N}_N/1 - \tilde{L} - \bar{I}_m)$ equal to 56%, and the share of employment in traded sector $\left(N_T/1 - L - \bar{I}_m\right)$ equal to 33%, all of which are consistent with the empirical data.

We set $\xi_m = 0.5$ so that the wage differential between migrant workers and domestic workers in the developing economy is about 2 times ($\tilde{w}_m/\tilde{w}_T = 2;\ \tilde{w}_m/\tilde{w}_N = 2.45$), a plausible scale given the data. Using the wage rates of Indian migrants in the Gulf and of Indians at home reported in Rajan et al. (2015), the relative wage rates of Indian migrants to workers in India for masons, carpenters, electrician, drivers, and housemaid range from 1.74 to 2.71.

For both production functions of the developing country, the choice of $\zeta_T = -0.1$ and $\zeta_T = -0.21$ yields an elasticity of substitution between capital stock and labor equal to 0.9 for the traded sector and 0.82 for the non-traded sector, respectively, both of which are in line with Duffy and Papageorgiou's (2000) estimate for developing countries. We set the level of technology of traded good production at $A_T = 2$ and that of non-traded good production at $A_N = 1.5$, which are lower than that of the developed country. This also produces the

share of traded output $\left(\tilde{Y}_T/\tilde{Y}\right)$ of 36%, generally within the range that is consistent with the data (see Morshed and Turnovsky, 2004). The relative foreign capital intensity for the traded sector is set at $\theta_T = 0.05$ and the relative domestic capital intensity for the non-traded sector is set at $\theta_N = 0.13$. Both are to obtain foreign capital stock to total output ratio $\left(\tilde{K}_f/\tilde{Y}\right)$ of 0.3 and the total capital-output ratio in the developing country $\left(\tilde{K}_f + \tilde{K}_N\right)/\tilde{Y} = 1.575$, which are reasonable and consistent with the data for the reference sample.

We assume that the government of the developing country taxes foreign income at 10% and consume traded goods at $G_T = 0.02$ and non-traded goods at $G_N = 0.15$. Thus, the final government consumption expenditure is about 23% of the aggregate output of which the share of its spending on traded goods (G_T/G) is 9.8%. These numbers are reasonable and consistent with the data. This also produces consumption-output ratio, $\tilde{C}/\tilde{Y} = 0.83$, a plausible number given the range in the reference sample.

4.3 Macroeconomic impacts of remittances

In this section, we calibrate the model to examine macroeconomic impacts of remittances and international migration on the influx of foreign capital and thus the manufacturing sector in developing countries. Embracing the standard procedure in earlier studies, we start by investigating an exogenous increase in remittances, followed by an increase in those resulting from labor migration. In particular, the economic growth in advanced countries raises its demand for labor, culminating in a pull factor for migrant workers. Because the model is set up in a way that firms are investing in developing countries, its economic growth may pull not only migrant labor but also its capital back. Thus, we also explore the push factor attributable to reduction in migration cost advocated by government in developing country. The long-run simulation results of a 10% increase in remittances are presented in Table 2.

An exogenous increase in remittances of 10% ($\bar{r}_m : 0.03 \rightarrow 0.0375$) leads to approximately 0.6% surge in aggregate consumption. As workers move from traded to non-traded sector, the exogenous shock reduces output in the former by 1.4% while boosting that in the

later by about 0.4%. As a result, aggregate output contracts by around 0.26%. This finding is in line with that in a two-sector economy of Chatterjee and Turnovsky (2018); however, we find no evidence of long-run Dutch disease.

To reflect the fact that economic growth in developed countries such as the Middle East has opened the floodgates to labor migration from the region, we calibrate the model with a 2.56% rise in total factor productivity (TFP) in the advanced economy ($A_h : 10 \rightarrow 10.256$). The immediate impact is a 0.35 percentage point increase in migrant workers, prompting a 10% rise in remittances, and a modest increase in consumption. While there is a minimal increase in non-traded output, as a result of foreign capital retreat traded output shrinks by almost 2%. Consistently, the real exchange rate remains unchanged, showing no sign of a long-run Dutch disease. However, due to labor migration, the economy diminishes by almost 0.75%. For the advanced economy, an interesting aspect to note is that the employment of domestic workers declines in spite of its economic growth, which is attributable to the imperfect substitute between migrant and native workers.

To demonstrate a long-standing policy of promoting overseas migrant jobs in many Asian countries, we examine the effect of migration cost reduction ($\xi_m : 0.5 \rightarrow 0.5157$). This would also isolate any effects of advanced economy's TFP growth on its capital abroad. Interestingly, the calibration results show similar increase in labor migration by 0.35 percentage points and a 10% increase in remittances. The increase in TFP in the advanced economy, while affecting labor migration, does not directly impact the flow of capital to the developing country. It is the labor migration that crowds out foreign capital. This result can be evidence to a paradox in international finance in which capital does not flow to developing countries because labor migration reduces the return to foreign investment.

One may suggest that as poor countries send it migrant workers to some developed nations, its FDI inflow is not limited to those from host countries but also from others. Thus, the effect of migration on the stock of foreign capital would be negligible. However, our results from examining the pull and push factors contradict that. The fact that both

factors produces the same impact on foreign capital indicates that it does not depend on the economic condition in the source country. Rather, it relies solely on its return in the developing country (i.e. in the steady state it is pinned down by the rate of time preference). As labor migration raises the cost of labor in the traded sector, it depresses the return to capital in the developing country. This model can be equally applicable to a situation where a developing country send migrant workers to one country and receive all its FDI from another.

4.4 Collateral effect of remittances

Chatterjee and Turnovsky (2018) show that remittances can be growth-enhancing through collateral effect. The improvement in the borrowing capacity of a country due to remittances enables it to expand the formal sector and thus the aggregate output. While they treat remittances as exogenous, we examine the collateral effect of remittances in the presence of labor migration. we consider a full collateral effect of remittances by permanently raising the collateral parameter κ in the interest rate equation (33) from the benchmark level of 0 (no collateral effect) to 1 (full collateral effect). First, the model is calibrated without any other structural shocks. Subsequently, an exogenous and endogenous increase in remittances are included. The findings are presented in Table 3.[5]

The results show that the collateral effect allows households to borrow and expand their consumptions. Because capital is flexible in the long run, the increase in foreign capital benefits the traded sector, thus raising its labor demand and output. The consequence is the reduction in labor supply in the non-traded sector, causing its output to fall slightly. Because of the positive externality of remittances in the borrowing constraint, migrant workers reduce their consumption and send more remittances. It is important to note that the response to the full collateral effect are relatively small; thus, the main results with or without it are largely consistent. Although the collateral effect is expansionary in the long run, the

[5]The results for the advanced economy are omitted since they are the same as those in Table 2.

contractionary impact of remittances with endogenous migration outweigh it. This finding contradicts that of Chatterjee and Turnovsky (2018) who report a larger collateral effect in the absence of labor migration.

4.5 Short run and transitional dynamics

In this section, we examine the short-run impacts and transitional dynamics of remittances. Figure 2 illustrates the transitional paths of the economies in response to an exogenous increase in remittances ($\bar{r}_m : 0.03 \rightarrow 0.0375$) and and to an endogenous change resulted from a reduction in migration costs ($\xi_m : 0.5 \rightarrow 0.5157$). Each shock is simulated with and without the collateral effect of remittances. The results highlight some important implications: (1) remittances can even have a negative impact on domestic output in the short run though the instantaneous decline in domestic output is more severe with the inflow of remittances that is accompanied by labor migration; (2) the transitional dynamics of domestic capital stock (in the non-traded sector) are sharply different under different scenarios. While (1) is straightforward, (2) requires further elaboration.

With the collateral effect of remittances, the non-traded sector benefits in the short run and even into the long run when labor migration is not accounted for (i.e. in the case of exogenous remittances). This is because an instant influx of remittances causes a short-run real exchange rate appreciation (i.e. the rise in the relative price of the non-traded goods), drawing labor quickly from the traded into non-traded sector. As a result, capital stock in the non-traded sector increases. This happens because remittances can be invested to accumulate capital. As a result, the non-traded sector improves at the expense of the traded sector. However, without accounting for the collateral effect, an increase in remittances generated by labor migration does not benefit the non-traded sector. This is because the positive impact of remittances seems to be offset by the negative impact from labor migration and this continues throughout the transition and into the long run.

For the advanced country, the influx of migrant workers benefits its economy tremen-

dously. An interesting aspect is the inverse U shape of native labor supply. In the short run, migrant workers replace natives in the production, thus cutting into native employment. However, as capital stock increases, raising the real wage of native workers, their employment transitorily rises. The boost in wage rate has two opposing effects on the labor supply. The substitution effect induces native workers to cut down leisure and increase the supply of labor, but the income effect reduces the marginal utility of wealth, prompting them to decrease labor supply. When the latter dominates, the supply of native labor declines, generating an inverse U shape of labor supply curve.

4.6 Sensitivity analyses

In this section, we conduct extensive sensitivity analyses for the macroeconomic impact of labor migration resulting from a reduction of migration cost. The results are reported in Table 4.

In earlier results, we have chosen foreign capital stock intensity, $\theta = 0.05$, to obtain a reasonable foreign capital stock to total output ratio. However, one may suggest that a higher foreign capital intensity may help drive the traded production back up with the collateral effect. Thus, we test the model with $\theta = 0.1$. Interestingly, the result in column (1) shows that foreign capital stock decreases by a smaller percentage (-1.83% vs -2.08% in Table 2) and the aggregate output contracts by about 0.69%. So, the larger foreign capital intensity, though lessens the contractionary impacts of migration cost, does not overturn the result.

Similarly, we have chosen $\zeta_T = -0.1$ to obtain the elasticity of substitution between capital and labor equal to 0.9, an estimate that is consistent with that of developing countries (see Duffy and Papageorgiou, 2000). However, it could be argued that the elasticity can be greater and the impact of labor migration on the developing economy is limited. With this regard, we let $\zeta_T = 0.08$, the same as that for the advanced economy. Once again, the result reported in column (2) is in line with previous finding.

The elasticity of substitution between migrant and native workers plausibly affects the stock of migrant workers in the host economy, thereby impacting the traded sector in the developing economy. We have chosen $\delta = 0.5$ to achieve the elasticity of substitution of 2 (Cortes, 2008). However, Ozden and Wagner (2014) find an elasticity of 2.4 in a survey of Malaysian labor force. To approximate that, we raise δ to 0.6, yielding an elasticity of 2.5. The result in column (3) shows that with a higher elasticity leads to lower labor migration but greater remittance inflows as a result of migration cost reduction. This implies that migrant workers earn higher wages and lower labor migration mitigates the negative impact on the traded and aggregate output.

Finally, we analyze the effect of a zero tax on foreign capital income, as compared to a 10% tax rate in Table 2. Consistently, the impacts of labor migration on the traded sector and the aggregate output remain contractionary.

5 Conclusion

In the last few decades, the topic of international migration and remittances has risen to prominence in the realm of development research and policy. A growing number of empirical and theoretical studies attempts to understand their multifaceted impacts on low-income economies. Among them are the two-sector model of Chatterjee and Turnovsky (2018) and the two-small-open-economy model of Lim (2021a, 2021b). In this paper, we aggrandize their proposed frameworks to capture the endogenous link between labor migration and remittances in the presence of cross-border capital mobility and collateral effect. In addition, we incorporate the stock of capital in the non-traded sector, allowing for remittances to be invested through utility maximization.

The model is calibrated to the sample of four Asian countries that have, for decades, actively facilitated emigration of their workers to more advanced economies. First, we study the exogenous shocks of remittances. Then, we examine the increase in remittances resulting

from the push and pull factor of labor migration. The results show that while remittances boost consumption, they generally have a negative effect on the economy. The economic contraction is even greater once we account for labor migration. In particular, the push and pull factors generate similar effect on labor migration, remittances, and foreign capital. However, the increase in TFP in the advanced economy does not directly affect the flow of capital. Its absorption of migrant workers, raising the cost of labor in the traded sector and depressing the return to capital, that crowds out foreign capital. This finding reiterates the observation that foreign capital does not appear to flow to developing countries due to constant labor emigration.

Even after we introduce the expansionary collateral effect, the decline in aggregate output persists in the long run. Specifically, the improvement in developing countries' borrowing capacity raises capital in the traded sector; however, it is not sufficient to overturn the negative impact of labor loss.

While many developing countries are incentivized by remittance inflows and greater household consumption, pursuing policy of facilitating labor emigration will drive the economy into a 'migration-remittance trap', cutting short of their long-term economic development. As far as our study is concerned, a better policy option is to attract foreign investment by retaining a robust labor force at home.

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Appendix

The steady-state equilibrium is described the following set of equations.

Advanced economy

$$\beta = r^* + \Omega_h \left(\frac{\tilde{B}_h}{f\left(\tilde{K}_h, \tilde{N}_h, \tilde{N}_m\right)} \right) \tag{A.1}$$

$$\beta = f_{K_h}\left(\tilde{K}_h, \tilde{N}_h, \tilde{N}_m\right) \tag{A.2}$$

$$f_{K_h}\left(\tilde{K}_h, \tilde{N}_h, \tilde{N}_m\right) = (1-\tau) F^T_{K_f}\left(\tilde{K}_f, \tilde{N}_T\right) \tag{A.3}$$

$$\begin{aligned} \beta\tilde{B}_h + \tilde{C}_h + G_h = {} & f_{K_h}\left(\tilde{K}_h, \tilde{N}_h, \tilde{N}_m\right)\tilde{K}_h + f_{N_h}\left(\tilde{K}_h, \tilde{N}_h, \tilde{N}_m\right)\tilde{N}_h \\ & + (1-\tau) F^T_{K_f}\left(\tilde{K}_f, \tilde{N}_T\right)\tilde{K}_f \end{aligned} \tag{A.4}$$

$$\frac{H_{L_h}\left(\tilde{C}_h, \tilde{L}_h\right)}{H_{C_h}\left(\tilde{C}_h, \tilde{L}_h\right)} = f_{N_h}\left(\tilde{K}_h, \tilde{N}_h, \tilde{N}_m\right) \tag{A.5}$$

$$\tilde{N}_h = 1 - \tilde{L}_h \tag{A.6}$$

Developing economy

$$\beta = r^* + \Omega_d \left(\frac{\tilde{B}_d}{\tilde{p}F^N\left(\tilde{K}_N, \tilde{N}_N\right) + F^T\left(\tilde{K}_f, \tilde{N}_T\right) + \kappa\tilde{R}_m} \right) \tag{B.1}$$

$$\beta = \tilde{p} F^N_{K_N}\left(\tilde{K}_N, \tilde{N}_N\right) \tag{B.2}$$

$$\beta\tilde{B} + \tilde{C}_T + G_T = \tau F^T_{K_f}\left(\tilde{K}_f, \tilde{N}_T\right)\tilde{K}_f + F^T_{N_T}\left(\tilde{K}_f, \tilde{N}_T\right)\tilde{N}_T + \tilde{R}_m \tag{B.3}$$

$$\frac{U_{C_N}\left(\tilde{C}_T, \tilde{C}_N\right)}{U_{C_T}\left(\tilde{C}_T, \tilde{C}_N\right)} = \frac{U_{C_N}\left(\tilde{C}_T, \tilde{C}_N\right)}{M_{C_m}\left(\tilde{C}_m\right)} \tag{B.4}$$

$$\frac{U_{C_N}\left(\tilde{C}_T, \tilde{C}_N\right)}{M_{C_m}\left(\tilde{C}_m\right)} = \tilde{p} \tag{B.5}$$

$$F^N\left(\tilde{K}_N, \tilde{N}_N\right) = \tilde{C}_N + G_N \tag{B6}$$

$$\frac{\Gamma_L\left(\tilde{L}\right)}{U_{C_T}\left(\tilde{C}_T, \tilde{C}_N\right)} = \tilde{p} F^N_{N_N}\left(\tilde{K}_N, \tilde{N}_N\right) \tag{B.7}$$

$$\frac{\Gamma_L\left(\tilde{L}\right)}{U_{C_T}\left(\tilde{C}_T, \tilde{C}_N\right)} = F^T_{N_T}\left(\tilde{K}_f, \tilde{N}_T\right) \tag{B.8}$$

$$F^T_{N_T}\left(\tilde{K}_f, \tilde{N}_T\right) = \xi_m f_{N_m}\left(\tilde{K}_h, \tilde{N}_h, \tilde{N}_m\right) \tag{B.9}$$

$$\tilde{R}_m = \xi_m f_{N_m}\left(\tilde{K}_h, \tilde{N}_h, \tilde{N}_m\right)\tilde{N}_m - \tilde{C}_m + \bar{r}_m \tag{B.10}$$

$$\tilde{N}_N + \tilde{N}_T + \tilde{N}_m = 1 - \tilde{L} - \bar{I}_m \tag{B.11}$$

Table 1: Parameters and steady–state values of the benchmark economies

Parameters of the benchmark economies

Advanced economy

Utility: $\gamma = -1.5;\ \varphi = 1.75;\ \beta = 0.05$

Production: $A_h = 10;\ \alpha_k = 0.17;\ \alpha_n = 0.92;\ \rho = 0.08;\ \delta = 0.5;\ h = 0.85;\ \eta = 15$

Interest rate: $a = 0.03$

Government: $G_h = 1.3$

Developing economy

Utility: $\sigma = 0.46;\ \delta_m = -0.8;\ \varsigma_m = 0.2;\ \delta_l = -0.2;\ \varsigma_l = 0.22$

Traded sector production: $A_T = 2;\ \theta_T = 0.05;\ \zeta_T = -0.1$

Non-traded sector production: $A_N = 1.5;\ \theta_N = 0.13;\ \zeta_N = -0.21;\ z = 0.85$

Interest rate: $b = 0.05;\ \kappa = 0$

Government: $\tau = 0.1;\ G_N = 0.15;\ G_T = 0.02$

Migration: $\xi_m = 0.5;\ \bar{I}_m = 0.05;\ \bar{r}_m = 0.03$

World interest rate: $r^* = 0.035$

Benchmark steady-state equilibrium values

Variables	Description	Model	Data[a]	Data Source
Advanced economy				
$\tilde{K}_h/\tilde{Y}_h$	Capital-output ratio	4.620	3.17 [1.51–5.01]	PWT 9.0
$\tilde{C}_h/\tilde{Y}_h$	Consumption-output ratio	0.793	0.40 [0.09–0.78]	PWT 9.0
$G_h/\tilde{Y}_h$	Gov't spending-output ratio	0.159	0.13 [0.03–0.21]	PWT 9.0
$\tilde{N}_h$	Native labor supply	0.349	0.3	Cooley (1999)
$\tilde{N}_m/\tilde{N}_h$	Ratio of migrant to native workers	0.151	0.16 [0.003–0.85][b]	WDI & UN
$\tilde{w}_h$	Native wage rate	17.47		
$\tilde{w}_m$	Migrant wage rate	3.916		
Developing economy				
$\tilde{R}_m/\tilde{Y}$	Remittance-output ratio	0.071	0.07 [0.03–0.13]	WDI
$\tilde{N}_m/(1-\tilde{L}-\bar{I}_m)$	Migrant-labor force ratio	0.105	0.09 [0.02–0.15]	WDI & UN
$\left(\tilde{K}_f+\tilde{K}_N\right)/\tilde{Y}$	Capital-output ratio	1.575	2.17 [1.53–2.62]	PWT 9.0
$\tilde{C}/\tilde{Y}$	Consumption-output ratio	0.826	0.71 [0.60–0.78]	PWT 9.0
$G/\tilde{Y}$	Gov't spending-output ratio	0.214	0.11 [0.06–0.15]	PWT 9.0
$\tilde{B}/\tilde{Y}$	Debt-output ratio	0.298	0.319[e]	WDI
Sectoral equilibrium values				
$\tilde{K}_f/\tilde{Y}$	Foreign capital-output ratio	0.308	0.11 [0.05–0.25]	UNCTAD
$\tilde{Y}_T/\tilde{Y}$	Share of traded output	0.360	0.41 [0.27–0.59]	MT (2004)[f]
G_T/G	Share of gov't spending on traded goods	0.098	0.07 [0.01–0.17]	MT (2004)
$\tilde{N}_N/(1-\tilde{L}-\bar{I}_m)$	Share of employment in non-traded sector	0.561	0.44[c] [0.25–0.60]	WDI
$\tilde{N}_T/(1-\tilde{L}-\bar{I}_m)$	Share of employment in traded sector	0.334	0.19[d] [0.12–0.24]	WDI
$\tilde{w}_T$	Wage rate in traded sector	1.958		
$\tilde{w}_N$	Wage rate in non-traded sector	1.596		

Notes:

a. The advanced economies include Hong Kong, Japan, South Korea, Kuwait, Malaysia, Qatar, Saudi Arabia, Singapore, and United Arab Emirates. The developing countries include Bangladesh, India, Pakistan, and the Philippines. The data from World Bank's WDI range from 2002 to 2017 and those from Feenstra et al.'s (2015) PWT 9.0 from 2002 to 2014. The data provided are means and ranges in brackets.

b. Ratio of migrants to native workers is proxied by average migrant share of advanced country's labor force.

c. Employment share in agriculture,

d. Employment share in industry.

e. The data represents external debt to GDP ratio for Low-Income countries. It is also consistent with Chatterjee and Turnovsky's (2018) private debt to GDP ratio at 30.89 for 56 developing countries.

f. MT stands for Morshed and Turnovsky.

Table 2: Macroeconomic impacts of remittances

A. Developing economy		Benchmark	Structural changes		
			$\bar{r}_m : 0.03 \rightarrow 0.0375$	$A_h : 10 \rightarrow 10.256$	$\xi_m : 0.5 \rightarrow 0.5157$
R_m	Remittances	0.0675	0.0743	0.0743	0.0743
			(+10%)	(+10%)	(+10%)
Y	Aggregate output	0.9518	0.9493	0.9447	0.9447
			(-0.26%)	(-0.75%)	(-0.75%)
C	Aggregate consumption	0.7865	0.7910	0.7865	0.7865
			(+0.57%)	(+0.005%)	(+0.005%)
Y_T/Y	Share of traded output	0.3604	0.3562	0.3556	0.3556
			(-0.42%pts)	(-0.48%pts)	(-0.48%pts)
Non-traded sector					
p	Real exchange rate	1.2269	1.2269	1.2369	1.2369
			(+0%)	(+0%)	(+0%)
K_N	Domestic capital stock	1.2061	1.2109	1.2062	1.2062
			(+0.40%)	(+0.004%)	(0.004%)
N_N	Non-traded sector labor	0.2801	0.2812	0.2801	0.2801
			(+0.11%pts)	(+0.001%pts)	(+0.001%)
Y_N	Non-traded output	0.4962	0.4981	0.4962	0.4962
			(+0.40%)	(+0.004%)	(+0.004%)
C_N	Non-traded consumption	0.3462	0.3481	0.3462	0.3462
			(+0.57%)	(+0.006%)	(+0.006%)
Traded sector					
K_f	Foreign capital stock	0.2927	0.2885	0.2866	0.2866
			(-1.44%)	(-2.08%)	(-2.08%)
N_T	Traded sector labor	0.1669	0.1645	0.1634	0.1634
			(-0.24%pts)	(-0.35%pts)	(-0.35%pts)
Y_T	Traded output	0.3431	0.3381	0.3359	0.3359
			(-1.44%)	(-2.08%)	(-2.08%)
C_T	Traded consumption	0.3618	0.3638	0.3618	0.3618
			(+0.57%)	(+0.005%)	(+0.005%)
B. Advanced economy					
N_m	Migrant labor	0.0525	0.0525	0.0560	0.0560
			-	(+0.35%pts)	(+0.35%pts)
N_h	Native labor	0.3489	0.3489	0.3417	0.3488
			-	(-0.15%pts)	(-0.01%pts)
K_h	Capital stock	37.861	37.861	39.155	37.932
			-	(+3.42%)	(+0.19%)
Y_h	Output	8.1948	8.1948	8.4562	8.2101
			-	(+3.19%)	(+0.19%)
C_h	Native consumption	6.5004	6.4004	6.7415	6.5082
			-	(+3.71%)	(+0.12%)

Notes:Numbers in parenthesis are percent(age) changes from the benchmark

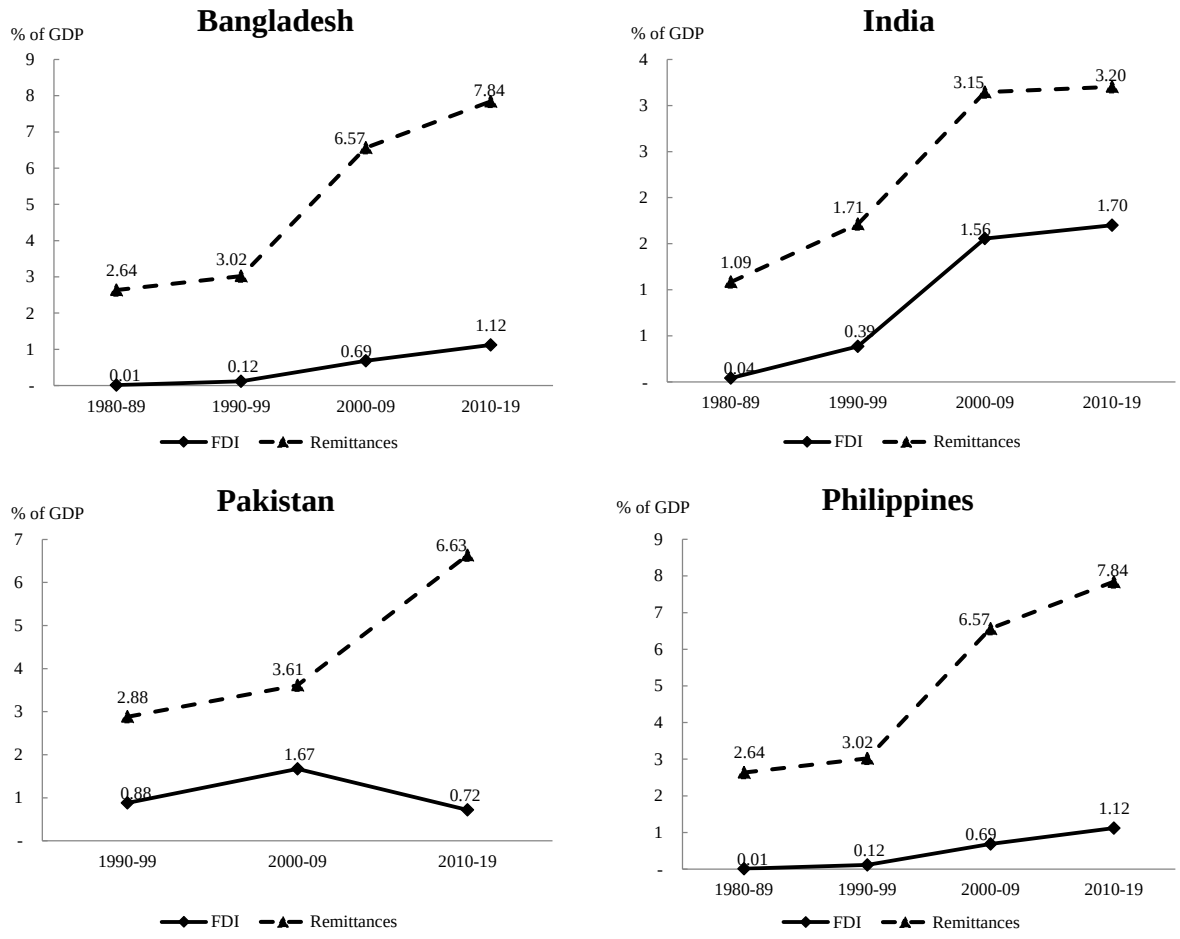
Table 3: Collateral effects

A. Developing economy		Benchmark	$\kappa: 0 \to 1$		
			$\kappa: 0 \to 1$	$\bar{r}_m: 0.03 \to 0.0375$	$\xi_m: 0.5 \to 0.5157$
N_m	Migrant workers	0.0525	0.0525	0.0525	0.0560
			-	-	(+0.35%pts)
R_m	Remittances	0.0675	0.0676	0.0747	0.0744
			(+0.15%)	(+10.17%)	(+10.17%)
B	Foreign debt	0.2834	0.3036	0.3049	0.3036
			(+7.14%)	(+7.59%)	(+7.10%)
Y	Aggregate output	0.9518	0.9521	0.9497	0.9450
			(+0.04%)	(-0.22%)	(-0.71%)
C	Aggregate consumption	0.7865	0.7859	0.7903	0.7858
			(-0.08%)	(+0.49%)	(-0.08%)
Y_T/Y	Share of traded output	0.3604	0.3610	0.3568	0.3562
			(+0.06%pts)	(-0.36%pts)	(-0.42%pts)
Non-traded sector					
p	Real exchange rate	1.2269	1.2269	1.2269	1.2269
			(+0%)	(+0%)	(+0%)
K_N	Domestic capital stock	1.2061	1.2055	1.2102	1.2055
			(-0.05%)	(+0.34%)	(-0.05%)
N_N	Non-traded sector labor	0.2801	0.2799	0.2810	0.2799
			(-0.02%pts)	(+0.10%pts)	(-0.02%pts)
Y_N	Non-traded output	0.4962	0.4959	0.4978	0.4959
			(-0.05%)	(+0.34%)	(-0.05%)
C_N	Non-traded consumption	0.3462	0.3459	0.3478	0.3459
			(-0.08%)	(+0.49%)	(-0.08%)
Traded sector					
K_f	Foreign capital stock	0.2927	0.2933	0.2891	0.2872
			(+0.19%)	(-1.23%)	(-1.87%)
N_T	Traded sector labor	0.1669	0.1672	0.1649	0.1638
			(+0.03%pts)	(-0.20%pts)	(-0.31%pts)
Y_T	Traded output	0.3431	0.3437	0.3389	0.3367
			(+0.19%)	(-1.23%)	(-1.87%)
C_T	Traded consumption	0.3618	0.3615	0.3635	0.3615
			(-0.08%)	(+0.49%)	(-0.08%)

Table 4: Sensitivity analyses

A. Developing economy		$\xi_m : 0.5 \rightarrow 0.5157$			
		(1)	(2)	(3)	(4)
		$\theta = 0.1$	$\zeta_T = 0.08$	$\delta = 0.6$	$\tau = 0$
ΔN_m	Migrant workers	+0.31%pts	+0.34%pts	+0.27%pts	+0.34%pts
$\Delta R_m/R_m$	Remittances	+11.01%	+10.04%	+17.75%	+10.07%
$\Delta Y/Y$	Aggregate output	-0.69%	-0.75%	-0.57%	-0.74%
$\Delta C/C$	Aggregate consumption	+0.003%	+0.005%	+0.004%	+0.01%
Non-traded sector					
$\Delta p/p$	Real exchange rate	+0%	+0%	+0%	-0%
$\Delta K_N/K_N$	Non-traded capital stock	+0.002%	+0.004%	+0.003%	0.006%
ΔN_N	Non-traded labor	+0.001%	+0.001%	+0.001%	-0.002%
$\Delta Y_N/Y_N$	Non-traded output	+0.003%	+0.004%	+0.003%	+0.006%
Traded sector					
$\Delta K_f/K_f$	Foreign capital stock	-1.83%	-2.07%	-1.48%	-2.05%
ΔN_T	Traded sector labor	-0.31%pts	-0.35%pts	-0.28%pts	-0.35%pts
$\Delta Y_T/Y_T$	Traded output	-1.83%	-2.07%	-1.48%	-2.05%

Figure 1: FDI and remittances

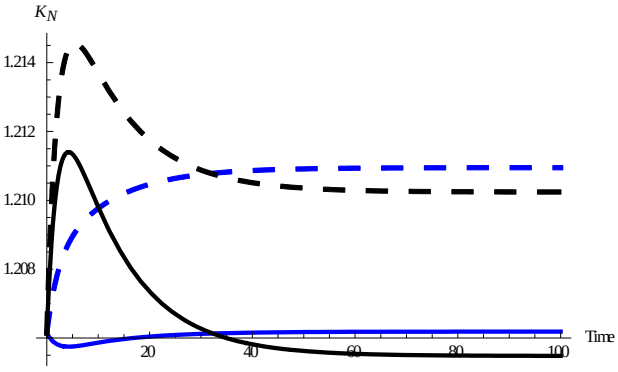


Source: World Bank's World Development Indicators

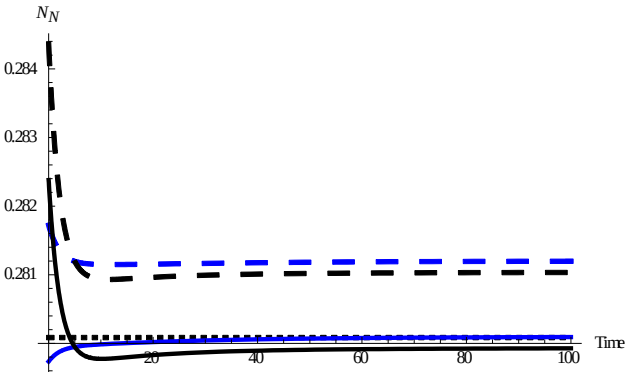
Figure 2: The short run and transitional dynamics

Initial steady-state value
Exogenous increase in remittances (without collateral effect)
Exogenous increase in remittances (with collateral effect)
Increase in remittances generated by labor migration (without collateral effect)
Increase in remittances generated by labor migration (with collateral effect)

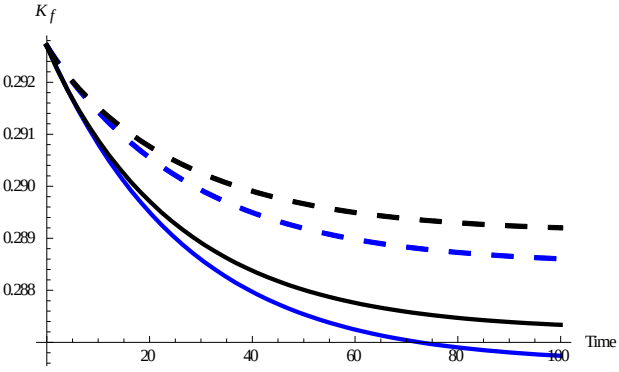
A. Developing economy



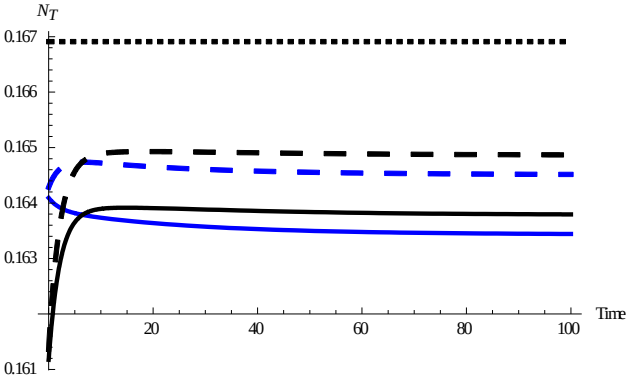
Non-traded capital stock



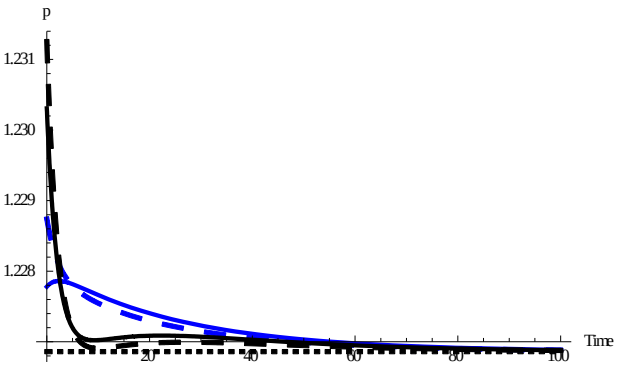
Non-traded labor employment



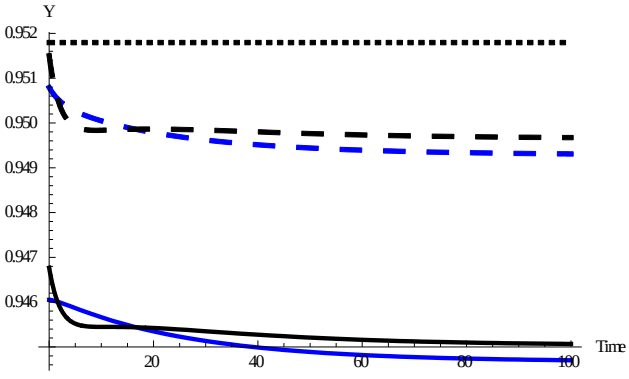
Foreign capital stock



Traded labor employment

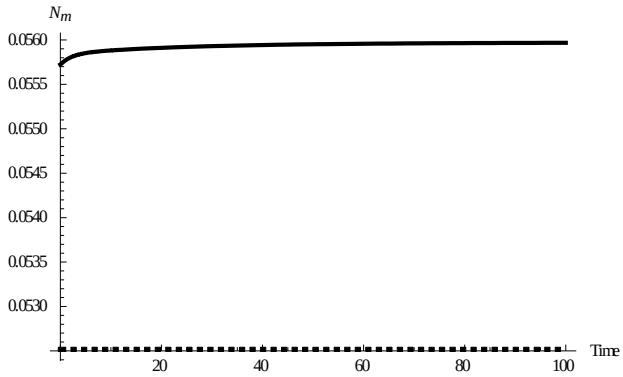


Real exchange rate

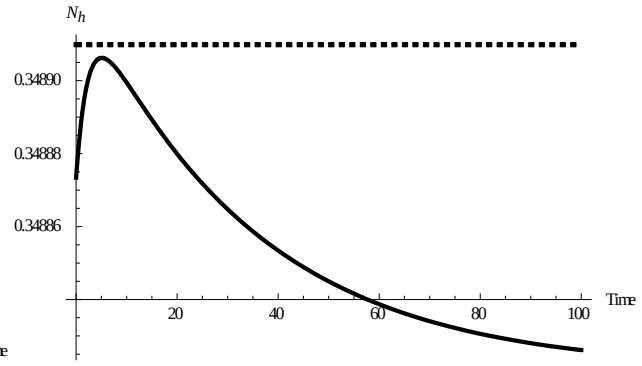


Aggregate Output

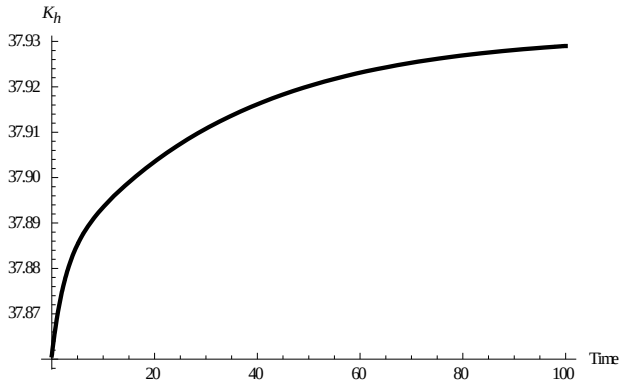
B. Advanced economy



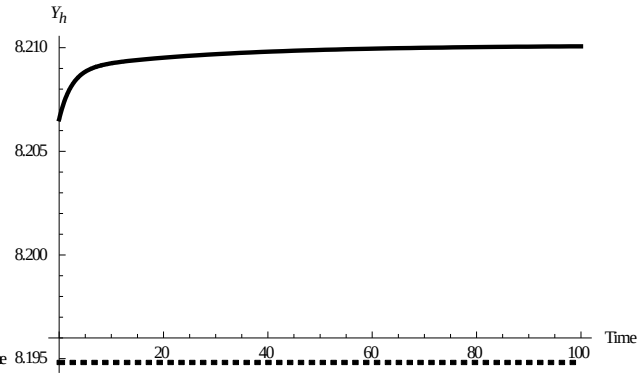
International Migrants



Native labor employment



Capital stock



Output