Migrant Labor and Remittances: Macroeconomic Consequences and Policy Responses*

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Abstract

Many developing countries experiencing poor domestic economic performance view migrant labor as an alternative. We employ a macro-dynamic model of two small open economies – a host country and a labor-exporting, developing country – to address this issue. We analyze how both economies are impacted by alternative tax policies, as well as structural changes occurring in the two economies, and plausible fiscal policy responses. The most important feature of the model is that remittances are endogenized, by being linked to the household members' decisions to migrate. Extensive numerical simulations in response to changing tax rates, structural changes, and alternative policy responses are conducted. These provide important implications for both fiscal and migration policies, and address important questions regarding the current efforts put forward by governments of several developing countries to encourage migrant labor.

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I. Introduction

This paper is motivated by several important factors occurring in the global economy today. In light of poor domestic economic performances, many developing countries have viewed migrant work as an alternative to help relieve their domestic unemployment pressure. A series of efforts has been proposed by the governments of some developing Asian countries to help facilitate and promote migrant employment. In 1971, the Pakistani government created the Bureau of Emigration and Overseas Employment to promote overseas employment. In 1982, the Philippine Overseas Employment Administration was founded for a similar purpose, seeking migrant work for Filipino workers. India enacted the Emigration Act in 1983, and later established the Ministry of Overseas Indian Affairs, to centralize all work related to the Indian diaspora. In 1984, the Bangladesh Overseas Employment and Services Limited was formed for the export of Bangladeshi workers. Nepal approved the Foreign Employment Act in 1985, which led to the establishment of the Department of Foreign Employment. Sri Lanka established the Sri Lanka Bureau of Foreign Employment under legislation approved in 1985.[1]

These efforts advanced by these governments of Asian countries were driven by a huge demand for labor in the Middle East. Migrant workers were also attracted by higher wages. By 1980, the presence of South Asian migrants in the Middle East surpassed that in the United States and the United Kingdom combined; and by 2010 it surpassed migration within its own region (see Lim and Basnet, 2017). These workers have been sending parts of their earnings back to their home countries. In 2015, the total flow of remittances to the five South Asian countries, Bangladesh, India, Nepal, Pakistan and Sri Lanka amounted to over $117 billion, of which well over 50% came from the Middle East (World Bank, 2016).

These characteristics raise important economic questions. Is this the right effort to pursue? Do these governments make efficient use of resources? What are the benefits and costs to the nations?

[1] In recent years, even a small country like Cambodia has signed Memorandum of Understanding (MOU) with several countries in the region to promote overseas jobs for Cambodian workers.

Could they do better using other policies at their disposal? These are questions that we intend to address, by directly examining the impact of different structural changes, specifically on migrant labor and alternative potential tax policy responses.

The question of the taxation of income and remittances in the context of international labor mobility has a long history and was heatedly debated in the 1970s (see Bhagwati and Wilson, 1989). A general conclusion was that the presence of international migration reduces the optimal income tax, and taxing migrants is necessary to compensate the labor-exporting country for the loss in its tax base. Mirrlees (1982) further showed that the optimal tax on migrants' income should be higher than that on home income when taxation of migrants is possible.[2] The debate regarding this type of taxation was driven by the fact that the outflow of skilled labor to a foreign country harms domestic production. Examples include the emigration of physicians and nurses that has contributed to health system crises in some African countries, and severe shortages of health care professionals in the Philippines (McHale, 2009). As a result, the Philippines has tried in various ways to tax the foreign income of its citizens (see Pomp, 1989). After an extended effort, it led to a collection of the Documentary Stamp Tax (DST) of 0.3 pesos for every 200 pesos sent by Filipino workers abroad in the late 1990s, but which was subsequently abolished by the Government of the Philippines. The removal of DST came at a huge cost, estimated at about $1.3 billion annually, to the government budget. In similar attempts to harness the inflows of remittances, Cuba has embedded a 20% tax in the exchange rate for all remittances in U.S. dollars. Desai et al. (2009) report that the brain drain from India to the U.S. cost the Indian government between 0.2 to 0.6% of GDP. In 2012, India put out a proposal to collect 12% tax on fees paid by remitters at the banks. This, however, was later withdrawn due to public objection.[3]

Some important aspects were not incorporated fully when the issue of the optimal income

[2] McHale (2009) introduces other fiscal instruments including exit taxes, emigration-related development aid, and receiving-country tax sharing besides sending-country imposed taxes (Bhagwati taxes). For economic impacts of international migration on source countries, see Hanson (2009, 2010).

[3] For DST in the Philippines, see Advisory No. 29, series 2010 of the Philippine Overseas Employment Administration. See Mohapatra (2010) on Cuba's tax on remittances in U.S. dollars, and for India's cancellation of its service fee, see Circular No. 163/14/2012-ST issued by the Tax Research Unit of the Ministry of Finance.

tax and tax on emigration was debated. At the national level, a remittance-receiving country may actually benefit from the inflows of remittances. There are arguments that the accumulation of foreign reserves from receiving remittance inflows has helped raise the repayment capacity of a receiving country, and thus potentially reduce the borrowing premium (Chami et al., 2008; Bugamelli and Paterno, 2009; IMF & World Bank, 2009). Chatterjee and Turnovsky (2018) reports that the country-level risk premiums for several developing countries are linked to the ratio of remittances to their GDP. Their data of 56 developing countries for the period 1990-2014 reveal that countries with a higher share of remittances in their GDP tend to have a lower risk premium. To analyze this, these authors have incorporated this relationship into a general equilibrium framework to examine the effect of remittances on an informal economy in which remittances may serve as collateral to varying degrees. But they did not consider the broader link between remittances and international migration, another aspect that may have potentially important implications for the labor market (in both countries).

Indeed, Lim and Morshed (2015) show that the increased inflow of remittances to developing countries is triggered by increased migration due to adverse income shocks. Thus, the remittance inflow is associated with a shrinking labor force in the labor-exporting country, which may then lead to higher domestic wages. For example, Mishra (2007) estimates the elasticity of wages with respect to emigration of Mexicans to the U.S. to be 0.40, while Bouton et al. (2011) obtain a wage elasticity of 0.32 in the case of Moldovans' emigration.

In this paper we address the above questions and examine the role of tax policy, most importantly the taxes on domestic labor income and migrant remittances of a labor-exporting, developing economy by building a macro-dynamic model that incorporates the important facts we have been describing. The model considers two small open economies – an advanced host country and a labor-exporting, developing country. The treatment of the host country as being small, is a reflection of the reality that many small advanced economies, such as the various Middle East states, Netherlands, Belgium, Australia, and Singapore, rely heavily on migrant labor from developing countries as an integral part of their production capacity.

The model we develop is related to an earlier study by Lim and Morshed (2017), though it differs substantially both in terms of its structure and focus. First, the earlier model is much more restrictive in that it assume that both countries have unlimited access to the world financial market, an empirically unrealistic assumption, especially for a developing economy. In contrast, this model assumes that both countries are subject to a borrowing constraint, which relates the borrowing cost to the economy's repayment capacity and for which supportive empirical evidence exists (see footnote 6). Apart from its relevance, the introduction of increasing debt costs for both small open economies adds an important channel linking the two economies. Specifically, the presence of migrant workers and their labor supply affects output in both the domestic and host economies. These changes in output indirectly impact the international borrowing costs faced by both countries, thereby opening additional avenues for the transmission of economic shocks between the two countries. Second, the earlier paper abstracts from capital accumulation in the developed economy, clearly a serious simplification. As a result of these restrictions, the earlier analysis does not generate the interdependence between the two economies, characteristic of the equilibrium discussed in Section 3, and which we view as an important element of the issue. Finally, an additional difference between two papers lies in their focus. While Lim and Morshed (2017) examine a government spending increase and various financing schemes, this study is concerned primarily with the effects of structural shocks on the welfare of the various constituents and possible policy responses.

Households in the host economy consume a traded good and enjoy leisure. Private capital in the host country can be converted from the traded good, without cost, while we assume capital in the developing country is fixed. Since agricultural production still constitutes a large portion of output in most developing countries, we can assume that the inelastically supplied capital stock reflects the fixed amount of land. The household in the host country decides only between leisure and working locally, thus no labor migrates to work in the developing country. In contrast, the household in the developing country decides on the allocation of time between (i) leisure, (ii) supplying labor for domestic production, and (iii)

providing migrant labor to the host country. Migrant workers earn a wage determined by the host economy, and after fulfilling their own consumption needs, remit a portion of their earnings back to their home country. This generates an endogenous flow of remittances that is associated with migration, in line with the results of Lim and Morshed (2015).

We assume that households (in both countries) have access to the international financial market, but in doing so they are charged an interest rate that includes a borrowing premium above the (given) world interest rate. The borrowing premium – a proxy for the country's risk – reflects the country's repayment capacity, measured by the ratio of its debt to GDP, augmented by foreign currency earnings, including remittances. We also assume that migration incurs a cost due to frictions that result from tightened immigration laws or stricter control over hiring migrant workers. For simplicity, and without serious loss of generality, we abstract from the government in the host country. However, the government of the developing country consumes a fraction of domestic output and collects taxes on consumption, domestic labor, capital income, and remittances. So as not to obscure our focus on the dynamics of remittances we adopt the routine simplifying assumption that the government uses lump-sum taxes to maintain a balanced budget.

Having derived the macroeconomic equilibrium, the model is then calibrated to reflect the flow of migrant workers between Bangladesh (the developing country) and a set of 5 Middle East countries (the advanced small economies). As we discuss below, in light of the fact that almost half of Bangladeshi migrant workers are employed in the wealthy countries of the Middle East, we view this as an appropriate context for our numerical analysis. One characteristic of the Bangladeshi tax structure and that of other similar economies, such as India, is the high tax rates on both labor income and consumption. To examine the significance of this tax structure for the decisions and welfare of the different constituents in the home and host economies, we first consider the impact of reducing these tax rates, as well the effect of introducing a tax on remittances. This enables us to identify the diverse channels through which they impact the two economies, and their effect on the flow of remittances.

We also consider three different structural changes that impact both the host and labor-exporting economies in diverse ways. These include: (i) a productivity increase in the host economy, (ii) a productivity increase in the home economy, and (iii) a reduction of costs associated with migration. In each case, in addition to the direct effect of the structural change, we also consider alternative plausible tax responses by the home country government. In most cases the policy responses that are directed toward benefiting the home country tend to have a mild adverse impact on the host economy.

A productivity increase in the advanced country raises the wages of both native and migrant workers. But native wages increase more, causing host firms to substitute in favor of migrant workers, who as a consequence increase their labor supply. This enables them to increase their remittances, which improves the welfare of their households in the home country. While migrant workers also may increase their consumption, overall the reduction in leisure they experience may dominate and lead to a welfare loss. However, this can be offset if the home government implements appropriate tax policies that induce migrants to reduce their labor supply, although this entails a reduction in the level of remittances.

Despite the fact that migrant workers are not impacted directly by the productivity increase in the domestic economy, and the associated increase in the wage rate, they actually benefit more than do the domestic residents. This is because of the need to maintain what we call "internal household equilibrium", which stems from the assumption that migrant workers and domestic residents operate as a single family unit and maximize their joint utility. As a consequence, since the domestic residents benefit directly from the productivity increase in the home economy, with higher wages and consumption, migrants choose to reduce their remittances, which decline drastically. Instead, they choose to increase their own consumption and to provide less labor.

Policies directed toward encouraging workers to migrate generally benefit both migrants and home residents. Reducing fixed migration costs means more money is available for migrants to remit to their family, allowing the home residents to increase their

consumption and leisure. At the same time the reduced migration costs permits migrants to increase their consumption while enjoying more leisure. The effects of this policy on the both output and consumption in the host country are essentially negligible, as are the effects on native employment, which if anything are positive. This finding sheds some light on the current heated debate over the benefits of migration and immigrants. Our simulations suggest that any deterioration of host output and consumption brought about by home country policy responses are also minor and can easily be neutralized by appropriate host country policy responses.

The final simulation we consider illustrates the transitional paths followed in response to a productivity increase in the host country and a reduction in migration costs. The main aspects that these highlight is that almost all of the adjustments in the home country occur on impact. This is primarily a reflection of it being a small economy that does not accumulate capital and the reality that it can essentially adjust instantaneously without disturbing the world economy. The fact that the transitional paths are so insignificant justifies our focus on the steady-state responses.

Recently, there has been a growing literature focusing on the impact of remittances on various aspects of the aggregate economy. These studies include the effect on the real exchange rate (Amuedo-Dorantes and Pozo, 2004; Acosta et al., 2009; Chatterjee and Turnovsky, 2018), on financial development (Giuliano and Ruiz-Arranz, 2009; Aggarwal et al., 2011), on current account (Bugamelli and Paterno, 2009), on economic growth (Chami et al., 2009; Giuliano and Ruiz-Arranz, 2009; Durdu and Sayan, 2010), on monetary and fiscal policy (Chami et al, 2005; and Chami et al., 2006, Lim and Morshed, 2017), on real business cycles (Mandelman and Zlate, 2012, Finkelstein Shapiro and Mandelman, 2016; Bahadir et al., 2018).

This paper contributes to the existing literature in several important respects. First, modeling the interaction between two small open economies captures important elements that are prevalent in the current global economy. Key features explicitly incorporated in the analysis include: (i) The endogeneity of the inflow of remittances and its link to migration,

with these decisions being optimally chosen by the household, and (ii) remittances affecting the borrowing premium component in determining the borrowing costs of the developing country. In addition, the numerical simulations provide insights into key policy discussions pertaining to both fiscal and immigration policies, and address important questions regarding the current efforts proposed by several governments of developing countries to encourage labor migration. The interaction between the home and host economies highlights how the role of migrant labor in providing remittances are in fact quite complex. In particular, the role of what we have called "internal household equilibrium" is crucial in determining the welfare consequences of different groups impacted by the migration.

The remainder of the paper proceeds as follows. Section II details the model, while Section III derives the macroeconomic equilibrium. Section IV discusses the calibration while Sections V and VI apply the model to address several types of tax changes, structural shocks, and policy responses. Section VII briefly considers the transitional dynamics, while Section VIII concludes. An Appendix provides the formal derivation of the macroeconomic equilibrium.

II. Analytical Framework

We construct a simple macro-dynamic model of two small open economies. One is a labor-exporting, developing country that we also refer to as the "domestic" or "home economy", while the other is a labor-importing advanced country, called the "host country". In keeping with the conventional literature on remittances, the developing country is a low wage economy lacking in capital resources. We assume that there is a continuum of households in the home country that because of their lack of resources seek to send a fraction, m, of their members abroad as migrant workers, with the intention that they would remit some portion of their higher wages earned abroad to supplement the family income. Both countries produce the same traded commodity and are small in the sense that they take the price of the traded good as given. Both countries also have access to the world financial market, but are subject to a borrowing premium which reflects their

associated risk, as perceived by lenders.

To develop a model that may plausibly match the empirical evidence underlying our simulations, two issues need to be taken into account. The first is that the relative sizes of the home and host countries vary enormously. In calibrating the model, as detailed in Section 5 below, we shall identify the home country with Bangladesh and the host country as comprising 5 small Middle East countries, which in both cases can plausibly be viewed as being "small" in terms of their impact on the world economy. But the population of Bangladesh is three times that of the Middle East countries. To account for this, we let θ denote the relative size of the home and host economies. But in addition, Bangladeshi workers migrate to a range of advanced economies, many to large economies, such as the United States and the European Union, where they account for a negligibly small fraction of the labor force and accept the conditions there as given. Accordingly, the impact of this group on the equilibrium between the two small economies, that are our focus, can be treated as exogenous.[4]

We shall assume that the fraction of the home country workers migrating to the small host country is μ so that the number of migrant workers relative to native workers in the host country is $\theta m \mu$. Assuming further that each migrant worker is endowed with a unit of time, a fraction of which N_m, (chosen by firms in the host country) is demanded as labor, the net supply of labor provided by migrant workers to the host country is $\theta m \mu N_m$. The two countries are described as follows.

A. Host Country (Labor-Importing Country)

Firms in the host country employ capital, K_h, native labor, N_h, and migrant labor, N_m, to produce output, Y_h. The host country's production technology is specified by the neoclassical function

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

[4] There is abundant evidence that citizens of many small developing countries emigrate to live and work in the U.S. and many advanced European countries.

where $f_{K_h} > 0,\ f_{N_h} > 0,\ f_{N_m} > 0,\ f_{K_h K_h} < 0,\ f_{N_h N_h} < 0, f_{N_m N_m} < 0, f_{K_h N_h} > 0, f_{K_h N_m} > 0, f_{N_h N_m} > 0$. Thus all three productive factors, and specifically, native and migrant workers, are co-operant in production.

The profit maximizing behavior of firms in the host country yields the following conventional demand functions for capital, native labor, and migrant workers:

$$p f_{K_h}(K_h, N_h, \theta\mu m N_m) = r_{K_h} \quad (2a)$$

$$p f_{N_h}(K_h, N_h, \theta\mu m N_m) = w_h \quad (2b)$$

$$p f_{N_m}(K_h, N_h, \theta\mu m N_m) = w_m \quad (2c)$$

where r_{K_h}, w_h and w_m denote the rental price of capital, the wage rate for native workers, and the wage rate for migrant workers, respectively, and p is the output price in the host country, which both countries take as given. The assumption that migrant and native workers are co-operant in production ($f_{N_h N_m} > 0$) implies that the inflow of migrant workers will raise the marginal product of native workers and thus, their wage rate (given the stock of physical capital). Furthermore, if native labor is more productive (skilled) than migrant workers then $w_h > w_m$, and vice versa.

Each household in the host country is endowed with one unit of time that it allocates between leisure (L_h) and work (N_h), so that native labor supply is subject to the constraint

$$N_h = 1 - L_h \quad (3)$$

Host country households also choose consumption (C_h) and leisure (L_h) to maximize the concave utility function

$$W_h = \int_0^\infty H(C_h, L_h) e^{-\beta t} dt \quad (4a)$$

where β is the rate of time preference, subject to their accumulation of foreign debt:[5]

[5] For simplicity, and to avoid corner solutions, we assume that output can be transformed costlessly into capital.

$$\dot{B}_h = r_h B_h + C_h + \dot{K}_h - r_{K_h} K_h - w_h N_h$$

(4b)

where r_h denotes unit borrowing costs to host residents, and B_h their holdings of international debt.

While consumers in the host economy have access to international financial markets, due to financial frictions these are restricted. These frictions are reflected in a borrowing cost function that 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 Y_h (GDP). The cost of borrowing is thus specified by[6]

$$r_h = r^* + \omega\left(\frac{B_h}{Y_h}\right); \quad \omega(0) = 0,\ \omega' > 0,\ \omega'' > 0$$

(5)

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

Performing the optimization yields the following optimality conditions:

$$H_{C_h}(C_h, L_h) = \pi \tag{6a}$$

$$H_{L_h}(C_h, L_h) = \pi w_h \tag{6b}$$

$$\beta - \frac{\dot{\pi}}{\pi} = r_h \tag{6c}$$

$$r_{K_h} = r_h \tag{6d}$$

where π is the shadow price of wealth in the form of internationally traded bonds.

Equation (6a) equates the marginal utility of consumption to the shadow price of wealth, while equation (6b) implies that the marginal utility of leisure is equal to the utility-

[6] Foreign borrowing constraints of the form (5) have a long tradition in international finance and form a convenient way of closing the "small economy model"; see Turnovsky (1997). They were first introduced by Bardhan (1967) who expressed the borrowing premium in terms of absolute level of debt. Many variants, based on various forms of normalization of the debt level, have been employed (see Finkelstein Shapiro and Mandelman, 2016; Bahadir et al., 2018). Empirical evidence supporting functions of the form (5) is provided by Edwards (1984) and more recently by Chung and Turnovsky (2010).

adjusted return to labor. Equation (6c) is the Keynes-Ramsey consumption rule which equates the rate of return on consumption to the borrowing costs. Equation (6d) is the no-arbitrage condition for private investment, which equates the rate of return on physical capital to the borrowing cost. In addition, the transversality conditions require that

$$\lim_{t\to\infty} \pi K_h e^{-\beta t} = 0, \lim_{t\to\infty} \pi B_h e^{-\beta t} = 0 \qquad (6e)$$

B. Domestic Country (Labor-Exporting Country)

As we have already noted, we assume that there is a unit continuum of household members, a fraction, *m* of which are migrant workers, while the rest $(1-m)$ remain and work at home. Also, as described earlier, of the fraction *m*, a fraction μ migrate to work in the small host economy, described above, while (1–μ) migrate to the large economy.

The home country receives remittances from those who migrate to work in the small host economy, as well as those who emigrate to other advanced economies. Migrant workers in the small host country remit a fraction of their income after consumption (C_m) back to their family in the home country. This specification draws upon the empirical work of Lim and Morshed (2015) who found that the increased remittances to developing countries are the result of migration triggered by income shocks. The remittances of this group are clearly endogenous, dependent on their labor supply and consumption decisions. In addition the home economy receive remittances, Ω, from migrants in the large advanced economies. Since these contributions are determined by conditions in these economies, which the migrant workers from the small home economy cannot control, these are treated as exogenous.[7] The aggregate remittances (R) can thus be written as

$$R = \mu m(w_m N_m - x - C_m) + (1-\mu)m\Omega \qquad (7)$$

where x are fixed costs associated with migration to the host economy, incurred by the migrant workers. These include expenses such as work permits, transportation, each of which would

[7] This accords with most of the literature which treats remittances as exogenous; see Chatterjee and Turnovsky (2018) for further discussion of this issue and the associated literature.

reduce the net income earned by migrant workers, causing them to reduce their remittances.[8]

The reason for introducing the exogenous components of migrant workers, μ, is purely to facilitate the calibration. While our focus is on the relationship between the two small open economies, in reality their bilateral migration reflects only a fraction of their respective migrant workers. For example, only a fraction of Bangladeshi migrants go to the Middle East, while at the same time the migrant workers in the Middle East come from many countries. Introducing this exogenous source of remittances is necessary in order to obtain an equilibrium that approximates the observed magnitudes of migrants and remittances that flow between Bangladesh and the Middle East host countries. With m, Ω assumed to remain constant it provides a constant source of revenue to the home country, and plays no role except in the case that the tax rate on remittances is changed.

1. The Private Sector

The labor-exporting country is a developing economy having minimal capital, and is certainly less capital intensive than is the advanced economy. Agricultural production still constitutes a large portion of output in most developing countries, and land, which is fixed, serves as capital in this case. Thus, assuming for simplicity that the developing economy is endowed with a fixed capital stock $\bar{K}_d$, and with a fraction m of the population employed as migrant workers, the production function in the home economy is:

$$Y = F(\bar{K}_d, (1-m)N_d) \tag{8}$$

where N_d is domestic labor and $F_{N_d} > 0$ and $F_{N_d N_d} < 0$. Thus, firms in the home economy choose only how much labor to employ, so that the corresponding profit maximizing condition is

$$F_{N_d}(\bar{K}_d, (1-m)N_d) = w \tag{9}$$

where w is the wage rate in the labor-exporting country. Assuming constant returns to scale,

[8] Mandelman and Zlate (2012) model migration friction in a similar fashion.

the return to the fixed capital stock is $F_{K_d}(\bar{K}_d, N_d)$.[9] By appropriate choice of units, the price level in the economy is assumed set at unity.

We assume that like the host country, the household in the labor-exporting country can borrow in the international financial market, but in doing so it also faces increasing borrowing costs. As noted by Chatterjee and Turnovsky (2018), the importance of remittances as a collateral in securing borrowing has received some attention, especially for countries having a high remittance to GDP ratio. Accordingly, we explicitly allow for some portion, $\kappa, 0 < \kappa < 1$, of the flow of earnings remitted by the migrant workers to serve as a component of repayment capacity. The interest rate function facing the developing country is thus

$$r = r^* + \upsilon\left(\frac{B}{Y+\kappa R}\right); \quad \upsilon(0) = 0, \quad \upsilon' > 0, \ \upsilon'' > 0 \tag{10}$$

where B is the country's stock of debt, r is the foreign interest rate faced by the household in the labor-exporting country, and $\upsilon[B/(Y + \kappa R)]$ is the borrowing premium. As κ increases, the country's ability to service the debt improves and its unit borrowing costs decline. As is the case for the host country, the individual household, in the labor-exporting economy cannot influence the interest rate and so takes it as given.

A critical element of our framework concerns the specification of the utility function, which reflects the nature of the relationship between the migrant workers and his family members who stay behind (the stayers). The fact that the migrants are sending remittances to their family members strongly suggests that they are obviously concerned about their welfare, and it is therefore appropriate to treat the household as a single family unit whose utility is a weighted average of the utility of those who stay and those who migrate to the small economy. Moreover, many migrant workers are frequently only temporary guest workers, who maintain

[9] With the stock of capital fixed, the return to capital is $(Y - F_{N_d}(\bar{K}_d, N_d)N_d)/\bar{K}_d$, which with constant returns to scale, reduces to $F_{K_d}(\bar{K}_d, N_d)$.

strong ties to their families, in which case the maximization of joint utility is further justified.[10] The household also derives utility from government consumption expenditure, G, which for convenience is introduced as additively separable from the other sources of utility.

The weighted utility of the two groups depends upon their respective consumption (C, C_m) and leisure (L, L_m). Thus, the household utility function is

$$W_d = \int_0^{\infty} [(1-m)U(C,L) + \mu m U(C_m, L_m) + \Gamma(G)]e^{-\beta t}dt \quad (11)$$

where $U_C > 0,\ U_L > 0,\ U_{CC} < 0, U_{LL} < 0, U(C_m, L_m)$ is the utility of migrants while working in the host country and has similar properties, and $\Gamma(G)$ is the utility derived from government expenditure.

Both domestic resident and migrant worker members of the household are endowed with one unit of time that can be allocated between work and leisure, implying the constraints

$$N_d + L = 1 \quad (12a)$$

$$N_m + L_m = 1 \quad (12b)$$

The domestic household is also subject to the budget constraint:

$$\dot{B} = rB + (1-m)[(1+\tau_c)C - (1-\tau_w)wN_d] - (1-\tau_k)F_K\bar{K}_d - T$$
$$-(1-\tau_m)\{\mu m[w_m N_m - x - C_m] + (1-\mu)m\Omega\} \quad (13)$$

where T represents the lump-sum tax, and $\tau_c, \tau_w, \tau_k,$andτ_m are distortionary taxes on consumption, domestic labor income, domestic capital income, and remittances received from migrants, respectively. This remittance tax is similar to the long-discussed emigration tax, later known as the Bhagwati tax.[11] This tax was proposed in the 1970s during a heated debate

[10] The approach we are adopting of evaluating welfare in terms of joint household utility is characteristic of the literature, in which migrant workers send remittances back to their families; see e.g. Lucas and Stark (1985), Hoddinott (1994), Ilahi and Jafarey (1999), and more recently Murard (2016), and Ivlevs, Nikolova, and Graham (2019) for examples that embody this jointness of welfare in varying ways. This contrasts with an alternative approach, more applicable to skilled migrants (like scientists and academics), who evaluate their decision to migrate in terms of their own personal career prospects and individual welfare gains; see e.g. Ehrlich and Kim (2015).

[11] In this study, we do not specifically focus on the brain drain, but rather on international migration in general. The

on the impact of a brain drain on labor-exporting countries (Bhagwati, 1976).[12]

Three features of our formulation of the decision problem confronting the home household merit comment. First, the budget constraint assumes that the remittances are allocated either to household consumption and/or to debt reduction. In practice, some is likely to be allocated to some form of domestic investment. But given our treatment of domestic capital stock as being fixed, and the reality that the average remittances are in fact a small percentage of GDP, this effect turns out to be very minor.[13] However, this would cease to be the case if we extended the model to allow the domestic economy to accumulate the capital indefinitely, to which the remittances could contribute on an ongoing basis.

Second, we assume that the fraction, *m*, of household members that are migrant workers is exogenous. The issue of migration is a complex one. While to some extent the decision to migrate is a choice, it is also severely constrained. Many countries impose strict quotas on the number of migrant workers they will admit, particularly low-skilled workers of the type envisioned by this study. For example, Saudi Arabia, by far the largest of the countries comprising our 5 Middle East host countries, imposes a strict quota. It requires a non-Saudi migrant worker to have a local sponsor who secures a work permit and residency card (the number of which is controlled by the Minister of Interior) in order to be able to work and stay in that country. Other countries also exercise controls, although they may be less stringent. Costa and Martin (2020) report that the U.S. Department of State issued over 200,000 visas to H-2A guest workers in fiscal 2019, while at the same time the US has approximately 11 million undocumented workers. Similar restrictions are observed for other countries.[14]

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idea of fiscal loss applies to both skilled and unskilled migration, though the former may be more significant. Furthermore, unskilled workers could also become important for some developing growing economies like China. Given the success of one-child policy and the substantial growth of its economy, we may see massive return of unskilled labor (Bhagwati, 2011).

[12] We should also note that the constraint (13) also incorporates the reality that many countries in the Middle East, employing migrant workers, do not impose income taxes.

[13] We have performed simulations to demonstrate this.

[14] For example, France another substantial employer of migrant workers, recently imposed quotas, the stated reason being to offset labor shortages.

Ideally, one should combine the endogenous decision to migrate with the subsequent gradual adjustment reflecting the reality of the quotas being imposed and the delays they involve. This would be necessary in order for our calibrations to approximate the reality of the situation we are aiming to mimic. This would also increase the dimensionality of what is already a high order nonlinear dynamic system. Hence we opt to treat *m* as a given parameter, determined by policy of the host country, recognizing that it is a reasonable polar assumption that may plausibly reflect many, but certainly not all, relevant situations.[15] For example, the case that emigration is driven by "push factors", determined by policy of the home country, would require that m be determined endogenously to meet some specified objective. In any event, one further possible justification for treating *m* as given, is to assume that the migrant workers are already located in the host country. In either case, the responses of the migrant labor supply we consider pertain to only the internal margin of adjustment.

The other aspect, ignoring the welfare of migrants to the large advanced countries, is simply a convenience. The point is that, in contrast to the migrants to the small host economy, the impact they exert on the determination of the equilibrium between the home and host economies is exogenous, and any utility benefits can without loss of generality be set to zero.

Choosing, $C, L, C_m, N_d, N_m,$ and B to maximize utility, (11), subject to the budget constraint, (13), and the labor allocation conditions (12a) and (12b) yields the optimality conditions

$$U_C(C, L) = \lambda(1 + \tau_c) \tag{14a}$$

$$U_L(C, L) = \lambda(1 - \tau_w)w \tag{14b}$$

[15] As an example of the structure of the system in the case where agents have the flexibility to choose *m* optimally we note the following. Optimizing the utility function with respect to *m* yields an arbitrage condition that equates the total utility benefits (inclusive of income differential) of staying to those migrating. This equation, when combined with the steady-state equilibrium conditions (26) and (27) determines the optimal steady-state migration rate, $\hat{m}$. The transitional dynamics associated with the gradual adjustment to this long-run equilibrium can be specified by an equation of the form $\dot{m} = \kappa(\hat{m} - m)$ and incorporating it into the dynamics of the macroeconomic equilibrium system as set out in Section 3. We should add, however, that the viability of this system may impose restrictions on the respective utility functions of migrants and stayers.

$$U_{C_m}(C_m, L_m) = \lambda(1 - \tau_m) \quad (14c)$$

$$U_{L_m}(C_m, L_m) = \lambda w_m(1 - \tau_m) \quad (14d)$$

$$\beta - \frac{\dot{\lambda}}{\lambda} = r \quad (14e)$$

where λ is the shadow value of wealth of agents in the developing economy.

Equation (14a) equates the marginal utility of consumption to the tax-adjusted shadow price of wealth. Equations (14b) and (14d) describe the equilibrium supply conditions for domestic and migrant labor, respectively. That is, the marginal utility of leisure equals the utility-adjusted after-tax return to labor from working, either at home or abroad. Thus, any changes in either of the wage rates will affect the amount of leisure, as well as consumption of final goods. Equation (14c) equates the marginal utility of migrant consumption and the shadow price of wealth. Equation (14e) is the Keynes-Ramsey rule for consumers in the home economy, which determines the intertemporal allocation of consumption where the real interest rate (r) is determined by (10) and the rate of time preference (β) is exogenous. Finally, the transversality condition, (14f), requires that the household satisfies its intertemporal budget constraint

$$\lim_{t\to\infty} \lambda B e^{-\beta t} = 0 \quad (14f)$$

2. The Government

We assume that the government of the developing country sets its expenditure policy so as to claim a fixed share, g, of output, where $0 < g < 1$, so that

$$G = gY \quad (15)$$

This means that the size of the government increases with the size of the economy.[16] We also assume that the government maintains a balanced budget at all points of time, expressed as

[16] While we view setting $G = gY$ as natural, particularly in a growth context, maintaining G fixed is also a plausible alternative. We have run several simulations to examine this briefly, and while the welfare attributable to the size of government services are obviously directly impacted, the main results and conclusions are unchanged. More specifically, the qualitative effects on the decisions of stayers and migrants as well as on their relative utility gains continue to hold.

$$\tau_c(1-m)C + \tau_w w(1-m)N_d + \tau_k F_{K_d}\bar{K}_d$$

$$+\tau_m\{\mu m[w_m N_m - x - C_m] + (1-\mu)m\Omega\} - T = gY \qquad (16)$$

This implies that, if $\tau_c, \tau_w, \tau_k, \tau_m$ and g are all fixed, as we shall assume, then along the transitional path, as economic activity and the tax/expenditure base is changing, the rate of lump-sum taxes (transfers) must be continuously adjusted to maintain budget balance.

III. Macroeconomic Equilibrium

This section combines the two small economies and derives their macro-dynamic equilibrium. The key element is that labor migration links the two countries, so that economic performance in the domestic developing economy depends upon productivity conditions in the host economy, while in return, tax policy of the home economy impacts the wellbeing of the host economy.

a. *A. Host country*

Dividing (6b) by (6a) and using (2b), yields

$$\frac{H_{L_h}(C_h, L_h)}{H_{C_h}(C_h, L_h)} = p f_{N_h}(K_h, N_h, \theta\mu m N_m) \qquad (17a)$$

Combining equation (17a) with the host country labor allocation condition (3), enables one to solve for C_h in the form:

$$C_h = C_h(K_h, N_h, N_m; p, \theta, \mu, m) \qquad (18a)$$

where: $\frac{\partial C_h}{\partial K_h}>0, \frac{\partial C_h}{\partial N_h}<0, \frac{\partial C_h}{\partial N_m}>0$.[17] Intuitively, the partial effect of an increase in the host country's physical capital is to raise host consumption. The partial effect of an increase in work by native labor reduces leisure and therefore reduces consumption (due to complementarity between consumption and leisure). Finally, if migrant workers and native workers are co-operant in production, an increase in migration will raise the native country real wage, thereby increasing native workers' consumption.

[17] These results are easily obtained by taking the differential of (17a) in conjunction with that of the labor allocation, (3). An analogous procedure yields the corresponding qualitative responses pertaining to (21).

Substituting equations (2a) and (5) into (6d) yields

$$pf_{K_h}(K_h, N_h, \theta\mu m N_m) = r^* + \omega\left(\frac{B_h}{f(K_h, N_h, \theta\mu m N_m)}\right) \equiv r_h(B_h, K_h, N_h, \theta\mu m N_m) \quad (17b)$$

which we can then solve for B_h in the form

$$B_h = B_h(K_h, N_h, N_m; p, \theta, \mu, m) \quad (18b)$$

Differentiating (6a), combining with (6c), and noting from (3) that $\dot{L}_h = -\dot{N}_h$ implies:

$$\frac{H_{C_h C_h}}{H_{C_h}}\dot{C}_h - \frac{H_{C_h L_h}}{H_{C_h}}\dot{N}_h = \beta - r_h(B_h, K_h, N_h, \theta\mu m N_m) \quad (19a)$$

Finally, substituting for r_h from (17b) into (4b), the host country's net accumulation of wealth is described by

$$\dot{B}_h - \dot{K}_h = r_h(B_h, K_h, N_h, \theta\mu m N_m)(B_h - K_h) + C_h - pf_{N_h}(K_h, N_h, \theta\mu m N_m)N_h \quad (19b)$$

B. Domestic Economy

Substituting equations (2c) and (9) into (14a)-(14c), we can derive the following equations

$$\frac{U_L(C,L)}{U_C(C,L)} = \frac{1-\tau_w}{1+\tau_c}F_{N_d}(\bar{K}_d, (1-m)N_d) \quad (20a)$$

$$\frac{U_{L_m}(C_m, L_m)}{U_{C_m}(C_m, L_m)} = (1-\tau_m)pf_{N_m}(K_h, N_h, \theta\mu m N_m) \quad (20b)$$

$$\frac{U_{C_m}(C_m, L_m)}{U_C(C,L)} = \frac{1-\tau_m}{1+\tau_C} \quad (20c)$$

Together with equations (12a) and (12b), we can solve for consumption (C) and domestic employment (N_d) as functions of capital stocks ($K_h, \bar{K}_d$), migrant labor (N_m), and native labor employment in the host country (N_h), as well as exogenous parameters, including the tax rates:

$$C = C(K_h, \bar{K}_d, N_m, N_h; p, \theta, \mu, m, \tau_w, \tau_m, \tau_c) \quad (21a)$$

$$N_d = N_d(K_h, \bar{K}_d, N_m, N_h; p, \theta, \mu, m, \tau_w, \tau_m, \tau_c) \quad (21b)$$

$$C_m = C_m(K_h, \bar{K}_d, N_m, N_h; p, \theta, \mu, m, \tau_w, \tau_m, \tau_c) \quad (21c)$$

where $\frac{\partial N_d}{\partial N_m} > 0, \frac{\partial C}{\partial N_m} < 0; \frac{\partial N_d}{\partial K_h} < 0, \frac{\partial C}{\partial K_h} > 0; \frac{\partial N_d}{\partial N_h} < 0, \frac{\partial C}{\partial N_h} > 0$.[18]

[18] The responses of C_m are similar to those of C.

Intuitively, the first pair of inequalities implies that as migrant labor supply increases leisure declines and so does migrant consumption (due to complementarity between consumption and leisure). As a result, domestic labor supply increases, while domestic leisure and consumption decrease. This reflects the need to maintain internal household equilibrium. Next, an increase in physical capital in the host country reduces employment in the domestic country, but raises its consumption. This is because the rise in the host country's capital stock increases the migrant wage rate and migrant labor supply. As a result, remittances increase which also boosts consumption of the domestic country. Finally, an increase in labor employment in the host country increases migrant labor supply as native and migrant labor are co-operant in production. This increases remittances, which reduces the employment of domestic labor supply and raises consumption. The increase in consumption in the labor-exporting country is magnified by the income effect which results from rises in real wages.

Differentiating (14a) and combining with (14e) yields:

$$\frac{U_{CC}}{U_C}\dot{C} - \frac{U_{CL}}{U_C}\dot{N}_d = \beta - r \qquad (22)$$

while inserting the government budget constraint (16) into the household's budget constraint (13), and recognizing the homogeneity of the domestic country's production function, yields the developing country's current account relationship

$$\dot{B} = rB + (1-m)C - [\mu m(w_m N_m - x - C_m) + (1-\mu)m\Omega] - (1-g)F(\bar{K}_d, N_d) \qquad (23)$$

C. Equilibrium Dynamics

In the Appendix we show that the equilibrium can be reduced to an autonomous system of differential equations in: (i) foreign debt, *B*, of the labor-exporting country, $\dot{B} = Y_B(B, L, N_h, K_h)$, (ii) migrant labor supply, N_m, of the labor-exporting country, $\dot{N}_m = Y_{N_m}(B, N_m, N_h, K_h)$, (iii) host country's employment N_h, $\dot{N}_h = Y_{N_h}(B, N_m, N_h, K_h)$, and (iv) host country's physical capital stockK_h,$\dot{K}_h = Y_{K_h}(B, N_m, N_h, K_h)$.

The local equilibrium dynamics are obtained by linearizing the system of differential

equations around the steady state $(\widetilde{B}, \widetilde{N}_m, \widetilde{N}_h, \widetilde{K}_h)$:

$$\begin{pmatrix} \dot{B} \\ \dot{N}_m \\ \dot{N}_h \\ \dot{K}_h \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{pmatrix} \begin{pmatrix} B - \widetilde{B} \\ N_m - \widetilde{N}_m \\ N_h - \widetilde{N}_h \\ K_h - \widetilde{K}_h \end{pmatrix} \tag{24}$$

where $a_{11} \equiv \frac{\partial Y_B}{\partial B}; a_{12} \equiv \frac{\partial Y_B}{\partial N_m}; a_{13} \equiv \frac{\partial Y_B}{\partial N_h}; a_{14} \equiv \frac{\partial Y_B}{\partial K_h}$

$$a_{21} \equiv \frac{\partial Y_{N_m}}{\partial B}; a_{22} \equiv \frac{\partial Y_{N_m}}{\partial N_m}; a_{23} \equiv \frac{\partial Y_{N_m}}{\partial N_h}; a_{24} \equiv \frac{\partial Y_{N_m}}{\partial K_h}$$

$$a_{31} \equiv \frac{\partial Y_{N_h}}{\partial B}; a_{32} \equiv \frac{\partial Y_{N_h}}{\partial N_m}; a_{33} \equiv \frac{\partial Y_{N_h}}{\partial N_h}; a_{34} \equiv \frac{\partial Y_{N_h}}{\partial K_h}$$

$$a_{41} \equiv \frac{\partial Y_{K_h}}{\partial B}; a_{42} \equiv \frac{\partial Y_{K_h}}{\partial N_m}; a_{43} \equiv \frac{\partial Y_{K_h}}{\partial N_h}; a_{44} \equiv \frac{\partial Y_{K_h}}{\partial K_h}$$

The dynamic equations (24) are employed to examine the evolution of the macrodynamic equilibrium. The host country's capital stock, K_h, the labor-exporting country's foreign debt, B, are assumed to move sluggishly, while migrant labor supply, N_m, and native labor supply N_h, are free to jump instantaneously. Our numerical simulations demonstrate that the system of linearized equations (24) is characterized by two stable (negative) and two unstable (positive) eigenvalues, so that the equilibrium yields a unique stable saddle path. The stable eigenvalues are denoted by μ_i for $i = 1, 2$. The (linearized) stable solutions for B, N_m, N_h, and K_h are written in the following forms

$$B(t) = \widetilde{B} + Z_1 e^{\mu_1 t} + Z_2 e^{\mu_2 t} \tag{25a}$$

$$N_m(t) = \widetilde{N}_m + v_{21} Z_1 e^{\mu_1 t} + v_{22} Z_2 e^{\mu_2 t} \tag{25b}$$

$$N_h(t) = \widetilde{N}_h + v_{31} Z_1 e^{\mu_1 t} + v_{32} Z_2 e^{\mu_2 t} \tag{25c}$$

$$K_h(t) = \widetilde{K}_h + v_{41} Z_1 e^{\mu_1 t} + v_{42} Z_2 e^{\mu_2 t} \tag{25d}$$

where the vector $(1\ v_{2i}\ v_{3i}\ v_{4i})$ with $i = 1,\ 2$ is the normalized eigenvector associated with stable eigenvalues, μ_i, and the constants, Z_i, are obtained by imposing the given initial values on K_h and B, $K_h(0) = K_{h,0}, B(0) = B_0$. Having obtained the time paths as set out in (25a)-(25d) the implied dynamics of the remaining variables can be derived.

D. Steady State

In the long run, the economy converges to a steady-state in which all variables remain constant through time. Setting $\dot{B} = \dot{N}_m = \dot{N}_h = \dot{K}_h = \dot{\lambda} = \dot{\pi} = 0$ in the relevant equations above, the steady-state (denoted by "~") can be summarized by the following set of relationships, applicable to the host and domestic economy respectively.

1. Host Economy

$$\frac{H_{L_h}(\tilde{C}_h,\tilde{L}_h)}{H_{C_h}(\tilde{C}_h,\tilde{L}_h)} = pf_{N_h}(\widetilde{K}_h, \widetilde{N}_h, \theta\mu m\widetilde{N}_m) \quad (26a)$$

$$\tilde{r}_h = r^* + \omega\left(\frac{B_h}{f(\widetilde{K}_h,\widetilde{N}_h,\theta\mu m\widetilde{N}_m)}\right) \equiv pf_{K_h}\left(\widetilde{K}_h, \widetilde{N}_h, \theta\mu m\widetilde{N}_m\right) = \beta \quad (26b)$$

$$\widetilde{N}_h + \tilde{L}_h = 1 \quad (26c)$$

$$\beta\widetilde{B}_h + \tilde{C}_h = \beta\widetilde{K}_h + pf_{N_h}\left(\widetilde{K}_h, \widetilde{N}_h, \theta\mu m\widetilde{N}_m\right)\widetilde{N}_h \quad (26d)$$

2. Domestic Economy

$$\frac{U_L(\tilde{C},\tilde{L})}{U_C(\tilde{C},\tilde{L})} = \frac{1-\tau_w}{1+\tau_c} F_{N_d}\left(\bar{K}_d, (1-m)\widetilde{N}_d\right) \quad (27a)$$

$$\frac{U_{L_m}(\tilde{C}_m,\tilde{L}_m)}{U_{C_m}(\tilde{C}_m,\tilde{L}_m)} = (1-\tau_m)pf_{N_m}\left(\widetilde{K}_h, \widetilde{N}_h, \theta\mu m\widetilde{N}_m\right) \quad (27b)$$

$$\frac{U_{C_m}(\tilde{C}_m,\tilde{L}_m)}{U_C(\tilde{C},\tilde{L})} = \frac{1-\tau_m}{1+\tau_C} \quad (27c)$$

$$\tilde{r} = r^* + \upsilon\left(\frac{\tilde{B}}{F(\bar{K}_d,(1-m)\widetilde{N}_d)+\kappa\tilde{R}}\right) = \beta \quad (27d)$$

$$\widetilde{N}_d + \tilde{L} = 1 \quad (27e)$$

$$\widetilde{N}_m + \tilde{L}_m = 1 \quad (27f)$$

$$\tilde{R} = \mu m\left[pf_{N_m}(\widetilde{K}_h, \widetilde{N}_h, \theta\mu m\widetilde{N}_m)\widetilde{N}_m - x - \tilde{C}_m\right] + (1-\mu)m\Omega \quad (27g)$$

$$\beta\widetilde{B} + (1-m)\tilde{C} = (1-g)F\left(\bar{K}_d, (1-m)\widetilde{N}_d\right) + \tilde{R} \quad (27h)$$

These fifteen equations determine the steady-state values of $\tilde{C}_h,\ \tilde{L}_h, \widetilde{K}_h, \widetilde{N}_h, \widetilde{B}_h, \tilde{r}_h$ for the host economy and $\tilde{C}, \tilde{L}, \widetilde{N}_d, \tilde{L}_m, \widetilde{N}_m, \tilde{C}_{\ m}, \tilde{R}, \widetilde{B}, \tilde{r}$, applicable to the domestic economy. The sets of equations (26) and (27) indicate some interdependence between the two economies. Primarily these go from production conditions in the host country influencing the domestic economy via their impact on remittances. But it is also the case that structural changes and tax policies in the

domestic economy that impact migrant workers will also impact the host economy.[19] Our numerical simulations will highlight examples of where this is the case.

IV. Calibration

To obtain further insights we calibrate the model to approximate the movement of migrant workers between Bangladesh, as the developing-labor exporting economy, and the 5 Middle East countries Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates, which collectively comprise the advanced labor-importing country. All of these countries are clearly "small" in terms of their impact on the world economy. The population in 2020 of Bangladesh is around 165 million, while the combined population of the 5 Middle Eastern countries is approximately 55 million, implying a relative size ratio of $\theta = 3$, for the formal model. In 2017, Bangladesh sent nearly 7.5 million migrant workers abroad, which we approximate by setting $m = 0.05$. More than 3 million went to the 5 Middle East countries, while the remainder are primarily in India, Malaysia, the United Kingdom, and the United States. There is clearly substantial movement of migrant workers between Bangladesh and the Middle East, justifying setting $\mu = 0.5$.

A. Functional Forms

The following functional forms are employed in the subsequent numerical simulations. The home country's utility functions for domestic households, migrant consumption, and public consumption are given by

$$U(C,L) = \frac{1}{\gamma}(CL^{\sigma})^{\gamma}; U_m(C_m,L_m) = \frac{1}{\gamma}(C_m{L_m}^{\sigma})^{\gamma}; \Gamma(G) = \frac{1}{\gamma}G^{\delta\gamma} \qquad (28a)$$

where σ represents the relative importance of leisure in domestic households' and migrants' utility and $1/(1-\gamma)$ is the intertemporal elasticity of substitution. $\delta > 0$ is the weight of public consumption in household's utility.

[19] We may note that in the extreme case that migrant workers supply their labor inelastically, structural changes and policy responses originating in the home economy have no effect on the host economy.

The production function in the home economy is of the CES form

$$Y = A_d \left[\theta_d \bar{K_d}^{\zeta} + (1-\theta_d)[(1-m)N_d]^{\zeta}\right]^{\frac{1}{\zeta}} \tag{28b}$$

where $-\infty < \zeta < 1$; $1/(1-\zeta)$ is the CES between the (fixed) stock of domestic capital and labor and $0 < \theta_d < 1$ is the relative intensity of capital used in production. A_d is the level of technology (TFP) of the domestic country. The interest rate faced by the domestic country's borrowers is[20]

$$r = r^* + \upsilon\left(e^{b\left(\frac{B}{(Y+\kappa R)}\right)} - 1\right) \tag{28c}$$

where r^* is the world interest rate, υ is the weight on the premium, b is the rate at which the borrowing premium increases with the debt ratio, and κ parameterizes the extent to which remittances may serve as collateral in determining the premium.

The host country's utility function is

$$H(C_h, L_h) = \frac{1}{\varphi}\left(C_h L_h^{\phi}\right)^{\varphi} \tag{29a}$$

where ϕ represents the relative importance of leisure in utility and $1/(1-\varphi)$ is the intertemporal elasticity of substitution. Host country's production is specified by the two-stage, three-input nested constant-elasticity-of-substitution (CES) function

$$Y_h = A_h\left[\alpha_1 K_h^{\rho_1} + (1-\alpha_1)\left[\alpha_2 N_h^{\rho_2} + (1-\alpha_2)(\theta\mu m N_m)^{\rho_2}\right]^{\frac{\rho_1}{\rho_2}}\right]^{\frac{1}{\rho_1}} \tag{29b}$$

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; $-\infty < \rho_1, \rho_2 < 1$ and $1/(1-\rho_1)$ and $1/(1-\rho_2)$ are the CES between capital stock and labor, and between native and migrant workers, respectively. In addition, $0 < \alpha_1, \alpha_2 < 1$ are the relative intensities of capital and native labor (in the nest), respectively, while A_h is the level of technology of the host country.

[20] This functional form is a widely adopted and by increasing *b* offers a convenient and flexible representation of increasing borrowing costs for numerical simulations.

The increasing borrowing costs faced by the host country's residents are specified by

$$r_h = r^* + \omega\left(e^{a\left(\frac{B_h}{Y_h}\right)} - 1\right) \tag{29c}$$

where ω is the weight on the premium, and 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 cost of borrowing reduces to r^*.

B. Parameter Values and Benchmark Steady-State Equilibrium

The chosen parameter values are summarized in Table 1, with the corresponding benchmark steady-state equilibrium presented in Table 2. Overall we view these parameters and the equilibrium they yield to be plausible in light of the extant literature and empirical evidence.

The choice of $\varphi = \gamma = -1.5$ implies an intertemporal elasticity of substitution of 0.4, which is well within the range of empirical evidence provided by Guvenen (2006). The world interest rate, r^*, is set at 3.5%, and the borrowing premium parameters are chosen to yield debt-to-GDP ratios that are consistent with the data. We set the collateral parameter pertaining to remittances at $\kappa = 1$, although given their modest size results are insensitive to this parameter. We also set the rate of time preference, β, at 5% which is plausible (for a developing economy) and with $\beta > r^*$ this will ensure that the economies are net debtors in the equilibrium.

For the domestic economy's production function, setting $\zeta = -0.21$ yields an elasticity of substitution between capital stock and labor equal to 0.82, slightly below unity, consistent with Duffy and Papageorgiou's (2000) estimate for the developing countries. We set the level of technology (TFP) of the domestic country's production at $A_d = 0.7$, relative capital intensity at $\theta_d = 0.1$, and the exogenous capital stock at $\bar{K}_d = 0.5$ to obtain a capital-output ratio of 2.6629, consistent with the data for Bangladesh which averaged about 2.74 during 2004-2014. The choice of the weight of leisure in the utility functions of the two countries $(\phi = \sigma = 1.75)$ is standard and yields consistent labor supplies for the two economies. The time allocation for the rich country, $\widetilde{N}_h = 0.3092$, is well documented in the

RBC literature (see Cooley, 1995) while the time allocation for Bangladesh, $\widetilde{N}_d = 0.2637$, is consistent with the time use survey for Bangladesh (see Bangladesh Bureau of Statistics, 2013). We set the domestic country's government consumption at 20% of output ($g = 0.2$), a plausible fraction consistent with the data. We also assume that the weight of public consumption δ on the welfare of the domestic economy is 0.3.[21] We set x equal to 0.07, which is equivalent to a 12-percent reduction in annual income due to migration friction, which over 5 years, say, is comparable to Mandelman and Zlate's (2012) prior mean sunk migration cost of approximately 2.8 quarters of income. The tax rates for capital income, consumption and labor income are the tax rates for corporate income, value-added, and individual income, respectively. They are taken from KPMG Tax Rates Online.[22] Bangladesh does not tax remittances, so it is assumed to be zero.

For the host country's production function, the choice of $\rho_1 = 0.08$ yields an elasticity of substitution between capital and labor equal to 1.08, slightly above unity, which is close to Duffy and Papageorgiou's (2000) estimate for rich countries and the choice of $\rho_2 = 0.5$ yields an elasticity of substitution between migrant and native labor equal to 2, which is consistent with Cortes' (2008) estimate for low-skilled workers in the U.S. We set the level of technology of the host country's production at 9 ($A_h = 9$) and relative capital intensity at 0.15 ($\alpha_1 = 0.15$) to get a capital-output ratio of 3.99, which is consistent with the data for a developed country.

Setting $\theta = 3, m = 0.05, \mu = 0.5$, implies $\theta m \mu = 0.075$, so that the relative supply of migrant workers to native workers in the Middle East is 7.5%. In addition, by choosing the relative native labor intensity to migrant workers of 0.5 ($\alpha_2 = 0.5$) we obtain that each migrant allocates 0.5384 of his unit of time to working ($\widetilde{N}_m = 0.5384$) so that $\theta m \mu \widetilde{N}_m = 0.0404$. With $\widetilde{N}_h = 0.3092$ this implies that around 13% of labor is supplied by migrant workers, which is within the range of Bangladeshi presence in the Middle East. The

[21] While no direct evidence on this parameter is available, $\delta = 0.3$ yields the optimal ratio of public to private consumption of 0.30, which is approximately the observed ratio in many advanced economies.

[22] These tax rates are typical of those in other developing countries such as India and Pakistan that send many migrants to the Middle East. Income tax rates in UAE and other Middle East countries are zero.

percentage of Bangladeshi migrant stock of the UAE's population is about 11% in 2017 (United Nations, 2017) and migrants in the Gulf worked more than 10 hours a day (Rajan et al., 2015). With the exogenous remittances (those from the large economies) assumed to be $\Omega = 0.20$, we obtain a remittance-to-GDP ratio of 5.7%, 53% of which come from the Middle East. These figures are consistent with the data for Bangladesh (see Lim and Basnet, 2017).[23]

Given all these chosen parameters, the model produces the real wage for the domestic economy $\widetilde{w} = 0.6470$, native real wage $\widetilde{w}_h = 5.2120$, and the migrants' real wage $\widetilde{w}_m = 1.0817$. These wage rates reflect the situation in the Middle East where many South Asian migrant workers are low-skilled workers while the natives are high-skilled professionals. The relative wages, $\frac{\widetilde{w}_m}{\widetilde{w}} = 1.67$ and $\frac{\widetilde{w}_h}{\widetilde{w}_m} = 4.82$, are consistent with 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 migrants to domestic labor for masons, carpenters, electrician, drivers, and housemaid range from 1.74 to 2.71. Given the geographic location of Bangladesh and India and their similar policy toward migration, the situations of these migrants in the Middle East are presumably similar. Finally, the benchmark parameterization implies the ratio of GDP between the host and the home country to be around 15, which is very similar to that of the 5 Middle East countries and Bangladesh.[24]

V. Effects of Tax Changes

In Section 6 below we consider the impact of alternative structural changes, together with some potential fiscal policy responses, on both the home and host economies. As a prelude to this, Table 3 summarizes the effects of these policy changes on key variables both in the home and host economies. In addition, the steady-state welfare gains relative to the initial benchmark, measured in terms of equivalent variations in income flows, are also reported.[25]

[23] Starting in 2000 remittances to Bangladesh increased steadily from around 3.7% of GDP to 10.6% in 2012. Since then it has declined to 5.4% in 2017, with an uptick to 5.7% in 2018. Our estimate of 5.7% matches the figure for 2018.

[24] For example in 2017 the ratio of the GDP of Saudi Arabia and the UAE, (the two largest countries of our Middle East group) to that of Bangladesh were 13 and 16 respectively.

[25] The welfare measures are conventional Hicksian measures of equivalent variations in income adapted to an

A key channel in determining the differential impact of these various tax policies on the domestic household members (the stayers) and the migrants is described by equation (27c), which we characterize as the "internal household equilibrium" condition. Computing the differential of this equation, any change due to the structure or policy must satisfy:

$$\frac{dU_{C_m}}{U_{C_m}} = \frac{dU_C}{U_C} - \left[\frac{d\tau_m}{1-\tau_m} + \frac{d\tau_c}{1+\tau_c}\right] \tag{30}$$

which, given the functional forms of the respective utility functions, yields:

$$\frac{dC_m}{C_m} - \frac{dC}{C} = \frac{\sigma\gamma}{(\gamma-1)}\left[\frac{dN_m}{(1-N_m)} - \frac{dN_d}{(1-N_d)}\right] - \left(\frac{1}{\gamma-1}\right)\left[\frac{d\tau_m}{(1-\tau_m)} + \frac{d\tau_c}{1+\tau_c}\right] \tag{31}$$

Apart from tax rates on remittances and the consumption of domestic household members, which impact (27c) directly, the internal household equilibrium condition requires that both domestic members' and migrant members' marginal utility of consumption change in equal proportions, resulting in diverse responses in their consumption and labor supply that reflect their respective incentives.

We begin by considering a cut in the income tax on domestic residents, τ_w from its current rate of 30% to 20%. The stayers, who benefit directly from the income tax cut increase their consumption, by 8.76%, which is welfare improving, but they also increase their labor supply by 2.80% points, which is welfare deteriorating. Overall, their welfare increases by 1.61% across the steady states. The increase in domestic labor supply increases home output substantially by 9.59%, and therefore home government services. With the substantial increase in home output, migrant workers, who do not benefit from the tax cut, have less incentive to send remittances. Accordingly, they choose to increase their leisure and consumption and to reduce their remittances, resulting in a substantial reduction in the $\frac{R}{Y}$ ratio from 5.69% to 5.03%. Their chosen combination of a mild increase in consumption and leisure yields welfare gains that exceed those of the domestic residents, whose significant

intertemporal utility measure; see e.g. Turnovsky (2004).

consumption gains are offset by significant increases in labor. While this result seems somewhat paradoxical, it appears to be robust across a plausible range of parameter values. For example, it continues to hold in the extreme case where migrant labor is supplied inelastically. It is also insensitive to variations in the importance of migrant labor to host production as parameterized by α_2 and the elasticity of substitution, $(1-\rho_2)^{-1}$. The reduction in migrant labor supply makes the host country worse off. Its output declines, and with it consumption. Native labor supply increases though the native real wage falls due to the decrease in migrant labor. However, all these effects on the host economy are extremely modest.

The direct effect of an increase in τ_m, reflected in the term $\frac{d\tau_m}{(1-\tau_m)}$ in (30), favors the consumption of migrants over that of stayers. This is because the higher remittance tax reduces their incentive to remit. As a consequence migrants increase their consumption and reduce their labor supply, leading to a substantial increase in their welfare. The reduction in remittances induces stayers to work more, which they do marginally. Domestic output increases slightly, but insufficiently, to compensate for the reduction in remittances and stayers' consumption falls, resulting in a net reduction in their welfare. But the increased output increases government services. The overall impact on the host country is similar to that of the reduction in the tax on labor income and is again small.

In contrast, reducing the consumption tax from 15% to zero benefits domestic citizens at the expense of migrant workers. This can be seen from the internal household equilibrium condition, with the reduction in τ_c directly favoring domestic residents. As a result, domestic output and consumption increase with domestic labor supply, while migrant consumption falls along with migrant leisure. Consequently, migrant labor supply increases, which slightly benefits the host country.

VI. Structural Changes and Policy Responses

In this section, we examine three structural changes, accompanied by a range of possible fiscal policy responses taken by the domestic economy. The structural changes include: (i) a productivity increase in the host country, (ii) a productivity increase in the home economy, and (iii) a reduction in migration costs. Since each of these structural changes impacts the constituents differentially, we also introduce policy responses along the lines of those discussed in Section 5. The first three policy responses comprise modest adjustments in $\tau_w, \tau_c,$ and τ_m, respectively. These tax changes all involve a change in the government budget that we assume is met by adjusting the lump-sum tax. The fourth case specifies a small reduction in the domestic labor income tax that is financed by an increase in the remittance tax, leaving the overall government budget unchanged. As discussed earlier, the government of the Philippines lost a huge amount of tax revenue from the elimination of the remittance tax. So, this case looks at the possible welfare gains if the remittance tax revenue could have been collected and used to finance the domestic labor income tax reduction. Most of the tax responses are directed toward benefiting the home economy and adversely impact the host economy. In all cases, changes in welfare, which as before are measured in terms of equivalent variations in output, now take into account the transitional path.[26]

A. Productivity Increase in Host Country of 10%

This case is motivated by the economic growth in the Middle East for past decades that drew significant labor demand, especially low-skilled labor, from many South Asian countries. The results are reported in Table 4.

A 10% increase in productivity (A_h) of the host country increases the return to capital and the wage rates of its native labor and migrant workers. The wages of the former increase by 13.3%, while those of the latter by 11.0%. With the high elasticity of substitution between

[26] We should note, however, that the differences welfare comparisons across steady state and those that take account of the transitional path are very slight. This is because most of the adjustment occurs on impact, with very little along the transition. Illustrations of this are given in Section 7 below.

the two types of labor (=2), host producers choose to substitute migrant labor for native labor, as a result of which N_m increases by over 2 percentage points, while N_h declines slightly. As migrant workers enjoy higher wages in the host country, they can now both consume more and also remit more to their home economy. Both migrant consumption and remittances rise in the long run. With more remittances, domestic consumption also increases, as does leisure. As a result, the domestic supply of labor in the domestic economy declines, thus causing domestic output to contract.[27] This affects domestic consumption adversely, but this negative effect is offset by the increase in remittance inflow and international borrowing (due to the collateral effect of remittances). Consequently, domestic consumption increases in the long run.[28] The productivity increase produces welfare gains for the stayers but a welfare loss for migrant workers, as they enjoy less leisure. There is also a welfare loss from the decrease in government consumption. Overall, there is a slight net welfare gain for the home economy, and of course the productivity increase yields a significant direct welfare gain to the host economy.

Again the result that despite the substantial increase in their wage rate migrant workers suffer a loss in welfare is paradoxical and stems from the internal household equilibrium condition. However, in this case it is sensitive to the elasticity of supply by migrant labor. In the extreme case that its supply is inelastic, the increase in consumption ensures an increase in welfare, but somewhat less than that of the stayers who also enjoy the benefits of enhanced remittances.

The first policy response we consider is to reduce the domestic labor income tax to 25%. This policy reverses the reduction in domestic labor supply and also slows down the increase in migrant labor supply. There is a substantial increase in domestic output, leading

[27] Empirical evidence shows that remittances have a negative impact on domestic labor supply. Households in the Caribbean Basin that receive remittances have reduced their working hours or stopped working (Itzigsohn, 1995 and Kim, 2007)

[28] This result seems to depict the empirical findings that there is a long-run positive relationship between remittances and consumption in remittance-receiving West African countries (see Donou-Adonsou and Lim, 2016) and in Caribbean countries (see Lim and Simmons, 2015) and that remittances are countercyclical (Frankel, 2011 and IMF, 2005).

to more consumption, and as a result, there are welfare gains for all agents in the domestic economy. The host country sees slower growth and lower welfare gains due to a smaller increase in labor migration. If the response is to cut the domestic consumption tax to 10%, this reverses the domestic labor supply reduction, but ends up encouraging more migrant labor being employed by the host economy. As a result, the welfare gains for domestic residents increase further, but at a larger expense of migrant workers since they now have to work longer and enjoy less leisure. The increase in domestic labor supply raises domestic output, thus leading to a welfare gain from an increase in government consumption. By contrast, if the response is to increase the remittance tax to 10% to discourage migrant labor participation, the policy has little impact on the output and the welfare of domestic stayers. But by discouraging remittances, it encourages migrant workers to keep more of their income, thereby improving their welfare.

All of these three tax responses increase the government deficit and are accommodated by an increase in the lump-sum tax. A combination policy of financing a cut in the domestic labor income tax rate to 28%, accompanied by an increase in the tax on remittances of 22.2% leaves the government budget unchanged, while yielding welfare gains for all agents in the domestic economy. On the one hand, the cut in the domestic labor income tax rate leads to a surge in domestic labor supply resulting in an increase in domestic production and thus consumption. At the same time, the tax increase on remittances reduces the labor supply of migrants, who choose more leisure, moderating their increase in consumption. This reduction in migrant labor supply adversely impacts the host economy, reducing the welfare gain from the technological increase by 0.23 percentage points.

B. Productivity Increase in Home Country of 10%

Table 5 reports the effects of, and policy responses to, a 10% increase in the productivity of the home country. Since these are analogous to those just discussed, our comments can be brief, pointing out the main difference in the transmission.

The direct impact of the increase in A_d is to raise the domestic wage rate and output by around 10%, leading to a comparable increase in consumption by domestic residents. With the elasticity of substitution of the domestic production function being 0.82 the demand for labor by domestic firms increases only slightly. Despite the fact that migrant workers in the host country are not impacted directly, they are indirectly affected, through the internal household equilibrium condition. Since the increase in A_d has a direct impact on the stayers' wage rate increasing it by 9.3%, they are able to enjoy a correspondingly large increase in consumption of 9.62%. With an overall increase in domestic income of 10.75% migrants choose to reduce their remittances, with the $\frac{R}{Y}$ ratio declining substantially from 5.69% to 4.82%. The reduced need to remit enables migrant workers to increase their consumption by 5.11%, while at the same time they can reduce their labor supply, which has the dual advantage of raising their wage by around 1.3% while simultaneously enabling them to enjoy more leisure. The net effect is that despite being only indirect beneficiaries of the domestic productivity increase migrants' welfare is increased more than that of the stayers. However, when migrant workers supply their labor inelastically the welfare gains are shared much more equally.

This decline in remittances in response to an improvement in domestic productivity is consistent with empirical evidence. Several authors have pointed to the counter-cyclical nature of remittance flows, suggesting that remittance inflows are likely to increase if the recipients in the home country face unexpected hardships; see e.g. Yang (2008), Acosta et al. (2009), Durdu and Sayan (2010), Mandelman (2013) and Finkelstein Shapiro and Mandelman (2016).

The reduction in migrant labor has a moderate adverse effect on the host country, the output of which declines by 0.82%. The policy responses reported in the table have analogous marginal effects to those reported in Table 4, with the same mechanisms in operation.

C. Decrease in Migration Cost

While many poor countries such as Bangladesh, Nepal, Pakistan, the Philippines, and Sri Lanka have devoted substantial effort to formalizing the migration process and to reducing its cost, the debate over whether or not labor migration and remittances benefit the poor countries is attracting the attention of economists and policy makers alike. At the same time, while it seems clear that labor migration has benefited advanced economies, especially those experiencing labor shortages, countries such as the U.S. and UK are concerned about immigration policies that favor migrant workers causing them to taking over their own citizens' jobs. Our model enables us to examine this issue from the perspective of reduced migration costs and to consider appropriate policy responses that would benefit the various constituents in both economies. The results are reported in Table 6.[29]

We consider an elimination of the migration cost specified by a reduction in x from 0.07 to 0. The direct effect is to increase the amount of earnings in excess of consumption that migrant workers have available to remit to their family, resulting in a substantial increase in the R/Y ratio from 5.69% to 6.64%. The increase in resources received by the stayers allows them to increase consumption and leisure, thereby reducing the time allocated to labor, resulting in a reduction in domestic output. Moreover, the reduced migration cost permits the migrants to increase their consumption and reduce their labor supply in accordance with the internal household equilibrium condition (31).

The resulting decrease in labor supplied by migrants reduces the productivity of capital in the host economy, the stock of which declines, thus reducing both output and consumption in that economy. As a consequence of the co-operant relationship between migrant and native labor, the decrease in migrant labor supply lowers the real wage of native labor, to which the firms in the host country respond by marginally increasing their labor demand. It should be stressed, however, that with the immigration costs being fixed in nature the spillover to the host economy is essentially negligible. Migrant workers are not displacing native workers to

[29] In an expanded version of this paper we have also considered the impact of an increase in migration as mandated by an increase in *m*. The results are generally similar to those resulting from a decrease in migration costs.

any significant degree; in fact N_h actually rises in response to this shock by 0.003%.

Overall, reducing the immigration costs benefits the home economy. Both stayers and migrant workers are made better off, by comparable amounts, although government consumption is slightly reduced by the decline in output. The overall reduction in welfare in the host economy due primarily to the reduction in consumption is just 0.01%.

Of the three policy responses reducing τ_w or τ_c benefit all domestic constituents and in particular increase the size of government services. The budget-neutral policy of cutting the domestic labor income tax to 28% and financing the cut with an increase in remittance tax to 22.35%, is clearly most beneficial to migrants, as well as benefitting the overall domestic economy, but it adversely affects the host country. This is because migrant workers reduce their labor supply even further.

In the event that the number of migrant workers is constrained by the policy of the host country, our simulations suggest that both economies will be better off if the host economy accompanies its reduced immigration costs with a modest increase in its immigration quota, for example from m = 0.05 to m = 0.055. In that case the labor provided by the additional migrant workers benefits the host country, the income of which increases by almost 3%. At the same time, the increased remittances resulting from the additional migrant workers, enables the home country to enjoy an overall welfare improvement of around 1.7%.

VII. Transitional Dynamics

In this section, we illustrate the transitional dynamics for two of the structural changes, together with the policy response (domestic labor income tax cut financed by remittance tax increase) that keeps the lump-sum tax fixed. Figure 1 illustrates the transitional dynamics for the host country's productivity increase (A_h increased by 10%), together with the policy response (reducing τ_w to 0.28 and increasing τ_m to 0.2220).

The responses in the home country happen virtually immediately. All of the variables jump on impact and converge very quickly to the new steady-state values. This is a

consequence of the home country being a small open economy that does not accumulate capital. The only potential source of sluggishness for the home country is through the accumulation of bonds, which in this case is negligible. In contrast, the host country's response is more gradual, reflecting the fact that the productivity increase is associated with a 15% increase in the capital stock, which takes time to accumulate.

The productivity increase in the host country causes migrant labor supply to increase on impact, resulting in an immediate increase in migrant consumption, as well as in domestic consumption due to the instantaneous increase in remittances sent by migrant workers. Domestic leisure also increases instantly, causing a sudden reduction in domestic labor supply. As a result, domestic output falls. In the host country, native labor supply also increases on impact together with a surge in migrant labor supply. However, as capital stock starts to accumulate, native labor supply starts declining while migrant labor supply continues rising, albeit very slightly. Eventually, native labor supply declines to a new steady-state value, slightly lower than the pre-shock level, as detailed in Table 4. The rising migrant labor supply continues to put downward pressure on the domestic labor supply and output though this transition happens at the margin.

The policy response by the government of the home country can reverse the instant impacts from the shock on its economy. Migrant labor supply instantaneously falls on impact of the policy, causing an instant increase in migrant leisure and consumption. Domestic consumption jumps up with domestic output as the lower labor income tax instantly increases domestic labor supply. As capital stock in the host country rises, migrant workers also start to gradually supply more labor. The increase in capital stock also raises the real wage of migrant workers which allows migrant consumption to rise to a new higher steady-state level. In addition, as the domestic labor supply gradually rises, domestic output also rises slowly to a new higher steady-state level.

Figure 2 depicts the transitional dynamics of the decrease in the migration cost (x $\rightarrow$ 0) vs the policy response (τ_w reduced to 0.28 and τ_m increased to 0. 2235). In contrast to the

transitional dynamics for the host country's productivity shock, an instant decrease in the migration cost causes migrant workers to instantaneously supply less labor which is accompanied by an immediate increase in migrant consumption as well as domestic consumption due to increased remittances. Domestic output falls with domestic labor supply on impact. The host country loses from the instantaneous reduction in migrant labor supply. Native labor supply, host output and consumption all decline instantaneously, although by negligible amounts. However, as the capital stock declines, decreasing the native real wage, native workers increase their supply of labor, although again the response is extremely slight.

The policy responses in the home country to the decrease in migration cost accommodate the shock, benefiting the home country at the larger expense of the host country. The sudden larger reduction in migrant labor supply causes native labor supply, host output and consumption to fall more on impact. In addition, as capital stock starts to decline, native labor supply rises gradually to a new steady-state level, higher than the pre-shock level while host consumption continues falling with host output.

VIII. Conclusions

This paper is motivated by the policy actions adopted by many developing countries to encourage migrant work for their citizens as a response to adverse conditions in the domestic labor market. In the process, some governments have tried to harness the benefits from this international migration by extracting a portion of migrant earnings through some forms of taxes. We have developed a macro-dynamic model of two small open economies -- a host advanced country and a labor-exporting, developing country -- to examine appropriate fiscal policy responses of the latter to various shocks occurring in the two economies. More generally, the model provides a framework for assessing the current efforts advanced by those developing countries for purposes of their domestic economic development. By adopting a general equilibrium framework we gain insights into elements of the adjustments that remain obscured in the more familiar single-small country setup.

The novel feature of the model is the endogenizing of remittances received by the developing economy which reflect the households' decisions for some of its members to work as migrants in the advanced host economy. The critical link in determining this is provided by what we have called the "internal household equilibrium" condition that holds between migrants and domestic resident family members. This is the required equilibrium condition between their respective marginal utilities of consumption, and is a key channel whereby policy changes and structural shocks that impinge directly on one group are transmitted to the other. It is a consequence of treating the household as a single unit in which migrants and stayers make decisions to maximize their collective utility.

We have calibrated the model to conduct numerical simulations focusing on two sets of issues. First, we have taken the tax structure of a typical developing economy such as Bangladesh to compare the effects of different taxes on the various constituents in both the home and host economies. While cutting taxes on labor income and consumption have generally similar effects on the stayers they have very different effects on the migrants. Also, introducing a tax on remittances, as was proposed in the early debate, does not appear to contribute significantly to increasing domestic income, or to enhancing the welfare of domestic residents, but it does have a substantial impact on the welfare of migrant workers. On the other hand, cutting taxes on income or consumption is much more stimulating, and while the former also has significant benefits to migrants (through the internal household equilibrium condition), the latter does not. From a revenue generating standpoint, taxing remittances is also ineffective. Introducing the remittance tax at 20%, results in a revenue loss of 6.0% and a negligible increase in income of 0.28%. This suggests that any tax on remittances to be effective must be part of a co-ordinated tax structure, whereby it introduces changes in behavior that enhance the impact of other taxes.

The second numerical application has been to introduce various structural changes, both in isolation and in conjunction with appropriate policy responses. Addressing these issues within a two-country framework yields some interesting and unexpected results. For

example, while the direct effect of a productivity increase in the host country benefits residents of the home country, it reduces the welfare of its migrant workers. However, by responding to this shock with an appropriate reduction in the tax on labor income this loss can be eliminated. Moreover, by supplementing this with an appropriate tax on remittances, migrants can benefit more, though this has some mild adverse effects on the host economy. In contrast, the direct effect of a productivity increase in the home country benefits migrant workers more than it does domestic workers, while at the same time having a mild adverse impact on the host country. Again, reducing the tax on labor income together with a tax on remittances can yield enhanced benefits for all constituents in the home country. Finally, the pattern of responses and benefits in the case where migration costs are eliminated are generally similar to those following an increase in host country productivity. These results bring out the importance of domestic policy to drive growth at home, rather than to encourage migrant work. Seeking overseas jobs for its citizens may be a short-term fix, but never serves as a long-term development policy.

While we focus on the aggregate flow of migrant workers and differentiate the potential skill levels between natives and migrant workers by the different wage rates in the host country, we do not specifically characterize different skill levels among migrant workers themselves. This is clearly an interesting aspect, one that is relevant to the current debates around migration, and though we believe that it does not change the main results of this paper, it certainly merits further detailed investigation.

Appendix: Derivation of Macrodynamic Equilibrium (24)

We begin by recalling solutions (18a), (18b), (21a), (21b), and (21c). For notational convenience, they are repeated here with all fixed parameters omitted:

$$C_h = C_h(K_h, N_h, N_m) \tag{A.1a}$$

$$B_h = B_h(K_h, N_h, N_m) \tag{A.1b}$$

$$C = C(K_h, N_h, N_m) \tag{A.1c}$$

$$N_d = N_d(K_h, N_h, N_m) \tag{A.1d}$$

$$C_m = C_m(K_h, N_h, N_m) \tag{A.1e}$$

In addition, the equilibrium borrowing rates (5) and (10) can be expressed as:

$$r_h = r_h(B_h, K_h, N_h, N_m) \tag{A.2a}$$

$$r = r(B, N_d, \kappa R) \tag{A.2b}$$

where
$$R = R(K_h, N_h, N_m, C_m) \tag{A.2c}$$

Next, differentiating equations (A.1c), (A.1d), (A.1a) and (A.1b) with respect to time yields

$$\dot{C} = \frac{\partial C}{\partial K_h}\dot{K}_h + \frac{\partial C}{\partial N_h}\dot{N}_h + \frac{\partial C}{\partial N_m}\dot{N}_m \tag{A.3a}$$

$$\dot{N}_d = \frac{\partial N_d}{\partial K_h}\dot{K}_h + \frac{\partial N_d}{\partial N_h}\dot{N}_h + \frac{\partial N_d}{\partial N_m}\dot{N}_m \tag{A.3b}$$

$$\dot{C}_h = \frac{\partial C_h}{\partial K_h}\dot{K}_h + \frac{\partial C_h}{\partial N_h}\dot{N}_h + \frac{\partial C_h}{\partial N_m}\dot{N}_m \tag{A.3c}$$

$$\dot{B}_h = \frac{\partial B_h}{\partial K_h}\dot{K}_h + \frac{\partial B_h}{\partial N_h}\dot{N}_h + \frac{\partial B_h}{\partial N_m}\dot{N}_m \tag{A.3d}$$

Substituting (A.3c) into (19a) yields:

$$\frac{H_{C_h C_h}}{H_{C_h}}\frac{\partial C_h}{\partial K_h}\dot{K}_h + \left(\frac{H_{C_h C_h}}{H_{C_h}}\frac{\partial C_h}{\partial N_h} - \frac{H_{C_h L_h}}{H_{C_h}}\right)\dot{N}_h + \frac{H_{C_h C_h}}{H_{C_h}}\frac{\partial C_h}{\partial N_m}\dot{N}_m = \beta - r_h \tag{A.4a}$$

Also, substituting (A.3d) into (19b) yields

$$\left(\frac{\partial B_h}{\partial K_h} - 1\right)\dot{K}_h + \frac{\partial B_h}{\partial N_h}\dot{N}_h + \frac{\partial B_h}{\partial N_m}\dot{N}_m = r_h(B_h - K_h) + C_h - pf_{N_h}N_h \tag{A.4b}$$

Next, substituting (A.3a) and (A.3b) into (22) yields

$$\left(\frac{U_{CC}}{U_C}\frac{\partial C}{\partial K_h} - \frac{U_{CL}}{U_C}\frac{\partial N_d}{\partial K_h}\right)\dot{K}_h + \left(\frac{U_{CC}}{U_C}\frac{\partial C}{\partial N_h} - \frac{U_{CL}}{U_C}\frac{\partial N_d}{\partial N_h}\right)\dot{N}_h$$
$$+\left(\frac{U_{CC}}{U_C}\frac{\partial C}{\partial N_m} - \frac{U_{CL}}{U_C}\frac{\partial N_d}{\partial N_m}\right)\dot{N}_m = \beta - r \qquad \text{(A.4c)}$$

Finally, we rewrite (23) as

$$\dot{B} = rB + (1-m)C + \mu m C_m - (1-g)F(\bar{K}_d, (1-m)N_d) - \mu m(w_m N_m - x) -$$
$$(1-\mu)m\Omega \quad \text{(A.4d)}$$

From (A.4a)-(A.4d), one can solve for the equilibrium system and linearize it to obtain (24).

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Table 1: Baseline parameter values

Parameters of the benchmark economies
Common parameters for both countries: $\beta = 0.05;\ r^* = 0.035; p = 1$
Home country (Bangladesh)
Utility: $\gamma = -1.5; \sigma = 1.75; \delta = 0.3; m = 0.05; \mu = 0.5$
Production: $A_d = 0.7; \theta_d = 0.1; \zeta = -0.21; \overline{K}_d = 0.5$
Borrowing constraint: $b = 0.04; \upsilon = 1; \kappa = 1$
Government: $g = 0.2; \tau_k = 0.25; \tau_b = 0; \tau_c = 0.15; \tau_w = 0.3; \tau_m = 0;\ \ T/Y = 0.266;$
Migration cost: $\Omega = 2, x = 0.07$
Host country (Middle Eastern Countries)
Utility: $\phi = -1.5; \varphi = 1.75$
Production: $A_h = 9; \alpha_1 = 0.15; \alpha_2 = 0.5; \rho_1 = 0.08; \rho_2 = 0.5; \theta = 3$
Borrowing constraint: $a = 0.02; \omega = 1$

Notes: The benchmark economy is to replicate the economy of Bangladesh as the home country and the Middle Easter countries as the host country. The Middle Eastern countries include Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates. In 2017 Bangladesh exports about 5% of its citizens abroad, half of which to the Middle East (United Nations, 2017). Thus, we take m = 0.05 and $\mu = 0.5$. The tax rates for capital income, consumption and labor income are the tax rates for corporate income, value-added, and individual income, respectively. They are taken from KPMG Tax Rates Online. Bangladesh has no taxes on bonds and remittances, so they are assumed to be zero. The value T/Y reported is that of the initial steady state.

Table 2: Steady-state values of the benchmark economies

Benchmark steady-state equilibrium values		
Variables	Description	Benchmark
Home country (Bangladesh)		
$\overline{K}_d / \tilde{Y}$	Capital-output ratio	2.6629
$\tilde{N}_d$	Domestic labor supply	0.2647
$\tilde{C} / \tilde{Y}$	Consumption-output ratio	0.8813
$\tilde{R} / \tilde{Y}$	Remittance-output ratio	0.0569
$\tilde{B} / \tilde{Y}$	Debt-output ratio	0.3934
$\tilde{w}$	Domestic wage rate	0.6470
Host country (Middle Eastern Countries)		
$\tilde{K}_h / \tilde{Y}_h$	Capital-output ratio	3.9956
$\tilde{C}_h / \tilde{Y}_h$	Consumption-output ratio	0.7504
$\tilde{N}_h$	Labor supply	0.3092
$\tilde{N}_m$	Supply of migrant worker	0.5384
$\theta\mu m \tilde{N}_m / \tilde{N}_h$	Share of migrants in the host country	0.1306
$\tilde{w}_h$	Native wage rate	5.2120
$\tilde{w}_m$	Migrant wage rate	1.0817

Notes: These equilibrium ratios are consistent with data of Bangladesh extracted from Penn World Table 9.0 and World Bank's World Development Indicators.

Table 3: Effects of Tax Changes

A. Effects on Home Country

	Effects on Key Variables						Welfare			
	R/Y	Y	C	N_d	C_m	N_m	$\Delta W_d^{\%}$	$\Delta W_m^{\%}$	$\Delta W_s^{\%}$	$\Delta W_d^{\%}$
Benchmark $\tau_w = 0.30, \tau_c = 0.15, \tau_m = 0$	5.69%	0.1878	0.1655	0.2647	0.2853	0.5384	--	--	--	--
Effects of Each Tax Change										
Decrease in τ_w to 0.20	5.03% (-0.66%pts)	0.2058 (+9.59%)	0.1780 (+8.76%)	0.2927 (+2.80%pts)	0.2923 (+2.44%)	0.5300 (-0.85%pts)	+1.61%	+5.75%	+2.79%	+1.88%
Increase in τ_m to 0.20	5.33% (-0.36%pts)	0.1883 (+0.28%)	0.1652 (-0.14%)	0.2655 (+0.08%pts)	0.2995 (+4.97%)	0.5213 (-1.71%pts)	-0.33%	+11.87%	+0.08%	+0.07%
Decrease in τ_c to 0	5.21% (-0.48%pts)	0.2063 (+9.89%)	0.1808 (+9.27%)	0.2936 (+2.89%pts)	0.2838 (-0.52%)	0.5402 (+0.18%pts)	+1.88%	-1.20%	+2.87%	+1.88%

$\Delta W_d^{\%}$ denotes change in steady-state welfare of residents of home country;

$\Delta W_m^{\%}$ denotes change in steady-state welfare of migrant workers;

$\Delta W_s^{\%}$ denotes change in steady-state welfare of home country arising from government expenditure;

$\Delta W_d^{\%}$ denotes overall change in steady-state welfare in home country.

B. Effects on Host Country

	Effects on Key Variables			Welfare
	Y_h	C_h	N_h	$\Delta W_h^{\%}$
Benchmark				
$\tau_w = 0.30, \tau_c = 0.15, \tau_m = 0$	2.7418	2.0574	0.3092	--
Effects of Each Tax Change				
Decrease in τ_w to 0.20	2.7310 (-0.39%)	2.0527 (-0.23%)	0.3093 (+0.01%pts)	-0.25%
Increase in τ_m to 0.20	2.7199 (-0.80%)	2.0478 (-0.46%)	0.3094 (+0.02%pts)	-0.51%
Decrease in τ_c to 0	2.7441 (+0.08%)	2.0583 (+0.05%)	0.3092 (-0.00%pts)	+0.05%

$\Delta W_h^{\%}$ denotes change in steady-state welfare of host country.

Table 4: Structural Changes: Increase in Host Country Productivity by 10%
A. Effects on Home Country

	Effects on Key Variables						Welfare			
	R/Y	Y	C	N_d	C_m	N_m	ΔW_d^d	ΔW_m^d	ΔW_s^d	ΔW_d
Benchmark $\tau_w = 0.30, \tau_c = 0.15, \tau_m = 0$	5.69%	0.1878	0.1655	0.2647	0.2853	0.5384	--	--	--	--
10% increase in A_h	6.71% (+1.02%pts)	0.1863 (-0.79%)	0.1661 (+0.40%)	0.2625 (-0.23%pts)	0.3020 (+5.85%)	0.5597 (+2.13%pts)	+0.88%	-2.37%	-0.22%	+0.63%
Policy responses										
Reduce τ_w to 0.25	6.30% (+0.61%pts)	0.1955 (+4.14%)	0.1736 (+4.89%)	0.2768 (+1.20%pts)	0.3059 (+7.21%)	0.5553 (+1.69%pts)	+1.92%	+0.70%	+1.22%	+1.80%
Reduce τ_c to 0.10	6.51% (+0.83%pts)	0.1921 (+2.32%)	0.1709 (+3.31%)	0.2715 (+0.67%pts)	0.3016 (+5.72%)	0.5601 (+2.17%pts)	+1.65%	-2.58%	+0.69%	+1.39%
Increase τ_m to 0.10	6.53% (+0.84%pts)	0.1865 (-0.65%)	0.1660 (+0.33%)	0.2629 (-0.19%pts)	0.3089 (+8.27%)	0.5520 (+1.36%pts)	+0.71%	+2.94%	-0.18%	+0.68%
Reduce τ_w to 0.28 and increase τ_m to 0.2220 to keep lump-sum tax fixed	6.11% (+0.42%pts)	0.1907 (+1.54%)	0.1689 (+2.05%)	0.2692 (+0.45%pts)	0.3204 (+12.32%)	0.5393 (+0.08%pts)	+0.93%	+12.19%	+0.47%	+1.21%

In tables 4-6:

ΔW_d^d denotes change in intertermporal welfare of residents of home country;

ΔW_m^d denotes change in intertemporal welfare of migrant workers;

ΔW_s^d denotes change in intertemporal welfare of home country arising from government expenditure;

ΔW_d denotes overall change in intertemporal welfare in home country.

B. Effects on Host Country

	Effects on Key Variables			Welfare
	Y_h	C_h	N_h	ΔW_h
Benchmark $\tau_w = 0.30, \tau_c = 0.15, \tau_m = 0$	2.7418	2.0574	0.3092	--
10% increase in A_h	3.1216 (+13.85%)	2.3336 (+13.43%)	0.3084 (-0.08%pts)	+7.39%
Policy responses				
Reduce τ_w to 0.25	3.1154 (+13.62%)	2.3309 (+13.30%)	0.3084 (-0.08%pts)	+7.35%
Reduce τ_c to 0.10	3.1221 (+13.87%)	2.3338 (+13.44%)	0.3084 (-0.08%pts)	+7.40%
Increase τ_m to 0.10	3.1106 (+13.45%)	2.3288 (+13.19%)	0.3085 (-0.07%pts)	+7.31%
Reduce τ_w to 0.28 and increase τ_m to 0.2220 to keep lump-sum tax fixed	3.0924 (+12.79%)	2.3209 (+12.81%)	0.3086 (-0.06%pts)	+7.16%

In Tables 4-6:

ΔW_h denotes change in intertemporal welfare of host country.

Table 5: Structural Changes: Increase in Home Country Productivity by 10%
A. Effects on Home Country

	Effects on Key Variables						Welfare			
	R/Y	Y	C	N_d	C_m	N_m	ΔW_d^d	ΔW_m^d	ΔW_s^d	ΔW_d
Benchmark $\tau_w = 0.30, \tau_c = 0.15, \tau_m = 0$	5.69%	0.1878	0.1655	0.2647	0.2853	0.5384	--	--	--	--
10% increase in A_d	4.82% (-0.87%pts)	0.2079 (+10.75%)	0.1814 (+9.62%)	0.2667 (+0.20%pts)	0.2999 (+5.11%)	0.5209 (-1.75%pts)	+9.31%	+12.39%	+3.06%	+8.62%
Policy responses										
Reduce τ_w to 0.25	4.51% (-1.18%pts)	0.2180 (+16.13%)	0.1895 (+14.53%)	0.2810 (+1.62%pts)	0.3038 (+6.49%)	0.5162 (-2.22%pts)	+10.45%	+15.92%	+4.52%	+9.88%
Reduce τ_c to 0.10	4.67% (-1.01%pts)	0.2143 (+14.14%)	0.1866 (+12.80%)	0.2757 (+1.10%pts)	0.2995 (+4.98%)	0.5213 (-1.71%pts)	+10.14%	+12.15%	+3.99%	+9.44%
Increase τ_m to 0.10	4.66% (-1.03%pts)	0.2082 (+10.88%)	0.1813 (+9.55%)	0.2671 (+0.23%pts)	0.3069 (+7.56%)	0.5126 (-2.58%pts)	+9.14%	+18.50%	+3.10%	+8.67%
Reduce τ_w to 0.27 and increase τ_m to 0.0455 to keep lump-sum tax fixed	4.56% (-1.13%pts)	0.2142 (+14.07%)	0.1863 (+12.56%)	0.2755 (+1.08%pts)	0.3054 (+7.04%)	0.5143 (-2.41%pts)	+9.96%	+17.27%	+3.97%	+9.43%

B. Effects on Host Country

	Effects on Key Variables			Welfare
	Y_h	C_h	N_h	ΔW_h
Benchmark $\tau_w = 0.30, \tau_c = 0.15, \tau_m = 0$	2.7418	2.0574	0.3092	--
10% increase in A_d	2.7193 (-0.82%)	2.0476 (-0.47%)	0.3094 (+0.02%pts)	-0.17%
Policy responses				
Reduce τ_w to 0.25	2.7132 (-1.04%)	2.0450 (-0.60%)	0.3095 (+0.03%pts)	-0.22%
Reduce τ_c to 0.10	2.7198 (-0.80%)	2.0478 (-0.46%)	0.3094 (+0.02%pts)	-0.17%
Increase τ_m to 0.10	2.7086 (-1.21%)	2.0429 (-0.70%)	0.3095 (+0.03%pts)	-0.25%
Reduce τ_w to 0.27 and increase τ_m to 0.0455 to keep lump-sum tax fixed	2.7108 (-1.13%)	2.0439 (-0.65%)	0.3095 (+0.03%pts)	-0.24%

Table 6: Structural Changes: Decrease in migration costs
A. Effects on Home Country

	Effects on Key Variables						Welfare			
	R/Y	Y	C	N_d	C_m	N_m	ΔW_d^d	ΔW_m^d	ΔW_s^d	ΔW_d
Benchmark $\tau_w = 0.30, \tau_c = 0.15, \tau_m = 0$	5.69%	0.1878	0.1655	0.2647	0.2853	0.5384	--	--	--	--
$\boldsymbol{X}$ **: 0.07 → 0**	6.64% (+0.95%pts)	0.1864 (-0.73%)	0.1661 (+0.38%)	0.2626 (-0.21%pts)	0.2864 (+0.38%)	0.5371 (-0.13%pts)	+0.89%	+0.89%	-0.22%	+0.76%
Policy responses										
Reduce τ_w to 0.25	6.24% (+0.55%pts)	0.1956 (+4.19%)	0.1735 (+4.86%)	0.2769 (+1.22%pts)	0.2901 (+1.69%)	0.5326 (-0.59%pts)	+1.94%	+4.05%	+1.21%	+1.92%
Reduce τ_c to 0.10	6.45% (+0.76%pts)	0.1922 (+2.37%)	0.1709 (+3.28%)	0.2716 (+0.69%pts)	0.2860 (+0.26%)	0.5375 (-0.09%pts)	+1.66%	+0.67%	+0.69%	+1.51%
Increase τ_m to 0.10	6.47% (+0.78%pts)	0.1866 (-0.60%)	0.1660 (+0.31%)	0.2630 (-0.17%pts)	0.2930 (+2.70%)	0.5291 (-0.94%pts)	+0.73%	+6.37%	-0.18%	+0.80%
Reduce τ_w to 0.28 and increase τ_m to 0.2235 to keep lump-sum tax fixed	6.06% (+0.38%pts)	0.1907 (+1.58%)	0.1688 (+2.03%)	0.2693 (+0.46%pts)	0.3042 (+6.64%)	0.5157 (-2.27%pts)	+0.96%	+16.02%	+0.46%	+1.33%

B. Effects on Host Country

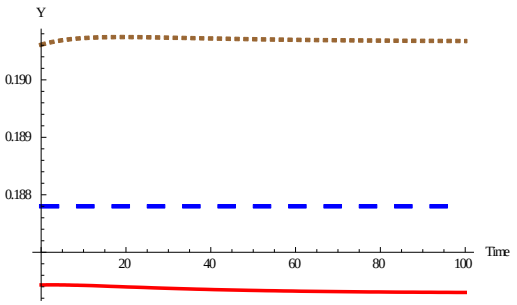
	Effects on Key Variables			Welfare
	Y_h	C_h	N_h	ΔW_h
Benchmark $\tau_w = 0.30, \tau_c = 0.15, \tau_m = 0$	2.7418	2.0574	0.30922	--
$\boldsymbol{X}$ **: 0.07 → 0**	2.7401 (-0.06%)	2.0566 (-0.04%)	0.30923 (+0.003%pts)	-0.01%
Policy responses				
Reduce τ_w to 0.25	2.7343 (-0.27%)	2.0541 (-0.16%)	0.30929 (+0.023%pts)	-0.06%
Reduce τ_c to 0.10	2.7407 (-0.04%)	2.0569 (-0.02%)	0.30923 (+0.003%pts)	-0.01%
Increase τ_m to 0.10	2.7298 (-0.44%)	2.0522 (-0.25%)	0.3093 (+0.026%pts)	-0.09%
Reduce τ_w to 0.28 and increase τ_m to 0.2235 to keep lump-sum tax fixed	2.7126 (-1.07%)	2.0447 (-0.62%)	0.3095 (+0.084%pts)	-0.23%

Figure 1: Transitional Dynamics

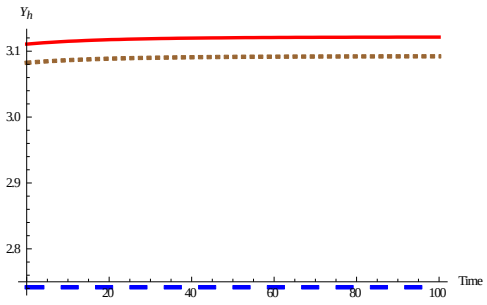
Host country productivity increase vs Policy response (τ_w = 0.28 and τ_m = 0. 2220)

Initial steady-state value

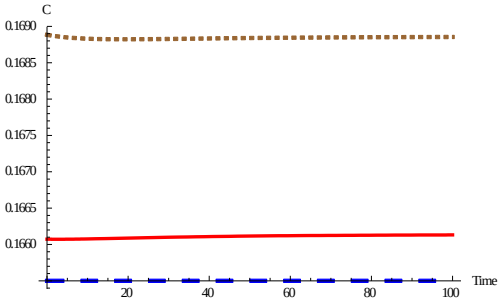
A. Home Country **B. Host Country**



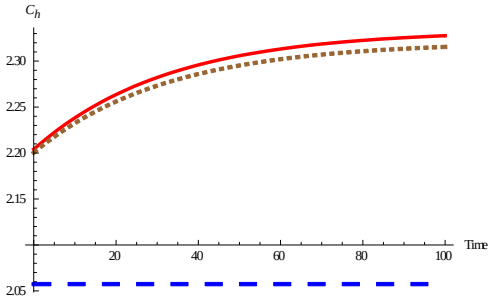
Home output



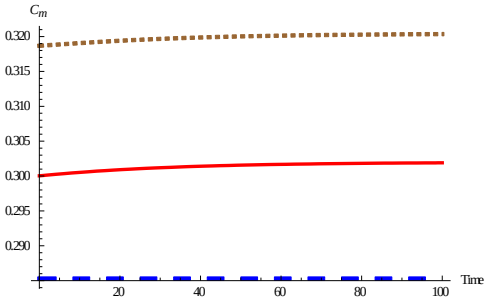
Host output



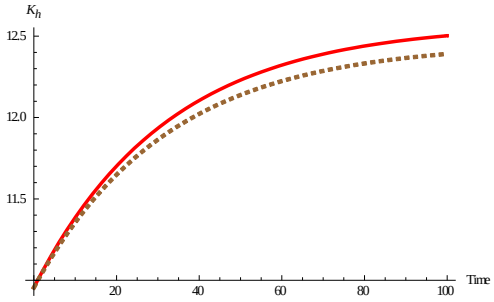
Home consumption



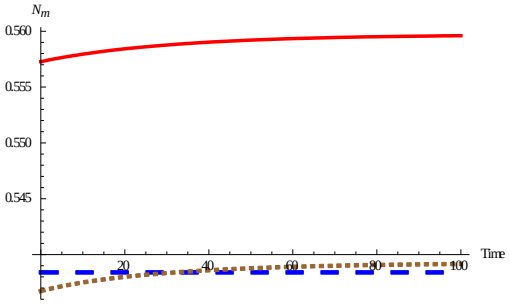
Host consumption



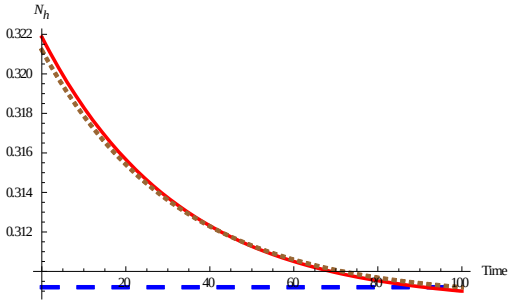
Migrant consumption



Capital stock



Migrant labor



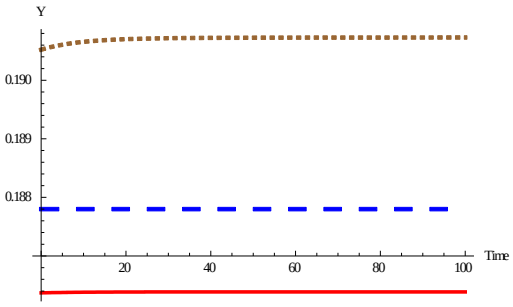
Native labor

Figure 2: Transitional Dynamics

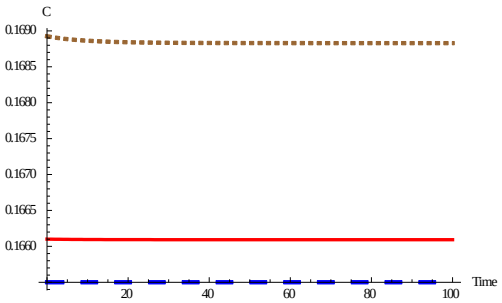
Migration cost decrease vs Policy response (τ_w to 0.28 and τ_m to 0.2235)

Initial steady-state value

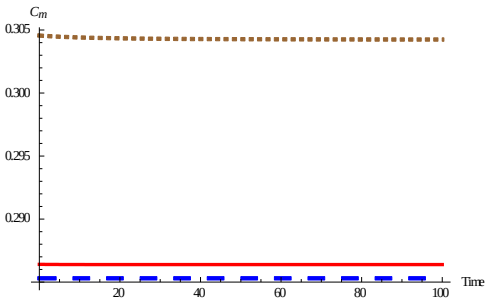
A. Home Country



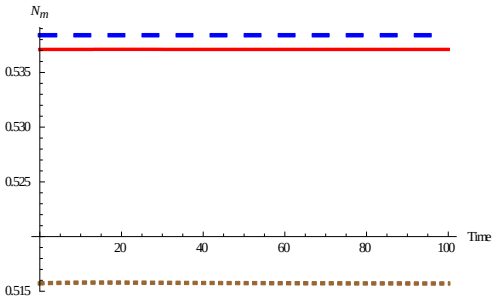
Home output



Home consumption

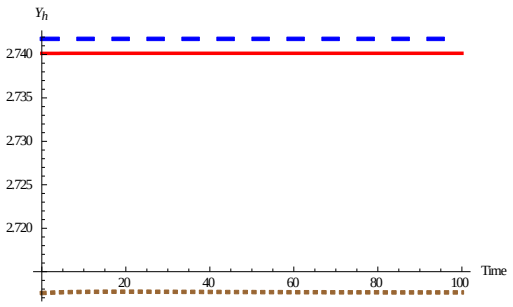


Migrant consumption

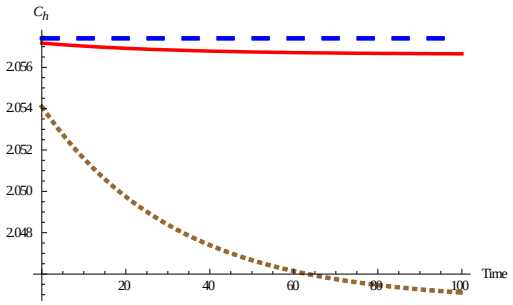


Migrant labor

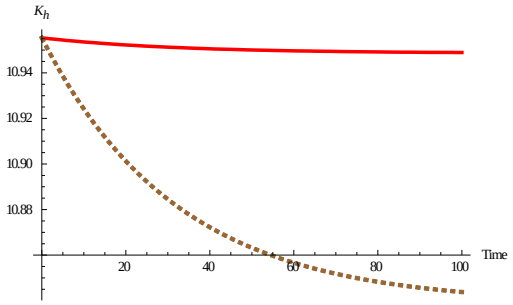
B. Host Country



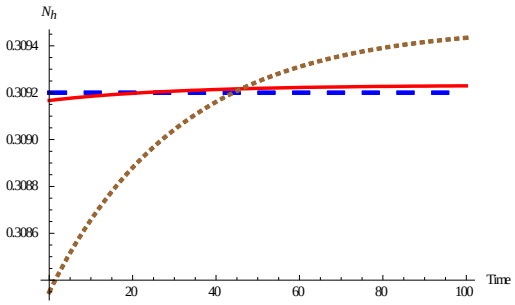
Host output



Host consumption



Capital stock



Native labor