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Regular Article Endogenous labor migration and remittances: Macroeconomic and welfare consequences *

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ABSTRACT

This paper develops a macrodynamic model of two small economies - a host country and a labor-exporting developing country - to address the impact of migrant workers and remittances on the two economies. It endogenizes the migration decision as part of the intertemporal utility maximization of households in the developing economy. This setup captures the dynamic process of migration, in which evolving circumstances may lead to fundamental differences from those based on treating remittances as exogenous. Extensive numerical simulations consider two diverse sources of structural change that impinge directly on the migration-remittance relationship. In both cases the long-run impact on the remittance-GDP ratio differs markedly from the immediate response, primarily as a consequence of the impact on the evolving migration during the transition. The welfare consequences of the different constituents - domestic residents, migrant workers, and host economy native workers - are considered. Alternative tax policies to offset effects, deemed adverse, are also discussed.

1. Introduction

Since 2000 the number of migrant workers has grown dramatically to the point where by 2020 they totaled around 281 million, constituting around 8.3% of the global labor force, making them a significant component of the world workforce. Over the same period the average world-wide ratio of remittances to GDP more than doubled from 0.372% to 0.79%. Unsurprisingly, there is a huge variation in this ratio across different economies. But it is noteworthy that for the three largest South Asian countries - Bangladesh, India, and Pakistan - the ratios in 2020 were 6.7%, 3.1%, and 8.7%, respectively, clearly contributing a substantial portion of their financial resources. This raises the question of the underlying forces driving these trends, and in this regard we can identify two effects.

First, many densely populated developing countries have long viewed migrant work as a viable alternative to domestic employment, insofar as these countries were unable to provide gainful employment for the young and unemployed. As a result, in the 1970s and 1980s several governments of developing Asian economies established bureaucracies to facilitate and promote migrant employment.¹ Second, these efforts by Asian governments were encouraged by a huge demand for labor in the Middle East, with migrant workers being attracted by the resulting higher wages. By 1980, the presence of South Asian migrants in the Middle East exceeded 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 portions of their earnings back to their home countries. In 2020, the total flow of remittances to the five South Asian countries, Bangladesh, India,

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¹ These included: the Pakistan Bureau of Emigration and Overseas Employment in 1971; the Philippine Overseas Employment Administration in 1982; the Indian Emigration Act, and subsequent Ministry of Overseas Indian Affair in 1983; the Bangladesh Overseas Employment and Services Limited in 1984; the Nepal Foreign Employment Act in 1985, the Sri Lanka Bureau of Foreign Employment under legislation approved in 1985. More recently, Cambodia has signed Memoranda of Understanding with several countries in the region to promote overseas jobs for Cambodian workers.

Nepal, Pakistan, and Sri Lanka amounted to over \$146 billion, of which well over 50% came from the Middle East (World Bank, 2022).²

The recent increase in remittance inflows into developing countries has stimulated a growing literature investigating the impact that remittances may have on various aspects of the recipient nation's economy. These studies include the effect on: the real exchange rate (Amuedo-Dorantes and Pozo, 2004; Acosta et al., 2009; Chatterjee and Turnovsky, 2018); financial development (Giuliano and Ruiz-Arranz, 2009; Aggarwal et al., 2011); the current account (Bugamelli and Paterno, 2009), economic growth (Chami et al., 2009; Giuliano and Ruiz-Arranz, 2009; Durdu and Sayan, 2010); monetary and fiscal policy (Chami et al., 2005, 2006; Lim and Morshed, 2017; Lim et al., 2021); and real business cycles (Mandelman and Zlate, 2012; Finkelstein Shapiro and Mandelman, 2016). It has also been shown how the impact of remittances depends upon their allocation within the economy and its structural characteristics. For example, Bahadir et al. (2018) show that remittances are contractionary when they are received by wage earners, but expansionary when they are directed to credit-constrained entrepreneurs. Chatterjee and Turnovsky (2018) discuss how their impact is dependent upon the presence (or absence) of an informal sector, a highly relevant issue for many developing economies.

The vast majority of studies treat remittances as exogenous, or specify them as countercyclical, ignoring any potential link between remittances and the growth of migrant labor. Lim and Morshed (2015), using remittance and migrant stock data for 122 countries from 1990 to 2010, show that while an income shock does not induce existing migrants to send more remittances, labor migration does indeed lead to increased remittances, thus providing confirmation for the need to analyze remittances and labor migration as joint decisions. Despite this evidence existing attempts to link migration and remittances are sparse, and as we shall suggest in Section 2.2 have addressed the relationship only under very restrictive conditions.

The framework we adopt is an extension of that developed by Lim et al. (2021). This setup consists of a macrodynamic model of 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 Middle East Gulf states, Netherlands, Belgium, Australia, and Singapore, rely heavily on migrant labor from developing countries as an integral part of their productive labor force. The key modification is to endogenize the fraction of workers migrating, by incorporating it as part of the home economy's household utility maximizing decision. Thus, not only do these households decide on how many of their members should migrate, but the migrant workers also decide on the allocation of their time between working and leisure. Migration occurs gradually, reflecting the deliberate intertemporal decision making process of the household, as well as the bureaucratic delays in obtaining approval from the host country. A secondary modification is to allow for capital accumulation by the home economy, reflecting the reality that some portion of the remittances may be allocated to saving and investment.

Our analysis, which employs extensive numerical simulations, highlights how endogenizing the migration process fundamentally changes how remittances impact both the home and host economies. It introduces sharp contrasts between the short-run and long-run effects, which are a consequence of the dynamic interaction between the economies generated by the migration process, as the various constituents respond during the transition.

Using this setup we address the consequences of two structural changes that are likely to impinge most directly on the migration decision. First, and more important, is a productivity increase in the developed host country, which being a potential source of higher wages for home country labor, is a key driving force behind the recent increase in migrant workers.

The other issue we address is the impact of eliminating the costs associated with remittances imposed on migrant workers. This issue is motivated by United Nations' 17 Sustainable Development Goals to be achieved by 2030. Two of the targets specified in Goal 10 pertain to international immigration and remittances:

- Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies.
- By 2030, reduce to less than 3% the transaction costs of migrant remittances and eliminate remittance corridors with costs higher than 5%.

Implicit in these targets is the question of the benefits of migration. In this respect, World Bank (2019) suggests that cross-border labor mobility reaps relatively larger global welfare gains than those obtained from full trade liberalization. High-income host countries benefit from increased labor supplies; migrants benefit from increases in income and better access to education and health services; and the developing, labor-exporting countries gain from increased remittances, investments, trade, and transfers of skill and technology.

Empirically, the benefits for host countries seem clear. Feenstra and Taylor (2017) summarize the literature documenting the net gains to the U.S. from immigration. Borjas (1995, 1999) estimates the gains in terms of GDP increase of about 0.1%–0.4% from a 10% stock of immigrants in the labor force. Kremer and Watt (2006) consider only household workers and estimate the gains of a 1.2%–1.4% increase of GDP for a 7% stock of immigrants. These gains depend on the complementarity of skills between immigrants and native workers. The gains are even larger if immigrants are highly skilled.³

The empirical evidence assessing the welfare gains of remittances for the migrants' home country is more ambiguous. While some studies find a negative, or no relationship, between remittances and economic growth (Chami et al., 2005; Chami et al., 2009; Donou-Adonsou and Lim, 2016; Gupta, 2005; IMF, 2005; Lim and Simmons, 2015), others find a positive relationship (Faini, 2007; Ramirez and Sharma, 2008; Ziesemer, 2009). As already suggested, a key determinant of the impact of remittances on home country activity is whether they are used for consumption or investment purposes (Bahadir et al., 2018; Lim and Basnet, 2017).

Our formal macroeconomic model is calibrated to reflect the flow of migrant workers and remittances between Bangladesh (the developing home country) and a set of 5 Middle East countries (the advanced small host economies). As we discuss below, in light of the fact that more than half of Bangladeshi migrant workers are employed in the wealthy oilrich countries of the Middle East, we view this as an appropriate context for our numerical analysis. For each of the structural shocks stipulated above, we trace the dynamic time paths of key economic variables in both the domestic and in the host economies.

Particular attention is devoted to the welfare implications, recognizing the fact that there are three constituents - domestic residents, migrant workers from the home economy, and host country citizens whom the migration/remittance decision may impact in conflicting ways. In instances where this occurs, we consider alternative taxes that the domestic government may impose intended to at least partially compensate for any unintended negative consequences. For this

² We may note that similar push factors are also in effect in the Central American and Caribbean countries, where the International Organization for Migration has a Western hemisphere initiative to help migrant workers.

³ See e.g. Peri et al. (2015) for U.S. evidence based on presence of foreign-born STEM workers who came to the U.S. under the H–1B visa program.

purpose, taxes on labor income and remittances are particularly appropriate since they impinge most directly on the migration and remittance decisions.⁴

Overall, our model confirms the empirical evidence in that the two structural changes that attract migrant workers will indeed benefit the host economy. This is seen most directly in the case of the elimination of migration costs, which our calibration suggests results in a long-run 28% increase in migrant workers yielding a long-run increase in GDP and welfare of around 1.87% and 2.6%, respectively. Normalizing the changes, these are seen to be of similar order of magnitude as suggested by Borjas (1995, 1999) and Kremer and Watt (2006). Also, tax policies introduced by the domestic government to alleviate any adverse impact on the home economy have very modest effects on the host economy.

The assessment of overall welfare gains and losses on the domestic economy is less straightforward. First, domestic residents and migrants possibly being impacted in conflicting ways is complicated by the fact that their relative sizes are changing over time with migration. Second, with the adjustments along the transitional path often involving substantial costs, the impact on steady-state welfare may contradict the impact on intertemporal welfare that incorporates the transitional adjustment costs. Taking these issues into account makes it difficult to give a definitive assessment of the welfare implications of remittances for the domestic economy. It depends upon the underlying driving force and precisely upon what is being measured, and in this respect its ambiguity is consistent with the empirical evidence. But despite that, by judicious tax policy, the simplest being a reduction in the tax on labor income, the domestic government can ensure that any adverse effects of remittances on any of its constituents can be offset, so that all groups share in the benefits.

The remainder of the paper proceeds as follows. Following this introduction Sections 2 and 3 set out the analytical framework, laying out the structure of the two economies. Section 4 then describes the macroeconomic equilibrium, emphasizing the dynamic interaction and the steady state. Section 5 gives a detailed discussion of the calibration, while Section 6 analyzes the transitional adjustment to, and the long-run consequences of, the two structural changes that we address. Section 7 briefly addresses issues of robustness, focusing particularly on the potential for migrant workers to be substitutes for native workers in the host economy and on parameters pertaining to migration costs. Section 8 concludes, while technical details are relegated to the Appendix and in some cases to an Online Appendix.

2. Two preliminary issues

We construct a simple macro-dynamic model of two small open economies. One is a low-income labor-exporting, developing country that we also refer to as the "domestic" or "home" economy, while the other is a labor-importing advanced country, referred to as the "host" country. The home economy comprises a continuum of households that because of their lack of resources choose to send a fraction, m, of their members abroad as migrant workers to the host country, 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 that reflects their respective risk, as perceived by the international financial market. Before detailing the model, we briefly address two issues, one pertaining to the "scale" of the economies, and the other to clarifying the distinctive way in which migration is being introduced.

2.1. Scale issues

As we shall discuss in Section 5 below, in calibrating the model 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 despite fitting our scenario well, there are "scale problems" that need to be taken into account, for the simulations to plausibly match the empirical magnitudes. One issue is that the relative sizes of the home and host countries vary extensively. Even though Bangladesh can reasonably be treated as a "small" economy from a global perspective, nevertheless its population is three times that of the 5 small Middle East countries (approximately 165 m vs 57 m). But in addition, Bangladeshi workers migrate to a range of advanced economies around the world, and by the same token, the Middle East countries employ migrant workers from many other developing economies. From the standpoint of the small developed economy (the host country), these scale issues can be taken as being exogenous.

Normalizing the number of native workers in the host country to be one, the relative number of migrant workers is θ . To reflect the fact that firms in the host country hire some proportion of their workers both from Bangladesh and the rest from elsewhere we can write:

 $\theta(m) \equiv \theta \cdot m = (\theta_1 + \theta_2)m$

where for simplicity we normalize the size of each country supplying migrant workers to that of the home country. Thus $\theta_1 \cdot m$ is the fraction of migrant workers in the host country *not* from the home country, while θ_2 adjusts for the relative size of host and home countries, and the fact that *m* is specified as a percentage of the home country population. Thus, in an initial equilibrium in which $m = m_0$, $\theta(m_0) \equiv (\theta_1 + \theta_2)m_0$ and the ratio of home migrant workers to total migrant workers in the host country is $\theta_2 / (\theta_1 + \theta_2)$. We shall assume that any structural change in the *host* country, such as a productivity increase, impacts all migrant workers employed there identically, irrespective of their country of origin. In that case the fraction of migrant workers from the home economy remains unchanged. However, in response to a shock in, or policy response by, the home country that has no impact on migrant workers from other countries the fraction of home migrant workers is determined by $\theta_2 m(t) / (\theta_1 m_0 + \theta_2 m(t))$, which evolves gradually over time with m(t).

2.2. Extensive vs intensive migrant decisions

In setting out the relationship between migrant workers and remittances it is important to distinguish between the decision to migrate vs. the decision to supply labor (rather than enjoy leisure), a difference that we characterize between a decision at the **extensive** margin and one at the **intensive** margin of migrant workers. As already noted, most of the literature treats remittances as exogenous, or to the extent that they relate them to the decisions to migrate, do so in very restrictive ways. For example, Lim and Morshed (2017) consolidate the labor provided by migrant workers and those family members that remain behind (stayers). Thus the time allocated to labor conflates both the extensive margin and intensive margin decisions of working abroad. At any instant of time, an individual can increase his work abroad, and this could involve either moving instantaneously abroad (extensive margin) or alternatively migrant workers already abroad allocating more time to labor (intensive margin). The model does not distinguish between these

⁴ We should note that the question of whether to tax remittances was debated heatedly in the 1970s (see Bhagwati and Wilson, 1989). Key elements of the debate are summarized by Lim et al. (2021).

two forms of adjustment, and obviously this is a restrictive assumption.⁵ A similar approach is adopted by Shen et al. (2010).

In contrast, Lim et al. (2021) separate out the stayers from the migrants with regard to labor, as specified by their respective labor allocation constraints. But they treat the fraction of migrant workers m as fixed, and therefore focuses only on the intensive margin with respect to the labor allocation decision by migrant workers; see also Naval (2019). This too is restrictive, but can be justified by appealing to fixed immigration quotas.⁶ Thus, their approach abstracts from the decision to migrate (the extensive margin), which as Lim and Morshed (2015) document is the dominant factor underlying the recent surge in remittances.

The key contribution of the present paper is to endogenize the migration decision, *m*, including it as an integral part of the home household intertemporal utility maximizing decision, that weighs up its time, costs, and potential benefits as they impinge on family welfare; see Sharma and Zaman (2009) who document this in detail for Bangladeshi households.⁷ This is clearly important and enables us to distinguish explicitly between the extensive and intensive labor supply decisions of migrant workers. As we will demonstrate in Section 6, this impacts the aggregate dynamics of the home economy in fundamental ways, generating more flexible and arguably more realistic dynamic adjustments by migrants which then spread throughout the two economies.

But we also recognize that our setup is related to several other recent contributions, the closest being Mandelman and Zlate (2012). While they specify what they call intensive and extensive margin of remittances at the household level, they do not capture both intensive and extensive margin of household decisions. In their framework, each unskilled household chooses to send an amount of new migrant labor every period by equating the sunk emigration cost with the expected stream of future wage gains (defined as the difference between immigrant wage and unskilled wage) whereas the stock of migrant labor is built according to the law of motion in which new immigrants start working one period after their arrival and continue to work until an exogenous shock (defined similarly to a depreciation rate) triggers return migration. This specification is restrictive, merging the flow of migration (resulting from the household decision to migrate) into the stock of migrant workers, thus capturing either the intensive or extensive margin, rather than both. In addition, it does not generate a natural return migration based on household decisions.

Other related studies introduce migration between less developed and developed regions, with much of this literature originating with Lundborg and Segerstrom (2002). These studies tend to focus on R and D differentials with remittances playing a very secondary role; see e.g. Levine et al. (2010). More recently, Ikhenaode and Parello (2020, 2022) focus on the interaction between migration and remittances in a two country world. They derive a dynamic equation determining the rate of migration analogous to our (16) below. But it is derived from a framework of labor market frictions that lead to unemployment, rather than being the result of household optimization. In addition, none of these papers appear to incorporate the distinction between the intensive and extensive decision-making margins pertaining to migration. Thus, by capturing both the (intensive) decisions of migrant workers to supply labor and the (extensive) decisions by households to migrate, in a simple, innovative way, we view this paper as providing a significant improvement over the existing literature.

Two general characteristics merit highlighting at this point. First, is the dramatic switch over time between intensive and extensive labor supply adjustments as the sources of remittances. If the circumstance calls for an increase in remittances, in the short run with the number of migrant workers fixed instantaneously, this is met by *existing* migrants increasing their individual labor supply. But these same forces for additional remittances encourage more migration, and over time, the additional work effort is quickly replaced by *increased* migrants, with *all* migrant workers gradually reducing their labor supply over time. Also, the model is able to generate endogenously the phenomenon of "reverse migration", a phenomenon strongly supported by empirical evidence, and which may be generated by the intensive margin dynamics as migrants respond to the changing conditions, or as they react to policy responses introduced by the home government.⁸

3. Analytical framework

We assume that all workers are endowed with a unit of time of which a fraction, N_h , in the case of native workers and, N_m , in the case of migrants, (both chosen by firms in the host country) is demanded as labor. Accordingly, the net supply of labor provided by native and migrant workers to the host country is N_h and $\theta(m)N_m$, respectively. The two countries are described as follows.

3.1. Host country (labor-importing country)

In the host country, firms utilize their domestic capital stock, K_h , native labor, N_h , and migrant workers, $\theta(m)N_m$, to produce traded output, Y_h . The production technology is specified by the standard neoclassical function

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

where $f_{K_h} > 0, f_{N_h} > 0, f_{\theta(m)N_m} > 0, f_{K_hK_h} < 0, f_{N_hN_h} < 0, f_{\theta(m)N_m,\theta(m)N_m} < 0, f_{K_hN_h} > 0, f_{K_h,\theta(m)N_m} > 0, f_{N_h,\theta(m)N_m} > 0.$

All productive inputs, including, native and migrant workers, are cooperant in production.

Profit maximizing behavior of firms yields the following conventional demand functions for capital, native labor, and migrant workers:

$$pf_{K_h}(K_h, N_h, \theta(m)N_m) = \rho_h$$
(2a)

$$pf_{N_h}(K_h, N_h, \theta(m)N_m) = w_h \tag{2b}$$

$$pf_{\theta(m)N_m}(K_h, N_h, \theta(m)N_m) = w_m$$
(2c)

where ρ_h , w_h and w_m denote the real rental rate on capital, the real wage

⁵ Other key differences between Lim and Morshed (2017) and the present paper include the following. They assume that both countries have unlimited access to the world financial market, and abstract from capital accumulation by the developed economy. These are restrictive assumptions that have the effect of eliminating the interdependence between the two economies that is being emphasized in this paper. Furthermore, they focus on the optimal tax structure, whereas our concern is to investigate the dynamic responses of migration/remittances to structural changes, with the role of alternative tax policies being to potentially redistribute the welfare benefits across constituents.

⁶ Many countries that employ substantial quantities of migrant workers adopt quotas. These include Saudi Arabia, which requires a non-Saudi migrant worker to have a local sponsor who secures a work permit and residence card known as the *Kafala* system. A brief discussion of the *Kafala* system is provided in Appendix B. Over time, quotas tend to get adjusted so that one interpretation of the assumption of a fixed migration stock is that it is short run.

⁷ Sharma and Zaman (2009) surveyed Bangladeshi remittances-recipient households and found that migration is indeed a long-drawn process, requiring both time and resources for the potential migrants to emigrate. They found that the upfront cost for a Bangladeshi migrant in 2008 was about US \$ 23,000, about five times Bangladesh's per capita income. They also found that the time taken to complete the migration-related documents can take up to 12 months. Financing of these costs includes borrowing from banks and also sometimes selling land and other assets.

⁸ For instance, in 2013 the United Nations estimates that the return migration rates for Bangladesh and India from the Gulf Corporation Council countries (which include our host countries) are 49% and 39%, respectively; see Doherty et al. (2014).

rate for native workers, and the real wage rate for migrant workers, respectively; *p* is the world price of the traded output and is exogenous to both small economies. In choosing how much migrant labor to employ, the firm takes $\theta(m) \equiv (\theta_1 + \theta_2)m$ as given. The assumption that migrant and native workers are co-operant in production $(f_{N_h,\theta(m)N_m} > 0)$ implies that the inflow of migrants will raise the marginal product of native workers, and thus their wage rate (given the stock of capital). Furthermore, if native labor is more productive (skilled) than are migrant workers then $w_h > w_m$, and vice versa.

Each household in the host country allocates its time between leisure (L_h) and work (N_h) so that native labor supply is subject to the constraint

$$N_h = 1 - L_h \tag{3}$$

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

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

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

$$\dot{B}_h = r_h B_h + C_h + \dot{K}_h + \delta_h K_h - \rho_h K_h - w_h N_h$$
(4b)

where r_h denotes unit borrowing costs to host residents, B_h is their holdings of international debt, and δ_h is the depreciation rate of capital.

Consumers in the host economy have access to the international financial market. Due to financial frictions, we assume that the borrowing cost is strictly increasing and convex in the nation's aggregate debt-output ratio (B_h / Y_h) , as reflection of its ability to service its debt. The cost of borrowing is thus specified by⁹

$$r_h = r^* + \Psi\left(\frac{B_h}{Y_h}\right); \quad \Psi(0) = 0, \Psi' > 0, \Psi'' > 0$$
(5)

where r^* is the exogenously given real world interest rate, and $\Psi(B_h / Y_h)$ is the borrowing premium. In making its decisions, the individual household cannot influence the economy's aggregate debt-output ratio and thus takes the borrowing cost as given.

Households' optimization yields the following conditions:

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

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

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

$$\rho_h - \delta_h = r_h \tag{6d}$$

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-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 noarbitrage condition for private investment, which equates the rate of return on physical capital net of depreciation to the borrowing cost. In addition, the transversality conditions require that

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

3.2. Domestic country (labor-exporting country)

As noted, we assume that there is a unit continuum of household members, a fraction, *m*, of which are migrant workers, employed in the host country, while the rest, (1-m), remain and work at home ("stayers"). The migrant worker earns $w_m N_m$ from his labor of which C_m is spent on consumption. In addition, working abroad incurs fixed costs, *x*, for items such as work permits and the cost of sending remittances. The balance is remitted back to the migrant's family in the home country, so that the aggregate remittances (*R*) received by the home economy is¹⁰

$$=m(w_mN_m-x-C_m) \tag{7}$$

3.2.1. The private sector

R

With a fraction m of the population migrating to work in the small host economy the production function in the home economy is

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

where Y is the domestic economy's output and N is domestic labor supply. We assume that the home production function has the usual properties of positive, but diminishing, marginal product and is homogenous of degree one in the two productive factors, capital and labor. Thus, the corresponding profit maximizing condition is

$$F_K(K,(1-m)N) = \rho \tag{9a}$$

$$F_{(1-m)N}(K, (1-m)N) = w$$
 (9b)

where ρ is the real return on capital and *w* is the wage rate. By appropriate choice of units, the price of the traded output in the home economy is assumed set at unity. We assume that new output can be converted to capital without incurring any adjustment costs.

We further 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 collateral in securing borrowing has received some attention, especially for countries having a high remittance to GDP ratio. Accordingly, we explicitly allow for the entire flow of remittances to serve as a component of repayment capacity. The interest rate function facing the developing country is thus

$$r = r^* + \Gamma\left(\frac{B}{Y+R}\right); \ \Gamma(0) = 0, \Gamma' > 0, \Gamma'' > 0$$
 (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 $\Gamma[B/(Y+R)]$ is the borrowing premium. 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.

The welfare of home country is represented by the weighted average of the utility of the stayers and migrants. This specification reflects the fact that this is a family unit whose members care mutually about one another, and that migrant workers send remittances to those who are left behind is a testament to that. In addition, many migrant workers are

⁹ 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).

 $^{^{10}}$ We should note that eq. (7) abstracts from remittances received by the home country from countries other than the designated host country. Since these are treated as exogenous to the two small economies, this omission does not affect our overall results; see Lim et al. (2021) for further discussion.

frequently only temporary guest workers, who migrate to work on contracts, while maintaining strong ties to their families, in which case the maximization of joint utility is further justified.¹¹ Thus, the house-hold utility function is

$$W = \int_{0}^{\infty} [(1-m)U(C,L) + mM(C_m,L_m)]e^{-\beta t}dt$$
(11)

where U(C,L) is the utility of the stayers with $U_C > 0$, $U_L > 0$, $U_{CC} < 0$, $U_{LL} < 0$; $M(C_m, L_m)$ is the utility of migrants working in the host country and has similar properties.

Both domestic resident and migrant members of the household are endowed with one unit of time that they allocate between work and leisure in accordance with the constraints:

$$N+L=1 \tag{12a}$$

$$N_m + L_m = 1 \tag{12b}$$

The domestic household is also subject to the following financial constraint, together with the gradual evolution of migration, I(t):

$$\dot{B} + (1 - \tau_m)R + (1 - \tau_k)\rho K + (1 - m)(1 - \tau_w)wN$$

= $rB + \dot{K} + \delta K + (1 - m)(1 + \tau_c)C + aI + \frac{h}{2}I^2 + T$ (13a)

$$\dot{m}(t) = I(t) \tag{13b}$$

where remittances, R(t), are specified in (7). Capital depreciates at a constant rate δ . *T* represents lump-sum taxes, while τ_k , τ_w , τ_c , and τ_m are distortionary taxes imposed on domestic capital income, labor income, consumption, and remittances, respectively.¹²

The left hand side of (13a) spells out the resources available to the household, namely its new borrowing, the after-tax remittances provided by the migrants, the after-tax return on capital, and net labor income earned by stayers. This equals the interest owing on its debt, investment expenditures, consumption expenditures, migration costs, $aI(t) + (h/2)I(t)^2$ and lump-sum taxes. It reflects the fact that gross investment inclusive of depreciation is financed partly out of general revenue defined by (13a) but is also subsidized by after-tax remittances.

A new critical feature of the dynamics is the quadratic nature of the costs incurred by the household associated with the process of migrating at the rate $\dot{m}(t) = I(t)$. This reflects the reality that the process of migrating is both costly and takes time. These costs are borne collectively by the household, and are reflected in *a* and *h*. The parameter *a* affects the long-run stock of migrant workers and may reflect such things as immigration quotas imposed by the host country. In contrast, *h* determines only the speed with which migration proceeds due to the bureaucratic costs associated with receiving necessary documentation. In the limiting case $h \rightarrow 0$, migration occurs instantaneously, whereas in the other extreme $h \rightarrow \infty$, assumed by Lim et al. (2021), $m(t) = m_0$. In that case, the fraction of migrant workers becomes an exogenously set quantity that can be interpreted as being determined by quotas imposed by the host country.

Substituting for R(t), (13a) may be rewritten as:

$$\dot{B} - \dot{K} = rB - [(1 - \tau_k)\rho - \delta]K + (1 - m)[(1 + \tau_c)C - (1 - \tau_w)wN] + (1 - \tau_m)m(C_m + x - w_mN_m) + aI + \frac{h}{2}I^2 + T$$
(13c)

Choosing, C, N, C_m, N_m, K, B, I , and *m* to maximize utility, (11), subject to the consolidated budget constraint (13c), the evolution of migration (13b), the labor allocation conditions (12a) and (12b), and remittances as defined by (7), yields the optimality conditions:

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

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

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

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

$$(1-\tau_k)\rho - \delta = r \tag{14e}$$

$$\beta - \frac{\lambda}{\lambda} = r \tag{14f}$$

$$I = \frac{q-a}{h} \tag{14g}$$

$$\frac{M(C_m, L_m) - U(C, L)}{q\lambda} + \frac{1}{q} (1 - \tau_m) [w_m N_m - x - C_m] - \frac{1}{q} [(1 - \tau_w) w N - (1 + \tau_c) C] = r - \frac{\dot{q}}{q}$$
(14h)

where λ is the shadow value of wealth (expressed in terms of utility) of households in the developing economy and q is the shadow value of migration (expressed in units of wealth).¹³

Equations (14a) and (14b) are conventional marginal conditions on consumption and leisure as applied to stayers, while equations (14c) and (14d) apply to migrants. Equation (14e) is the equality of the return to capital, net of depreciation, to the borrowing costs, while (14f) 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.¹⁴

The remaining two equations apply to migrants. Equation (14g) states that the rate of migration is proportional to the difference between the shadow value of being a migrant and the base costs, at a speed that varies inversely with the marginal costs. Equation (14h) treats migration as an asset. It asserts that the net rate of return to migration comprises the difference in utility, plus the difference in the net income between migrants and stayers per unit of cost, and given by the left hand side, must equal the opportunity cost of investing, taking into account the "capital gains" of migrating, and given by the right hand side.

Finally, the transversality condition, (14i), ensures that the household is intertemporally solvent

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

3.2.2. The government

The government of the developing country is assumed to set its expenditure policy so as to claim a fixed share, g, (0 < g < 1), of output, so that government spending, G, is

$$G = gY \tag{15a}$$

We also assume that the government maintains a balanced budget at

¹¹ The approach we are adopting of evaluating welfare in terms of joint household utility is consistent with the literature, in which migrant workers send remittances back to their families; see e.g. Lucas and Stark (1985), Hod-dinott (1994), Ilahi and Jafarey (1999), and more recently Murard (2016), and Ivlevs et al. (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).

¹² For simplicity we abstract from government debt, the role of which is adequately proxied by lump-sum taxes.

¹³ Appending the costate variables λ , q' to the dynamic eqs. (13c) and (13b), respectively, q is defined as $q = q'/\lambda$.

¹⁴ For simplicity we assume that all agents in the two economies have the same rate of time discount.

all points of time. The government budget constraint is expressed as

$$G = (1 - m)(\tau_c C + \tau_w w N) + \tau_m m(w_m N_m - x - C_m) + \tau_k \rho K + T$$
(15b)

This implies that, if τ_m , τ_c , τ_w and τ_k 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), *T*, must be continuously adjusted to maintain budget balance. For simplicity, we assume that the utility benefits government consumption yields to households are additively separable. It therefore has no impact on consumer behavior and without loss of generality its utility has been set to zero in eq. (11); the primary reason for introducing it is to facilitate the calibration.

4. Macroeconomic equilibrium

We now combine the two economies to derive their macroeconomic equilibrium. The key element linking them is the migration of labor. As we have stressed, the productivity of the host economy is affected by both the intensive and extensive margins of migrant labor. Furthermore, any structural changes in the host country that influence labor migration also impact the wellbeing of the developing home country, while any responses by migrants to tax policy of the home economy impacts the economic performance of the host economy.

4.1. Domestic economy

Using (2c), (9a), (9b), and (10), we can derive the short-run equilibrium conditions from (14a) - (14e) and reported as (A.1a)-(A.1d) in the Appendix. Comparing (A.1a) and (A.1c) we see that the marginal rate of substitution between consumption and leisure for stayers is driven by the tax-adjusted productivity of labor in the home economy, while that of migrants is determined by the productivity of migrants in the host economy. Also, the ratio of the marginal utility of consumption of stayers to that of migrants, (A.1 b), is driven entirely by tax considerations. It can be characterized as an "internal household equilibrium" condition and plays an important role in determining the differential impacts of alternative tax rates on these two groups.

Together with (7), (12a), and (12b), we can solve (A.1a) - (A.1d) for domestic consumption (*C*), migrant consumption (*C*_m), domestic labor supply (*N*), and debt (*B*) as functions of the aggregate capital stock of the domestic economy (*K*), migrant labor supply (*N*_m), fraction of migrant workers (*m*), the host country's capital stock (*K*_h), and its native labor supply (*N*_h), as well as exogenous parameters, including the tax rates. Since these are not of any particular interest, but are only necessary to derive the macrodynamic equilibrium, they are relegated to Online Appendix B, where they are reported as eqs. (B.1a) – (B.1d).

The relevant dynamic equations pertaining to the domestic economy are also relegated to the Online Appendix. But one critical equation, obtained by substituting (14g) into (13b) is

$$\dot{m} = \frac{q-a}{h} \tag{16}$$

Equation (16) is the key relationship describing how the migration decision at each point of time is driven by the difference between the shadow value of migrating at that time, q(t), and the basic cost of migrating, a, with the rate of migration varying inversely to the marginal cost, h. As long as q(t) > a, there will be positive migration ($\dot{m}(t) > a$)

0), with "reverse migration" occurring whenever q(t) < a. This relationship will be recognized as being analogous to the corresponding relationship in the pioneering Harris and Todaro (1970) migration model.¹⁵

4.2. Host country

Using (2a), (2b) and (5), we can derive the short-run equilibrium conditions from (6a), (6b), and (6d) for the host country. These are reported in the Appendix as (A.2a) and (A.2 b) and are analogous to (A.1a) - (A.1 d), respectively. Together with (3), we can then solve these equations for C_h and B_h as functions of its capital stock, K_h , native labor supply, N_h , migrant workers, m, and migrant labor supply, N_m . Again, they are of no intrinsic interest and are therefore also relegated to Online Appendix B, where they are reported as (B.1e) and (B.1f), respectively.

4.3. Equilibrium dynamics

The Online Appendix spells out the details showing how the macroeconomic equilibrium linking the two economies can be summarized by an autonomous system of six dynamic equations in: (i) the domestic economy's aggregate capital stock, K, (ii) migrant labor supply, N_m , (iii) migrant workers, m, (iv) the shadow value of migration, q, (v) the host country's capital stock, K_h , and (vi) its native labor supply, N_h . Of these six dynamically evolving variables, m, K, and K_h are constrained to evolve gradually, while q, N_m , and N_h are free to respond instantaneously as new information becomes available. The numerical simulations presented in subsequent sections demonstrate that the system is characterized by three stable (negative) and three unstable (positive) eigenvalues, so that the macro equilibrium yields a unique stable saddle path. The stable solutions for K, N_m , m, q, K_h , and N_h can be written as set out in (B.7a)-(B.7f) in Online Appendix B, obtained by imposing the given initial values on K, m, and Kh. Having obtained the transitional paths as set out in (B.7a) - (B.7f), we can derive the implied dynamics of all the remaining variables in (B.1a) - (B.1f).

4.4. Steady state

In the long run, both economies converge to a steady state in which all variables are constant through time. The steady-state values, denoted by "~", are set out as eqs. (A.3) and (A.4) in Appendix A. Together they comprise 16 equations that jointly determine 11 steady-state values, \tilde{C}, \tilde{N} , $\tilde{L}, \tilde{C}_m, \tilde{N}_m, \tilde{L}_m, \tilde{m}, \tilde{q}, \tilde{R}, \tilde{K}, \tilde{B}$, pertaining to the home economy and 5 steadystate values, $\tilde{C}_h, \tilde{N}_h, \tilde{L}_h, \tilde{K}_h, \tilde{B}_h$, for the host economy. They indicate the sources of long-run inter-dependence between the two economies, and how they operate in both directions. Some go from production conditions in the host country influencing the home economy via their impact on remittances. Others reflect how structural changes and tax policies in the home economy that influence migrant workers, including their decision to migrate, will also impact the host economy.

5. Calibration

To obtain further insights, we calibrate the model to the data of a sample of labor-importing, advanced economies and labor-exporting, developing economies. To do so we need to specify functional forms, appropriate parameter values, as well as specifying more precisely the

¹⁵ That paper postulated the movement of labor between rural and urban areas to be proportional to the wage differential between the two sectors. Being based on intertemporal optimization, the current wage rate is replaced by the shadow value, which reflects the discounted present value of future earnings of a migrant worker; see also Turnovsky and Basher (2009) and Chatterjee and Turnovsky (2018) for analogous relationships describing the migration between the formal and informal sectors.

welfare measures used to evaluate specific shocks and policy responses.

5.1. Functional forms

We employ the following functional forms in the numerical simulations. The home country's utility functions for domestic households' ("stayers") and migrants' preferences are:

$$U(C,L) = \frac{1}{\gamma} (CL^{\sigma})^{\gamma}; \quad M(C_m, L_m) = \frac{1}{\gamma} (C_m L_m^{\sigma_m})^{\gamma}$$
(17a)

where σ, σ_m represents the relative importance of leisure in domestic residents' and migrants' utility, respectively. $1/(1-\gamma)$ is the intertemporal elasticity of substitution.

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

$$Y = A[\vartheta K^{\zeta} + (1-\vartheta)[(1-m)N]^{\zeta}]^{\frac{1}{\zeta}}$$
(17b)

where $-\infty < \zeta < 1$; $1/(1-\zeta)$ is the CES between the stock of domestic capital and domestic labor and $0 < \vartheta < 1$ is the relative intensity of capital used in production. *A* is the level of technology (TFP) of the domestic country. The interest rate faced by the domestic country's borrowers is¹⁶

$$r = r^* + e^{b(B/(Y+R))} - 1 \tag{17c}$$

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

The host country's utility function is analogous

$$V(C_h, L_h) = \frac{1}{\gamma} (C_h L_h^{\sigma})^{\gamma}$$
(18a)

The host country's production is specified by the two-stage, threeinput nested CES function

$$Y_{h} = A_{h} \left[\alpha_{k} K_{h}^{\varphi} + (1 - \alpha_{k}) \left[\alpha_{n} N_{h}^{\xi} + (1 - \alpha_{n}) \left(\theta(m) N_{m} \right)^{\xi} \right]^{\frac{\varphi}{\xi}} \right]^{\frac{\varphi}{\xi}}$$
(18b)

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

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

 $r_h = r^* + e^{d(B_h/Y_h)} - 1 \tag{18c}$

where d parameterizes the rate at which the borrowing premium increases with its debt position.

5.2. Welfare measures

A key issue is how migration and its response to different structural changes impacts the welfare of the different constituents in the two economies, namely the stayers and migrant workers of the home economy and the citizens of the host economy. To calculate the change in welfare on these constituent groups we use the conventional Hicksian measure of equivalent variation.

Details of the calculation of the various measures are provided in

Appendix A.3. We assume that the economy is initially in steady-state equilibrium and begin by considering the impact on the welfare of the typical individual, in the home economy and then aggregate over the groups of stayers and migrant workers, as well as residents of the host economy. We provide two sets of welfare measures. The first measures intertemporal welfare, which takes account of the welfare gains or losses along the transitional path as the economies evolve from the initial equilibrium to the new steady state. The other measure is the welfare gains across the steady states for each individual, each group, and each country. We regard both welfare measures as being of interest. The steady-state measure is more appropriate for comparing the long-run welfare of two economies experiencing the specified structural differences, while the intertemporal welfare measure is more relevant for a single economy as it transitions following the structural change.

5.3. Parameter values and benchmark steady-state equilibrium

Table 1 reports the parameter values used to obtain the benchmark steady-state equilibrium presented in Table 2. These parameters draw heavily on, and are generally consistent with, the relevant empirical evidence and yield a plausible benchmark equilibrium. The "host" country comprises the 5 Middle East countries, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates, which import large numbers of migrant workers from South Asian countries including Pakistan, Nepal, India, and Sri Lanka, as well as Bangladesh, the "home" country. We should emphasize with the imprecise nature of data pertaining to remittances and migrant workers, coupled with the substantial variations over time, it is impractical to calibrate the model by targeting specific moments. Rather, our objective is to use the available information to characterize an initial plausible equilibrium.

In the absence of any contrary evidence, we assume that the residents of the home and host countries share many common taste parameters. Thus individuals in both countries have the same intertemporal elasticity of substitution and the rate of time preference. The choice of $\gamma = -1.5$ implies an intertemporal elasticity of substitution of 0.4, which is well within the consensus range of estimates provided by the extensive meta-study Havranek et al. (2015). The value for the weight of leisure in the utility functions ($\sigma = 1.75$, $\sigma_m = 2.5$) yields consistent labor supplies for the two economies. The resulting equilibrium time allocation of native workers in the host country, $\tilde{N}_h = 0.3167$, is compatible with the time allocation typically assumed for advanced economies, associated with the real business cycle literature (see e.g. Cooley, 1995). The time allocation of workers in the home country, $\tilde{N} = 0.2575$, is consistent with the time use survey for Bangladesh (see Bangladesh Bureau of Statistics, 2013; Narasimhan and Pandey, 1999).

The common rate of time preference, β , is set at 5%, (plausible for developing and emerging economies) and with the world interest rate, r^* , at 3.5%, both economies are net debtors in long-run equilibrium. In either case, the long-run debt-GDP ratio is determined by the borrowing premium coefficient. Setting b = 0.05, the debt-GDP ratio for the home country (*B*/*Y*) is 31%, which is close to the recent Bangladesh experience. The recent debt-GDP ratios for the 5 Middle East countries vary extensively between around 30% for Saudi Arabia to 150% for Qatar. Setting d = 0.02, for the wealthy host country, as a reflection of its less risky nature, implies $B_h/Y_h = 74\%$. But we emphasize that our results are robust with respect to these two parameters.¹⁷

For the production of the domestic economy, setting $\zeta = -0.21$ yields an elasticity of substitution between its capital stock and labor equal to 0.82, consistent with Duffy and Papageorgiou's (2000) estimate for the developing countries. We set the depreciation rate at $\delta = 0.04$ and the level of technology (TFP) of its production at A = 1. The relative

 $^{^{16}}$ This functional form is widely adopted and by increasing *b* offers a convenient and flexible representation of increasing borrowing costs for numerical simulations.

¹⁷ This can be seen directly from (18c) in steady-state when the relationship reduces to $\beta - r^* = e^{d(B_h/Y_h)} - 1$.

Table 1Baseline parameter values.

Parameters of the benchmark economies
Common parameters for both countries:
Utility: $\beta = 0.05$; $\gamma = -1.5$; $\sigma = 1.75$
World interest rate and world price: $r^* = 0.035$; $p = 1$
Migrant workers
Utility: $\sigma_m = 2.5$
Migration cost: $a = 5$; $x = 0.15$; $h = 25$
Home country
Production: $A = 1$; $\vartheta = 0.23$; $\zeta = -0.21$; $\delta = 0.04$; $\varepsilon = 0.5$
Borrowing constraint: $b = 0.05$
Government: $g = 0.15$; $\tau_k = 0.25$; $\tau_c = 0.15$; $\tau_w = 0.3$; $\tau_m = 0$;
Host country
Production: $A_h = 5$; $\alpha_k = 0.28$; $\alpha_n = 0.88$; $\varphi = 0.04$; $\xi = -1$; $\theta_1 = 14$; $\theta_2 = 3$; $\delta_h = 0.04$
Borrowing constraint: $d = 0.02$

Steady-state	values	of 1	the	benchmark	economies

Benchmark steady-state equilibrium values										
Variables	Description	Benchmark	Data	Sources						
A. Home cou										
$\widetilde{K}/\widetilde{Y}$	Capital-output ratio	1.7120	2.121	PWT						
			[1.234–3.327]							
$\widetilde{C}/\widetilde{Y}$	Consumption-	0.8260	0.731	PWT						
~ . ~	output ratio	0.0005	[0.702–0.782]	1 A 7 - 1 -1						
R/Y	ratio	0.0305	0.036	World						
$\widetilde{\mathbf{R}} / \widetilde{\mathbf{V}}$	Debt-output ratio	0.3069	0.293	Dalik						
<i>B</i> / 1	Debt output luito	0.0000	[0.177-0.445]	WDI, 2022						
\widetilde{N}	Domestic labor	0.2575	0.252	DDC						
	supply		[0.217-0.287]	BBS						
<i></i>	Domostia wago roto	0.0227		(2013)						
W B Migrant v	vorkers	0.9227								
m	Fraction of migrant	0.0355	0.032	UN						
	workers		[0.023-0.045]							
\widetilde{N}_m	Migrant workers'	0.4344	Over 0.417	Daian						
	supply of labor			Najali et el						
				(2015)						
<i>w</i> _m	Migrant wage rate	1.9149		(2013)						
C. Host cour	ntry									
$\widetilde{K}_h / \widetilde{Y}_h$	Capital-output ratio	3.4880	2.823	PWT						
,			[1.247–7.439]							
$\widetilde{C}_h / \widetilde{Y}_h$	Consumption-	0.7261	0.328	PWT						
(0)	output ratio	0.0000	[0.086–0.793]							
$(\theta_1 + \alpha) \widetilde{a}$	Share of migrants in	0.6028	0.62	WDI, 2022						
$\tilde{\theta}_2 m$	Native labor supply	0 3167	[0.32-0.88]							
<i>w</i> _h	ivative labor suppry	0.0107	0.0 [0.00-0.40]	Cooley						
				(1995)						
\widetilde{w}_h	Native wage rate	9.5987								

Notes.

The remittance-GDP ratio is that from the Middle East which is calculated as 56% of total remittances.

Fraction of migrant workers in Bangladesh is the share of its labor force.

Bangladesh Bureau of Statistics (BBS, 2013) reports that Bangladeshi males work on average 6.9 h a day while females work 5.2 h a day.

Most data are taken from Penn World Table (PWT) for period 1990–2014 and World Bank's World Development Indicators Online for period 1991–2015. Remittance data come from World Bank's (2016) Bilateral Migration and Remittances Database for period 2010–2015 and migrant data come from the United Nations' International Migrant Stock Database – the 2017 Revision.

capital intensity is set at $\vartheta = 0.23$ to obtain a capital-output ratio of 1.7120, consistent with the data for Bangladesh that averaged about 2.1 and ranged between 1.23 and 3.3 between 1990 and 2014.

We set the migration/remittance cost x = 0.15, which is equivalent to 8 percent of the migrants' wage rate.¹⁸ This parameter is an important determinant of the rate of migration and since information on it is sparse we subject it to sensitivity analysis in Section 7. Setting a = 5 implies that in steady state 3.55% of home residents migrate to the host country providing a corresponding remittance-to-GDP ratio R/Y = 3.05%. These figures are consistent with the anecdotal fact that approximately 5% of Bangladeshis are migrant workers, with the recent total R/Y ratio averaging around 6.6%, but of whom only around 50–55% work in the identified set of Middle East countries.¹⁹

The domestic country's government consumption is set at 15% of output (g = 0.15), close to the recent Bangladeshi ratio of 15.3%, as reported by the Ministry of Finance. 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.²⁰ There are no taxes on remittances in these countries, so in the benchmark equilibrium $\tau_m = 0$.

For the host country's production function, the choice of $\varphi = 0.04$ yields an elasticity of substitution between capital and labor equal to 1.04, which is close to Duffy and Papageorgiou's (2000) estimate for richer countries. An important issue concerns the nature of the substitutability/complementarity relationship between migrant and native labor. Setting $\xi = -1$ implies an elasticity of substitution between migrant and native labor equal to 0.5, and treats them as complements, which is typical of the characterization of low-skilled migrant workers and appropriate in this context. However, as part of our sensitivity analysis in Section 7, we also vary ξ to allow for the possibility of the two

¹⁸ Evidence on the fraction of their earnings migrant workers remit home is sparse. The UN Department of Economic and Social Affairs' News on Remittances suggests anecdotally that it is around 15%. Figures reported by Yang (2011) indicate that it varies extensively across countries, exceeding well over 30% in many cases, but no figure for Bangladesh is provided. Setting x = 0.15 implies that Bangladeshis remit about 30% of their gross income. While this may seem high, we should keep in mind that we assume (as has been the case) that the host country does not impose income taxes. If, for example, the income earned by migrant workers in the host country were taxed at say 15%, the fraction of their gross income remitted would drop to around 15%.

¹⁹ There is substantial year-to-year variation in countries' (including Bangladesh) *R/Y* ratio. The *R/Y* ratio for Bangladesh averaged about 3% in the 1990s, increased dramatically to peak at 10.6% in 2012, then dropped to 5.4% in 2017 before increasing to 6.7% in 2020; see https://fred.stlouisfed.org/serie s/DDOI11BDA156NWDB.

²⁰ These tax rates are typical of 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.

types of labor being substitutes.

We set the level of technology of the host country's production at $A_h = 5, 5$ times that of the developing country. This implies a relative GDP ratio between the host and home country of about 17, which is generally consistent with the data.²¹ The relative capital intensity is set at $\alpha_k = 0.28$ to get a capital-output ratio of 3.50, which is consistent with the data for the Middle Eastern countries.²² Setting $\theta_2 = 3$, to account for the relative size of the home and host economies, and $\theta_1 = 14$ implies that the total ratio of migrant workers to native workers in the host country is 52.6%, while the share of total migrants from the home country is around 17.6%. These shares are typical of the Middle East economies.²³ The relative native labor intensity to migrant workers is set at $\alpha_n = 0.88$ to obtain the time allocation of migrant workers $\widetilde{N}_m =$ 0.4344. With $\tilde{N}_h = 0.3167$ this implies that around 45% of total labor is supplied by migrant workers, which is within the range of South Asian presence in the Middle East. The 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 h a day (Rajan et al., 2015).²

Given all the chosen parameters, the model produces the real wage for the domestic economy $\tilde{w} = 0.9227$, native real wage $\tilde{w}_h = 9.5987$, and the migrants' real wage $\tilde{w}_m = 1.9149$. These wage rates reflect the situation in the Middle East where most South Asian migrant workers are low-skilled while the natives are high-skilled professionals. The relative wage rates, $\tilde{w}_m/\tilde{w} = 2.08$ and $\tilde{w}_h/\tilde{w}_m = 5.01$, are consistent with the data. Using the wage rates reported in Rajan et al. (2015), the relative wage rates of Indian migrants to domestic labor for masons, carpenters, electrician, drivers, and housemaid range from 1.74 to 2.71.

One final aspect of the calibration concerns the speed of migration, which is the critical new feature of this model. Empirical evidence suggests that somewhere between 350,000 and 400,000 Bangladeshi workers migrate each year. With the stock of migrant workers being around 9-10 million, this suggests an annual migration rate of around 4-4.5%. The critical determinant of the migration rate is the marginal cost h, [see (16)], on which direct information is unavailable. Applying our simulations to (16) and assuming h = 25 suggests that during the first year following a 10% productivity increase in the host country, migration will increase by around 4.5%, generally consistent with the data. But we should also keep in mind that in our simulations this is a one shot increase, in response to which the rate of migration gradually declines over time, whereas the migration is ongoing. In fact, other shocks are continuously occurring suggesting that setting h = 25 is reasonable in tracking their impact on migration, at least during early stages.

6. Structural changes and policy responses

In this section, we examine the macroeconomic and welfare

 $^{22}\,$ Between 1990 and 2014, the capital-output ratio for Saudi Arabia averaged around 3.2 and for UAE around 3.5.

consequences of two structural changes that are likely to impinge directly on migrant workers. These include: (1) a productivity increase in the host country, and (2) the elimination of migration costs by the host economy. These structural changes are also accompanied by suggested possible fiscal policy responses undertaken by the home government to mitigate any adverse effects these structural changes may impose on their various constituents.

6.1. Productivity increase in host country of 10%

Strong economic growth in the Middle East for the past decades has attracted an influx of migrants, especially low-skilled labor, from many South Asian countries. This phenomenon has stimulated debate as to the development and welfare consequences for the home country. We examine this issue by considering a 10% increase in productivity (A_h) in the host country. The long-run consequences for key economic measures of the two economies are reported in Table 3, and the transitional dynamics are presented in Fig. 1a.

An increase in productivity (A_h) of the host country instantaneously increases the return to its capital and the wage rates for both native and migrant workers. As a result, the labor supply of current migrant workers (N_m) immediately increases, while additional migration, which occurs only gradually, starts to increase $(\dot{m}(0) > 0)$. With higher incomes, migrant workers immediately increase their consumption, as well as their remittances, the latter substantially, causing the R/Y ratio to increase to 4.2%. The internal household equilibrium condition, (A.1 b), causes the increase in N_m to put upward pressure on the domestic labor supply (N), so that the output of the home country immediately rises as well. Consequently, domestic residents respond by reducing leisure and consumption, although these initial domestic responses are extremely slight.

This early response is soon reversed. In the short run, the productivity increase in the host country, with its expectations of higher future wages, leads a dramatic increase in the shadow value, q, causing a rapid increase in the rate of migration. However, this tapers off rapidly as the flood of migrants causes a rapid decline in the migrant wage rate, which also causes the individual supply of migrant labor and migrant consumption, to decline with equal speed. Despite more migrant workers sending remittances, as the wage rate falls during the transition causing each individual migrant to send less, the net effect is a declining remittance-GDP ratio. The declining remittance-GDP ratio, coupled with the loss of domestic labor through migration, also leads to a decrease in domestic output and capital, though there is a slight uptick in the latter as the loss of labor due to migration tapers off. After about 6 years the marginal benefits of further migration, reflected in q have declined to slightly below the marginal migration costs a, h, causing some mild reverse migration and a general leveling off in the home economy.

In the long run, the remittance-GDP ratio settles at 3.32%, 0.27 percentage points higher than its initial steady-state level. This is entirely due to the extensive adjustment reflected in the increased migration and enables the staying residents in the home country to enjoy more consumption and leisure. Domestic consumption rises by 0.09% and leisure (domestic labor supply) increases (decreases) by 0.06 percentage points. As a result, comparing steady states, individual stayer's welfare increases by 0.24%, but the collective welfare of stayers falls by 0.08%, as more workers have moved abroad.

In the new steady state individual migrant consumption and leisure increase slightly, implying that each individual enjoys a small steady-state welfare gain of 0.22%. The substantial increase in migration, 0.30 percentage points or 8.45%, (and which also reflects some slight reverse migration) means that their collective welfare improvement across steady states is 8.72%. However, the transition is associated with large increases in migrant labor supply (decreases in leisure) that occur during its early stages. These dominate the modest steady-state welfare gains, and individuals who migrate at time 0 suffer an intertemporal welfare loss of 0.31%. Those migrating later in the transition supply less

²¹ While the per capita GDP in terms of PPP of Bangladesh has grown steadily over the last several decades, that of the Gulf countries has fluctuated substantially, causing extensive variations in the GDP ratios. Over the period 2011–2020, the ratio of the annual GDP of Saudi Arabia and the UAE, (the two largest countries of our Middle East group) to that of Bangladesh averaged 13.4 and 17.5 respectively, with corresponding standard deviations of 5.1 and 5.3. The mean of the GDP ratio of Qatar, the richest country, was 29.0 with a standard deviation 14.2; see https://data.worldbank.org/indicator/.

²³ In 2017, the share of international migrant workers ranged from 25% in Saudi Arabia to 77% in United Arab Emirates and the share of migrant workers from Bangladesh to Saudi Arabia and UAE was 10% and 13%, respectively (United Nations, 2017).

²⁴ Note N_m for migrant workers is highly sensitive to σ_m . Setting $\sigma_m = 2.5$ is motivated by the desire to target an equilibrium value for N_m that is closer to the empirical evidence cited by Rajan et al. (2015).

Table 3 Increase in productivity of the host country A_h by 10%.

	A. Home country (Stayers) B. Migrant workers									Tot	al welfare			
	R/Y	K	Y	С	Ν	$\Delta \omega_d \ \Delta \omega_d^s$	ΔW_d ΔW^s_d	m	Cm	N _m	$\Delta \omega_m \ \Delta \omega_m^s$	ΔW_m ΔW_m^s	ΔW ΔW	2
Benchmark	3.05%	0.4939	0.2885	0.2383	25.75%	_	_	3.55%	0.4333	43.44%	-	-	-	
(i) Increase in h	ost country produ	ctivity rowhead	d											
$\Delta Ah = +$	3.32%	0.4911	0.2868	0.2385	25.69%	+0.02%	+0.24%	3.85%	0.4337	43.41%	-0.31	% -5.79	% +0.	03%
10%	(+0.27%pts)	(-0.56%)	(-0.56%)	(+0.09%)	(-0.06%pts)	+0.24%	-0.08%	(+0.30%pts)	(+0.10%) (-0.03%pts	s) +0.22 ^e	% +8.72	% +0.	24%
(ii) Policy respo	nses rowhead													
$\tau_w: 30\% {\rightarrow}$	2.97%	0.5199	0.3037	0.2506	27.11%	+0.74%	+0.81%	3.56%	0.4451	43.28%	+1.63%	-0.27%	+0.77%	
25%	(-0.08%pts)	(+5.27%)	(+5.27%)	(+5.18%)	(+1.36%pts)	+1.83%	+1.82%	(+0.01%pts)	(+2.74%)	(-0.15%pts)	+3.44%	+3.73%	+1.89%	
$\tau_k: 25\% \rightarrow$	3.06%	0.5677	0.2990	0.2451	26.04	-0.83%	-0.82%	3.69%	0.4412	43.21%	-1.78%	-2.05%	-0.86%	
15%	(+0.01%pts)	(+14.9%)	(+3.65%)	(+2.85%)	(+0.29%pts)	+2.16%	+2.00%	(+0.14%pts)	(+1.83%)	(-0.22%)	+2.84%	+7.03%	+2.18%	
$\tau_m: 0\% \rightarrow 15\%$	2.91%	0.4939	0.2897	0.2382	25.79%	+0.11%	+0.09%	3.27%	0.4576	43.08%	+7.52%	+8.02%	+0.37%	
	(-0.14%pts)	(+0.42%)	(+0.42%)	(-0.05%)	(+0.03%pts)	-0.12%	+0.16%	(-0.28%pts)	(+5.61%)	(-0.36%pts)	+7.30%	-1.06%	+0.12%	
						C. I	lost country							
			K	1		Y_h		(C _h		N _h			ΔW_h ΔW_h^s
Benchmark			18	3.003	-	5.1615		3.7479			31.67%			_
(i) Increase in host country productivity $\Delta Ah = +10\%$		21	21.050 (+16.92%)		6.0111 (+16.46%)		4.4015 (+17.44%)			31.69% (+0.02%pts)			+8.45% +17.39%	
(ii) Policy responses $\tau_w: 30\% \rightarrow 25\%$		21.007 (+16.68%)			5.9988 (+	5.9988 (+16.22%)		4.3860 (+17.03%)			31.68% (+0.01%pts)			
$\tau_k:25\%{\rightarrow}15\%$			21	21.026 (+16.79%)		6.0041 (+	6.0041 (+16.32%)		4.3926 (+17.20%)		31.68% (+0.01%pts)			+7.64% +17.16%
$\tau_m: 0\%{ o}15\%$			20	0.963 (+16.44%)	5.9862 (+	-15.98%)	2	4.3702 (+16.60%)		31.67% (+0.0	0%pts)		+7.55% +16.60%





labor and suffer smaller welfare losses, which collectively aggregate to 5.79%.

Thus, the productivity increase in the host country has mixed welfare implications for the home economy. From a steady-state perspective individual stayer and migrants would both benefit. Collectively, due to migration the latter would gain at the cost of the former, but with a net gain to the home economy. However, taking into account the substantial impact on the labor supply of migrants during the transition, these relative welfare effects are reduced intertemporally, with an overall increase in the home economy's intertemporal welfare of just 0.03%. Comparing these responses to those obtained by Lim et al. (2021) for fixed migrant workers highlights the importance of endogenizing the migration process. While the earlier study also found a loss in migrant workers' intertemporal welfare, it is sensitive to the elasticity of migrant labor supply. In the extreme case that the migrant supply of labor is inelastic, the increase in migrant consumption would ensure a slight welfare increase for migrant workers. But the key difference here is due to the influx of migrant workers to the host country, depressing the migrant wage rate over time, and thus individual migrant consumption. Also, in sharp contrast to the earlier analysis, where virtually all



Fig. 1. (continued).

responses occur on impact, the gradual migration process introduces dramatic differences between the short-run and long-run welfare consequences.

The fact that some constituents are adversely impacted by the productivity increase raises the question of appropriate policy responses directed to alleviate this outcome. One natural response is to reduce the domestic labor income tax to say 25%. This raises the net wage earned by stayers, leading to an immediate increase in domestic labor supply that is maintained over the duration of the transition. It also slows down the rate of migration, which continues until the reduction in the migrant wage renders further migration unbeneficial and a portion of migrant workers return to the home economy, leaving the long-run stock of migrants virtually unchanged (3.56% vs. 3.55%). As a result, the migrant wage rate remains high in the new steady state, which leads to a substantial increase in migrant consumption. Thus, individual migrant workers enjoy substantially higher steady-state and intertemporal welfare. The substantial increase in domestic output due to the increased domestic labor supply increases domestic consumption, despite the fact that the lower tax rate induces migrants to reduce their remittances, thereby lowering the remittance-GDP ratio. The net effect is that all agents in the home country enjoy welfare gains both in steady state and intertemporally.

As already noted, another direct adverse consequence of the productivity increase in the host country is that the long-run stock of capital in the home economy declines. While this can be neutralized by reducing the tax on labor, a more direct approach is to reduce the capital income tax. As Fig. 1 illustrates, cutting the capital income tax to say 15% leads to a very different dynamic adjustment. By raising the net return to domestic capital it encourages domestic investment. This causes an instant reduction in domestic consumption for investment, as well as in leisure for domestic labor supply. As the capital stock rises over time, so does domestic output, thus benefiting the domestic residents as consumption increases with leisure. Consequently, the steadystate welfare for domestic residents increases, though with reduced consumption at early stages, coupled with the increase in labor supply, they experience lower intertemporal welfare.

A striking aspect of the reduction in τ_k , is the response of the rate of migration, which initially declines before sharply increasing and converging to a higher long-run stock of migrant workers. This reversal is a result of two opposing influences. While the tax cut and resulting increase in domestic capital and higher wage discourages migration, the productivity increase abroad has the opposite impact. With the full effects of the productivity increase taking time, the first effect initially dominates, but after a few periods the latter prevails. In the long run, the decrease in the domestic tax on capital enables migrant to increase consumption and leisure, thereby increasing their steady-state welfare. However, the increase in labor supply particularly during the early stages of the transition means that, despite their long-run gains, migrant workers' intertemporal welfare declines.

The issue of whether remittances should be taxed has long been a controversial one. According to the Philippine Overseas Employment Administration the elimination of the remittance tax, also known as the documentary stamp tax (DST) in 1995 has cost an estimated \$1.3 billion to the annual budget. To reassess the broader welfare consequences of this policy, we consider the impact of setting the remittance tax at 15%. Doing so would discourage labor migration, and have a small positive impact on the output and the welfare of the domestic stayers. None-theless, by discouraging remittances, it encourages migrant workers to keep more of their income, thereby significantly increasing their consumption and thus their welfare, with an overall slight welfare gain to the home economy.

To summarize: of these three policy responses, reducing the domestic labor income tax, τ_w , and raising the tax on remittances, τ_m , benefit both domestic stayers and migrant workers by sharing the gains from the host country's productivity increase. As one would expect, the home country's policy response has only minimal impact on the host country, leading to slight reductions in output and welfare gains due to return migration of some workers.²⁵ In all cases, the marginal migration decisions both to the productivity increase in the host economy and to the alternative policy responses, are driven entirely through their impact on the relative benefit of migration, q, as these compare to the marginal costs, in accordance with (16).

6.2. Elimination of migration cost

The United Nations and World Bank have actively worked with the governments of developing countries as well as their private sectors to improve the migration process and reduce the cost of sending remittances. These objectives are stipulated in one of the UN Sustainable Development Goals. While it seems apparent that worker migration has benefited advanced economies, especially those experiencing labor shortages, countries such as the United States and United Kingdom are concerned about their immigration policies favoring migrant workers and enabling them to take over their own citizens' jobs. At the same time, the evidence that it has also benefited migrants' countries of origin, is mixed. Our model enables us to address this issue from the perspective of the elimination of migrant/remittance costs, and to consider appropriate policy responses by the government of the developing country that would benefit the residents in both economies. The results are reported in Table 4 and transitional dynamics are presented in Fig. 2.

The elimination of the migration cost, that is a reduction in x from 0.15 to 0, leads to an immediate increase in the rate of migration, causing a rapid decline in the migrant wage rate and in their individual labor supply.²⁶ As a result, each individual migrant reduces his rate of consumption. The net effect is to enable each migrant to send more remittances, which with the increased number of migrants, leads to a large short-term increase in the remittance-GDP ratio, although it declines rapidly over time with the declining wage.

In the long run, migrant stock increases from 3.55% to 4.54%, causing the host country's output to increase by 1.87% and a consumption increase of 3.23%, as well as a comparable increase in its welfare. Native labor supply also increases by 0.07 percentage points, reflecting the assumption that migrant and native workers are complements in host production and belying the suggestion that migrants are usurping the jobs of natives, consistent with the empirical evidence provided by Peri (2014).

The long-run impact of the elimination of migration costs on the home economy is mixed. Individual migrant workers enjoy both intertemporal and steady-state welfare gains of 7.20% and 9.15%, respectively. This is despite the fact that their consumption falls as increased migration depresses their wage rate, and reflects the fact that they enjoy more leisure, which increases by 5.04 percentage points. But with the loss of migrant workers, home output declines by about 1.35%, while the capital stock, following an initial precipitous decline, partially recovers during the latter part of the transition. This response reflects the rapidity of the initial increase in migration followed by its abrupt tapering off. Consumption increases as a result of increased remittances, which also enable staying residents to enjoy more leisure. Therefore, individual stayers' steady-state welfare increases although their collective welfare declines as more workers are now living abroad.

Of the policy responses, reducing the domestic labor income tax, τ_w , benefits both domestic stayers and migrant workers, improving their intertemporal welfare and increasing the overall welfare of the home economy. This is because it slows down the increased rate of migration resulting from the elimination of migration costs; it also slows down the reduction in migrant consumption. As a result, migrants' aggregate intertemporal welfare improves 4.34%, compared to a 7.19% welfare loss without any policy intervention. In addition, the policy response increases domestic output by 4.65%, and the aggregate intertemporal welfare of the stayers by 0.51%. The effect of responding by raising a tax on remittances depends upon the level at which it is imposed. This can be seen by considering after-tax remittances, $(1 - \tau_m)R$, and observing that the direct effect of increasing τ_m is to offset that of reducing *x*. If τ_m is sufficiently large, say 20%, both domestic output and capital stock

²⁵ All of these responses raise the government budget and require an increase in the lump-sum tax (debt) to maintain budget balance. In an earlier version of this paper we show how a combination policy of financing a cut in the domestic labor income tax rate to 28.8% accompanied by a tax on remittances of 20% leaves the government budget unchanged while yielding output growth and welfare gains for all domestic constituents.

²⁶ We assume that the elimination of the migration cost imposed by the host country applies to all its migrant workers.

Table 4 Elimination of migration cost in the host country *x*.

	A. Home country (Stayers)								B. Migrant workers					
	R/Y	K	Y	С	Ν	$\Delta \omega_d \ \Delta \omega^s_d$	ΔW_d ΔW_d^s	m	Cm	Nm	$\Delta \omega_m \ \Delta \omega_m^s$	ΔW_m ΔW_m^s	ΔW ΔW^{s}	
Benchmark	3.05%	0.4939	0.2885	0.2383	25.75%	-	-	3.55%	0.4333	43.44%	-	-	_	
(i) Decrease in	migration cost row	head												
$\Delta x = - 0.15$	3.40% (+0.35% pts)	0.4872 (-1.35%)	0.2846 (-1.35%)	0.2385 (+0.11%)	25.67% (-0.08%pts)	-0.47% +0.31%	$^{+0.13\%}_{-0.73\%}$	4.54% (+0.99% pts)	0.3821 (-11.8%)	38.40% (-5.04% pts)	+7.20% +9.15%	-7.19% + 39.8%	-0.73% +0.71%	
(ii) Policy responses $\tau_w : 30\% \rightarrow 25\%$ $\tau_k : 25\% \rightarrow 15\%$ $\tau_m : 0\% \rightarrow 15\%$	Dispess rowhead 2.99% (-0.06% pts) 3.10% (+0.05% pts) 2.87% (-0.18% pts)	0.5168 (+4.65%) 0.5637 (+14.1%) 0.4939 (+ 0.00%)	$\begin{matrix} 0.3019 \\ (+4.65\%) \\ 0.2969 \\ (+2.93\%) \\ 0.2885 \\ (+0.00\%) \end{matrix}$	$\begin{array}{c} 0.2506 \\ (+5.18\%) \\ 0.2451 \\ (+2.86\%) \\ 0.2381 \\ (-0.01\%) \end{array}$	$\begin{array}{c} 27.11\% \\ (+1.36\% \text{pts}) \\ 26.03\% \\ (+0.28\% \text{pts}) \\ 25.80\% \\ (+0.05\% \text{pts}) \end{array}$	+0.32% +1.84% -1.18% +2.20% -0.34% -0.16%	+0.51% +1.24% -1.10% +1.37% -0.25% -0.33%	4.11% (+0.57% pts) 4.33% (+0.78% pts) 3.71% (+0.16% pts) <i>C_h</i>	$\begin{array}{c} 0.3932 \\ (-9.24\%) \\ 0.3891 \\ (-10.2\%) \\ 0.4053 \\ (-6.46\%) \end{array}$	38.39% (-5.04% pts) 38.24% (-5.20%) 38.29% (-5.15% pts) N _h	+9.61% +12.4% +5.94% +11.9% +15.9% +16.3%	+4.34% +30.4% +3.65% +36.4% +13.2% +21.6%	$\begin{array}{c} +0.64\% \\ +2.28\% \\ -0.93\% \\ +2.62\% \\ +0.23\% \\ +0.45\% \end{array}$	
Benchmark			18.003	_	5.1615			3.7479	-	31.67%				
(i) Decrease in $\Delta x = -0.15$ (ii) Policy respo	migration cost		18.339 (+1.879 18.296 (+1.629	6) 6)	5.2578 (+1.8	57%) 52%)		3.8689 (+3.23%) 3.8531 (+2.81%))	31.74% (+0.07 31.73% (+0.06	7%pts) 5%pts)		+2.64% +3.05% +1.66%	
$\tau_w: 30\% \rightarrow 25\%$ $\tau_k: 25\% \rightarrow 15\%$	6		18.316 (+1.73%	6)	5.2510 (+1.7	'3%)		3.8603 (+3.00%))	31.73% (+0.06	5%pts)		$^{+2.65\%}_{+1.56\%}$ $^{+2.84\%}_{-2.84\%}$	
$\tau_m:0\%{\rightarrow}15\%$			18.252 (+1.38%	6)	5.2328 (+1.3	8%)		3.8373 (+2.38%))	31.72% (+0.05	5%pts)		+1.50% +2.25%	



Fig. 2. Reduction in migration cost & policy responses.

increase in the long run, by almost 0.5 percentage points each, although consumption now declines slightly. $^{\rm 27}$

While these tax policy responses create welfare improvement for the home economy, they have at most extremely mild adverse effects on the host country, which can still enjoy the benefits from the elimination of the migration cost. This is because of the complementarity between

²⁷ More detailed discussion of the changing impact of τ_m as it varies is provided in an expanded version of this paper.

migrant and native workers in the host production function. The increase in the native labor supply N_h increases the host output as well as its welfare by at least about 1%, even if some of the policy interventions leave smaller migrant stock in the long run.

7. Some robustness checks

In carrying out the numerical simulations we have experimented extensively with alternative parameter values, particularly those pertaining to the number and role of migrant worker, for which the data are



Fig. 2. (continued).

quite imprecise. Overall, the qualitative results summarized in Tables 3 and 4 are generally robust and we therefore present them with some confidence. But inevitably results there is sensitivity to the calibrated parameters.

One critical assumption is that the migrant workers and native workers in the host country are complements ($\xi = -1$). Given that

migrants to the Gulf States from South Asia are mostly unskilled, hired to do jobs that the skilled native workers do not wish to do, this assumption is appropriate. Nevertheless, migrants may offer a range of skills, and as a robustness check we briefly consider the case where the migrant and native workers in the host country are substitutes, by setting $\xi = 0.5$ in the host country production function. This implies an elasticity of sub-

Table 5

Robustness checks.

	A. Home co	ountry (Stayers)					B. Migrant workers						
	R/Y	Y	С	Ν	$\Delta \omega_d \ \Delta \omega^s_d$	ΔW_d ΔW^s_d	m	Cm	N _m	$\Delta \omega_m \ \Delta \omega_m^s$	ΔW_m ΔW^s_m	ΔW ΔW^{s}	
(a) $\xi = 0.5$													
Benchmark values	1.76%	0.2964	0.2373	26.06%	-	-	2.07%	0.4311	43.57%	-	-	-	
(i). $\Delta Ah =$	2.40%	0.2924	0.2378	25.91%	-0.01%	+0.36%	2.80%	0.4322	43.50%	-0.47%	-14.8%	+0.05%	
+ 10%	(+0.64% pts)	(-1.34%)	(+0.21%)	(-0.15% pts)	+0.57%	-0.18%	(+0.73% pts)	(+0.25%)	(–0.07% pts)	+0.54%	+36.0%	+0.57%	
(ii). $\Delta x = -$	2.77%	0.2887	0.2381	25.82%	-0.40%	+0.51%	3.72%	0.3812	38.47%	+6.88%	-23.0%	+0.02%	
0.15	(+1.01% pts)	(-2.60%)	(+0.33%)	(-0.24% pts)	+0.91%	-0.79%	(+1.65% pts)	(-11.6%)	(–5.10% pts)	+9.77%	+97.1%	+1.24%	
(b) $x = 0.8$													
Benchmark values	2.50%	0.2944	0.2379	25.89%	-	-	2.07%	0.5917	54.16%	-	-	-	
(i). $\Delta Ah =$	2.73%	0.2932	0.2380	25.83%	+0.07%	+0.21%	2.25%	0.5922	54.14%	-0.11%	-6.14%	+0.08%	
+ 10%	(+0.23%)	(-0.40%)	(+0.07%)	(-0.06%	+0.20%	+0.02%	(+0.18%	(+0.09%)	(-0.02%)	+0.20%	+9.16%	+0.20%	
	pts)			pts)			pts)		pts)				
(ii). $\Delta x = -$	2.58%	0.2936	0.2379	25.87%	-0.11%	+0.01%	2.26%	0.5603	52.45%	+3.43%	-2.30%	-0.08%	
0.15	(+0.08%	(-0.27%)	(+0.02%)	(-0.02%	+0.07%	-0.13%	(+0.19%	(-5.30%)	(-1.71%	+3.78%	+13.4%	+0.15%	
	pts)			pts)			pts)		pts)				
		C. Hos	st country										
		Y_h			C_h			N_h				$\Delta \omega_h$ $\Delta \omega_h^s$	
(a) $\xi = 0.5 \text{ rowh}$	ead												
Benchmark val	lues	4.948	2		3.7802		31.92%				-		
(1). $\Delta An = +$	$\Delta Ah = +$ 5.8442 (+18.11%)			4.4110 (+16.69%)			31.84% (-0.08%pts)				+7.99%		
(ii). $\Delta x = -0$	0.15	5.159	7 (+4.27%)		3.8705 (+2	2.39%)		31.83% (-0.09%pts)				+1.46%	
(b) 0.0	d											+2.62%	
(D) $x = 0.8$ rown Benchmark val	lues	4 975			3 3080				21 /6%				
(i) $\Delta Ah = +$	lues	5.703	2 5 (+16 99%)		4.0225 (+1	8 35%)		31,49% (+0.0)	34%nts)			- +9.044%	
10%		0.700	5 (110.5570)		1.0220 (+.	0.0070)		01.1970 (10.00	5170213)			+18.25%	
(ii). $\Delta x = -0$	0.15	4.930	7 (+1.14%)		3.4652 (+1	1.95%)		31.50% (+0.04	4%pts)			$^{+1.79\%}_{+1.84\%}$	

stitution between migrant and native workers of 2, consistent with Cortes's (2008) estimate for the low-skilled migrants in the U.S. Panel (a) of Table 5 briefly summarizes the main long-run effects of the two changes addressed in Section 6. The checks are performed for the two shocks alone, without the policy responses.

First, increasing ξ from -1 to 0.5, in isolation, will in general produce a new initial steady-state equilibrium, though most variables are subject to only minor deviations from our initial benchmark. The main difference is that a much smaller fraction of the developing economy's population would be migrants (2.07% vs. 3.55%), which as a result would receive a smaller fraction of remittances. This reflects the fact that with migrants now competing with natives, they will receive a lower wage. But since these numbers grossly understate the actual data, this supports our assumption of treating migrant workers and native workers as complements.²⁸

Comparing the top row in Panel (a) in Table 5 with the corresponding rows in Tables 3 and 4 it is seen that the responses to the structural changes are generally qualitatively similar to those of the benchmark, but substantially larger in magnitude. A 10% increase in the host country's productivity results in an increase in migrant stock of 0.73 percentage points (vs 0.3 percentage points in Table 3), leading to the output contraction in the developing economy of 1.34% (vs 0.56% in Table 3). The large increase in the migrant stock means that the overall collective migrants' welfare is greatly increased, while the losses to stayers is exacerbated, but overall steady-state welfare to the home country is increased. But the most striking difference introduced when migrants are substitutes is felt by the host country, where the influx of migrant workers in response to the productivity increase does indeed cause native workers to reduce their employment by 0.07 percentage points. In the case the concern of native workers losing jobs to migrants is justified although the loss is small.

The elimination of migration cost results in an increase in migrant stock by 1.65 percentage points (vs one percentage point in Table 4), leading to the home output contraction by 2.6% (vs 1.3% in Table 4). A similar magnitude is observed for the effects on consumption and leisure of domestic residents (stayers) and migrant workers. As a result, the steady-state welfare gains from migration due to the shocks are also larger in the case of migrant-native substitutes than for complements. However, it is opposite for the host country. Because of migrant-native labor being substitutes rather than complements, the shocks generate a native labor supply reduction. The natives enjoy more leisure, but less increase in consumption as more capital is needed with larger stock of migrant workers. As a result, the host country enjoys a smaller welfare gain, but larger increase in aggregate output.

As noted earlier (footnote 18), the choice of x = 0.15 implies that migrant workers send about 30% of their income home. The UN reports that remittances account for only 15% of what migrants earn. In addition to the points already raised, we should be aware that migrant workers also remit their money to their families through informal channels and some even carry with them when they return. In any event, to check the sensitivity of our results to this chosen parameter value, we

²⁸ This change in initial equilibrium is an endemic problem in conducting sensitivity analysis. Ideally, in order to determine the sensitivity to ξ one should start from the same initial equilibrium and in order to do so one needs to change some other parameter(s) to compensate for the change in ξ . Doing this then raises the problem of identifying whether the sensitivity being studied is reflecting the change in ξ or in the other compensating parameter(s). We do not attempt to resolve this issue here, but simply draw attention to it.

choose x = 0.8, which implies a remittance share of 20% of migrants' income. The steady-state values for migrant stock and remittance-GDP ratio reported in Panel (b) of Table 5 are in the lower range of the data for Bangladesh as reported in Table 2. In addition, the results for the impact of both shocks, the host country's productivity increase and the elimination of migration cost, on the aggregate economies and the welfares of both countries are consistent with our main results, suggesting that the results are generally robust with respect to the specific value of *x*. Fig. 2

Finally, since a central aspect of our setup is the rate of migration, we have conducted simulations in which the crucial parameter h varies between 15 and 100, which spans a first year migration rate of between around 5.6% and 2.8%. Fig. A, in Online Appendix C, indicates that our results are robust with respect to the variation in h. Furthermore, contrasting them with the corresponding figure in Lim et al. (2021) which focuses only the intensive margin of adjustment by migrants, underscores the importance of endogenizing the migration process itself.

8. Conclusions

The 21st century has witnessed a dramatic increase in both the number of migrant workers and in the world-wide average ratio of remittances to GDP. Particularly notable has been the increased migration of low-skilled workers from South Asian countries to the wealthy Middle East Gulf states. The impact of remittances on the recipient country's economy is potentially far-reaching, and this situation has led to a rapidly expanding literature focusing on better understanding the consequences.

This paper has introduced two key features that thus far have received virtually no treatment in the existing literature. The first is to address the issue within a general equilibrium framework linking the host and home economies. This is important because the significance of migrant workers and their remittances creates an intimate connection between the two economies, and viewing this from a more integrated standpoint enhances our understanding of the process. Second, and most importantly, we endogenize the migration decision as part of the intertemporal utility maximization decision made by the household, seeking to take advantage of superior employment opportunities in wealthier countries abroad. The importance of adopting this approach is that it enables us to capture the gradual process of migration, during which the changing circumstances may lead to fundamentally different effects from those based on treating remittances as exogenous. In particular, the flexibility of the setup can easily generate the process of reverse migration, commonly experienced, as circumstances in the home economy improve.

Having calibrated the model to reflect the Bangladesh-Middle East remittance-migrant worker relationship, we have considered two sources of structural change that impinge directly on this relationship. These include: (i) a productivity increase in the host economy that will attract migrant workers, and (ii) the elimination of migration costs by the host economy. As is evident from the analysis in Section 6, both of these structural changes bring into play different elements driving the responses of the different agents.²⁹ But in both cases the long-run impact on the remittance-GDP ratio differs markedly from the immediate response, partially offsetting it, as a consequence of the impact on migration that occurs during the transition.

Much of the emphasis has been on the welfare implications. Whether the home country benefits from sending migrant workers abroad is unclear, and depends upon the underlying driving force and the time horizon. The complications arise because migrants and stayers are impacted differently, while their relative sizes are constantly changing with migration. In the most common case where higher productivity in the host country is the driving force underlying the migration, both individual migrant workers and stayers would be better off from a steadystate viewpoint, but losses due to reduced consumption and leisure incurred during the transition outweigh these gains from an intertemporal perspective. But by introducing relatively minor changes to tax rates the transition can be adjusted so that both stayers' and migrants' welfare is improved unambiguously.

Policies directly aimed at encouraging migration, such as eliminating ongoing migration costs, always benefit the host country and while they may adversely impact stayers, again by taxing remittances the home government can redistribute the benefits so that both domestic constituents are made better off without any serious adverse consequences for the host economy.

Authors statement

The authors have no financial interests or conflicts of interest related to this research project.

Data availability

No data was used for the research described in the article.

Appendix

A.1 Macrodynamic equilibrium

This section summarizes the key relationships characterizing the macrodynamic equilibrium. Substituting (2c), (9a), (9 b), and (10) into (14a) - (14e) we can derive the following short-run equilibrium conditions characterizing the home economy:

$\frac{U_L(C,L)}{U_C(C,L)} = \frac{1-\tau_w}{1+\tau_c} F_{(1-m)N}(K,(1-m)N)$	(A.1a)
$\frac{M_{C_m}(C_m,L_m)}{U_C(C,L)} = \frac{1-\tau_m}{1+\tau_c}$	(A.1b)

$$\frac{M_{L_m}(C_m, L_m)}{M_{C_m}(C_m, L_m)} = pf_{\theta(m)N_m}(K_h, N_h, \theta(m)N_m)$$
(A.1c)

 $(1 - \tau_k)F_K(K, (1 - m)N) - \delta = r(B, K, m, N, R)$ (A.1d)
As previously noted, jointly with eqs. (7), (12a) and (12b) we can solve (A.1a – A.1 d) for *C*, *C*_m, *N*, and *B*, as functions of *K*, *N*_m, *m*, *K*_h, and *N*_h.

²⁹ In an expanded version of this paper we also consider the impact of a productivity increase in the home country, with different elements impacting different agents, including the decision to migrate.

reported as eqs. (B.1a) – (B.1 d) in Online Appendix B.

Analogously, using (2a), (2b), and (5), we can derive the following equations from (6a), (6b), and (6d), characterizing equilibrium in the host country:

$$\frac{V_{L_h}(C_h, L_h)}{V_{C_h}(C_h, L_h)} = pf_{N_h}(K_h, N_h, \theta N_m)$$
(A.2a)

$$pf_{K_h}(K_h, N_h, \theta(m)N_m) - \delta_h = r_h(B_h, K_h, N_h, \theta(m)N_m)$$
(A.2b)

Together with (3), we can then solve these equations for C_h and B_h as functions of, K_h , N_h , m_h and N_m , which appear as eqs. (B.1e) and (B.1f) in Online Appendix B.

Starting from (A.1), (A.2), Online Appendix B then describes the formal derivation of the macroeconomic equilibrium linking the two economies and shows how it can be summarized by an autonomous system of six dynamic equations in: K, N_m , m, q, K_h , N_h .

A.2 Steady state

In the long run, both economies converge to a steady state in which all variables remain constant through time. The steady-state values, denoted by "~", are obtained by setting $\dot{K} = \dot{N}_m = \dot{m} = \dot{q} = \dot{K}_h = \dot{N}_h = \dot{B} = \dot{B}_h = \dot{\lambda} = \dot{\pi} = 0$ in the relevant equations. This results in the following relationships pertinent to the home and host economies, respectively:

A.2.1 Domestic economy

$$\frac{U_L(\widetilde{C},\widetilde{L})}{U_C(\widetilde{C},\widetilde{L})} = \frac{1 - \tau_w}{1 + \tau_c} F_{(1-m)N}(\widetilde{K}, (1-\widetilde{m})\widetilde{N})$$
(A.3a)

$$\frac{M_{C_m}(\widetilde{C}_m, \widetilde{L}_m)}{U_C(\widetilde{C}, \widetilde{L})} = \frac{1 - \tau_m}{1 + \tau_c}$$
(A.3b)

$$\frac{M_{L_m}(\widetilde{C}_m,\widetilde{L}_m)}{M_{C_m}(\widetilde{C}_m,\widetilde{L}_m)} = pf_{\theta(m)N_m}(\widetilde{K}_h,\widetilde{N}_h,\theta(\widetilde{m})\widetilde{N}_m)$$
(A.3c)

$$\frac{M(\widetilde{C}_{m},\widetilde{L}_{m}) - U(\widetilde{C},\widetilde{L})}{U_{C}(\widetilde{C},\widetilde{L})}(1+\tau_{c}) - \left[(1-\tau_{w})F_{(1-m)N}\widetilde{N} - (1+\tau_{c})\widetilde{C}\right] + (1-\tau_{m})\left(pf_{\theta(m)N_{m}}\widetilde{N}_{m} - x - \widetilde{C}_{m}\right) = a\beta$$
(A.3d)

$$\beta = r^* + \Gamma\left(\frac{\widetilde{B}}{F(\widetilde{K}, (1-\widetilde{m})\widetilde{N}) + \widetilde{R}}\right) = (1 - \tau_k)F_K(\widetilde{K}, (1-\widetilde{m})\widetilde{N}) - \delta$$
(A.3e)

$$\widetilde{R} = \widetilde{m} \left(p f_{\theta(m)N_m}(\widetilde{K}_h, \widetilde{N}_h, \theta(\widetilde{m})\widetilde{N}_m)\widetilde{N}_m - x - \widetilde{C}_m \right)$$
(A.3f)

$$\widetilde{q} = a$$
 (A.3g)

$$\widetilde{N} + \widetilde{L} = 1 \tag{A.3h}$$

$$N_m + L_m = 1 \tag{A.3i}$$

$$\beta B + (1 - \tilde{m})C + \delta K = (1 - g)F(K, (1 - \tilde{m})N) + \widetilde{m} \left(pf_{\theta(m)N_m}(\widetilde{K}_h, \widetilde{N}_h, \theta(\widetilde{m})\widetilde{N}_m)\widetilde{N}_m - x - \widetilde{C}_m \right)$$
(A.3j)

A.2.2 Host economy

1

 $\frac{V_{L_h}(\widetilde{C}_h,\widetilde{L}_h)}{V_{C_h}(\widetilde{C}_h,\widetilde{L}_h)} = pf_{N_h}(\widetilde{K}_h,\widetilde{N}_h,\theta(\widetilde{m})\widetilde{N}_m)$ (A.4a)

$$pf_{K_h}(\widetilde{K}_h, \widetilde{N}_h, \theta(\widetilde{m})\widetilde{N}_m) - \delta_h = r^* + \Psi\left(\frac{\widetilde{B}_h}{f(\widetilde{K}_h, \widetilde{N}_h, \theta(\widetilde{m})\widetilde{N}_m)}\right) = \beta$$
(A.4b)

$$\widetilde{N}_h + \widetilde{L}_h = 1 \tag{A.4c}$$

$$\beta \widetilde{B}_h + \widetilde{C}_h = \beta \widetilde{K}_h + p f_{N_h} (\widetilde{K}_h, \widetilde{N}_h, \theta(\widetilde{m}) \widetilde{N}_m) \widetilde{N}_h$$
(A.4d)

A.3 Welfare

The calculation of the equivalent variation measures of welfare proceeds as follows. We begin with the typical individual, k, in the home economy and assume that the economy is initially in steady-state equilibrium, implying that the corresponding level of base intertemporal welfare for this individual is

$$U_{k,0}(Y_{k,0}) \equiv \frac{1}{\gamma} \int_{0}^{\infty} \left(C_{k,0} L_{k,0}^{\sigma} \right)^{\gamma} e^{-\beta t} du = \frac{1}{\gamma \beta} \left(C_{k,0} L_{k,0}^{\sigma} \right)^{\gamma}$$
(A.5a)

where $Y_{k,0}$ is the initial base level of income that will generate the flow of utility associated with

 $C_{k,0}$ and $L_{k,0}$. Likewise, the individual's intertemporal welfare following a structural change is

$$U_{k,1}(Y_{k,1}) \equiv \frac{1}{\gamma} \int_{0}^{\infty} (C_k(u)L_k(u)^{\sigma})^{\gamma} e^{-\beta u} du$$
(A.5b)

where $Y_{k,1}$ is the equivalent initial level of income that will generate the utility associated with $C_k(u)$ and $L_k(u)$ along the transition.

The equivalent variation in welfare is given by the percentage change in the initial income level, $\psi_k - 1$, so that the household is indifferent between $U_{k,0}(\psi_k Y_{k,0})$ and $U_{k,1}(Y_{k,1})$,

and can be written as

 $\Delta W = (1 - m_0) \Delta W_d + m_0 \Delta W_m$

$$\Delta \omega_{k} \equiv \psi_{k} - 1 = \left[\frac{U_{k,1}(Y_{k,1})}{U_{k,0}(Y_{k,0})}\right]^{\frac{1}{\gamma}} - 1 = \frac{1}{C_{k,0}L_{k,0}^{\sigma}} \left[\beta \int_{0}^{\infty} (C_{k}(u)L_{k}(u)^{\sigma})^{\gamma} e^{-\beta u} du\right]^{\frac{1}{\gamma}} - 1$$

In the case of an individual stayer, who never migrates this is given by:

$$\Delta \omega_d \equiv \psi_d - 1 = \left[\frac{U_1(Y_1)}{U_0(Y_0)}\right]^{\frac{1}{\gamma}} - 1 = \frac{1}{C_0 L_0^{\sigma}} \left[\beta \int_0^{\infty} \left(C(u)L(u)^{\sigma}\right)^{\gamma} e^{-\beta u} du\right]^{\frac{1}{\gamma}} - 1$$
(A.6a)

Analogously, the change in the intertemporal welfare for an individual who migrates at time 0 is

$$\Delta\omega_m \equiv \psi_m - 1 = \left[\frac{M_1(Y_1)}{M_0(Y_0)}\right]^{\frac{1}{\gamma}} - 1 = \frac{1}{C_{m,0}L_{m,0}^{\sigma_m}} \left[\beta \int_0^\infty (C_m(u)L_m(u)^{\sigma_m})^{\gamma} e^{-\beta u} du\right]^{\frac{1}{\gamma}} - 1$$
(A.6b)

Also, the welfare change for an individual resident of the host country is

$$\Delta\omega_{h} \equiv \psi_{h} - 1 = \left[\frac{V_{1}(Y_{h,1})}{V_{0}(Y_{h,0})}\right]^{\frac{1}{r}} - 1 = \frac{1}{C_{h,0}L_{h,0}^{\sigma}} \left[\beta \int_{0}^{\infty} (C_{h}(u)L_{h}(u)^{\sigma})^{\gamma} e^{-\beta u} du\right]^{\frac{1}{r}} - 1$$
(A.6c)

To obtain the aggregate change in intertemporal welfare for stayers and migrant workers we sum over their respective individual welfare changes (A.6a), (A.6 b), taking into account that the relative sizes of the two groups is changing over time as migration occurs. This is approximated by³⁰

$$\Delta W_d = \frac{1}{C_0 L_0^{\sigma}} \left[\frac{\beta}{1 - m_0} \int_0^{\infty} (1 - m(t)) (C(t)L(t)^{\sigma})^{\gamma} e^{-\beta t} dt \right]^{\frac{1}{\gamma}} - 1$$
(A.7a)

$$\Delta W_m = \frac{1}{C_{m,0}L_{m,0}^{\sigma_m}} \left[\frac{\beta}{m_0} \int_0^\infty m(t) (C_m(t)L_m(t)^{\sigma_m})^{\gamma} e^{-\beta t} dt \right]^{\frac{1}{\gamma}} - 1$$
(A.7b)

which reduce to $\Delta \omega_d$, $\Delta \omega_m$ if $m(t) = m_0$ and the number of migrants remains constant. Otherwise an individual's welfare may increase, while the overall group's welfare declines (or vice versa). The overall average change in intertemporal welfare for the home economy is a weighted average of the two groups, weighted by their initial size, and can be expressed as

Analogously, we can calculate the welfare gains across the steady states for each individual, each group, and each country.

Individual stayers and migrants :
$$\Delta \omega_d^s = \frac{\widetilde{CL}^{\sigma}}{C_0 L_0^{\sigma}} - 1$$
; $\Delta \omega_m^s = \frac{\widetilde{C}_m \widetilde{L}_m^{\sigma_m}}{C_{m,0} L_{m,0}^{\sigma_m}} - 1$ (A.9a)

³⁰ An individual who migrates at some time $\bar{t} > 0$ would be a stayer over the period $0 < t < \bar{t}$ and a migrant for $\bar{t} < t < \infty$. His welfare would be a corresponding average of (A.6a) and (A.6 b). Since we focus on the welfare of the overall groups (stayers vs migrants) rather than on that of specific individuals, the approximations (A.7a) and (A.7 b) suffice for our purpose.

(A.9c)

Collective stayers and migrants :
$$\Delta W_d^s = \left(\frac{1-\widetilde{m}}{1-m_0}\right) \frac{\widetilde{CL}^{\sigma}}{C_0 L_0^{\sigma}} - 1; \ \Delta W_m^s = \frac{\widetilde{m}}{m_0} \frac{\widetilde{C}_m \widetilde{L}_m^{\sigma_m}}{C_{m,0} L_{m,0}^{\sigma_m}} - 1$$
 (A.9b)

Home country :
$$\Delta W^s \equiv (1 - m_0) \Delta W^s_d + m_0 \Delta W^s_m$$

Host country :
$$\Delta W_h^s = \frac{\widetilde{C}_h \widetilde{L}_h^\sigma}{C_{h,0} L_{h,0}^\sigma} - 1$$
 (A.9d)

B. Migration in the Middle East: Some background issues

In calibrating the model, we have chosen relevant parameters to reflect, insofar as possible, the nature of immigration and the economic structures of the home and host economies. But there have also been specific institutional constraints imposed on migrant workers seeking short-term employment in the Middle East that need to be borne in mind. These involve the *kafala* sponsorship system that was established in the 1970s for South Asian citizens to obtain short-term employment in the Middle East.

Under this system, all migrant workers require a local sponsor, usually their employer, who sponsors their visa and work permit. Kafala imposed stringent conditions on migrant workers, such as stipulating their work hours, length of contract, with no prospect of permanent residency. In its most extreme form migrant workers would lack the flexibility with respect to their migration/labor/leisure decisions reflected in our model. In fact, the treatment of migration as an exogenous parameter, under the control of the host country authorities as assumed by Lim et al. (2021), may be a more accurate reflection of the migration setup under kafala.

However, in practice the system was not as stringent as is sometimes suggested, with migrant workers having some flexibility. According to Rahman (2011), about 23% of migrant workers from Bangladesh to Saudi Arabia returned after one to two years, 23% between three to five years, 33% between six to ten years while the remaining 21% continued working in Saudi Arabia for over 11 years. This evidence suggests that migrant workers who want to renew their contracts can do so. But the movement of labor in and out of the host country cannot happen instantaneously due to their employment contracts and other bureaucratic processes. Hence our model of sluggish movement of migrant workers is consistent with this nature of migration.

More importantly, cases of worker exploitation and abuse by employers has led to the recent systematic scrutinizing of the Gulf States' kafala system. This has led to extensive reforms by Saudi Arabia and even to it being dropped by other countries such as Qatar and Bahrain.

The other issue is the timing of remittances by migrant workers. In the past it is likely that migrant workers saved much of their earnings and chose to remit/take home when their contract ended. Even then, migrant workers used *hawala* (underground banking) to send money. These types of remittances were hard to detect and were not recorded. According to Puri and Ritzema (1999), the share of unrecorded remittances in the 1980s was 20% of total remittances for Bangladesh, 40% for India, and 43% for Pakistan. Now, because of the increased scrutiny over money laundering and innovations in the financial sector including banks, post offices, FinTech, and digital transfer apps, remittances have become more accessible and cheaper to send. The cost of remittances is the lowest in South Asia, at about 4.1%, close to the Sustainable Development Goal (SDG) target of 3% (World Bank, 2022b). According to World Bank (2022a), a study by the World Bank shows that the cost elasticity of remittances is large. A 1% decrease in remittance costs can raise remittances by more than 1%.

Thus the upshot of this is that the model, although stylized, adequately captures these two aspects. First, the flexibility afforded migrant workers in their decision making is entirely appropriate as a reflection of the system as it is currently evolving. In addition, the specification of remittances is broadly consistent with current practices and is also consistent with the formulations adopted in the recent literature.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jdeveco.2023.103110.

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S. Lim et al.

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