From Diaspora Dollars to Default Risk: Remittances and Sovereign Spreads*

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Abstract

Most developing countries are characterized by two facts: (1) net emigration, and (2) net remittances received. This paper studies how these two facts interact with the sovereign default risk. In theory, the effect of remittances is ambiguous. On the one hand, they are an additional source of income that increases its ability to repay. On the other hand, by reducing the production share of income, it undermines the default penalties available to international lenders that enforce repayment. Using a panel of developing countries, we document a positive correlation between spreads and net remittances. We then construct a sovereign default model with emigration and remittances. Critical to the ability of the model to reproduce the positive correlation is the countercyclical nature of emigration and remittances. Because the government internalizes that default leads to an increase in remittances that partially cushions against the default penalties, in equilibrium, countries with a large income share from remittances face a steeper government bond spread schedule and hold lower debt levels. When we simulate the model for our panel matching countries' average emigration and net remittances, we are able to reproduce the sign of the observed correlations between emigration, remittances, and spreads.

Keywords: Sovereign default, migration, remittances

JEL classification: F22, F34, F41, F43, J61

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1 Introduction

Since the early 1990s, the World has witnessed a gradual increase in international labor migration. This increase accelerated by the turn of the century and has been dominated by emigration from developing to developed countries. Accompanying the rise in international labor migration there has been a sizeable increase in international remittances sent to developing countries, as depicted in Figure 1. Between 1980 and 2020, global remittances (in 2019 USD) increased eightfold, with more than 80 percent accounted for by developing countries. Thus, as illustrated in Figure 2, by 2019, most developing countries were characterized by two salient features: (1) net labor emigration, and (2) positive net remittances. Remittances received can have a significant impact on the economies of developing countries. In effect, as shown by Panel b, for around 20 percent of developing countries in 2019, net remittances represented more than 10 percent of their GDP.[1]

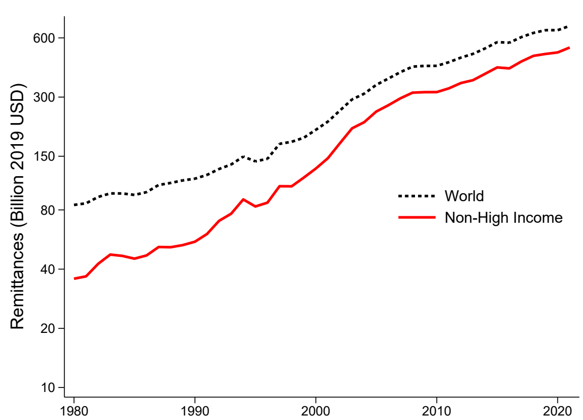
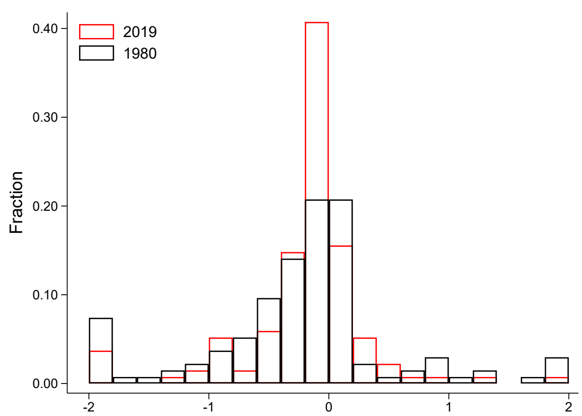


Figure 1: World remittances from 1980–2022
Notes: Remittances are measured as the sum of remittances received in billions of 2019 USD by all countries (black dotted line) and non high-income countries (red solid line). Data are from the World Bank Database (2023).

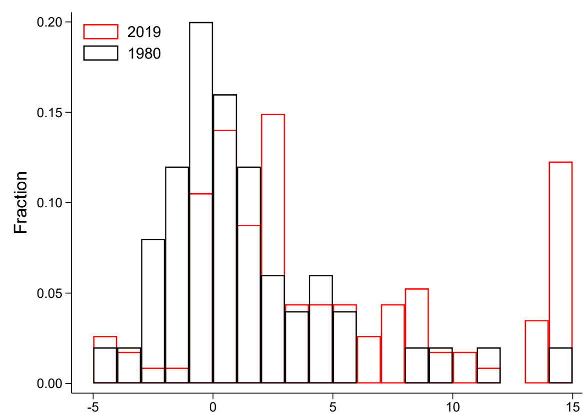
In this paper, we study how emigration and received remittances affect a country's government default risk. A long tradition in the sovereign default literature posits that

[1]This includes, for example, the Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, Tajikistan, Kyrgyzstan, Uzbekistan, Moldova, Georgia, Montenegro, Ukraine, and Nepal. Other relatively large economies for which net remittances to GDP are considerable include Albania (9%), Serbia (8%), Croatia (6%), Mexico (3%), Pakistan (7%), the Philippines (9%), Nigeria (5%), Egypt (8%) and Jordan (9%).

governments with limited commitment strategically default in the advent of a negative productivity shock, all the while internalizing that default penalizes their future productivity. However, received remittances are neither subject to the same idiosyncratic shock process nor are they affected by the typical default penalties imposed by international lenders. Thus, for countries that receive a large fraction of their income in the form of remittances, default decisions encompass a wider range of incentives. In fact, the effect of emigration and remittances on sovereign default risk is potentially ambiguous. On the one hand, remittances offer a steady stream of income that increases the government's ability to repay. On the other hand, given their immunity to the standard default penalties, remittances can potentially increase the government incentives to default. Such effects are compounded by the counter-cyclical nature of net migration, as remittances received tend to increase during economic downturns and the associated outflow of the working population.



(a) Net Migration per capita



(b) Net Remittances to GDP

Figure 2: Migration and remittances in 1980 & 2019, developing countries

Notes: Net migration per capita is defined as immigration minus emigration divided by the total population of a country. Net remittances to GDP is defined as remittances received minus remittances paid divided by nominal GDP. The sample includes all countries classified as non high-income by the World Bank in 2023. Data are from the World Bank Database (2023).

To make progress, as a first pass, we examine the empirical relationship between emigration, remittances and government default risk. Focusing on developing countries we find that net remittances increase significantly with emigration, that emigration increases with sovereign default risk, and that sovereign default risk correlates positively with net remittances to GDP. While the first two facts have been documented previously, the latter constitutes the first contribution of this paper. Guided by these results, we develop a framework that incorporates emigration and remittances into an otherwise standard model of sovereign default. We then use the model to study the effect of remittances on the equilibrium bond price schedule and in response to negative shocks. Our key finding is that due to the counter-cyclical nature of emigration and remittances, the government's internalizes that by defaulting remittances offer a partial compensation for the productivity losses and therefore increase the default value. Thus, remittances lead to increased government bond spreads and lower equilibrium levels of debt-to-GDP. We also test the model's ability to reproduce some untargeted moments of our cross-country panel analysis.

Our model of sovereign default builds on Alessandria et al. [2020] and incorporates emigration and remittances in a parsimonious fashion. We consider a consolidated problem in which the government maximizes household utility by making production, borrowing, and default decisions. Production uses labor as the only input, and the only uncertainty in the economy is regarding productivity, which follows a Markov process.[2] Default entails a period of financial autarky as well as a productivity penalty, as is standard in the literature. While Alessandria et al. [2020] models counter-cyclical emigration as a result of the trade-off between domestic and foreign income and a stochastic migration cost, we formulate emigration in a reduced form as a function of the productivity shock. Every period, a fraction of the labor force leaves the country to work abroad, sends remittances back to their home country, and returns at the end of the period. The main novelty of the model is that the government receives additional income – remittances – that is not subject to the idiosyncratic domestic productivity shock but instead increases with low productivity realizations as more workers emigrate.

Emigration and remittances affect the governments incentives to default in various ways. On the one hand, remittances offer an increased endowment that increases its ability to repay and lowers the default risk. On the other hand, three channels raise the

[2] All results are similar when we extend the model to include capital and an investment decision. See Section 6 for this model extension.

government's default risk. First, counter-cyclical emigration reduces the labor force in the face of a negative productivity shock, thus amplifying its effect as the country's productive capacity is further reduced. This is the main channel in Alessandria et al. [2020]. Second, the scope of the default penalty in terms of the country's income is effectively smaller, as remittances are unaffected by the available default penalties. Third, in the advent of default, the increase in emigration increases remittances effectively cushioning against the productivity losses of default. Thus, in theory, the effect of remittances on sovereign default risk can go in either direction depending on the strength of these channels.

We quantify our model by matching some key moments regarding GDP, spreads, emigration, and remittances of the 88 out of 114 developing countries for which net migration was negative and net remittances were positive on average between 1980 and 2021. We then compare our benchmark model with remittances to a model with the same emigration rate but without remittances. This allows us to isolate the effects of remittances from the effects of emigration studied in Alessandria et al. [2020], by calibrating both models to have the same labor force. We find that remittances increase the government default risk in comparison to the model without remittances. The key driver of this result is the cushioning effect of remittances in the face of productivity losses from default. International lenders anticipate that the government will receive increased remittances due to the productivity loss from default and thus require a higher spread at every level of debt. In contrast, without counter-cyclical emigration, remittances have no significant effect on the government's default decision relative to a model without remittances, as the endowment and cost channels nearly cancel each other out.

Next we study the response to a negative productivity shock, again comparing our benchmark model to a model without remittances. Besides experiencing the same productivity shock and thus emigration response, the drop in GDP in the economy without remittances is twice as large. Naturally, this is because GDP in the benchmark model additionally includes remittances, which rise in the aftermath of the productivity shock. While the spread spikes in both models, the increase is larger in the economy with remittances. The rise in spreads results in a large decline in borrowing that similar in both models. However, the drop in consumption in the model with remittances is only half as in the model without remittances. Thus, remittances allow the country to smoothen the adverse effects of the recession, albeit at higher borrowing costs.

At last we consider our model's ability to reproduce the three facts documented in the data, namely that remittances increase with emigration, that net emigration increases with spreads, and that spreads increase with remittances. To do so we calibrate and simulate the model for the 88 countries in our sample of countries with negative net migration and positive net remittances, matching their average net remittance received and the average and dispersion of net emigration. When we estimate the analogous regressions with the simulated data from the model we find that the sign of the estimates of the three facts is the same as in the data, even though non of the cross-sectional moments are targeted and countries differ along several key dimensions.

Related Literature Our paper contributes to two main strands of the literature. First, it builds on the sovereign default literature pioneered by Eaton and Gersovitz [1981], Arellano [2008], Aguiar and Gopinath [2006] and Yue [2010]. Most of the work in this literature focuses on economies in which national income equals the country's endowment or production. To the best of our knowledge, our paper is the first to study the effect on sovereign default risk when a fraction of a country's income – remittances received – follow a shock process unrelated to its own production capacity and potentially increases in the face of default. In this sense, the paper most related to ours is Alessandria et al. [2020], which introduces a migration choice into an otherwise standard default model, but abstracts from the role of remittances. Other papers that study the link between sovereign debt and labor market dynamics including migration are Balke [2016], Gordon and Guerron-Quintana [2019] and Deng [2024].

Second, the paper contributes to the literature studying the macroeconomic effects of remittances. For instance, Mandelman and Zlate [2012] considers a two-country business cycle model with endogenous migration matching cyclical patterns of the U.S. and Mexico to study the insurance role in consumption smoothing of remittances. Mandelman [2013] studies how the business cycle effects of differ across exchange rate regimes. Other papers that study the role of remittances in small open economy models are Acosta et al. [2009], Durdu [2010] and Mandelman and Finkelstein Shapiro [2016]. Our contribution lies in studying the effect of remittances in small open economy with sovereign default risk.

The rest of the paper is organized as follows. Section 2 documents the empirical facts regarding emigration, remittances, and sovereign default risk. Section 3 presents our benchmark model. Section 4 lays out its quantification, the equilibrium bond price schedule, and its response to a productivity shock. Section 5 presents the cross-sectional analysis. Section 6 considers some extensions of the model and section 7 concludes.

2 Empirical Evidence

We study the relationship between economic activity, migration, remittances, and sovereign default considering a panel of developing countries between 1980 and 2021. We obtain economic data from the World Bank Databank and population data from the U.N. Population Database. Depending on the country-specific data availability, we measure the government default risk either using the Emerging Markets Bond Index (EMBI) spread from the Global Economic Monitor or using the five-year maturity credit default swap (CDS) obtained from Bloomberg. The key variables of our analysis are net migration, net remittances, and the government default risk measured by spread. Precisely, net migration (NM) is the difference between immigration and emigration as a percentage of total population; net remittances (NR) is the difference between received and paid remittances as a percentage of nominal GDP; and the spread (s) is the log of the CDS rate or of the EMBI rate (in percent), if the former is not available.[3] Our baseline analysis focuses on developing economies from 1980–2021. We follow the country income group classification of the World Bank in 2020 and define developing countries as those that are not high income. We also report all results for the subsample of countries for which average net migration was negative and average

[3] Given that in all our specification we include country-level fixed effects, the difference in scales of the two measures does not affect our results.

net remittances positive over our sample period (88 out of 114 countries), and which we label "+R,-M". We are interested in this subsample because we will target the model of section 3 to each of these countries and then consider its ability to reproduce some of the moments documented here. In what follows, we document three key facts regarding the relation between economic activity, net migration, net remittances, and sovereign default risk.

Fact 1: Net remittances increase with emigration. First, we consider the relation between remittances and migration by estimating the following equation:

$$NR_{it} = \alpha^{RM} NM_{it} + \Gamma' X_{it} + D_i + D_t + \varepsilon_{it}, \tag{1}$$

where X_{it} is a vector of country-level controls including the log of real GDP, real GDP growth, the log GDP deflator, the log of the real exchange rate, and the log population; D_t are year fixed effects that capture global factors such as U.S. GDP and the global finance cycle; and D_i are country fixed effects so that captures country's average level of remittances-to-GDP and sets the identifying variation to be within a country over time. Table 1 reports the results of (1). Column 1 reports the results when considering the baseline sample of developing countries. As expected, net remittances are negatively related to net migration, indicating that larger emigration flows result in an increased share of a country's income coming from remittances. Column 2 shows that this relation does not hold for high income countries, while column 3 shows that the relation is virtually unchanged when focusing on the "+R,-M" sample. Column 4 shows that the effect of net migration on net remittances is cumulative and increases as we add lags of net migration. Finally, columns 5 and 6 indicate that these effects are driven by received remittances, rather than paid remittances.

Fact 2: Emigration increases with the sovereign default risk. Second, we consider the relation between spreads and net migration by estimating:

$$s_{it} = \alpha^{sM} NM_{it} + \Gamma' X_{it} + D_i + D_t + \varepsilon_{it}, \tag{2}$$

Table 1: Remittances and Migration

Dep. Var.:	Net Rem./GDP				Rem. Rec.	Rem. Paid
Sample:	Baseline (1)	High Income (2)	+R,-M (3)	Baseline (4)	Baseline (5)	Baseline (6)
Net Mig. pc	-0.19***	0.01	-0.20**		-0.05**	-0.01
	(0.06)	(0.05)	(0.08)		(0.02)	(0.02)
$\sum_{h=0}^{3}$ Net Mig. pc$_{t-h}$				-0.52***		
				(0.11)		
RGDP	-3.00***	0.04	-3.69***	-3.01***	0.50***	1.63***
	(0.34)	(0.25)	(0.45)	(0.33)	(0.10)	(0.11)
Δ RGDP	8.89***	0.67	11.03***	8.92***	2.91***	0.00
	(1.30)	(1.18)	(1.94)	(1.31)	(0.38)	(0.39)
GDP Deflator	-0.06	1.09***	0.15	0.01	0.63***	0.96***
	(0.29)	(0.30)	(0.42)	(0.29)	(0.09)	(0.09)
Population	-0.25	-5.18***	1.29	-0.22	0.55***	-1.45***
	(0.56)	(0.51)	(0.84)	(0.56)	(0.16)	(0.18)
REER	1.36***	-1.35***	1.85***	1.30***	-0.24***	-0.20***
	(0.20)	(0.39)	(0.26)	(0.20)	(0.06)	(0.06)
Fixed Effects	i, t	i, t	i, t	i, t	i, t	i, t
Number of Countries	114	52	77	114	117	114
Observations	3304	1682	2234	3304	3671	3448
Adjusted R^2	0.80	0.81	0.78	0.80	0.85	0.80

Note. The column labeled "+R,-M" refers to the sample of countries with positive net remittances and negative net migration. All variables are in log except net remittances to GDP and net migration per capita. Robust standard errors are in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

where X_{it} is a vector of country-level controls including the log of real GDP per capita, the log GDP deflator, the log of the real exchange rate, and the log unemployment; and D_i and D_t are country and year fixed effects. The results of (2) are reported in Table 2. We find that net migration is negatively related to sovereign defaults risk, i.e. as spreads increase, net migration decreases. This relation has previously been documented in Alessandria et al. [2020], who focus on 23 European countries. Column 2 shows that the effects are indeed also present for high income countries; however, they are larger for developing countries. In the last two columns, we show these results are robust to using the detrended components of the vector of control variables X_{it}, as in Alessandria et al. [2020].

Table 2: Migration and Spreads

Dep. Var.: Net Migration pc				HP-filtered controls	
				$\lambda = 6.25$	$\lambda = 10^6$
Sample:	Baseline (1)	High Income (2)	+R,-M (3)	Baseline (4)	Baseline (5)
Spreads	-0.19***	-0.09***	-0.19**	-0.21***	-0.14**
	(0.07)	(0.03)	(0.08)	(0.06)	(0.07)
RGDP pc	0.44	0.09	0.32	-0.04**	0.01**
	(0.28)	(0.20)	(0.31)	(0.02)	(0.00)
GDP Deflator	-0.45*	0.60***	-0.42	-0.02**	-0.01***
	(0.25)	(0.23)	(0.35)	(0.01)	(0.00)
REER	-0.25	-0.35	-0.37	0.01**	0.00
	(0.21)	(0.26)	(0.32)	(0.01)	(0.00)
Unemployment	-0.19*	-0.20***	-0.23*	-0.00	-0.00
	(0.11)	(0.06)	(0.13)	(0.00)	(0.00)
Fixed Effects	i, t	i, t	i, t	i, t	i, t
Number of Countries	46	30	30	46	46
Observations	782	518	525	782	782
Adjusted R^2	0.18	0.61	0.05	0.18	0.19

Note. The column labeled "+R,-M" refers to the sample of countries with positive net remittances and negative net migration. All variables are in log except net migration per capita. Robust standard errors are in parentheses, $^{*}\ p < 0.1$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$.

Fact 3: Sovereign default risk increases with net remittances. At last, we consider the relation between spreads and remittances by estimating:

$$s_{it} = \alpha^{sR} NR_{it} + \Gamma' X_{it} + D_i + D_t + \varepsilon_{it}, \tag{3}$$

where X_{it} includes the same control variables as in (3), except that it considers the change in real GDP per capita, and further includes debt-to-GDP, a critical explanatory variable of the sovereign default risk. Column 1 of Table 3 reports the results of (3). The sovereign default risk is significantly and positively related to net remittances; that is, as the share of remittances to GDP increases, countries face a larger spread. Note this effect is not explained by changes in GDP, since the change in real GDP (RGDP) per capita is part of the control variables. Column 2 indicates that there is no evidence of this relation for high income countries. Column 3 illustrates that it applies similarly to the "+R,-M" subsample. Column 4 shows that it is robust to excluding the country fixed effects. Column 5 reports the results when all right hand side variables are standardized: The size of the effect of one standard deviation increase in net remittances is non-trivial when compared to, for example, the effect of debt-to-GDP or unemployment. Finally, again, the last two columns show that these results are also robust to considering the detrend components of the vector of control variables.

These fact suggest that, especially in developing countries, migration and remittances play an important role during periods of elevated sovereign default risk. First, remittances increase with emigration. Second, emigration increases during periods increased risk of sovereign default. Third, this risk increases if countries rely increasingly on remittances to finance their expenditures. In the next section we develop a model that captures these facts.

3 Model

In this section, we present a model of sovereign default with migration and remittances. We consider a small open economy with a production technology, a continuum of workers, and a benevolent government. The aggregate output Y is produced with labor L using production function $Y = zL$, where z is the stochastic productivity.[4] The government borrows

[4] The effect of remittances on sovereign default risk is similar in a model that includes capital accumulation. To isolate the role of remittances we present the most simple production economy.

Table 3: Spreads and Remittances

Dep. Var.: Spreads						HP-filtered controls $\lambda = 6.25$	HP-filtered controls $\lambda = 10^6$
Sample:	Baseline (1)	High Income (2)	+R,-M (3)	Baseline (4)	Baseline (5)	Baseline (6)	Baseline (7)
Net Rem./GDP	0.03**	-0.11	0.04***	0.02**	0.19**	0.05***	0.05***
	(0.01)	(0.07)	(0.02)	(0.01)	(0.09)	(0.02)	(0.01)
Δ RGDP pc	-2.45***	-6.03***	-3.43***	-6.86***	-0.15***	-0.01	-0.03***
	(0.59)	(1.21)	(0.71)	(0.91)	(0.04)	(0.01)	(0.01)
GDP Deflator	-0.32**	-2.74***	-0.55**	-0.96***	-0.23**	0.00	-0.00
	(0.16)	(0.69)	(0.24)	(0.17)	(0.11)	(0.00)	(0.00)
REER	-0.36***	0.38	0.05	-0.10	-0.16***	-0.01***	-0.00***
	(0.13)	(0.76)	(0.26)	(0.15)	(0.06)	(0.00)	(0.00)
Unemployment	0.35***	0.97***	0.33***	0.13***	0.29***	0.00	0.00***
	(0.07)	(0.14)	(0.07)	(0.04)	(0.06)	(0.00)	(0.00)
Debt/GDP	0.49***	-0.19	0.47***	0.32***	0.42***	0.01***	0.00***
	(0.07)	(0.17)	(0.10)	(0.05)	(0.06)	(0.00)	(0.00)
Fixed Effects	i,t	i,t	i,t	t	i,t	i,t	i,t
Number of Countries	44	18	28	45	44	44	44
Observations	678	287	444	679	678	683	683
Adjusted R^2	0.80	0.87	0.79	0.36	0.80	0.75	0.79

Note. The column labeled "+R,-M" refers to the sample of countries with positive net remittances and negative net migration. In column 5 all right hand side variables are standardized. All variables are in logs except net remittances-to-GDP. Robust standard errors are in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

state-uncontingent bonds internationally and can default on them with the punishment of lower productivity and exclusion from international markets for some periods. The labor supply L in the economy fluctuates due to emigration. At the beginning of each period, a fraction of workers emigrate, work abroad, and return at the end of the period. While abroad, emigrants send remittances to their home country, which become available within the same period.[5] Our formulation of the emigration is a reduced form of the discrete emigration choice postulated by Alessandria et al. [2020]. In particular, we specify emigration to be a negative function of productivity, so that when productivity is low, a larger number of workers emigrate. This is consistent with empirical evidence that net migration is pro-cyclical (and emigration is counter-cyclical), as during downturns more workers seek opportunities abroad.[6] As documented in the empirical section above, as emigration increases during economic downturns, so do remittances sent back to the home country. The focus of our analysis here is on how increases in remittances interact with the sovereign default risk.

3.1 Workers and Government

In our small open economy, every period L workers either supply labor inelastically at home or emigrate and obtain income abroad. We set the emigration rate to $m_t = \bar{m}e^{\phi(\bar{z}/z_t - 1)}$, where $\bar{m}$ is the average emigration rate, $\bar{z}$ is the average productivity level, and z_t is the productivity of the economy. When productivity is average, $z_t = \bar{z}$, the emigration rate equals $\bar{m}$, while for lower than average productivity, emigration is higher than $\bar{m}$. This captures the counter-cyclical nature of emigration: during good economic periods, fewer workers migrate abroad for work, whereas during economic downturns, more workers seek higher earnings abroad. The elasticity of emigration to productivity is disciplined by ϕ.

[5] The assumption that emigrants return at the end of the period and that remittances are received within the same period simplify the model since it allows us to abstract from the stock of emigrants.

[6] See for example Mayda [2010] and Clemens [2011]. In Table B.1 of the Appendix we show net migration per capita is positively associated with real GDP per capita, both in levels and changes in the panel data presented in section 2.

Each emigrant sends remittances F back home and returns at the end of the period.[7] Thus, the mass of workers at the end of each period is always L. However, within the period, the mass of workers available to produce domestically is given by $\tilde{L} = (1 - \bar{m}e^{\phi(\bar{z}/z_t - 1)})L$. Workers staying at home provide one unit of labor inelastically, and receive or pay a lump-sum transfer from or to the government. Workers have a discount factor β and a constant relative risk aversion utility function over consumption c, $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, where σ is the risk aversion parameter.

The government is benevolent and it maximizes the welfare of all the residents $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \tilde{L} u(c_t)$. The government can issue state-uncontingent bonds internationally but may default on these obligations. Default involves temporary output loss and exclusion from financial markets. The output loss is modelled as a cut in productivity $z_d(z) \leq z$, which lasts as long as the country's exclusion from international financial markets. With probability λ, the country in default regains a good credit standing and access to international borrowing and lending. Following the sovereign default literature, we assume that only the government can borrow and lend internationally and that the government rebates all the proceeds back to the workers in a lump-sum fashion.

3.2 Recursive Formulation

Each period the economy starts with a level of productivity, z and public debt, B. In what follows, we omit the time subscript t to simplify notation, and we use x' to denote variable x in the next period. The timing of the model is as follows. At the beginning of each period, the aggregate shock z is realized. If the country is in good financial standing, the government, observing the price of issuing new bonds, then chooses whether or not to default on this period's bond payment obligations. Following the government's default decision, workers emigrate and send remittances back to their home country. Note, given the output cost of default, emigration is higher if the government defaults. If the

[7] Empirical evidence from Artal-Tur and Requena-Silvente [2014] suggests that remittances are negatively correlated with the receiving countries' business cycle not only at the aggregate, but also at the per emigrant level [Artal-Tur and Requena-Silvente, 2014]. Since we focus on the sovereign's default problem we abstract from this margin.

government fulfills its payment obligations, it chooses new borrowing and consumption. If instead it chooses to default on its debt, the country enters financial autarky and only chooses consumption. At the end of the period all emigrants return.

When not in default, the government chooses whether or not to default to maximize the workers' welfare:

$$V(z, B) = \max\left\{V^c(z, B), V^d(z)\right\}, \tag{4}$$

where V^c denotes the non-defaulting value and V^d the default value. Let $D(z, B) = 1$ denote default. If the government repays its debt, it issues new bonds, B', by solving the following dynamic programming problem:

$$V^c(z, B) = \max_{C,B'} \quad \tilde{L}u\left(\frac{C}{\tilde{L}}\right) + \beta\mathbb{E}[V(z', B')] \tag{5}$$

subject to the budget constraint:

$$C + B = z\tilde{L} + Q(z, K', B')B' + mF, \tag{6}$$

where output is produced with post-emigration workers $\tilde{L}$, C is the aggregate consumption by the post-emigration workers, $Q(z, B')$ is the bond price, $Q(z, B')B'$ are the proceeds of government issuing debt, and F are the remittances sent by each emigrant, so that the total amount of remittance sent back to the home country is given by mF.

If the government defaults, the economy suffers a loss in productivity from z to z_d and enters financial autarky that prevents the government from borrowing and lending internationally. With probability λ, the government returns to the international financial market and the productivity cost from default is removed. The default value is given by:

$$V^d(z) = \max_{C} \ \tilde{L}u\left(\frac{C}{\tilde{L}}\right) + \beta\mathbb{E}[\lambda V(z', 0) + (1-\lambda)V^d(z')]$$

subject to the budget constraint

$$C = z_d\tilde{L} + mF,$$

where $m = \bar{m}e^{\phi(\bar{z}/z_d - 1)}$ increases relative to no-default due to the productivity loss z_d. Thus, while default implies an output loss and financial autarky, it also implies increased remittances from increased emigration.

International lenders are competitive and risk neutral. They face a constant world risk free rate r. The break-even condition implies the bond price schedule satisfies

$$Q(z, B') = \frac{1}{1+r}\mathbb{E}[1 - D(z', B')].$$

Hence the bond price compensates lenders for their losses during sovereign default. These prices depend on the country current productivity shock, z, and newly issued debt, B'.

The recursive equilibrium of the model is given by (i) the government's choices, $B'(z, B)$, with associated value functions $V(z, B)$, $V^c(z, B)$, $V^d(z)$, consumption rules $C(z, B)$, $C^d(z, B)$, and default probabilities $D(z, B)$; and (ii) an equilibrium pricing function for sovereign bonds $Q(z, B')$ such that: (1) given bond price, the government's choices solve the recursive maximization problem (4); and (2) The consumption rules $C(z, B)$, $C^d(z, B)$ satisfy the resource constraint of the economy; and (3) the bond pricing function $Q(z, B')$ satisfies the arbitrage condition of international lenders.

3.3 The Mechanism

To highlight the roles of emigration and remittances on the government's default choices, we revisit the government budget constraint (6) in normal times:

$$C + B = z\tilde{L} + Q(z, B')B' + mF.$$

Naturally, without remittances, the last term of the right hand side is eliminated and counter-cyclical emigration unambiguously amplifies negative productivity shocks by lowering $\tilde{L}$, thus severing the effects of sovereign default risk. As documented in Alessandria et al. [2020], introducing migration into models of sovereign default increases the elasticity of the spread to productivity and amplifies the effects of sovereign default risk. We label this the *labor channel*. While this channel remains operative, with remittances F, emigration and the accompanying remittances have three additional, albeit ambiguous, effects that are unique to our model. On the one hand, the government now receives a steady stream of income that increases its ability to repay, thus reducing the sovereign default risk. We label this the *endowment channel*. On the other hand, two effects of remittances increase the default risk. First, remittances are out of reach of the international sanctioning mechanisms, namely the productivity loss and financial autarky. Thus, remittances reduce the share of national income affected by the default penalties. We label this the *cost channel*.[8] Second, due to the counter-cyclical nature of net emigration, the potential productivity loss from default leads to an increase in emigration and hence remittances. As the government internalizes that the adverse effects of default are mitigated by increased remittances, it becomes more likely to default. We label this the *cushioning channel*. As we will see, overall, the effect of remittances on the sovereign default risk depends critically on the elasticity of emigration to productivity.

4 Quantitative Analysis

In this section, we calibrate the model and evaluate the quantitative properties of the model. First, we study how remittances affect the sovereign default risk in equilibrium. Second, we consider the response to a negative productivity shock. Third, we explore the ability of the model to replicate the pattern found in the data. Before we perform these analysis we describe our calibration strategy.

[8]Remittances are one source of deviations between GDP and GNI. In fact, the endowment and cost channels result from any such deviation, e.g. foreign aid or investment income from abroad. However, remittances are unique due to their link to the country's workforce as well as their counter-cyclicality.

4.1 Parameterization and Moments

The model is calibrated at an annual frequency. We assume that the productivity shock z follows a first-order autoregressive process:

$$\log(z_t) = \rho_z \log(z_{t-1}) + \eta_z \varepsilon_t,$$

where ρ_z captures the persistence of the shock, η_z determines the shock volatility, and the shock ε_t follows a standard normal distribution. If the government defaults, the economy suffers a productivity loss. Following Chatterjee and Eyigungor [2012], the productivity loss takes a quadratic form $z_d(z_t) = z_t - \max\left\{\chi_1 z_t + \chi_2 z_t^2, 0\right\}$ with $\chi_1 < 0 < \chi_2$, so that the default loss is especially large in high productivity states.

Table 4 reports the parameter values of the benchmark economy. Overall, our calibration strategy is to match some key properties of the 88 countries of our sample in section 2 for which net migration is on average negative and net remittances positive, the sample labelled "+R,-M" in Tables 1-3. There are two groups of parameters. The parameters in the first group Panel a) are taken directly from the literature or from our data, and those in the second group are chosen to match relevant empirical moments jointly. The first group of parameters includes $\{r, \sigma, \lambda, \rho_z, \bar{m}, \beta\}$. Following convention, we set the risk-free rate r to 4% and the risk aversion σ to 2. The return parameter λ is set to 0.25 so that defaulting countries are excluded from international financial markets for an average of four years, consistent with the findings of Gelos et al. [2011]. The persistence of the productivity process, ρ_z, is set to 0.9, following the convention of the international real business cycle literature. We set the average emigration rate to 0.46% as in the data. Following Alessandria et al. [2020], we set the discount factor β to 0.83.[9]

The second group (Panel b) includes five parameters: the standard deviation η_z of the productivity process, the default cost parameters χ_1 and χ_2, the foreign income parameter F, and parameter ϕ that disciplines the elasticity of emigration to productivity. We choose

[9] In order to generate reasonable default rates, as is well-known, standard sovereign default models require a low discount factor. We set the same value of discount factor as Alessandria et al. [2020].

Table 4: Parameters

Parameter	Description	Value	Target/Source
Panel a: Assigned parameters			
r	Risk-free interest rate	0.04	Conventional value
σ	Risk aversion	2	Conventional value
λ	Reentry probability	0.25	Gelos et al. [2011]
ρ_z	Productivity persistence	0.90	Conventional value
$\bar{m}$	Avg net migration	-0.46%	Our sample
β	Discount factor	0.83	Alessandria et al. [2020]
Panel b: Calibrated parameters			
η_z	Std. productivity shocks	0.086	SD GDP
χ_1	Default loss	-0.3	Avg spread
χ_2	Default loss	0.37	SD spread
F	Foreign income	5.8	Avg remittances-to-GDP
ϕ	Elasticity of emigration	4.8	SD net migration

these parameters to jointly target the following moments: the volatility of GDP 15.11%, the average and volatility of spreads of 4.17% and 4.56%, the mean of net remittance-to-GDP ratio of 5.66%, and the volatility of net migration of 1.4%.[10] Even though we chose all these parameters jointly, we can give a heuristic description of how the data moments inform specific parameters. The default cost parameters mostly influence the average and volatility of spreads. The volatility of productivity shocks affects the volatility of GDP and spreads. The net remittances-to-GDP ratio is largely determined by the foreign income parameter F. Lastly, the volatility of net migration informs the elasticity of emigration of productivity ϕ. Table 5 presents the moments generated by the model, demonstrating a good fit with the data.

To provide some more intuition regarding the parameters specific to our model, namely F and ϕ, we conduct the following comparative analysis: We vary F and ϕ, respectively, while keeping all other parameters constant, and then consider the five targeted moments

[10] A subtle measurement issue is whether to include remittances when calculating the analog of GDP in the model. In the data, most countries measure GDP using an expenditure approach. Hence, we include remittances as part of GDP in the model.

Table 5: Targeted Moments and Model Fit

	Data	Model
SD GDP (%)	15.11	14.93
Avg spread (%)	4.17	4.16
SD spread (%)	4.56	5.10
Avg remittances-to-GDP (%)	5.66	5.51
SD net migration (%)	1.40	1.44

from Table 5. Table 6 illustrates how changes in the parameters F and ϕ influence the behavior of GDP volatility, spreads, remittances, and emigration. First, increases in F mostly affect the standard deviation of GDP and the average remittances-to-GDP, lowering the former while increasing the latter. The intuition for the first result is that, given the lack of volatility of remittances, as remittances increase the share of GDP affected by the productivity shocks is smaller. Note the spread changes with F but not monotonically. Second, the elasticity of emigration to productivity mostly affects the standard deviation of net migration and the average remittances-to-GDP. While the former is intuitive, the latter is explained by the fact that, given the exponential characterization of emigration m, the average emigration is increasing in ϕ and, hence, increases in ϕ also increase average remittances-to-GDP. The effect of ϕ on the GDP volatility is small and non-monotonic. Similarly, as it was the case of F, the effect of varying ϕ on the average and the volatility of the spread is ambiguous.

4.2 The Role of Remittances in the Bond Schedule

To examine the effect of remittances on sovereign default risk we compare our benchmark model to an economy with the same fundamentals but without remittances. In particular, the *no-remittances* model sets all parameters values to be the same as in the benchmark, and reported in Table 4, except setting the foreign income, F, to zero.[11] This comparison

[11]In Appendix A we compare our benchmark economy to two alternative economies without remittances and: (1) the same fundamentals and GDP level, and (2) that matches the same targeted moments.

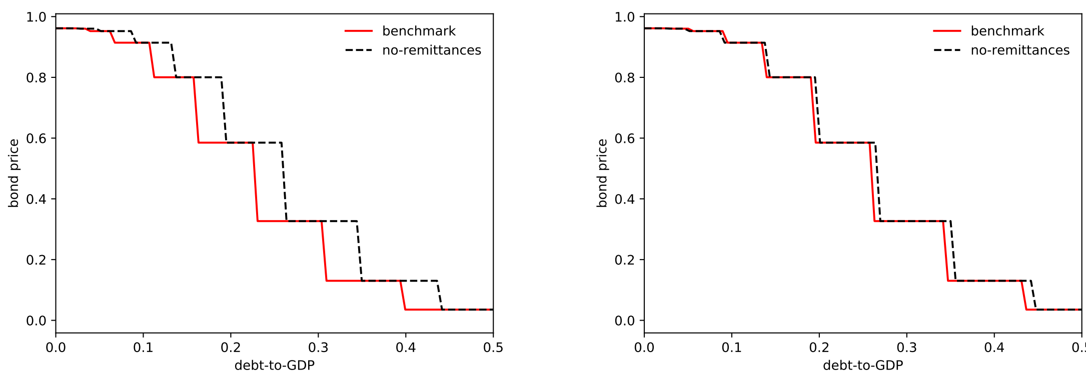
Table 6: Changing Values for Parameter F and ϕ

	changing F				changing ϕ			
	3.8	4.8	6.8	7.8	2.8	3.8	5.8	6.8
SD GDP	16.15	15.49	14.51	14.19	16.91	15.79	15.24	17.40
Avg spread	4.10	4.22	3.93	3.57	4.55	4.12	3.50	3.97
SD spread	4.78	5.08	4.57	4.70	5.21	4.82	4.70	5.29
Avg remittances-to-GDP	3.84	4.69	6.28	7.04	3.75	4.51	6.71	8.11
SD net migration	1.43	1.43	1.44	1.45	0.42	0.77	2.75	5.34

Note. This table reports the comparative statistics for different values of F and ϕ. In the benchmark model, $F = 5.8$ and $\phi = 4.8$. All units are in percent (%).

allows us to isolate the role of remittances and control for the labor channel discussed in section 3.3, since given inelastic labor supply, in both calibrations emigration will be the same in equilibrium and in response to productivity shocks. More precisely, given the default penalty, productivity is endogenous to the default decision. Thus, in response to a negative productivity shock, the emigration response is the same if the default probability of the two models is the same. As we shall see, this is indeed the case. Panel a of Figure 3 plots the bond price schedules as the function of debt-to-GDP under the median productivity level z. In the benchmark model (solid red line), the government faces lower bond price schedule, i.e. a higher spread, for the same level of debt-to-GDP than in the no-remittances model (dashed black line). The explanation is that, conditional on the same level of debt, remittances lower the burden of default: For one, the productivity cost of default has a smaller impact on the country's income (cost channel); and, in addition, a lower productivity increases emigration and thus remittances (cushioning channel). Therefore, international lenders respond by requiring a higher bond spread. In equilibrium, this implies that countries with large levels of remittances sustain smaller debt levels.

To further investigate the role of remittances, we turn off the elasticity of emigration to productivity by setting $\phi = 0$. Thus, in both models emigration is constant and the labor force equals $L = 1 - \bar{m}$. Thus, the no-remittance model effectively collapses to the standard sovereign default model without migration. Nevertheless, with remittances, the endowment and cost channels remain, allowing us to assess their relative strength as well as the contribution of the cushioning channel to the previous result. Panel b of Figure 3 plots the bond price schedule as a function of debt-to-GDP ratio, for both models. The two schedules are almost identical, indicating that without counter-cyclical emigration the two opposing effects of remittances almost entirely offset each other and deliver the same bond schedule as the standard sovereign default model without migration nor remittances. This striking result indicates that the cushioning channel is the key driver of the result that remittances heighten the default risk and the spread, as depicted in Panel a.



(a) Benchmark calibration

(b) Constant labor force ($\phi = 0$)

Figure 3: The Bond Price Schedule Comparison

Notes: This figure plots the bond price schedule as a function of debt-to-GDP ratio for the model with remittances (solid red lines) and the model without remittances (dashed black lines). Panel a is our benchmark calibration. Panel b corresponds to the case when $\phi = 0$, so that the labor force in both models is constant at $L = 1 - \bar{m}$.

4.3 The Role of Remittances in Response to Shocks

We now explore the effects of a negative productivity shock in our benchmark model and the no-remittances model. To construct the impulse response functions (IRFs), we simulate 5,000 paths for each model over 500 periods. From periods 1 to 400, the productivity shock follows its underlying Markov chains so that the cross-sectional distribution of debt and credit standing converges to the limiting distribution. In period 401 (period 1 in the plots), we introduce a negative productivity shock of 10 percent in all simulations of both models (Panel a). From period 401 on, productivity follows its Markov process again. We then report the average impulse response over the 5,000 paths of each model. Figure 4 plots the IRFs of productivity, remittances, GDP, and consumption in percent changes; the spread and debt-to-GDP in levels (unit is percent); and the default rate and net migration in percentage point changes. The solid red lines are for our benchmark model and the dashed black lines are for the no-remittances model.

Panel b plots the average default rate across all the simulation paths for both models. The default rates are almost the same in the two economies. Despite having the same default rate, the negative productivity shock results in a larger increase in the government bond spread (Panel c) in the benchmark model. Note that Panel c plots the average spread across the simulations that do not default because spreads are not well defined when government is in default. With remittances, spread increases from around 5.7 percent to around 7.6 percent, while without remittances the increase from around 5.7 to 6.7 percent. Thus, consistent with the lower equilibrium bond schedule documented in the previous section, in response to a negative productivity shock, remittances also lead to a larger spread response.

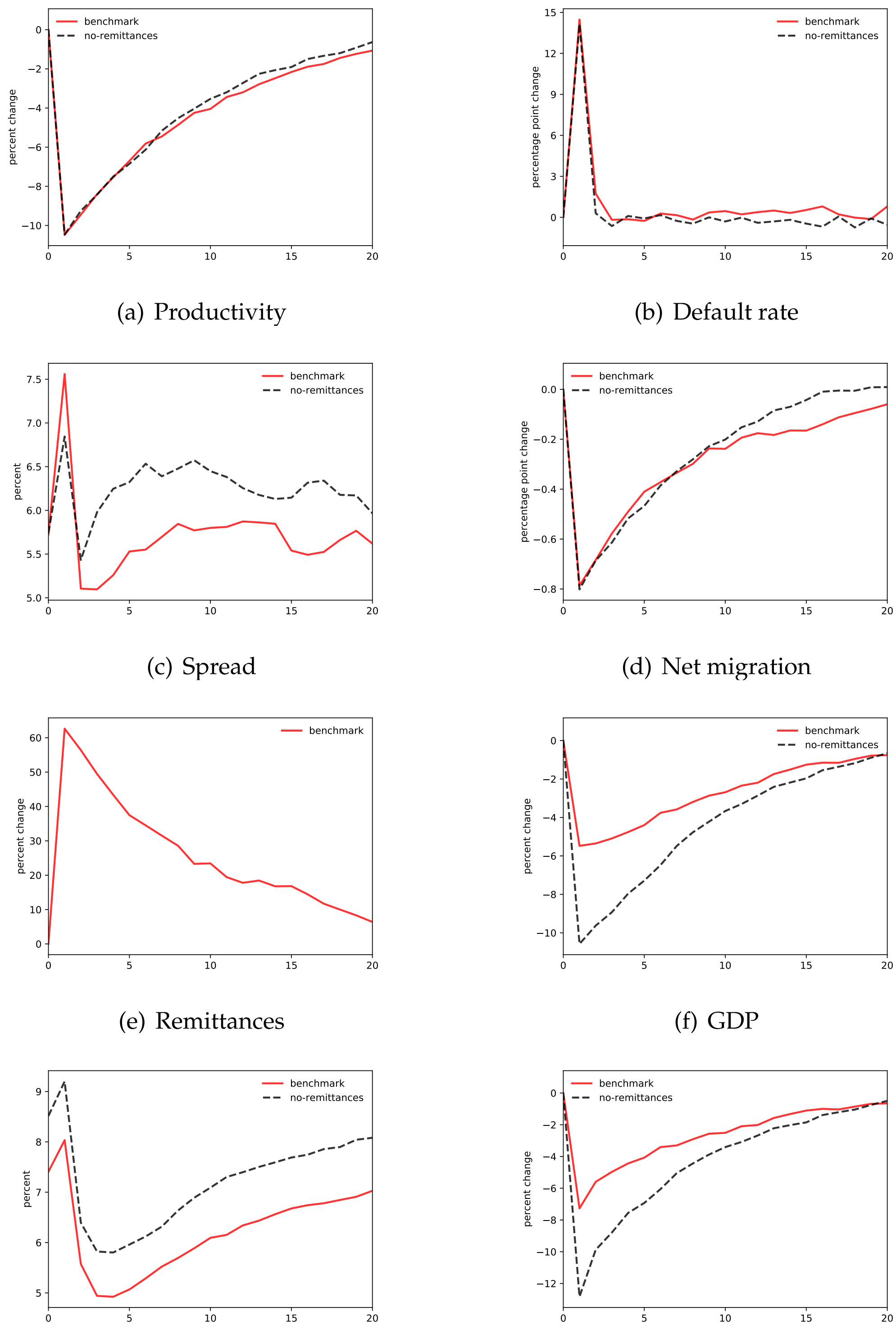
Panel d shows that more workers migrate out of the country during downturns. With more emigrants, remittances increase by 60 percent in the benchmark model following a negative productivity shock (Panel e). In terms of levels, it represents remittances-to-GDP ratio increasing from around 6 to 10 percent. Panel f illustrates how remittances received generate a gap between the country's income and its domestic production. Even though in both economies the productivity decline is the same (Panel a), the drop in GDP is twice as large in the economy without remittances. This is entirely due to the increase in remittances.

Panel g plots the response of debt-to-GDP ratio. In both economies, there is a substantial drop in debt-to-GDP ratio. Note before the shock, the equilibrium level of debt-to-GDP is substantially smaller in the benchmark economy, consistent with the higher spread schedule in Figure 3. Finally, Panel h shows that remittances allow countries to better weather the storm as consumption drop by around a half of the decline in the model without remittances. Note consumption drops by more than GDP in both models due to the decline in the net foreign asset position from the increase in the spreads.

5 Cross-sectional Analysis

While in the previous section we studied the effect of remittances on sovereign default risk by comparing it to a model without remittances, in this section we examine whether the benchmark model can reproduce the empirical facts documented in section 2. To do so, we consider 88 calibrations of the model for each of the country in our "+R,-M" sample of developing countries. Precisely, we vary F, $\bar{m}$, and ϕ to generate the observed net remittances-to-GDP and the average and standard deviation of net migration of each country. The targeted moments of each country are reported in Table B.3 of the Appendix. We then simulate the 88 calibrations of the model to generate a simulated country-year panel that mimics the data and allows us to run analogous regressions to equations 1 to 3 of our empirical analysis, that is controlling the same aggregate variables (except prices and unemployment) and including country fixed effects.

Table 7 reports the result. Column 1 reproduces the three coefficients of interest from the data (column 3 of Tables 1 to 3) and column 2 presents the results of the model simulations. We find that qualitatively we are able to reproduce the correlations of the data, as the sign of the correlations are the same in the model and the data. Especially in the case of facts 2 – migration and spreads – and 3 – spreads and remittances –, this result is not trivial since F, ϕ, and $\bar{m}$ vary across countries and jointly determine the response of spreads, remittances and emigration to productivity shocks. Thus, it might not necessarily be the case that countries with higher remittances also display higher levels of spreads, as possibly lower values of ϕ and $\bar{m}$ could decrease their spread response. Nevertheless, quantitatively the results of the model differ by orders of magnitudes from the model, especially in the case of fact 1 – remittances and migration. We conjecture that by introducing additional uncertainty to the model, for example in the foreign income process, the model could be further aligned with the data.



(a) Productivity (b) Default rate

(c) Spread (d) Net migration

(e) Remittances (f) GDP

(g) Debt-to-GDP (h) Consumption

Figure 4: IRFs in Benchmark Model and No-Remittances Model

Notes: This figure plots the impulse response functions to a negative productivity shock in the benchmark model (solid lines) and no-remittances model (dashed black lines). Productivity, remittances, GDP, and consumption are in percent changes; spread and debt-to-GDP are in levels (unit is percent); and the default rate and net migration rate are in percentage point changes.

Table 7: Regression with Model-simulated Data

	Data	Model
Net. Rem./GDP on Net. Mig. pc (Fact #1)	-0.20	-3.25
Net. Mig. pc on Spreads (Fact #2)	-0.19	-0.02
Spreads on Net Rem./GDP (Fact #3)	0.04	0.13

6 Extensions

6.1 Alternative Government Preferences

We consider two alternative assumptions related to social welfare function. First, the government cares about average utility of the staying workers. Second, the government cares both the staying workers and the emigrants. Under the first assumption, the repayment value and the default value of the government are given by:

$$V^c(z,B) = \max_{C,B'} \quad u\left(\frac{C}{\tilde{L}}\right) + \beta\mathbb{E}[V(z',B')]$$

and

$$V^d(z) = \max_{C} \ u\left(\frac{C}{\tilde{L}}\right) + \beta\mathbb{E}[\lambda V(z',0) + (1-\lambda)V^d(z')].$$

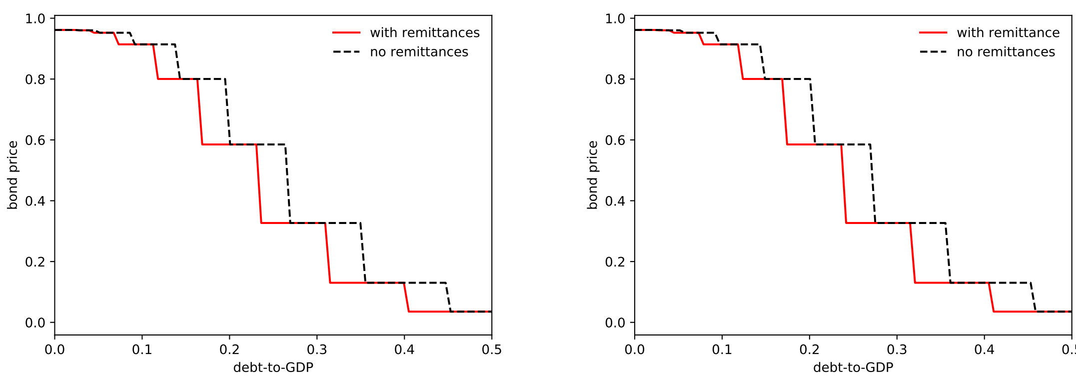
Under the second assumption, the repayment value and the default value of the government are given by:

$$V^c(z,B) = \max_{C,B'} \quad u\left(C\right) + \beta\mathbb{E}[V(z',B')]$$

and

$$V^d(z) = \max_{C} \ u\left(C\right) + \beta\mathbb{E}[\lambda V(z',0) + (1-\lambda)V^d(z')].$$

We resolve the model under those alternative government preferences. Table B.4 reports the moments generated by the models under alternative social welfare function assumptions. With alternative assumptions, the models generate similar moments as in the benchmark. Figure 5 plots the bond price schedules as functions of debt-to-GDP ratios for the model with and without remittances under the alternative assumption that government cares about the average utility of the staying workers (Panel (a)) and alternative assumption that government cares about both staying workers and emigrants (Panel (b)). Consistent with our benchmark model, remittances are associated with lower bond prices, i.e., higher levels of bond spreads.



(a) Average Utility (b) All Citizen

Figure 5: Bond Price Schedule Comparison Under Alternative Government Preferences
Notes: This figure plots the bond price schedule as a function of debt-to-GDP ratio for the model with remittances (solid red lines) and the model without remittances (dashed black lines). Panel (a) assumes that the government cares about the average utility of the staying workers. Panel (b) assumes that government cares about both staying workers and emigrants.

6.2 Model with Capital

In this section, we incorporate capital into the model. In particular, the aggregate output Y is produced with capital K and labor L using a Cobb-Douglas production function $Y = zK^{\alpha}L^{1-\alpha}$. If the government repays its debt, it can choose both investment and new international borrowing, B', by solving the following dynamic programming problem:

$$V^c(z, K, B) = \max_{C,B',K'} \quad \tilde{L}u\left(\frac{C}{\tilde{L}}\right) + \beta\mathbb{E}[V(z', K', B')] \tag{7}$$

subject to the budget constraint:

$$C + B = zK^{\alpha}(\tilde{L})^{1-\alpha} - K' + (1-\delta)K + Q(z, K', B')B' + mF, \tag{8}$$

where output is produced with current capital stock K and post-migration workers $\tilde{L}$, $Q(z, K', B')$ is the bond price and $Q(z, K', B')B'$ are the proceeds of government issuing debt. The default value is given by:

$$V^d(z, K) = \max_{C, K'} \tilde{L}u\left(\frac{C}{\tilde{L}}\right) + \beta\mathbb{E}[\lambda V(z', K', 0) + (1 - \lambda)V^d(z', K')]$$

subject to the budget constraint

$$C = z_d K^\alpha (\tilde{L})^{1-\alpha} - K' + (1 - \delta)K + mF,$$

where $m = \bar{m}e^{\phi(\bar{z}/z_d - 1)}$ increases relative to no-default due to the productivity loss z_d. During a default, the country cannot engage in international borrowing or saving. However, it can still self-insure through capital accumulation.[12] The bond price schedule is given by:

$$Q(z, K', B') = \frac{1}{1 + r}\mathbb{E}[1 - D(z', K', B')],$$

which depends on the country current shock z, level of capital, K', and debt, B'.

Quantitatively, we set the capital depreciation rate δ to 10% and the capital share α to 0.5, following Alessandria et al. [2020]. We recalibrate the model such that the model generates the targeted data moments as listed in Table 5. Table 8 presents the parameters in this with-capital model. With the recalibrated model, we shut down remittances by setting $F = 0$ and compare the bond price schedules. Figure 6 plots the bond price schedules for the model with remittances and the model without remittances. It indicates that the inclusion of capital into the model does not change our baseline results.

[12] Note that this formulation implicitly assumes that remittances are used for consumption and investment at the same rate as income from production. Despite the conventional wisdom that remittances are mostly used for consumption, Giuliano and Ruiz-Arranz [2009] provides evidence that remittances are used to finance investment.

Table 8: Matching Same Moments in Benchmark and Model with Capital

Parameter	Description	Benchmark	With Capital
η_z	Std. productivity shocks	0.086	0.049
χ_1	Default loss	-0.3	-0.3
χ_2	Default loss	0.37	0.348
F	Foreign income	5.8	10
ϕ	Elasticity of emigration	4.8	9.5

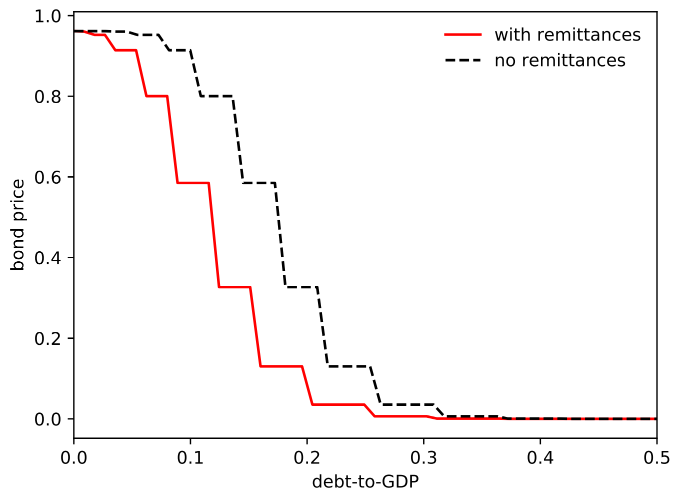


Figure 6: Bond Price Schedule Comparison for Model with Capital
Notes: This figure plots the bond price schedule as a function of debt-to-GDP ratio for the with-remittance (solid red line) and the no-remittance model (dashed black line) when we include capital.

7 Conclusions

Spurred by rising international migration, in the last three decades, remittances received have become an important fraction of many developing country's national income. In this paper, we examine how remittances affect country's sovereign default risk. Remittances received introduce non-trivial effects into the standard sovereign default model since they are neither subject to the same uncertainty as domestic production nor to the typical sanctioning mechanisms enforcing debt repayment. In our data analysis, we show government spreads tend to correlate positively with remittances across developing countries. To reproduce this pattern in a model of sovereign default with emigration and remittances, the counter-cyclical nature of emigration and thus remittances is crucial. As the government internalizes that remittances can cushion against the productivity losses from default, the value of default increases relative to a model with the same emigration rate but no remittances and lenders require a higher return on their loans to the sovereign. In equilibrium, this leads to higher spreads and/or lower debt levels. Thus, our paper provides a new mechanism that explains why many developing countries tend to face high borrowing costs even with relatively low levels of debt.

While our analysis provides a sharp implication of the effects of remittances on sovereign default risk, it also abstracts from some potentially important aspects. For instance, by focusing on the consolidated planner's problem, all remittances become readily available for debt repayment in the same period. Arguably households may decide to spend remittances received differently during economic downturns than in normal times. Moreover, for tractability, in our model emigrants return in each period. However, in the more realistic case of an existing stock of emigrants already abroad and sending remittances, the current stock of emigrants becomes an additional state variable of the government default decision, leading to potentially interesting dynamics. Finally, an interesting future research question is to consider what policies may allow reducing the increased borrowing costs due to remittances.

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Appendix

A Alternative No-Remittances Calibrations

In section 4 we quantified the no-remittances model by using the same fundamentals as in our benchmark model, with the exception of the foreign income F, set to zero. The main advantage of this choice is that it allows us to control for the labor channel, as both in equilibrium and in response to shocks, both models deliver the same net migration. In this section we compare our benchmark model to two alternative versions of economies for which foreign income, F, is zero.

The first alternative no-remittances economy, which we call *same GDP*, considers the same parameter values as our benchmark economy with remittances except that the the average productivity, $\bar{z}$, is set to match the benchmark's equilibrium GDP. Note that we need a higher $\bar{z}$ to match the same GDP due to the lack of remittances contributing to GDP in this economy. While this economy allows us to fix in the two country's gross income to be the same, it no longer implies the same emigration flows as the benchmark. Our second alternative no-remittances economy, labeled *same moments*, recalibrates the parameters listed in Panel b of Table 4, except foreign income, to match the moments in Table 5, except average remittances-to-GDP. The resulting parameter values are reported in Table A.1. To generate the same moments, the no-remittances model requires lower productivity shock volatility (η_z), a smaller default loss parameter (χ_2), and a higher elasticity of emigration to productivity (ϕ). The intuition is as follows: without remittances, the model produces greater GDP volatility since in the limiting distribution foreign income is less volatile than domestic output. Therefore, to match the same GDP volatility, a lower productivity shock volatility (η_z) is required. With smaller productivity shocks, a lower default penalty (χ_2) is necessary to obtain the same spread level, as reduced punishment increases the default risk and the spread. Finally, lower productivity volatility decreases migration volatility, so a larger elasticity (ϕ) is required to match the volatility of net migration.

Table A.1: Matching Same Moments in Benchmark and No-remittances Model

Parameter	Description	Benchmark	No-Remittances
η_z	Std. productivity shocks	0.086	0.062
χ_1	Default loss	-0.3	-0.3
χ_2	Default loss	0.37	0.36
F	Foreign income	5.8	0
ϕ	Elasticity of emigration	4.8	7.1

Note. This table reports the parameters used in benchmark model and the *same moments, no-remittances* reference model. Both calibrations target the moments listed in Table 5, except for the average remittances-to-GDP which is zero in the no-remittances model.

Next we consider their bond price schedule in comparison to the benchmark model. Figure A.1 plots the schedules of all four calibrations of the model. When the no-remittances model is characterized by the same fundamentals and same GDP as the benchmark economy, the bond price schedule shifts further to the right in comparison the no-remittances model presented in the main article. Thus, the spread differential caused by remittances increases even further. The reason is that although both economies have the same income, the default penalty is effectively smaller in the economy with remittances, inducing lenders to require a higher spread at each level of debt. In the case of the "same moments" no remittances economy, the effect of remittances on the spread becomes ambiguous. At low levels of debt-to-GDP the spread is higher, while at high levels of debt-to-GDP the spread with remittances is smaller. This may be explained by the additional differences in parameter values other than F: A smaller productivity shock volatility (η_z) decreases the sovereign default risk, while a slightly smaller default loss (χ_2) a substantially larger elasticity of emigration (ϕ) increase the sovereign default risk.

We now turn to the comparison of the response to a negative productivity shocks. Figure A.2 presents the results. First, we discuss the response of the "same GDP" economy. They are plotted with blue dotted lines and labeled as "no-remittances: same fundamental, same GDP" in the figures. Following a negative productivity shock (Panel a), the increase in default rate is significantly larger as it goes from around 15 to around 35 percent. This translates into an observed reduction in spreads – as observing spreads is conditional on

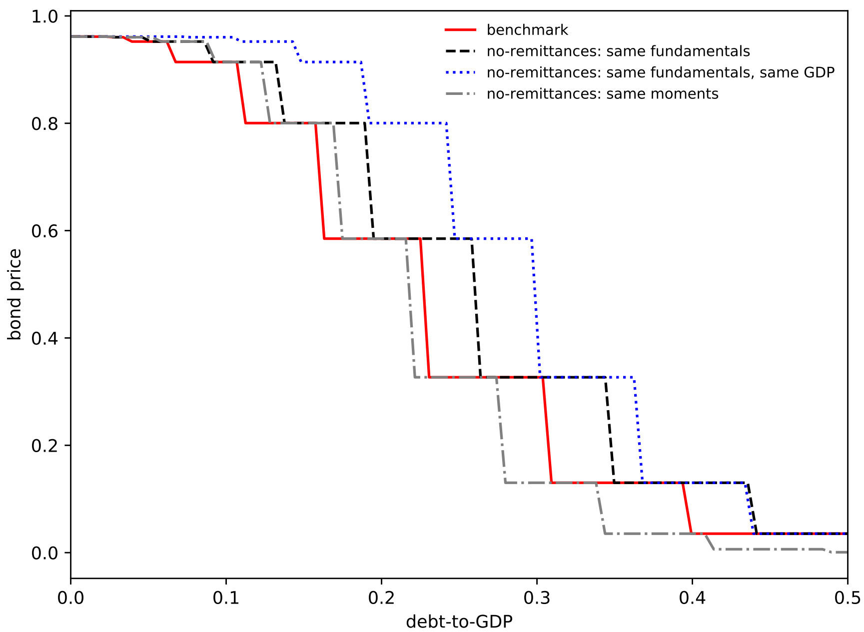
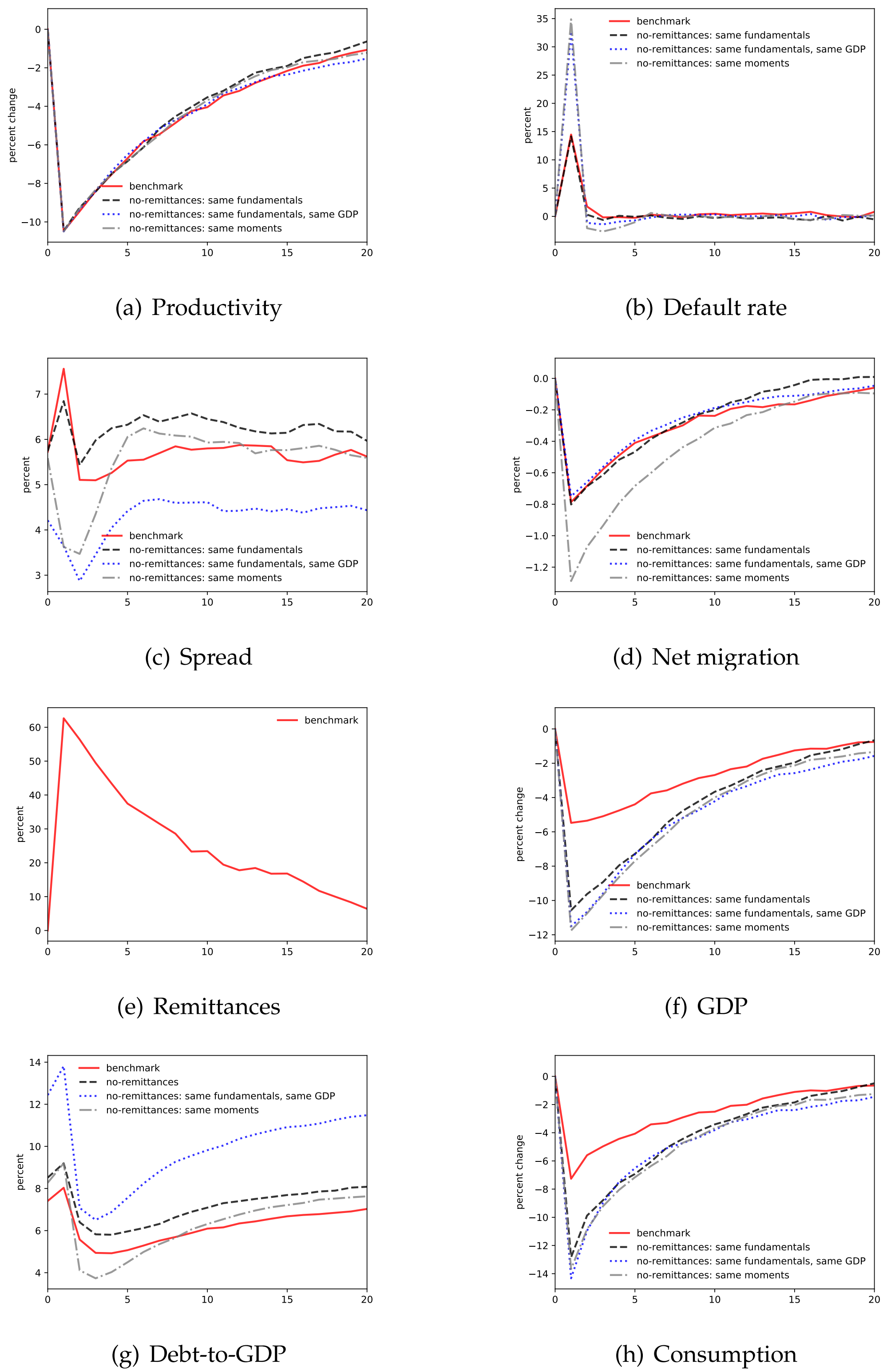


Figure A.1: Bond Price Schedule with Alternative No-Remittances Calibrations
Notes: This figure plots the bond price schedule as a function of debt-to-GDP ratio for the benchmark model with remittances (solid red line) and the three calibrations of the model without remittances.

no default, and those simulations of the "same GDP" economy that didn't default have relatively high productivity at the time of the shock. Also, as shown in Panel g, the decline in the debt-to-GDP ratio is large, contributing to a lower spread in response. The decline in GDP is also larger than the no-remittances model with same fundamentals. This is because with higher default rate, the effective productivity is lower, leading to lower GDP (Panel f) and lower consumption (Panel h).[13] Note that before the shock, this economy has lower equilibrium spread (Panel c) and higher debt-to-GDP (Panel g) due to the fact that this economy has higher equilibrium productivity level (to match the same level of GDP).

Next, we discussion the response of the "same moments" economy. They are plotted with gray dash-dotted lines and are labeled as "no-remittances: same moments" in the figures. The response to a negative productivity shock in the "same moments" no-remittances model is again markedly different than the no-remittances model with the same fundamentals as our benchmark. Similar to the case of the "same GDP" no-remittances model, the default rate is significantly larger. However, more workers emigrate (Panel d) because the elasticity of emigration to productivity is higher in this recalibrated economy (see higher ϕ in Table A.1). With more emigrants and thus smaller working population, the decline in GDP is larger (Panel f). In terms of spread (Panel c), since the parameters are recalibrated to match equilibrium spread, unlike the "same GDP" no-remittances model, the equilibrium spread before the shock is the same as other models and higher than that in "same GDP" no-remittances model. Following the negative productivity shock, the spread declines because the default rate is very high, meaning that the paths plotted for the spread correspond to selectively better economic conditions. In addition, the debt-to-GDP ratio declines more compared to the no-remittances model with the same fundamentals. With lower debt, the spread also tends to decline. The comparison between the benchmark model and this alternative remittances model is complicated by the fact that, besides remittances, other factors determining sovereign default risk also differ significantly from those in the benchmark model with remittances. In particular, the level of debt is higher at the time of the shock, and the increase in emigration is substantially larger.

[13] We have also considered giving both economies the same GDP shock, where we adjust the sizes of the productivity shocks such that the economies have the same decline in GDP. In this case, the increase in spreads and default probabilities is higher in the economy with the same GDP.



(a) Productivity

(b) Default rate

(c) Spread

(d) Net migration

(e) Remittances

(f) GDP

(g) Debt-to-GDP

(h) Consumption

Figure A.2: IRFs in Benchmark and Alternative No-Remittances Models

Notes: This figure plots the impulse response functions to a negative productivity shock in the benchmark model (solid lines) and all three no-remittances models. Productivity, remittances, GDP, and consumption are in percent changes; spread and debt-to-GDP are in levels (unit is percent); and the default rate and net migration rate are in percentage point changes.

B Additional Tables

Table B.1: Net Migration and RGDP

				HP-filtered controls	
				$\lambda = 6.25$	$\lambda = 10^6$
Sample:	Baseline	High Income	+R,-M	Baseline	Baseline
	(1)	(2)	(3)	(4)	(5)
Dep. Var.: Net Migration pc					
RGDP pc	0.24***	0.80***	0.30***	0.04***	0.01***
	(0.05)	(0.12)	(0.08)	(0.00)	(0.00)
Observations	5051	2723	3368	5051	5051
Adjusted R^2	0.21	0.46	0.17	0.22	0.22
Dep. Var.: Δ Net Migration pc					
Δ RGDP pc	3.34***	-0.16	3.74***	0.05***	0.03***
	(0.27)	(0.42)	(0.39)	(0.00)	(0.00)
Fixed Effects	i,t	i,t	i,t	i,t	i,t
Number of Countries	133	76	88	133	133
Observations	4998	2692	3333	4998	4998
Adjusted R^2	0.00	-0.02	-0.00	0.01	0.00

Note. Robust standard errors are in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table B.2: Target Moments from the Data by Countries

	Std.	Spreads		Avg. Net	Net Mig. pc	
	RGDP pc	Avg.	Std.	Rem./GDP	Avg.	Std.
Afghanistan	13.95			0.32	-0.50	4.89
Albania	20.56			11.34	-1.19	0.64
Armenia	20.72			11.91	-1.12	1.13
Azerbaijan	34.21	3.09	0.79	0.59	-0.17	0.32
Burundi	14.32			0.87	-0.33	2.65
Burkina Faso	7.60			1.89	-0.18	0.17
Bangladesh	17.79			5.60	-0.29	0.19
Bulgaria	13.29	2.68	2.56	3.12	-0.21	0.11
Bosnia and Herzegovina	23.97			14.40	-0.82	2.11
Bolivia	11.07			1.75	-0.20	0.09
Brazil	10.82	4.37	4.71	0.14	0.00	0.02
China	13.09	0.84	0.45	0.13	-0.03	0.02
Colombia	5.51	2.76	1.98	1.34	0.00	0.28
Comoros	5.70			6.46	-0.37	0.17
Cabo Verde	15.54			12.80	-0.76	0.61
Dominica	10.81			4.83	-0.91	0.97
Dominican Republic	7.42	4.81	2.35	7.21	-0.33	0.06
Algeria	10.04	7.94	4.99	0.62	-0.04	0.13
Ecuador	7.07	11.73	7.44	2.78	-0.08	0.25
Egypt	6.63	3.34	1.82	6.31	-0.01	0.06
Eritrea	9.91			0.14	-0.71	2.83
Fiji	7.05			2.79	-1.00	0.49
Micronesia, Fed. Sts.	3.90			1.09	-1.44	0.98
Georgia	47.75	4.62	2.59	9.17	-1.13	1.07
Ghana	21.60	5.94	1.84	1.35	-0.12	0.25
Guinea	4.85			0.00	-0.22	0.54
Guinea-Bissau	9.60			1.14	-0.38	0.46
Grenada	8.70			3.74	-0.75	0.81
Guatemala	6.11	2.50	0.51	6.11	-0.37	0.12
Honduras	4.89			14.58	-0.18	0.11
Haiti	11.06			9.87	-0.34	0.04
Indonesia	6.45	1.72	1.03	0.64	-0.01	0.02
India	13.28	1.60	0.40	2.18	-0.02	0.02
Iraq	22.71	4.58	2.87	0.13	-0.03	1.21
Jamaica	8.48	4.86	1.53	9.31	-0.69	0.27
Kenya	8.52			1.69	-0.12	0.12
Kyrgyz Republic	20.70			12.98	-0.58	0.40
Kiribati	8.86			7.69	-0.62	0.29
Lao	7.59			0.41	-0.31	0.22
Lebanon	19.84	7.19	12.90	6.79	-0.08	2.61
Liberia	11.27			4.33	-0.20	5.63
St. Lucia	13.88			2.12	-0.42	0.45
Sri Lanka	8.20	5.70	3.21	6.68	-0.31	0.17
Lesotho	7.04			62.77	-0.52	0.46
Morocco	4.18	3.05	1.67	5.90	-0.29	0.12
Moldova	7.33			17.63	-0.99	0.77
Madagascar	9.31			0.94	-0.01	0.01
Mexico	8.27	1.91	1.45	2.21	-0.33	0.25

Note. All variables except real GDP per capita (column 1) are in percent. Net remittances are defined as remittances received minus remittances paid; net migration is immigration minus emigration.

Table B.3: Target Moments from the Data by Countries, continued

	Std.	Spreads		Avg. Net	Net Mig. pc	
	RGDP pc	Avg.	Std.	Rem./GDP	Avg.	Std.
Marshall Islands	10.63			7.45	-2.20	1.45
North Macedonia	7.78			2.90	-0.32	0.51
Mali	5.11			2.94	-0.42	0.31
Myanmar	32.64			1.84	-0.18	0.12
Montenegro	5.51			9.16	-0.39	0.17
Mongolia	19.77	5.20	1.80	1.61	-0.18	0.24
Mozambique	14.00			0.42	-0.23	0.89
Nicaragua	21.56			10.74	-0.56	0.17
Nepal	10.66			14.52	-0.43	0.55
Pakistan	5.07	6.18	3.58	5.28	-0.15	0.54
Peru	20.24	2.49	1.99	1.01	-0.22	0.37
Philippines	11.86	2.50	1.79	7.24	-0.20	0.13
Paraguay	12.42			1.15	-0.30	0.25
West Bank and Gaza	10.42			14.51	-0.37	0.69
Rwanda	25.21			0.03	-0.20	6.11
Sudan	18.15			2.21	-0.35	0.55
Senegal	7.96	4.77	0.81	3.75	-0.31	0.13
Sierra Leone	19.19			1.18	-0.22	1.57
El Salvador	12.12	4.00	1.40	13.49	-1.05	0.43
Somalia	3.68			3.58	-0.56	2.16
Sao Tome and Principe	2.25			2.40	-0.85	0.33
Eswatini	6.43			4.61	-0.59	0.94
Syria	25.52			0.50	-0.46	2.35
Togo	10.48			2.66	-0.02	1.20
Tajikistan	43.23			27.26	-0.48	0.51
Tonga	4.42			22.59	-2.02	0.44
Tunisia	6.69	3.08	2.02	4.18	-0.11	0.13
Turkiye	6.43	3.88	2.32	0.14	-0.01	0.24
Tuvalu	7.37			10.68	-0.82	0.70
Tanzania	6.43			0.23	-0.12	0.42
Uganda	6.49			1.66	-0.25	0.32
Ukraine	26.14	8.15	5.86	4.53	-0.04	0.14
Uzbekistan	18.46			8.70	-0.15	0.07
St. Vincent and the Grenadines	6.92			4.17	-1.40	0.33
Vietnam	3.55	1.77	1.14	5.12	-0.05	0.08
Vanuatu	4.20			1.54	-0.40	0.21
Samoa	6.70			18.45	-1.88	0.57
Kosovo	2.37			15.39	-1.44	2.50
Yemen, Rep.	19.44			11.73	-0.22	0.15
Zimbabwe	17.62			4.10	-0.37	1.07
Average	15.11	4.17	4.56	5.66	-0.46	1.40
United States	4.90	-	-	-0.25	0.43	0.14

Note. All variables except real GDP per capita (column 1) are in percent. Net remittances are defined as remittances received minus remittances paid; net migration is immigration minus emigration.

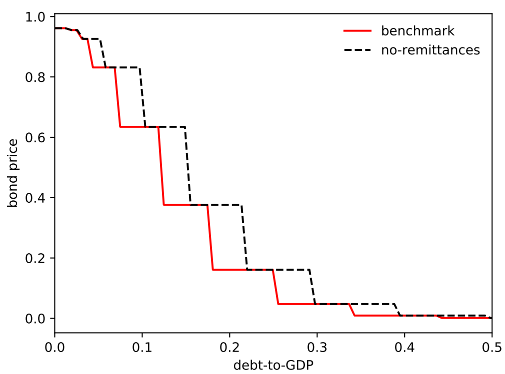
Table B.4: Moments with alternative social welfare functions

	Benchmark	Average Utility	All Citizen
SD GDP (%)	14.93	14.94	14.96
Avg spread (%)	4.16	4.21	4.08
SD spread (%)	5.10	5.08	4.78
Avg remittances-to-GDP (%)	5.51	5.48	5.51
SD net migration (%)	1.44	1.42	1.44

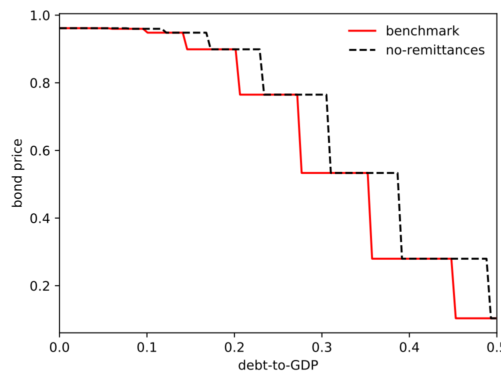
Note. This table reports the simulated moments for the alternative social welfare functions. "Benchmark" refers to our benchmark model, where the government maximizes the aggregate utility of all staying workers. "Average Utility" refers to an alternative assumption that the government maximizes the average utility of all staying workers. "All Citizen" refers to an alternative assumption that the government maximizes the aggregate utility of all citizen, including both the staying workers and the emigrants.

C Additional Figures

Figure C.1 plots the bond price schedules when we use different levels of productivity instead of the median productivity level. As shown, despite varying productivity levels, the bond price schedules follow a consistent pattern as in Figure 3(a): in the benchmark model with remittances, the government faces lower bond price schedule, i.e., a higher spread for the same level of debt-to-GDP than in the no-remittances model.



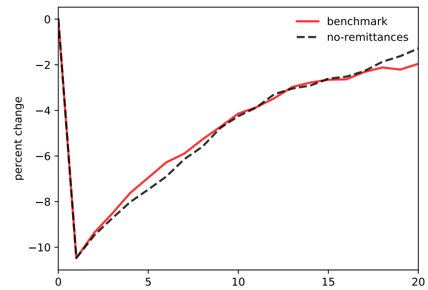
(a) Low z



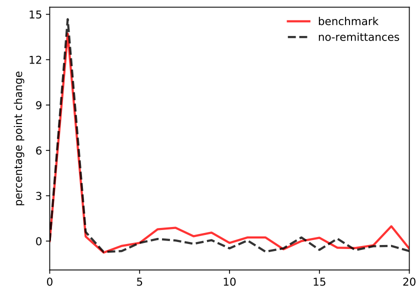
(b) High z

Figure C.1: Bond price schedule for different levels of productivity
Notes: This figure plots the bond price schedule as a function of debt-to-GDP ratio for the model with remittances (solid red lines) and the model without remittances (dashed black lines) with different productivity levels.

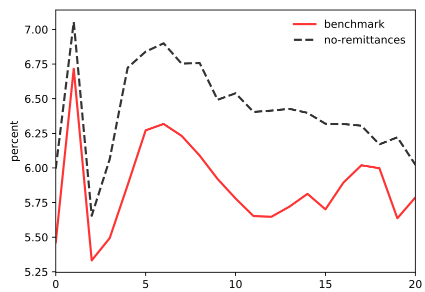
Figure C.2 plots the impulse response functions to a negative productivity shock in the benchmark model (solid lines) and no-remittances model (dashed black lines) when we have a constant labor force ($\phi = 0$). The method of shutting down remittances here follows the main article, i.e., set foreign income F to 0, while keeping other parameters the same. With constant labor force, remittances do not play a significant role in the responses of the economy. With a negative productivity shock, migration (Panel d) and remittances (Panel e) do not change. The default rate (Panel b) and spread (Panel c) increase are of the similar magnitude. The declines in GDP (Panel f), debt-to-GDP (Panel g) and consumption (Panel h) are similar as well. This is consistent with Figure 3(b), which highlights that countercyclical emigration and remittances are key features of the model that allow us to replicate the pattern in the data.



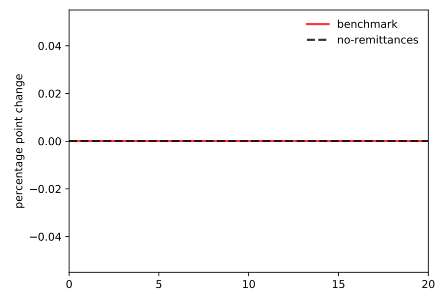
(a) Productivity



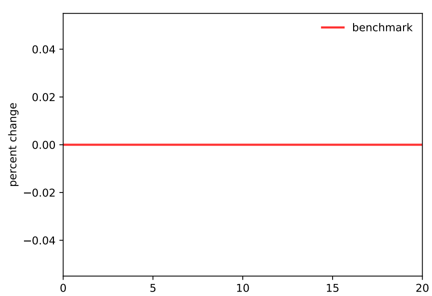
(b) Default rate change



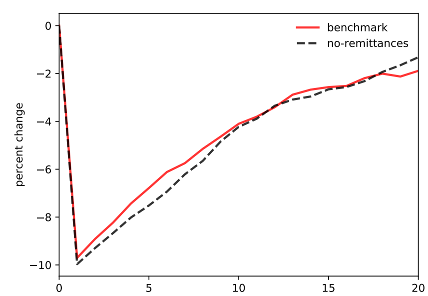
(c) Spread



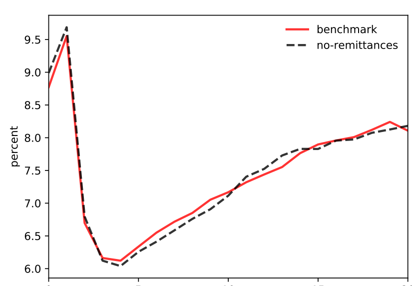
(d) Net migration change



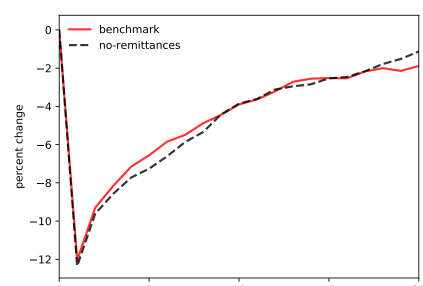
(e) Remittances



(f) GDP



(g) Debt-to-GDP



(h) Consumption

Figure C.2: IRFs in Benchmark Model and No-Remittances Model under Constant Labor

Notes: This figure plots the impulse response functions to a negative productivity shock in the benchmark model (solid lines) and no-remittances model (dashed black lines) when labor is constant. Productivity, remittances, GDP, and consumption are in percent changes; spread and debt-to-GDP are in levels (unit is percent); and the default rate and net migration rate are in percentage point changes.