UNIVERSITAT DE BARCELONA

Essays on structural transformations: remittances, fertility and informality

Arianna Garofalo

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PhD in Economics

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Essays on structural transformations: remittances, fertility and informality

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1 Introduction

Developing nations have different economic aspects in common like poverty, high dependency from the agriculture sector, migration, remittances, high fertility rate, and informal economy. The three chapters of the thesis focus on three noteworthy characteristics of developing countries as structural change, the decline of fertility, and the decrease in the informal size of the economic activities. In the first chapter, I investigate how external factors such as remittances sent by migrants in the countries of origin shift employment from manufacturing to services. In the second chapter, I study how migration negatively affects fertility in the origin countries. In the third chapter, we examine how the demand for quality embodied in goods and services in the formal market drives the observed labor reallocation across the informal and formal sectors. In the development process, the flow of money sent at home by migrants can bring changes in the demographic trends, allocation of resources, and sectoral composition of employment. The reallocation of economic activity across three broad sectors of an economy, from agriculture to industry, and from industry to services, has been of great interest to economists for its implication on productivity, labor force participation, income inequality, and other aspects of development. In particular, the last decades have been characterized by an increase in the service sector, driven by different variables.

The literature about the structural transformation and the driving forces behind it focused on two main mechanisms: the income effect, resulting from non-homothetic preferences in a multi-sector growth model (Echevarria, 1997, Kongsamut et al., 2001, Laitner, 2000, Echevarria, 1997, Caselli and Coleman, 2001, Foellmi and Zweimuller, 2008, Boppart 2014, Duarte and Restuccia, 2014, Herrendorf et al., 2013, Buera and Kaboski 2015), and relative price effects, resulting from the heterogeneous sectoral production functions in the multi-sector growth model (Ngai and Pissarides, 2007, Acemoglu and Guerrieri, 2008, Alvarez-Cuadrado, 2017). In the first mechanism, as the income increases, the marginal rate of substitution varies across the three-sector, reducing the relative need for workers in agriculture, and leading to labor reallocation towards the most expensive goods and services. Kongsamut et al., (2001) were the first to address this mechanism, trying to be consistent with the Kaldor facts and Kuznets facts. Foellmi and Zweimuller (2008) study that when the income grows, the share of agricultural goods consumed de-

clines, the share of services demanded increases and the pattern for manufacturing has a hump-shaped curve. Herrendorf (2013) shows the same pattern, building panel data for the US for the period 1947-2010, founding that the service sector is more capital-intensive than manufacturing while the agriculture sector is more capital-intensive than the manufacturing sector. Authors like Boppart (2014) and Buera and Kaboski (2015) quantify the importance of the two effects. According to the second mechanism, introduced first by Baumol (1967) together with the "cost-disease" hypothesis, the process of reallocation of the activities across sectors is the result of the variation in relative sectoral prices, which, the latter are induced by cross-sector differences in technology.

As a consequence, due to the differences in the rate of sectoral technical progress, the labor shifts from the sectors that grow the most to the sector in which productivity increases least. Ngai and Pissarides (2007) generalized this hypothesis, assuming that productivity grows at the fastest rate in agriculture and the slowest rate in services. In this case, the structural change is the result of changes in relative (sectoral) prices resulting from differences in productivity (TFP) growth across sectors. Acemoglu and Guerrieri (2008) emphasize the role of capital intensity assuming that agriculture is more capital-intensive than manufacturing, and at the same time, manufacturing is more capital-intensive than service. As a consequence, the relative supplies of capital and labor drive the change in the relative prices. Assuming that the elasticity of substitution between the two sectors is lesser than one, the employment shifts away from the capital-intensive sector for the same reasons as explained in Ngai and Pissarides (2007). Alvarez-Cuadrado et al. (2017) introducing the rebalancing effect, explored the structural change from the perspective of the sectoral differences in the elasticity of substitution between factors. According to them, the most flexible sectors, with higher elasticity of substitution between capital and labor, can become more capital-intensive, when the aggregate capital-labor ratio rises. This allows the sectoral capital-labor ratios to grow at a different rate and to develop differently the factor income shares. Uy, Yi, Zhang (2013), Swiecki (2017), Sposi (2019), and Lewis et al (2021) study how international trade helps the process of structural change. According to this theory, the opening of the border of the countries with differences in sectoral productivity and trade costs has as a result the reallocation of the activities driven by the comparative advantages.

At the same time, just as structural change analysis has an important part in development economics, studies of fertility change have also an important standing. The higher fertility rate is explained as a result of lack of family planning options, lack of education, and the belief that more children could result in a higher labor force for the family to earn income. Over the last 50 years, and along the development process, fertility rates have decreased drastically around the world. In particular,

as the income of the countries rises, the relationship between women's labor supply and fertility has inverted. The literature about the evolution of fertility has been widely explored, emphasizing its determinants and the different socioeconomic factors which contribute to its decrease. The first who approached the issue was Gary Becker (1960). He stated that parents obtain utility from the numbers and the quality of children and they are seen as a durable good. The idea of the model is that as the income of the family rises, parents will give the children a higher level of life, and then they will rise the number of children. Subsequently, he introduced the role of the decline of mortality as an explanation for the decline in fertility. According to Becker (1960), after the two previous effect, the household adjust the level of fertility in presence of a decrease in mortality, due to the better conditions of life. His thesis suggests that less mortality, together with the increase in income, increases the opportunity cost of raising children, inducing the parents to substitute the quality for the quantity of children and leading to a decrease in fertility. Mincer (1963) highlights the value of the time approach, focusing on female time allocation decisions.

In this model, the decline in fertility is the result of the increase in the salary of the working female, which increases the opportunity cost of having children. Becker (1960), also clarified the quantity-quality approach, where when the income expands the demand for quality of children gets more elastic and rises fastly, leading to a progressive reduction in the demand for quantity of children. Authors like Rosenzweig and Wolpin (1980), Hanushek (1992), Angrist et al. (2008), Rosenzweig and Zhang (2009) and Black et al. (2005), use data from different countries to quantify the importance of this mechanism. In subsequent papers, Becker and other scholars focused their attention on other factors which can affect fertility, household production (Becker, 1991), human capital (Becker,1993, Galor and Weil, 2000), and preferences (Becker, 1996, Becker and Kevin Murphy, 1988).

Concurrent with structural change and fertility, the informal economy remains another feature of developing countries. In presence of low qualifications and precarious working conditions, the informal sector represents a mechanism of job creation for the work-seeking in emerging economies. The literature examined the role of informality from the employment and consumer perspective. From the employment perspective, according to Lewis (1954), Harris and Todaro (1970), and De Soto (1989), informal jobs are the consequence of poverty and a strategy to have a subsistence level income for low-skilled workers. Perry et al. (2007), Loayza, Oviedo, and Servén (2006), De Paula and Scheinkman, (2010), (2011), and Bobba, (2021) analyze the role of human capital in the reduction of the informality, while Rauch, 1991, Maloney, 2004, Loayza, 1996, emphasize the role of the regulation and labor cost. La Porta and Shleifer (2014) and Loayza (2018) relate informality

with low productivity and low-skill workers. Other studies examine how informality evolves, suggesting that national programs of government (Ulyssea, 2018) and tax relief (de Mel, McKenzie, and Woodruff, 2013) contribute to the reduction of informality. From the demand side perspective, we can classify three explanations of the participation of the consumer in the informal market. In the first explanation, consumers maximize their utility buying at the lowest possible price, for financial reasons (Schneider and Enste, 2000; Williams, 2008, Williams, 2017, 2019). The second explanation is for social motives. (Williams 2006, 2008, Chikweche and Fletcher 2010, Viswanathan et al. 2012, Williams et al. 2012, Williams and Martinez-Perez 2014, Williams and Horodnic 2016, Marumo and Mabuza 2018). Consumers buy goods and services, in the informal sector, from relatives, neighbors, and acquaintances as a way of mutual help. The third explanation sees the individuals purchasing in the informal market for an institutional reason. According to this view, participation in this market is justified by the failure of the formal institutions which lacks of norms, laws, and regulation. (Culiberg and Bajde, 2013, Littlewood et al., 2018, Williams, 2008; Williams Horodnic, 2016; Williams Bezeredi, 2019). In this thesis, I contribute to the literature analyzing the effect of remittances, migration, and informality on developing countries.

In chapter 2, co-authored with X.Raurich, we analyze the effect of improvement in household income through remittances on the development process. In particular, we study how important are remittances to explain the observed rise of the services sector and their implication for economic growth in developing countries. To this end, we build a multisectoral growth model where we assume that migration is an exogenous choice, while, remittances are an exogenous variable to the model. In the model, the flow of remittances increases household income. Given the assumption of non-homothetic preferences, the demand for the good with higher income elasticity, which in this case is represented by services, will increase. As a consequence, employment is allocated to the services sector to satisfy the increasing demand for services. The model is calibrated to replicate the observed paths of employment in the service sector for 73 developing countries. Then, we perform two counterfactual exercises to quantify the role of remittances. The contribution is two-fold. The first contribution measures the importance of the income effect in developing countries and explains the sectoral composition. The result of the first counterfactual exercise indicates that, on average, 5.2% of the total employment services sector of a receipt-remittances country is due to remittances. The second contribution is to analyze the role of remittances in the process of development. In this case, the result of the second counterfactual exercise indicate that for three developing countries, selected because characterized by a high level of money flow, like Guatemala, Honduras and El Salvador, the remittances can explain respectively 5%, 12%, and

27% of this total variation in the share of employment in services

In chapter 3, I examine the negative relationship between fertility choices and the opportunity costs associated with migration. For this purpose I present a model based on Delacroix (2014) to quantify the role of migration on the reduction of fertility experimented by some developing countries in the last 26 years. In the model, we include the time dedicated to migrating, working in the home country, and taking care of children, which has not been left out of the analysis in standard macroeconomic models of fertility. We found that migration, through a general equilibrium mechanism, raises the cost opportunity to have children, which induces a reduction in fertility. This mechanism explains the inverse relationship between fertility and migration that we observe in the data. Adult members of the household divide their time between working, taking care of the children, and migrating abroad. They the foreign salary is higher they migrate. Through a general equilibrium effect, the individuals who stay have a higher salary but less available time to take care of the children. This raises the cost opportunity to have children which induce a reduction in fertility. To quantify the inverse relationship between fertility and migration we perform two counterfactual exercises. In the first, we raise the time migration cost, finding that a higher migration time cost is associated with a higher fertility rate. In the second we analyze how important is the mechanism of general equilibrium induced by migration to explain the cross-country differences in fertility, finding that, if the share of migrants had not changed over time, the difference between the countries that have the most children and the least children would have been higher than the observed differences in fertility. This chapter contributes to the literature by highlighting that migration is an important element to explain the evolution of fertility and provides a complementary mechanism to explain the demographic transition of developing countries.

In chapter 4 co-authored with E. Cruz, we study informality from the demand perspective with a focus on the Mexican economy. We first show empirical evidence that Mexico has been characterized by an increase in consumption and employment in the formal sector for goods and services. As a consequence, we argue that informal consumption decreases due to the increasing consumer demand for quality products, impulsing a reallocation from informal to formal jobs. To this end, we propose a dual growth model, consisting of goods and services, composed of formal and informal industries. The formal and informal industries produce goods and services and just the formal firms produce goods or services that embody quality, with taxable production. We assume that the quality embodied in the product from formal firms increases exogenously along the development process and that individuals consume goods and services, differentiating between formal and informal products based on the products' embody or lack of quality. In this model, we pro-

pose a new mechanism where the increasing demand for formal goods and services generates the reallocation of labor from informal to formal firms. For the Mexican economy, we first calibrate the model to replicate the stylized facts of the formal and informal economy in Mexico from 1995-2018, and then we analyze and quantify the effect of the consumers' demand for formal products on the observed change in informal employment. We found that quality contributes to explicating the change in the demand for goods and services respectively at the 31% and 41% and for the change in the employment for goods and services the 45% and the 65%.

2 Remittances and Structural Change[§]

2.1 Introduction

Structural change in the sectoral composition is one of the most robust facts of development. As countries develop, employment shifts from the goods (agriculture and manufacturing) to the service sector. This fact has been extensively analyzed by the literature that has proposed different mechanisms explaining the link between development and sectoral composition. One classical mechanism is the income effects that arise when preferences are non-homothetic. With this class of preferences, income elasticities are different across consumptions goods and, as a result, when income increases employment shifts towards those sectors with higher income elasticities (Alder et al., 2021; Boppart, 2014; Caselli and Coleman, 2001; Comin et al., 2021; Dennis and Iscan, 2009; Echevarria, 1997; Foellmi and Zweimueller, 2008; Kongsamut et al., 2001 and Laitner, 2000). Another mechanism is the price effect that arises when preferences are such that the elasticity of substitution is different from one. When this elasticity is lower than one, Ngai and Pissarides (2007) show that the observed increase in the price of services relative to the price of goods can explain the shift of employment towards the service sector.[2]

In this paper, we contribute to this literature that explains the process of structural change in the sectoral composition by showing that remittances of emigrants may explain a sizeable part of the differences in sectoral composition among developing countries. To show the effect of remittances, we first document a strong and positive correlation in developing countries between remittances and employment

[§]This chapter is co-authored with Dr. Xavier Raurich from Universitat de Barcelona (Spain).

[2]More recently, the literature has introduced other mechanism. For instance, the process of capital deepening associated to development also generates structural change when capital intensities are different across sectors (Acemoglu and Guerrieri,2008) or when there are differences in the capital-labor substitution (Alvarez-Cuadrado et al., 2017). Another example is Garcia-Santana et al. (2021) who show that the dynamics of the investment rate may alter the sectoral composition.

in the services sector.[3] We argue that this correlation is the outcome of an income effect generated by remittances. Remittances increase households' income, and consumption demand shifts towards the service sector when the service sector has a larger income elasticity. This variation in the composition of consumption demand leads to a gradual increase in the size of the service sector and explains the shift of employment towards this sector. Therefore, we argue that remittances affect the sectoral composition through an income effect. The literature has already stressed the importance of the income effect. For instance, Dennis and Iscan (2009) analyze the movement of activities out of agriculture in the United States from 1820 to 2000 and Comin et al.(2021) focus on OECD countries from 1970 to 2005. These authors conclude that the income effect has been the dominant mechanism explaining the shift of labor from goods to services in later stages of economic development. Consistent with these findings, we argue that remittances may be an important factor explaining cross-country differences in sectoral composition, since they are an important source of income in many developing countries.

We measure the effect of remittances on sectoral composition using a two-sector growth model in which households' preferences are non-homothetic and imply that the income elasticity of the consumption of services is larger than the income elasticity of the consumption of goods. We also assume that the fraction of population that emigrates and the amount of remittances are exogenous variables. Remittances increase household income and, given the differences in sectoral income elasticities, they contribute to explain the shift of employment towards the service sector.

We calibrate the model to explain the observed patterns of structural change in the sectoral composition of a sample of 73 developing countries (poor and middle-income countries). We use this calibration, to perform two difference quantitative exercise. In a first exercise, we measure the effect of remittances to explain cross-country differences in sectoral composition. We show that remittances can explain 5.2% of the average size of the service sector in our sample of countries. We also show that the effect of remittances on sectoral composition is significative to explain differences between poor and middle-income countries, whereas it is a minor to explain differences in sectoral composition among more developed countries. In the second exercise, we study the importance of remittances to explain the process of structural change in the sectoral composition in the period 1995-2019, for three developing countries, El Salvador, Guatemala, and Honduras. These countries are selected because they exhibit a high level of remittances and a sizable shift of labor from agriculture to service sector. Our results indicate that remittances contribute

[3]The data are described in more detail in section 2.

to explain a significant part of the total variation in the share of employment in services in these countries. In particular, remittances explain respectively 5%, 12% and 27% of this total variation in Guatemala, Honduras and El Salvador. From these quantitative exercise, we conclude that remittances have a significant impact on sectoral composition in developing countries.

We contribute to the literature in two dimensions. The first contribution is to measure the importance of the income effect in developing countries and explain the sectoral composition. These countries are very different in their economic composition so that the impact of remittances on employment varies across them. The second contribution is to analyze the role of remittances in the process of development. While the most of empirical work analyzes the role of remittances in the development process through education (Calero, Bedi, Sparrow, 2009; Amuedo-Dorantes, Georges and Pozo, 2010; Acosta, 2011; Alcaraz ,Chiquiar, and Salcedo, 2012; Bouoiyour and Miftah, 2016), health, (Duryea, Cordova, and Olmedo, 2005; Amuedo-Dorantes and Pozo, 2011; Frank et al., 2009) and government (Fayissa, and Nsiah, 2010). We show a new channel where the remittances contribute to structural change.

The rest of the paper is organized as follows. Section 2 presents the empirical evidence on the effect of remittances on employment. Section 3 introduces the model, and Section 4 presents the quantitative analysis. Finally, Section 5 includes some concluding remarks and discusses other possible extensions of the basic model.

2.2 Remittances and the service sector

Figure 2.1 shows the decline of employment in agriculture and the rise of employment in the service sector as the Gross National Income (GNI) increases in a sample of 73 middle and low-income countries over the period 1995 to 2019.[4] Therefore, this figure illustrates the shift of employment from agriculture to services, which is one of the most robust features of the development process (Herrendorf et al. 2008).

[Insert Figure 2.1]

[4]To characterize the path of the employment shares, we use available data on employment shares in agriculture and services for 73 developing countries from 1995 to 2019. We pool together the data and filter out the level differences by regressing employment in agriculture and services on a low order polynomial of log GNI and country effects following García-Santana, Pijoan-Mas, and Villacorta (2019). See Appendix B for details.

At the same time, in developing countries, structural change is characterized by a significant rate of migration, and this is correlated with a substantial flow of remittances. Figure 2.2 shows the path of these variables in the previous sample. In particular, Figure 2.2, in panel a shows the evolution of migration along the development process. We observe that the rise of income is associated an increase in the migration rate[5]. In this case, migration is defined as the ratio between the total migration and total population. Figure 2.2, panel b, also shows a positive correlation between migration rates and remittances. Remittances consist of all current transfers in cash or in kind made or received by resident households to or from non-resident households, and they are defined as personal transfers and compensation of employees measured as a share of GNI. From this figure, we observe that remittances are a significant source of income for labor-sending countries considered, ranging between 10% and 23% of the GNI. Consequently, the migration process contributes to the economic and overall development of labor-sending countries through remittances. More specifically, remittances represent a critical mechanism through household income increases in labor-sending countries.

[Insert Figure 2.2]

Finally, Figure 2.3 shows that there is strong positive correlation between the share of employment in the service sector and remittances as a share of GNI. This correlation is the main empirical finding of this paper.

[Insert Figure 2.3]

The correlation shown in the previous figure could be driven by other variables. Therefore, to confirm that remittances increase the service sector, we regress the employment share in services on remittances, defined as personal transfers measured as a share of GNI, and on a set of control variables that the literature has shown to influence the service sector.[6] These control variables are GNI per capita,

[5]This increase of migration can be explained by the Zelinsky's theory of the mobility transition (1971), which suggests that the increase in development increases migration from the poorest countries, up to a long-term stabilization of equilibrium and a consequent decrease in migratory flows.

[6]Ngai and Olivetti (2015) argue that women labor force participation and structural transformation are linked. In particular, during the process of sectoral reallocation of employment, women they observe that women move from the agriculture sector to the service sector faster than men, while male employment in manufacturing increases faster than female employment. Porzio and Santangelo (2017) explain that the labor reallocation is due to the human capital accumulation. They use the years of schooling as direct measure to demonstrate how the increase in human capital has led to the the shift of the employment out of agriculture. Michaels et al. (2012) investigate about the evolution

urban population, female labor participation , aggregated investment rate, education enrollment, the size of the government, natural resources, trade of goods, and migration stock.

[Insert Table 2.1]

Table 2.1 reports the estimated effect of remittances on the share of total employment in the services sector based on a standard two-way fixed effects approach.[7] In particular, Table 2.1 reports eight model specifications. The first column reports the result from our baseline model, where we only include the size of the urban population as a control variable and time fixed effects. Note that remittances, the GNI per capita, and the urban population size are significantly positive. Given that remittances are measured as a percentage of GNI, the reported results imply that an increase of 100 basis points of remittances is associated with an increase of 20 basis points in the share of total employment in the service sector, holding other factors constant. The results in columns two to eight in Table 2.1 report the effect of remittances controlling by other variables in the baseline model, such as female participation in the labor markets (column two), aggregated investment rate (column three), or importance of trade in the size of the economy (column three). Each column shows that the estimated effect of remittances is robust, and its size is between 17 and 23 basis points.

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of the population of the USA from 1880 to 2000. They argue that the distribution of the urban population has, as consequence, the reallocation of the workers out from the agriculture sector. García-Santana, Pijoan-Mas, and Villacorta (2021) show that changes in the investment rate shift the sectoral composition of the economy. Matsuyama (2009), Hicks (1999), Clark (2002), Teignier (2018) and Uy et al. (2013) show that international trade is another driver of structural change. Lin and Monga (2013) argue that government policies may affect sectoral composition. Auty (2007) stresses the importance of the natural resource. Belaid and Slany (2018) examine how migration patterns impact the reallocation of production factors across sectors.

[7] We estimate the following empirical model

$$Y_{it} = b + \beta X_{it} + \alpha_{it} + \gamma_t + \varepsilon$$

where Y_{it} is the employment in services sector, of country *i* at time *t*, measure as share of total employment; b is a constant term, β is a vector, and α_{it} and $\gamma_t$represent country and time fixed effects, respectively. The last variable ε_t, epsilon is the error term. The vector X_{it} includes all the regressors used in the estimations. We use a fixed-effects rather than a random-effects model to estimate remittances' effect on the share of total employment in services, based on the Hausman Test.

2.3 The model

2.3.1 Firms

We consider an economy with two productive sectors: the goods and service sectors. The former produces a tradable good that can be devoted to either consumption or investment, whereas the service sector produces a non-tradable consumption good. Each sector produces by using the following Cobb-Douglas technology:

$$Y_{i,t} = A_{i,t} \left(s_{i,t} K_t\right)^{\alpha} \left(u_{i,t} L_t\right)^{1-\alpha}, \; i = g, s \tag{2.1}$$

where s_i is the share of total capital, K_t, employed in sector i, u_i is the share of total employment, L_t, in sector i, A_i measures total factor productivity (TFP) in sector i, $\alpha \in (0,1)$ is the capital output elasticity. The subindexes g and s amount for the goods and service sector, respectively. Obviously, the sectoral shares of capital and employment satisfy $s_{g,t} + s_{s,t} = 1$ and $u_{g,t} + u_{s,t} = 1$. Note that the production function (2.1) can be rewritten as

$$y_{i,t} = A_{i,t} \left(s_{i,t} k_t\right)^{\alpha} u_{i,t}^{1-\alpha}, \; i = g, s, \tag{2.2}$$

where $y_{i,t} = Y_{i,t}/L_t$ and $k_t = K_t/L_t$.

We assume perfect competition and perfect factors mobility across sectors, implying that each production factor is paid according to its marginal productivity and that wages, w_t, and the rental price of capital, r_t, are equal across sectors. These assumptions imply that

$$r_t = \alpha p_{i,t} A_{i,t} \left(s_{i,t} k_t\right)^{\alpha - 1} u_{i,t}^{1-\alpha} - \delta, \tag{2.3}$$

and

$$w_t = (1-\alpha) \, p_{i,t} A_{i,t} \left(s_{i,t} k_t\right)^{\alpha} u_{i,t}^{-\alpha}, \tag{2.4}$$

where $\delta \in [0,1]$ is the depreciation rate of capital and p_i is the price. We assume that the goods sector is the numéraire and, hence, $p_g = 1$. Therefore, p_s is the relative price of the service sector in units of the good produced in the goods sector.

Using (2.3) and (3.30), we obtain that the efficient allocation of production factors implies $s_{i,t} = u_{i,t}$ and the relative price of services satisfies

$$p_{s,t} = \frac{A_{g,t}}{A_{s,t}}. \tag{2.5}$$

Therefore, the relative price depends only on the sectorial differences in technological progress.

2.3.2 Households

The economy is populated by an infinitely lived representative household formed by a continuum of members of mass N_t. We assume that N_t grows at an exogenous constant gross growth rate $n > 1$. In every period, an exogenous fraction l_t of the household's members are residents in the home country whereas the rest live are migrant that provide remittances, R_t, to the household. We consider remittances and migration decision exogenous to the model. However, emigration is costly. Each new emigrant generates a fixed cost of ψ units of goods. After paying this cost, the household does not incur in other expenditures associated to migrants. As for residents in the home country, they supply one unit of labor, obtain a wage w_t, consume goods and services, $c_{g,t}$ and $c_{s,t}$, and invest. It follows that the budget constraint of the household is

$$N_t l_t w_t + r_t S_t + R_t N_t (1-l_t) = (c_{g,t} + p_{s,t} c_{s,t}) N_t l_t + \psi \left[(1-l_t) N_t - (1-l_{t-1}) N_{t-1} \right] + S_{t+1} - S_t,$$

where S_t is the aggregate amount of assets, r_t is the rental price of capital and $(1-l_t) N_t - (1-l_{t-1}) N_{t-1}$ measures the members of the household that at the beginning of period t emigrate. It is convenient to rewrite the budget constraint as follows[8]

$$w_t + (1+r_t) s_t + R_t \left(\tfrac{1}{l_t} - 1 \right) = c_{g,t} + p_{s,t} c_{s,t} + \psi \left[\left(\tfrac{1}{l_t} - 1 \right) - \left(\tfrac{1-l_{t-1}}{l_t} \right) \tfrac{1}{n} \right] + n \tfrac{l_{t+1}}{l_t} s_{t+1}, \tag{2.6}$$

where $s_t = K_t / N_t l_t$ measures assets per resident member.

We assume that the household utility function is the discounted sun of the flow utilities of all resident members[9]

$$U = N_0 \sum_{t=0}^{\infty} n^t \beta^t l_t \ln c_t, \tag{2.7}$$

where β is the subjective discount factor and c_t is a composite good. We assume that this composite good is

$$c_t = \left[\omega_g \left(c_{g,t} - \overline{c} \right)^{\frac{\varepsilon-1}{\varepsilon}} + \omega_s c_{s,t}^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}}, \tag{2.8}$$

[8] We assume that in this economy there is always emigration, implying that $(1-l_t) N_t - (1-l_{t-1}) N_{t-1}$ must be positive.

[9] We could rationalize the exogenous flow of remittances as equalizing the flow utility of emigrants with the flow utility of residents. Under this rationalization, when the household maximizes the utility of residents, he is also maximizing the utility of emigrants.

where $c_{g,t}$ and $c_{s,t}$ denote, respectively, the consumption of goods and services, and $\overline{c} > 0$ denotes a minimum consumption of goods. The relative preference for each type of consumption goods is measured by ω_g and ω_s, which satisfy that $\omega_g + \omega_s = 1$. The elasticity of substitution between the two consumption goods is given by $\varepsilon > 0$.

We define total consumption expenditures as $e_t = c_{g,t} + p_{s,t}c_{s,t}$. In Appendix B, we use this definition to show that the solution of the household's problem is characterized by the following equations:

$$c_{g,t} - \overline{c} = \frac{e_t - \overline{c}}{1 + p_{s,t}^{1-\varepsilon}\left(\frac{\omega_g}{\omega_s}\right)^{-\varepsilon}}, \tag{2.9}$$

$$p_{s,t}c_{s,t} = \frac{p_{s,t}^{1-\varepsilon}\left(\frac{\omega_g}{\omega_s}\right)^{-\varepsilon}}{1 + p_{s,t}^{1-\varepsilon}\left(\frac{\omega_g}{\omega_s}\right)^{-\varepsilon}}\left(e_t - \overline{c}\right), \tag{2.10}$$

$$\frac{e_{t+1} - \overline{c}}{e_t - \overline{c}} = \beta(1 + r_{t+1}). \tag{2.11}$$

Equations (2.9) and (2.10) determine the sectoral composition of consumption expenditures. As follows from these equations, when the elasticity of substitution is different from one, price changes will modify the sectoral composition of consumption expenditures. These equations also show that an increase in total consumption expenditures shifts the sectoral composition of consumption towards the service sector when $\overline{c} > 0$. Thus, the sectoral composition of consumption expenditures depends both on income and price effects. Finally, equation (2.11) is the Euler equation that determines the intertemporal decision between consumption and savings.

2.3.3 Equilibrium

In this section, we use the market clearing conditions to obtain the equilibrium. As a preliminary step, we obtain GDP per worker, $y_t = Y_t/L_t$, which is defined as $y_t = y_{g,t} + p_{s,t}y_{s,t}$. Using (2.2) and (2.5), we obtain

$$y_t = A_{g,t}k_t^{\alpha}. \tag{2.12}$$

Since the service sector produces a non-tradable good, the market clearing condition implies that the production per worker equals the consumption of each resident member: $y_{s,t} = c_{s,t}$. Using this condition, (2.2), (2.5), (2.10) and (2.12), we obtain

the employment share in the service sector

$$u_{s,t} = \frac{p_{s,t}^{1-\varepsilon}\left(\frac{\omega_g}{\omega_s}\right)^{-\varepsilon}}{1+p_{s,t}^{1-\varepsilon}\left(\frac{\omega_g}{\omega_s}\right)^{-\varepsilon}}\frac{e_t-\overline{c}}{y_t}. \tag{2.13}$$

Next, we assume that there are no international capital flows. As a result, households' assets coincide with productive capital, $S_t = K_t$. In addition, since all residents supply one unit of labor, total employment satisfies $L_t = N_t l_t$ and thus asset per resident equals capital per worker, that is $s_t = k_t$. Using this equation, the households' budget constraint, (4.5), (2.3) and (3.30), we determine next period stock of capital per worker[10]

$$k_{t+1} = \frac{l_t}{n l_{t+1}}\left(y_t + (1-\delta)\,k_t + R_t\left(\frac{1}{l_t}-1\right) - e_t - \psi\left[\left(\frac{1}{l_t}-1\right) - \left(\frac{1-l_{t-1}}{l_t}\right)\frac{1}{n}\right]\right). \tag{2.14}$$

We define an equilibrium as a path of $\{y_t,\ k_t,\ e_t,\ u_{s,t},\ r_t,\ w_t, p_t\}_{t=0}^{\infty}$ that, given an initial condition for k_t and the exogenous processes $\{A_{g,t},\ A_{s,t},\ l_t,\ N_t,\ R_t\}_{t=0}^{\infty}$, solves the firms' optimization problem, (2.3), (3.30) and (2.5, the household's optimization problem and the budget constraint, (2.11) and (2.14), the definition of GDP, (2.12), and the market clearing condition of the service sector, (2.13).[11]

The transitional dynamics of this equilibrium are driven by the exogenous processes. On the one hand, we assume sectoral biased technological progress, meaning that $A_{g,t}$ and $A_{s,t}$ grow at different rates. This biased technological progress implies that the equilibrium exhibits sustained growth and relative price changes. Income growth and price changes affect the sectoral composition of employment, since the Stone-Geary utility function considered in this paper introduces income and price effects (see Herrendorf, et al., 2013). On the other hand, two other ex-

[10] Capital stock could also be obtained from the market clearing in the goods sector. Since the good produced in this sector is tradable, market clearing implies that production plus trade deficit equals investment, consumption in goods and the cost of emigration:

$$y_{g,t} + q_t = \frac{n l_{t+1}}{l_t} k_{t+1} - (1-\delta)\,k_t + c_{gt} + \psi\left[\left(\frac{1}{l_t}-1\right) - \left(\frac{1-l_{t-1}}{l_t}\right)\frac{1}{n}\right],$$

where q_t is trade deficit per resident. The balance of payments implies that $q_t = \frac{1-l_t}{l_t} R_t$ and $y_{g,t} = y_t - p_{s,t} c_{s,t}$. Using these two equations, we deduce that the market clearing in the goods sector is equivalent to (2.14).

[11] In Appendix C, we obtain the dynamic system of equations governing the equilibrium and determine the balanced growth path when the exogenous variable l_t remains constant and the rest, $A_{g,t}$, $A_{s,t}$, and R_t, grow at a constant rate.

ogenous process, emigration and remittances, are the novelty of this paper. In the following section, we analyze how these two processes affect the sectoral composition.

2.4 Quantitative analysis

We perform two different exercise. First, we quantify the effect of remittances on cross-country differences in the sectoral composition. To perform this quantitative exercise, we assume economies are at a steady-state, and we calibrate sector specific sectoral TFP levels to match the GDP per capita of these economies. In the second exercise, we analyze the contribution of remittances and migration to structural change in the period 1995 to 2017, in some developing countries with an outstanding flow of remittances.

2.4.1 Calibration

We distinguish between two sets of parameters to perform the first quantitative exercise. The first set includes parameters that are common to all countries. These parameters are the preference parameters $\{\bar{c}, \beta, \omega_g\}$ and the technological parameters $\{\alpha, \delta\}$. To jointly set the value of the three preferences, we use as targets of calibration the average value (across time and countries) of the real rate of return of capital, and the average values (over time) of the employment share in the services sector of the poorest and wealthiest economies in our sample of 69 countries.[12] On the other hand, we set the values of the technological parameters to match the average values (across time and countries) of the labor income share and the capital-output ratio in the sample.The second set of parameters are country-specific, and the parameters are $\{A_{g,i}, A_{s,i}, \psi_i\}$. We set the values of these parameters to match the average values (over time) of the consumption expenditure to GDP ratio, the GDP per capita, and the relative prices of each country in the sample. Finally, we set the value of the elasticity of substitution , ε, from the economic literature. In particular, we set the value of the elasticity of substitution accordingly to Stockman and Tesar (1995), who estimated the elasticity of substitution between goods and services in an international macroeconomic context.[13] Table (2.2) reports the tar-

[12] In this quantitative exercise, we focus on 69 countries due to the lack of data on relative prices for China, Korea, Mauritania and Oman.

[13] Stockman and Tesar (1995) estimated the elasticity of substitution between tradable and non-tradable goods using a cross-sectional dataset (a sample of 30 countries) from the World Bank Income Comparison Project. They estimated the value of the elasticity of substitution at 0.44. This value differs

get's values and common calibrated parameters, while in Table (2.3), we reported the country-specific parameters' values obtained from this calibration strategy.

2.4.2 Cross-country comparison

Based on this calibration strategy, we measure how much of the cross-country differences in the sectoral composition can be explained by cross-country differences in remittances. To this end, we first simulate the economies, assuming they are at a steady state, and compute the size of the services sector given the amount of remittances and migration.[14] We refer to these results as the benchmark model. We then use the calibrated model to perform a counterfactual exercise to address the importance of remittances and migration to explain cross-country differences in sectoral composition. In this counterfactual, we assume that the steady-state level of remittances is equal to zero, and we analyze how the predicted size of the services sector changes relative to the benchmark model to infer the contribution of remittances explaining the data. Table (2.4) reports the results. In the first column, we report the average service employment share for the observed data and the benchmark and counterfactual data. The average share of total employment in services across countries is 0.44 in data, whereas the benchmark and the counterfactual yield 0.40 and 0.38, respectively. In the second column, we quantify how well the benchmark and the counterfactual replicate the average size of actual service employment. The model replicates 90.5% of the actual data in the benchmark case, whereas the counterfactual replicates around 85.3% of the data. Finally, in the third column, we report the contribution of remittances to explain the average sectoral composition. Since the benchmark model accounts for around 91% of the observed average size of the services sector, we deduce that remittances explain 5.17% of the actual size of the services sector. In other words, this result implies that, on average, a receipt-remittances economy allocates almost 5.17% of total employment into the services sector due to remittances.

[Insert Table 2.4]

from estimations using time series from a single country. For instance, Herrendorf et al. (2013) estimated the elasticity of substitution at 0.02, Acemoglu and Guerrieri (2008) and Ngai and Pissarides (2007) calibrated this value of 0.76 and 0.10 for the US economy; meanwhile, Kaboski and Buera estimated the value of the elasticity of substitution of 0.5. Given our quantitative international comparison, we take the value of 0.44 as a baseline for our calibration.

[14] We assume that the long run values of remittances and the migration rate are equal to average values of these variables over the period by country.

These results suggest that remittances may contribute to explain the observed large differences in the sectoral composition in our sample, which goes from 0.17 (Mozambique) to 0.75 (Argentina). To address this question, we compute the ratios 90/10 and 50/10 using the actual data and the data generate by the benchmark and the counterfactual model. In Table (2.5), the first column reports the ratio of the mean value of the employment share in the 90th relative to the 10th of the income distribution. These ratios show that employment in the services sector is 2.38 times larger in the wealthiest countries compared to the poorest countries. Note that the benchmark and counterfactual data replicates 63.10% and 61.19% of these differences, which implies that remittances explain around 1.90% of the observed differences in sectoral composition between the richest and poorest countries in the sample. In contrast, the ratio of 50/10 (third column) shows that the differences in sectoral composition between the median and the poorest countries group are 1.78 times. In this case, the benchmark and counterfactual models replicate 97.41% and 85.24% of these observed differences (fourth column). In this case, remittances explain 12.17% of the observed differences.

[Insert Table 2.5]

These results suggest that remittances can be an important mechanism for fostering structural transformation in countries at the early stages of development. To study how important remittances can be along the developing process, we perform a quantitative exercise in the following section.

2.4.3 Structural change in developing countries

In this section, we study how important remittance is to explain employment's sectoral composition in three development economies: El Salvador, Guatemala, and Honduras. These countries report sustained growth of remittances and emigration since 1995, which have reached a sizeable share of the total population and the Gross Domestic Income (GNI) in 2019. In particular, in these three economies, remittance and emigration have more than doubled during 1995-2019, as Figure (2.4) shows.

[Insert Figure 2.4]

To study the effects of remittances on the sectoral composition of these economies, we discipline the model to replicate the time path of the employment share of services. To this end, we calibrate the model's parameter based on the following calibration strategy. We first set the value of the sectoral TFP levels in the services and goods sectors to match the time path of the relative price of services and GDP. Sec-

ond, we calibrate the minimum consumption and the weight of goods in the utility function to match the size of employment in the services sector in 1995 and achieve the highest fit to the observed trend of the employment share in services. Third, we set the value of the remittances and migration rates equal to the average value of these two variables in each country during the period.[15] Table 2.6 reports the calibrated values of these parameters.

[Insert Table 2.6]

Finally, we assume that initial capital is such that the initial value of capital per efficiency unit of labor equals its long-run asymptotic value.[16] Thus, the model exhibit a small transition even if it is initially at its long run value together the assumption of permanent bias in technological progress and the time path of exogenous remittances and migration flow. Under these assumptions, we simulate the time path of the employment share in the services sector and refer to this time series as the benchmark case. We then use the calibrated model to perform a counterfactual experiment where the value of remittances is equal to zero along all the periods and refer to the resulting time series as the counterfactual case. Figure 2.5 shows the benchmark and counterfactual times series with the actual time path of employment in the services sector. From the comparison among times series, we observed that remittances contribute to explain the size of the employment share in the services sector.

[Insert Figure 2.5]

Table 2.7 provides different performance measures aimed to show the contribution of remittances to structural change.[17] In particular, the table provides Adjusted R^2, the root mean square error, tha Akaike information critieria and the total variation. For all measures and in the three countries, the benchmark economy provides a substantially better fit than the counterfactual economy to explain the time path of employment in the services sector. Furthermore, Tables 2.7 also shows that remittance contribute to explain between 5% and 27% of the total variation of the employment share in these economies during the period 1995-2019. We conclude that remittances account for a significant part of structural change in El Salvador,

[15] We set the values of the remaining parameters equal to those reported in Table (2.2).

[16] The model exhibits sustained growth and, hence, capital diverges to infinite. However, capital per efficiency unit, $k_t A_{g,t}^{\frac{1}{\alpha-1}}$; converges asymptotically to a long run fine value.

[17] Figure (2.6) shows the model's performance to replicate the targets of calibration .

Guatemala, and Honduras.

[Insert Table 2.7]

2.5 Concluding remarks

In this paper, we analyze the effect of remittances on the sectoral composition of employment in developing countries. We argue that the remittances increase households' income and, as a result, consumption demands shifts towards those sectors with a larger income elasticity. Since the service sector is the sector with the largest income elasticity, remittance increase the service sector and contribute to explain the differences cross-country differences in the sectoral composition.

We use a two-sector growth model to quantify the effect of remittances in a sample of 73 developing countries during the period 1995-2019. We obtain three main findings. First, we show that remittances can explain 5.2% of the average size of the service sector in our sample of countries. Second, we also show that the effect of remittances on sectoral composition is significative to explain differences between poor and middle-income countries, whereas it is a minor to explain differences in sectoral composition among more developed countries. Finally, we show that remittances contribute to explain a significant part of the total variation in the share of employment in services in the period 1995-2019 in some developing countries.

In this paper we have shown that remittances have a sizeable effect on the size of the service sector in developing countries. However, as shown by Herrendorf (2014), industries in the service sector are very different, some with fast growing productivity and others with low growth productivity. The effect that remittances may have on the economic development of these countries will depend on the type of industries of the service sector that benefit the most from remittances. Therefore, future research should consider the effect of remittances on the different industries of the service sector.

References

[1] Acemoglu, D., & Guerrieri, V. (2008). Capital deepening and nonbalanced economic growth. Journal of political Economy, 116(3), 467-498.

[2] Acosta. (2011). School Attendance, Child Labour, and Remittances from International Migration in El Salvador. The Journal of Development Studies, 47(6), 913–936.

[3] Alcaraz, Chiquiar, D., & Salcedo, A. (2012). Remittances, schooling, and child labor in Mexico. Journal of Development Economics, 97(1), 156–165.

[4] Alder, S., Boppart, T., Muller, A. (2022). A theory of structural change that can fit the data. American Economic Journal: Macroeconomics, 14(2), 160-206.

[5] Alvarez-Cuadrado, F., Poschke, M. (2011). Structural change out of agriculture: Labor push versus labor pull. American Economic Journal: Macroeconomics, 3(3), 127-58.

[6] Amuedo-Dorantes, Georges, A., & Pozo, S. (2010). Migration, Remittances, and Children's Schooling in Haiti. The Annals of the American Academy of Political and Social Science, 630(1), 224–244.

[7] Amuedo-Dorantes, C., Pozo, S. (2011). New evidence on the role of remittances on healthcare expenditures by Mexican households. Review of Economics of the Household, 9(1), 69-98.

[8] Auty, R. M. (2007). Natural resources, capital accumulation and the resource curse. Ecological economics, 61(4), 627-634.

[9] Belaid, F., & Slany, A. (2018). Economic Development in Africa Report 2018.

[10] Boppart, T., (2014). Structural change and the Kaldor facts in a growth model with relative price effects and non-Gorman preferences, Econometrica 82 (6), 2167-2196.

[11] Bouoiyour, & Miftah, A. (2016). The Impact of Remittances on Children's Human Capital Accumulation: Evidence from Morocco. Journal of International Development, 28(2), 266–280.

[12] Calero, Bedi, A. S., & Sparrow, R. (2009). Remittances, liquidity constraints and human capital investments in Ecuador. World Development, 37(6), 1143–1154.

[13] Caselli, F., Coleman II, W. J. (2001). The US structural transformation and regional convergence: A reinterpretation. Journal of political Economy, 109(3), 584-616.

[14] Clark, D. P. (2002). Intra-Industry Specialization and the North American Free Trade Agreement. The International Trade Journal, 16(4), 393-411.

[15] Comin, D., Lashkari, D., Mestieri, M. (2021). Structural change with long-run income and price effects. Econometrica, 89(1), 311-374.

[16] Dennis, B. N., & İşcan, T. B. (2009). Engel versus Baumol: Accounting for structural change using two centuries of US data. Explorations in Economic history, 46(2), 186-202.

[17] Duryea, S., López-Córdova, E., Olmedo, A. (2005). Migrant remittances and infant mortality: Evidence from Mexico. Unpublished manuscript.

[18] Echevarria, C. (1997). Changes in sectoral composition associated with economic growth. International economic review, 431-452.

[19] Fayissa, & Nsiah, C. (2010). The impact of remittances on economic growth and development in africa. The American Economist (New York, N.Y. 1960), 55(2), 92–103.

[20] Foellmi, R., Zweimüller, J., 2008. Structural change, Engel's consumption cycles and Kaldor's facts of economic growth, Journal of Monetary Economics 55 (7), 1317-1328.

[21] Frank, Palma-Coca, O., Rauda-Esquivel, J., Olaiz-Fernandez, G., Diaz-Olavarrieta, C., & Acevedo-Garcia, D. (2009). The Relationship Between Remittances and Health Care Provision in Mexico. American Journal of Public Health (1971), 99(7), 1227–1231.

[22] García-Santana, M., Pijoan-Mas, J., & Villacorta, L.(2021). Investment demand and structural change. Econometrica, 89(6), 2751-2785.

[23] Herrendorf, B., Valentinyi, A. (2008). Measuring factor income shares at the sectoral level. Review of Economic Dynamics, 11(4), 820-835.

[24] Herrendorf, B., Rogerson, R., Valentinyi, A., (2013). Two perspectives on preferences and structural transformation, American Economic Review 103 (7), 2752-2789.

[25] Herrendorf, B., Rogerson, R., Valentinyi, A., (2014). Growth and structural transformation, Chapter 6, Handbook of Economic Growth 2, 855-941.

[26] Hicks, D. (2011). Structural change and industrial classification. Structural Change and Economic Dynamics, 22(2), 93-105.

[27] Laitner, J. (2000). Structural change and economic growth. The Review of Economic Studies, 67(3), 545-561.

[28] Kongsamut, P., Rebelo, S., Xie, X., (2001). Beyond balanced growth, Review of Economic Studies 68 (4), 869-882.

[29] Matsuyama, K. (2009). Structural change in an interdependent world: A global view of manufacturing decline. Journal of the European Economic Association, 7(2-3), 478-486.

[30] Michaels, G., Rauch, F., & Redding, S. J. (2012). Urbanization and structural transformation. The Quarterly Journal of Economics, 127(2), 535-586.

[31] Ngai, L. R., Pissarides. C,. (2007). Structural change in a multisector model of growth, American Economic Review 97 (1), 429-443.

[32] Olivetti, C., Ngai, R. (2015). Structural Transformation and the U-Shaped Female Labor Supply. In 2015 Meeting Papers (No. 1501). Society for Economic Dynamics.

[33] Porzio, T., Santangelo, G. (2017). Structural change and the supply of agricultural workers. Available at SSRN 3089710.

[34] Stiglitz, J. E., Lin, J. Y., & Monga, C. (2013). Introduction: the rejuvenation of industrial policy. In The Industrial Policy Revolution I (pp. 1-15). Palgrave Macmillan, London.

[35] Stockman, & Tesar, L. L. (1995). Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements. The American Economic Review, 85(1), 168–185.

[36] Swiecki, T., (2017). Determinants of Structural Change. Review of Economic Dynamics, 24, 95-131.

[37] Teignier, M. (2018). The role of trade in structural transformation. Journal of Development Economics, 130, 45-65.

[38] Uy, T., Yi, K. M., & Zhang, J. (2013). Structural change in an open economy. Journal of Monetary Economics, 60(6), 667-682.

Appendix

2.A Figures and Tables

Figure 2.1. Structural change in developing countries

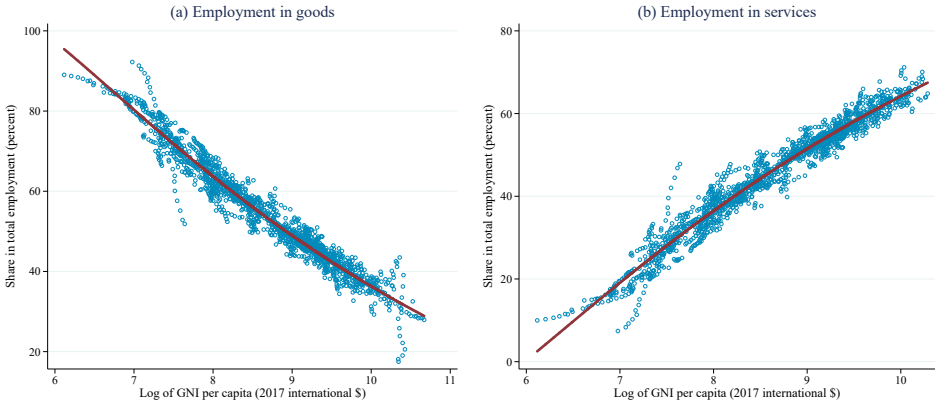


Figure 2.1 shows the employment shares in goods and services sectors obtained by controlling the differences in GDP as in M.García-Santana, J.Pijoan-Mas, L.Villacorta (2021). See the Appendix B. The panel a shows the decreasing relationship between the employment share in agriculture and the GNI per capita. The panel shows the increasing relationship between the employment share in services and GNI per capita. Source: World Bank.

Figure 2.2. Migration and remittances in developing countries

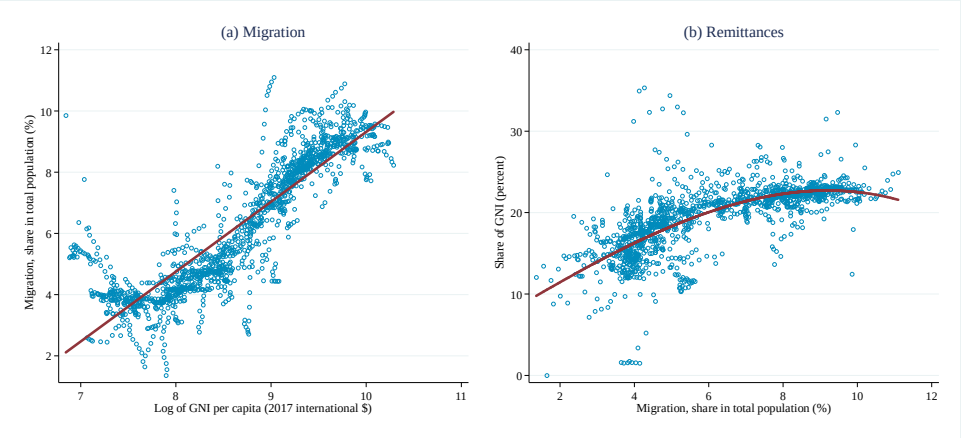


Figure 2.2 shows the trend in data on migration and remittances by controlling the differences in GDP as in M.García-Santana, J.Pijoan-Mas, L.Villacorta (2021). See the Appendix B. Panel a shows the increasing relationship between migration and GNI per capita. Panel b shows the positive relationship bewteen remittances and migration. Data came from UNDP and World Bank.

Figure 2.3. Correlation between remittances and employment in services

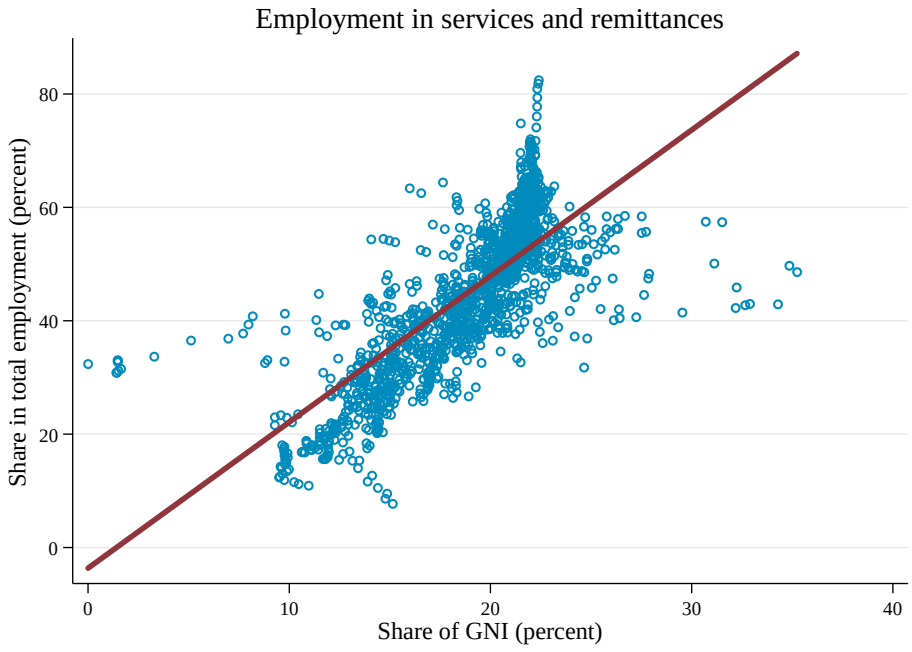


Figure 2.3 shows the scatter plot between employment in the service sector and remittances as in M.García-Santana, J.Pijoan-Mas,L.Villacorta (2021). See the Appendix B. The simple correlation between employment and remittances is 0.76 after controlling by country fixed effects and income level differences. Source: World Bank

Figure 2.4. Remittances and emigration in El Salvador, Guatemala, and Honduras

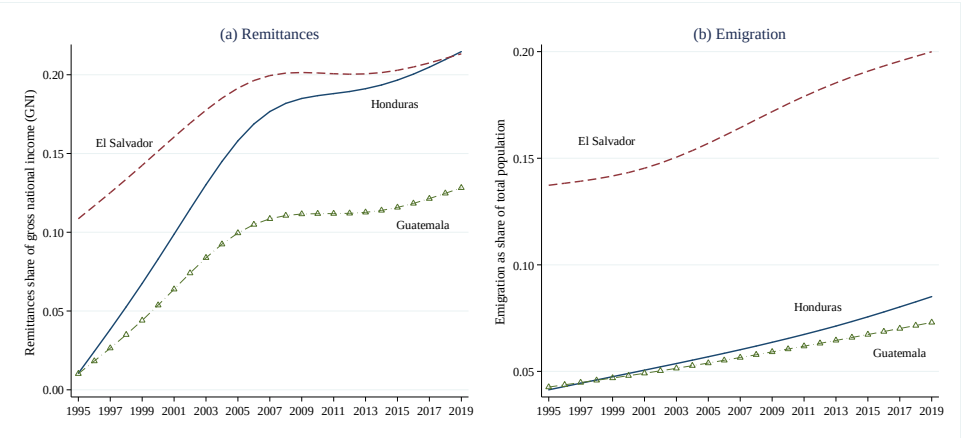


Figure 2.5. Benchmark and counterfactual simulations: El Salvador, Guatemala, and Honduras

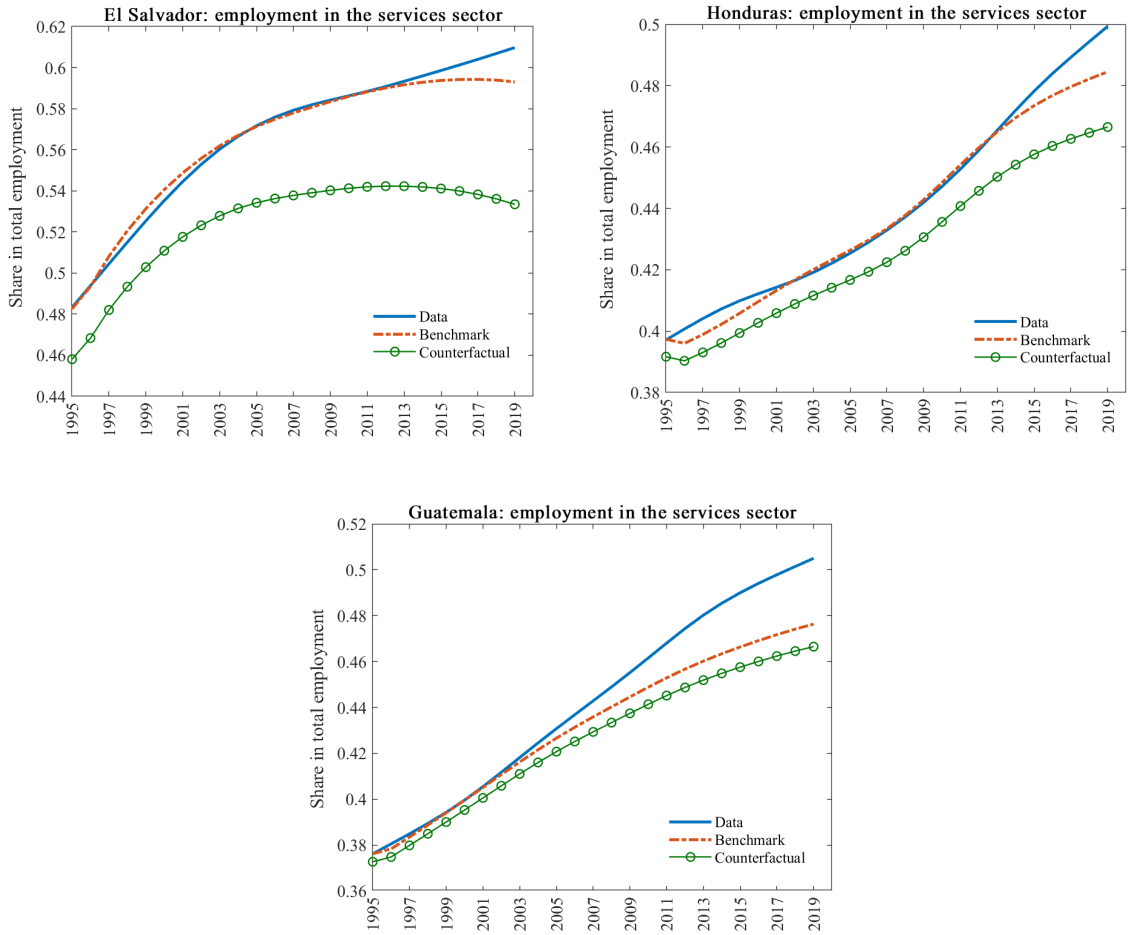


Figure 2.6. Model performance: targets of calibration

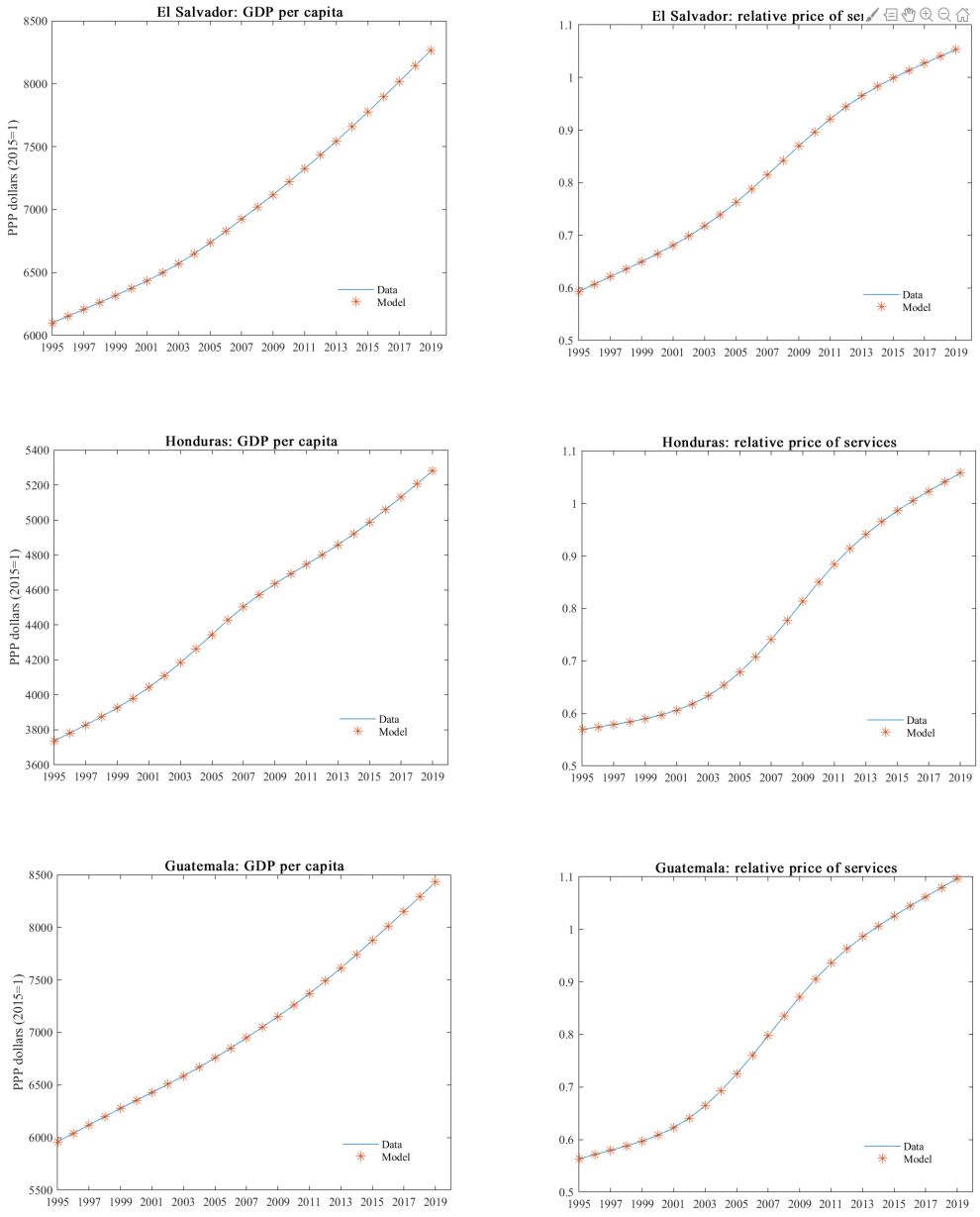


Table 2.1: Estimated effect of remittances on the employment share in services

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
REMITT	0.208***	0.173**	0.175**	0.227***	0.221***	0.232***	0.240***	0.237***
	(0.0659)	(0.0694)	(0.0694)	(0.0638)	(0.0620)	(0.0590)	(0.0623)	(0.0605)
GNICAP	6.513***	5.229**	5.299**	6.276*	6.234*	7.446*	7.391*	7.664*
	(2.435)	(2.448)	(2.446)	(3.548)	(3.553)	(3.812)	(3.784)	(3.946)
URBPOP	0.243***	0.274***	0.272***	0.299**	0.296**	0.198*	0.176	0.173
	(0.0837)	(0.0912)	(0.0911)	(0.113)	(0.114)	(0.109)	(0.112)	(0.116)
FEMPAR		-0.301**	-0.305***	-0.271**	-0.275**	-0.222**	-0.227**	-0.233**
		(0.115)	(0.115)	(0.119)	(0.121)	(0.0957)	(0.0956)	(0.0967)
INVEST			-0.0189	-0.0348	-0.0287	-0.0649*	-0.0588*	-0.0620
			(0.0203)	(0.0291)	(0.0287)	(0.0337)	(0.0320)	(0.0381)
SCHOOL				0.0178	0.0113	0.0158	0.0184	0.0234
				(0.0270)	(0.0276)	(0.0255)	(0.0252)	(0.0247)
GOVERT					0.102	0.0946	0.104	0.0874
					(0.111)	(0.111)	(0.111)	(0.103)
NATURE						-0.145*	-0.146*	-0.156*
						(0.0771)	(0.0787)	(0.0811)
GTRADE							-0.0201	-0.0179
							(0.0188)	(0.0174)
MIGRAT (lagged)								1.121
								(1.956)
Constant	-26.81	-2.603	-2.482	-14.35	-14.81	-20.03	-17.81	-34.41
	(19.62)	(21.09)	(21.08)	(27.52)	(27.49)	(29.00)	(28.21)	(49.54)
Observations	1,607	1,607	1,607	1,083	1,080	1,003	1,003	971
R-squared	0.638	0.672	0.673	0.631	0.632	0.648	0.650	0.653
Number of id	73	73	73	68	68	67	67	67
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

In order to isolate the relationship between employment in services (EMPSER) and remittances (REMITT), we control for country characteristics that can also influence the employment share in the service sector accordingly to the literature. As explanatory variables, we consider the GNI per capita (GNICAP), urban population (URBPOP), female labor participation (FEMPAR), aggregated investment rate (INVEST) as percentage of GDP, education enrollment (SCHOOL), the size of the government (GOVERT), natural resources (NATURE) as percentage of GDP, trade of goods (GTRADE) as percentage of GDP, and migration stock (MIGRAT). The time-fixed effect allows eliminating bias from unobservables that change over time but are constant over entities, and it controls for factors that differ across entities but are constant over time. Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Sources: World Bank Development Indicators and UN Population Division.

Table 2.2: Baseline Calibration

Parameters	Values	Targets	Data
β	0.8890	Real rate of return of capital	0.120
$\bar{c}$	615.56	Employment share in the services sector (poorest economy)	0.652
ω_g	0.0557	Consumption expenditure share in services (wealthiest economy)	0.540
α	0.5108	Labor income share	0.489
δ	0.0283	Capital-output ratio	3.330
ε	0.4400	Stockman and Tesar (1995)	-

We jointly calibrated the parameters values. To this end, we use data of average values (across time and countries) of labor income share, the real rate of return of capital and capital-output ratio from Penn World Table version 10.0. We use the World bank Development Indicators to obtain data on the employment share in the services sector for the poorest country in our sample (Mozambique), and we use the Global Consumption Database from the World Bank to compute the share of services in total consumption expenditure for the richest country (South Africa) in our sample available in the Global Consumption Database.

Table 2.3: Country-specific calibration

	Parameters			Targets		
Country	A_g	A_s	ψ	C/Y	Y	P_s
Mozambique	16.424	18.474	0.116	0.798	1076.134	0.889
Niger	16.662	16.249	0.133	0.738	1108.213	1.025
Togo	18.961	18.627	0.185	0.746	1443.473	1.018
Rwanda	18.972	19.371	0.081	0.821	1445.163	0.979
Sierra Leone	19.107	19.375	-0.129	0.882	1466.198	0.986
Madagascar	19.841	20.924	0.108	0.787	1583.729	0.948
Burkina Faso	19.956	36.524	0.232	0.779	1602.557	0.546
Uganda	20.152	23.272	0.150	0.828	1634.915	0.866
Ethiopia	20.511	21.756	0.177	0.761	1694.999	0.943
Tanzania	20.615	22.825	0.119	0.769	1712.579	0.903
Guinea-Bissau	21.151	23.631	0.213	0.706	1804.841	0.895
Mali	21.252	20.937	0.312	0.676	1822.544	1.015
Guinea	21.788	22.028	0.262	0.916	1917.795	0.989
Nepal	22.648	25.066	0.004	0.830	2075.795	0.904
Cambodia	23.143	23.299	0.114	0.745	2169.571	0.993
Lesotho	23.582	24.546	1.172	0.732	2254.568	0.961
Senegal	24.461	26.197	0.216	0.780	2429.709	0.934
Benin	24.974	22.836	0.472	0.729	2535.083	1.094
Bangladesh	25.736	26.690	0.040	0.809	2695.585	0.964
Haiti	26.757	31.996	1.303	0.875	2918.926	0.836
Cameroon	26.829	28.781	0.198	0.744	2934.949	0.932
Kenya	26.886	26.402	0.105	0.736	2947.732	1.018
Pakistan	28.548	32.280	0.192	0.653	3332.263	0.884
Kyrgyz Republic	30.208	32.430	0.117	0.772	3740.367	0.931
India	30.230	29.960	0.598	0.709	3746.053	1.009
Myanmar	30.256	27.947	0.100	0.733	3752.504	1.083
Cote d'Ivoire	30.491	30.589	0.338	0.422	3812.311	0.997
Nigeria	30.684	35.545	0.443	0.630	3861.806	0.863
Ghana	31.922	37.032	0.194	0.769	4187.121	0.862
Nicaragua	32.698	35.235	0.285	0.758	4398.023	0.928
Honduras	32.938	32.722	0.985	0.547	4464.208	1.007
Congo, Rep.	33.846	35.774	0.589	0.632	4719.327	0.946
Vietnam	33.965	35.771	0.446	0.880	4753.459	0.950
Philippines	34.202	39.794	0.121	0.740	4821.341	0.859
Morocco	34.851	35.451	0.130	0.729	5010.327	0.983
Bolivia	37.274	38.892	0.182	0.723	5748.452	0.958
Guatemala	38.879	40.257	0.466	0.579	6265.752	0.966
El Salvador	39.192	43.113	0.057	0.833	6369.306	0.909
Armenia	42.669	43.887	0.108	0.665	7578.247	0.972
Namibia	42.869	39.890	30.404	0.799	7651.083	1.075
Sri Lanka	43.254	45.269	0.328	0.853	7792.371	0.955
Tunisia	43.543	53.169	0.105	0.691	7899.308	0.819
Peru	44.042	46.333	0.434	0.667	8085.421	0.951
Egypt, Arab Rep.	44.932	48.270	0.196	0.653	8422.931	0.931
Jamaica	45.016	45.157	0.074	0.759	8455.292	0.997
Jordan	45.449	44.926	0.144	0.623	8622.327	1.012
Ecuador	45.670	44.214	0.097	0.695	8708.039	1.033
Paraguay	49.179	53.711	0.277	0.648	10131.190	0.916
Indonesia	49.695	49.193	0.263	0.549	10349.600	1.010
Algeria	50.119	51.932	0.103	0.709	10530.810	0.965
Mongolia	50.665	42.520	0.192	0.520	10766.880	1.192
Colombia	52.085	55.401	0.294	0.352	11392.750	0.940
South Africa	52.131	50.324	0.139	0.687	11413.170	1.036
Dominican Republic	52.270	58.733	0.132	0.641	11475.500	0.890
Iran, Islamic Rep.	53.765	55.280	0.185	0.600	12156.610	0.973
Georgia	54.124	52.263	29.788	0.653	12323.300	1.036
Brazil	55.306	62.678	0.072	0.708	12879.710	0.882
Botswana	55.427	60.423	0.258	0.468	12937.450	0.917
Gabon	56.212	72.130	0.155	0.463	13314.640	0.779
Costa Rica	57.830	61.032	0.074	0.692	14109.950	0.948
Lebanon	60.334	55.680	0.113	0.326	15387.380	1.084
Uruguay	60.836	65.785	0.275	0.546	15650.560	0.925
Kazakhstan	61.304	66.629	0.083	0.672	15897.560	0.920
Mexico	61.820	68.013	0.295	0.693	16172.120	0.909
Malaysia	62.890	54.620	0.087	0.554	16749.690	1.151
Turkey	63.372	66.536	0.105	0.639	17013.620	0.952
Panama	65.292	78.421	0.096	0.494	18084.160	0.833
Argentina	65.376	62.161	0.105	0.564	18131.310	1.052
Chile	66.099	71.475	0.123	0.594	18543.900	0.925

Table 2.3 reports the country-specific parameters values for A_g, A_s and ψ to match the average (across time by country) consumption-output ratio (C/Y), the GDP per capita in PPP terms (Y) and the relative price of services (P_s). In Table 2.3, the cost of migration per migrant (ψ) is expressed as a percentage of the GDP per capita ((ψ times migrants / GDP per capita)*100).

Table 2.4: Mean effect of remittances on the sectoral composition

	Share of total employment in services (mean value)	Explained (%)	Share of total employment in services explained by remittances (%)
Actual	0.445	-	-
Benchmark	0.403	90.56%	-
Counterfactual	0.380	85.39%	5.17%

Table 2.5: Effect of remittances on the cross-country sectoral differences

	Ratio 90/10	Explained (%)	Ratio 50/10	Explained (%)	Differences explained by remittances	
					Ratio 90/10	Ratio 50/10
Actual	2.385	-	1.787	-	-	-
Benchmark	1.505	63.10%	1.741	97.41%	-	-
Counterfactual	1.460	61.19%	1.523	85.24%	1.90%	12.17%

Table 2.6: Baseline Calibration: El Salvador, Guatemala and Honduras

Parameters	El Salvador	Guatemala	Honduras
$\bar{c}$	1450.57	2615.57	1515.57
ω_g	0.04055	0.00227	0.05139
TFP growth in services	-0.0210	-0.0214	-0.0187
TFP growth in goods	0.0026	0.0061	0.0069

Table 2.7. Remittances' effect on the sectoral composition of employment

Panel (a)	El Salvador		
	Benchmark	Counterfactual	Difference
Adjusted R2	0.9840	0.8960	0.0020
RMSE	0.0047	0.0120	-0.0073
AIC	-195.67	-148.33	47.34
Total variation	87.34%	59.64%	27.70%

Panel (b)	Guatemala		
	Benchmark	Counterfactual	Difference
Adjusted R2	0.9910	0.9890	0.0020
RMSE	0.0040	0.0044	-0.0004
AIC	-202.79	-276.64	4.194
Total variation	77.73%	72.81%	4.91%

Panel (c)	Honduras		
	Benchmark	Counterfactual	Difference
Adjusted R2	0.9840	0.9830	0.0010
RMSE	0.0041	0.0042	0.0000
AIC	-201.59	-201.15	0.44
Total variation	85.30%	73.24%	12.05%

2.B Data sources, samples, and statistical treatment

2.B.1 Countries in the sample

Algeria; Argentina; Armenia; Bangladesh; Benin; Bolivia; Botswana; Brazil; Burkina Faso; Cambodia; Cameroon; Chile; China; Colombia; Congo, Rep.; Costa Rica; Cote d'Ivoire; Dominican Republic; Ecuador; Egypt, Arab Rep.; El Salvador; Ethiopia; Gabon; Georgia; Ghana; Guatemala; Guinea; Guinea-Bissau; Haiti; Honduras; India; Indonesia; Iran, Islamic Rep.; Jamaica; Jordan; Kazakhstan; Kenya; Korea, Rep.; Kyrgyz Republic; Lebanon; Lesotho; Madagascar; Malaysia; Mali; Mauritania; Mexico; Mongolia; Morocco; Mozambique; Myanmar; Namibia; Nepal; Nicaragua; Niger; Nigeria; Oman; Pakistan; Panama; Paraguay; Peru; Philippines; Rwanda; Senegal; Sierra Leone; South Africa; Sri Lanka; Tanzania; Togo; Tunisia; Turkey; Uganda; Uruguay; Vietnam.

2.B.2 Filter data data

The figure 1, 2 and 3 have been built as follows, according to Garcia-Santana, "Investment Demand and Structural Change", 2020: first we regress the wanted variable, z_{it} on a low polynomial of log y_{it} and country fixed effects α_{zi} :

$$z_{it} = \alpha_{zi} + \alpha_{z1}\log(y_{it}) + \alpha_{z2}\log(y_{it})^2 + \varepsilon_{it}$$

The second step is to use the prediction equation,

$$\hat{z}_{it} = \alpha_{zi} + \hat{\alpha}_{z1}\log(y_{it}) + \hat{\alpha}_{z2}\log(y_{it})^2$$

with α as intercept equal to the unweighted average of country fixed effect α_{zi} . The lines in the graphs represent all the countries in the dataset. We use this method, filtering the data for remittances, fertility and migration.

2.C Solution of the household optimization problem

The household maximizes (4.1) subject to (4.5). Let λ_t be the Lagrange multiplier. The solution of this maximization problem is characterized by the following first order conditions:

$$\lambda_t = \beta^t n^t l_t \frac{\omega_g \left(c_{g,t}-\overline{c}\right)^{-\frac{1}{\varepsilon}}}{\omega_g \left(c_{g,t}-\overline{c}\right)^{\frac{\varepsilon-1}{\varepsilon}} + \omega_s c_{s,t}^{\frac{\varepsilon-1}{\varepsilon}}}, \tag{2.15}$$

$$\lambda_t p_{s,t} = \beta^t n^t l_t \frac{\omega_s c_{s,t}^{-\frac{1}{\varepsilon}}}{\omega_g \left(c_{g,t}-\overline{c}\right)^{\frac{\varepsilon-1}{\varepsilon}} + \omega_s c_{s,t}^{\frac{\varepsilon-1}{\varepsilon}}}, \tag{2.16}$$

$$\lambda_t n \frac{l_{t+1}}{l_t} = \lambda_{t+1}(1+r_{t+1}). \tag{2.17}$$

Combining (2.15) and (2.16), we obtain

$$p_{s,t}^{1-\varepsilon}\left(\frac{\omega_g}{\omega_s}\right)^{-\varepsilon}\left(c_{g,t}-\overline{c}\right) = p_{s,t}c_{s,t}.$$

Using the previous equation and the definition of consumption expenditures, we obtain (2.9) and (2.10) in the main text. We combine (2.9), (2.10) and (2.15) to obtain $\lambda_t = \beta^t n^t l_t / \left(e_t - \overline{c}\right)$. We finally use this expression and (2.17) to obtain (2.11) in the main text.

2.D The dynamic system and the balanced growth path

In this appendix, we first obtain the system of difference equations governing the time path of the variables in equilibrium. Since technological progress causes sustained growth, we define transformed variables that remain constant i the long run. We obtain the equations using the following transformed variables: capital stock per efficiency unit of labor, $z_t = k_t A_{g,t}^{\frac{1}{\alpha-1}}$, consumption share in GDP, $\eta_t = \frac{e_t}{y_t}$, minimum consumption per unit of GDP, $v_t = \overline{c}/y_t$, and remittances per unit of GDP, $\rho_t = R_t/y_t$.

We first combine (2.3) and (2.11), to obtain

$$\frac{\eta_{t+1}-v_{t+1}}{\eta_t - v_t} = \beta(1+\alpha z_{t+1}^{\alpha-1}-\delta)\frac{y_t}{y_{t+1}},$$

and, using (2.12), we deduce that

$$\frac{\eta_{t+1}-v_{t+1}}{\eta_t - v_t} = \beta(1+\alpha z_{t+1}^{\alpha-1}-\delta)\left(\frac{z_t}{z_{t+1}}\right)^{\alpha}\left(\frac{A_{g,t}}{A_{g,t+1}}\right)^{\frac{1}{1-\alpha}}. \tag{2.18}$$

We next combine (2.14) and (2.12) to obtain

$$z_{t+1} = \frac{l_t z_t^{\alpha}}{n l_{t+1}}\left(\frac{A_{g,t}}{A_{g,t+1}}\right)^{\frac{1}{1-\alpha}}\left(1+(1-\delta)z_t^{1-\alpha}+\rho_t\left(\frac{1}{l_t}-1\right)-\eta_t-\frac{\psi\left[\left(\frac{1}{l_t}-1\right)-\left(\frac{1-l_{t-1}}{l_t}\right)\frac{1}{n}\right]}{z_t^{\alpha}A_{g,t}^{\frac{1}{1-\alpha}}}\right) \tag{2.19}$$

Finally, using the definition of v_t and (2.12), we obtain

$$\frac{v_{t+1}}{v_t} = \frac{y_t}{y_{t+1}} = \left(\frac{z_t}{z_{t+1}}\right)^{\alpha} \left(\frac{A_{g,t}}{A_{g,t+1}}\right)^{\frac{1}{1-\alpha}} \tag{2.20}$$

Given the path of the exogenous variables, $A_{g,t}$, l_t and ρ_t, the system of equation (2.18)-(2.20) determines the path of the transformed variables: η_t, z_t and v_t. We assume that the exogenous variables satisfy: $l_t = l$, $\rho_t = \rho$, $A_{g,t+1}/A_{g,t} = \gamma_g > 1$, and $A_{s,t+1}/A_{s,t} = \gamma_s > 1$. We therefore assume that the fraction of residents in the total population, l, and remittances as a share of GDP, ρ_t, are constant and technological progress grows at a constant rate in both sectors. We next show that with these assumptions, the equilibrium exhibits an asymptotic balanced growth path (BGP), along which the transformed variables remain constant.

Since z_t is constant in a BGP, (2.20) implies that along a BGP $v_{t+1}/v_t = (1/\gamma_g)^{\frac{1}{1-\alpha}} < 1$ and, hence, $v^* = 0$ asymptotically. Using (2.18) and (2.19), and the fact that η_t is constant in the long run, we obtain that the long run values of z and η are

$$z^* = \left[\left(\frac{\gamma_g^{\frac{1}{1-\alpha}}}{\beta} - (1-\delta)\right)\frac{1}{\alpha}\right]^{\frac{1}{\alpha-1}}$$

and

$$\eta^* = 1 + \rho\left(\frac{1}{l} - 1\right) - \frac{\alpha}{\beta}\frac{\gamma_g^{\frac{1}{1-\alpha}} n - (1-\delta)}{\gamma_g^{\frac{1}{1-\alpha}} - \beta(1-\delta)}.$$

Finally, using (2.13), we obtain that the employment share is

$$u_{s,t} = \frac{p_{s,t}^{1-\varepsilon}\left(\frac{\omega_g}{\omega_s}\right)^{-\varepsilon}}{1 + p_{s,t}^{1-\varepsilon}\left(\frac{\omega_g}{\omega_s}\right)^{-\varepsilon}}(\eta_t - v_t).$$

If we assume that $\gamma_g > \gamma_s$ and $\varepsilon < 1$ then $p_{s,t}$ diverges to infinite and the asymptotic long run share of employment is $u_s^* = \eta^*$.

3 Fertility and Migration

3.1 Introduction

In this paper, we document the existence of a negative correlation between migration and fertility by analyzing a large sample of developing countries. We argue that this correlation is the result of the opportunity cost associated with migration: when a family member emigrates abroad, individuals remaining at home face a higher opportunity cost with a consequent reallocation of household time. This reorganization of time leads to a decrease in fertility.

To show this argument, we build a model based on Delacroix (2014). In De la Croix model (2014) households care about their consumption, the number of children, and their education, and adult members of the household divide their time between working and taking care of the children. In our model, we further assume that individual adult members decide to migrate abroad. In this framework, migration generates two opposite effects on fertility. On the one hand, migration increases the fertility rate. When the salary abroad is more attractive than the local salary, the agents have an incentive to migrate, and the family left in the home country receives remittances. This increase in income, due to remittances, induces the household to increase the number the children, given they are normal goods. On the other hand, migration decreases the fertility rate through two mechanisms. The first mechanism is the substitution between children and education. Migration relaxes the household budget constraint via remittances. This causes the adults to increase the amount of education expenditure reducing directly the quantity of children. The second mechanism is a general equilibrium effect due to migration. When the migration takes place, the local labor supply decrease and, consequently, the local salary increases. Individuals who stay in the home country now face a higher local salary, but a lower salary level to migrate, which implies a higher opportunity cost to take care of children. This induces a change in the household time allocation choices that induces a reduction in fertility. Thus, the new critical elements in our paper are that the reorganization of the activities and the general equilibrium effect jointly induce the decrease in fertility.

From the theoretical point of view, our paper is in line with the literature. In

Becker's publications on fertility (1960), he states that a couple gets utility from their consumption, the number of their children, and their quality producing a positive income effect on fertility, i.e. that family size increases household income. Children are viewed as durable goods also because they are seen as labor service providers. Furthermore, in another work, Becker extended his theory assuming that as income rise with growth and development, the demand for quality gets more elastic. This leads to an increase in the demand for quality, raising the cost of children and reducing their quantity (Becker and Lewis 1973). In another work, Mincer (1963) develops the theory that the variation in the number of children is due to the opportunity cost of the women's time as measured by the women's wage rate, which is negatively related to fertility. This has already progressed by Becker (1960) who associates the greater effect of technological progress on the productivity of women's time concerning domestic production, with the rising opportunity cost of time women spent in child-rearing. In another approach (Barro, Becker 1988) parents care about the future of their children but also their retirement. In this sense parents with lower incomes choose to invest less in their children while parents with higher incomes will invest in the optimal amount of human capital. Willis (1994) extends the work of Becker adding institutional context to the fertility transition. In more recent work, De la Croix and Doepke (2003) show that inequality and growth explain the differential in the fertility rate.

In the first part of the paper, we show empirical evidence of the negative impact of migration on fertility by controlling for different cofactors. In the second part, we build a general equilibrium model able to explain the empirical findings. In the third section, we calibrate the parameters of the model and we show that it can replicate the fertility pattern across countries. Based on this framework, we perform two quantitative exercises to analyze the role of migration on fertility.

In the first counterfactual exercise, we show what is the effect of the time cost to migrate on the fertility rate in the model. For this purpose, we raise the time migration cost. We found that a higher migration time cost is associated with a higher fertility rate. The intuition is the following: when people can't migrate due to a higher time cost, the working hours in the home country increase, while the intern salaries decrease. The consequence is that the birth rate increases since the opportunity cost of having children, in terms of wage, decreases.

In the second counterfactual exercise, we analyze what would have happened to the cross-country fertility differences if the time cost dedicated to migration had not changed. More precisely we observe a change in the differences in fertility across countries between the years 1991 and 2017. At the same time, the level of migration in the year 1991 compared with the year 2017 has increased. We argue that this increase in migration, measured as dispersion, is associated with the

observed differences in fertility. To quantify how the differences in migration affect the differences in fertility among countries we first calibrate the model to replicate the distribution of fertility across countries in the years 1991 and the year 2017. Then, we simulate again the model using the economic information from 2017 but setting the value of the time cost of migration at the observed level in 1991 level for all the countries. The result of this counterfactual exercise indicates that the time cost of migrating in 1991, the fertility would have been 53% higher than the value of fertility with the time cost of migrating in 2017.

This result is due to the interaction between two effects: the first effect is associated with an income effect of remittances on fertility. Migrating now is more time costly, but the family left behind is still receiving the amount remitted in 2017, which is higher than the amount remitted in 1991. This led to an increase in household income. The second effect is associated with a substitution effect of migration on the opportunity cost of having children. Given that the time cost of migrating remains stable, the labor supply increases (more people working in the home country), and the intern wages decrease. In this case, the opportunity cost of having children, induced by migration is lower. This generates a substitution mechanism: given that the children are considered a normal good the households prefer to substitute quantity for quality of children, which means raising the fertility rate. Thus, in this counterfactual exercise, the sum of the income effect and the mechanism associated with the opportunity cost is larger than the effect associated with the education on fertility.

3.2 Empirical motivation

In this section, we show empirical evidence about the facts that motivate the paper. First, we want to show the negative relationship between fertility and migration. To do this we use data from World Bank, United Nation Population Division, WHO, and ILO for a large panel of countries. We pool the data of all countries from 1991 to 2017, and we filter out cross-country differences in level by regressing the fertility against the quadratic term of GDP per capita in dollars and country fixed effect.

Figure 3.1, panel a, shows the scatter plot of the share of migrants and remittances in a sample of 50 developing countries, over the period from 1991 to 2017. A more detailed description of the data and the countries are reported in the Appendix. The graph indicates a positive correlation between migration and remittances. The first motivations for migration from developing countries are generally linked to economic opportunities overseas and sharing part of this newly acquired economic

opportunity with family members remained behind (Skeldon, 1997; Faist, 2000; Oda, 2004; Piper 2007; de Haas, 2010, 2012; Ullah, 2010; Adams et al., 2012; Rajan, 2012; Sirkeci et al.,2012). In these terms, remittance represents the most direct beneficial private transactions in the global economy. At the same time, this transmission of money and the diaspora, have been accompanied by a decrease in fertility.

[Insert Figure 3.1]

The Figure 3.1, panel b, is a scatter plot showing a negative relation of fertility and remittances. This decreasing relationship between the two variables suggests that money sent at home by these migrants is an important source for the left-behind households, but also has an impact on the households' reproductive behavior. This impact extends beyond the households that migrants left behind in their home countries As a consequence, Figure (3.2), panel a, show the positive correlation between education spending and remttances and Figure (3.2) panels b shows the negative correlation between migration and fertility rate. At the same time the issue of international migration linked with the fertility behavior of the migrants has been studied by different scholars (Fargues,2007; Kulu,2007; Goldstein et al.,1981). They show that the fertility rates of source countries are affected by the rates prevailing in their migrants' host countries. Their explanation is that the impact of host countries' fertility rates on those in migrants' home countries is the result of the transfer of behavioral norms from host to source country.

[Insert Figure 3.2]

3.2.1 Data

In this section, we build a panel dataset (unbalanced) that contains data from WORLD BANK, ILO, UNDP, and WHO for 50 developing countries from 1991 to 2017. More precisely we use aggregate data on migration, remittances, expenditure in education, GDP per capita, and labor force participation of women.

We set as dependent variable birth per woman (FERTRATE), defined as the number of children that would be born to a woman if she were to live to the end of her childbearing years.

As explanatory variables, we use the share of emigrants (MIGRRATE), calculated as the ratio between the total migration and total population. Since several studies demonstrated that remittances have a negative impact on fertility, we added the log of remittances per capita (REMPERCAP) which represents the current transfers in cash or in-kind made or received resident households to or from nonresident households. The intuition is that remittances affect the budget constraint and expen-

diture behavior of the households left behind, decreasing fertility rates. Following Anwar and Mughal (2014), we control also contraceptives (CONTRACC), the mortality rate of children (INFMORTR), primary enrollment rate school (PRIMATOT), and health expenditure per capita (HEEXPFEM). The first variable reports the values of contraceptive prevalence (for any modern method and specific modern methods) as a percentage of married or in-union women of reproductive age; the second indicates the number of infants dying before reaching one year of age, per 1,000 live births in a given year. The third is the ratio of total enrollment, to the population of the age group that officially corresponds to the level of primary education. The fourth shows the current expenditures on health, goods, and services, per capita in current US dollars. All these four variables, contribute to lowering the fertility rate. Furthermore, as in Naufal and Vargas (2009), we control for the female labor force participation (FEMLABPART), calculated as% of the female population that is economically active. Finally, we control for GDP per capita (LOGGDPPP) and education expenditure (EDEXPEND), which refers to the current operating expenditures in education, including wages and salaries. Table (3.B.1) and (3.B.2) in the Appendix displays the descriptive statistics of the variables used in the empirical analysis.

3.2.2 Estimation

To estimate this relation, we use cross-country analysis over time (panel analysis) to examine empirically the effects of migration on fertility. More specifically, we need a fixed-effects assumption to avoid systematic biases connected to unobserved characteristics that remain constant over years and might affect fertility. We think that the standard two–way fixed effects seem the more appropriate since the variables vary over time and across countries. For the estimation, we use the following specification.

$$Y_{it} = b + \beta X_{it} + \alpha_{it} + \gamma_t + \varepsilon$$

where Y_{it} is fertility of country *i* at time *t*, b is the constant term, β is a coefficient vector, and α_{it} and γ_t represent country and time fixed effects, respectively. The last variable ε_i, epsilon is the error term. The vector X includes all the regressors used in the estimations. The estimations were performed using four specifications to ensure the robustness of the results. In table 1 we display the estimation results of the relation between fertility and migration, controlling for other covariates. We can observe that migration has a negative effect on the fertility rate in all four specifications. This is consistent with previous studies of the relationship between migration

and fertility. Jensen and al. (2004) find that, in the Philippines, fertility declines accompanying migration may be large enough to be explained by the effect of normative adaptation. Lindstrom and Giorguli-Saucedo (2002) found that Mexico-US temporary migration of women reduces long-term household fertility. In the same way, Beine et al. (2008), argue that migration raises households' incentive in investing in the education of their children and so reducing fertility. In particular, in the first column, we estimate the effect of migration on the fertility rate controlling for remittances, GDP, female labor participation, infant mortality rate, and rural population.

[Insert Table 3.1]

Observe that the sign of remittances is negative, which means that they have a negative impact on the fertility rate of the home country. This suggests that a part of remittances could be spent on health services, and education, which contributes to decreasing fertility. The GDP is negatively correlated with the fertility rate as expected since poor countries tend to have higher levels of fertility than rich countries. More specifically, the sign of the quadratic term of the GDP implies that the curve is concave. Also, female labor participation has a negative impact on fertility because the more females participate in the labor force more high is the opportunity cost they have to face, and this lowers the fertility rates (Naufal, Vargas 2009). A negative relationship between the infant mortality rate and fertility is expected. In the second column, we added the level of current health expenditure. For developing countries, the effects of expenditure on health care goods and services have a positive effect on fertility and, consequently, a negative on the infant mortality rate. In the third column, controlling also for contraceptives, we found an expected negative impact on the fertility rate. In the fourth column, the last term we check for is the ratio of total enrollment in primary school, which is negative, since a higher level of literacy tends to decrease fertility. In this sense, educated women become more skilled and the opportunity cost of bearing children become relatively high. This result was already obtained by Castro Martìn (2015) analyzing the relationship between women's education and fertility, confirming that school allows women to change reproductive choices. In the fifth column, we added the expenditure education, where the sign is negative. The effect of the educational investment of the government on fertility has been analyzed by DeCicca and Krashinsky (2016) who demonstrated that expenditure in education compress the fertility distribution and woman are less likely to have multiple children.

We argue that these results exist because the left of a member of the household implies a cost for the family. The intuition is the following: when a member of the family migrates abroad the available total time of the family is reduced, implying a

reorganization of the activities inside of the household. In the next section, we built a theoretical model incorporating the time constraint of the household.

3.3 The model

3.3.1 Households

The model based on De la Croix (2014), considers an economy populated by a continuum of agents with a mass of one. The agents live for childhood and adulthood and their decisions are taken when they are adults. Agents care about their consumption, the number of children, and their children's education. The utility function that represents the agents' preferences is:

$$U_t = \ln c_t + \gamma(\ln n_t + \eta \ln e_t), \tag{3.1}$$

where $\gamma > 0$ means the weight attached to children in the function, and $\eta\gamma$ represents the weight attached to their education, with $0 < \eta < 1$. Parents care about both child quantity and quality. The budget constraint for a single agent is about in terms of resources and time and it is represented by the following equations:

$$c_t = h_t w_t + \Pi + (R_t - \psi)m_t - e_t n_t, \tag{3.2}$$

and

$$1 - \phi_n n_t = \phi_h h_t + \phi_m m_t, \tag{3.3}$$

where h_t is the share of household members that work at home country; w_{it} represents the salary in the home country. Π is the profit deriving from being the owner of a firm; R_t is the salary abroad while m_t and ψ represent respectively the share of household members that decide to migrate and the cost of sending remittances. The expenditure in education is indicated like e_t, while n_t the number of children. In the equation (3.3), the time endowment of the household is normalized to 1; The parameters ϕ_n, ϕ_h,and ϕ_m are the time cost of child care, work in the home country, and work abroad which are considered to be constant. As a result, the interaction between the parameters and the variables represents the share of total hours spent in child care, working in the home country, and migrating. Consequently, the household chooses the number of the children, the number of household members who work in the home country and abroad such that the agents maximize their utility subject to the equation (3.2) and (3.3). In Appendix A, we show that the solution of

the household's problem is characterized by the following equations:

$$e_t = \frac{\eta}{1-\eta}\frac{\phi_n}{\phi_h}w_t, \tag{3.4}$$

$$c_t = \frac{1}{1+\gamma}\left(\Pi + \frac{w_t}{\phi_h}\right), \tag{3.5}$$

$$n_t = \frac{\phi_h}{\phi_n}\frac{1-\eta}{w_t}\frac{\gamma}{1+\gamma}\left(\Pi + \frac{w_t}{\phi_h}\right), \tag{3.6}$$

$$m_t = \frac{1}{\phi_m} - \frac{\phi_h}{\phi_m}h_t - \frac{\phi_n}{\phi_m}n_t. \tag{3.7}$$

We can see that the education of children depends on w_t, c_t and n_t are a function of the earning profit, while m_t depends from the profit wage, and the labor supply of the households. In equilibrium the labor supply in the home country will be determined by the following condition:

$$\frac{w_t}{\phi_h} = (R_t - \psi)\frac{1}{\phi_m} \tag{3.8}$$

The decision to migrate in this economy is given by w_t. The worker is indifferent to the decision to migrate if the labor income in the home country, applying the effort which corresponds to the worked hours abroad, is the same as the labor income abroad. If the labor income is higher in the home country with respect to the income abroad, the agent chooses to stay

3.3.2 Firm

Production of the consumption good is carried out by a single representative firm which operates the technology:

$$y = Ah^{\alpha}, \tag{3.9}$$

where h is the labor input, $A > 0$ represents the TFP, and the elasticity of the output respect to labor is $\alpha \in (0, 1)$. The firm solves the maximization problem:

$$\max_h \Pi = Ah^{\alpha} - wh, \tag{3.10}$$

choosing the amount of labor. From the first order condition we obtain the demand function of labor equal to:

$$h^d = \left(\frac{\alpha A}{w}\right)^{\frac{1}{1-\alpha}},$$

which implies that the profit is:

$$\Pi^* = (1-\alpha) A \left(\frac{\alpha A}{w}\right)^{\frac{\alpha}{1-\alpha}}.$$

3.4 Equilibrium

We define a competitive equilibrium as an allocation,{c,e,m,n,h}, and prices,{w}, such that I)consumers choose the quantity of the consumption, level of education, migration, numbers of children, and hours to work in the home country to maximize the (3.1), II) firms choose the quantity of labor demand to maximize 3.10, III) the goods and domestic labor markets are cleared. In this equilibrium the optimal demand of labor is:

$$h^* = \left(\frac{\alpha A}{w}\right)^{\frac{1}{1-\alpha}}, \tag{3.11}$$

Given this constant demand of labor, the household decision to migrate is:

$$m_t^* = \Delta_1 - \Delta_2 w_t^{-\left(\frac{1}{1-\alpha}\right)}, \tag{3.12}$$

and the amount of children is:

$$n_t^* = \Delta_3 + \Delta_4 w_t^{-\left(\frac{1}{1-\alpha}\right)}, \tag{3.13}$$

where $\Delta_1, \Delta_2, \Delta_3$ and Δ_4 are function of parameters which are showed in the appendix. The optimal choice of consumption and education are defined in the equation (3.5) and (3.4).

3.4.1 Comparative statics

Based on the previous equations, we find that migration causes two effects on fertility: income and substitution effect. The substitution effect prevails on the first, which entails a decrease in fertility. To examine the implications and the reduction in fertility we examine the partial derivatives of the equilibrium solution, in particular the solution of *m* and *n*. From (3.12) we have:

$$\frac{\partial m_{it}^*}{\partial R_{it}} = \frac{\Delta_2}{1-\alpha} \frac{\left[(R_t - \psi)\frac{\phi_h}{\phi_m}\right]^{-\frac{1}{1-\alpha}}}{R_t - \psi} > 0$$

where we substituted the wage using (3.8). This result shows that when the wage abroad increases and is higher that local wage migration increases, which is consis-

tent with the empirical evidence in the previous section. From (3.13) we obtain that the effect of remittances on the fertility rate is:

$$\frac{\partial n_{it}}{\partial R_{it}} = -\frac{\Delta_4}{1-\alpha}\frac{\left[(R_t-\psi)\,\frac{\phi_h}{\phi_m}\right]^{-\left(\frac{1}{1-\alpha}\right)}}{R_t-\psi} < 0$$

The negative effect of remittance on fertility is explained by two mechanisms. The first mechanism is associated with the general equilibrium effect on the local labor market induced by migration. When migration takes place, the local labor supply declines and as a consequence the intern salary increases. This is due to the internal equilibrium market to satisfy the firm demand for labor. As a result, the individual who stays in the home country faces up a higher salary, but also a higher opportunity cost for raising children. The second mechanism is associated with an income effect deriving from the remittances due to migration: when the family receives the money, this relaxes the budget constraints and allows expending more for the education of the children (and for the consumption). This implies that parents substitute the number of children with the quality, which means having fewer children but more educated. The migration process, in our model, boosts the quality-quantity pointed out by De la Croix (2014) through remittances. This increase in the opportunity cost of having children induces a reduction in fertility.

3.5 Quantitative analysis

3.5.1 Calibration

In this section, we present the strategy to calibrate the model's parameters to analyze the effect of migration on fertility. For this purpose, in this first exercise, we show that our model can replicate the observed fertility rate in the countries in our sample.[1] Our strategy consists of identifying first the parameters which are common to all the economies, and then those parameters which are specific to each country.

The first set of parameters is represented by $\{\gamma, \eta, \alpha\}$. We set the value of elasticity of the output with respect to labor, α equals to 0.53 which is the average value of the labor income share in the Penn World Table. Then we give a value of 0.08 to the weight attached to children in the household's utility, γ, and 0.64 to the elasticity of

[1] Our sample consists of 42 countries described in the appendix. We focus on this group of countries given the available data on labor income share, cost of sending remittances, number of children per woman, migration stock, GDP per capita, GDP per worker, total remittances, and education spending per child.

income to schooling, η as in Delacroix (2014). These two parameters are taken inside an interval estimated by Delacroix (2014) which correspond to the upper limit of the estimated coefficient to match the median value of fertility rate for the poorest countries and the median value of the labor income share from the total sample, respectively.[2] The second set of the country-specific parameters is represented by $\{A, \phi_h, \phi_m, \phi_n\}$. We set jointly the value for $\{A, \phi_h, \phi_m, \phi_n\}$ to match, the following targets: the GDP per capita, the share of migrants and the persons engaged in the home country as a fraction of total population, and the education spending as percentage of GDP. We take the average value of them for each country. To set the value of the remaining parameter, ψ, we assume that the cost of sending remittances is a fraction of the wage abroad, and we approximate the value of the wage abroad using the average of remittances per migrant. In particular, we take the value of cost sending remittances from World Bank, for every country of our database. Note that A, ϕ_h, ϕ_m, ϕ_n are calibrated given the exogenous wage abroad, R, and the cost of sending remittances ψ.[3] The values of the calibrate parameters are reported in the table 3.2.

[Insert Table 3.2]

Figure 3.3 shows the results of this strategy of calibration. In Figure 3.3, panel (a), reports the existing correlation between the simulation of the model and the data. Note that the model replies in a very good way to the data since that most part of the simulated information are on the line of 45 degrees. [4]. The second result we obtain is in panel (b). We observe the relation between the stock of migration and the fertility rate of the model and of the data. The model replicates in a good way the correlation between these two variables. From these analyses, we conclude that the model can replicate the fertility pattern of the countries. As a consequence, these results allow us to explore the impact of migration on fertility. For this purpose, in the next subsection, we perform two exercises: in the first, we want to know what is the effect of the time constraint introduced by the migration process on fertility rate in the model. In the second exercise, we want to quantify how much of the

[2] We compute the quartiles of income (GDP per capita, PPP) to calculate the median value of the fertility rate for the poorest country group.

[3] Moreover, in the Supplementary Appendix, figure (3.D.1) reports how the model matches the targets based on this strategy. As figure (3.D.1) shows, the model replicates the GDP, the migration rate, the labor in the home country and education of the model with the data

[4] The existing correlation between the data and the model is 0.98, although the model overestimates the value of some countries.

differences in fertility between countries is explained to the migration.

[Insert Figure 3.3]

3.5.2 First quantitative exercise: effect of change in the time cost of migration on fertility

In this section, we compute the first counterfactual experiment. The purpose of the exercise is to answer the following question: what would happen to the fertility rate if the time cost of migration increased? To this end, we keep the migration constant as in the benchmark model, while we give to ϕ_m a higher value. In particular, we assume that the cost to migrate abroad in terms of time ϕ_m, for the 42 countries, is a 20% more than the ϕ_m calibrated. The results of this exercise are reported in the Figure 3.4 and in the Figure 3.5. In the Figure 3.4, we observe that the fertility rate increases in all the countries. In particular, the growth is higher in the countries with a higher number of children. In the 3.5, we show that the labor supply increases at home (panel b), while the salary decreases (panel c). Simultaneously, the household stops receiving remittances, which reduce the expenditure on education (panel d).

[Insert Figure 3.4]

The intuition of these results is the following. Since family members can no longer go abroad because the time cost to migrate is higher, this implies that more people stay in the home country. Due to a lower opportunity cost, more people stay at home, so that the individuals have more time to take care of the children. At the same time, the number of people working in the home country increase, implying a reduction in local wages. The second consequence is due to the trade-off between quantity and quality of children. Since the family is not receiving remittances, the total income decreases, so they cannot finance the education of children anymore. The sum of the two effects is that the fertility rate increase.

[Insert Figure 3.5]

3.5.3 Second quantitative exercise: effect of migration to explain cross-country differences in fertility

Since the beginning of the 1990s, developing countries have been undergoing a process of demographic transition which has led to major changes in fertility levels (Lee, 2015; World Fertility Report, United Nations, 2015). This difference in the

number of children is reflected in the distribution of our sample of countries that we analyzed before. Taking data about fertility in two different periods (1991 and 2017) for these countries, we observe that there is an important variation in the differences in fertility. In particular, the Figure 3.6 shows the distribution of fertility across countries in two different years. In 1991, the distribution of fertility (blue line) is characterized by a variance value around 1.6758, and the mean value of children was around 3.8. In contrast, in 2017, the variance and the mean value of the distribution function of fertility (red line) were around 1.06 and 2.5, respectively. Thus, the dispersion of fertility (measured by the variance) was higher in 1991 at around 60% than in 2017, while the mean value was around 50% higher in 1991 than in 2017. Simultaneously to this fact, the number of people migrating from their country of origin to another one has been grown dramatically in recent decades (Démurger, 2015). For the same periods and for the same countries, we observe in the Figure 3.6 the level of migration of 1991 compared with 2017. The blue line of the year 1991 indicates that the dispersion is very low and around 0.5. On the contrary, in 2017 there is a shift to the right of the red line making the dispersion higher. This suggests that migration has increased. We argue that this increase in migration, measured as dispersion, is associated with the observed differences in fertility. To assert and quantify how the differences in migration affect the differences in fertility among countries, we do the following counterfactual exercise.

First, we calibrate the the parameters such that the model replicates the distribution of fertility across countries in the year 1991. We repeat the calibration and the simulation using economic information for the year 2017. We then simulate again the model using data from 2017 but setting the time cost to migrate, ϕ_m, at the observed level in 1991 for all the countries. The purpose of the exercise is to answer the following question: what would have happened to the cross-country fertility differences if the time cost to migrate would have not changed? The result of this counterfactual exercises is reported in the Figure 3.7 and in Table 3.5 while the parameters calibrated for the year 1991 and the year 2017 are reported in the appendix. Figure 3.7 plots the distribution of fertility in the year 1991 (blue line) and 2017 (red line) as in the Figure 3.6 and the counterfactual distribution (green line), generate by the model. The graphic analysis indicates that maintaining constant the time dedicated to migrate, the average number of children, and the dispersion would have been higher than the values of the year 2017 given that the distribution shifts towards right. Table 3.5. reports the differences in the average number of children according to the 90-10, the median, and the coefficient of variation between the years 1991, 2017, and the counterfactual (2017).More precisely, we report, for every type of descriptive statistics, the simulated and actual data of the distribution of fertility.

In the first column, we see that the model replicates exactly the data of the year 1991. In the second and third columns are reported respectively the actual data of the year 1991 and the year 2017. Setting the value of migration of the year 2017 equals to the value of migration of 1991 we obtain the values reported in the fourth column. In the fifth and sixth columns, we report respectively the ratio between the actual data of 2017 and between the data of 2017 generated by the counterfactual exercise, to compare how the statistics changes. In the last column, we report the differences between the two ratios. With respect to the statistic 90-10, we notice that the value of the ratio between the values of the year 2017 with the actual migration data of 2017 is equal to 1.1639. The value of the ratio with the counterfactual data is 1.69. The difference between the two values is 0.53. This result indicates the difference between the countries that have the most children and the least children, with the share of migrants of 1991 the fertility would have been 53% higher than the value of fertility with the share of migrants of 2017. Regarding the median, we obtained a similar result. The values of the ratio between the values of the year 2017 are 0.66, while the value of the ratio with the counterfactual data is 0.77. The difference between the two values is 0.11, meaning that with the share of migrants of 1991 the fertility would have been 11% higher than the value of fertility with the share of migrants of 2017. For the coefficient of variation, the difference between the two ratios is 82%. These results suggest that the demographic transition of fertility would have been slower without the migration process through which these countries went through between 1991-2017.

In our model, this result is due to the interaction between two effects. The first effect is associated with an income effect of remittances on fertility. In our counterfactual exercise, we set the share of migrants of each country to their reported values in 1991 instead of the share of migrants of 2017. Although fewer people migrate, the family left behind is still receiving the number of remittances of 2017, which are higher than the number of remittances of 1991.[5]. This implies an increase in the household income and consequently, this arise the fertility rate as the children are a normal good. The second effect is associated with a substitution effect of migration on the opportunity cost of having children. Given that the time cost dedicated to migrate does not change and more people stay in the home country, the labor supply increases (more people working in the home country), and the intern wages decrease. In this case, the opportunity cost of having children, induced by migration is lower. This generates a substitution mechanism: the households prefer

[5]In 1991 the average amount of remittances relative to GDP received was 8%, while in 2017 was 11%.

to substitute quantity for quality of children, which means raising the fertility rate. Thus, in this counterfactual exercise, the sum of the income effect and the mechanism associated with the opportunity cost is larger than the effect associated with education on fertility. Our results suggest that migration is an important element to explain the cross-country differences in fertility.

3.6 Concluding remarks

The objective of this paper is to examine the negative relationship between fertility and migration. To do that, we developed a model that allows us to quantify the role of migration on the reduction of fertility experimented by some developing countries in the last 26 years. We build a model based on the De la Croix framework of fertility choice (2014), including the time dedicated to migrating, working in the home country, and taking care of children. These elements have been left out of the analysis in standard macroeconomic models of fertility. In particular, we found that migration, through a general equilibrium mechanism, raises the cost opportunity to have children which induce a reduction in fertility. This mechanism explains the inverse relationship between fertility and migration that we observe in the data.

We perform two quantitative exercises to analyze and quantify the role of migration on fertility. In the first counterfactual exercise, we raise the time migration cost to show what is its effect on the fertility rate in the model. We found that a higher migration time cost is associated with a higher fertility rate. The intuition of this result is explained by the following mechanism: when more people can not migrate due to a higher migration cost, the working hours in the home country increase, while the intern salaries decline. Given that the household cannot finance the education of children anymore because is not receiving remittances anymore, the family decides to have more children. This implies implying a rise in the fertility rate due to a lower opportunity cost of having children.

In the second counterfactual, we analyze how important is the mechanism of general equilibrium induced by migration to explain the cross-country differences in fertility. We discipline the model to replicate the distribution of fertility across countries in the year 1991 and for the year 2017. Then, we simulate again the model for the year 2017, but setting the time cost of migration at the observed level of 1991 level for all the countries. Thus, in this exercise, we show what would have happened to the cross-country fertility differences if share of migrants had not changed. The results suggest that the difference between the countries that have the most children and the least children would have been 53% higher than the observed differences in fertility in 2017. Our results lead to these conclusions:

migration is an important element to explain the evolution of fertility in a developing country and why some countries experienced more decrease in fertility with respect to other countries. In this sense, this paper contributes to the literature by providing a complementary mechanism to explain the demographic transition of developing countries.

References

[1] Adams Jr, R., de Haas, H., and UO, O. (2012). Migrant remittances and development: Research perspectives. SSRC Web Antholog, pages 1–132.

[2] Anwar, A. I., Mughal, M. Y. (2016). Migrant remittances and fertility. Applied Economics, 48(36), 3399-3415.

[3] Becker, G. and Barro, R. (1988). A reformulation of the economic theory of fertility. The Quarterly Journal of Economics, 103(1):1–25.

[4] Becker, G. S. (1965). A theory of the allocation of time. The economic journal, 75(299):493–517.

[5] Becker, G. S. et al. (1960). Demographic and economic change in developed countries. An economic analysis of fertility, pages 209–231.

[6] Becker, G. S. and Lewis, H. G. (1973). On the interaction between the quantity and quality of children. Journal of Political Economy, 81(2):S279–S288.

[7] Beine, M., Docquier, F., and Rapoport, H. (2008). Brain drain and human capital formation in developing countries: winners and losers. The Economic Journal, 118(528):631–652.

[8] Boyd, M., Pikkov, D., and Piper, N. (2008). New perspectives on gender and migration: Livelihood, rights and entitlements.

[9] Chowdhury, N. J. and Ullah, M. H. (2010). Socio-economic conditions of female garment workers in chittagong metropolitan area an empirical study. Journal of Business and Technology (Dhaka), 5(2):53–70.

[10] De Haas, H. (2010). Migration and development: A theoretical perspective. International migration review, 44(1):227–264.

[11] De la Croix, D. (2013). Fertility, Education, Growth, and Sustainability. The CICSE Lectures in Growth and Development. Cambridge University Press.

[12] De La Croix, D. and Doepke, M. (2003). Inequality and growth: why differential fertility matters. American Economic Review, 93(4):1091–1113.

[13] DeCicca, P. and Krashinsky, H. (2017). The effect of education on overall fertility. Technical report, National Bureau of Economic Research.

[14] Démurger, S. (2015). Migration and families left behind. IZA World of Labor.

[15] Faist, T. (2000). Transnationalization in international migration: implications for the study of citizenship and culture. Ethnic and racial studies, 23(2):189–222.

[16] Fargues, P. (2006). The demographic benefit of international migration: Hypoth- esis and application to Middle Eastern and North African contexts, volume 4050. World Bank Publications.

[17] Goldstein, S. and Goldstein, A. (1981). The impact of migration on fertility: An âown childrenâ analysis for thailand. Population Studies, 35(2):265–284. PMID: 11630857.

[18] Hervitz, H. M. (1985). Selectivity, adaptation, or disruption? A comparison of alternative hypotheses on the effects of migration on fertility: The case of brazil. International Migration Review, 19(2):293–317.

[19] Itzigsohn, J. and Saucedo, S. G. (2002). Immigrant incorporation and sociocultural transnationalism. International Migration Review, 36(3):766–798.

[20] Jensen, E. and Ahlburg, D. (2004). Why does migration decrease fertility? evidence from the philippines. Population studies, 58(2):219–231.

[21] Kulu, H., Vikat, A., and Andersson, G. (2007). Settlement size and fertility in the nordic countries. Population studies, 61(3):265–285.

[22] Kulu, H., Hannemann, T., Pailhé, A., Neels, K., Rahnu, L., Puur, A., Krapf, S., González-Ferrer, A., Castro-Martin, T., Kraus, E., et al. (2015). A comparative study on fertility among the descendants of immigrants in europe.

[23] Mincer, J., Christ, C., Friedman, M., and Goodman, L. (1963). Measurement in economics. In Market prices, opportunity costs and income effects. Stanford University Press Stanford, Calif.

[24] Naufal, G. and Vargas-Silva, C. (2009). Changing fertility preferences one migrant at a time: the impact of remittances on the fertility rate.

[25] Organization, W. H. et al. (2015). Trends in maternal mortality: 1990-2015: estimates from WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. World Health Organization.

[26] Rajan, S. I. (2014). India migration report 2012: Global financial crisis, migration and remittances. Routledge India.

[27] Siah, A. K. and Lee, G. H. (2015). Female labour force participation, infant mortality and fertility in malaysia. Journal of the Asia Pacific Economy, 20(4):613–629.

[28] Sirkeci, I., Cohen, J. H., and Ratha, D. (2012). Migration and remittances during the global financial crisis and beyond. World Bank Publications.

[29] Skeldon, R. (1997). Rural-to-urban migration and its implications for poverty alleviation. Asia-Pacific Population Journal, 12(1):3–16.

[30] Willis, R. (1994). Population and economic development and the environment

Appendix

3.A Figures and Tables

Figure 3.1. Correlation between the stock of migrants, fertility and remittances

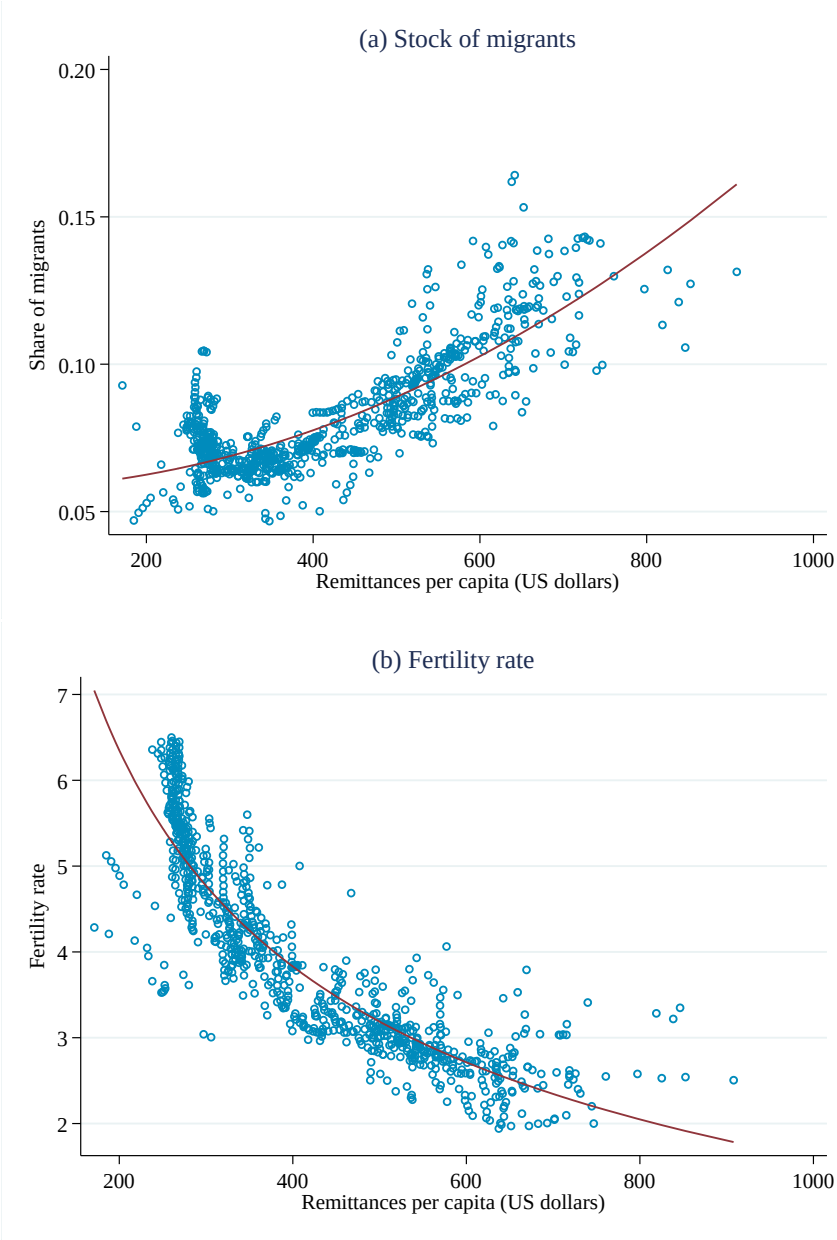


Figure 3.2. Correlation between education, remittances, fertility and migration

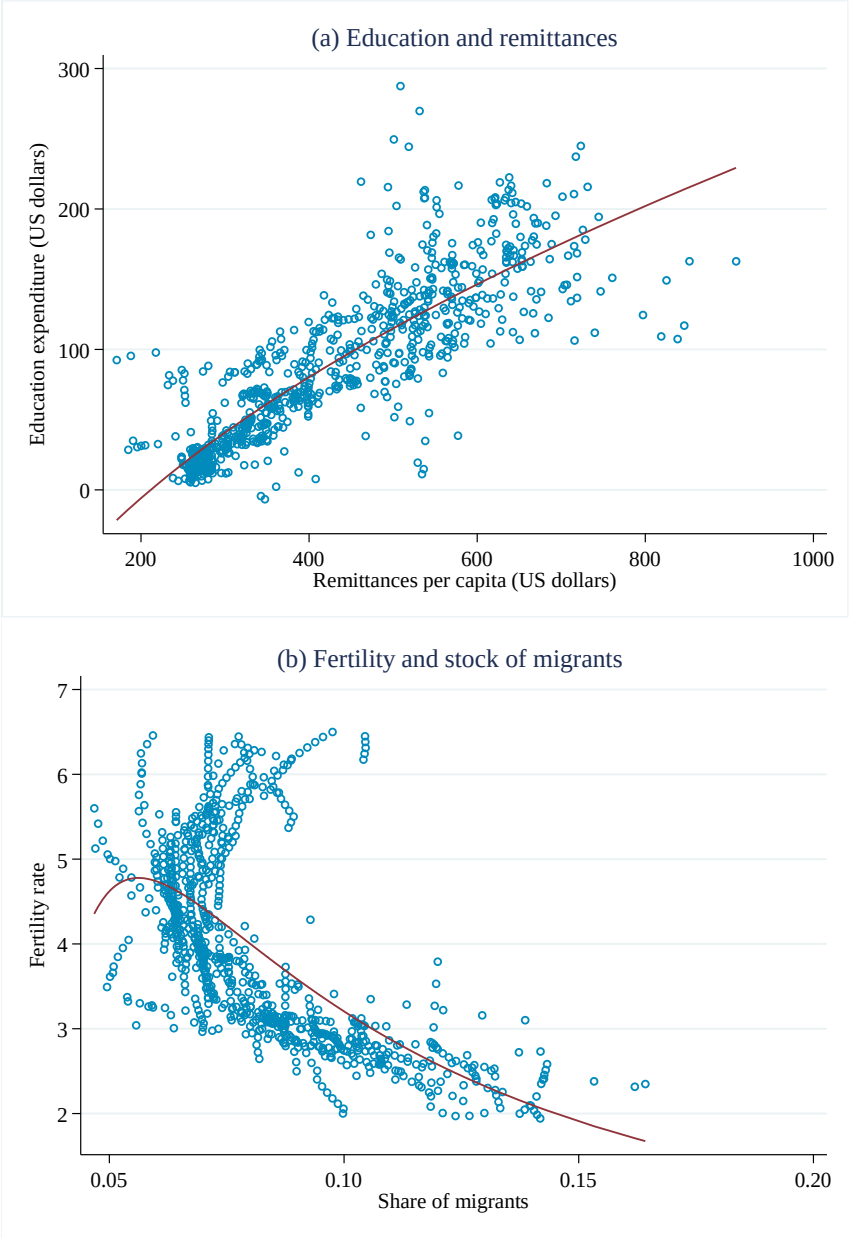


Figure 3.3. Performance of simulation: fertility rate (non-target moment)

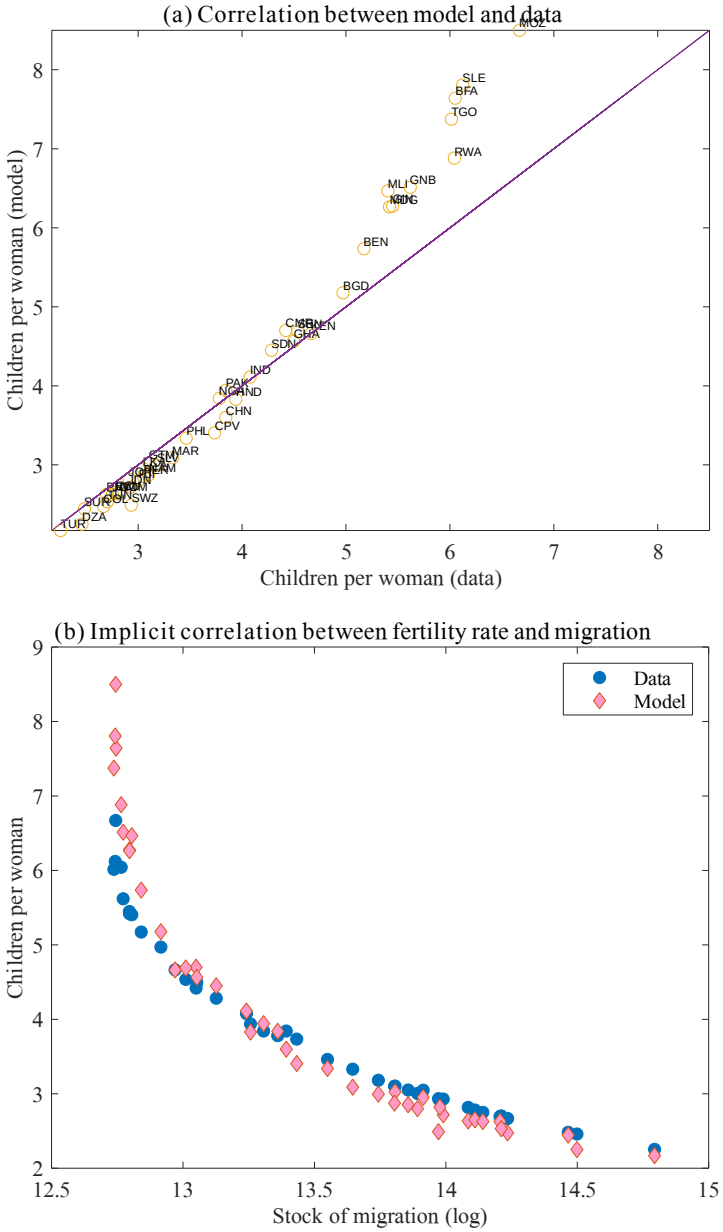


Figure 3.4. Changes in fertility rates due to changes in the time cost of migration

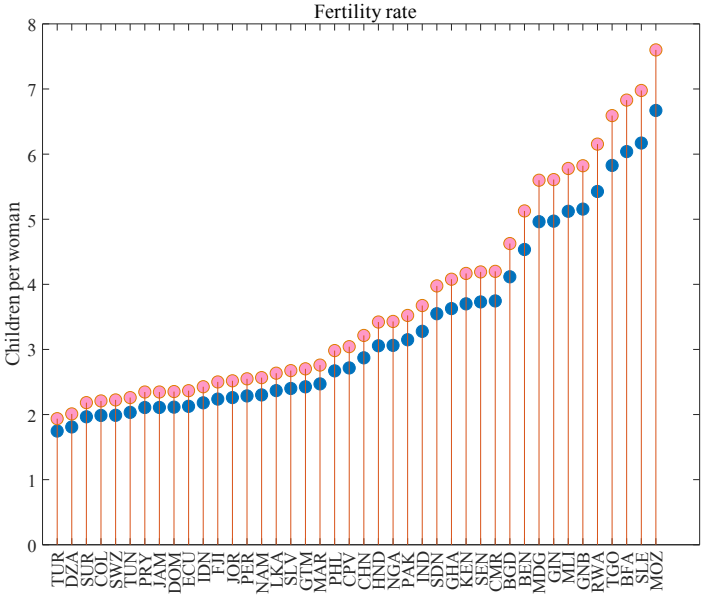


Figure 3.5. Implicit changes due to reduction in the time cost to migrate

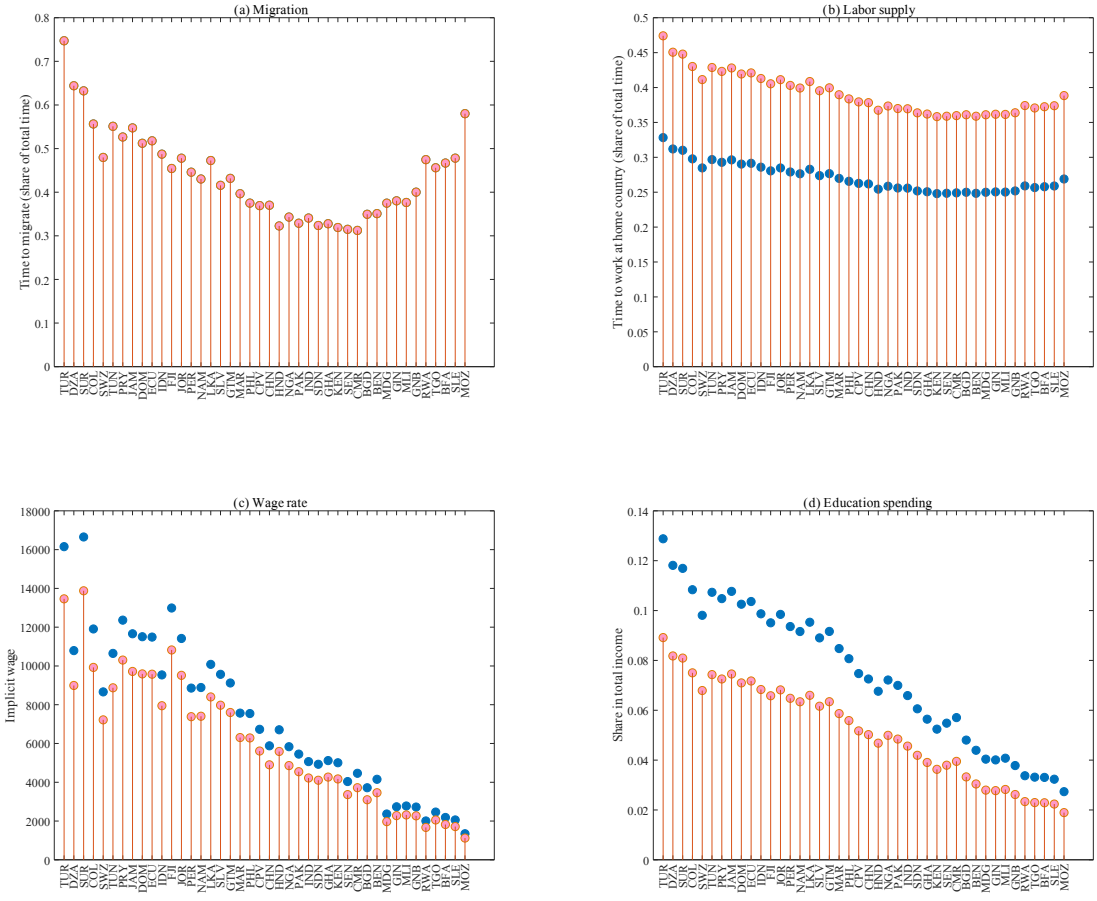


Figure 3.6. Cross-country differences in fertility: 1991 vs 2017

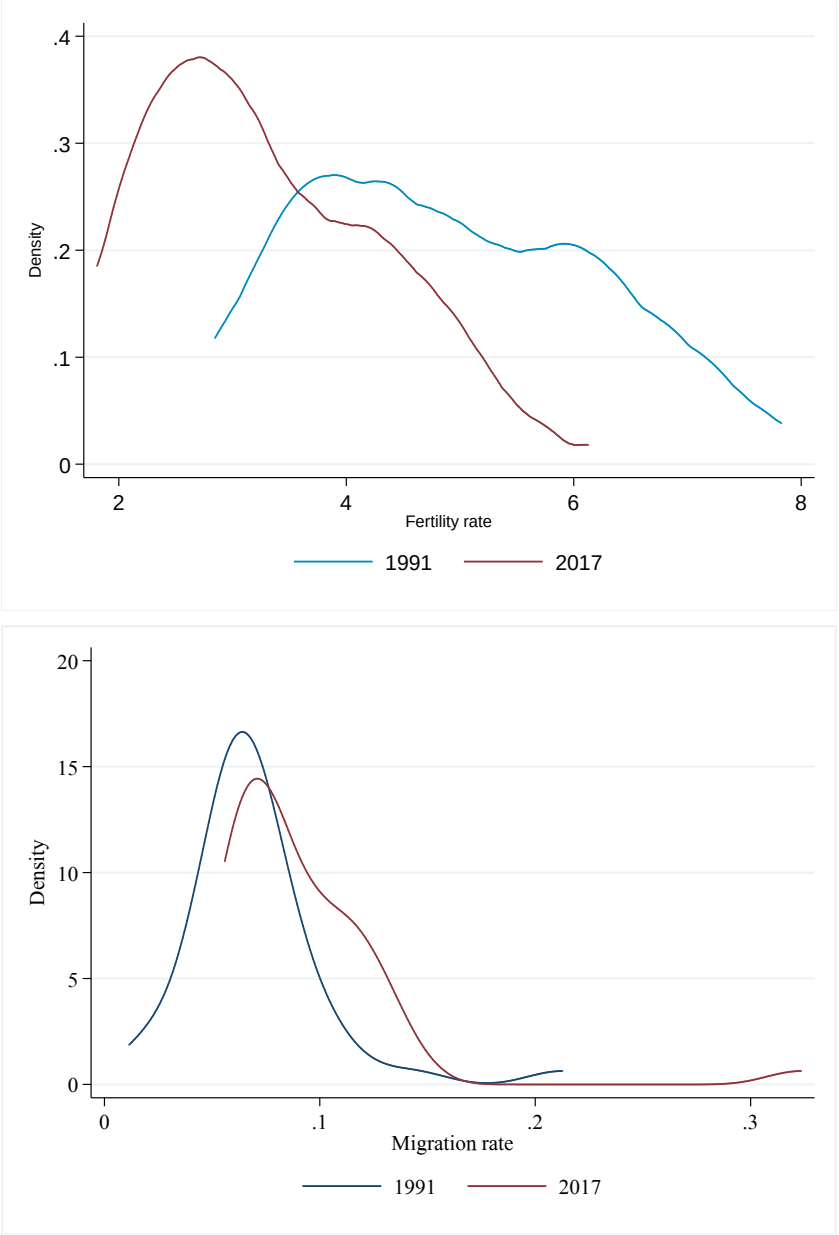


Figure 3.7. Cross-country differences in fertility: actual vs counterfactual distribution

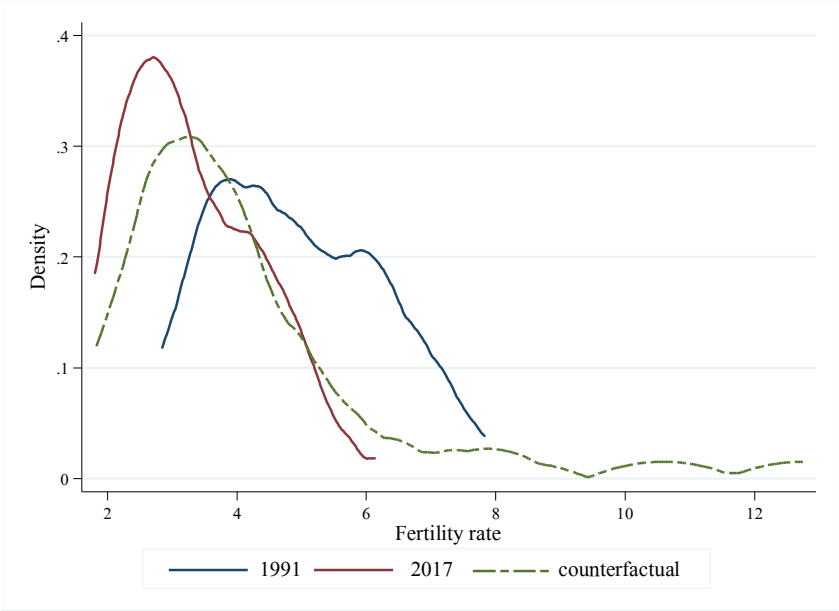


Table 3.1. Estimated effect of migration on fertility

	(1)	(2)	(3)	(4)
VARIABLES	FE (a)	FE (b)	FE (c)	FE (d)
MIGRSHAR	-1.652**	-2.469**	-3.662***	-3.943***
	(0.827)	(1.042)	(1.179)	(1.150)
REMPERCAP	-0.0232**	-0.0316***	-0.0326***	-0.0313***
	(0.0106)	(0.0110)	(0.0117)	(0.0114)
LOGGDPPP	-5.463***	-6.409***	-5.993***	-5.689***
	(0.649)	(0.687)	(0.766)	(0.749)
$LOGGDPPP^2$	0.348***	0.410***	0.379***	0.359***
	(0.0393)	(0.0415)	(0.0464)	(0.0454)
FEMLABPT	-0.0116***	-0.00393	-0.00414	-0.00293
	(0.00274)	(0.00287)	(0.00312)	(0.00306)
INFMORTR	0.000312	-0.00851***	-0.0109***	-0.0109***
	(0.00159)	(0.00190)	(0.00214)	(0.00210)
HEEXPFEM	0.000199**	0.000296***	0.000415***	0.000213**
	(7.73e-05)	(7.43e-05)	(8.16e-05)	(9.38e-05)
CONTRACC		-0.0140***	-0.0143***	-0.0146***
		(0.00157)	(0.00164)	(0.00160)
PRIMATOT			-0.00274**	-0.00561***
			(0.00112)	(0.00131)
EDEXPEND				-0.00659***
				(0.00208)
Constant	26.37***	30.67***	29.83***	28.87***
	(2.762)	(2.936)	(3.270)	(3.194)
Observations	617	514	457	457
R-squared	0.843	0.868	0.865	0.873
Number of id	45	42	41	41
Country effects	YES	YES	YES	YES
Time effects	YES	YES	YES	YES
Interaction		YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.2. Calibrated country specific parameters

	A	ϕ_m	ϕ_h	ϕ_n
Algeria	2488.15	5.975	1.369	0.027
Bangladesh	14690.35	6.488	1.015	0.073
Benin	6098.59	9.281	1.328	0.045
Burkina Faso	7149.26	8.580	1.211	0.055
Cabo Verde	12711.16	7.091	1.049	0.068
Cameroon	3256.27	7.695	1.383	0.033
China	14440.14	6.975	1.049	0.070
Colombia	21918.49	5.418	0.929	0.080
Dominican Republic	5882.11	9.735	1.271	0.046
Ecuador	4789.56	9.720	1.331	0.043
El Salvador	6562.56	9.745	1.226	0.052
Eswatini	1656.51	4.483	1.429	0.025
Fiji	2968.33	6.223	1.390	0.028
Ghana	8046.19	9.886	1.240	0.051
Guatemala	7051.02	9.228	1.232	0.055
Guinea	8197.76	8.554	1.215	0.057
Guinea-Bissau	14686.08	6.549	1.021	0.073
Honduras	5934.44	9.387	1.364	0.042
India	12084.93	6.877	1.038	0.070
Indonesia	11098.99	7.415	1.082	0.068
Jamaica	10955.41	6.678	1.103	0.074
Jordan	2425.02	5.818	1.411	0.029
Kenya	11379.53	7.734	1.078	0.065
Madagascar	5302.93	10.016	1.296	0.044
Mali	14244.09	5.328	0.921	0.081
Morocco	2812	7.800	1.387	0.033
Mozambique	4928.03	8.159	1.424	0.037
Namibia	3306.20	7.772	1.385	0.034
Nigeria	15844.70	6.393	1.007	0.074
Pakistan	6092.26	9.240	1.252	0.050
Paraguay	11879.51	8.023	1.091	0.064
Peru	11083.78	7.663	1.096	0.066
Philippines	9332.52	8.228	1.138	0.062
Rwanda	2639.41	6.113	1.376	0.028
Senegal	16315.53	7.103	1.109	0.071
Sierra Leone	4423.81	8.743	1.326	0.038
Sri Lanka	9236.65	8.696	1.157	0.059
Sudan	3249.90	7.259	1.385	0.032
Suriname	13730.12	6.139	0.987	0.075
Togo	15380.06	6.082	0.984	0.076
Tunisia	15024.59	6.175	0.990	0.075
Turkey	21834.60	4.663	0.857	0.087

Table 3.3. Calibrated country specific parameters (year 1991)

	A	ϕ_m	ϕ_h	ϕ_n
Algeria	9335.965	6.814	1.051	0.051
Bangladesh	15067.95	9.040	1.374	0.057
Benin	14158.75	7.150	1.020	0.054
Burkina Faso	8171.813	7.578	1.113	0.054
Cabo Verde	13841.51	6.000	0.912	0.048
Cameroon	3066.959	8.786	1.224	0.042
China	3630.387	5.780	1.626	0.035
Colombia	3053.424	18.264	0.895	0.033
Dominican Republic	10665.76	9.524	1.347	0.059
Ecuador	3880.836	9.487	1.132	0.034
El Salvador	3785.552	9.418	1.420	0.041
Eswatini	9602.349	8.487	1.260	0.050
Fiji	2597.706	6.609	1.228	0.034
Ghana	8407.192	9.916	0.817	0.042
Guatemala	1587.823	4.220	1.326	0.028
Guinea	9774.892	3.373	2.124	0.052
Guinea-Bissau	14752.97	22.610	1.819	0.070
Honduras	10061.69	9.860	1.041	0.048
India	13332.31	25.642	1.162	0.058
Indonesia	2531.094	7.685	1.324	0.032
Jamaica	1716.111	5.423	0.984	0.032
Jordan	24481.61	17.995	1.050	0.067
Kenya	2551.21	7.285	1.056	0.049
Madagascar	7061.313	9.820	1.145	0.044
Mali	2734.547	6.625	1.339	0.038
Morocco	13030.71	3.796	1.703	0.057
Mozambique	7227.76	7.763	1.364	0.059
Namibia	5350.365	8.965	1.268	0.041
Nigeria	5984.759	8.689	1.494	0.036
Pakistan	7139.643	1.943	3.093	0.051
Paraguay	2863.605	6.126	1.720	0.035
Peru	14475.02	8.591	1.086	0.052
Philippines	757.5777	2.283	1.117	0.029
Rwanda	5188.111	9.983	1.158	0.040
Senegal	4164.628	8.911	1.324	0.039
Sierra Leone	3027.567	4.958	1.710	0.035
Sri Lanka	4268.233	6.727	1.519	0.042
Sudan	9375.983	7.605	1.509	0.051
Suriname	5558.632	8.011	1.417	0.052
Togo	3092.157	7.299	1.460	0.034
Tunisia	7195.908	7.372	1.643	0.051
Turkey	18165.1	4.290	0.703	0.066

Table 3.4. Calibrated country specific parameters (year 2017)

	A	ϕ_m	ϕ_h	ϕ_n
Algeria	2192.08	4.637	1.246	0.033
Bangladesh	7622.28	6.892	1.401	0.058
Benin	12815.54	7.749	1.115	0.066
Burkina Faso	5323.24	6.558	1.411	0.049
Cabo Verde	17242.08	7.125	0.901	0.070
Cameroon	3817.52	8.366	1.370	0.042
China	6159.55	9.486	1.111	0.054
Colombia	2877.88	7.943	1.289	0.044
Dominican Republic	24090.85	4.757	0.715	0.081
Ecuador	3570.51	6.684	1.116	0.038
El Salvador	8460.73	10.042	0.880	0.060
Eswatini	9125.54	8.647	0.694	0.061
Fiji	18861.12	4.942	0.787	0.097
Ghana	15934.69	4.351	1.030	0.077
Guatemala	13129.00	5.594	0.714	0.068
Guinea	26591.38	1.808	0.756	0.096
Guinea-Bissau	7709.49	10.216	0.934	0.068
Honduras	10864.49	5.347	1.123	0.071
India	3298.61	8.898	0.958	0.041
Indonesia	13630.47	8.550	0.977	0.072
Jamaica	16189.68	4.567	1.455	0.120
Jordan	18569.94	6.051	0.785	0.082
Kenya	3840.79	8.836	1.062	0.045
Madagascar	6725.20	9.267	1.063	0.054
Mali	4225.55	7.832	1.254	0.045
Morocco	2626.89	7.910	1.045	0.046
Mozambique	22182.78	4.320	0.943	0.071
Namibia	8315.05	10.044	0.863	0.050
Nigeria	6771.89	7.942	1.066	0.047
Pakistan	11117.20	8.717	1.235	0.061
Paraguay	17563.80	5.201	0.816	0.079
Peru	15030.07	5.103	0.733	0.078
Philippines	17170.11	5.562	0.810	0.085
Rwanda	12498.06	7.706	0.737	0.090
Senegal	21178.52	5.456	0.783	0.091
Sierra Leone	3473.68	8.931	1.234	0.039
Sri Lanka	23973.86	7.017	1.053	0.067
Sudan	19648.50	6.501	0.841	0.067
Suriname	5370.20	11.381	0.864	0.048
Togo	13353.49	4.681	0.998	0.078
Tunisia	16994.28	6.042	0.907	0.074
Turkey	40088.18	4.281	0.752	0.107

Table 3.5. Cross-country difference in fertility

Statistics	Model	1991 (actual)	2017 (actual)	2017 (counterfactual)	Ratios 2017-1991 (actual)	Ratios 2017-1991 (countefactual)	Ratio differences (actual less) contrafactual)
90 - 10	2.10	2.10	2.45	3.58	1.16	1.69	0.53
Median	4.50	4.50	2.97	3.5	0.66	1.77	0.11
Coeffcient of variation	0.26	0.26	0.31	0.53	1.18	2.01	0.82

3.B Data sources, samples, and statistical treatment

3.B.1 The data

The data used in the regression are available for the following countries: Algeria, Bangladesh, Belize, Benin, Burkina Faso, Cabo Verde, Cameroon, China, Colombia, Dominican Republic, Ecuador, El Salvador, Eswatini, Ethiopia, Fiji, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Honduras, India, Indonesia, Jamaica, Jordan, Kenya, Madagascar, Maldives, Mali, Morocco, Mozambique, Namibia, Niger, Nigeria, Pakistan, Paraguay, Peru, Philippines, Rwanda, Samoa, Senegal, Sierra Leone, Sri Lanka, Sudan, Suriname, Thailand, Togo, Tunisia, Turkey, Vanuatu.

The data used for the calibration and numerical simulation are available for the following countries: Benin, Burkina Faso, Bangladesh, China, Cameroon, Colombia, Cabo Verde, Dominican Republic, Algeria, Ecuador, Fiji, Ghana, Guinea, Guinea-Bissau, Guatemala, Honduras, Indonesia, India, Jamaica, Jordan, Kenya, Sri Lanka, Morocco, Madagascar, Mali, Mozambique, Namibia, Nigeria, Pakistan, Peru, Philippines, Paraguay, Rwanda, Sudan, Senegal, Sierra Leone, El Salvador, Suriname, Eswatini, Togo, Tunisia, Turkey.

3.B.2 Filtering the panel data

The figure 1, 2 and 3 have been built as follows, according Garcia-Santana, "Investment Demand and Structural Change", 2020: first we regress the wanted variable, z_{it} on a low polynomial of log y_{it} and country fixed effects α_{zi} :

$$z_{it} = \alpha_{zi} + \alpha_{z1}\log(y_{it}) + \alpha_{z2}\log(y_{it})^2 + \varepsilon_{it}$$

The second step is to use the prediction equation,

$$\hat{z}_{it} = \alpha_{zi} + \hat{\alpha}_{z1}\log(y_{it}) + \hat{\alpha}_{z2}\log(y_{it})^2$$

with α as intercept equal to the unweighted average of country fixed effect α_{zi} . The lines in the graphs represent all the countries in the dataset. We use this method, filtering the data for remittances, fertility and migration.

Table 3.B.1. Definition of variables

VARIABLE	ABBREVIATION	EXPLANATION
Fertility rate	FERTRATE	The number of children that would be born to a woman if she were to live to the end of her childbearing years
Flow of migration	MIGRRATE	Logarithm of flow of migration calculated as the difference between the stock of total migrationin year 1and year 0
Remittances per capita	REMPRCAP	Logarithm of remittances per capita
Contracceptive	CONTRACC	Contracceptive prevalence, any method is the percentage ofmarried women ages 15-49
GDP	LOGGDPPP	Logarithm of GDP, PPP (constant 2017 international $) divided by total population
Labor force partecipation	FEMLABPT	The proportion of the population age 15 and older that is economically active
Infant mortality rate	INFMORTR	Number of infants dying before reaching one year of age, per 1,000 live births in a given year
Health expenditure per woman	HEEXPFEM	Level of current health expenditure per women between ages 15-49
School enrollment, primary	PRIMATOT	Ratio of children of official school age who are enrolled in school to the population of the corresponding official school age
Education expenditure	EDEXPEND	The current operating expenditures in education expressed as a percentage of GDP

Table 3.B.2. Descriptive Statistics

		Mean	Std. Dev.	Min	Max	N/n/T-bar
FERTRATE	overall	3.189684	1.659875	1.085	7.761	4428
	between		1.59748	1.284444	7.545407	164
	within		.467153	1.179018	6.213684	27
INFMORTR	overall	35.28955	32.98132	1.5	176	4239
	between		30.70282	2.866667	126.0259	157
	within		3.521787	29.17316	65.07116	26.96341
REMPRCAP	overall	3.670435	2.019436	-6.497116	8.149185	3565
	between		1.927915	-2.981202	7.785658	154
	within		1.10741	-5.326743	7.257447	23.14935
CONTRACC	overall	47.48518	23.0761	1.7	88.12857	2931
	between		22.45721	4.722222	85.88182	141
	within		6.379206	23.30185	92.41375	20.78723
MIGRRATE	overall	8.867091	1.886273	1.788762	14.42375	3485
	between		1.748474	3.465803	12.81034	158
	within		.8456015	4.103577	13.56653	22.05696
LOGGDPPP	overall	9.01838	1.237964	6.083686	11.72824	4077
	between		1.219826	6.63405	11.65109	155
	within		.2608361	6.455745	10.17853	26.30323
HEEXPFEM	overall	2150.298	2716.543	32.09975	16636.78	2713
	between		2568.737	65.43828	11031.44	154
	within		864.4327	-2589.486	9091.541	17.61688
EDEXPEND	overall	78.06555	58.61227	-6.609402	287.5457	956
	between		56.83881	11.60631	210.4127	50
	within		25.54107	-42.77722	233.463	19.12

3.C Solution of the consumer problem

The consumers maximize the utility function subject to the budget constraint 3.2. The Lagrange function value associated to this maximization problem is:

$$\mathscr{L} = \ln c_t + \gamma \ln \left[n_t \pi_t \left(e_t\right)\right] + \lambda_1 \left[h w_t + \Pi + R_t m_t - \psi m_t - e_t n_t - c_t\right] + \lambda_2 [1 - \phi_h h - \phi_n n_t - \phi_m m_t] \tag{3.14}$$

The first order conditions with respect to $c_t, n_t, e_t, m_t,$ and $h_t,$ are, respectively,

$$\begin{aligned}
c_t &: \frac{1}{c_t} = \lambda_1, && (3.15)\\
n_t &: \frac{\gamma}{n_{it}} = \lambda_1 e_t + \lambda_2 \phi_n, && (3.16)\\
e_t &: \frac{\eta\gamma}{e_t} = \lambda_1 n_t, && (3.17)\\
m_t &: \lambda_1 \left(R_t - \psi\right) = \phi_m \lambda_2, && (3.18)\\
h_t &: \lambda_1 w_t = \phi_h \lambda_2, && (3.19)\\
\lambda_1 &: h w_t + \Pi + R_t m_t = \psi m_t + e_t n_t + c_t, && (3.20)\\
\lambda_2 &: 1 = \phi_h h_t + \phi_n n_t + \phi_m m_t. && (3.21)
\end{aligned}$$

From (3.15) and (3.20), we obtain

$$\lambda_2 = \frac{1}{c_t} \frac{w_t}{\phi_h}. \tag{3.22}$$

We can substitute (3.15) and (3.22) in (3.16) to obtain fertility rate as a function of education and consumption

$$n_t = \frac{\gamma c_t}{e_t + \frac{\phi_n}{\phi_h} w_t}. \tag{3.23}$$

Then, we substitute (3.23) together with (3.15) in (3.17) to obtain education expenditure

$$e_t = \frac{\eta}{1-\eta} w_t \frac{\phi_n}{\phi_h}. \tag{3.24}$$

We obtain the fertility rate as a function of consumption expenditure by substituting (3.24) in (3.23),

$$n_t = \frac{\phi_h}{\phi_n} \left(1 - \eta\right) \gamma \frac{c_t}{w_t}. \tag{3.25}$$

From (3.18) and using (3.15) and (3.22), we can obtain the following knife condition

$$R_t - \psi = \frac{\phi_m}{\phi_h} w_t \tag{3.26}$$

which means that the individual in this condition it is indifferent if to migrate or stay in the country. We use (3.20), (3.26) and (3.21) to obtain share of migrants

$$m_t = \frac{1}{\phi_m} - \frac{\phi_h}{\phi_m} h_t - \frac{\phi_n}{\phi_m} n_t. \tag{3.27}$$

We then substitute (3.27), (3.24) in (3.23) and, after arranging terms, we obtain the consumption expenditure as function of wage and profit,

$$c_t = \frac{1}{1+\gamma}\left(\Pi + \frac{w_t}{\phi_h}\right) \tag{3.28}$$

Substituting (3.28) in (3.25) to obtain the optimal fertility choice is

$$n_t = \gamma \frac{\phi_h}{\phi_n} \frac{1-\eta}{1+\gamma} \frac{1}{w_t}\left(\Pi + \frac{w_t}{\phi_h}\right). \tag{3.29}$$

3.C.1 Firm's problem with profits

The representative firm maximize profits choosing the amount of labor given the exogenous wage

$$\max_h \Pi = Ah^\alpha - wh$$

which implies

$$w = \alpha A h^{\alpha-1} \tag{3.30}$$

We obtain the demand function of labor by clearing h from (3.30),

$$h^d = \left(\frac{\alpha A}{w}\right)^{\frac{1}{1-\alpha}}. \tag{3.31}$$

Given the labor demand, the optimal production is

$$y^* = A\left(\frac{\alpha A}{w}\right)^{\frac{\alpha}{1-\alpha}}, \tag{3.32}$$

and the profits Π are

$$\Pi^* = (1-\alpha)\, y^*. \tag{3.33}$$

3.C.2 The optimal migration and fertility rates

To obtain the optimal share of migrants, we use the market clearing condition in the home-country labor,

$$h = h^d.$$

Consequently, we substitute (3.33), (3.31) and (3.29) in (3.27) to obtain that the optimal share of migrants is

$$m_t^* = \Delta_1 - \Delta_2 w^{-\left(\frac{1}{1-\alpha}\right)} \tag{3.34}$$

where

$$\Delta_1 = \frac{1+\gamma\eta}{1+\gamma}\frac{1}{\phi_m},$$

and

$$\Delta_2 = \left[\frac{1}{1+\gamma} + \frac{\gamma}{\alpha}\frac{1-(1-\alpha)\eta}{1+\gamma}\right]\frac{\phi_h}{\phi_m}(\alpha A)^{\frac{1}{1-\alpha}}.$$

Substituting (3.33) in (3.29), we obtain the fertility rate is

$$n_t^* = \Delta_3 + \Delta_4 w^{-\left(\frac{1}{1-\alpha}\right)},$$

where

$$\Delta_3 = \frac{1-\eta}{\phi_n}\frac{\gamma}{1+\gamma},$$

and

$$\Delta_4 = \left[(1-\eta)\frac{\phi_h}{\phi_n}\frac{\gamma}{1+\gamma}\frac{1-\alpha}{\alpha}\right](\alpha A)^{\left(\frac{1}{1-\alpha}\right)}. \tag{3.35}$$

3.C.3 Remittances effect on migration and fertility

From (3.26), we obtain that the home-country wage should satisfy the following condition for an interior solution

$$w_t = (R_t - \psi)\frac{\phi_h}{\phi_m}. \tag{3.36}$$

Substituting this condition in (3.34), we obtain that migration depends on the wage abroad, R_t, as follows

$$m_t = \Delta_1 - \Delta_2\left[(R_t - \psi)\frac{\phi_h}{\phi_m}\right]^{-\left(\frac{1}{1-\alpha}\right)},$$

which partial derivative respect to the wage abroad is

$$\frac{\partial m_t}{\partial R_t} = \frac{\Delta_2}{1-\alpha}\frac{\left[(R_t-\psi)\frac{\phi_h}{\phi_m}\right]^{-\frac{1}{1-\alpha}}}{R_t - \psi}$$

and under the assumption that $R_t - \psi > 0$, the partial derivative is positive. Substituting (3.36) in (3.35),and taking the partial derivative respect to fertility, we obtain

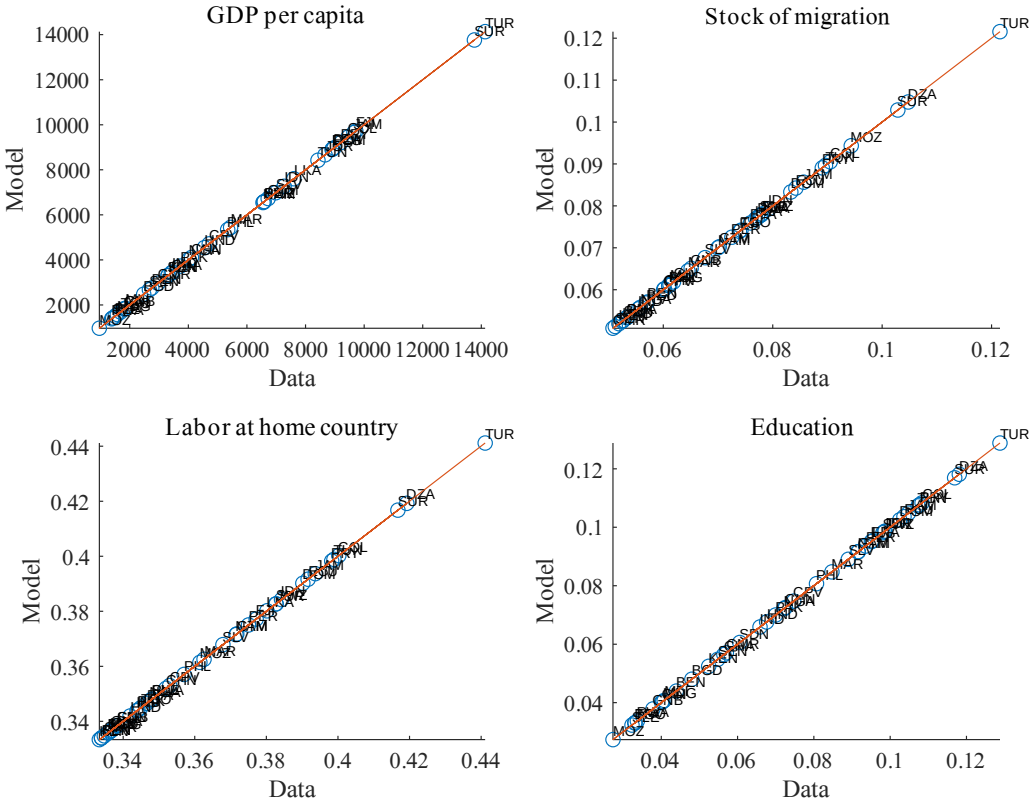
that

$$\frac{\partial n_t}{\partial R_t} = -\frac{\Delta_4}{1-\alpha}\frac{\left[(R_t-\psi)\,\frac{\phi_h}{\phi_m}\right]^{-\left(\frac{1}{1-\alpha}\right)}}{R_t-\psi}.$$

which is negative given the assumption $R_t - \psi > 0$.

3.D Supplementary appendix

Figure 3.D.1. Model performance: target moments



4 Consumption and the Size of Informal Employment[§]

4.1 Introduction

We document two structural transformations of the Mexican economy from 1995 to 2018. The first structural transformation refers to the number of employees engaged in the informal economy (henceforth informal employment) in the goods and services sectors.[2] Figure 4.1 shows the trend of the size of informal employment, measured as a share of total employment in the goods (panel a) and services (panel b) sectors, respectively. This figure shows that the size of informal employment in both the sectors has decreased steadily since 1995.

[Insert Figure 4.1]

The second structural transformation refers to changes in the consumption expenditure on goods and services purcharsed through informal markets. Following Bachas, Gadenne, and Jensen (2020), Figure 4.2 shows the trend of aggregate consumption expenditure in goods (panel a) and services (panel b) that are purchased in the informal sector of the economy (henceforth *informal consumption*) as a share of total

[§]This chapter is co-authored with Dr. Edgar Cruz from University of Guanajuato (Mexico).

[2]In this paper, we refer as informal employment to the employees engaged in the (i) informal sector as in informal sector enterprises, or all persons who, during a given reference period, were employed in at least one informal sector enterprise, irrespective of their status in employment (ILO's definition of employment in the informal sector); (ii) own-account workers in agriculture activities and (iii) unpaid workers. Under this definition, the size of informal employment is lower than that derived from applying ILO's broad concept of informal employment. We compute this measure of informal employment using two representative national employment surveys in Mexico: the National Survey of Employment (ENE) for the period 1994-2004 and the National Survey of Occupations and Employment (ENOE) for 2005-2018. See Appendix A for details.

expenditure in goods and services, respectively.[3]

[Insert Figure 4.2]

This figure shows that the importance of informal consumption in the household aggregate expenditure on goods and services has followed a similar trend to the one observed in the informal employment. As a consequence of these changes at sectoral levels, informal employment and consumption, measured as shares of total employment and aggregate consumption expenditure, have decreased steadily during the period, as Figure 4.3 shows.

[Insert Figure 4.3]

The economic literature has broadly studied the economic factors that explain the evolution of informal employment, while the literature on informal consumption has been growing in recent years. In the branch of literature on informal employment, changes in the economic and social factors that promote the existence of the informal economy can explain the decrease in the size of informal employment described in Figure (4.1). In this literature, informal economy arises due to not exclusive factors such as (i) poverty (e.g., Lewis, 1954; Harris & Todaro, 1970; De Soto, 1989), (ii) high regulation costs (e.g., Rauch, 1991; Maloney, 2004; and Loayza, 1996), and (iii) productivity differences across firms and workers (e.g., La Porta & Shleifer, 2014; and Loayza, 2018).[4] Consequently, reducing poverty, regulation cost, or productivity increases would explain the reduction in informal employment size.[5]

[3] Bachas, Gadenne, and Jensen (2020) identify informal and formal purchases based on retail censuses. They show that large modern retailers are much more likely to remit taxes (formal business) than smaller traditional retailers (informal business). Based on these criteria, we use the National Survey of Household Incomes and Expenditures (ENIGH), a representative sample of Mexican households, and the information that consumers provide regarding the purchase places to proxy the amount of consumption expenditure on goods and services in informal and formal markets. See Appendix A for details.

[4] The earliest explanation of informality, as a result of poverty, argues that the economic system of developing countries does not create enough regular employment to allow all the workers to enter the formal job market. Complementary to this explanation, the role of the high cost of regulations, for instance, taxation, minimum wages, and unions, contribute to explaining the limited mobility of labor between informal to formal jobs (see Loayza, Oviedo, & Servén, 2006; Perry et al., 2007; De Paula & Scheinkman, 2010, and Bobba, 2021) together with the differential in productivity and skills among employees and entrepreneurs that limits their participation in the formal economy.

[5] This reduction in informal employment, for instance, could be driven by government programs (Fajnzylber et al., 2009, 2011; Ulyssea, 2018) and simplification of the fiscal system (de Mel, McKenzie, & Woodruff, 2013; De Giorgi & Rahman, 2013; Alcázar & Jaramillo, 2016; Monteiro & Assunção,

In the branch of literature on informal consumption, there are three explanations for the evolution of informal consumption, which is described in Figure (4.2). The first explanation refers to financial motives. In this literature, the consumers, as rational economic actors, buy in the informal sector to obtain the cheapest possible price of goods and services, not subject to fiscal taxes (Schneider & Enste, 2000; Williams, 2008; Williams, 2017, 2019). The second explanation refers to social motives. In this approach, informal consumption arises as a form of reciprocal help between relatives, work colleagues, and neighbors (Williams, 2006; 2008; Chikweche & Fletcher, 2010; Viswanathan et al., 2012; Williams et al., 2012; Williams & Martinez-Perez, 2014; Williams & Horodnic, 2016, Marumo and Mabuza,2018). The third explanation refers to institutional motives. In this perspective, informal consumption arises due to the failures of the formal institutions related to the scarcity of regulations, laws, and norms that induce consumers to choose to buy goods and services in the informal sector because of the lack of products or services in the formal market (Culiberg and Bajde, 2013, Littlewood et al., 2018, Williams, 2008; Williams & Horodnic, 2016; Williams & Bezeredi, 2019).

In this paper, we contribute to the literature mentioned above, assembling a joint explanation of the informal employment decrease in both the goods and service sectors and the informal consumption decrease in household consumption expenditures. To explain these two facts, we argue that consumers differentiate goods and services by the embodied quality of these products. We also assume that formal firms only provide quality products in the economy. Under these assumptions, increasing consumers' demand for quality goods and services induces the reallocation of employment from informal to formal firms as the quality increases along the development process.[6] To formalize this rationalization, we build a parsimonious multisector growth model.

The model comprises two broad sectors: goods and services, composited by a formal and an informal industry. We assume that only firms that produce goods or services that embody quality and whose production is taxable are in the formal industry (formal firms). To maintain a parsimonious model, from the supply side of the model, we assume that the quality embodied in the product from formal firms increases exogenous along the development process. From the demand side of the model, we assume that individuals consume goods and services, differentiating between formal and informal products based on the products' embody or lack

2012; Bernal et al., 2017; McKenzie & Sakho, 2010; Bruhn, 2011; Kaplan, Piedra, and Seira, 2011).

[6]Using fieldwork and World Bank firm-level data, La Porta & Sheifler (2011) documented significant differences in quality products between informal and formal firms in 24 African countries.

of quality. Given that quality increases exogenous along the development process, consumer demand for the goods and services that embody quality also increases. Thus, in the model, the increasing demand for formal goods and services induces the reallocation of labor from informal to formal firms. This result arises due to two mechanisms.

The first mechanism is the increasing demand for quality goods and services. Under the plausible assumption of substitutability between formal and informal goods and services, increasing demand for formal goods and services induces reallocating labor from informal to formal industries to satisfy the demand. The second mechanism is biased technical change. As we assume that informal firms are the least productive in the economy, as empirical evidence suggests, the model implies that relative prices of informal goods and services increase along the development process. Under the assumption of substitutability between formal and informal goods and services, constant biased technical change induces the reallocation of labor across industries will be from the slow-growing (informal) to the fast-growing (formal) industries, as Ngai and Pissarides (2007) pointed out. Consequently, we show that the proposed model can explain the change in the size of informal employment and the decrease in informal consumption.

We then discipline the model to analyze and quantify the effect of the consumers' demand for formal products on the observed change in informal employment in the Mexican economy. For this purpose, we calibrate the model to replicate the stylized facts of the formal and informal economy in Mexico from 1995-2018, obtaining the benchmark of the model. Then we perform a counterfactual exercise to quantify the change in the demand and employment of formal good and services, holding constant the growth quality rate. The difference between the values obtained indicate that quality contribute to explicate the change in the demand for good and services respectively for the 31% and 41% and for the change in the employment for good and services the 45% and the 65%.

Our numerical results suggest that the consumers' demand for formal goods or quality is a significant mechanism to explain (i) the increase of the size of formal employment across the sector, (ii) the size of the aggregate informal economy, and (iii) it contributes to explain the change of sectoral composition of the Mexican economy. The paper is organized as follows. In the section 2 we introduce the model and we characterizes the equilibrium. In section 3, we solve the model numerically and obtains and discusses the main results. Finally, section 4 includes some concluding remarks and discusses other possible extensions of the basic model.

4.2 The model

We consider a multi-sector exogenous growth model, distinguishing between goods and services sectors. In each sector, there are two industries: formal and informal industry. Thus, goods and services are produced by firms allocated in the formal and informal industries. On the other hand, we assume that individuals consume goods and services, differentiating between formal and informal products based on the products' embody or lack of quality. In the following sections, we describe the households' preferences and the technology that characterizes formal and informal firms in our model.

4.2.1 Households

This economy is populated by an infinitely lived representative individuals characterized by the utility function

$$u_t = \sum_{n=0}^{\infty} \beta^n \ln C_{t+n}, \tag{4.1}$$

where $\beta > 0$ is the subjective discount rate and C_t is a bundle of goods and services represented by the following function

$$C_t = \left[\eta z_{g,t}^{\frac{\varepsilon-1}{\varepsilon}} + (1-\eta) z_{s,t}^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}}. \tag{4.2}$$

In this bundle of goods and services, $z_{g,t}$ is a composite consumption good and $z_{s,t}$ is a composite consumption service, where $\eta > 0$ measures the weight of the composite consumption good in the utility function and $\varepsilon \geq 0$ is the elasticity of substitution among the composite good and service. We assume that $z_{g,t}$ and $z_{s,t}$ are functions of the amount of consumption of goods and services purchased by the household in the formal and informal economy. In particular, we assume that the composite consumption good $z_{g,t}$ is

$$z_{g,t} = \left[\upsilon \left(q_{g,t} x_{g,t} \right)^{\frac{\sigma-1}{\sigma}} + (1-\upsilon) c_{g,t}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{4.3}$$

where $x_{g,t}$ and $c_{g,t}$ are the quantity of goods purchased in the formal and informal economy, respectively. Note that we assume that goods purchased in the formal economy embody the quality level, $q_{g,t}$, whereas informal goods lack quality. In this sense, we assume that the individuals differentiates between goods based on the embodied quality level that is exogenous for the consumers. Under these assumptions, the parameter $\upsilon \in (0,1)$ measures the weight of formal goods in the

utility, and $\sigma \geq 0$ is the elasticity of substitution between formal and informal consumption of goods. As in the case of composite consumption goods, we assume that the composite consumption services is

$$z_{s,t} = \left[\omega \left(q_{s,t} x_{s,t}\right)^{\frac{\varphi-1}{\varphi}} + (1-\omega)\, c_{s,t}^{\frac{\varphi-1}{\varphi}}\right]^{\frac{\varphi}{\varphi-1}}, \tag{4.4}$$

where $x_{s,t}$ and $c_{s,t}$ are the quantity of services purchased in the formal and informal economy, respectively. As before, we assume that the formal services purchased in the formal economy embodied the quality level, q_s, and, in this case, $\omega \in (0,1)$ measures the weight of formal services in the utility, and $\varphi \geq 0$ is the elasticity of substitution between formal and informal consumption of services.

We assume that individuals are endowed with a unit of time that devoted enterily to work. Thus, individuals decide on the value of consumption expenditures to maximize the utility function subject to the budget constraint

$$w_t + r_{t+1} k_t - E_t = k_{t+1} - k_t \tag{4.5}$$

where w_t is the wage rate per unit of work, r_{t+1} is the rental price of capital, and k_t is the amount of assets. We define $E_t = x_{g,t} + p_{x,t} x_{s,t} + p_{g,t} c_{g,t} + p_{s,t} c_{s,t}$, where E_t represent the total consumption expenditure, and $p_{x,t}$ is the relative price of formal services while $p_{g,t}$ and $p_{s,t}$ are the relative price of the informal good and services, taking as the numeraire the manufactured good in the formal economy. From the solution to this maximization problem (see Appendix A), we characterize the sectoral composition of household expenditure as functions of relative prices and quality levels. In the Appendix, we show that the share of total expenditure on goods purchased in the formal economy is

$$e_{x_g,t} \equiv \frac{x_{g,t}}{E_t} = \frac{1}{1 + \varrho_{g,t} + (1+\varrho_{s,t})\, \varrho_{x,t}}, \tag{4.6}$$

while the share of total expenditure on services purchased in the formal economy is

$$e_{x_s,t} \equiv \frac{p_{x,t} x_{s,t}}{E_t} = \frac{\varrho_{x,t}}{1 + \varrho_{g,t} + (1+\varrho_{s,t})\, \varrho_{x,t}}, \tag{4.7}$$

and the share of total expenditure on goods and services purchased in the informal economy are

$$e_{g,t} \equiv \frac{p_{g,t} c_{g,t}}{E_t} = \frac{\varrho_{g,t}}{1 + \varrho_{g,t} + (1+\varrho_{s,t})\, \varrho_{x,t}}, \tag{4.8}$$

and

$$e_{s,t} \equiv \frac{p_{s,t} c_{s,t}}{E_t} = \frac{\varrho_s \varrho_{x,t}}{1 + \varrho_{g,t} + (1+\varrho_{s,t})\, \varrho_{x,t}}, \tag{4.9}$$

where $\varrho_{g,t}, \varrho_{x,t}, \varrho_{s,t}, \varrho_{x,t}$ are variables that depend only on relative prices and quality. Finally, we show in Appendix A, that the Euler condition driving the intertemporal trade-off between consuming today and in the future is

$$\frac{E_{t+1}}{E_t} = \beta\left(1 + r_{t+1}\right). \tag{4.10}$$

4.2.2 Firms

On the economy's supply side, we assume that competitive firms produce goods and services both in the formal and informal industries using capital and labor. In the case of formal firms, we assume the production function of a representative firm in the formal industry is

$$Y_{x,i,t} = A_{x,i,t}\left(s_{x,i,t}K_t\right)^{\alpha}\left(u_{x,i,t}L_t\right)^{1-\alpha} q_i^{-\phi},\ i = g, s, \tag{4.11}$$

where $Y_{x,i,t}$ is the production of the formal representative firm in the goods and services sectors. In the production function (4.11), $A_{x,i,t}$ measures the total factor productivity (TFP), $\alpha \in (0,1)$ is the capital-output elasticity, and $s_{x,i,t}$ and $u_{x,i,t}$ are the shares of aggregate capital (K_t) and total employment (L_t) allocated in goods and services sectors given the level of embodied quality q_i, which we assume is exogenously determined. Under these assumptions, formal firms require q_i^{ϕ} additional capital and labor units to produce an extra unit of quality goods and services, with $\phi \in (0,1]$ measuring the output elasticity of the quality level embodied in the product.[7] In contrast, we assume that informal firms in the goods and services sectors produce using capital and labor, but the production lacks quality.[8] Specifically, we assume that the production function of a representative informal firm is

$$Y_{i,t} = A_{i,t}\left(s_{i,t}K_t\right)^{\alpha}\left(u_{i,t}L_t\right)^{1-\alpha},\ i = g, s \tag{4.12}$$

where $Y_{i,t}$ is the amount product produced by informal firms, $A_{i,t}$ measures total factor productivity (TFP) and $s_{i,t}$ and $u_{i,t}$ are the shares of aggregate capital and employment allocated in the informal goods and services industries. Consequently, under these assumptions, the capital and employment shares must satisfy

$$s_{x,g,t} + s_{x,s,t} + s_{g,t} + s_{s,t} = 1, \tag{4.13}$$

[7] In this regard, we assume that product quality requires input quality Baldwin and Harrigan (2011), Kugler and Verhoogen (2012) and Papageorgiou, Perez-Sebastian, and Spatafora (2017).
[8] See La Porta Sheifler (2011)

and

$$u_{x,g,t} + u_{x,s,t} + u_{g,t} + u_{s,t} = 1. \tag{4.14}$$

Regarding the TFP growth rates, we assume that the TFP growth in formal and informal firms is constant. Specifically, the TFP growth rate in the formal firms in the sector i is given by

$$A_{x,i,t+1} = \gamma_{x,i} A_{x,i,t}, \tag{4.15}$$

where $\gamma_{x,i} > 1$, and the TFP growth rate in the informal firms is given by

$$A_{i,t+1} = \gamma_i A_{i,t}, \tag{4.16}$$

where $\gamma_i > 1$. We complete the description of the formal firms' technology, assuming that the pace of quality is exogenously determined and increases at the following constant rate across sectors. In particular, the quality growth rate in formal firms in the sector i is

$$q_{i,t+1} = \gamma_{q,i} q_{i,t},, \; i = g, s \tag{4.17}$$

where $\gamma_{q,i} > 1$. Finally, we assume that only formal firms pay a tax on production, τ, which reflects the costs of formal activity and we allow firms to face constant firm-specific labor distortions.[9] Based on these assumptions, we proceed to rewrite the production functions (4.11) and (4.12) in intensive form as follows

$$y_{x,i,t} = A_{x,i,t} \left(s_{x,i,t} k_t\right)^{\alpha} u_{x,i,t}^{1-\alpha} q_{i,t}^{-\phi}, \; i = g, s, \tag{4.18}$$

and the production function of the informal firms in intensive form as

$$y_{i,t} = A_{i,t} \left(s_{i,t} k_t\right)^{\alpha} u_{i,t}^{1-\alpha}, \; i = g, s, \tag{4.19}$$

where $y_{x,i,t} = Y_{x,i,t}/L_t$ and $y_{i,t} = Y_{i,t}/L_t$ are the formal and informal production per worker, and $k_t = K_t/L_t$ is the aggregate capital per worker. In appendix B, we show that under these assumptions the formal firms' optimization conditions are

$$r_{x,i} = \alpha \left(1 - \tau\right) A_{x,i,t} p_{x,i,t} \left(s_{x,i,t} k_t\right)^{\alpha - 1} u_{x,i,t}^{1-\alpha} q_{i,t}^{-\phi} - \delta, \tag{4.20}$$

[9] On the one hand, we introduce tax production in the model to fit the economic definition of the informal economy, which establishes that informal firms avoid taxes and regulations (Dell'Anno, 2021). Thus, in the model, firms that pay taxes are formal by construction. On the other hand, we introduce labor distortions as constant wedges between labor costs faced by formal and informal producers in different sectors as in Hsieh, & Klenow (2009) and Święcki (2017). The intuition behind these labor distortions is that labor costs faced by formal firms may be higher than those faced by informal firms due to labor regulations (e.g. social security or minimum wage).

and

$$w_{x,i} = (1-\alpha)\frac{1-\tau}{1+\zeta_i}(A_{x,i,t})\,p_{x,i,t}\,(s_{x,i,t}k_t)^{\alpha}\,u_{x,i,t}^{-\alpha}q_{i,t}^{\phi} \tag{4.21}$$

where $r_{x,i}$ and $w_{x,i}$ are the rental price of capital and wage rate, δ is the depreciation rate of capital, τ is the production tax rate, and ζ_i is the wedget in the sector i in the formal industry. In the case of informal firms, the optimization conditions are

$$r_{i,t} = p_{i,t}\alpha A_{i,t}\,(s_{i,t}k_t)^{\alpha-1}\,u_{i,t}^{1-\alpha} - \delta \tag{4.22}$$

and

$$w_{i,t} = \frac{1-\alpha}{1+\theta_i}p_{i,t}A_{i,t}\,(s_{i,t}k_t)^{\alpha}\,u_{i,t}^{-\alpha} \tag{4.23}$$

where r_i and w_i are the rental price of capital and wage rates, and θ_i is the wedget in the sector i in the informal industry. In the Appendix B, we show that from (4.20)-(4.23) the relative price of informal goods and services are

$$p_i = \frac{1-\tau}{q_i^{\phi}}\left(\frac{1+\theta_i}{1+\zeta_g}\right)^{1-\alpha}\frac{A_{x,g}}{A_i}, \tag{4.24}$$

the relative price of the formal services is

$$p_{x,s} = \left(\frac{1+\zeta_s}{1+\zeta_g}\right)^{1-\alpha}\left(\frac{q_s^{\phi}}{q_g^{\phi}}\right)\frac{A_{x,g}}{A_{x,s}}. \tag{4.25}$$

Using (4.20)-(4.23) and (4.24) and (4.25), we obtain the efficient allocation of capital the informal firms are

$$s_{i,t} = \frac{(1+\theta_i)\,u_{i,t}}{1+\zeta_g-(\zeta_g-\theta_g)\,u_{g,t}-(\zeta_g-\theta_s)\,u_{s,t}-(\zeta_g-\zeta_s)\,u_{x,s,t}} \tag{4.26}$$

for $i = g, s$, and the efficient allocation of capital in the formal firms in the service sector is

$$s_{x,s,t} = \frac{(1+\zeta_s)\,u_{x,s,t}}{1+\zeta_g-(\zeta_g-\theta_g)\,u_{g,t}-(\zeta_g-\theta_s)\,u_{s,t}-(\zeta_g-\zeta_s)\,u_{x,s,t}}, \tag{4.27}$$

and the efficient allocation of capital in the goods sector is[10]

$$s_{x,g,t} = \frac{u_{x,g,t}}{1+\zeta_g-(\zeta_g-\theta_g)\,u_{g,t}-(\zeta_g-\theta_s)\,u_{s,t}-(\zeta_g-\zeta_s)\,u_{x,s,t}}. \tag{4.28}$$

4.2.3 Equilibrium

In this section, we define the equilibrium and obtain the long run values of the consumption expenditure on formal and informal goods and services, and the shares of total employment allocated in formal and informal industries. To this end, we firts obtain the employment shares in formal and informal industries across sectors using (4.18) and (4.19) and the market clearing conditions in the formal services industry $y_{x,s,t} = x_{s,t}$; in the informal services industry $y_{s,t} = c_{s,t}$; and in the informal goods industry $y_{g,t} = c_{g,t}$. Thus, in Appendix B, We show that the share of total employment allocated in the formal industry of services is implicity defined by

$$u_{x,s,t} = \Delta_{x,t}\frac{\varrho_{x,t}}{\Gamma_t}\frac{e_t}{z_t^{\alpha-1}}, \tag{4.29}$$

and the share of total employment allocated in the informal industry of goods is

$$u_{g,t} = \Delta_{g,t}\frac{\varrho_{g,t}}{\Gamma_t}\frac{e_t}{z_t^{\alpha-1}}, \tag{4.30}$$

and services is

$$u_{s,t} = \Delta_{s,t}\frac{\varrho_{s,t}\varrho_{x,t}}{\Gamma_t}\frac{e_t}{z_t^{\alpha-1}}, \tag{4.31}$$

where $\Delta_{x,t}$, $\Delta_{g,t}$, $\Delta_{s,t}$ and Γ_t are functions of the relative prices and the employment shares and we have defined the aggregate consumption expenditure per unite of capital as $e_t = E_t/k_t$, the stock of capital per efficiency unit $z = k_t/\tilde{A}_{x,g}^{\frac{1}{1-\alpha}}$, and $\tilde{A}_{x,g} = A_{x,g}/q_g^{\phi}$.[11] We show in the Appendix, that the growth rate of consumption

[10] Note that, without the constant labor and tax distortions and quality in the production functions, the model follows the canonical model of structural change of Ngai and Pissarides (2007). In Nagi and Pissarides (2007), the permanent bias in sectoral technological progress defines the reallocation of labor across sectors. Given our assumptions on constant distortions, the biased technical change and the growth rate of the quality embodied in products drive labor allocation across sectors and industries.

[11] In the case of zero labor and tax distortions, we obtain $\Delta_{x,t} = \Delta_{g,t} = \Delta_{s,t} = 1$,and consequently (4.29), (4.30), and (4.31) defined explicitly the amount of labor allocated across sectors and industries.

expenditure per unite of capital is

$$e_{t+1} = \alpha\beta\left(z^{\alpha-1}\Delta_{e,t} + 1 - \delta\right)\frac{z_t}{z_{t+1}}e_t\tilde{\gamma}_{x_g} \tag{4.32}$$

and the growth rate of capital per efficiency unit is

$$z_{t+1} = \left[z_t^{\alpha-1}\Delta_{z,t} + (1-\delta) - e_t\right]\frac{z_t}{\tilde{\gamma}_{x_g}} \tag{4.33}$$

where $\Delta_{e,t}$ and $\Delta_{z,t}$ are functions of the relative prices and the employment shares. Note that equations (4.6)-(4.9) characterize the sectoral composition of consumption, and equations (4.29)-(4.31) characterize the sectoral composition of the employment. All these equations depend on the relative price, quality, and capital.

Definition 4.1. We can now define a dynamic equilibrium of this economy as a path of $\{z_t, e_t, c_{s,t}, c_{g,t}, x_{s,t}, x_{g,t}, u_{x,s,t}, u_{g,t}, u_{s,t}, p_{s,t}, p_{g,t}, p_{x,t}\}_{t=0}^{\infty}$ such that, given the initial conditions z_0, $A_{x,g,0}$, $A_{x,s,0}$, $A_{g,0}$, $A_{s,0}$, and $q_{g,0}$ and $q_{s,0}$; satisfies the household' optimization conditions, the firms' optimization conditions, the market clearing conditions, and the time paths of $q_{i,t} = q_{i,0}\left(\gamma_{q,i}\right)^t$, $A_{x,i} = A_{x,i,0}\left(\gamma_{x,i}\right)^t$ and $A_{i,t} = A_{i,0}\left(\gamma_i\right)^t$ for $i = g, s$.

The assumption of permanent bias in technological progress and constant growth rate of the quality of goods and services implies that the relative prices could diverge to infinite. As a consequence, the long-run equilibrium can only be attained asymptotically when the variables characterizing the sectoral composition of consumption and employment converge to a corner solution where depending on the values of φ, σ, and ε, they take either its minimum or its maximum possible value. Given that these long-run values arise because technological progress and quality are permanently biased towards a given sector, they inform about the direction of labor reallocation through the time path of relative prices. In the following section we study the process of structural transformation along the transition to this steady state.

4.3 Quantitative analysis

This section aims to quantify the effect of consumers' demand on the size of the informal economy. To this end, we first discipline the model to replicate the stylized facts of the formal and informal economy in Mexico from 1995-2018. We show that the model replicates the main trends in the data. Then, we use the calibrated model to quantify the contribution of increasing consumers' demand for quality to the increase of the formal economy through the following counterfactual exercise:

we assume that quality remains constant along the development process. Thus, this strategy we allow us to quantify the change of the size of informal industries that is explained by the consumers' demand of quality.

4.3.1 Calibration

To discipline the model, we set the value of the parameters based on the following strategic. We set the value of $\alpha = 0.32$ such that the model replicates the labor income share in 2015 reported by Ibarra and Ros (2019). We then set the values of $\delta = 0.05$ and $\beta = 0.94$ as in Ordóñez (2014), who calibrated these parameters for the Mexican economy. In the case of taxes in the formal goods and services firms, we assume that the tax rate τ equal to the consumption tax in Mexico. Thus, we set $\tau = 0.16$. In the case of the frictions $\{\zeta_g, \zeta_s, \theta_g, \theta_s\}$, we jointly set their values together $\{\sigma, \varphi\}$ to match the share of total employment in the informal goods, informal services, and the formal services in 1995 and 2018, normalizing the initial value of quality to the unit, $q_{g,0} = q_{s,0} = 1$ and given the relative prices. We have assumed that relative prices grow at exogenous constant rates, which depends on the pace of sectoral TFP growth rates and quality growth rates. Thus, we jointly set the values of the growth rate of sectoral TFP $\{\gamma_{xg}, \gamma_{xs}, \gamma_g, \gamma_s\}$ and quality γ_q to match the growth rate of relative prices of formal services, informal goods and services, the growth rate of GDP per capita and the growth rate of the relative labor productivity in the formal sector in the period 1995-2018. Finally, we jointly set the value of preferences parameters $\{v, \omega, \eta\}$ and ϕ to match the initial value of the consumption expenditures on informal goods, informal services, formal services, and the time path of aggregate formal consumption given a value of $\varepsilon = 0.01$ from Herrendorf et al. (2014). Table (4.1) reports a resume of this strategy of calibration.

[Insert Table 4.1]

Figure (4.4) shows the evolution of the formal economy implied by the model compared to the actual data. In particular, panels a and b in Figure (4.4) show the consumption expenditure in formal goods and services measured as a share of total consumption in goods and services, respectively. Note that the actual formal consumption expenditures in goods increase substantially between 1995 and 2018. In the case of formal goods, formal consumption expenditure represented 32 percent of total consumption expenditure on goods in 1995 and increased to 70 percent in 2018; this is a total variation of 38 percentage points. In the case of formal services, formal consumption expenditure represented 59.5 percent of total consumption expenditure on goods in 1995 and increased to 70 percent in 2018; this is a total

variation of 10.5 percentage points. In relative terms, the consumption expenditure on formal goods increases more than three times compared to the observed expansion of formal consumption expenditure on services. Based on the calibration strategy, the model replicates around 58 percent of the actual total variation of formal consumption expenditure on goods and around 70 percent actual total variation of formal consumption expenditure on services. In relative terms, the model replicates the observed increase of consumption expenditure on formal goods relative to the observed expansion of formal consumption expenditure on services. In this regard, we conclude that the model fits the data accurately. On the other hand, panels c and d in Figure (4.4) show the employment share in formal goods and services measured as a share of total employment in the goods and services sectors, respectively. In this case, the model replicates the total variation in the size of formal employment in the goods and services sector by construction accordingly with our calibration strategy.

[Insert Figure 4.4]

4.3.2 Numerical experiment

To quantify the effect of consumers' demand for quality on the size of informal employment, we conduct the following counterfactual experiment. We simulate the model based on the previous calibration, but, in this case, we impose that quality in the utility function is constant. Expressly, we set the value of quality that individuals perceive in goods and services to their calibrated values in 1995. By holding constant the quality level, we observe significant changes in the time path of the formal consumption expenditure on goods and services and the size of formal employment in the economy. Figure (4.5) shows the results of this counterfactual experiment. First, in the counterfactual scenario, consumption expenditures on formal goods and services would grow lower, particularly in services (see Figure 4.5 panels a and b). Second, the lower pace in consumption expenditures induces a decrease in the growth rate of formal employment, both in goods and services. In particular, we observe a significant change in the trend of formal employment in the goods sectors and a loss of size in both sectors.

[Insert Figure 4.5]

Table (4.2) reports these changes in the demand and employment of formal goods and services, keeping the growth quality rate constant. The first column of Table (4.2) reports the total variation in the consumption expenditure and employment shares between 1995 and 2018. The second and third columns report the total vari-

ation in consumption and employment that the model implies based on the calibration strategic (or benchmark) and the counterfactual exercises. The fourth and fifth columns report the fraction of the total variation in consumption and employment explained by the benchmark and counterfactual simulations. Finally, the sixth column reports the contribution of the quality mechanism to explain the actual data, computed as the differences between the total variation explained by the benchmark and the counterfactual. Thus, we can observe that the changes in demand for formal goods and services driven by the implied quality substantially explain the increase in consumption and employment. In the case of consumption, we observe that the quality mechanism explains around 14 percent of the total variation in consumption expenditure on formal goods.

[Insert Table 4.2]

In contrast, this mechanism explains around 41.9 percent of the total variation in the consumption expenditure on formal services. In the case of employment, the decrease in consumption expenditure induces a reduction in the amount of employment allocated in the formal economy. Thus, in our counterfactual exercise, we can observe that the decrease in consumption expenditure on formal goods reduces the amount of employment allocated to this industry substantially. In particular, from the counterfactual exercise, we deduce that consumers' demand for quality contributes to explaining more than half (52 percent) of the observed total variation of formal employment in the goods sector between 1995 and 2018. We observed similar results in the case of formal employment in the services sector. In this case, the change in the consumers' demand for quality explains 59 percent of the total variation in the size of formal employment in the services sector. These results suggest that demand for goods with embody quality is a significant mechanism for explaining informal employment's evolution. Note that the Figure (4.5) shows that formal consumption expenditures and formal employment in the goods and services are growing even when the consumers' demand for quality is constant. This result arises due to the permanent biased technical change. To replicate the time path of relative prices, TFP growth in the formal goods and services industries must grow at a higher rate than the TFP growth in the informal goods and services industries. More specifically, the TFP growth rates must satisfy that $\gamma_{xg} > \gamma_{xs} > \gamma_g \geq \gamma_s$. In this case, the reallocation of labor across industries will be from the slow-growing (informal) to the fast-growing (formal) industries, as in Ngai and Pissarides (2007) pointed out. In the numerical experiment, the described changes in the size of formal consumption and employment across sectors suggest that the consumers' demand has potential implication on the aggregate consumption and

employment. Figure (4.6), in panel a, shows the time path of formal consumption, measure as share of aggregate consumption expenditures, in benchmark and counterfactual economies. From the Figure, we can note that holding constant quality demand, the consumption expenditure on formal goods and services relative to total consumption expenditure would be lower than what the benchmark economy predicts. In particular, the share of total consumption devoted to formal goods and services would be around five percentage point lower than the benchmark economy. On the other hand, this decrease in aggregate formal consumption induces a decrease in the size of aggregate formal employment to around 4.1 percent points. These results suggest that the aggregate size of formal employment responds similarly to changes in the aggregate demand for quality.

[Insert Figure 4.6]

4.4 Concluding remarks

The scope of this paper is to analyze the evolution of the informal sector from a demand perspective in the Mexican economy for the period 1995-2018. To do that we consider a multi-sector exogenous growth model, distinguishing between goods and services sectors, which are composed of a formal and an informal industry. Both produce goods and services but just the formal industry provides quality products. We also assume that quality increases along the development process. From the demand side of the model, individuals consume goods and services, differentiating between formal and informal products based on the products' embody or lack of quality. We argue that the increasing demand for formal goods and services induces the reallocation of labor from informal to formal firms. To quantify the effect of consumers' demand for quality on the size of informal employment, we conduct a counterfactual experiment. We first calibrate the model to obtain the benchmark, then we set the value of quality that individuals perceive in goods and services to their calibrated values in 1995. By holding constant the quality level, the exercise displays significant changes in the time path of the formal consumption expenditure on goods and services and the size of formal employment in the economy. We found that consumers' demand for quality contributes to explaining around 52 percent of the observed total variation of formal employment in formal goods, and around 59 percent of the total variation in the size of formal employment in the services sector between 1995 and 2018. These results suggest that the consumers' demand for formal goods or quality is a significant mechanism to explain the increase in the size of formal employment across the sector and the change in sectoral composition of the Mexican economy.

References

[1] Alcázar, L., Andrade, R., & Jaramillo, M. (2010). Panel/tracer study on the impact of business facilitation processes on enterprises and identification of priorities for future business enabling environment projects in Lima, Peru–Report 5: impact evaluation after the third round. Report to the International Finance Corporation, Mimeo.

[2] Alvarez, J., Ruane, M. C. (2019). Informality and aggregate productivity: The case of Mexico. International Monetary Fund.

[3] Bachas, P., Gadenne, L., & Jensen, A. (2020). Informality, Consumption Taxes and Redistribution. Published.

[4] Baldwin, R. & Harrigan, J. (2011). Zeros, Quality, and Space: Trade Theory and Trade Evidence. American Economic Journal. Microeconomics, 3(2), 60–88.

[5] Bernal, J. L., Cummins, S., & Gasparrini, A. (2017). Interrupted time series regression for the evaluation of public health interventions: a tutorial. International journal of epidemiology, 46(1), 348-355.

[6] Bobba, Matteo, Luca Flabbi, and Santiago Levy. "Labor Market Search, Informality, and Schooling Investments." International Economic Review 63.1 (2022): 211-259.

[7] Bruhn, M., & Loeprick, J. (2014). Small business tax policy, informality, and tax evasion–evidence from Georgia. World Bank Policy Research working paper, (7010).

[8] Buera, & Kaboski, J. P. (2009). Can traditional theories of structural change fit the data? Journal of the European Economic Association, 7(2), 469–477.

[9] Chatterjee, S., & Turnovsky, S. J. (2018). Remittances and the informal economy. Journal of Development Economics, 133, 66–83.

[10] Chikweche, T., & Fletcher, R. (2010). Understanding factors that influence purchases in subsistence markets. Journal of Business Research, 63(6), 643-650.

[11] Culiberg, B., Bajde, D. (2013). Consumer recycling: An ethical decision-making process. Journal of Consumer Behaviour, 12(6), 449-459.

[12] De Giorgi, G., & Rahman, A. (2013). SME's Registration: Evidence from an RCT in Bangladesh. Economics Letters, 120(3), 573-578.

[13] De Mel, S., McKenzie, D., & Woodruff, C. (2009). Are women more credit constrained? Experimental evidence on gender and microenterprise returns. American Economic Journal: Applied Economics, 1(3), 1-32.

[14] De Paula, A., & Scheinkman, J. A. (2010). Value-added taxes, chain effects, and informality. American Economic Journal: Macroeconomics, 2(4), 195-221.

[15] De Paula, A., & Scheinkman, J. A. (2011). The informal sector: An equilibrium model and some empirical evidence from Brazil. Review of Income and Wealth, 57, S8-S26.

[16] De Soto, H. (1989). The other path.

[17] Dell'Anno. (2021). Theories and definitions of the informal economy: A survey. Journal of Economic Surveys.

[18] D'Haese, M., & Van Huylenbroeck, G. (2005). The rise of supermarkets and changing expenditure patterns of poor rural households case study in the Transkei area, South Africa. Food Policy, 30(1), 97-113.

[19] Elgin. (2015). Informal Economy in a Dynamic Political Framework. Macroeconomic Dynamics, 19(3), 578–617.

[20] Fajnzylber, P., Maloney, W. F., & Montes-Rojas, G. V. (2009). Releasing constraints to growth or pushing on a string? Policies and performance of Mexican micro-firms. The Journal of Development Studies, 45(7), 1027-1047.

[21] Harris, J. R., & Todaro, M. P. (1970). Migration, unemployment and development: a two-sector analysis. The American economic review, 60(1), 126-142.

[22] Hsieh, & Klenow, P. J. (2009). Misallocation and Manufacturing TFP in China and India. The Quarterly Journal of Economics, 124(4).

[23] Kaplan, D. S., Piedra, E., & Seira, E. (2011). Entry regulation and business start-ups: Evidence from Mexico. Journal of Public Economics, 95(11-12), 1501-1515.

[24] Kugler, & Verhoogen, E. (2012). Prices, Plant Size, and Product Quality. The Review of Economic Studies, 79(1), 307–339.

[25] La Porta, R. (2010). The Unofficial Economy in Africa Rafael La Porta and Andrei Shleifer.

[26] La Porta, R., & Shleifer, A. (2014). Informality and development. Journal of economic perspectives, 28(3), 109-26.

[27] Lewis, W. A. (1954). Economic development with unlimited supplies of labour.

[28] Loayza, N. (2018). Informality: why is it so widespread and how can it be reduced?. World Bank Research and Policy Briefs, (133110).

[29] Littlewood, D., Holt, D. (2018). Social entrepreneurship in South Africa: Exploring the influence of environment. Business Society, 57(3), 525-561.

[30] Loayza, N. V. (1996, December). The economics of the informal sector: a simple model and some empirical evidence from Latin America. In Carnegie-Rochester conference series on public policy (Vol. 45, pp. 129-162). North-Holland.

[31] Loayza, N. V., Oviedo, A. M., & Servén, L. (2005). The impact of regulation on growth and informality: Cross-country evidence (Vol. 3623). World Bank Publications.

[32] Maloney, W. F. (2004). Informality revisited. World development, 32(7), 1159-1178.

[33] Marlow, S., Swail, J., & Williams, C. C. (2017). Entrepreneurship in the Informal Sector: an institutional perspective. Routledge.

[34] Marumo, O., & Mabuza, M. L. (2018). Determinants of urban consumers' participation in informal vegetable markets: Evidence from Mahikeng, North West province, South Africa, and implications for policy. South African Journal of Economic and Management Sciences, 21(1), 1-9.

[35] McKenzie, D., & Sakho, Y. S. (2010). Does it pay firms to register for taxes? The impact of formality on firm profitability. Journal of Development Economics, 91(1), 15-24.

[36] Monteiro, J. C., & Assunção, J. J. (2012). Coming out of the shadows? Estimating the impact of bureaucracy simplification and tax cut on formality in Brazilian microenterprises. Journal of Development economics, 99(1), 105-115.

[37] Ngai, & Pissarides, C. A. (2007). Structural Change in a Multisector Model of Growth. The American Economic Review, 97(1), 429–443.

[38] Ordonez. (2014). Tax collection, the informal sector, and productivity. Review of Economic Dynamics, 17(2), 262–286.

[39] Papageorgiou, C., Perez-Sebastian, F., Spatafora, N. (2017). Quality upgrading and the stages of diversification. Available at SSRN 2946105.

[40] Perry, G. (Ed.). (2007). Informality: Exit and exclusion. World Bank Publications.

[41] Rauch, J. E. (1991). Modelling the informal sector formally. Journal of development Economics, 35(1), 33-47.

[42] Schneider, F., & Enste, D. H. (2000). Shadow economies: Size, causes, and consequences. Journal of economic literature, 38(1), 77-114.

[43] Święcki, T. (2017). Determinants of structural change. Review of Economic Dynamics, 24, 95-131.

[44] Ulyssea, G. (2018). Firms, informality, and development: Theory and evidence from Brazil. American Economic Review, 108(8), 2015-47.

[45] Viswanathan, M., Sridharan, S., Ritchie, R., Venugopal, S., & Jung, K. (2012). Marketing interactions in subsistence marketplaces: A bottom-up approach to designing public policy. Journal of Public Policy & Marketing, 31(2), 159-177.

[46] Williams, C. C. (2006). How much for cash? Tackling the cash-in-hand ethos in the household services sector. The Service Industries Journal, 26(5), 479-492.

[47] Williams, C. C. (2008). Consumers' motives for buying goods and services on an off-the-books basis. The International Review of Retail, Distribution and Consumer Research, 18(4), 405-421.

[48] Williams, C. C., & Horodnic, I. A. (2016). Cross-country variations in the participation of small businesses in the informal economy: An institutional asymmetry explanation. Journal of Small Business and Enterprise Development.

[49] Williams, C. C., & Martinez-Perez, A. (2014). Why do consumers purchase goods and services in the informal economy?. Journal of Business Research, 67(5), 802-806.

[50] Williams, C., & Bezeredi, S. (2019). Explaining and tackling unregistered employment: evidence from an employers' survey. Journal of Contemporary Central and Eastern Europe, 27(2-3), 173-189.

Appendix

4.A Figures and Tables

Figure 4.1. Informal employment by sector

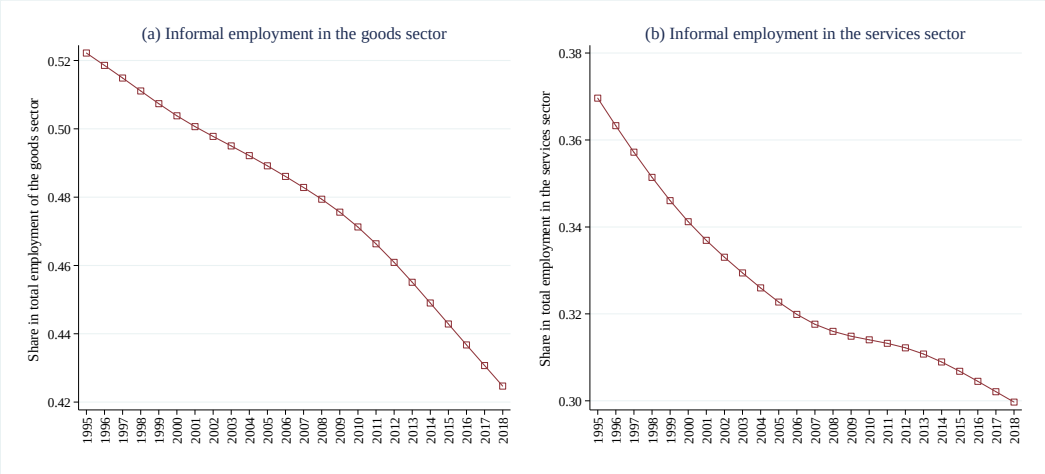


Figure 4.1 shows the aggregate consumption expenditure on goods and services purchased through informal markets relative to the Mexican economy's total expenditure on goods and services. To compute the formal and informal aggregate consumption expenditure by sector, we use the microdata from the National Survey of Household Incomes and Expenditures (ENIGH) and the weights or expansion factor in obtaining a representative sample of the population in Mexico (see Appendix 2.A). We identify the informal consumption following the identification strategy in Bachas, Gadenne, and Jensen (2020).

Figure 4.2. Informal consumption by sector

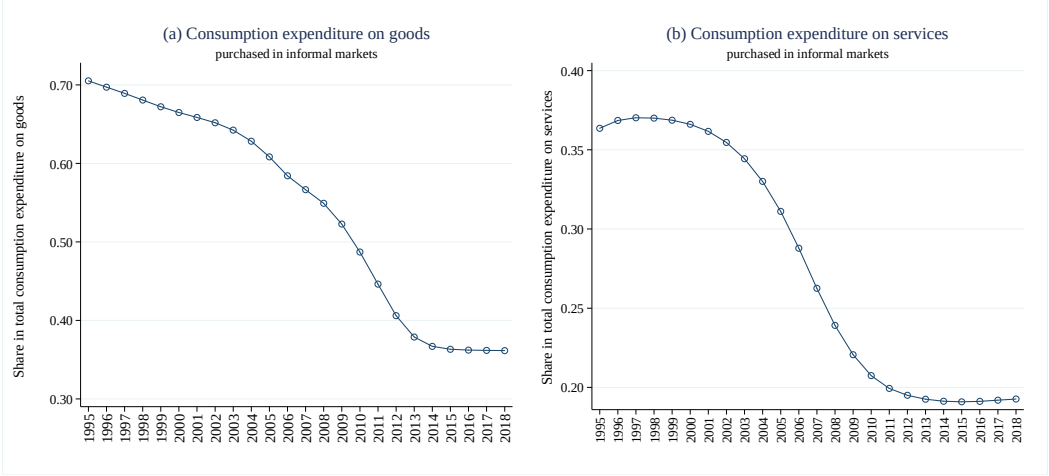


Figure 4.2 shows the trend of informal employment as a share of total employment in the goods and services sector. We compute this measure of informal employment using two representative national employment surveys in Mexico: the National Survey of Employment (ENE) for the period 1994-2004 and the National Survey of Occupations and Employment (ENOE) for 2005-2018. See Appendix 2.A

Figure 4.3. Aggregate informal consumption and employment

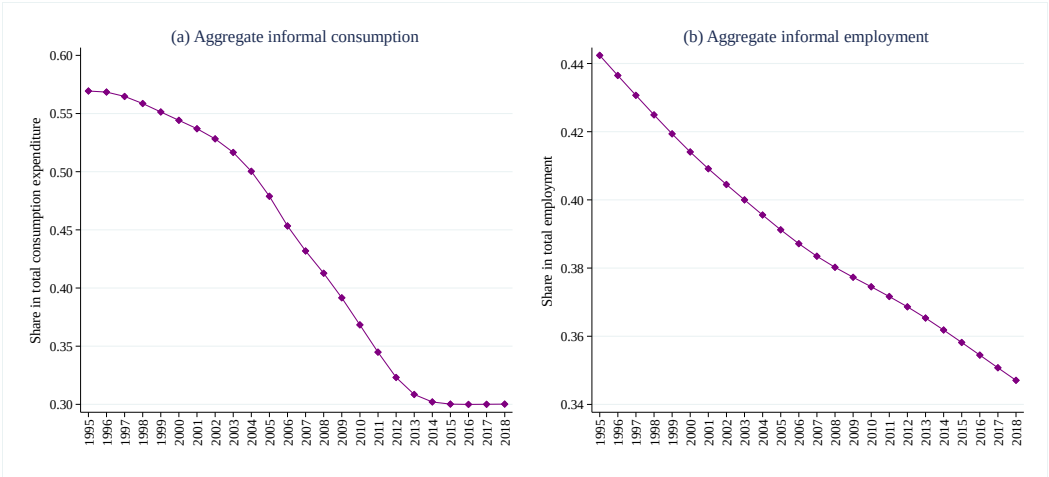


Figure 4.3 shows the trend of aggregate informal consumption and employment in the Mexican economy. We compute this measure using the National Survey of Employment (ENE) for the period 1994-2004 and the National Survey of Occupations and Employment (ENOE) for 2005-2018, and following Backus and Kehoe (1992), we estimated the trend using the Hodrick-Prescott filter with a value of 100 for the smoothing parameter.

Figure 4.4. Simulation of the Mexican economy: benchmark case

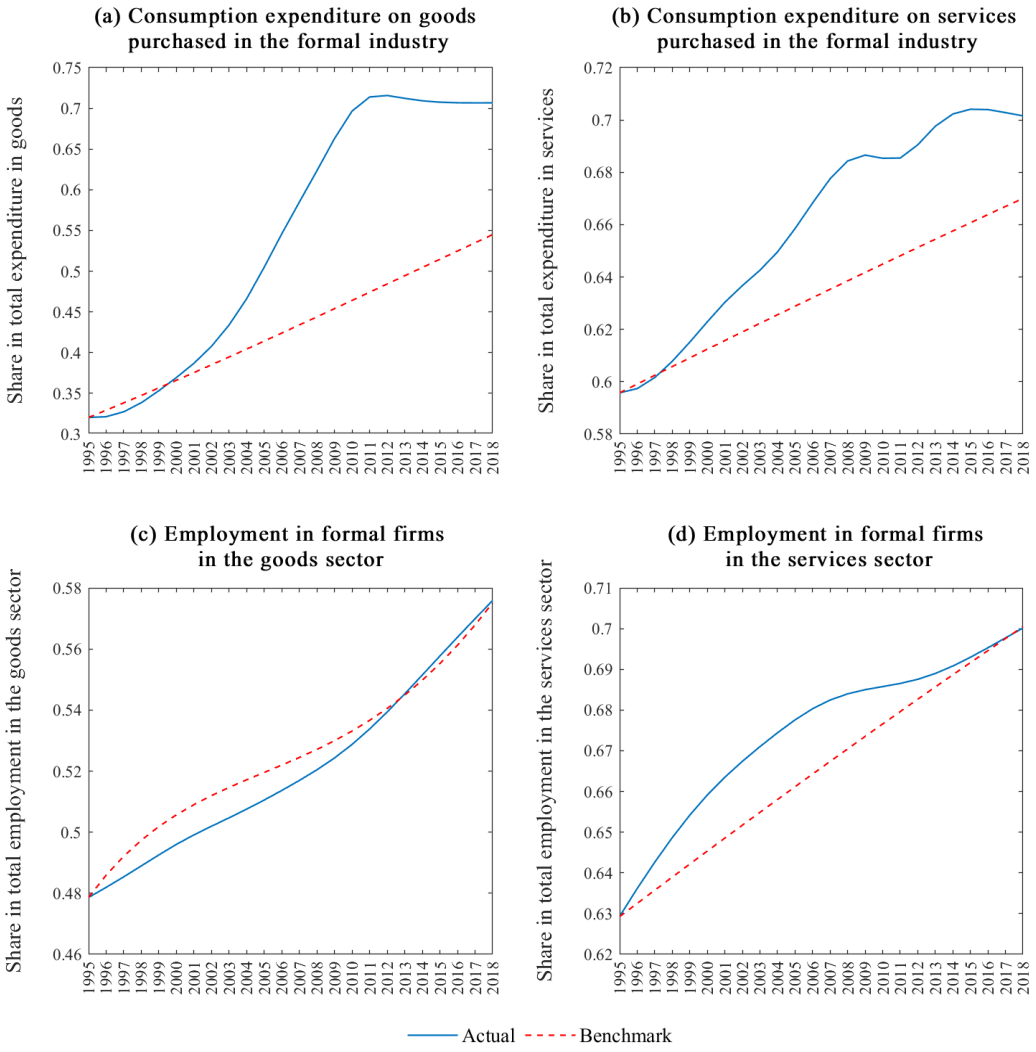


Figure 4.4 shows the trend of aggregate informal consumption and employment in the Mexican economy. We compute this measure using the National Survey of Employment (ENE) for the period 1994-2004 and the National Survey of Occupations and Employment (ENOE) for 2005-2018, and following Backus and Kehoe (1992), we estimated the trend using the Hodrick-Prescott filter with a value of 100 for the smoothing parameter.

Figure 4.5. Simulation of the Mexican economy: counterfactual case

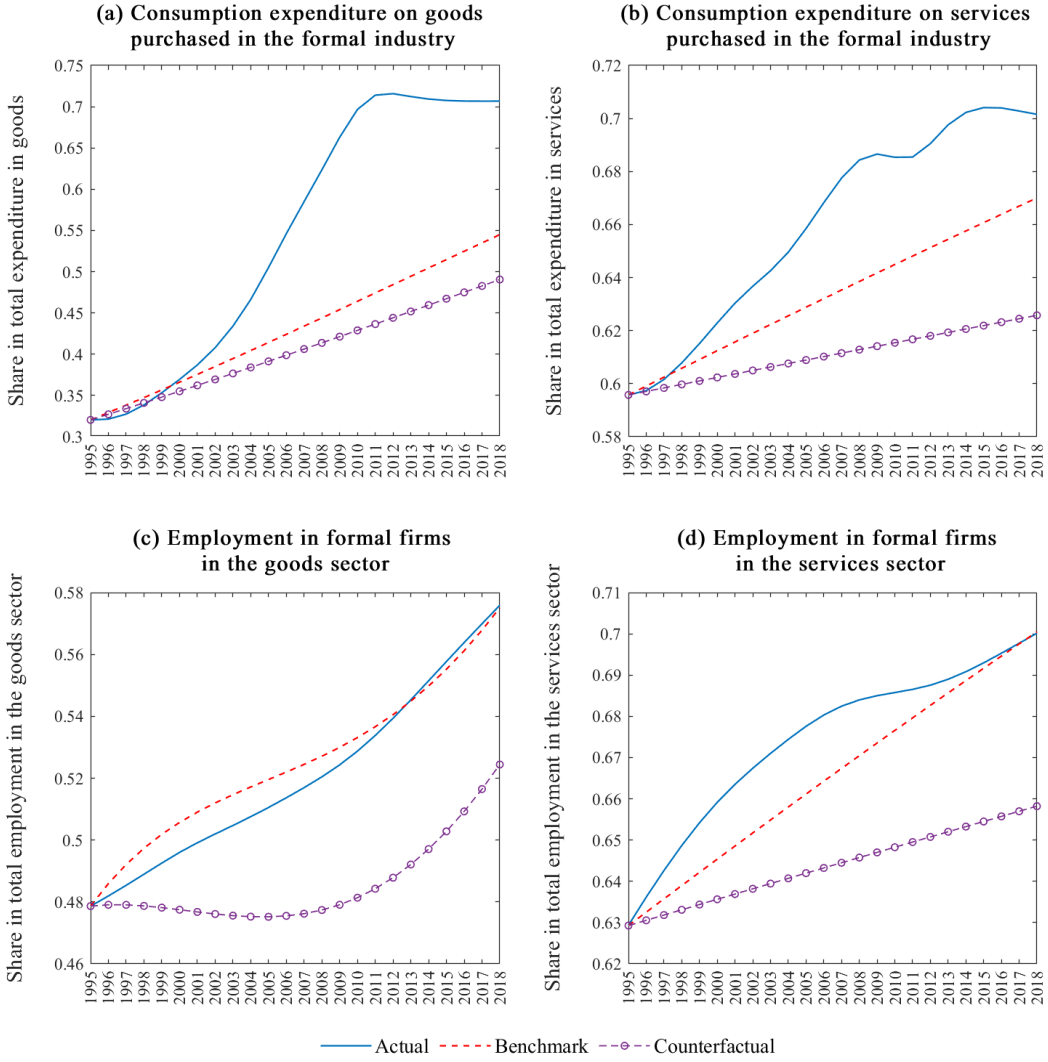


Figure 4.4 shows the trend of informal consumption in goods and services and employment in the goods and services sector of the Mexican economy in the counterfactual case. We compute this measure using the National Survey of Employment (ENE) for the period 1994-2004 and the National Survey of Occupations and Employment (ENOE) for 2005-2018, and following Backus and Kehoe (1992), we estimated the trend using the Hodrick-Prescott filter with a value of 100 for the smoothing parameter.

Figure 4.6. Simulation of the Mexican economy: aggregate consumption and employment

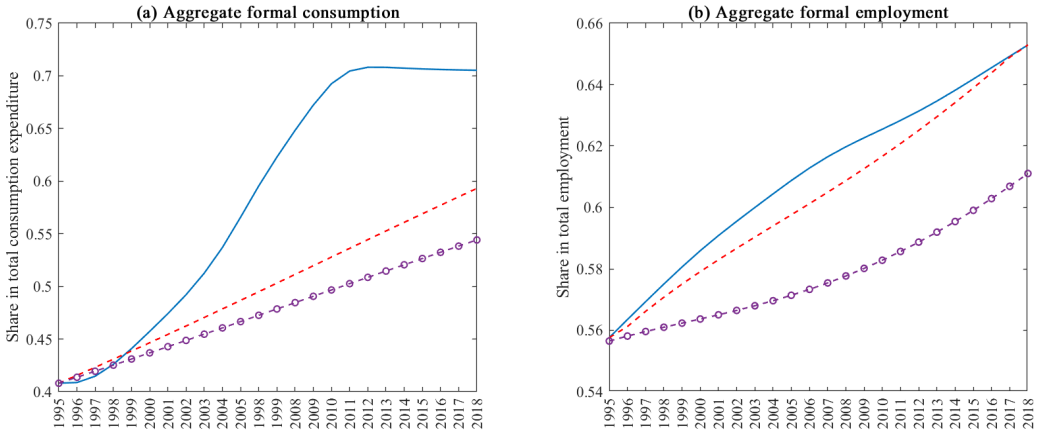


Figure 4.6 shows the trend of aggregate informal consumption and employment in the Mexican economy. We compute this measure using the National Survey of Employment (ENE) for the period 1994-2004 and the National Survey of Occupations and Employment (ENOE) for 2005-2018, and following Backus and Kehoe (1992), we estimated the trend using the Hodrick-Prescott filter with a value of 100 for the smoothing parameter.

Table 4.1. Calibration: benchmark economy

Parameters	Targets	Parameter Value	Data	Model
α	Labor income share	0.320	0.250	0.242
ζ_g	Employment in the formal services (1995)	0.478	0.329	0.325
ζ_s	Employment in the informal services (1995)	-0.720	0.194	0.191
θ_g	Employment in the informal goods (1995)	0.048	0.249	0.250
θ_s	Employment in the formal services (2018)	-0.617	0.435	0.446
σ	Employment in the informal services (2018)	1.585	0.189	0.191
φ	Employment in the informal goods (2018)	1.520	0.161	0.153
γ_{xg}	GDP growth rate (1995-2018)	1.012	1.015	1.015
γ_{xs}	Growth rate of relative price, formal services	0.969	1.043	1.043
γ_g	Growth rate of relative price, informal goods	0.964	1.049	1.049
γ_s	Growth rate of relative price, informal services	0.959	1.054	1.054
γ_q	Growth rate of relative labor productivity in formal economy	1.017	1.021	1.014
υ	Consumption expenditure on formal services (1995)	0.326	0.189	0.189
ω	Consumption expenditure on informal goods (1995)	0.563	0.128	0.128
η	Consumption expenditure on informal services (1995)	0.873	0.463	0.463
ϕ	Aggregate formal consumption expenditure share	0.0509	-	-
ε	Herrendorf et al.(2014)	0.0100	-	-
δ	Ordóñez (2014)	0.0500	-	-
β	Ordóñez (2014)	0.9400	-	-
τ	Consumption tax	0.1600	-	-

As we pointed out, we calibrate jointly the parameters $\{\alpha,\zeta_g,\zeta_s,\theta_g,\theta_s,\sigma,\varphi,\gamma_{xg},\gamma_{xs},\gamma_g,\gamma_s,\gamma_q,\upsilon,\omega,\eta,\phi\}$ given tha parameter values $\{\varepsilon,\delta,\beta,\tau\}$ from the literature. In the case of ϕ, we solve the model as a function of these parameters, and we choose the value of ϕ to minimize the root-mean-square errors (RMSE) of the model's predictions concerning the aggregate formal consumption share (see Figure consumo_agregado). In Table (4.1), employment refers to shares in total employment in the goods and services sector, and consumption expenditures refer to shares in total consumption of goods and services. o set the value of the quality growth rate γ_q, we target the relative labor productivity in the formal economy (RLPF for short). We compute the RLPF as the ratio between labor productivity in formal firms to GDP per worker in the Mexican economy. To this end, we use the Structural Statistics on Industry and Services (SSIS) database from OECD that contains information about the number of workers, value-added, and production by the size of firms since 1995. Under the assumption that firms with more than 250 workers are more likely formal firms, we compute the labor productivity we use to compute RLPF. To simulate the economy, we set the initial sectoral TFP values $\{A_{x,g,0},A_{x,s,0},A_{g,0},A_{s,0}\}$ such that the model replicate the relative price levels in 1995 and we set the initial capital per efficiency unit $z_0 = 1.45$ such that the model replicates the wage gap between formal and informal sector (47%) computed by Alvarez and Ruane (2022).

Table 4.2. Estimated effect of quality on the size of formal employment

	Total variation 1995-2018			Total variation explained by		
	Data	Benchmark	Counterfactual	Benchmark	Counterfactual	Differences
Consumption of						
Formal goods	0.386	0.224	0.170	0.580	0.440	0.140
Formal services	0.105	0.074	0.030	0.704	0.285	0.419
Employment in						
Formal good	0.097	0.097	0.045	1.000	0.471	0.528
Formal services	0.071	0.071	0.029	1.000	0.408	0.591

4.B Solution of the consumer problem

The consumers maximize the utility function subject to the budget constraint. The Hamiltonian present value associated to this maximization problem is:

$$\mathcal{H} = \ln C + \lambda_t \left[w + rk - p_g c_g - p_s c_s - p_{x_s} x_s - x_g \right] \tag{4.34}$$

The first order conditions with respect to c_g, c_s, x_s, and x_g, are, respectively,

$$\frac{\eta z_g^{\frac{-1}{\varepsilon}}}{\eta z_g^{\frac{\varepsilon-1}{\varepsilon}} + (1-\eta) z_s^{\frac{\varepsilon-1}{\varepsilon}}} \left[\upsilon (q_g x_g)^{\frac{\sigma-1}{\sigma}} + (1-\upsilon) c_g^{\frac{\sigma-1}{\sigma}} \right]^{\frac{1}{\sigma-1}} (1-\upsilon) c_g^{\frac{-1}{\sigma}} = p_g \lambda \tag{4.35}$$

$$\frac{(1-\eta) z_s^{\frac{-1}{\varepsilon}}}{\eta z_g^{\frac{\varepsilon-1}{\varepsilon}} + (1-\eta) z_s^{\frac{\varepsilon-1}{\varepsilon}}} \left[\omega (q_s x_s)^{\frac{\varphi-1}{\varphi}} + (1-\omega) c_s^{\frac{\varphi-1}{\varphi}} \right]^{\frac{1}{\varphi-1}} (1-\omega) c_s^{\frac{-1}{\varphi}} = p_s \lambda \tag{4.36}$$

$$\frac{(1-\eta) z_s^{\frac{-1}{\varepsilon}}}{\eta z_g^{\frac{\varepsilon-1}{\varepsilon}} + (1-\eta) z_s^{\frac{\varepsilon-1}{\varepsilon}}} \left[\omega (q_s x_s)^{\frac{\varphi-1}{\varphi}} + (1-\omega) c_s^{\frac{\varphi-1}{\varphi}} \right]^{\frac{1}{\varphi-1}} \omega (q_s x_s)^{\frac{-1}{\varphi}} q_s = p_{x_s} \lambda \tag{4.37}$$

$$\frac{\eta z_g^{\frac{-1}{\varepsilon}}}{\eta z_g^{\frac{\varepsilon-1}{\varepsilon}} + (1-\eta) z_s^{\frac{\varepsilon-1}{\varepsilon}}} \left[\upsilon (q_g x_g)^{\frac{\sigma-1}{\sigma}} + (1-\upsilon) c_g^{\frac{\sigma-1}{\sigma}} \right]^{\frac{1}{\sigma-1}} \upsilon (q_g x_g)^{\frac{-1}{\sigma}} q_g = \lambda \tag{4.38}$$

$$r\lambda = -\dot{\lambda} + \rho \tag{4.39}$$

Dividing (4.35) by (4.38), we obtain

$$c_g = x_g q_g \left(\frac{\upsilon}{1-\upsilon} q_g p_g \right)^{-\sigma} \tag{4.40}$$

We obtain c_s as a function of x_s using (4.36) and (4.37),

$$c_s = x_s q_s \left(\frac{\omega}{1-\omega} q_s \frac{p_s}{p_{x_s}} \right)^{-\varphi} \tag{4.41}$$

Then, we should divide (4.37) by (4.38) to obtaing x_s as a function of x_g,

$$\frac{1-\eta}{\eta} \frac{\omega}{\upsilon} \frac{z_s^{\frac{-1}{\varepsilon}} \left[\omega (q_s x_s)^{\frac{\varphi-1}{\varphi}} + (1-\omega) c_s^{\frac{\varphi-1}{\varphi}} \right]^{\frac{\varphi}{\varphi-1}-1} (q_s x_s)^{\frac{-1}{\varphi}} q_s}{z_g^{\frac{-1}{\varepsilon}} \left[\upsilon (q_g x_g)^{\frac{\sigma-1}{\sigma}} + (1-\upsilon) c_g^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}-1} (q_g x_g)^{\frac{-1}{\sigma}} q_g} = p_{x_s} \tag{4.42}$$

We susbtitute (4.40) and (4.44) in z_s and z_g, and substituting in (4.42), we obtain $x_s$as a function of x_g, the relative prices and quality as follows

$$x_s = x_g \left(\frac{q_g}{q_s}\right)^{1-\varepsilon} \left(\frac{1-\eta}{\eta}\right)^{\varepsilon} p_{x_s}^{-\varepsilon} \frac{\omega^{\frac{\varphi(\varepsilon-1)}{\varphi-1}}}{\upsilon^{\frac{\sigma(\varepsilon-1)}{\sigma-1}}} \frac{\left[1+\left(\frac{1-\omega}{\omega}\right)^{\varphi}\left(\frac{q_s p_s}{p_{x_s}}\right)^{1-\varphi}\right]^{\frac{\varepsilon-\varphi}{\varphi-1}}}{\left[1+\left(\frac{1-\upsilon}{\upsilon}\right)^{\sigma}\left(q_g p_g\right)^{1-\sigma}\right]^{\frac{\varepsilon-\sigma}{\sigma-1}}}. \quad (4.43)$$

Then, we use (4.43) and (4.41) to obtain c_s as function of x_g , the relative prices and quality

$$c_s = \frac{1}{p_s}\left(\frac{q_s p_s}{p_{x_s}}\right)^{1-\varphi}\left(\frac{1-\omega}{\omega}\right)^{\varphi}\left(\frac{1-\eta}{\eta}\right)^{\varepsilon}\left(\frac{q_g}{q_s}p_{x_s}\right)^{1-\varepsilon} \frac{\omega^{\frac{\varphi(\varepsilon-1)}{\varphi-1}}}{\upsilon^{\frac{\sigma(\varepsilon-1)}{\sigma-1}}} \frac{\left[1+\left(\frac{1-\omega}{\omega}\right)^{\varphi}\left(\frac{q_s p_s}{p_{x_s}}\right)^{1-\varphi}\right]^{\frac{\varepsilon-\varphi}{\varphi-1}}}{\left[1+\left(\frac{1-\upsilon}{\upsilon}\right)^{\sigma}\left(q_g p_g\right)^{1-\sigma}\right]^{\frac{\varepsilon-\sigma}{\sigma-1}}} x_g. \quad (4.44)$$

We define the aggregate consumption expenditure

$$E = x_g + p_{x_s} x_s + p_g c_g + p_s c_s$$

and substituting (4.40), (4.43) and (4.44) in the definition of total expenditure, we obtain

$$E = x_g\left(1+\varrho_g+\varrho_x+\varrho_s\varrho_x\right) \quad (4.45)$$

where we define the auxliary variables

$$\begin{aligned}
\varrho_g &= \left(\frac{1-\upsilon}{\upsilon}\right)^{\sigma}\left(q_g p_g\right)^{1-\sigma}, \\
\varrho_s &= \left(\frac{1-\omega}{\omega}\right)^{\varphi}\left(\frac{q_s p_s}{p_{x_s}}\right)^{1-\varphi}, \\
\varrho_x &= \kappa\frac{\left(1+\varrho_s\right)^{\frac{\varepsilon-\varphi}{\varphi-1}}}{\left(1+\varrho_g\right)^{\frac{\varepsilon-\sigma}{\sigma-1}}}\left(\frac{1-\eta}{\eta}\right)^{\varepsilon}\left(\frac{q_g p_{x_s}}{q_s}\right)^{1-\varepsilon},
\end{aligned}$$

and the constant $\kappa = \frac{\omega^{\frac{\varphi(\varepsilon-1)}{\varphi-1}}}{\upsilon^{\frac{\sigma(\varepsilon-1)}{\sigma-1}}}$. We then calculate the consumption expenditure share of formal goods in total expenditure using (4.45) to obtain

$$\frac{x_g}{E} = \frac{1}{1+\varrho_g+\varrho_x+\varrho_s\varrho_x}, \quad (4.46)$$

and the consumption expenditure share of formal services in total expenditure

$$\frac{p_{x_s} x_s}{E} = \frac{\varrho_x}{1 + \varrho_g + \varrho_x + \varrho_s \varrho_x}, \tag{4.47}$$

the consumption expenditure share of informal goods

$$\frac{p_g c_g}{E} = \frac{\varrho_g}{1 + \varrho_g + \varrho_x + \varrho_s \varrho_x}, \tag{4.48}$$

and, finally, the consumption expenditure share of informal goods

$$\frac{p_s c_s}{E} = \frac{\varrho_s \varrho_x}{1 + \varrho_g + \varrho_x + \varrho_s \varrho_x}, \tag{4.49}$$

as they are reported in the main text. To find the Euler equaler equation, we fisrt define

$$\Gamma = 1 + \varrho_g + \varrho_x + \varrho_s \varrho_x, \tag{4.50}$$

which we substitute in (4.45) and taking the log and differentiating, we obtain the growth rate of aggregate consumption

$$\frac{\dot{E}}{E} = \frac{\dot{x}_g}{x_g} + \frac{\dot{\Gamma}}{\Gamma}, \tag{4.51}$$

which is a function of the changes in the consumption of the formal good and changes in relative prices and quality capture by Γ. We can obtain the growth rate of x_g. To this end, use the definions of z_g and z_s together (4.43), (4.44) and the auxiliary variables $\varrho_g, \varrho_x, \varrho_s$ to write (4.38) as follows

$$\lambda = \frac{1}{\Gamma} \frac{1}{x_g}.$$

Taking log an derivative, we obtain the growth rate of the consumption of the formal good

$$\frac{\dot{x}_g}{x_g} = -\frac{\dot{\Gamma}}{\Gamma} - \frac{\dot{\lambda}}{\lambda}. \tag{4.52}$$

Finally, we sisbtitute (4.52) in (4.51) and using (4.39) to obtain the Euler equation

$$\frac{\dot{E}}{E} = r - \rho.$$

4.C The firms' problem

Firms in the goods and services industries of the formal sector maximize profits by choosing the fraction of capital and labor given taxes and the price factors: interest rate (r) and the wage (w). In those industries, the profit function is

$$\pi_{x,i} = (1-\tau)\left[\frac{p_{x,i}A_{x,i}\left(s_i k\right)^{\alpha}\left(u_{x,i}\right)^{1-\alpha}}{q_i^{\phi}} - w_{x,i}\left(u_{x,i}\right) - \left(r_{x,i}+\delta\right)\left(s_{x,i}k\right)\right],$$

where $\delta \in (0,1)$ is the drepation rate, and the optimal choice of the share of capital and labor implies

$$\frac{\partial \pi_{x,i}}{\partial s_{x,i}} : \alpha\left(1-\tau\right)\left(\frac{A_{x,i}}{q_i^{\phi}}\right) p_{x,i}\left(s_{x,i}k\right)^{\alpha-1} u_{x,i}^{1-\alpha} - \delta = r_{x,i}, \tag{4.53}$$

and

$$\frac{\partial \pi_{x,i}}{\partial u_{x,i}} : \left(1-\alpha\right)\left(1-\tau\right)\left(\frac{A_{x,i}}{q_i^{\phi}}\right) p_{x,i}\left(s_{x,i}k\right)^{\alpha} u_{x,i}^{-\alpha} = w_{x,i}, \tag{4.54}$$

where $r_{x,i}$ and $w_{x,i}$ are the industry-specific interest rate and take-home wage. Given that firms in the goods and services industries of the informal sector do not pay any tax for their productive activity or benefits. In this case, the profit function is

$$\pi_i = p_i A_i \left(s_i k\right)^{\alpha}\left(u_i\right)^{1-\alpha} - w_i\left(u_i\right) - \left(r_i+\delta\right)\left(v_i k\right),$$

and the optimal choice of the share of capital and labor implies

$$\frac{\partial \pi_i}{\partial s_i} : \alpha p_i A_i \left(s_i k\right)^{\alpha-1} u_i^{1-\alpha} - \delta = r_i, \tag{4.55}$$

and

$$\frac{\partial \pi_i}{\partial u_i} : \left(1-\alpha\right) p_i A_i \left(s_i k\right)^{\alpha} h_i^{-\alpha} = w_i. \tag{4.56}$$

We have assumed perfect competition and perfect factors' mobility across sectors (formal and informal) and industries (goods and services). These assumptions implies that each factor is paid according to its marginal productivity and that marginal productivities equalize across. Thus, the efficient allocation of labor an capital across sectos and industries must satisfied

$$\frac{w_i}{r_i} = \frac{w_{x,i}}{r_{x,i}}. \tag{4.57}$$

which implies that the fraction of capital in the goods industries equals to the share of employment in the goods industri, both in the formal and informal sectors,

$$s_{x,g} = u_{x,g} \text{ and } s_{x,s} = u_{x,s}, \tag{4.58}$$

and

$$s_g = u_g \text{ and } s_s = u_s. \tag{4.59}$$

Using (4.58) and (4.59) in (4.53)-(4.56), we obtain that the relative prices in the informal sector are

$$p_g = \frac{(1-\tau)}{q_g^{\phi}} \frac{A_{x,g}}{A_g} \text{ and } p_s = \frac{(1-\tau)}{q_g^{\phi}} \frac{A_{x,g}}{A_s},$$

and the relative price of services in the formal sector is

$$p_x = \frac{A_{x,g}}{A_{x,s}} \frac{q_s^{\phi}}{q_g^{\phi}}$$

5 Conclusions

The thesis explores three characteristics of developing countries: structural change, fertility, and informality, and their implications. In this section, I present the summary of the chapters and the future extensions.

In Chapter 2, co-authored with Xavier Raurich, we explore how remittances affect the sectoral composition of developing countries. Empirical evidence shows that employment in the service sector has risen while employment in the agriculture sector has decreased in the last 24 years. We argue that remittances affect the sectoral composition through an income effect, increasing households' income and consumption demand, and shifting employment towards the service sector when the service sector has a more significant income elasticity. To this end, we calibrate a two-sector growth model with non-homothetic preferences and perform two counterfactual exercises to address the importance of remittances. The result of the first exercise suggests that, on average, a receipt-remittances economy allocates almost 5.17% of total employment into the services sector due to remittances. In the second exercise, we study how important are remittance to explain the change in the sectoral employment composition for El Salvador, Guatemala, and Honduras, characterized by a high level of money flow. We found that remittance contributes to explaining between 5% and 27% of the total variation of the employment share.

In Chapter 3, I develop a fertility choice model to analyze how migration affects fertility in developing countries. In this model, migration decreases the fertility rate through two mechanisms. When migration occurs, the household's income rises due to remittances sent to home. This remittance implies a rise in education expenditure for children. At the same time, the second mechanism is a general equilibrium effect due to migration. When people migrate, the local labor supply decrease while the local salary increases. The individuals who stay have a higher salary, but less time to take care of the children. This raises the opportunity cost to have children, which induces a reduction in fertility. This increase in the relative cost of children implies a decline in fertility. I calibrate the model to replicate the fertility pattern for a group of developing countries. Then I perform two counterfactual exercises to assess the importance of migration. The results indicate that the migration process is a complementary explanation for the demographic transition in developing countries.

In Chapter 4, co-authored with E.Cruz, we study informality from the demand perspective. Taking into consideration the case of the Mexican economy, we explore how quality explains the increase in formal employment. We argue that the increasing consumer quality demand for goods and services is a driver for the change in the sectoral composition. To this end, we propose a dual growth model consisting of two broad sectors, goods, and services, which are composited by a formal and an informal industry. We assume that the formal and informal industries produce goods and services, and just the formal firms produce goods or services that embody quality. Quality increases exogenous along the development process.

The increasing demand for formal goods and services induces the reallocation of labor from informal to formal firms. Our numerical findings suggest that quality is an important mechanism that contributes to explaining the decrease in the size of the informal sector and the change in the sectoral composition of the Mexican economy. The main contributions and the future extension of the papers are the following.

The second chapter reports the importance of remittances in driving employment from agriculture to services. Future work will investigate how international remittances can affect the TFP and the economic development of the countries of Latin America. In the third chapter, since we showed the negative relationship between fertility and migration, a future extension will be using microdata, in particular, time-use surveys and migration surveys, to understand the dynamics of the female labor markets of the migrant countries. In this sense, when the labor demand generally expands, we could analyze which sector of economic activity women incorporate. Lastly, in the fourth chapter, we show that quality is a driver for the change in the sectoral composition. A possible work could be expanding the counterfactual exercise to a cross-country level for developing countries, using different micro survey data.

6 Bibliography

[1] Acemoglu, D., & Guerrieri, V. (2008). Capital deepening and nonbalanced eco- nomic growth. Journal of political Economy, 116(3), 467-498.

[2] Acosta. (2011). School Attendance, Child Labour, and Remittances from Inter- national Migration in El Salvador. The Journal of Development Studies, 47(6), 913–936.

[3] Adams Jr, R., de Haas, H., and UO, O. (2012). Migrant remittances and develop- ment: Research perspectives. SSRC Web Antholog, pages 1–132.

[4] Alcaraz, Chiquiar, D., & Salcedo, A. (2012). Remittances, schooling, and child labor in Mexico. Journal of Development Economics, 97(1), 156–165.

[5] Alcázar, L., Andrade, R., & Jaramillo, M. (2010). Panel/tracer study on the im- pact of business facilitation processes on enterprises and identification of priorities for future business enabling environment projects in Lima, Peru–Report 5: impact evaluation after the third round. Report to the International Finance Corporation, Mimeo.

[6] Alder, S., Boppart, T., Muller, A. (2022). A theory of structural change that can fit the data. American Economic Journal: Macroeconomics, 14(2), 160-206.

[7] Alvarez, J., Ruane, M. C. (2019). Informality and aggregate productivity: The case of Mexico. International Monetary Fund.

[8] Alvarez-Cuadrado, F., Poschke, M. (2011). Structural change out of agriculture: Labor push versus labor pull. American Economic Journal: Macroeconomics, 3(3), 127-58.

[9] Amuedo-Dorantes, C., Pozo, S. (2011). New evidence on the role of remittances on healthcare expenditures by Mexican households. Review of Economics of the Household, 9(1), 69-98.

[10] Amuedo-Dorantes, Georges, A., & Pozo, S. (2010). Migration, Remittances, and Children's Schooling in Haiti. The Annals of the American Academy of Political and Social Science, 630(1), 224–244.

[11] Anwar, A. I., Mughal, M. Y. (2016). Migrant remittances and fertility. Applied Economics, 48(36), 3399-3415.

[12] Auty, R. M. (2007). Natural resources, capital accumulation and the resource curse. Ecological economics, 61(4), 627-634.

[13] Bachas, P., Gadenne, L., & Jensen, A. (2020). Informality, Consumption Taxes and Redistribution. Published.

[14] Baldwin, R. & Harrigan, J. (2011). Zeros, Quality, and Space: Trade Theory and Trade Evidence. American Economic Journal. Microeconomics, 3(2), 60–88.

[15] Becker, G. and Barro, R. (1988). A reformulation of the economic theory of fertility. The Quarterly Journal of Economics, 103(1):1–25.

[16] Becker, G. S. (1965). A theory of the allocation of time. The economic journal, 75(299):493–517.

[17] Becker, G. S. and Lewis, H. G. (1973). On the interaction between the quantity and quality of children. Journal of Political Economy, 81(2):S279–S288.

[18] Becker, G. S. et al. (1960). Demographic and economic change in developed coun- tries. An economic analysis of fertility, pages 209–231.

[19] Beine, M., Docquier, F., and Rapoport, H. (2008). Brain drain and human capital formation in developing countries: winners and losers. The Economic Journal, 118(528):631–652.

[20] Belaid, F., & Slany, A. (2018). Economic Development in Africa Report 2018.

[21] Bernal, J. L., Cummins, S., & Gasparrini, A. (2017). Interrupted time series re- gression for the evaluation of public health interventions: a tutorial. International journal of epidemiology, 46(1), 348-355.

[22] Bobba, Matteo, Luca Flabbi, and Santiago Levy. "Labor Market Search, Infor- mality, and Schooling Investments." International Economic Review 63.1 (2022): 211-259.

[23] Boppart, T., (2014). Structural change and the Kaldor facts in a growth model with relative price effects and non-Gorman preferences, Econometrica 82 (6), 2167- 2196.

[24] Bouoiyour, & Miftah, A. (2016). The Impact of Remittances on Children's Human Capital Accumulation: Evidence from Morocco. Journal of International Develop- ment, 28(2), 266–280.

[25] Boyd, M., Pikkov, D., and Piper, N. (2008). New perspectives on gender and mi- gration: Livelihood, rights and entitlements.

[26] Bruhn, M., & Loeprick, J. (2014). Small business tax policy, informality, and tax evasion–evidence from Georgia. World Bank Policy Research working paper, (7010).

[27] Buera, & Kaboski, J. P. (2009). Can traditional theories of structural change fit the data? Journal of the European Economic Association, 7(2), 469–477.

[28] Calero, Bedi, A. S., & Sparrow, R. (2009). Remittances, liquidity constraints and human capital investments in Ecuador. World Development, 37(6), 1143–1154.

[29] Caselli, F., Coleman II, W. J. (2001). The US structural transformation and regional convergence: A reinterpretation. Journal of political Economy, 109(3), 584-616.

[30] Chatterjee, S., & Turnovsky, S. J. (2018). Remittances and the informal economy. Journal of Development Economics, 133, 66–83.

[31] Chikweche, T., & Fletcher, R. (2010). Understanding factors that influence pur- chases in subsistence markets. Journal of Business Research, 63(6), 643-650.

[32] Chowdhury, N. J. and Ullah, M. H. (2010). Socio-economic conditions of female garment workers in chittagong metropolitan area an empirical study. Journal of Business and Technology (Dhaka), 5(2):53–70.

[33] Clark, D. P. (2002). Intra-Industry Specialization and the North American Free Trade Agreement. The International Trade Journal, 16(4), 393-411.

[34] Comin, D., Lashkari, D., Mestieri, M. (2021). Structural change with long-run income and price effects. Econometrica, 89(1), 311-374.

[35] Culiberg, B., Bajde, D. (2013). Consumer recycling: An ethical decision-making process. Journal of Consumer Behaviour, 12(6), 449-459.

[36] D'Haese, M., & Van Huylenbroeck, G. (2005). The rise of supermarkets and chang- ing expenditure patterns of poor rural households case study in the Transkei area, South Africa. Food Policy, 30(1), 97-113.

[37] De Giorgi, G., & Rahman, A. (2013). SME's Registration: Evidence from an RCT in Bangladesh. Economics Letters, 120(3), 573-578.

[38] De Haas, H. (2010). Migration and development: A theoretical perspective. Inter- national migration review, 44(1):227–264.

[39] De la Croix, D. (2013). Fertility, Education, Growth, and Sustainability. The CICSE Lectures in Growth and Development. Cambridge University Press.

[40] De La Croix, D. and Doepke, M. (2003). Inequality and growth: why differential fertility matters. American Economic Review, 93(4):1091–1113.

[41] De Mel, S., McKenzie, D., & Woodruff, C. (2009). Are women more credit con- strained? Experimental evidence on gender and microenterprise returns. American Economic Journal: Applied Economics, 1(3), 1-32.

[42] De Paula, A., & Scheinkman, J. A. (2010). Value-added taxes, chain effects, and informality. American Economic Journal: Macroeconomics, 2(4), 195-221.

[43] De Paula, A., & Scheinkman, J. A. (2011). The informal sector: An equilibrium model and some empirical evidence from Brazil. Review of Income and Wealth, 57, S8-S26.

[44] De Soto, H. (1989). The other path.

[45] DeCicca, P. and Krashinsky, H. (2017). The effect of education on overall fertility. Technical report, National Bureau of Economic Research.

[46] Dell'Anno. (2021). Theories and definitions of the informal economy: A survey. Journal of Economic Surveys.

[47] Démurger, S. (2015). Migration and families left behind. IZA World of Labor.

[48] Dennis, B. N., & I˙şcan, T. B. (2009). Engel versus Baumol: Accounting for struc- tural change using two centuries of US data. Explorations in Economic history, 46(2), 186-202.

[49] Duryea, S., López-Córdova, E., Olmedo, A. (2005). Migrant remittances and infant mortality: Evidence from Mexico. Unpublished manuscript.

[50] Echevarria, C. (1997). Changes in sectoral composition associated with economic growth. International economic review, 431-452.

[51] Elgin. (2015). Informal Economy in a Dynamic Political Framework. Macroeco- nomic Dynamics, 19(3), 578–617.

[52] Faist, T. (2000). Transnationalization in international migration: implications for the study of citizenship and culture. Ethnic and racial studies, 23(2):189–222.

[53] Fajnzylber, P., Maloney, W. F., & Montes-Rojas, G. V. (2009). Releasing constraints to growth or pushing on a string? Policies and performance of Mexican micro-firms. The Journal of Development Studies, 45(7), 1027-1047.

[54] Fargues, P. (2006). The demographic benefit of international migration: Hypoth- esis and application to Middle Eastern and North African contexts, volume 4050. World Bank Publications.

[55] Fayissa, & Nsiah, C. (2010). The impact of remittances on economic growth and development in africa. The American Economist (New York, N.Y. 1960), 55(2), 92–103.

[56] Foellmi, R., Zweimüller, J., 2008. Structural change, Engel's consumption cycles and Kaldor's facts of economic growth, Journal of Monetary Economics 55 (7), 1317-1328.

[57] Frank, Palma-Coca, O., Rauda-Esquivel, J., Olaiz-Fernandez, G., Diaz-Olavarrieta, C., & Acevedo-Garcia, D. (2009). The Relationship Between Remittances and Health Care Provision in Mexico. American Journal of Public Health (1971), 99(7), 1227–1231.

[58] García-Santana, M., Pijoan-Mas, J., & Villacorta, L.(2021). Investment demand and structural change. Econometrica, 89(6), 2751-2785.

[59] Goldstein, S. and Goldstein, A. (1981). The impact of migration on fertility: An âown childrenâ analysis for thailand. Population Studies, 35(2):265–284. PMID: 11630857.

[60] Harris, J. R., & Todaro, M. P. (1970). Migration, unemployment and development: a two-sector analysis. The American economic review, 60(1), 126-142.

[61] Herrendorf, B., Rogerson, R., Valentinyi, A., (2013). Two perspectives on pref- erences and structural transformation, American Economic Review 103 (7), 2752- 2789.

[62] Herrendorf, B., Rogerson, R., Valentinyi, A., (2014). Growth and structural trans- formation, Chapter 6, Handbook of Economic Growth 2, 855-941.

[63] Herrendorf, B., Valentinyi, A. (2008). Measuring factor income shares at the sec- toral level. Review of Economic Dynamics, 11(4), 820-835.

[64] Hervitz, H. M. (1985). Selectivity, adaptation, or disruption? A comparison of alternative hypotheses on the effects of migration on fertility: The case of brazil. International Migration Review, 19(2):293–317.

[65] Hicks, D. (2011). Structural change and industrial classification. Structural Change and Economic Dynamics, 22(2), 93-105.

[66] Hsieh, & Klenow, P. J. (2009). Misallocation and Manufacturing TFP in China and India. The Quarterly Journal of Economics, 124(4).

[67] Itzigsohn, J. and Saucedo, S. G. (2002). Immigrant incorporation and sociocul- tural transnationalism. International Migration Review, 36(3):766–798.

[68] Jensen, E. and Ahlburg, D. (2004). Why does migration decrease fertility? evidence from the philippines. Population studies, 58(2):219–231.

[69] Kaplan, D. S., Piedra, E., & Seira, E. (2011). Entry regulation and business start- ups: Evidence from Mexico. Journal of Public Economics, 95(11-12), 1501-1515.

[70] Kongsamut, P., Rebelo, S., Xie, X., (2001). Beyond balanced growth, Review of Economic Studies 68 (4), 869-882.

[71] Kugler, & Verhoogen, E. (2012). Prices, Plant Size, and Product Quality. The Review of Economic Studies, 79(1), 307–339.

[72] Kulu, H., Hannemann, T., Pailhé, A., Neels, K., Rahnu, L., Puur, A., Krapf, S., González-Ferrer, A., Castro-Martin, T., Kraus, E., et al. (2015). A com- parative study on fertility among the descendants of immigrants in europe.

[73] Kulu, H., Vikat, A., and Andersson, G. (2007). Settlement size and fertility in the nordic countries. Population studies, 61(3):265–285.

[74] La Porta, R. (2010). The Unofficial Economy in Africa Rafael La Porta and Andrei Shleifer.

[75] La Porta, R., & Shleifer, A. (2014). Informality and development. Journal of eco- nomic perspectives, 28(3), 109-26.

[76] Laitner, J. (2000). Structural change and economic growth. The Review of Eco- nomic Studies, 67(3), 545-561.

[77] Lewis, W. A. (1954). Economic development with unlimited supplies of labour.

[78] Littlewood, D., Holt, D. (2018). Social entrepreneurship in South Africa: Explor- ing the influence of environment. Business Society, 57(3), 525-561.

[79] Loayza, N. (2018). Informality: why is it so widespread and how can it be reduced?. World Bank Research and Policy Briefs, (133110).

[80] Loayza, N. V. (1996, December). The economics of the informal sector: a simple model and some empirical evidence from Latin America. In Carnegie-Rochester conference series on public policy (Vol. 45, pp. 129-162). North-Holland.

[81] Loayza, N. V., Oviedo, A. M., & Servén, L. (2005). The impact of regulation on growth and informality: Cross-country evidence (Vol. 3623). World Bank Publica- tions.

[82] Maloney, W. F. (2004). Informality revisited. World development, 32(7), 1159- 1178.

[83] Marlow, S., Swail, J., & Williams, C. C. (2017). Entrepreneurship in the Informal Sector: an institutional perspective. Routledge.

[84] Marumo, O., & Mabuza, M. L. (2018). Determinants of urban consumers' par- ticipation in informal vegetable markets: Evidence from Mahikeng, North West

[85] Matsuyama, K. (2009). Structural change in an interdependent world: A global view of manufacturing decline. Journal of the European Economic Association, 7(2-3), 478-486.

[86] McKenzie, D., & Sakho, Y. S. (2010). Does it pay firms to register for taxes? The impact of formality on firm profitability. Journal of Development Economics, 91(1), 15-24.

[87] Michaels, G., Rauch, F., & Redding, S. J. (2012). Urbanization and structural trans- formation. The Quarterly Journal of Economics, 127(2), 535-586.

[88] Mincer, J., Christ, C., Friedman, M., and Goodman, L. (1963). Measurement in economics. In Market prices, opportunity costs and income effects. Stanford Uni- versity Press Stanford, Calif.

[89] Monteiro, J. C., & Assunção, J. J. (2012). Coming out of the shadows? Estimat- ing the impact of bureaucracy simplification and tax cut on formality in Brazilian microenterprises. Journal of Development economics, 99(1), 105-115.

[90] Naufal, G. and Vargas-Silva, C. (2009). Changing fertility preferences one migrant at a time: the impact of remittances on the fertility rate.

[91] Ngai, & Pissarides, C. A. (2007). Structural Change in a Multisector Model of Growth. The American Economic Review, 97(1), 429–443.

[92] Ngai, L. R., Pissarides. C,. (2007). Structural change in a multisector model of growth, American Economic Review 97 (1), 429-443.

[93] Olivetti, C., Ngai, R. (2015). Structural Transformation and the U-Shaped Female Labor Supply. In 2015 Meeting Papers (No. 1501). Society for Economic Dynam- ics.

[94] Ordonez. (2014). Tax collection, the informal sector, and productivity. Review of Economic Dynamics, 17(2), 262–286.

[95] Organization, W. H. et al. (2015). Trends in maternal mortality: 1990-2015: esti- mates from WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. World Health Organization.

[96] Papageorgiou, C., Perez-Sebastian, F., Spatafora, N. (2017). Quality upgrading and the stages of diversification. Available at SSRN 2946105.

[97] Perry, G. (Ed.). (2007). Informality: Exit and exclusion. World Bank Publications.

[98] Porzio, T., Santangelo, G. (2017). Structural change and the supply of agricultural workers. Available at SSRN 3089710.

[99] province, South Africa, and implications for policy. South African Journal of Eco- nomic and Management Sciences, 21(1), 1-9.

[100] Rajan, S. I. (2014). India migration report 2012: Global financial crisis, migration and remittances. Routledge India.

[101] Rauch, J. E. (1991). Modelling the informal sector formally. Journal of develop- ment Economics, 35(1), 33-47.

[102] S´więcki, T. (2017). Determinants of structural change. Review of Economic Dy- namics, 24, 95-131.

[103] Schneider, F., & Enste, D. H. (2000). Shadow economies: Size, causes, and conse- quences. Journal of economic literature, 38(1), 77-114.

[104] Siah, A. K. and Lee, G. H. (2015). Female labour force participation, infant mortal- ity and fertility in malaysia. Journal of the Asia Pacific Economy, 20(4):613–629.

[105] Sirkeci, I., Cohen, J. H., and Ratha, D. (2012). Migration and remittances during the global financial crisis and beyond. World Bank Publications.

[106] Skeldon, R. (1997). Rural-to-urban migration and its implications for poverty alle- viation. Asia-Pacific Population Journal, 12(1):3–16.

[107] Stiglitz, J. E., Lin, J. Y., & Monga, C. (2013). Introduction: the rejuvenation of in- dustrial policy. In The Industrial Policy Revolution I (pp. 1-15). Palgrave Macmil- lan, London.

[108] Stockman, & Tesar, L. L. (1995). Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements. The American Eco- nomic Review, 85(1), 168–185.

[109] Swiecki, T., (2017). Determinants of Structural Change. Review of Economic Dy- namics, 24, 95-131.

[110] Teignier, M. (2018). The role of trade in structural transformation. Journal of De- velopment Economics, 130, 45-65.

[111] Ulyssea, G. (2018). Firms, informality, and development: Theory and evidence from Brazil. American Economic Review, 108(8), 2015-47.

[112] Uy, T., Yi, K. M., & Zhang, J. (2013). Structural change in an open economy. Journal of Monetary Economics, 60(6), 667-682.

[113] Viswanathan, M., Sridharan, S., Ritchie, R., Venugopal, S., & Jung, K. (2012). Mar- keting interactions in subsistence marketplaces: A bottom-up approach to designing public policy. Journal of Public Policy & Marketing, 31(2), 159-177.

[114] Williams, C. C. (2006). How much for cash? Tackling the cash-in-hand ethos in the household services sector. The Service Industries Journal, 26(5), 479-492.

[115] Williams, C. C. (2008). Consumers' motives for buying goods and services on an off-the-books basis. The International Review of Retail, Distribution and Consumer Research, 18(4), 405-421.

[116] Williams, C. C., & Horodnic, I. A. (2016). Cross-country variations in the partic- ipation of small businesses in the informal economy: An institutional asymmetry explanation. Journal of Small Business and Enterprise Development.

[117] Williams, C. C., & Martinez-Perez, A. (2014). Why do consumers purchase goods and services in the informal economy?. Journal of Business Research, 67(5), 802- 806.

[118] Williams, C., & Bezeredi, S. (2019). Explaining and tackling unregistered employ- ment: evidence from an employers' survey. Journal of Contemporary Central and Eastern Europe, 27(2-3), 173-189.

[119] Willis, R. (1994). Population and economic development and the environment