Trade, poverty and inter-household transfers in a dual-dual economy

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Abstract

This paper revisits the impact of trade liberalization on poverty and income inequalities by considering the role of internal migrations, inter-household transfers and the informal economy. A new macro-micro Computable General Equilibrium (CGE) model is developed and applied on the Senegal's economy, which is negotiating new trade agreements with Europe and suffers from important manifestations of dualism. To characterize a typical African economy, the dual-dual economy framework (Stifel and Thorbecke 2003, Thorbecke, 1997) provides a basis to analyse the distributional effects of tariff removals among modern and informal sector activities in both rural and urban areas, in which labor migration is specifically modeled. The micro-economic dimension is integrated to perform a micro-simulated poverty analysis, based on successive household surveys. Particular attention is paid to the remitting behavior which is endogenized and integrated to the household utility function. The optimal function of transfers is implemented on the basis of alternative micro-founded theoretical models (altruism, self-interest, strategic motives). This approach allows us to quantify the macro and micro-economic impacts of alternative scenarios of trade liberalization and to improve the assessment of re-distributional effects implied by sectorial interdependence, labor migration and inter-household transfers. These factors, introduced in simulations, have important implications for the magnitudes of change in poverty after trade liberalization.

Keywords: *trade liberalization, domestic remittances, income inequalities, informal sector, CGE model*

JEL: D31, D58, E62, D64, F62, F63

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> "While establishing a clear link between trade liberalization and absolute poverty poses a tremendous challenge, especially in rural areas, documenting the correlation between trade liberalization and certain indicators of urban poverty in the short- or medium-run seems more promising." Goldberg and Pavcnik (2004)

In the literature, trade liberalization has often been presented as a potential leverage for poverty alleviation (Bhagwati and Srinivasan, 2002; Dollar and Kraay, 2004; Anderson and Martin, 2005) but conclusions are far from consensual,[1] especially when considering the distributional income effects. According to Goldberg and Pavcnik (2004), trade policies bring contrasted effects on poverty but region or sector-specific conclusions can be done. Indeed, most developing countries suffer from several manifestations of economic dualism which intensify the contrasting impact of trade on poverty. In addition to the regional dichotomy between urban and rural zones, in which poverty is higher, the *informal sector* is characterized by low-productivity process of production, low-qualified labor and low-financial development. The double dichotomy is fully justified by the fact that, contrary to common beliefs, informality also concerns urban activities. When trade is liberalized, activities are differently affected and consequently, labor migration occurs, across sectors and space. That is why, the dual-dual economy model (Thorbecke, 1997 and Stifel and Thorbecke, 2003) will be the theoretical foundation of this paper , since this framework consists in modelling the labor migration between urban and rural areas and across modern and traditional sectors, in an archetype African economy.

If internal labor migration is an important factor to consider, trade policy analysis is also puzzling because of the importance of inter-household transfers and their potential effect on poverty. As underlined by Cox (1990, 2002), Cox and Jimenez (1998) and Morduch (1995), private transfers can significantly help households to deal with exogenous risk and similar studies also find evidence of an efficient risk sharing between the poorest households thanks to private cash exchange (Deaton, 1997; Townsend, 1995; Jalan and Ravallion, 1997). As a result, the fact that most trade policy analysis have forgotten to implement a solid modelling of domestic transfers, is likely to affect the estimation of the costs and benefits of a trade policy. In other words, the impact of trade liberalization in terms of income inequalities is potentially under/overestimated by traditional CGE-simulations. Evaluating the extend of this mismeasurement constitutes an one important target of this work.

In this paper, a new *macro-micro* CGE is designed in order to capture these specific economic features and applied on the Senegal's economy. As most African-Carribean-Pacific (ACP) countries, Senegal is negotiating its Economic Partnership Agreement (EPA, hereafter) with Europe, which requires a progressive *reciprocal* trade liberalization, following the Cotonou convention which established preferential agreements. However, the EPAs raise several concerns amongst ACP countries. Firstly, countries fear that giving prefer-

[1] See for instance Winters, McCulloch and McKay (2004) or Goldberg and Pavcnik (2007)

ential access to EU products, under a reciprocal arrangement, would put their producers in numerous sectors at risk of increased competition. Secondly, they also fear that cutting tariffs for EU products would result in a sizable loss of tariff revenue that would hurt their public budgets (Fontagné et al., 2011). Senegal is also a relevant case study since it suffers from important manifestations of dualism (Wade, 2002).[2]The country is characterized by large regional disparities in terms of employment rates, qualifications and poverty. These inequalities are particularly marked between urban and rural areas. Furthermore, the choice of Senegal is justified for working on remitting behavior, since the country is the ground of massive internal migration towards urban areas, especially in Dakar. This is heightened by geography and climate: Senegal is located between desert areas (to the North) and tropical zones (to the South) which implies a long dry season, when agricultural activities are diminished. Consequently, Senegal is characterized by temporary migrations towards urban areas, that should affect economic outcomes and policy analysis, especially regarding trade.

With the development of CGE-based analysis of trade policies, many works have progressively tried to incorporate additional elements in order to refine the understanding of poverty impacts of trade policies. As a result, economists have used household surveys in order to disaggregate their analysis into a macro-micro framework. Indeed, the use of microsimulation helps to tackle the household heterogeneity in terms of income nature, consumption structure and saving behavior. As state of the art, Davies (2004), Savard (2005) or Boccanfuso, Decaluwe and Savard (2008) have reviewed the different microsimulation approaches for studying poverty and income inequalities analysis. But among all the studies that have used single CGE microsimulated models (Annabi, Cissé, Cockburn, and Decaluwé on Senegal, 2005; Cockburn on Nepal, 2003; Cororaton and Cockburn on the Philippines, 2007; Vos and de Jong on the Ecuador, 2003 to take some applied examples), a very few of them have integrated in their modelling domestic private transfers (Raihan on Bangladesh, 2010; Taylor, Yunez-Naudo and Dyer, 2007). Besides, no model has introduced micro-foundations to household transfers so that these models are not likely to capture their redistributive effects. If most studies of trade effects on poverty have adopted microsimulation approaches, very few of them have tackled the household heterogeneity through a labor-market segmentation.

Contrary to previous macro-micro CGE analysis, this paper implements micro-foundations to the remitting behavior. In this perspective, we develop a methodology to establish the matrix of bilateral transfers, on the basis of micro-founded allocation rule of total transferred amounts. Once, the model is built and calibrated on the Social Accounting Matrix of Senegal dated from 2006 (Fall, 2009), two scenarios are simulated: the EPA between Europe and the Economic Community of western African States (ECOWAS), including Senegal, and a full trade liberalization under the WTO rules. Depending on the theoretical model considered, remittances can bring pro-cyclical or anti-cyclical effects that

[2]In Senegal only 40% of the informal employment is rural but represents more that 80% of the primary sector.

potentially affect the income distribution that would prevail with a trade liberalization without considering the remitting behavior.

This paper has to deal with three main challenges. Firstly, an important issue consists in modelling the labor market as reflecting a dual-dual economy, which distinguishes urban sectors from rural ones and formal activities from informal ones. As a result, based on the pioneer works of Harris and Todaro (1957), Rodrick (1997) and Stifel and Thorbecke (2003) we design a model that endogenizes labor supply for each labor-market segment. To refine the modelling of this labor-market segmentation, a dualism of workers is modeled, distinguishing skilled workers from others. Contrary to Stifel and Thorbecke (2003) who worked on four representative sectors, we extend the model to the 34 sectors contained in the SAM of Senegal.

Then, the second important issue to deal with is the identification and the definition of the motivations to remit, as illustrated by the multiplicity of theoretical models which have been developed since the late eighties. Actually, identifying the reasons of remittances is puzzling and controversial within the theoretical literature, especially as empirical evidence is scarce and complicated to interpret. In the early 1980s, private income transfers have been increasingly recognized as a key economic fact that affects income distributions of an economy subject to political changes. Two main motivations have been considered to explain the decision to remit: altruism and exchange-motivated decision. Based on these two basic principles, numerous microeconomic models have been developed based successively on altruistic motive (Becker, 1974; Stark, 1985, 1995) and mutual exchange strategy (Cox, 1987; Cox, Eiser et Jimenez 1998), the latter being especially relevant in the case of inter-generational transfers (Laferrére and Wolff, 2001). Other common models rely on strategic game analysis (Stark and Wang, 2002), insurance strategy, moral hazard (Stark and Levhari , 1982; Rozenzweig, 1988; Lambert, 1994) and mixed motives (Lucas and Stark , 1985; Andreoni, 1989; and Cox and al., 1998). Facing these many theoretical models, it is important to check the robustness of our conclusions by implemented different micro-founded functions of transfers and then compare the outputs after simulating trade shocks. Consequently, a prerequisite will be to review the alternative models of remittances that can be implemented in our model.

Finally, the third challenge consists in dealing with the credibility of the data on inter-household transfers and treating household heterogeneity which is essential and justifies the choice of a macro-micro framework. Thus, households are dis-aggregated following the milieu and region of living, qualifications and gender, which leads to select 78 household categories, allowing capturing a part of the individual heterogeneity. Then, because reliable national data on bilateral remittances is most often not available or inaccurate, we solve this problem thanks to the reviewed microfoundations of transfers. Indeed, we calculate bilateral remittances from total amounts of paid and received remittances. Following Ratha and Shaw (2007), we allocate the total remittances received among other households using a weight rule, specific to each micro-founded model that is implemented. We apply a three-step methodology for each model of transfers chosen: the first step consists in estimating

bilateral transfers among households and using the theoretical motivations to remit as a distribution rule. The second step aims at implementing specific micro-foundations in our CGE model. Finally, the third step consists in implementing different scenarios of trade liberalization. This three-step procedure allows testing the robustness of the conclusions about the link between trade patterns, regional disparities and domestic transfers. It is also important to underline that this approach does not allow testing the validity of one behavior among others but proving that forgetting the foundations of household transfers leads to mismeasure the distributional effects of trade policies. Thus, to summarize, we review the alternative motives of transfers in order to choose the more appropriated to our case study and to our CGE model. Then, using the microfoundations selected, we use them as an allocation rule to build the bilateral matrix of inter-household transfers. Next, optimal transfers are introduced in the CGE-model before simulating trade policies scenarios. The final objective is to evaluate if distributional effects suffer from mismeasurement when inter-household transfers are forgotten.

This paper is organized as following. A first section presents some key features about Senegal, especially regarding household poverty, economic informality and trade perspectives, that would justify the choice of our scenarios. A second section reviews some theoretical foundations to remittances. Among the multitude of theories, a selection is done in order to match with our CGE framework. Thirdly, the CGE model is presented with data and the needed manipulations. Finally, the results of trade policies simulations are presented in section 4, with a focus on poverty and income inequalities indicators.

1 Selected features of the Senegal's economy

Senegal has been chosen as an interesting case study for different reasons. As some other sub-Saharan countries, Senegal is a poor country that has been classified as a least developed country (LDC) following three main criteria: poverty, human weakness (health, nutrition and education) and economic vulnerability linked to income instability, exports and import volatility, specialization concentration and exposure to natural disasters. Despite severe poverty and the lack of natural resources,[3] Senegal also presents important assets, compared to other sub-Saharan countries. In particular, its geographical situation and its 530km of coastline[4] and above all its relative political stability have implied foreign direct investments from Europe and the United States, which have favored the industrialization process, especially in the food-processing industry, phosphates mines and the chemical industry (in particular fertilizers). Contrariwise, the economic share of the primary sector, which still employs 70% of the labor force, has decreased to reach 20% of GDP since the crisis in groundnut sector in the late nineties, when pluviometry dramatically fell down. Cultures of Mil and Sorgho have become the main agricultural exports. Its

[3] excepted the halieutic resources that have suffered from overexploitation, according to the FAO, FAO Fisheries and Aquaculture Circular No. 1037 (2009)

[4] Contrary to most Least Developed Countries, Senegal is not landlocked, which represents an important asset to trade.

major trading partners are European countries (especially France), West African countries (Mali, Nigeria) and India (mainly on chemical products).

Turning to trade, Senegal has historically benefited from trade preferences granted by Europe. Actually, spurred on by the Lome convention (1975),[5] which consisted in putting trade and aid agreements in force between Europe and ACP (African-Caribbean-Pacific) countries, Senegal has today a wide market access towards European members, and this for forty years. Furthermore, as it is Least Developed Country (LDC), Senegal has also benefited of the Everything but Arms initiative (EBA, 2001), which is a duty-free quota-free preferential agreement[6] granted by Europe to all LDCs. Both of these agreements are non-reciprocal trade agreements. If the EBA initiative has unlimited period of application, the ACP agreement expired on 2007. On the occasion of the Cotonou Agreement in 2000, Europe has expressed its wish to extend its trade agreements with ACP countries in 2008, but converting them into reciprocal regional agreements in order to match the WTO rules.[7] These regional trade agreements, called EPAs are under negotiation but already imply three potential limits from the Senegal point of view: a low traffic creation effect since Senegal already benefits of the EBA initiative, a high traffic diversion effect linked to European exports and thirdly an important lose of government income, mainly constituted of tariff revenue.[8] Now, contrary to ACP countries which are not LDCs, Senegal will still benefit from European preferences through the EBA initiative. But, trade under this preferential scheme is not systematically fostered, in reason of restrictive rules of origin (Candau and Jean, 2008) of higher importance than under Cotonou agreements. Thus, negotiations with Europe are ongoing and the Economic Community of West African States (ECOWAS) is the African regional formation which takes an active part in these negotiations, including Senegal. Reciprocity does not mean that ECOWAS members have to fully liberalized their market. In fact, the EPA are negotiated under the condition of asymmetry in trade liberalization (100% for Europe, around 80% for ECOWAS members). Of course, if potential costs are considered, an EPA is also likely to bring some advantages to Senegal, especially in terms of regional integration with ECOWAS countries and in terms of local consumption which takes advantage of lower imported prices, locally produced. Knowing the summary of the main trade agreements of Senegal, our aim is to assess the impact of an EPA scenario but also the impact of a full liberalization, which is the long-term target spurred on by the WTO. To do this, we need to build a CGE-model which reflects as far as possible Senegal. For this reason, we quickly describe some selected features that

[5] converted in 2000 into the Cotonou Agreement

[6] This agreement excludes the exchange of arms and has excluded rice sugar and bananas until 2009, mainly in reason of overseas European regions, for which rice, sugar and bananas are sensitive products.

[7] Actually, ACP agreements under the Cotonou convention were not in accordance with the WTO rules about preferences. In fact, preferences can be granted only if they are intended to a group of countries, defined on objective criteria such as the EBA initiative. The discriminatory effect is of lesser importance than in the case of bilateral preferential agreements. Similarly, the African Growth Opportunity Act (AGOA) granted by the U.S. to ACP countries violates the WTO precepts and no waiver has been yet accorded to the U.S. Berisha-Krasniqi, Bouët and Mevel (2008)

[8] Adenikinju et Alaba (2005) have estimated that 26% of the Senegal government income comes from tariffs.

have determined our modelling choices.

The productive system of Senegal is characterized by the importance of the informal economy. Following Todaro (1969) and Harris and Todaro (1970), an informal sector is defined by an unproductive and stagnant process of production, especially located in urban areas, considering that the informal economy is absorbing the surplus in labor force coming from rural areas. Senegal is especially concerned by domestic migration between urban and rural areas, in both sides, following seasonal meteorological fluctuations. Indeed, as Senegal is located in a tropical region and is subject to a dry season and an important rainy season which foster seasonal migrations. Consequently, these population movements of seasonal workers have fostered the importance of the informal economy in both urban and rural areas. Informal activities are subsequent and represent 54% of GDP, 46% of intermediary inputs (Wade, 2002), but also 80% of the primary sector, 95% of the housing sector, 52% of transports. Farming, fishing and forestry are almost totally informal, characterized by traditional processing. Importantly, 40% of workers employed in informal sectors are living in rural areas, 70% of them are illiterate and are mainly 25-44 years old. Now, in order to match with these selected figures, we adapt our CGE model, in particular the labor market modelling and household disaggregation criteria. Actually, we choose to define a specific labor supply for unskilled and skilled workers, for each sectorial category in each area of living, namely for formal/informal sectors in urban and rural areas.

At the final point, these temporal migrations are inherent to domestic inter-household transfers, which are considerable in Senegal. In average, private transfers represent 19% of the household income, 18% in rural areas and 19.8% in urban areas. Table 1 reports some figures that characterized the nature and repartition of transfers, knowing that cash transfers represent around 80% of total transfers, the remaining 20% are gifts and transfers in nature.

Location	*Versed*	*Received*		*Versed*	*Received*
Dakar	39.2	54.2	Same place	56.7	34.3
Oth. urban areas	23.9	20.1	Oth. place	40.4	40.1
Rural areas	36.9	25.7	Abroad	2.9	25.6
Total	100	100	Total	100	100

Source: Enquête Sénégalaise auprès des ménages (ESAM) I

Table 1: Household Transfers, selected figures in percentage

From Table 1, it appears that Dakar concentrates cash transfers compared to other rural and urban areas. The general rule is that cash exchanges, expressed in value (FCFA) are higher in urban areas, including Dakar. Now, looking at the last two columns of Table 1, an important statement is the high share of domestic origin in total received transfers. International transfers represent a quarter of total remittances, which confirms the relevance of studying domestic remittances in our case study. Actually, among the few CGE models that have integer remittances in trade policy analysis, none of them devote

the attention on urban-rural transfers, which seems to be simplistic from this standpoint. So, our approach attempts to consider the total amount of cash transfers.

Regarding the link between transfers and household consumption, a bell-shaped curve is formed as illustrated by Table 1.

Cons/capita	*Versed*	*Received*
less than 60 000	2 087	6308
60 000-100 000	8 147	28 870
100 000-150 000	12 619	40 151
150 000-225 000	12 442	35 208
225 000-350 000	16 310	34 232
350 000-600 000	15 506	20 956
6 000 000-1 500 000	13 247	13 608
More *than* 1 500 000	8 057	3 274

in Franc CFA, source: ESAM I

Table 2: Consumption and cash transfers

Domestic transfers do not appear to be a linear function of consumption per capita, which is linked to household income. Regarding the remitting behavior, a growing function is noticeable until the threshold of 350 000 FCFA, from which transfers decrease as consumption per capita rises. This statement leads us to consider that transfers cannot be fully explained by altruistic motive. As the existing literature has underlined, identifying the microeconomic determinants of transfers is puzzling and controversial.

Now, following this, In order to assess the impact of domestic transfers and to check the robustness of our conclusions, we decide to use several models of remitting behavior, for comparison. In no way the aim of this paper is to check the validity of one model among others. Two reasons justify our approach based on the use of various theories: the need to establish a bilateral matrix of transfers, based on the total given and received amounts reported in surveys and the wish to endogenize bilateral transfers on the basis of theoretical foundations. The next step consists in reviewing the different motives found in the literature to give a global idea of the theoretical variety. This approach allows us to determine which models can be used in our theoretical context.

2 Literature Review of remitting behaviors

Regarding the existing literature of CGE models, the main statement is that no CGE-based study has taken into account the literature on microeconomic foundations of remittances. In fact this literature is even never quoted as bibliographic reference in these studies. When integrating remittances in CGE models, authors either suppose that they are exogenous, or they suppose that they are a fixed proportion of the migrant's income. Supposing that remittances are exogenous is obviously the simplest way to include these transfers in CGE models. However this option may be considered as too simplistic, or even misleading.

The literature has broadly considered two main motivations to explain the decision to remit: pure altruism and pure self-interest. This literature has been broadly influenced by the work of Lucas and Stark (1985). In the roots of these two remitting behaviors, exchange-motivated decisions have been based on "tempered altruism" or "enlighted self-interest" conceptions. Actually, in order to deepen the explanation of remitting behavior, the literature has focused on the different purposes of cash-transfers more than on its motives. More precisely, these subsequent models are exempted from the arbitrage between altruism and self-interest, by mixing these feelings and focus on intertemporal purposes of cash-transfers, arising out of ex-ante familial arrangements. In this way, remittances have been explained as an insurance or a risk-reducing strategy, or have been considered as repayments of a precursory investment in human capital, if the household had supported the migration cost. Many authors have worked on establishing literature reviews of the determinants of remittances. Among them, we can mention Carling (2008), Hagen-Zanger and Siegel (2007), Rapoport and Docquier (2006) and Stark (2009). This next section aims at synthesizing the different determinants of remitting behavior and subsequent optimal transfer functions.

2.1 Precursory models: Altruism, self-interest and strategic interactions

Models based on altruism, self-interest and strategic interactions are at the roots of all the future developments in the literature. Focusing on two opposite behaviors, namely altruism and selfishness, we highlight a third important framework, the strategic remitting-decision, developed by Stark (1995).

All along this section we consider a migrant m and its family stayed at home h. The amount of remittances sent by the migrant is T. The migrant's income is Y^m while Y^h is the revenue of the family stayed at home. Utility is $U^i, \forall i \in \{m, h\}$. Finally we call $V^i, \forall i \in \{m, h\}$ the indirect utility derived from consumption, so it can be expressed as the maximum utility given the income and the price structure. As price is exogenous we write indirect utility as a unique function of income.

2.1.1 Pure Altruism

Let us present first the idea of altruistic interactions within households which comes from Becker (1974) and has been followed by Ishikawa (1975), Adams (1980), Menchik (1980), Menchik and David (1983).

Lucas and Stark (1985) have considered both altruistic and self-interest motives and construct a model for each, which have inspired the theoretical literature until nowadays. The following formalization is inspired from Stark (1995, chapter 1), which assumes both mutual (two-sided) and unilateral (one-sided) altruism.

Each agent's utility is affected by the satisfaction derived from his own consumption

and by the utility of the other:

$$U^m(C^m, C^h) = (1 - \beta^m)V^m(Y^m) + \beta^m U^h(C^h, C^m)$$

$$U^h(C^h, C^m) = (1 - \beta^h)V^h(Y^h) + \beta^h U^m(C^m, C^h)$$

where β^i is a parameter such that $0 \leq \beta^i \leq 1/2$ reflecting the degree of altruism of agent $i, \forall i \in \{m, h\}$ for agent j with $j \in \{m, h\}$ and $j \neq i$.

It is straightforward to get:

$$U^m(C^m, C^h) = (1 - \gamma^m)V^m(Y^m) + \gamma^m V^h(Y^h)$$

$$U^h(C^h, C^m) = (1 - \gamma^h)V^h(Y^h) + \gamma^h V^m(Y^m)$$

with $\gamma^i = \frac{\beta^i(1-\beta^j)}{1-\beta^i\beta j}$. We can suppose: $0 \leq \gamma^i \leq 1/2 \ \forall i \in \{m, h\}$. The optimal remittance T is the solution of the migrant's maximization problem:

$$Max_T U^m(C^m, C^h) = (1 - \gamma^m)V^m(Y^m - T) + \gamma^m V^h(Y^h + T)$$

Considering a logarithm specification of indirect utility $V^m = ln(Y^m)$, the first order-condition is:

$$-\frac{(1 - \gamma^m)}{(Y^m - T)} + \frac{\gamma^m}{(Y^h + T)} = 0$$

Therefore if we rule out negative transfers, the optimal remittance T^* is:

$$T^* = \max(\gamma^m Y^m - (1 - \gamma^m)Y^h, 0)$$

where γ^m is an expression combining the altruistic parameters of both family members (assuming two-sided altruism) or at least function of β^m in case of one-sided altruism. The remittance depends:

- positively of the migrant's income, (Y^m) since: $\frac{\partial T}{\partial Y^m} = \frac{(1-\beta^h)\beta^m}{(1-\beta^h\beta^m)} \geq 0$
- positively on his altruism degree (β^m) since: $\frac{\partial T}{\partial \beta^m} = \frac{(1-\beta^h)(Y^h+Y^m)}{(1-\beta^h\beta^m)^2} \geq 0$
- negatively on the recipient's income (Y^h) since: $\frac{\partial T}{\partial Y^h} = -\frac{(1-\beta^m)}{(1-\beta^h\beta^m)} \leq 0$,
- and negatively on his altruism degree (β^h) since: $\frac{\partial T}{\partial \beta^h} = -\frac{\beta^m(1-\beta^m)(Y^h+Y^m)}{(1-\beta^h\beta^m)^2} \leq 0$.

So in case of two-sided altruism remittance ($\beta^m > 0$ and $\beta^h > 0$) is less than in case of one-sided altruism ($\beta^m > 0$ and $\beta^h = 0$).[9] One-side altruism is called "Beckerian altruism model". This underlines the potential inefficiency of two-sided altruism which can be at the origin of puzzling redistributive effects. The literature calls this issue "infinite regress" or "Hall of Mirrors Effects" (Becker, 1974; Kimball, 1987). According to this framework

[9] Under one-sided altruism and logarithm specification the optimal transfer is $T = \beta^m Y^m - (1-\beta^m)Y^h$.

remitting decision relies on utility optimization and may be altered by the characteristic of other household's members.

2.1.2 Pure self-interest

Lucas and Stark (1985) have distinguished three motives that are all related to selfishness and that may be complementary. The first is the aspiration to inherit, the second is investment in assets at home and their maintenance and the third one is the intent of the migrant to return home. Let us present the basic self-interest model.

Let us consider an intertemporal framework with two periods, in which the migrant sends money to its home area in order to pay a service S. The price of this service is α such that the migrant must send $T = \alpha S$. A model of pure selfishness, without discount, consists in maximizing the following utility function:

$$U^m\left(C^m, S\right) = \ln(C_1^m) + \ln(C_2^m) + \nu \ln(S)$$

under the budget constraint:

$$Y^m = C_1^m + C_2^m + T$$

where ν is the importance given to the service by the migrant. Ruling out again a negative transfer the optimization of this program gives the following optimal transfer function: W

$$T^* = max(\frac{\nu}{2+\nu} Y^m; 0)$$

The remittance T is increasing with the migrant's income Y^m and the importance given to the service S, namely ν. This optimal transfer is linear with the migrant's income. This is important since it implies that the elasticity of transfer with respect to the migrant's income is equal to unity.

By introducing this notion of service, the model shows the difficulty to distinguish the real motive of remittances, since self-interest feeling nourishes the probability of familial arrangements,[10] which is in turn affected by altruism. Indeed, pure self-interest is at the origin of investing in personal assets in the present, to maintain a social status, or in the future, through expected inheritance. But, these motives can be intrinsically linked to intertemporal familial arrangements, such as an insurance contract between the migrant and the household. Moreover, many empirical studies have shown that remittances, modeled as an insurance contract or any familial investment, increase also with the migrant's altruism degree. This preliminary statement justifies the development of models that are more focused on the *aim* of cash-transfers than on migrant's personal features. Before, the next sub-section presents an alternative specification that views transfers as the result of a strategic game.

[10] Such arrangements are based on mutuality, depending on the bargaining power of the migrant and the household. A theoretical model (Aisa, Andaluz and Larramona, 2011) has shown the impact of bargaining power on the level of remittances.

2.1.3 Strategic Motive and optimal transfers

Another alternative theoretical specification takes its roots in the model developed by Stark (1995, chapter 4) which defines remittances as a result of a "strategic" motive and illustrates another aspect of self-interest aspect of remittance. In this model, potential migrants are heterogeneous in skills and individual productivity is not perfectly observable in the host region's labor market while it is perfectly observable in the origin region's one. Therefore workers are paid the average productivity of their migrant group. This leads to a positive migrant self-selection behavior and cooperative arrangement. Skilled workers decision to remit incorporates a desire to limit migration of less skilled workers to prevent a decrease on migrant income in the host region.

As reported by Rapoport and Docquier (2006), the model of Stark (chapter 4, 1995) presents two workers who migrate or not. If they do, they are m-type with an income Y^m while if they do not, they are h-type and they get an income of Y^h. Both agents have different level of skills, with agent 1 having a higher productivity than agent 2: productivity level of agent 2 is a proportion π of the productivity level of 1, where $0 < \pi < 1$.

Both kind of workers can migrate in this model, meaning that unskilled and skilled workers can move towards urban areas, matching the dual-dual model (Stifel and Thorbecke, 2003) that assumes labor market dichotomies between rural and urban areas (also formal and informal sectors), in which both skilled and unskilled workers can migrate. To simplify, we borrow the payoff matrix from Rapoport and Docquier (2006), that reports the different gains of m and h if they decide to migrate or not

Table 3: Payoff Matrix of the strategic motives game

	Agent 2	
Agent 1	Migrate	Not migrate
Migrate	$\left(\frac{1+\pi}{2}Y^m, \frac{1+\pi}{2}Y^m\right)$	$\left(Y^m, Y^h\right)$
Not migrate	$\left(\frac{Y^h}{\pi}, \pi Y^m\right)$	$\left(\frac{Y^h}{\pi}, Y^h\right)$

If nobody migrates towards urban areas then both agents are h-type. However agent 2 earns Y^h while agent 1 earns $\frac{Y^h}{\pi}$, as he is more productive and it is observable. Migration gives to all migrants the average productivity observed. So if player 1 migrates towards urban area, whereas player h stays at home, then the migrant earns Y^m which is by assumption higher than Y^h and higher than $\frac{Y^h}{\pi}$ (note that the second condition implies the first one). If only player 2 migrates, then average productivity is agent 2's productivity πY^m. Finally if both agents migrate, then average productivity is $(Y^m + \pi Y^m)/2 = \frac{1+\pi}{2}Y^m$.

Looking at the payoff matrix, we consider the case of a sufficiently high gain related to migration: $\frac{1+\pi}{2}Y^m > \frac{Y^h}{\pi}$. This implies that: $\frac{1+\pi}{2}Y^m > Y^h$. Then the Nash equilibrium

is the situation in which both workers migrate.[11] Indeed if skilled and unskilled workers migrate, the host region will pay both migrants according to the average productivity, since the employer is confronted to imperfect information.

Remittance can then play a strategic role by giving agent 2 an incentive to stay at home while agent 1 migrates. The remittance must increase income of both agents as compared to the previous Nash equilibrium. In other words, the following conditions must be respected:

$$Y^m - T \geq \frac{1+\pi}{2} Y^m$$
$$Y^h + T \geq \frac{1+\pi}{2} Y^m.$$

Therefore, the minimal optimal transfer is the following:

$$T^* = \frac{(1+\pi)}{2} Y^m - Y^h$$

where π is a parameter reflecting the migrant's productivity. This is the transfer corresponding to a case in which the migrant has the whole bargaining power. In case of the individual staying at home getting all the bargaining power, the transfer is:

$$T^* = \frac{(1-\pi)}{2} Y^m$$

Note that in the latter case remittance is a linear function of the migrant's income with a unitary elasticity while in the former and all intermediate cases remittance is a function of both the migrant's and the home agent's incomes.

It is important to remind that this model assumes that incomes are expressed net of migration costs.

2.2 Derivative models and mixture of motives

The pioneering work of Lucas and Stark(1985) has extended the analysis and develop the concept of "enlightened self-interest" and "tempered altruism". Following it, Andreoni (1989) has introduced the concept of "impure altruism". All these concepts rely on the same idea of a mixture of altruism and selfishness which both enforces contractual arrangements and intra-household exchanges motives. By adopting this standpoint, it is clear that remittances are not only explained by the intrinsic nature of the migrant at time t (which consists in wondering which feeling sustains cash transfers) but can also be interpreted by the migrant's intention and its pursued aim at home. Consequently, determinants of remittances are then viewed from the angle of the *purpose* more than the *motive*, to use the same rhetoric of de la Brière et *al.* (2002). The models described in Appendix A are based on *mutuality* and motivated by two main aims: *investment and risk-sharing.*

[11] Migration is a dominating strategy for all agents

Why the literature had to change the angle of explanation? Apart from the difficulty of distinguishing intentions, three more reasons can be advanced. First, a model of remittances needs to consider the migration context, namely temporary vs. definitive migrations or domestic vs. international movements (Carling, 2007). Indeed, the migration context strongly conditions the desire to remit and that is why an approach by the *purpose* of cash-transfers is more appropriated. Secondly, the nature of familial relationships and household structure also affect the relevance of precursory models and their developments, depending on the country considered. Sana and Massey (2005) have shown the role of household composition and the important differences between four Latin American countries. Finally, an important issue that is often forgotten in the literature (Carling, 2007) is the confusion between the desire and the capacity to remit. If models based on altruistic or self-interest considerations predict the desire of remitting, it is important to design theoretical models that predict the capacity to remit.

These models are presented and a summary table is reported in Appendix A.

Now turning to our CGE model, the choice of theories strongly depends on data availability and more precisely on the number of behavioral parameters which are gathered in the optimal transfer function. Actually, due to the lack of bilateral data, we cannot work with more than one parameter to calibrate. Furthermore, models based on mutuality such as investment and risk-sharing motivation would need to work with a dynamic CGE framework, since income volatility and temporal space are in force. For these reasons, we choose to work with the first three precursory models presented in the last sub-section.

3 The model

The CGE model presented in this section is a single-country model that combines a macro-micro framework, in which the representative household is disaggregated. Calibrated on the SAM dated from 2006 (Fall, 2009), 34 economic sectors are listed, including five primary sectors, 24 industries and four private services and finally the administration and public services. A public agent is modeled, producing a public good and consuming its intermediate inputs. There is a representative firm in each sector and to finish the SAM reports the rest of the world interactions with Senegal households, firms and the government. Focusing on production, four factors are represented: capital, skilled and unskilled labor, the specific sector, only employed in primary sectors. Economic sectors are gathered in four categories[12] in order to match with the dual-dual framework. In fact, the labor supply in those categories is endogenously determined by migratory equilibrium conditions, which are described in the next subsection.

This section is organized as follows. A first sub-section is devoted to the description of the labor market, the supply side of this modelling. Next, a second sub-section concerns the demand side, income and transfers modelling. At each stage, data issues and calibration strategy are exposed.

[12] Rural formal and informal sectors; urban formal and informal ones

3.1 A dual-dual economy

The dual-economic models of Lewis (1954) and Fei and Ranis (1964) are pertinent frameworks to build a model adapted to Senegal. The central concept of these models is the modelling of sectorial dualism, inherent in most developing countries. But actually, as underlined by Stifel and Thorbecke (2003), two main features can help to conceive the idea of dualism: first, the existence of strong inequalities between rural and urban regions, in terms of localization of the activities and in second place the dichotomy between traditional technologies, in which most of firms are family-owned and modern technologies hold by more complex organizations. This double dichotomy between sectors, thus underlined, leads to classify sectors into four categories: in one hand, rural sectors that can be divided into formal (exporting agriculture, with capital-intensive technology) and informal sectors (subsistence agriculture), and urban sectors, formal (mainly manufacturing) or informal (services) in the other. In reference to this double-dichotomy, Thorbecke (1997) called this kind of models "dual-dual economy". Contrary to the dual-economic models, these new developments introduce a geographical component of analysis, where both urban and rural areas know situations in which informal sectors emerge to absorb the residual labor force, unemployed in the formal sector (Gelb et *al.*, 2009). This geographical dimension allows improving our understanding of poverty, migrations and the motivations to remit and above all, it provides a rich model in which distributional effects of trade policies can be better explained.

Thus, on the basis of the dual-dual economic model from Stifel and Thorbecke (2003), we build a single computable general equilibrium in which the economic dichotomy is determinant to the construction of the labor market.

3.1.1 Supply and the labor market

In our model, domestic production of sector i (xd_i) is decomposed into value-added (va_i) and intermediate consumptions (ci_i), following a Leontief function. The value-added is produced using a composite of mobile inputs (capital K, skilled L_S and unskilled labor L_U) and specific inputs (land) that are derived from a Constant-Elasticity of Substitution (CES) function. Finally, at a third stage, another CES function reflects the combination of mobiles factors. This specification of the production allows specifying different degrees of substituability at each stage. We need to precise that the public agent does not produce public good following the same scheme, since production is a Leontief function of intermediate consumption, labor and capital. Now, a description of the different forms of dualism presented in the model is needed.

There are two kinds of labor: skilled and unskilled workers. If the unskilled workers are perfectly mobile between formal and informal sectors both in urban and rural areas, the skilled workers are only employed in the formal sectors. This means that production function of informal sectors does not contain units of skilled workers and only combine unskilled jobs and capital. Considering some stylized facts, we pick up important features

that need to be modeled. First, concerning the unskilled workers, wages in the informal sectors are lower than wages in the formal one, such as

$$w_U^{i,\cdot} < w_U^{f,\cdot}$$

where exponent "i" denotes informal sectors whereas "f" denotes formal ones and index "U" refers to unskilled workers. Further explanations can be advanced: presence of a minimum wage in formal sectors that implies a rise of all wages or the presence of transaction costs which can be considered as a social cost to move from informal to formal sectors, compensated by a financial retribution. Besides, productivity per worker is higher in the formal sector, benefiting from capital-intensive process of production. Furthermore, as Harris and Todaro (1970) have underlined, there is a wage premia in the urban formal sector compared to the rural one. So, finally, wages in formal sectors are always higher than in informal sectors, and urban wages usually exceed rural wages. Following that statement, we should observe that most workers are employed in rural sectors in the case of Senegal.

Because unskilled and skilled workers are not substitutable, our model contains two distinct labor markets, following the level of education. Here it is important to notice that the supply of skills is exogenous in the economy

$$\bar{L} = \bar{L_U} + \bar{L_S}.$$

Next, we describe the equations defining both supplies and demands of different kinds of labor in each sector, and equilibrium wages.

Starting with the equilibrium conditions of the unskilled labor, the following migration condition determines the supply of unskilled workers between urban and rural areas, precisely $L_U^{\cdot,u}$ and $L_U^{\cdot,r}$. In the same spirit of Harris and Todaro (1970) and Stifel and Thorbecke (2003) we model the urban-rural wage gap such that unskilled workers move towards urban areas until the rural wage is equal to the expected wage in the urban sector. We precise that each worker who cannot obtain a job in the urban formal sector is likely to work in the informal one until he reaches his objective to be hired in the formal importing sector in the next period. This equilibrium condition is expressed by

$$w_U^{f,r} = \left(1 - \frac{hL_U^{f,u}}{L_U^{f,u} + L_U^{i,u}}\right) w_U^{i,u} + \left(\frac{hL_U^{f,u}}{L_U^{f,u} + L_U^{i,u}}\right) w_U^{f,u} \tag{1}$$

where $\frac{hL_U^{f,u}}{L_U^{f,u}+L_U^{i,u}}$ is the probability of being hired in the formal urban sector, expressed as the share of urban uneducated labor force in this sector, multiplied by a scale parameter h. This equilibrium condition defines the proportion of unskilled workers who moves to urban areas $L_U^{\cdot,u}$, so we write

$$L_U^{\cdot,r} = \bar{L_U} - L_U^{\cdot,u}$$

to define the supply of unskilled workers in rural areas. Now, it should be precise how

unskilled workers are allocated into formal or informal sectors in each location. At the equilibrium, wages between formal and informal activities are expressed as it follows

$$w_U^{f,r} = w_U^{i,r}(1+\delta) \tag{2}$$

where δ is the transaction cost implied by migration from informal to formal sector in rural area. Taking a job in rural exporting sector induces psychological and financial costs that are represented as a financial compensation, which justifies that δ is strictly positive. Now, turning to the urban area, workers who are employed in the formal sector receive a share of profits which implies a better remuneration than in informal activities. The urban formal sector adopts efficiency wages to prompt intensive efforts. As a result, the spatial equilibrium condition in the urban area between formal and informal sectors is written

$$w_U^{f,u} = w_U^{i,u} + \gamma \frac{\Pi}{L_U^{f,u}} \tag{3}$$

where $w_U^{i,u} = \frac{pp^{i,u} x d^{i,u} \beta_{L_U}}{L_U^{i,u}}$ the marginal revenue product of unskilled workers (β is the output elasticity with respect to unskilled labor), γ is the share of profit-sharing, and Π the profit.

Now turning to the skilled labor force, which is only employed in formal sectors, we need to explain the wage differential between urban and rural skilled jobs, $w_S^r < w_S^u$ As many studies have underlined, this inequality is often explained by the presence of union labor forces in urban sectors. The specification used is the one proposed by Booth (1995), namely the monopoly union labor which is powerful and thus fixes the urban wage for skilled workers, by maximizing its utility function:

$$\underset{w_S}{Max} U(w_S, L_S)$$
$$L = L_S(w_S).$$

The labor union gives the same importance to the present skilled labor force, hired in the urban sector, than to the potential labor force currently hired in the rural sector. Thus there is an alternative wage, namely, in rural area. Knowing this, the utility function to maximize is expressed by the following equation

$$U\left(w_S^u\right) = \left[L_S^u\left(w_S^u\right)\right] u\left(w_S^u\right) + \left[L_S - L_S^u\left(w_S^u\right)\right] u\left(w_S^r\right),$$

where $u\left(w_S\right) = \frac{w_S^{1-\theta}}{1-\theta}$, and θ is a preferential parameter, reflecting a time preference. This specification, reported in Stifel and Thorbecke (2003), comes from the three main hypothesis of skilled job market: the perfectly inelastic substituability between skilled and unskilled, the full employment of skilled workers and the distinctive feature of these skilled workers, only hired in formal sectors. Finally, the equilibrium condition of urban-rural

skilled labor force resulting from this maximizing problem, is

$$w_S^{f,u} = \left[\frac{1 - \beta_U^{f,u}}{(1-\theta)\beta_S^{f,u} + \theta(1 - \beta_S^{f,u})} \right]^{\frac{1}{1-\theta}} w_S^{r,f} \tag{4}$$

where β values are elasticities of production with respect to skilled workers. This migratory condition defines variable L_S^u thus we only need one more equation to define L_S^u assuming the absence of unemployment

$$L_S^r = \bar{L_S} - L_S^u$$

Finally, at the equilibrium, all wages are ascertained by the equalizing of labor supplies and labor demands, on each labor market. Demands of labors follow from profit maximizing in each sector of the economy.

3.1.2 Data and calibration

Turning to data issues, the SAM of 2006 informs us on supplies and demands of factors of 34 sectors. Then, an important step consists in defining the nature of each sector. All primary and agricultural activities are classified as rural sectors, while industry and services are defined as urban activities. Then following the criteria of Harris and Todaro (1970) and Stifel and Thorbecke (2003), exporting-sectors are mainly classified as formal activities, while traditional sectors, food crops, construction and urban services which are essentially constituted of real-estate business are considered as informal activities. Applying this classification to the 34 sectors represented gives the total supplies and demands of factors by sub-category. Now, the missing data mainly concerns the initial values of nominal wages in each sector, we base their initialization on stylized facts found in the existing literature. A report dated from 2012 (Benjamin and Aly Mbaye, 2012) has proceeded to a large review of the African informal economy. The first important statement is that wages in formal sectors are higher than in informal ones. Table 4 reports the monthly remunerations in Dakar with regards to the type of activity, following Benjamin and Aly Mbaye (2012). It appears that 91% of workers in formal activities receive more than 200 000 FCFA per month against only 18% of workers employed in informal activities. Poapongsakorn (1991) estimates between 13% and 22% the difference in legislation, namely due to absence of legislation in informal activities.

Table 4: Monthly remunerations between formal and informal activities

	<35 000 FCFA	35 000 - 200 000	> 200 000	Total
Formal	2	7	91	100
Informal (large)	6	16	77	100
Informal	41	41	18	100
Total	21	25	54	100

Source: Benjamin, Aly Mbaye 2012

Authors made a distinction among informal activities, following the size of firms

To refine this statement, data on household expenditures are exploited, with regards to the sector of employment. Table 5 presents the differences in expenditure per capita between formal and informal employment, in agriculture, industry and services.

Table 5: Annual expenditure per capita in formal and informal employment

Sector	Formal	Informal	Ratio	Empl.
Agriculture	251 822	145 855	1.73	48.1
Manufactures	356 498	261 770	1.36	6.6
Construction	562 881	247 131	2.28	5.3
Transport	499 678	295 728	1.70	3.4
Trade	593 752	316 356	1.88	23.7
Oth. services	531 313	420 604	1.26	12.9

Source: DPS 2002, Benjamin and Aly Mbaye 2012

From Table 5, we can deduce the differences in costs of living between formal and informal employment, in both regions. Actually, in rural areas wages are higher in formal firms by a coefficient of 1.73. In urban areas, this coefficient is included between 1.26 (oth. services) and 2.28 (in construction). On average, the coefficient of urban formal sectors on informal ones, weighted by employment is 1.69. Furthermore, we need to collect information about the urban wage premium in Senegal. As this data is missing, we use these expenditures data to estimate the differences in costs-of-living between areas. We find a ratio of urban to rural expenditures per capita equal to 2.14. Now, turning more specifically to skilled workers, we need to estimate the gap in remuneration between unskilled and skilled workers. In public administration, skilled workers' remunerations are twice as high as other employees. Consequently, when parameters and variables are initialized, the lowest wage rate, namely the remuneration rate of unskilled workers in rural area that are employed in the informal sector, is normalized to one ($w_U^{i,r} = 1$). Then, it follows that the wage rate of the unskilled in the rural formal sector is $w_U^{f,r} = 1.73$, which implies that the urban unskilled are paid $w_U^{i,u} = 2.13$ in the informal sector and $w_U^{f,u} = 3.59$ in the formal economy, always in reference to our normalization. Now, skilled workers employed in the rural area are paid more that twice as high as the unskilled labor employed in the formal economy, so $w_S^r = 3.70$, and $w_S^u = 7.92$ in Dakar and other urban areas. These initializations allow calibrating other key parameters, which refers to the process of calculating share and behavioral parameters of the mathematical functions in this CGE model, so that the model will replicate the base year SAM as an equilibrium solution.

Regarding Equation (1), the first step is to calibrate the probability $p = \frac{hL_U^{f,u}}{L_U^{f,u}+L_U^{i,u}}$ of being hired in the formal urban sector. Once p is initialized, it is easy to calibrate the scale parameter h, as initial labor supplies in each sector are known from the SAM. The next step of the calibration is to fix the initial value of parameters δ and γ in equations (2) and (3), by using initial values for labor supplies and profits paid back to workers as dividends. Then, turning to the skilled labor segment, we need to fix initial values for elasticities of production with respect to skilled workers β and the preferential parameter θ, reflecting

a time preference. For that, we borrow the elasticities from Stifel and Thorbecke (2003) in order to calibrate the parameter θ, thanks to initial wages and skilled labor supplies in rural and urban areas.

3.2 Consumption, Income and transfers

3.2.1 Household demand and income

Starting with the private agents, household gross income is composed of the sum of earned income, income from real estate, the share of corporate income, public transfers (allowances and pensions) and net private transfers (domestic and international remittances). The household net income is defined as the residual of income after that all direct taxes have been deducted. An important feature here is that an additional income tax can be debited as a compensation mechanism to maintain the public account constant when trade is liberalized. The Households savings are defined as a propensity of net income (propensity which is calibrated thanks to initial values of income and savings recorded in the SAM). Demand of goods and services comes from a nested-CES system of preferences. More precisely, each representative household consumes an agricultural good and non-agricultural good, which is itself a combination of all non-agricultural varieties.

The household disaggregation requires micro data on incomes, sorted by source, consumption of each product reported in macro-level data, savings, taxes and other transfers, any interaction of each household with any economic agent. We have at our disposal three surveys, ESAM I (*Enquête Sénégalaise auprès des ménages I*) which has been collected in 1995-1996, ESAM II (*Enquête Sénégalaise auprès des ménages I*I) in 2002 and ESPS (*Enquête de Suivi de la Pauvreté au Sénégal*) in 2005-2006. These three rounds of household surveys had for objective to gather information about household poverty and its evolution over time. But, it is noticeable that the modalities of these investigations are quite different, in terms of number of questioned households, number of visits and nature of questions. As a result, this leads to gather information from each survey. For instance, data on incomes, transfers and taxes are available in ESAM I, while ESPS focuses on expenditures and social indicators. The main difficulty lies in the fact that the questioned households are not the same between these successive surveys. So, in order to use information, extracted from ESAM I and ESPS, we need to define common criteria, that will be used to aggregated households in same categories. As a result, we use information about the milieu of living, region, gender and qualification. This procedure allows controlling for household heterogeneity and to gather information in a reasonable number of household categories. Milieu is defined as rural or urban area of living; the country is cut up into ten regions;[13] gender consists in distinguishing male or female household heads, and finally dummies variables are generated following literacy and the level of qualification, for which a threshold has been fixed at tertiary education. Besides, to maintain a sufficient degree of representativeness, we fix the minimum number of households by category to 25. This

[13] Dakar, Djourbel, Fatick, Kaolack, Kolda, Louga, Saint-Louis, Tambacounda, Thiès, Ziguinchor

leads us to keep 78 household categories.

3.2.2 Transfers

Transfers can be of two natures, namely from the public agent to the benefit of private agents and between private agents. In this model, public transfers are taken as exogenous, as well as transfers emanating from the representative firm. Contrariwise, inter-households transfers will be considered as endogenous in order to capture their effects when trade liberalization occurs. We use three alternative theoretical models in order to check the robustness of our conclusions. As our CGE-model is a static model and as some theories would be a source of increasing complexity, especially when considering the mixture of motives to remit, we choose three main pure motives, based on altruism, pure self-interest and finally a strategic motive resulting from games theory. These models have been detailed in a previous section. We report here the optimal transfer functions of respectively pure altruism, pure self-interest and pure strategic motives:

$$T^*_{mh} = \gamma^m Y^m - (1-\gamma^m) Y^h$$

$$T^*_{mh} = \frac{\nu}{2+\nu} Y^m$$

$$T^*_{mh} = \frac{(1+\pi)}{2} Y^m - Y^h$$

These three alternative specifications allow us to initiate bilateral household transfers in order to match with the SAM initial values. This is the object of the next paragraph.

We remember that our goal is to assess and evaluate the importance of redistributive effects of inter-household transfers, and to test the robustness of our results. That is why we use alternative micro founded specifications of domestic transfers, both to allocate the aggregate amount of transfers among all households and to implement a micro-founded function of transfers in our CGE model. The SAM informs us about the total received and versed amounts transferred from and to other Senegal households. Moreover, ESAM I contains the total amounts of transfers for each questioned household. Now, we elaborate a procedure in order to allocate total cash transfers in a bilateral matrix of transfers. In the same spirit of Ratha and Show (2007) who use three alternative weights to allocate an aggregated amount of remittances, at a macro level we work at a micro-level and choose to use different weights on the basis of micro-founded theories of transfers. The three specifications of optimal transfers, presented above, are function of incomes and behavioral parameters. More precisely, γ, ν and π are behavioral parameters reflecting respectively altruism, self-interest and the migrant's productivity, that would need to be fixed in order to match the initial data. Actually, the data generating-process is threefold. Firstly, a bilateral matrix is generated in the same framework as the SAM, namely in which rows represents the received transfers and in columns are reported the versed amounts. To do

this, we use the optimal transfer function bilaterally defined (under one of the three alternative specifications) and allocate the total amounts reported in the household survey ESAM 1 by using this function. This process implies to fix a value to the behavioral parameters. The solution we propose is to set up a loop procedure on all possible values of these behavioral parameters and to retain the solution that minimize the sum of discrepancies between the generated values and the observed total values. Thirdly, once the behavioral parameter is selected, the last-step consists in balancing the bilateral matrix of transfers by using a cross-entropy approach, as applied for the macro SAM. The advantage of this methodology is that no assumption is imposed on behavioral parameters regarding the remitting behavior, but there are calibrated in order to match the initial values of total transfers.

3.3 International Trade and closure

3.3.1 Trade modelling, data and parameter estimations

Demand for goods and services emanates from households (final demand) and firms (intermediate inputs), demand which is aimed at the local producers and at international imports. The choice between domestic or imported goods is derived under the Armington assumption with a CES function. On the other side, domestic producers supply their production towards the domestic and international markets, following a Constant-Elasticity of Transformation (CET) function.

The SAM gives us imports and exports by product, for each tradable sector among the 34 sectors from and to the rest of the world. But, in order to refine the trade policies analysis, a distinction of the origins and destinations at different levels can be relevant, especially in order to precise distinct trade elasticities of substitutions. For this reason, total exports are split into two destinations (developing countries vs. developed ones), following a CET function. A second nested level of repartition is modeled to distinguish European partners from the other developed countries and to isolate the ECOWAS members from the other developing partners. This adoption of a double CET allows us to evaluate the impact of an EPA between European and ECOWAS countries, today under negotiation. Symmetrically, imports are modeled following the same scheme, with nested CES functions. The geographical repartition of exports and imports is done thanks to UN Comtrade database, for the year 2006.

Turning to the price of exported and imported goods, we need to initiate tariff rates, so that domestic prices of production can be calibrated. All tariffs come from the MacMaps database (v3, 2007), initially at the HS6 level so that we need to aggregate the tariff lines in order to match with our sectorial classification. Our approach to estimate an average tariff rate at the sectorial level is founded on a weighting system based on imports from a reference group, similarly to the MacMaps methodology. Elasticities of substitution are either borrowed in the literature such as Armington elasticities (Cabral, 2005 from GTAP) or econometrically estimated. Actually, using UN Comtrade data on bilateral trade flows

and export/import unit values combined with tariff data from MacMaps, we are able to estimate the elasticities of substitution between developed and developing countries and then in a last level between ECOWAS/other developing partners and Europe/other developed partners. We follow Okagawa and Ban (2008) to econometrically estimate these elasticities of substitution.

3.3.2 Macroeconomic closure

Before examining the effects of trade liberalization, the model closure is presented. Total investment is the sum of sectorial investments which are considered as exogenous. Total savings are made up by private savings (defined as a propensity of net income) and public savings (government income less the total cost of public good production and less the sum of public net transfers). The government income is widely made up of direct taxes (on household income and corporate profits) and of indirect taxes based on value added and tariffs, but also of international transfers. The public account is fixed as a constant value and thus needs a compensation mechanism. An additional tax on household income is used as compensation when an external shock affects the public account. Now, the model closure is defined by the external balance which is equal to the sum of domestic savings less total investment, less public balance. External balance is the difference between value of exports and imports, net of any transfers. It is important to note that we choose the nominal exchange rate as the *numéraire*.

4 Simulations and results on Macro and Micro variables

Two main trade scenarios are simulated: an EPA with European members and a full trade liberalization. Moreover to refine the results in terms of poverty and distributional effects, inter-household transfers are taken as endogenous. As robustness checks, alternative theoretical specifications of transfers are used. Firstly, we report some selected global indicators, then sectorial effects are mentioned and subjected to separated tables. Finally, a last sub-section is dedicated to poverty and income inequalities effects.

4.1 Results on macro variables

Table 6 reports the first global indicators of trade impact under the two scenarios. Only a few figures are selected to present a broad outline of the impact of trade policies and to focus in the next sub-section to the distributional effects. Two columns are reported for respectively an EPA scenario between European and ECOWAS members and a full trade liberalization for comparison. All figures represent variations implied by each scenario, all are expressed in percentage.

Table 6: Global indicators of trade liberalization

variations in %	EPA	FULL
Foreign market access	1.08	1.38
Domestic market openness	6.36	11.12
GDP	0.05	0.04
Volume of exports	4.58	7.90
Volume of imports	3.26	4.49
Government income	-1.01	-1.69

EPA: Economic Partnership Agreement
FULL: full liberalization

The first indicator, *foreign market access* is the gain of market access expressed as the difference of initial and simulated tariffs paid on the value of exports. A positive value means a decrease of paid tariffs. Its variation exceeds 1% for both scenarios, which means that Senegal can benefit from these trade policies in spite of historical preferential schemes. This is a first point: an EPA implies a trade creation effect. This is confirmed by the variation of the volume of exports, at 4.58% level. On the other side the *domestic market openness* i.e. the variation of tariffs paid by all trading partners, with respect to initial tariff rates. An increase of this indicator is interpreted as high penetration of imports. The EPA implies an important market opening, an increase of 6.36%, which is an expected result since Senegal was trading under non-reciprocal trade agreements. A full liberalization presents an opening process even stronger. It entails an important increase of the volume imported. Comparing exports and imports variations, it appears that exports are more fostered than imports under both scenarios. A sectorial analysis will be interesting in order to detect the potential trade diversion effects implied by the EPA in comparison with full liberalization. The growth effects are slightly positive, around 0.05%. Another important element which leads to policy implications is the cut in government income under both scenarios. The EPA seems to lessen this effect, but a decrease of more than 1% is still recorded. As expected, full liberalization cuts tariff income at 1.69% level. This negative effect matters in the negotiations between ECOWAS countries and Europe since duties represent an important share of revenue (25% in average).

Now, turning to the sectorial effects of trade liberalization, a first comparison can be done between the four segments of the labor market. Thus, Table 7 reports the variation in production of each type of sectors, following the double dichotomy of the Senegal's economy. Following it, table 8 presents the sectorial variations of production and exports, expressed in volume, under the two scenarios.

Table 7: Variation of the volume of production in each segment of activity

variation in %	EPA	FULL
Formal Rural	-0.22	0.00
Formal Urban	-0.51	-1.07
Informal Rural	1.18	2.46
Informal Urban	-0.29	-0.56

EPA: Economic Partnership Agreement
FULL: full liberalization

At first state, trade liberalization affects formal activities in rural and urban areas. Volumes of production are globally contracted further to liberalization. When the EPA is simulated, formal rural activities suffer from eroded preferences up to -0.22%, at the benefit of other producers. This effect can be perfectly illustrated with the groundnut sector, which is a strong Senegal specialization. The actual system of preferences has fostered groundnut exports from Senegal. This is especially true comparing with Nigeria, another ECOWAS member, which has not benefited from the same preferences. Trade liberalization has implied an erosion of Senegal groundnut exports, which explains why the rural formal production is decreasing. By the same way, urban activities know a decrease of their production. Only, the informal rural category pull out with an important increase up to 1.18%. This is mainly explained by the predominance of fishing and crustaceans for which exports are fostered by trade liberalization, because of high initial levels of protection. This is even more true that full liberalization is concerned. Contrary to the EPA, the second scenario does not imply a deterioration of formal rural production, but a larger decrease in formal urban sectors. To precise which sectors are concerned by restructuring, Table 8 reports sectorial variations of production and exports, expressed in volume.

Table 8: sectorial percentage variations of production and exports, in volume

Sectoral variations (%)			Volume of Prod (%)		Exports (%)	
	Code	Share	EPA	FULL	EPA	FULL
Food crops	A1	0,04	-1,04	-0,68	-0,09	0,89
Industrial Agriculture	A2	0,01	-1,01	-0,56	1,20	1,86
Farming and hunting	A3	0,03	-0,24	-0,17		
Forestry	A4	0,01	-0,69	-0,47		
Fishing	A5	0,02	1,80	1,42	2,40	2,82
Extractive activities	A6	0,01	-0,58	-0,24	1,34	2,10
Prepared foodstuffs	A7	0,03	-0,34	-0,14	-0,07	0,61
Animal or vegetable fats, oils	A8	0,01	-2,66	-1,47	-0,79	0,20
Milling industry products	A9	0,02	-1,82	-1,07	-1,00	0,02
Cereal products	A10	0,02	0,06	0,01		
Sugar confectionery	A11	0,01	-4,65	-2,77	-3,00	-1,24
Edible preparations	A12	0,02	-3,20	-1,83	-1,79	-0,43
Beverages	A13	0,01	-1,56	-0,98		
Manufactured tobacco	A14	0,00	-0,74	-0,43	-0,06	0,62
Cotton fabrics and textile	A15	0,02	-1,41	-0,88	-0,95	0,02
Leather	A16	0,00	-6,40	-4,05	-4,76	-2,50
Wood and wooden articles	A17	0,01	0,73	0,38	1,30	1,40
Paper products and paper pulp	A18	0,01	-0,58	-0,33	0,29	0,85
Mineral fuels	A19	0,02	-4,37	-2,45		
Chemical products	A20	0,03	-1,36	-0,72	0,78	1,39
Rubber articles	A21	0,01	-1,54	-0,87	0,53	1,21
Pottery, glass products	A22	0,02	1,02	0,63	-3,67	-1,35
Base metal products	A23	0,01	0,07	0,08	-4,10	-1,58
Machinery	A24	0,00	1,44	0,87	2,04	2,21
Equipments and electric products	A25	0,00	2,11	1,30	0,61	1,32
Transportation	A26	0,00	2,35	1,28		
Diverse products	A27	0,01	-1,28	-0,73	-10,01	-5,57
Power, gas and water	A28	0,03	-0,34	-0,21		
Construction	A29	0,10	2,59	1,49		
Public Administration	A30	0,05				
Education and formation	A31	0,02	0,40	0,21	0,07	0,07
Health and social activities	A32	0,01	0,25	0,12	-0,51	-0,26
Collective activities	A33	0,02	0,19	0,10	-0,01	0,01
Market services	A34	0,39	0,27	0,16	-0,10	-0,03
Total		1,00	-0,68	-0,39	-0,81	0,19

Sectors which take the highest advantage of trade openness are fishing, wood and wooden products, machinery, equipment and electric products and some services, such as education. Actually for those sectors, production and exports are fostered by trade liberalization under both scenarios. Conversely, primary sectors, including groundnut production, food-processing sectors such as sugar confectionery, most manufactured sectors such as leather industry are less produced in volume. But, this statement has to be put in perspective with exports evolution. Indeed, chemical products are less produced but know an important increase in exports when a full liberalization occurs. In fact, chemical products, which in fact refer to fertilizers, are one of the specialization of Senegal and exports to the Indian market suffer from high levels of protection. Furthermore, a positive effect

is notable on the production of some non tradable sectors, especially for construction and transportation. In the eyes of this table, many sectors are restructured further to trade liberalization, since Senegal loose its preferences resulted from its LDC status.

A geographical decomposition is worthwhile to show the potential costs and benefits of such trade policies. Tables 9 and 10 present the variation of exports by sector and by destination (developing and developed partners, in which ECOWAS and EU members are distinguished) for respectively an EPA and a full liberalization.

Table 9: Variation of exports for an EPA agreement, by sector and destination

Variation of exports for an EPA, by sector and destination (%)

Code	Sector	ecowas	eu	oth. Devd	oth. Devg	Total
A1	Food crops	3,48	-0,81	-1,28	-1,75	-0,09
A2	Industrial Agriculture	4,48	0,79	0,24	-0,73	1,20
A5	Fishing	5,43	2,28	1,66	0,24	2,40
A6	Extractive activities	4,60	0,97	0,41	-0,61	1,34
A7	Prepared foodstuffs	2,21	-0,42	-0,78	-1,31	-0,07
A8	Animal or vegetable fats, oils	1,63	-1,27	-1,60	-1,91	-0,79
A9	Milling industry products	1,44	-1,50	-1,82	-2,11	-1,00
A11	Sugar confectionery	-0,22	-3,86	-4,09	-3,84	-3,00
A12	Edible preparations	0,78	-2,43	-2,72	-2,80	-1,79
A14	Manufactured tobacco	2,28	-0,42	-0,70	-1,42	-0,06
A15	Cotton fabrics and textile	1,52	-1,44	-1,70	-2,20	-0,95
A16	Leather	-1,89	-5,69	-5,82	-5,64	-4,76
A17	Wood and wooden articles	3,51	1,09	0,76	-0,16	1,30
A18	Paper products and paper pulp	2,58	-0,01	-0,31	-1,12	0,29
A20	Chemical products	4,08	0,31	0,00	-1,26	0,78
A21	Rubber articles	3,85	0,02	-0,27	-1,48	0,53
A22	Pottery, glass products	0,07	-4,71	-4,88	-5,17	-3,67
A23	Base metal products	-0,31	-5,19	-5,34	-5,55	-4,10
A24	Machinery	5,29	1,66	1,32	-0,10	2,04
A25	Equipments and electric products	3,95	0,10	-0,20	-1,41	0,61
A27	Diverse products	-6,86	-11,51	-11,48	-10,19	-10,01
A31	Education and formation	0,03	0,26	-0,05	0,03	0,07
A32	Health and social activities	-0,44	-0,41	-0,69	-0,50	-0,51
A33	Collective activities	-0,03	0,17	-0,14	-0,03	-0,01
A34	Market services	-0,10	0,06	-0,23	-0,12	-0,10
Total		1,65	-1,28	-1,59	-2,05	-0,81

oth. devd refers to «other developed countries» while oth. devg refers to «other developing countries».

Regarding Table 9, exports towards other ECOWAS members are globally fostered, especially for primary goods, food-processing, wood and paper products, chemical and rubber products. Some products suffer from trade openness whatever the destination, as well illustrated by the leather sector, for which Senegal loose preference at the benefit of other ACP countries. This EPA simulation highlights the diversion effect of such a regional agreement. Actually, if exports towards other African countries and to a small extent towards European markets, it is widely to the detriment of other developing countries for most sectors. This effect is clear when full liberalization is simulated, as exports towards

other developing and other developed countries are raised.

Table 10: Variation in percentage of exports for a full liberalization, by sector and destination

Variation of exports for a full liberalization, by sector and destination (%)

Code	Sector	ecowas	eu	oth. Devd	oth. Devg	Total
A1	Food crops	1,56	-0,92	1,14	1,77	0,89
A2	Industrial Agriculture	2,26	0,19	2,37	2,63	1,86
A5	Fishing	2,98	1,24	3,54	3,51	2,82
A6	Extractive activities	2,44	0,45	2,66	2,84	2,10
A7	Prepared foodstuffs	1,10	-0,29	0,42	1,22	0,61
A8	Animal or vegetable fats, oils	0,77	-0,75	-0,04	0,83	0,20
A9	Milling industry products	0,62	-0,95	-0,25	0,65	0,02
A11	Sugar confectionery	-0,40	-2,36	-1,69	-0,54	-1,24
A12	Edible preparations	0,26	-1,45	-0,76	0,23	-0,43
A14	Manufactured tobacco	1,18	-0,21	0,24	1,26	0,62
A15	Cotton fabrics and textile	0,67	-0,85	-0,41	0,67	0,02
A16	Leather	-1,48	-3,58	-3,16	-1,79	-2,50
A17	Wood and wooden articles	1,83	0,65	1,10	2,01	1,40
A18	Paper products and paper pulp	1,37	0,05	0,51	1,48	0,85
A20	Chemical products	2,18	0,31	0,76	2,31	1,39
A21	Rubber articles	2,02	0,12	0,57	2,14	1,21
A22	Pottery, glass products	-0,19	-2,60	-2,18	-0,41	-1,35
A23	Base metal products	-0,40	-2,85	-2,43	-0,64	-1,58
A24	Machinery	2,89	1,18	1,65	3,13	2,21
A25	Equipments and electric products	2,12	0,23	0,69	2,25	1,32
A27	Diverse products	-4,21	-6,80	-6,41	-4,87	-5,57
A31	Education and formation	0,05	0,19	0,02	0,05	0,07
A32	Health and social activities	-0,23	-0,20	-0,36	-0,26	-0,26
A33	Collective activities	0,00	0,11	-0,06	0,00	0,01
A34	Market services	-0,03	0,07	-0,10	-0,04	-0,03
Total		0,77	-0,76	-0,09	0,82	0,19

oth. devd refers to «other developed countries» while oth. devg refers to «other developing countries».

This sectorial analysis allows us to underline the trade diversion effects that appear under an EPA, in comparison to full liberalization. Table 7 has revealed an idea of the distributional effects of trade policies. The next sub-section is now devoted to poverty/distribution effects of trade policies, by taken into consideration inter-household transfers.

4.2 Results of the micro-simulation

For evaluating poverty and distributional effects of trade policies, we use the set of indicators proposed by Boccanfuso, Decaluwe and Savard (2008) which suggest several methods to measure income inequalities and household poverty. We first examine the effects of trade policies under the two scenarios when transfers are treated as exogenous. For analyzing household income inequalities, we use the mean income changes in the representative households of our 78 sub-categories as an input into changes of the distribution of income of a sub-group of a population, after what we compute the five alternative indicators of income inequalities: the Gini, Atkinson, coefficient of variation, quantile ration ans share

ratio indexes. Then, we compare to the output when transfers are considered as endogenous. We start to focus on the Altruistic motive of transfers. This is the object of the next sub-section.

4.2.1 Exogenous and altruistic transfers: effects on poverty

Table 11 reports the first set of results in terms of income distribution. The first important statement is that trade liberalization implies a reduction of income inequalities. This is a strong result but which is not surprising when considering the effects on trade liberalization on wages presented in Table 7. Actually, both scenarios imply an important rise in the rural informal sector, boosted by the fishing sector which benefits a lot from trade openness. Actually, both scenarios imply an important rise in the rural informal sector, boosted by the fishing sector which benefits a lot from trade openness. Actually, fishing in Senegal is an important sector which represents more than 1.5% of GDP and 11% of the value added in the primary sector (ANSD, *Situation Economique et Sociale du Sénégal*, 2007). Two reasons can explain why this sector is likely to benefit a lot of these two scenarios: the first is the initial high level of protection imposed on fishing products and the second reason is that Senegal is dominating the market due to its important halieutic resources and so the country is not suffering from international competition, especially of other West African economies. Thus, trade liberalization implies a decrease in income inequalities as rural informal wages are fostered contrary to other sectors. This result is robust whatever the measure retained, as reported in Table 11.

Table 11: Inequalities effects, measured with household's net income

	Base	Exogenous Transfers		Altruistic Transfers	
Variation in percentage		EPA	FULL	EPA	FULL
Gini index	0,647	-0.092	-0.104	-0.002	-0.054
Atkinson Index	0,356	-0.117	-0.223	-0.063	-0.098
Coefficient of variation index	2,331	-0.056	-0.092	-0.001	-0.003
Quantile Ratio index	0,040	-0.243	-0.399	-0.142	-0.178
Share ratio index	0,078	-0.291	-0.503	-0.157	-0.199

Now, turning to the effects of transfers, it appears that altruistic behavior is likely to reduce the benefits of trade policies. In fact, the reduction of income inequalities is of lesser importance when considering the redistributive effect of inter-households transfers. This is explained by the counter-cyclical effects of remittances.

Table 12 examines the effects of trade on poverty alleviation. Variations in percentage are reported for the scenarios. It appears that trade brings poverty reduction effects since the lowest wages are increasing following the liberalization of exchanges. The three indicators are unanimous of this poverty alleviation effect of trade. But, it is important to underlined that considering inter-households transfers as endogenous limits this effect, which is still positive but of lesser importance.

Table 12: Poverty reducing effects of liberalization

		Exogenous transfers		Altuistic transfers	
Variation in percentage	Base	EPA	FULL	EPA	FULL
Foster, Greer and Thorbecke index	0,943	-0,060	-0,078	-0.053	-0.064
Watts index	3,677	-0,102	-0,099	-0.086	-0.089
Sen, Shorrocks and Thon index	0,978	-0,011	-0,022	-0.000	-0.009

Poverty line fixed at 1000 CFA/a day

Finally from these effects estimations, we can conclude that Senegal can take advantage of trade liberalization in absolute and relative terms since poverty and income inequalities are reduced. But, the benefits are overestimated when bilateral transfers are omitted, which is an important conclusion since they are often ignoring by previous CGE-analysis.

4.2.2 Robustness checks

Now, we present the same poverty and distribution analysis, but we replace altruistic behavior by self-interested and strategic motivated transfers. We remember that this approach implies to re-calibrate the bilateral matrix of transfers and to replace the optimal function of inter-household transfers. It allows us to check to robustness of our results and not to verify the validity of one motive among others. Table 13 reports these results.

Table 13: Income distribution and poverty effects with alternative motives of transfers

	Base	Self-interest Transf.		Strategic Transf.	
Variation in percentage		EPA	FULL	EPA	FULL
Gini index	0,647	-0.003	-0.034	-0.005	-0.063
Atkinson Index	0,356	-0.042	-0.057	-0.078	-0.085
Coefficient of variation index	2,331	-0.001	-0.002	-0.004	-0.006
Quantile Ratio index	0,040	-0.069	-0.079	-0.136	-0.169
Share ratio index	0,078	-0.075	-0.096	-0.143	-0.174
Foster, Greer and Thorbecke index	0,943	-0,048	-0,053	-0,052	-0,069
Watts index	3,677	-0,067	-0,073	-0,071	-0,083
Sen, Shorrocks and Thon index	0,978	-0,001	-0,009	-0,003	-0,010

Poverty line fixed at 1000 CFA/a day

Conclusions advanced in the last sub-section are robust to the use of alternative models of transfers. At first sight, this result may be surprising since motivations to remit are quite different. But in fact, as the migrant income is essential in the remitting behavior the main effect is a diminishing of the distributional effects of trade policies.

5 Conclusion

This work aims at assessing the effects of trade liberalization as considered in actual negotiations in which Senegal is an active participant. As Europe has reopened the question of reciprocity of regional trade agreements signed with the ACP countries, it is important

to evaluate the potential costs and benefits of such trade policies. We design a theoretical framework on the basic idea that the labor market of Senegal is suffering from dualism following three criteria: qualifications of workers, region and sectorial formalism. It was important to consider the distributional effects of inter-household transfers in order to avoid some mismeasurement in trade effects. We find that globally trade liberalization is poverty and inequality reducing. This is strong result which need to be put in perspective with one specificity of the Senegal's economy, namely the economic weight of fishing. This explains while rural informal activities are the large beneficiaries of trade liberalization. This reducing effect may be overestimated. Actually when transfers are endogenously determined in the CGE model, poverty alleviation is still observed but of lower importance.

To improve these conclusions, a key element may concern the sectorial classification into formal/informal activities, in order to integer precisely the weight of informal activities within each sector rather than between them. Furthermore, a sensitivity analysis with respect to the behavior parameters may be justified by the fact that this dual-dual approach implies a multitude of elasticities and other estimated parameters.

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Appendixes

Appendix A: Derivative models and mixture of motives to remit

Mutual exchange

Transfers that are motivated by an underlying exchange previously established in the midst of the family, are often related to temporary migration. Indeed, as underlined by Rapoport and Docquier (2006), mutual exchange motive reveals the migrant's intention to go back home. Exchange as a motive to remit can often be considered as an inter-temporal decision, based on mutuality between the migrant and its family. At the basis of this kind of models: the bargaining power of each family member which depends on income, family structure, or labor market conditions and cost of living in each location.

Assuming a migrant m and its family stayed at home h and the amount of remittances T to buy a service executed at home S (family in charge of children caring, property...).

The first condition of the mutual exchange is that the recipient of transfer needs to be compensated for the cost of service, meaning that its indirect utility should be equal or higher:

$$V^h(Y^h + T, S) \geq V^h(Y^h, 0)$$

The minimal transfer $\underline{T}$ is obtained by solving this equality of indirect utilities. Similarly, the migrant's participation constraint is expressed as followed:

$$V^m(Y^m - T, S) \geq V^m(Y^m, 0).$$

This defines a maximum transfer $\overline{T}$ that the migrant is ready to pay. Then the only condition for an effective transfer to take place is:

$$\overline{T} > \underline{T}$$

We can illustrate this with the example taken in section 2.1.2. The home agent's utility function is:

$$U^h\left(C_1^h, C_2^h, S\right) = \ln(C_1^h) + \ln(C_2^h)$$

under the budget constraint:

$$Y^h + T = C_1^h + C_2^h + \alpha S$$

It is straightforward that the participation constraint of the home agent is respected if and only if:

$$T \geq \alpha S$$

So in this case: $\underline{T} = \alpha S$. The migrant's utility function is:

$$U^m\left(C^m, S\right) = \ln(C_1^m) + \ln(C_2^m) + \nu \ln(S)$$

under the budget constraint:

$$Y^m = C_1^m + C_2^m + T$$

where ν is the importance given to the service by the migrant. If $T = 0$, $S = 0$ and: $V^m(Y^m, 0) = 2\ln(Y^m/2)$. If $T > 0$, $S > 0$ and $V^m(Y^m - T, S) = 2\ln((Y^m - T)/2) + v\ln(S)$. The migrant's participation constraint is:

$$T \leq Y^m \phi(S, v) = \overline{T}$$

with $\phi_S > 0$ and $\phi_\nu > 0$. A profitable exchange is possible as soon as:

$$\alpha S \leq T \leq Y^m \phi(S, v)$$

If we exclude extreme cases, the remittance depends on the amount of service expected, S, the price of this service α, the migrant's income Y^m and the importance given by the migrant to this service in her/his utility function ν.

Family arrangements

The case of investment This model explains remittances as a repayment of loans on investments in human capital. This is a particular version of exchanges of services in an household, that can be especially relevant in a context of imperfect credit-markets. This strategy aims at increasing the global family income. Then, if investment is the main motivation of remittance, a household will send migrants to regions benefiting from greater labor opportunities, on condition that the migration cost supported by the family is enough low and that the increase in total income can compensate it. As underlined by Rapoport and Docquier, this model implies that only relatively rich households can adopt this strategy since the poorest can not support the migration cost for every profitable migration, and then it involves inter-household inequalities. This is why investment motive does not take into account the intra-household income distribution but the inter-household one.

Cox and Jimenez (1992) were the first authors to develop a theoretical model implying investment motive, working on the interactions between the social security system and private transfers (in Peru). They have been followed by many papers, such as Cox, Eiser and Jimenez (1998), Ilahi and Jafarey (1999), Poirine (1997) and Massey and Parado (1998) or Dustmann and Kirshamp (2001) who find some evidence of this motive at the micro-level.

Let us quickly present the framework of this model in the same lines of Rapoport and Docquier (2006) but with simplification in order to keep the same illustrative framework. The model is composed of two successive periods. The family lives in rural area, and is composed of two individuals producing an agricultural good in quantity X_a with a

quadratic production function:

$$X_a = \mu\left(L - \frac{\psi}{2}L^2\right)$$

where L is the number of rural workers ($L \in \{1, 2\}$). μ is a size parameter and ψ captures the decreasing labor productivity ($0 < \psi < 1$). It is notable that the technological parameter μ implies ambiguous effects on migration incentives since it affects family's wealth. Income is equally shared between all the members so that, if there is no migration and therefore no remittance, each member's income is:

$$Y_1^h = Y_2^h = \mu(1 - \psi)$$

One family member can migrate towards urban area, with a migration cost c that includes education expenditures; migration gives an income denoted Y^m. The cost$c$ is financed by first-period savings. The decision that one member migrates is taken if and only if:[14]

$$2\mu(1 - \psi) - c + Y^m + \mu(1 - \frac{\psi}{2}) \geq 4\mu(1 - \psi)$$

It leads to a condition on a minimal level of urban income net of migration cost:

$$Y^m - c \geq \mu(1 - \frac{3\psi}{2})$$

The remittance is obtained thanks to the condition of income equality:

$$Y^m - T = \mu(1 - \frac{\psi}{2}) + T \Leftrightarrow T = \frac{Y^m}{2} - \frac{\mu(1 - \psi/2)}{2}$$

The remittance T depends positively on the migrant's income Y^m, negatively on the scale parameter of the agricultural production function μ and positively on the labor marginal productivity parameter ψ. It does not depend on the migration cost, since this cost is paid on period 1 while the remittance is implemented on period 2 to equalize incomes.

The case of insurance The insurance motive is another important model advanced for explaining remittances, especially in the case of developing countries, in which insurance and credit markets fail. This concept relies obviously on family arrangements, referring to the "tempered altruism" of Stark and Lucas (1985). Migration is viewed as a mean of risk-diversification, since a migrant works in different region, sector, with different skill level. This is the most important assumption of the insurance model: migrant's income should be uncorrelated to the household's income, in such a way that remittances can insure a smoothed consumption. The model that illustrates this mechanism is the model presented in de la Brière, Sadoulet, de Janvry and Lambert (2002), in a Principal-Agent framework, in which the household is the principal and the migrant is the agent.

[14] We do not consider the migration of the whole family

The household is defined as risk-adverse and is confronted to an incertain situation in which an income Y^h is received with probability π and $Y^h - \Delta$ is received with probability $1-\pi$, where Δ is the income shock randomly defined. Knowing that, an informal insurance can be contracted with the migrant, who is also risk-adverse. This contract is mutually defined since the household pay a premium p for supporting the migration cost and any other costs that will insure the migration process, and in exchange, the migrant fulfill its engagement by transferring an amount $T = a\Delta$, with $0 \leqslant a \geqslant 1$ the coverage of income shock. The household, which is the principal in the model choose the parameters p and a which maximize his expected utility, denoted $E(U^h)$, subject to$(E(U^m) \geq U^m)$.

With λ as a Lagrange's multiplier, we have:

$$\max_{p,a} E(U^h) = \pi U^h(Y^h - p) + (1-\pi)\, U^h(Y^h - p - \Delta(1-a))$$

subject to the constraint of migrant participation

$$\pi U^m(Y^m + p) + (1-\pi)\, U^m(Y^m + p - a\Delta) \geqslant U^m\left(Y^m\right).$$

The first order conditions give the following equation:

$$\frac{U^{m\prime}(Y^m + p - a\Delta)}{U^{m\prime}(Y^m + p)} = \frac{U^{h\prime}(Y^h - p - \Delta(1-a))}{U^{h\prime}(Y^h - p)}.$$

Taking the Taylor expansion around incomes net of migration costs supported by the household p , one can obtain

$$\frac{a}{1-a} = \frac{\chi(Y^h - p)}{\xi(Y^m + p)},$$

where $\chi(.)$ and $\xi(.)$ are the household's and migrant's risk aversions, which are expressed as following

$$\xi = -\frac{U^{m\text{"}}(Y^m + p)}{U^{m\prime}(Y^m + p)}$$

$$\chi = -\frac{U^{h\text{"}}(Y^h\text{-}p)}{U^{h\prime}(Y^h - p)}.$$

Then, the optimal risk-sharing level, that is determined by the household, strongly depends on the relative risk aversions of the two players. Following this statement, the optimal level of remittances is expressed by

$$T = a\Delta = \frac{\xi(Y^m + p)}{\xi(Y^m + p) + \chi(Y^h - p)}\Delta.$$

It is clear that cash-transfers modeled as insurance allowances, depend on the income shock and on the income shock coverage, which depends on the risk aversions of both players. But this particular solution considers that the parameter p , which includes the migration cost and other costs supported by the household to insure the migration, is fixed.

Now, assuming that this parameter can affect the risk aversions, it may also impact the level of remittances. Knowing that, de la Brière et *al.* (2002) offer a complete analytical solution, around incomes Y^m and Y^h. For that, they solve a second-order Taylor expansion of the migrant participation constraint, as expressed below

$$U^{m'}(Y^m)\left[p - a\Delta(1-\pi)\right] + \frac{1}{2}U^{m"}(Y^m)\left[\pi p^2 + (1-\pi)\left(p - a\Delta\right)^2\right] \approx 0.$$

This expression can be rearranged

$$-\frac{U^{m"}(Y^m + p)}{U^{m'}(Y^m + p)} \approx \frac{2\left[p - a\Delta(1-\pi)\right]}{\left[\pi p^2 + (1-\pi)\left(p - a\Delta\right)^2\right]}$$

and solved for the optimal level of parameter $p(a)$. Knowing that $\xi = -\frac{U^{m"}(Y^m+p)}{U^{m'}(Y^m+p)}$, the equation to solve is rewritten as it follows

$$\xi p^2 - 2\left[a\xi\Delta(1-\pi) + 1\right]p + (1-\pi)\,a\Delta(a\xi\Delta + 2) \approx 0.$$

The only positive root that can be admitted[15], according to the condition $p(a) < a\Delta$ is expressed by

$$p^*(a) = a\Delta(1-\pi) + \frac{1}{\xi} - \frac{\sqrt{A}}{\xi},$$

where $A = 1 - \pi(1-\pi)\xi^2 a^2 \Delta^2$.

At last, to complete this analytical resolution, the optimal $p^*(a)$ is replaced in the household's utility function.

$$\max_a E(U^h) = \pi U^h\left\{Y^h - \left[a\Delta(1-\pi) + \frac{1}{\xi} - \frac{\sqrt{A}}{\xi}\right]\right\}.$$

$$+ (1-\pi)\,U^h\left\{Y - \left[a\Delta(1-\pi) + \frac{1}{\xi} - \frac{\sqrt{A}}{\xi}\right] - \Delta(1-a)\right\}$$

The first order condition of this program is

$$-\left\{\left[1 + \frac{\pi\xi a\Delta}{\sqrt{A}}\right]U^{h'}\left[Y^h - a\Delta(1-\pi) - \frac{1}{\xi} + \frac{\sqrt{A}}{\xi}\right]\right\}.$$

$$+\left\{\left[1 - \frac{(1-\pi)\xi a\Delta}{\sqrt{A}}\right]U^{h'}\left[Y^h + \Delta(-1+\pi a) - \frac{1}{\xi} + \frac{\sqrt{A}}{\xi}\right]\right\} = 0$$

This condition can be rearranged by using a first-Taylor expansion around $Y^m$to give

$$-\frac{\xi a\Delta}{\sqrt{A}}U^{h'}(Y^h) + \left[-\Delta + \frac{\xi\Delta^2}{\sqrt{A}}(1-\pi)\,a + \frac{\Delta a}{\sqrt{A}}\right]U^{h"}(Y^h) \approx 0.$$

[15] To obtain more details about these solutions, please refer to the original paper de la Brière et *al.* (2002)

After replacing $\chi = -\frac{U^{h"}(Y^h)}{U^{h'}(Y^h)}$, this first order condition is solved for the parameter a to give

$$a^* = \frac{1}{\sqrt{\Delta^2(1-\pi)\xi^2 + 2\Delta(1-\pi)\xi\left(1+\frac{\xi}{\chi}\right) + \left(1+\frac{\xi}{\chi}\right)}}.$$

Optimal function of remittances is obtained

$$T = a^*\Delta$$

$$T = T\left(+\Delta, -(1-\pi), +\chi, -\xi\right).$$

Optimal remittances are positively impacted by the size of income shock (Δ) and the household risk aversion around its income (χ) and these cash transfers are negatively affected the migrant's risk aversion, as well as the probability of an decreasing income shock ($1-\pi$). The main conclusion of this model of insurance is that, since risk aversions depend on wealth (the richer you are, the less you are risk-adverse), richer migrants are likely to send more money than poorer ones. Symmetrically, the poorest households will receive relatively more remittances.

Table A.1 summarizes the main findings of this section. We listed six microeconomic motivations of remittances. Explanatory variables are diverse but this list always includes migrant's income and most of the time the home agent's income. It is noteworthy that only one specification (Pure Self Interest) expresses remittances as a linear function of the migrant's income: this requires of course a logarithm specification but it is worth noting that in this case the migrant's income-elasticity of remittances is unitary.

Title	Specification	Explanatory variables
Pure Altruism	$T = \gamma^m Y^m - (1-\gamma^m)Y^h$	Migrant's income; home income; degrees of altruism of migrant and home agent
Pure Self Interest	$T = \frac{\nu}{2+\nu} Y^m$	Migrant's income; weight given by migrant to home service
Strategic motivation	$\frac{(1+\pi)}{2} Y^m - Y^h \leq T \leq \frac{(1-\pi)}{2} Y^m$	Migrant's income; home income productivity gap between migrant and home agent
Mutual Exchange	$\alpha S \leq T \leq Y^m \phi(S, v)$	Migrant's income; quantity of service; price of this service; weight given by migrant to home service
Investment Motivation	$T = \frac{Y^m}{2} - \frac{\mu(1-\psi/2)}{2}$	Migrant's income; scale parameter reflecting technology; labor marginal productivity
Insurance Motivation	$T = T(+\Delta, -(1-\pi), +\chi, -\xi)$	Migrant's and household's risk aversions, depending on income Size and probability of income shock