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Intra-household Selection into Migration: Evidence from a Matched Sample of Migrants and Origin Households in Senegal*

Isabelle Chort† Jean-Noël Senne‡

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Abstract

This paper fills the gap between individual selection models and household approaches to migration. We build a theoretical model to account for household-based migration decisions and derive its implications on migrant selection. Assuming that the origin household takes into account both earnings and future remittances when choosing where to allocate its members, we show that migrant selection resulting from a household model may differ from self-selection predicted by an individual model. This paper thus investigates the so far under-explored issue of intra-household selection into migration in order to identify the key determinants of household members' location choices. The estimation procedure is derived from an extension of the Roy-Dahl model of mobility and earnings and is applied to a unique matched sample of Senegalese migrants in three destination countries - France, Italy and Mauritania - and their origin household in Senegal. Our results show that expected remittances, along with earnings differentials, play a major role in shaping intra-household selection patterns, which stands in striking contrast with the usual predictions derived from individual self-selection models.

Keywords : migration, remittances, intra-household allocation, selection, Roy model
JEL classification : F22, F24, D13, C51

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1 Introduction

The question of the characteristics that differentiate individuals who migrate from those who stay in their home country is still a major issue in the migration literature. Migrant selection has indeed been studied in many articles since the seminal paper by Borjas (1987) who applied to international migration the Roy (1951) model of self-selection. In this theoretical framework, location choices depend on individuals' comparative advantages based on both their observed and unobserved characteristics. All the papers derived from the Roy model of self-selection thus explicitly share an individual-based approach, in line with the first models of migration as an individual income-maximizing strategy (Harris and Todaro (1970); Sjaastad (1962)).

While the household dimension of migration decisions has been acknowledged since the 1980s by a large strand of literature, initiated in particular by Stark and Bloom (1985), it has been mostly used to enrich the understanding of remittances behaviors, beyond mere altruism. However, no paper has yet investigated the implications of a household migration decision on migrant selection. Yet, if migration is regarded as the result of a household welfare-maximizing strategy and thus decided on at the household level, the selection of one or more migrants among household members may not be equivalent to individual self-selection into migration. Indeed, future remittances to non-migrant members may be part of the household decision-making process at the migration stage, jointly with comparative advantages in earnings. This paper is thus the first to explicitly model the implications of a household-based migration decision on migrant selection, and to put a special emphasis on the role of expected remittances. This issue is indeed ignored in the migration literature which is either focused on selection as a purely individual process or on remittances as the result of a household strategy, while assuming that the migration decision is exogenous.

One reason why intra-household selection into migration has not been studied to date probably lies in the lack of suitable data. Indeed, in order to uncover the main factors that shape selection patterns within the household, one needs to compare counterfactual allocations of household members across alternative locations, accounting for the non-random double selection of who migrates and where. To control for this double selection, information on the characteristics of both migrant and non-migrant members originating from the same origin household is required. We exploit in this paper unique matched survey data collected among

Senegalese migrants in three host countries and members of their origin household who remained in Senegal. The structure of these data make them particularly appropriate for the analysis of intra-household selection.

This article thus contributes to fill a major gap in the migration literature by providing and estimating a household model for migrant selection using unique migrant-origin household matched data. We specifically address the issue of intra-household selection into migration and aim at answering the following questions: who, among household members, is more likely to migrate and what are the key determinants of household-based migration decisions?

We first build a general theoretical model to account for the household allocation decision. We assume that the household chooses where to allocate its members and that this choice results from the maximization of a household utility function that depends on expected household members' earnings at each location and future remittances sent by each potential migrant. We derive theoretical predictions about migrant selection and show in particular that intra-household variations in remittances potential, along with earnings differentials across members, play a key role in the household migration decision.

Second, we derive from our theoretical setting an extended Roy model of intra-household mobility. To recover the structural parameters of our model of household migration decision, we suggest a three-step estimation procedure of a discrete choice model of location choices based on the model developed by Dahl (2002), extended to a household-level joint selection process with multiple alternatives. We then provide an empirical application using unique survey data on Senegalese migrants and members from their origin households in Senegal. These data, collected in 2009-2010 as part of the MIDDAS project, provide information on migrants' characteristics in the top three destination countries of Senegalese migrants (France, Italy, and Mauritania) as well as detailed information on all members of their origin household in Senegal. We collected in particular information on earnings of migrants in host countries and non-migrants in Senegal, and on remittances sent by migrants to their origin household. Our results show that both earnings and remittances differentials play a role in shaping intra-household selection patterns. We find that the household selects into migration the member with the highest remittances potential, conditional on earnings. This finding enriches the usual predictions of individual self-selection models, and allows us to account for the fact that household members with koranic

education or who are the eldest of their siblings both have higher migration propensities and remit larger amounts, despite having no comparative advantages in earnings.

The household-based framework that we adopt is particularly relevant to the Senegalese migration context under study. Indeed, according to our data, 56% of surveyed migrants covered part or totality of migration costs through family funding which indicates that migration is a household investment. Furthermore, the data show evidence of the strength of the links between migrants and their origin household. More than 80% of surveyed migrants send remittances to their origin households, mostly on a regular (monthly) basis. The average amount of remittances account for between 15% and 30% of migrants' monthly income depending on host countries and amounts to a large share of the resources of recipient households. In addition, remitted amounts are primarily used for daily consumption - 84% of money transfers - in order to cover the basic needs of all household members - 78% of money transfers are indeed targeted to the household as a whole for collective expenditures. Finally, around 60% of sampled migrants state their intention to return to Senegal, mostly in their origin household. These figures therefore indicate that, in spite of the geographical distance, both non-migrants and migrants remain part of a "transnational" household in which at least part of the resources are pooled and support our choice of a unitary model of household decision-making. These empirical findings additionally suggest that remittances cannot be fully explained by a risk-sharing strategy.

This paper thus fills a gap between the literature on migrant selection, exclusively focused on self-selection of immigrants as an individual process (Chiswick (1999), Orrenius and Zavodny (2005), McKenzie and Rapoport (2010), Fernandez-Huertas Moraga (2011), Fernandez-Huertas Moraga (2013), among others), and other strands of the migration literature which have acknowledged the household dimension of the migration decision, but mainly through the lens of remittances motives (see Rapoport and Docquier (2006) for a review). Note that a first attempt to investigate the impact of the family on migrant selection can be found in Borjas and Bronars (1991). However, their model does not really depart from an individual selection approach. Since their theoretical results are based on the simplifying assumption that households do not split, they do not account for remittances and fail to address most of the issues related to household migration decisions. For many developing countries, including Senegal, the assumption that the household does not split is overly restrictive.

The empirical part of the paper builds on Dahl (2002) who enriched the theoretical two-sector self-selection model inherited from Roy (1951) by allowing for multiple alternatives. The same methodology has been applied by De Vreyer et al. (2010) to the analysis of location choices in West African capital cities, and by Bertoli et al. (2013) to the migration of Ecuadorians to Spain and the U.S. However, all these papers study individual location decisions. We contribute to this strand of literature by adapting Dahl's individual theoretical framework to the modelling of household migration decisions. This article also contributes to the estimation of non-standard conditional logit models. Indeed, since we explore within-household allocation choices of members, the set of alternatives available to each household depends on the number of potential migrant members in the household. To date, only a few papers, with applications to marketing (Berry et al. (2004), Allenby and Rossi (1998)) or electoral choices (Yamamoto, 2012), have developed estimation techniques of conditional logit models with a number of alternatives varying across observations

Finally, this paper is one of the few empirical studies exploiting the rich information contained in matched data samples of migrants and origin households. The same survey design is found in Osili (2007) who studies the determinants of remittances of Nigerian migrants in the U.S., but the resulting matched sample is only made of 61 pairs of migrants and families of origin. A similar data structure is obtained by Abramitzky et al. (2012) and Ambler (2012), although constructed with very different methodologies. In the first case, the authors exploit data on individuals' names and ages from the 1865 and 1900 Norwegian and the 1900 US censuses to link Norwegian migrants to their childhood household and investigate returns to migration experience among siblings. In the second case, the author designed a controlled experiment to assess the role of information asymmetries between Salvadoran migrants in Washington and their origin household, during which family members back in Salvador were reached by phone and asked very specific questions related to the experiment.

The paper proceeds as follows. Section 2 presents a household-based model for migration and derives an extension of the Roy model of selection. Section 3 outlines the estimation procedure. Data are described in Section 4. Empirical specification and identification issues are discussed in Section 5. Estimation results are then presented in Section 6. Section 7 concludes.

2 Theoretical framework

In this section, we develop a structural model for household-based migration decisions. We assume that household members' location choices are decided on at the origin household level so as to maximize a household utility function depending on both earnings and remittances. We derive predictions regarding migrant selection. We then build on Dahl (2002) to define an extended Roy model of intra-household selection and suggest a three step estimation procedure to recover the structural parameters of our model of household migration decision.

2.1 A household model of migration decision

We consider a household made of several members whose geographical allocation is decided on at the household level. Each member can migrate to one of the available destination countries or stay in the home country. We make the following two preliminary assumptions. First, we consider only households participating in migration. Indeed, this paper focuses on intra-household selection, that is to say, on the simultaneous choice of which member is to migrate and live abroad and its destination once the household decision to participate in migration has been taken[1]. Second, for the sake of simplicity, and consistent with the empirical estimation, we ignore the fact that households can have several migrants[2].

General setting

We consider an origin household h made of n members who can migrate to J possible destination countries. M_{hij} is a dummy variable equal to one if member i of household h migrates to country j and all other members stay in the home country[3]. We define the utility of each member at her relevant location as a function of individual earnings abroad and sent remittances if she migrates, or pooled home country earnings and received remittances if she

[1]Moreover, this choice is consistent with the following empirical application and the structure of the matched sample that we use, which is exclusively made of migrant households (see section 4).

[2]Modelling household migration decisions while allowing for several migrants is left for further research. Note that more than 60% of origin households that were successfully tracked reported the surveyed migrant as being their only member abroad. For households with more than one migrant, however, the survey questionnaire does not record detailed information on other migrants from the same origin household. Yet, the following empirical results are robust, though less precise due to the small size of the resulting sample, to the exclusion of households with multiple international migrants.

[3]In the following empirical analysis, we restrict the pool of potential migrants to working-age household members.

stays in the origin household. Remittances sent by the migrant member enter the $(n-1)$ utility functions of non-migrant members positively. We additionally assume that the latter equally benefit from received amounts[4]. Conversely, we assume that remittances enter the migrant's own utility negatively, and that they are discounted by a positive and lower than one factor reflecting any indirect or deferred individual utility derived from remittances[5]. Therefore, depending on the migration status of member i, her individual utility U_i writes:

$$U_i(M_{hij}) = U_i\left[(1-M_{hij})\left(\frac{\sum_{m\neq k} Y_{ms} + R_{kj}}{(n-1)}\right) + M_{hij}(Y_{ij} - \delta_i R_{ij})\right] \quad \forall i,j \text{ and } k \neq i \quad (1)$$

where U_i is a concave and twice differentiable utility function. Y_{ms} stands for earnings of member m in home country s and Y_{ij} for earnings of member i in destination country j, R_{ij} refers to remittances sent by migrant member i from host country j and R_{kl} to remittances received from migrant member k in host country j. δ_i is an individual-specific discount factor with $0 < \delta_i < 1$.

The closer δ_i is to 0, the lower the negative effect of remittances in the migrant's direct utility. Intuitively, in the extreme case where δ_i is equal to 0, the implied loss for the migrant in her direct individual utility is totally compensated by the indirect utility derived from remittances to the home country: remittances do not affect the migrant's own welfare. In the polar case where it is equal to 1, remitted amounts basically translate into lower disposable income at destination for the migrant. Note that δ_i may encompass any motive for remittances from which the migrant derives positive but indirect or deferred utility. It might involve any exchange of services between the migrant and her origin household, the "warm glow" of taking care of those left behind through altruism or commitment to solidarity norms, or any form of deferred benefits and social prestige associated with migration and remittances upon return. The δ_i parameter will be crucial in the following analysis through its dual effect on transferred amounts and on the discounted loss in the migrant member's direct utility that it induces.

[4]This might be too strong an assumption if remittances are targeted to specific recipients within the household for private use. It is nevertheless relevant in our context where remittances are mostly designed to the whole household to cover collective expenditures. This assumption is moreover consistent with the findings by De Vreyer et al. (2009) on a representative sample of Senegalese households. They find that remittances used for daily consumption benefit all household members equally. The assumption of income pooling within the origin household is extended to non-migrant members earnings. However the predictions of the model remain unchanged if we assume that earnings are not pooled.

[5]We could also consider the case of money transfers from the origin household to the migrant. However this case is ignored since according to our data only 0,4% of migrants received money from their family in Senegal.

We then define the household's total utility U_h as an additively separable function of the weighted sum of each household member's individual utility plus a migrant-specific taste factor:

$$U_h(M_{hij}) = \sum_{i=1}^{n} \theta_i U_i(M_{hij}) + T_h(M_{hij}) \qquad \forall i, j \qquad (2)$$

where θ_i is the individual weight of member i in the household utility, with $\sum \theta_i = 1$. An alternative interpretation of these welfare weights is that they represent the bargaining power of each household member in the intra-household allocation process. The additional taste factor T_h aims at capturing the non-monetary determinants entering the total utility function. It includes in particular migration costs and any other non-monetary or psychic costs and benefits for household h of having member i in country j. Note that the taste component is also a weighted sum of migrants' and non migrants' costs and benefits[6].

We choose to represent the household migration decision in a unitary model that can be characterized by a consensus model a la Samuelson (1956). Each member has specific preferences but these preferences are interrelated by a consensus that takes into account the welfare of other household members. In other words, household members agree on a common objective and then act as if they were maximizing a well-behaved (Bergsonian) social welfare function. In our model, we consider that individual migration and remittances decisions are interrelated and decided on at the household level in order to maximize the above defined household utility[7].

Optimal amount of remittances

From the expression in equation (2), the utility for household h associated with having member i in country j and all other members in the home country s writes:

$$\begin{aligned} U_{hij} &= U_h(M_{hij} = 1) \\ &= \sum_{k \neq i} \theta_k U_k \left(\frac{\sum_{k \neq i} Y_{ks} + R_{ij}}{(n-1)} \right) + \theta_i U_i \left(Y_{ij} - \delta_i R_{ij} \right) + T_{hij} \qquad \forall i, j \qquad (3) \end{aligned}$$

[6]However, since our focus is on the relative role of earnings and remittances in the household decision, we leave the structural form of the taste component unspecified.

[7]Although such unitary models have been criticized first because the mechanism that leads to an agreement within the household remains unspecified and second because it somehow ignores household members' own rational preferences, as noted by Samuelson, it is particularly relevant in the case where household total resources are properly broken down into pre-specified shares so that the primary objective is to maximize the total (earnings) surplus. The only consensus decision to be made then relates to the allocation of the household surplus among members.

We consider that earnings and tastes at each location as well as parameters such as individual-specific bargaining powers and discount factors on remittances are exogenously given and known to all household members, or at least accurately expected conditional on the observed characteristics of members and locations[8]. On the other hand, in our model, the amount of remittances sent back to the origin household by each potential migrant is endogenously determined so as to maximize the household total utility. Hence, the optimal amount of remittances R_{ij}^* sent by migrant i living in country j should satisfy the following first order condition:

$$\frac{\partial U_{hij}}{\partial R_{ij}} = \sum_{k \neq i} \frac{\theta_k}{(n-1)} U_k^{'} \left(\frac{\sum_{k \neq i} Y_{ks} + R_{ij}^*}{(n-1)} \right) - \theta_i \delta_i U_i^{'} \left(Y_{ij} - \delta_i R_{ij}^* \right) = 0 \qquad \forall i, j \quad (4)$$

By differentiating the previous equality with respect to each parameter (see Appendix A), it can first be shown that the optimal amount of remittances R_{ij}^* is unsurprisingly an increasing function of migrant's earnings at destination Y_{ij} and a decreasing function of non-migrants' earnings in the home country Y_{ks}. Conditional on household members' total earnings, R_{ij}^* is also a decreasing function of the remittances discount factor δ_i. This last finding is quite intuitive: at the household level, when δ_i is lower than one and small enough, the marginal gain from each additional unit of remittances in non-migrants' utilities outbalances the concurrent marginal loss in the migrant's utility, therefore inducing an increase in the equilibrium amount of remittances. Overall, these predictions provide a first rationale for household-based migration choices to differ from pure individual self-selection based on earnings differentials. Indeed, conditional on members' individual earnings, intra-household variations in the δ_i parameter could well play an additional role in the household migration decision through induced individual variations in the propensity to remit larger amounts.

Note also that R_{ij}^* is a decreasing function of the bargaining power of migrant i, θ_i, and an increasing function of the bargaining powers of non-migrants, θ_k. However, the previous predictions are robust to different specifications of these individual bargaining powers. Their specific role in the migrant selection process is further discussed in the following sections.

Intra-household selection into migration

[8]We further assume that bargaining powers and discount factors are pre-determined at the time when mobility decisions are taken. They are thus assumed not to be endogenous to migration.

From the above determined optimal amount of the remittances sent by migrant member i, the corresponding value V_{hij} of the utility function for household h of sending member i in destination country j and having all other members stay in the home country s writes:

$$V_{hij} = U_{hij}(R^*_{ij}) = \sum_{k \neq i} \theta_k U_k \left(\frac{\sum_{k \neq i} Y_{ks} + R^*_{ij}}{n-1} \right) + \theta_i U_i \left(Y_{ij} - \delta_i R^*_{ij} \right) + T_{hij} \qquad \forall i, j \quad (5)$$

Since any of the n household member can migrate in one of the J destination countries, the household's problem then boils down to choosing among $n \times J$ alternatives the geographical allocation of its members that maximizes the value of its utility. Household h thus decides to locate member i in country j according to:

$$M_{hij} = \begin{cases} 1 & \text{if} \quad V_{hij} = \max(V_{h11}, ..., V_{h1J}, ..., V_{hn1}, ..., V_{hnJ}) \\ 0 & \text{otherwise} \end{cases} \quad (6)$$

From the expression in equation (5), through application of the envelope theorem (see Appendix B), we show that, conditional on welfare weights and migration costs and tastes, the value of the household utility at the remittances optimum is first an increasing function of the migrant's earnings at destination, Y_{ij}, and an increasing function of non-migrant members' earnings in the home country, Y_{ks}. This last prediction indirectly reflects the fact that the opportunity cost of sending a member with high earnings at home is larger. Therefore, what precisely matters in the household decision is the comparative advantage in earnings across locations among potential migrant members, that is to say the difference between $(Y_{kj} - Y_{ks})$ and $(Y_{ij} - Y_{is})$ for two different members k and i. Put differently, the household thus selects into migration the member with the highest earnings differential between host and home countries.

Second, the optimal value of the household utility is a decreasing function of the remittances discount parameter δ_i. This is again intuitive, since for small enough δ_i, the marginal loss from remittances in the migrant member's welfare in the destination country is offset at the household level by the induced marginal gains in the non-migrant members' welfare in the home country. Together with the related and above stated effect of δ_i on remitted amounts, this result merely puts forward the fact that, conditional on earnings differentials, welfare weights and tastes, household members with a higher propensity to remit have a higher probability of being

selected into migration. Note that the double effect of δ_i on remittances and the propensity to migrate basically results from the induced discounted marginal loss from transferred amounts in the migrant's utility. As a consequence, the interaction between δ_i and individual remitted amounts has a key role in the selection process, as implicitly shown in equation (5). This last point is crucial to identification of the role of remittances potentials in the following empirical analysis and is further discussed in the next subsection.

Third, the optimal value of the household utility is found to be an increasing function of both migrant and non-migrants' bargaining powers $\{\theta_i, \theta_k\}$. Hence, the higher the relative weight of member i's utility in the household utility, the higher her probability of being selected into migration. For the sake of simplicity, we assume in the followings that bargaining powers are equal. Indeed, as bargaining powers only affect the allocation of welfare within the household, allowing them to differ across household members does not challenge the main predictions of our theoretical model[9].

2.2 An extended Roy model of intra-household selection

In the rest of the paper, we test the relevance of our theoretical model to account for observed patterns of intra-household selection into migration and investigate the responsiveness of household members' location choices to both individual earnings differentials and remittances potentials.

First, we take a linear approximation of the above defined household utility function to allow tractable estimation of the structural parameters driving location choices. Second, we assume that household members have accurate expectations about individual earnings, remittances and tastes, based on observable characteristics of each member and location[10]. Third, we consider that welfare weights are equal across household members. The value V_{hij} of the household

[9]Still, this last remark intuitively suggests that the respective role of individual earnings differentials and remittances potentials in the migration decision might vary according to differences in individual welfare weights within the household. In the following empirical analysis, we nevertheless did not find evidence of such an heterogeneity with respect to different proxy measures of bargaining powers within the household, lending further support to the equality assumption in our setting. A detailed discussion is provided in Section 6.3.

[10]This might be too strong an assumption since migrant earnings and remittances are only observed ex-post by the household. Moreover, information asymmetries may exist between the migrant and the origin household, due in particular to geographical distance. However, this assumption simplifies the analysis and, as noted by Dahl (2002), adding uncertainty to the Roy setting so that migration is based on expected utility maximization does not affect the main insights of the model.

random utility of locating member i in country j can then be written:

$$\tilde{V}_{hij} = \underbrace{\alpha(\sum y_{ks} + y_{ij})}_{\substack{\text{Earnings} \\ \text{component}}} + \underbrace{\beta(1-\delta_i)r_{ij}}_{\substack{\text{Remittances} \\ \text{component}}} + \underbrace{\gamma_j t_{ij}}_{\substack{\text{Taste} \\ \text{component}}} + \epsilon_{hij} \qquad \forall i, j \qquad (7)$$

with:

$$y_{ks} = E(Y_{ks}|x_k); \quad y_{ij} = E(Y_{ij}|x_i); \quad r_{ij} = E(R_{ij}|x_i); \quad t_{ij} = E(T_{hij}|z_{ij})$$

where x_k is a set of characteristics of non-migrant member k affecting home earnings, x_i is a set of characteristics of migrant i affecting destination earnings and remittances, z_{ij} is a vector of migrant i and destination j characteristics affecting tastes and ϵ_{hij} is an error term.

Following our theoretical framework, the remittances discount factor δ_i can be approximated by a subset x_{1i} of individual characteristics x_i that affect remittances amounts conditional on the household earnings surplus. As such, note that the whole remittances component $(1-\delta_i)r_{ij}$ could be regarded as a simple reduced-form function $f(x_{1i})$ of those characteristics. Yet, to the extent that such characteristics also influence tastes t_{ij}, they would then stand for a mixed component of remittances and tastes. Therefore, further assessing their effect in interaction with expected remittances amounts, as it appears in the structural form of the utility, will allow to disentangle and identify the role of remittances and tastes in the selection process, once earnings are properly taken into account[11]. Finally, note that allowing welfare weights to differ across household members would simply introduce additional heterogeneity in the structural parameters α and β with respect to relevant measures of individual bargaining powers. This potential heterogeneity is tested and ruled out in the empirical application that follows.

The utility function consists of two parts: a deterministic mean component, which is a function of individual and location (observed) characteristics and a stochastic (unobserved) component which stands for household members' deviations from mean earnings, remittances and tastes[12]. The set of parameters $\{\alpha, \beta, \gamma_j\}$, which represents the relative weights of each factor in the above utility, is assumed to be identical across households. Moreover, while the

[11] Intuitively, if the x_{1i} proxies for δ_i were only capturing a taste effect, they should play no role through remittances differentials. Hence, identifying the latter effect comes down to empirically investigating the heterogeneous effect of remittances with respect to those proxies.

[12] The stochastic component is a complex sum of household members' individual-specific error terms. This point, as well as the choice of a functional form for expected earnings, remittances and tastes are further developed in Section 3.1.

γ_j parameters are location-specific to account for destination-specific costs or benefits of migration, the set of parameters $\{\alpha, \beta\}$ is further assumed to be homogenous across locations. Put differently, any increase in labor market earnings or remittances provides identical utility gains or losses, whatever the country of residence[13].

Considering that the household selects among $n \times J$ alternatives the geographical allocation of its members that maximizes the value of its random utility, the intra-household selection equations in (6) can alternatively be written as:

$$M_{hij} = \begin{cases} 1 & \text{if} \quad \tilde{V}_{hij} > \tilde{V}_{hkl} \qquad \forall (k,l) \neq (i,j) \\ 0 & \text{otherwise} \end{cases} \tag{8}$$

where M_{hij} is a dummy variable which is equal to one if member i from household h lives in destination country j and all remaining members k stay in the home country. The selection rule is such that non-migrant members' home earnings, migrant's earnings and remittances are only observed for the allocation choice that maximizes the household utility[14]. Equations (7) and (8) therefore define an extended Roy model of location choices, such as in Dahl (2002), the difference with Dahl (2002) being that in our model location choices result from a household utility-maximizing strategy.

2.3 Estimation issues

Since this paper aims at investigating which component of the household utility mostly drives location choices, we are particularly interested in estimating the set of structural parameters $\{\alpha, \beta, \gamma_j\}$ from equation (7), which is equivalent to estimating a within-household discrete choice model of members' location depending on earnings and remittances. Such an estimation raises two main challenges.

[13] As noted by De Vreyer et al. (2010), this might be too strong an assumption if large differences exist between countries in the set of available goods and their prices (for instance public services), so that the living standards of individuals with equal incomes but residing in different country would be indirectly impacted. However, we can plausibly assume that households are not in a position to take this dimension into account in their utility. Moreover, earnings will be converted into Purchasing Power Parity (PPP) units in the following empirical application, to allow relevant inter-country comparisons.

[14] Formally, each household h faces a $n \times J$ number of alternatives, so that $n \times J$ binary variables M_{hkl} can actually be defined, corresponding to $n \times J$ selection equations. M_{hij} equals one if alternative $\{ij\}$ is chosen and observed; consequently all the remaining M_{hkl} equal 0 since, by construction, only one allocation can be chosen. In other words, exactly one of the binary variables $M_{h11}, ..., M_{h1J}, ..., M_{hn1}, ..., M_{hnJ}$ is non-zero for each household.

A first identification issue stems from the fact that earnings and remittances are only observed at one location for each household member. To identify the determinants of the household location choices, we therefore need to compute counterfactual earnings and remittances for each household member at each location[15]. However, a selection bias may result from the fact that households choosing a specific utility-maximizing geographical allocation are not a random subsample of the population. In other words, selected migrants and non-migrants are likely to have specific observed and unobserved characteristics that simultaneously drive migration, earnings and remittances. "Naive" imputations based on earnings and remittances equations uncorrected for endogenous selection would then yield biased results. As a consequence, earnings and remittances for other locations must be imputed, taking into account the fact that location choices are not random but partially driven by observed and unobserved characteristics explaining earnings and remittances gaps. To solve this identification issue, we apply a three-step parametric estimation procedure derived from the semi-parametric method developed by Dahl (2002) and compute counterfactuals that correct for selection biases.

A second estimation issue lies in the fact that households are not necessarily of equal size[16]. As a consequence, the number of potential migrant members varies across households. Each household is actually faced with a varying number of alternatives, each corresponding to the location of one specific member in one specific destination country. We thus need to estimate a within-household multiple choice model which takes into account variations in the size of the choice set across households. A few implementations of such non-standard multiple choice models can be found in the marketing literature, to estimate market shares of products' brands that are not available to every consumer from different regions (see Allenby and Rossi (1998) or Berry et al. (2004)), or in the political science literature, to analyze electoral choices within partially contested multiparty elections in which some parties do not run candidates in every district (see Yamamoto (2012)). We build on these papers to develop an estimation procedure based on a (within-household) conditional logit model of location choices with a varying number of alternatives, which is extensively described in the following section.

[15]We need to compute counterfactual earnings of migrants in the home country, *had they not migrated*, and counterfactuals earnings and remittances of both migrants and non-migrants in each possible destination country, *had they migrated* (for non-migrants) or, for migrants, had they migrated in another destination country than the one in which they were surveyed.

[16]However, the number of possible destinations for potential migrants is considered fixed.

3 Estimation strategy

We present in this section our three-step parametric estimation procedure of an extended Roy-Dahl model of intra-household selection into migration. We first estimate a reduced-form conditional logit model of intra-household location choices with a varying number of alternatives. Second, results from the first-stage estimation are used to estimate individual earnings and remittances equations corrected for endogenous selection. Third, based on the second step results, we compute counterfactual earnings and remittances predictions to recover the unbiased earnings and remittances structural parameters by estimating a structural-form conditional logit model of location choices.

Expected earnings, remittances and tastes

First, we specify a standard Mincer-type earnings equation for non-migrant household members k living in the home country s as:

$$Y_{ks} = x_k^{'}\rho_s + \mu_{ks} \tag{9}$$

where x_k is a set of individual characteristics of non-migrant member k affecting (home) earnings and μ_{ks} is an individual-specific error term. The vector of parameters ρ_s identifies home country-specific returns to individual characteristics with respect to earnings.

Second, we specify a standard Mincer-type earnings equation for migrant i in destination country j as:

$$Y_{ij} = x_i^{'}\rho_j + \eta_{ij} \qquad \forall j \tag{10}$$

where x_i is a set of characteristics of migrant i affecting (destination) earnings and η_{ij} is an individual-specific error term. The vector of parameters ρ_j identifies destination country-specific returns to individual characteristics with respect to earnings.

Third, we similarly define a remittances equation for migrant i living in destination country j:

$$R_{ij} = x_i^{'}\pi_j + \nu_{ij} \qquad \forall j \tag{11}$$

where x_i is a set of characteristics of migrant i affecting the amount of remittances sent back to the origin household and ν_{ij} an individual-specific error component. The vector of parameters π_j identifies destination-specific returns to individual characteristics with respect to remittances. We are particularly interested in investigating individual determinants of remittances amounts. To this end, we add the migrant's and non-migrants' earnings to the vector x_i in the remittances equation in order to identify a subset x_{1i} of individual characteristics that (positively) affect remittances once earnings are accounted for. This latter subset allows us to identify relevant proxies for (low) values of the δ_i parameter, capturing individual variations in the propensity to remit conditional on the household earnings surplus.

Finally, we specify tastes T_{hij} as a flexible function of migrant i and destination j characteristics that we denote z_{ij}. Many destination-specific variables may enter this taste component, some of them being potentially unobserved. We sidestep the estimation of the taste component by introducing country-specific dummies that account for differences in the costs or benefits of migration across destinations, including for instance moving costs, global standards of living or differences in public services, institutions and culture. We nevertheless assume that these costs and benefits may vary across individuals within a particular destination. The vector z_{ij} thus includes a destination dummy λ_j and a set of interactions with individual characteristics x_i . In the followings, the taste component is thus denoted $x_i'\phi_j$.

Intra-household selection equation

We now substitute the above expressions of Y_{ks}, Y_{ij} and R_{ij}, together with the flexible specification of tastes T_{hij}, in equation (7) to get the reduced form of the household random utility:

$$\tilde{V}_{hij} = \alpha(\sum_{k \neq i} x_k^{'}\rho_s + x_i^{'}\rho_j) + \beta(1-\delta_i)(x_i^{'}\pi_j) + x_i'\phi_j + \epsilon_{hij} \qquad \forall i,j \qquad (12)$$

where $\epsilon_{hij} = \alpha(\sum_{k \neq i} \mu_{ks} + \eta_{ij}) + \beta(1-\delta_i)\nu_{ij} + \xi_{ij}$ and ξ_{ij} stands for individual deviations from mean tastes. The stochastic component of the utility is then a (weighted) sum of individual deviations from mean earnings y_{ks} and y_{ij}, remittances r_{ij} and tastes t_{hij}, which are specified as deterministic functions of individual observable characteristics.

Equation (12), together with the selection rule in equation (8), define an additive random

utility model. Under the statistical assumption that error components ϵ_{hij} are i.i.d and have a type-1 Extreme Value distribution, the probability P_{hij} that household h locates member i in country j:

$$P_{hij} = P(M_{hij} = 1) = P(\tilde{V}_{hij} > \tilde{V}_{hkl}) \qquad \forall (k,l) \neq (i,j) \tag{13}$$

can be written:

$$P_{hij} = \frac{exp[\alpha x_i^{'}(\rho_j - \rho_s) + \beta(1-\delta_i)(x_i^{'}\pi_j) + x_i^{'}\phi_j]}{\sum_{k=1}^{n}\sum_{l=1}^{J} exp[\alpha x_k^{'}(\rho_l - \rho_s) + \beta(1-\delta_k)(x_k^{'}\pi_l) + x_k^{'}\phi_l]} \tag{14}$$

P_{hij} is the usual conditional probability derived from a standard conditional logit model with a $n \times J$ number of alternatives corresponding to each possible intra-household choice of member allocation[17]. A first characteristic of the model is that the set of reduced-form parameters is destination-specific but alternative-invariant across choices of the member to be located at a given destination. Identification then relies on intra-household variations in individual characteristics of household members. An additional specific feature is that the reduced-form probability for a member to be selected into migration depends on both his own individual characteristics and the characteristics of all other potential migrant members within the household.

As previously noted, an important issue is that households are not of equal size. As a consequence, the number of potential migrant members n varies across households so that each household h actually faces $n_h \times J$ alternatives. If we further assume that the set of parameters to be estimated is identical across households, we can however easily write both conditional probabilities and the contribution to the log-likelihood function of a given household-level observation conditional on the specific number of alternatives available to that household, as follows:

$$\mathcal{L}_h = \ln(L_h) = \sum_{i=1}^{n_h}\sum_{j=1}^{J} M_{hij} \ln P_{hij} \tag{15}$$

[17]Note that $\tilde{V}_{hij} > \tilde{V}_{hkl}$ writes: $\alpha(\sum_{k\neq i} x_k^{'}\rho_s) + ... + \epsilon_{hij} > \alpha(\sum_{m\neq k} x_m^{'}\rho_s) + ... + \epsilon_{hkl}$ where sums on both sides of the inequality reduce: $-\alpha(x_i^{'}\rho_s) + ... + \epsilon_{hij} > -\alpha(x_k^{'}\rho_s) + ... + \epsilon_{hkl}$ and yields the simplified expression in equation (14). Note that components $\sum_{k\neq i}\mu_{ks}$ and $\sum_{m\neq k}\mu_{ms}$ also reduce in the household error term so that ϵ_{hij} (resp. ϵ_{hkl}) appears to be a function of individual i (resp. individual k) error terms only. This allows us to plausibly state the i.i.d assumption in equation (12).

where n_h is the number of potential migrant members in household h, J is the fixed number of possible destination countries for migrant member i, M_{hij} is the dummy equal to one if household h has a member i in country j and P_{hij} the associated conditional probability from equation (14) but which denominator now depends on a household-specific $n_h \times J$ number of allocation choices.

The log-likelihood function for a sample of N households then writes as usual:

$$\mathcal{L}_N = \sum_{h=1}^{N} \mathcal{L}_h = \sum_{h=1}^{N} \sum_{i=1}^{n_h} \sum_{j=1}^{J} M_{hij} \ln P_{hij} \tag{16}$$

Equation (16) generalizes the sample log-likelihood function from a standard conditional logit model, in which choice sets are allowed to vary across observations. Standard maximization routines can then be applied to get consistent estimates of the set of reduced-form parameters.

Counterfactual earnings and remittances predictions

Considering that individual unobserved heterogeneity drives the intra-household probability of being selected into migration as well as individual earnings and remittances, observed samples of individuals at a given location are obviously not random. Earnings and remittances equations thus need to be corrected for endogenous selection so that we can generate consistent counterfactual predictions.

We apply the selectivity-correction method implemented by Dahl (2002)[18]. Following Dahl, we use the results of the above defined multiple choice model to compute, for each household member, a set of predicted location choice probabilities. A flexible function of these probabilities, denoted $\lambda(p_{hij})$, is then included as an additional set of regressors in equations (9), (10) and (11) to correct for selectivity biases. In theory, all choice probabilities could enter the $\lambda(p_{hij})$ control function. In practice, to avoid potential multicollinearity issues, Dahl (2002) suggests to use a high order polynomial of the first-best choice probability, i.e. the probability of the observed allocation, and a subset of other relevant probabilities. Our implementation choices are discussed in Section 5.

[18]For an exhaustive comparison of existing methods for selection bias correction based on a multinomial model, see Bourguignon et al. (2007). Resorting to Monte Carlo's simulations, they find that Dahl's approach is to be preferred to other commonly used methods such as Lee (1983) or Dubin and McFadden (1984).

Potential drawbacks of the conditional logit model may be pointed out, and in particular the Independence of Irrelevant Alternatives (IIA) property. For this reason, a nonparametric estimation of choice probabilities may be preferred. However, it would require a large number of observations[19]. Moreover, Bourguignon et al. (2007) show that, even when the IIA property is seriously questioned, selection bias corrections based on multinomial models can be considered as a reasonable alternative when the focus is to consistently estimate a given outcome over selected populations. Therefore, our results should not be affected by the choice of the conditional logit model at this stage [20].

Structural model of intra-household location choices

In order to finally recover consistent estimates of the set of structural parameters $\{\alpha, \beta\}$ in the within-household model of location choices, a last step is needed. Using the unbiased estimates $\hat{\rho}_s$, $\hat{\rho}_j$ and $\hat{\pi}_j$ from the selectivity-corrected earnings and remittances equations, we compute consistent earnings and remittances counterfactuals for each individual at each possible location, and then estimate the following structural conditional logit model with $n_h \times J$ alternatives:

$$\begin{aligned} P_{hij} &= \frac{exp[\alpha x_i^{'}(\hat{\rho}_j - \hat{\rho}_s) + \beta(1-\delta_i)(x_i^{'}\hat{\pi}_j) + x_i'\phi_j]}{\sum_{k=1}^{n_h}\sum_{l=1}^{J} exp[\alpha(x_k^{'}\hat{\rho}_l) - x_k^{'}\hat{\rho}_s) + \beta(1-\delta_i)(x_k^{'}\hat{\pi}_l) + x_k'\phi_l]} \\ &= \frac{exp[\alpha(\hat{y}_{ij} - \hat{y}_{is}) + \beta(1-\delta_i)\hat{r}_{ij} + x_i'\phi_j]}{\sum_{k=1}^{n_h}\sum_{l=1}^{J} exp[\alpha(\hat{y}_{kl} - \hat{y}_{ks}) + \beta(1-\delta_k)\hat{r}_{kl} + x_k'\phi_l]} \end{aligned} \tag{17}$$

Consistent with our theoretical model, the probability of being located abroad first depends on intra-household variations in expected earnings differentials $(\hat{y}_{ij} - \hat{y}_{is})$ between home and

[19]The nonparametric method suggested by Dahl (2002) consists in dividing the population into mutually exclusive cells according to observable characteristics such as gender, age or education. Migration probabilities are then estimated as the fraction of individuals in the same cell observed in a given country. The same approach is pursued in Bertoli et al. (2013). In this paper, we rely on the parametric method implemented by De Vreyer et al. (2010).

[20]Note that the violation of the IIA assumption could question the use of a conditional logit model at the next stage, so that estimation methods that relax this assumption might be preferred. For instance, Bertoli et al. (2013) resort to the estimation of a nested logit that allows for the correlation of individual unobserved heterogeneity in the propensity to migrate across possible destination countries. In our setting, we could consider an alternative correlation of unobserved heterogeneity in the propensity to choose a given destination across members of the same household. However, alternative estimation procedures are hardly feasible because of the additional challenge of dealing with a varying number of alternatives and the limited size of the sample in the following empirical application.

relevant destination countries. Second, selection into migration depends on intra-household variations in remittances potentials. As above stated, this additional selection channel can be captured through individual variations in relevant proxies x_{1i} for the δ_i parameter. However, proxy characteristics for δ_i and individual controls x_i that enter the taste component may overlap so that reduced-form parameters may not allow us to separately identify both channels. The introduction of interactions between remittances amounts and proxies for δ_i allows us to disentangle their potential joint effect through remittances and tastes. Note that exclusion restrictions are needed, in particular in steps two and three. Specification and identification issues are discussed in details in Section 5.

In the rest of the paper, we provide an empirical application using a matched sample of Senegalese migrants in three different destination countries - France, Italy and Mauritania - and their origin household in Senegal. The next section presents the data.

4 Data

4.1 The MIDDAS data

This article uses data from the surveys conducted between 2009 and 2010 within the framework of the MIDDAS project[21]. . Using Senegal as a case-study, this research project aims at documenting the links between migration, remittances and development. Most of the existing studies on migration issues are based on data that are generally truncated: they are indeed collected either among migrants in host countries, thus providing only indirect and partial information on origin households, or among households in home countries, giving in this case very few and imprecise insights on the characteristics of migrants, especially on their earnings abroad and the remittances they send. The main objective of the MIDDAS project was to build an original data set matching representative samples of Senegalese migrants in host countries with their origin household in Senegal, in order to collect accurate information on both "sides" of migration.

[21] MIDDAS is a three-year project standing for "Migration and development in Senegal: an empirical analysis using matched data on Senegalese migrants and their origin households (MIDDAS)" funded by the French Agence Nationale de la Recherche and the Agence Française de Développement. Surveys were designed and carried out by a research team from the IRD-DIAL (France and Senegal). Fieldwork in Italy was conducted by the Forum Internazionale ed Europeo di Ricerche sull' Imigrazione (FIERI). For further details on the institutional setting and the global objectives of the MIDDAS project, see `http://www.dial.prd.fr/dial_enquetes/dial_enquetes_middas.htm`.

An important contribution of this project is thus the collection of matched and multi-sited data, on which the subsequent analysis is based.

The data collection was carried out in two successive stages. First, surveys were conducted among representative samples of Senegalese migrants in the top four destination countries of Senegalese migrants, namely France, Italy, Mauritania and Côte d'Ivoire[22]. Second, migrants' origin households were tracked and interviewed in Senegal, thanks to the contacts provided by the migrants. The migrant questionnaire records in particular precise information on the migrant's socio-demographic characteristics, individual earnings and remittances. The same information was recorded for each resident member of migrants' origin household in the tracking survey[23].

All origin households were tracked, except those of migrants residing in Côte d'Ivoire. We thus focus the following analysis on the French, Italian and Mauritanian samples which are composed of 326 migrant-origin household pairs. Table 7 in Appendix presents tracking and matching statistics by country. Sample representativeness is analyzed in Appendix D.

4.2 Descriptive statistics

Characteristics of origin households in Senegal depending on the location of the migrant are shown in Table 11 in Appendix. Note that the average household size is very large (around 12), and the proportion of working age adults is around 60%. In most households, the pool of potential migrants is therefore large, which further justifies our choice to investigate intra-household selection. Finally, although origin households have on average two international migrants, 64% of them reported having only one member living abroad.

Migrants' and non migrants' individual characteristics by location are shown in Table 1. The non-migrant samples are made of all the non-migrant members of migrants' origin households. Migrants are predominantly male, and on average a few years younger than non migrants. Migrants in France and Italy are much more educated on average than non-migrant members of their origin household, whereas the educational characteristics of migrants in Mauritania are

[22] According to the 2012 United Nations Database on international migrants' stocks. Moreover, according the last 2002 Senegalese census, migration flows to these four countries accounted for 65% of total emigration flows from Senegal between 1997 and 2002. These figures exclude the Gambia, due to its peculiar landlocked position within the Senegalese territory.

[23] Remittances were thus recorded twice. Importantly enough, we did not find any systematic differences between sent amounts reported by migrants and received amounts reported by the non-migrant members of their origin household (Seror, 2012).

Table 1: Individual characteristics by migrant's location

	France/Italy			Mauritania		
	Non-migrants	Migrants	t/χ^2	Non-migrants	Migrants	t/χ^2
Age	43.8	37.6	-6.2***	38.6	36.5	-2.1*
Gender (%)						
...Male	41.2	79.2	70.1***	41.9	65.7	31.6***
...Female	39.8	20.8		58.1	34.3	
Schooling level (%)						
...No schooling	40.7	14.9	64.5***	54.3	38.6	27.2***
...Primary	21.6	16.9		29.1	28.7	
...Middle School	17.5	18.4		8.5	19.8	
...High School and more	20.2	49.8		8.1	12.9	
Koranic schooling (%)						
...Only	10.1	13.6	3.5**	23.1	30.2	7.1**
...Some	52.4	63.1	10.7***	51.8	64.3	12.5***
Link to household head (%)						
...Son/daughter	24.7	62.9	134.8***	29.8	58.4	165.2***
...Brother/sister	6.3	13.6		4.2	22.7	
...Head/spouse	35.2	3.9		32.4	5.8	
...Other	33.8	19.6		33.6	13.1	
Eldest (%)						
...Son/daughter	35.8	64.2	28.4***	41.3	59.7	18.4***
...Brother/sister	27.2	72.8	45.6***	25.4	74.6	49.2***
Migration funding (%)						
...Family	/	60.5		/	52.1	
...Own savings only	/	18.9		/	23.6	
...Other channel only	/	20.6		/	24.3	
Migration duration	/	12.1		/	6.2	
Observations	568	146		716	164	

Notes: Sample restricted to individuals aged 18-59 at the time of migrant's departure. Samples of non-migrants are composed of non-migrant members from migrant households. χ^2 test for the equality of distributions for categorical variables, t-test for the equality of means for continuous variables between non-migrant and migrant samples.
Source: MIDDAS Survey, 2009 - 2010. Authors' calculation.

more similar to those of the members of their origin household. Migrants at both destination are more likely to have koranic education. Most migrants are either a child or sibling of the origin household head, the eldest one in a vast majority of cases. Finally, note that our survey mostly captures permanent migration since the average duration of stay ranges from 6 years in Mauritania to 12 years in Europe. Part or totality of the costs associated to migration were covered through family funding for respectively 60.5% and 52.1% of the migrants in Europe and Mauritania.

Table 2 shows descriptive statistics on earnings and remittances. PPP-adjusted earnings of working migrants are unsurprisingly much lower in Mauritania than in France and Italy, and higher in all three destination countries than PPP earnings of non-migrants. 77% of migrants

Table 2: Individual earnings and remittances by migrant's location

	France/Italy			Mauritania		
	Non-migrants	Migrants	t/χ^2	Non-migrants	Migrants	t/χ^2
Earnings						
Labour status (%)						
...Unemployed/Non-working	46.9	20.1	25.1***	44.8	15.7	49.4***
...Working	53.1	79.9		55.2	84.3	
Monthly earnings	92,690.6	1,255.7	/	59,048.7	78,326.4	/
Monthly earnings (PPP)	301.8	1,420.5	1,118.7***	192.3	407.8	215.5***
Remittances						
Propensity (%)						
...to any household	/	87.1		/	79.1	
...to origin household	/	84.4		/	76.7	
Frequency (%)						
...Monthly	/	63.8		/	59.7	
...Bimonthly/Quarterly	/	10.3		/	12.7	
...Less frequently	/	25.9		/	28.6	
Use (%)						
...Daily consumption	/	83.6		/	88.1	
...Education/Health	/	10.6		/	5.6	
...Other	/	5.8		/	6.3	
Targeted expenditures (%)						
...Collective	/	79.5		/	84.1	
...Private	/	11.1		/	11.8	
...Both	/	9.4		/	4.1	
Monthly remittances (XOF)	/	141,701.6		/	39,689.5	
Observations	568	146		716	164	

Notes: Sample restricted to individuals aged 18-59 at the time of migrant's departure. Sample of non-migrants are composed of non-migrant members from migrant households. χ^2 test for the equality of distributions for categorical variables, t-test for the equality of means for continuous variables between non-migrant and migrant samples. Earnings are expressed in euros for France and Italy, in XOF for Senegal (656 XOF = 1 euro) and in MRO for Mauritania (388 MRO = 1 euro). PPP refers to USD Purchasing Power Parity amounts, using the consumption conversion factor published by the World Bank (2009).
Source: MIDDAS Survey, 2009 - 2010. Authors' calculation.

in Mauritania and 84% in Europe send remittances to their origin household in Senegal, most of the time on a regular monthly basis. While remittances from Mauritania are significantly lower than remittances from France and Italy, they amount on average to a larger share of migrants' income (around 30% in Mauritania and 15% in France and Italy). Remittances amounts are quite substantial compared to average earnings in Senegal. They represent on average 24% of the monthly earnings of the origin household. More than 80% of remittances are targeted to the household as a whole in order and spent on daily consumption.

Overall, these statistics highlight the strength of the link between migrants and their origin household and lend further credence to our model of migration as a household welfare-

maximizing strategy.

5 Econometric specification

In this section we turn to the three-step estimation of our model, following the procedure described in section 3. We now discuss in more details the empirical specifications and sources of identification at each stage.

5.1 Intra-household selection equation

The reduced-form estimation of the intra-household conditional logit model of location choices (equation (14)) is conducted on the whole sample of migrants and non-migrant members from their origin households. The migrant sample is restricted to working-age individuals, i.e aged 18-59, at the time of the surveyed migrant's departure[24]. All members of origin households aged between 18 and 59 years at the time of the surveyed migrant's departure are considered as potential migrants[25]. Two possible destinations are considered: Europe (pooling France and Italy) and Mauritania. The household is faced with several location choice alternatives, depending on the number of potential migrants in the household, each corresponding to sending one member abroad, either in Europe or in Mauritania, and having all other members stay in Senegal.

The dependent variable is a dummy equal to one for the chosen (observed) allocation of household members. The vector x_i of independent variables includes gender, age and a set of dummy variables indicating three different levels of formal education: elementary, middle and high school and above. These variables are expected to affect earnings potentials at each location according to the standard Mincer framework. In line with our model, and in order to test the role of both earnings and remittances differentials on intra-household selection into migration, we add to the initial set of explanatory variables three additional dummy variables for koranic schooling, being the eldest child and being the eldest sibling of the household head[26].

[24] To focus the analysis on labor migration and selection within the origin household with respect to earnings and remittances outcomes, we also drop from the sample individuals born in the host country, those who migrated to study abroad and non-working women who migrated for family reasons (adding up to 3.2% of the sample).

[25] This definition does not account for potential changes in the household structure since the observed migration episode. Unfortunately, our data do not allow us to reconstruct the exact composition of the origin household at the time of migration. The household set of relevant alternatives is thus made of all working-age members at the time of the surveyed migrant's departure who are still members of the household at the time of the survey.

[26] Among surveyed household members.

We indeed expect those variables to have no or limited impact on earnings but to be relevant determinants of remittances behavior. First, koranic schooling is expected to capture a higher commitment to the prevailing solidarity norms conveyed by the islamic religion[27]. Second, the two eldest dummies account for the fact that first-born children in the Senegalese society traditionally bear a greater responsibility for providing for their household[28].

Note that all independent variables are measured at the individual level and are thus alternative-specific. Therefore, identification relies on within-household variations in members' individual characteristics. Yet, we allow the parameters on these variables to vary across destinations by interacting them with destination-specific dummy variables. The reduced-form parameters that are estimated at this stage capture the overall effect of individual characteristics on intra-household selection through earnings differentials, remittances potentials and tastes. The next two steps aim at disentangling the relative role of these channels in the household allocation decision.

The first-step estimation results are indeed used to compute location choice probabilities p_{hij} that are added to the second-step earnings and remittances equations in order to correct for endogenous selection in a given location. Robust identification at this second stage consequently relies on the inclusion in the first-step regression of at least one variable that explains location choices but does not affect earnings nor remittances. Following Munshi (2003) and Pugatch and Yang (2010), we exploit rainfall as an exogenous source of variation in emigration from Senegal[29]. Due to differential costs of migration to alternative destination countries, rainfall are expected to additionally affect the choice of a specific location. In the Senegalese context under study, migration to European countries is indeed much more costly than migration to Mauritania, which is a neighbouring country that imposes very few restrictions on the circulation

[27]Using the same dataset,Chort et al. (2012) analyze the influence of solidarity norms conveyed by migrant networks on the remittances behavior of Senegalese migrants. They point out the significant impact of koranic schooling on both the probability to remit and remitted amounts.

[28]Note that the eldest dummies may capture the simultaneous effect of being the eldest, and being a child or sibling of the household head. However, almost 80% of migrants are a child or sibling of the head. Identification thus mostly relies on the variability in birth order among surveyed siblings. On the issue of intergenerational relationships and the role of age and primogeniture in the Senegalese society, see Antoine (2007).

[29]Indeed, as shown by the above mentioned study in the Mexican context, precipitations in origin regions are expected to affect emigration flows through different channels, their net effect being context-dependent: on the one hand, lower-than-average precipitations may damage local economic conditions and generate or increase incentives to emigrate; on the other hand, the induced negative shock on household income may also negatively impact propensities to emigrate if migration is costly and households are credit-constrained. Note that rainfall can affect migration from both rural and urban areas through direct and indirect channels. Indirect channels include for instance increases in food prices due to lower returns in the agricultural sector.

of Senegalese.

Rainfall data come from gridded datasets of monthly precipitations matched with our household-level survey data in Senegal thanks to recorded GPS coordinates[30]. We compute local precipitation deviations from long-term averages to obtain normalized yearly precipitation variables or z-scores defined as observed precipitations minus the long term average (1970-2009), divided by the long-term standard deviation. The average z-score over the 5 years preceding the surveyed migrant's year of departure is then added to the set of explanatory variables in the first-step selection equation[31]. Identification is first achieved through both local and yearly variations in precipitations. Besides, since rainfall variations simultaneously affect all members of the same household, z-scores are interacted with individual characteristics to further identify differential effects on the intra-household probability to migrate. We can reasonably argue that precipitations in the home country have no impact on earnings at destination. Moreover, since estimation relies on past levels of precipitations at the time of realized migration, we additionally argue that rainfall variables do not affect current earnings in Senegal nor current remittances from abroad[32].

5.2 Earnings and remittances equations

In a second step, we estimate earnings and remittances equations on the samples of migrants and non-migrant members of their origin households, using Mincer-type specifications (9), (10) and (11). We run separate OLS regressions for each of the three locations (Europe, Mauritania and Senegal). Dependent variables are, respectively, the log of monthly earnings in Senegal and the log of monthly earnings and remittances in destination countries[33]. Remittances amounts are expressed in CFA francs (FCFA). For comparison purposes, earnings amounts in all countries are expressed in U.S. Purchasing Power Parity (PPP) dollars[34]. This conversion is also needed in the third-step estimation where predicted earnings differentials between locations are allowed

[30] We use data published by the Climate Research Unit of the University of East Anglia: `http://www.cru.uea.ac.uk/fr`. Worldwide and historical rainfall records (1901-2009) are provided at a 5 degree latitute/longitude resolution.

[31] We therefore additionally assume that the timing of migration is exogenous in our setting.

[32] This last assumption is nonetheless debatable in the case of very recent migration episodes. Our results are however robust to the exclusion of recent migrants (less than 3 years) from the sample.

[33] Monthly earnings in Europe include labor income and social benefits.

[34] We use the conversion factors published by the World Bank in its World Development Indicators. PPP factors for private consumption in 2009 (country currency units buying the same amount of consumption goods as 1 USD in the U.S.) were 0.85 for Italy, 0.92 for France, 143.03 for Mauritania and 307.12 for Senegal (http://data.worldbank.org/indicator/PA.NUS.PRVT.PP).

to affect intra-household location choices. To expand the range of predicted earnings and remittances, we keep in the sample individuals who reported zero amounts[35].

The basic specifications include the following independent variables x_i/x_k: gender, age and age squared, education level, koranic schooling and eldest dummies. Migrants' earnings at destination and non-migrants' earnings in Senegal are additionally included in remittances equations in order to identify proxies for low values of the δ_i parameter, that is to say, characteristics that affect remittances amounts conditional on earnings. .

In order to correct for selection in a given location, we add to the set of explanatory variables a function $\lambda(p_{hij})$ of choice probabilities obtained from the first-step estimation. In practice, we choose to take a second order polynomial of the predicted first-best choice probability[36]. Since the "true" selection probabilities are unknown, standard errors are bootstrapped to account for the extra sampling variability caused by using estimates.

5.3 Structural model of intra-household location choices

Unbiased parameter estimates from the second step are used in the third step to identify the effect of expected earnings and remittances differentials on the probability of being selected as a migrant within the household. In this third step, we impute counterfactual earnings and remittances for each member at each location, that is to say, for migrants, had they not migrated or migrated elsewhere, and for non-migrants, had they migrated abroad. Imputed earnings differentials between destination and home countries are first included as alternative-specific explanatory variables in the structural form of the conditional logit model from equation (17). Additional control variables include gender, age, koranic schooling, eldest dummies, above defined rainfall variables and their interactions with destination-specific dummies, in order to account for any non-wage determinant of location choices. As above noted, the koranic and eldest dummies may capture both the impact of tastes and the role of remittances potential in the intra-household selection process. To disentangle the remittances and tastes channels, we add to the initial specification interaction terms between the koranic and eldest dummies and

[35] An issue raised by this sample definition is that we do not properly take into account additional selection on the labour market and into remittances. Bertoli et al. (2013) jointly model individual migration and working decisions. Within our household framework, dealing with both issues would nevertheless add to much theoretical complexity and is empirically hindered by the limited size of our sample.

[36] Note that in our setting, the first-best choice probability is similar to the selection probability for migrants and to a retention probability for stayers, since it corresponds to the probability that the latter were not selected as migrants within the household.

imputed remittances amounts. Standard errors are again bootstrapped to correct for the extra sampling variability in imputed variables.

Identification at this stage is first achieved through within-household variations in earnings and remittances realizations. Yet, it more crucially depends on the exclusion from the structural model of selection of at least one variable that enters the earnings and remittances equations. We argue here that formal education affects earnings and remittances but not location choices, once earnings and remittances are accounted for. This might not be the case if, for instance, households benefit directly from having an educated member at home, through externalities on other members. Moreover, educated individuals could have preferences for migrating to countries where the average level of education is higher. Finally, migration costs could vary across education levels. However, it is not clear whether the overall non-wage utility gains or losses from the migration of an educated member should be large. We can reasonably argue that the direct effect of education on location choices is negligible compared to its indirect effect through expected earnings and remittances. Both De Vreyer et al. (2010) and Bertoli et al. (2013) indeed find that education plays a limited role in shaping migration decisions once earnings are accounted for. They conclude that selection with respect to education is mainly explained by expected wage differentials. Although some bias might remain, the above-specified structural model allows us to consistently identify the structural parameters of interest α and β without resorting to ad-hoc non-linear functional forms.

6 Results

This section presents estimation results from each step, focusing in particular on the relative role of earnings and remittances in the migration decision.

6.1 Step 1: Intra-household selection

Table 3 reports estimation results from the first-step reduced-form conditional logit model of location choices with two migration alternatives (Europe and Mauritania). Specification (1) includes the basic set of individual regressors and the koranic schooling and eldest dummies. Specification (2) includes rainfall z-score interactions as additional determinants of migration decisions.

Estimated coefficients on gender and age are respectively positively and negatively significant for both destination alternatives, though they are slightly larger for the European one. Being a men and relatively younger therefore increases the probability of being selected as a migrant within the household, whatever the chosen location. Some differences between locations are however observed with respect to education. Educated individuals (above the elementary level) have a higher propensity to be in France or Italy than individuals who never went to school. This positive effect is also found to increase with the level of education. Education is however a weaker determinant of selection in Mauritania. Overall, these findings are in line with the usual results derived from self-selection models. In addition, koranic education and eldest dummies are found to be important determinants of intra-household selection into migration. The positive coefficients on these variables are fairly large and highly significant.

Results from specification (2) show that rainfall are additional relevant determinants of migration decisions. Indeed, Wald tests for the joint significance of rainfall variables interacted with individual characteristics, reported at the bottom of Table 3, prove highly significant for both locations. Positive shocks on the level of precipitations seem to accentuate the above described patterns of intra-household selection according to gender and age, and to a lesser extent to education and eldest dummies in Europe. They also seem to foster migration of members with high school education to Mauritania[37]. To the extent that rainfall measured at the time of the migrant's departure can reasonably be excluded from current earnings and remittances equations, interactions between rainfall and individual characteristics can instrument for selection in the second step of our estimation procedure.

Note that the reduced-form parameters at this stage identify the joint effect of individual characteristics on intra-household selection through overall differentials in individual earnings, remittances and benefits or costs of migration. The next two steps thus aim at disentangling these channels.

[37]Note that since rainfall simultaneously affects all members of the same household, we cannot draw any clear conclusion about its overall effect on migration that cannot be identified through our within-household estimation procedure. Only its differential effect according to individual characteristics can be assessed and is anyhow relevant for the matter at hand.

Table 3: Intra-household location choices - Reduced-form conditional logit estimates

	Without rainfall		With rainfall	
	France/Italy	Mauritania	France/Italy	Mauritania
	(1)		(2)	
Male (d)	1.018***	0.418**	1.472***	0.615***
	(0.243)	(0.210)	(0.368)	(0.309)
Age	-0.026***	-0.038***	-0.029**	-0.047***
	(0.010)	(0.010)	(0.014)	(0.013)
Elementary school (d)	0.477	0.390	0.423	0.526
	(0.356)	(0.279)	(0.442)	(0.367)
Middle school (d)	1.420***	0.866***	1.252**	0.587**
	(0.375)	(0.321)	(0.504)	(0.281)
High school and more (d)	2.667***	0.610*	3.530***	0.912*
	(0.356)	(0.369)	(0.602)	(0.542)
Koranic school (d)	0.713**	1.754***	0.598**	2.785***
	(0.289)	(0.324)	(0.297)	(0.414)
Oldest child (d)	1.185***	1.033***	1.574***	1.007***
	(0.210)	(0.216)	(0.312)	(0.318)
Oldest brother/sister (d)	1.297***	1.690***	1.221***	1.733***
	(0.364)	(0.312)	(0.444)	(0.381)
Rainfall z-score x Male			0.854**	0.728**
			(0.425)	(0.361)
Rainfall z-score x Age			-0.013*	-0.026**
			(0.007)	0.011)
Rainfall z-score x Elementary			-0.209	-0.321
			(0.392)	(0.458)
Rainfall z-score x Middle			-0.315	-0.296
			(0.458)	(0.452)
Rainfall z-score x High			1.095*	1.737**
			(0.659)	(0.698)
Rainfall z-score x Koranic			0.436*	0.111
			(0.256)	(0.387)
Rainfall z-score x Oldest child			0.656*	0.122
			(0.374)	(0.383)
Rainfall z-score x Oldest brother/sister			-0.157	-0.281
			(0.492)	(0.424)
Destination dummy	yes		yes	
Observations	1,594		1,567	
Wald test for joint significance of rainfall variables			31.02***	19.22**
p-value			0.006	0.046

Notes: Sample is restricted to individuals aged 18-59 at the time of migrant's departure. Dependent variable is a dummy equal to 1 if member i of household h lives in country j. (d) stands for dummy variables. Reference category for education is no schooling. Rainfall z-scores refer to yearly deviations from the 1970-2009 trend period and correspond to the average z-score over the five years previous to the reported date of migration. Coefficients reported, standard errors in brackets.
*p<0.10; ** p<0.05; ***p<0.01
Source: MIDDAS Survey, 2009 - 2010. Authors' calculation.

6.2 Step 2: Earnings and remittances

Tables 4 and 5 provide estimation results of individual earnings and remittances equations at each location. Uncorrected regressions refer to standard Mincer-type specifications, whereas corrected ones additionally include a correction term specified as a second order polynomial function $\lambda(p_{hij})$ of the first-best selection probability obtained from step 1, specification (2).

As regards earnings, men unsurprisingly tend to earn significantly more than women, with a wage premium of around 130% in each location. We also find positive but decreasing marginal returns to potential experience (for which age is a proxy), although only marginally significant in Mauritania. Positive returns to education are somewhat larger in destination countries than in Senegal. An interesting result is that returns to education are particularly large in Europe for migrants who have at least a high school degree (around 130%) and in Mauritania for migrants who have a middle school degree (around 80%)[38]. To the extent that earnings differentials are taken into account in the household decision, this finding is consistent with the first-step selection results.

Estimation results of remittances equations provide further insights into the determinants of household location decisions. Unsurprisingly, remitted amounts from each destination country are found to increase with migrants' earnings and to decrease with non-migrants' earnings. An increase of 100 PPP US dollars in migrants' income corresponds to an increase in remitted amounts of 20% for Europe and 30% for Mauritania. Men tend to remit larger amounts than women, from 25% in Europe to 100% in Mauritania. Everything being equal, migrants with education above high school in Europe and migrants with middle education in Mauritania are found to remit significantly larger amounts. These results are consistent with our theoretical prediction that remittances potential play a role in the household selection process and might account for the first-step selection results.

Conditional on earnings, the koranic schooling and eldest dummies are found to be strong and significant determinants of individual remittances behaviors. Migrants with koranic schooling remit on average larger amounts (+35% for migrants in Europe and +53% for migrants in Mauritania). The same proves true for the eldest child dummy (+32% in Europe and +25% in

[38]Note that since overall samples include individuals with zero earnings, the large point estimates additionally point out the relatively lower participation to the labour market of women and individuals with less experience and low levels of education.

Table 4: Individual earnings equations - OLS estimates

Dependent variable:	Senegal		France/Italy		Mauritania	
Log of monthly earnings, PPP	Uncorrected (1)	Corrected (2)	Uncorrected (3)	Corrected (4)	Uncorrected (5)	Corrected (6)
Male (d)	1.541***	1.579***	1.347**	1.258**	1.314***	1.283***
	(0.226)	(0.198)	(0.672)	(0.623)	(0.451)	(0.362)
Age	0.245***	0.297***	0.362**	0.394**	0.121*	0.136*
	(0.042)	(0.061)	(0.172)	(0.197)	(0.069)	(0.078)
Age squared (/100)	-0.286***	-0.322***	-0.483*	-0.496*	-0.067	-0.075
	(0.067)	(0.039)	(0.275)	(0.295)	(0.112)	(0.114)
Elementary school (d)	0.495***	0.568***	0.621	0.588	0.479*	0.385*
	(0.158)	(0.197)	(0.954)	(0.895)	(0.283)	(0.228)
Middle school (d)	0.426**	0.456**	0.665*	0.592*	0.934**	0.823***
	(0.212)	(0.221)	(0.387)	(0.346)	(0.469)	(0.309)
High school and more (d)	0.254*	0.174*	1.403***	1.250**	0.327	0.509
	(0.141)	(0.104)	(0.519)	(0.611)	(0.478)	(0.563)
Koranic schooling (d)	0.094	0.033	-0.301	-0.292	-0.326	-0.447
	(0.122)	(0.146)	(0.543)	(0.524)	(0.417)	(0.513)
Oldest child (d)	0.113	0.145	0.226	0.311	0.317	0.208
	(0.241)	(0.269)	(0.452)	(0.624)	(0.296)	(0.163)
Oldest brother/sister (d)	0.222	0.315	0.359	0.265	0.104	0.071
	(0.432)	(0.468)	(0.658)	(0.567)	(0.165)	(0.159)
Constant	-3.399***	-4.568***	-3.457**	-3.864**	-3.962**	-4.112**
	(0.758)	(0.871)	(1.612)	(1.804)	(1.917)	(2.025)
First-best probability		1.887**		-1.658*		-1.122*
		(0.947)		(1.006)		(0.677)
First-best probability^2		-1.492*		1.915		0.956
		(0.894)		(2.154)		(0.789)
Observations	1,248	1,248	141	141	160	160
R^2	0.27	0.30	0.27	0.29	0.21	0.24
Wald test for $\lambda(p_{hij})$		7.52**		3.25		4.21
p-value		0.03		0.17		0.12

Notes: Samples are restricted to individuals aged 18-59 at the time of migrant's departure. (d) stands for dummy variables. Reference category for education is no schooling. PPP refers to USD Purchasing Power Parity amounts, using the consumption conversion factor published by the World Bank (2009). Coefficients reported, bootstrapped standard errors in brackets (1000 replications) for corrected specifications.
*p<0.10; ** p<0.05; ***p<0.01
Source: MIDDAS Survey, 2009 - 2010. Authors' calculation.

Mauritania) and the eldest sibling dummy (+42% in Europe and +45% in Mauritania). By contrast, these variables are found to have no impact on individual earnings, whatever the location considered. In light of the results from the first-step, showing higher migration probabilities for individuals having koranic education and being the eldest child or sibling of the household head, these results suggest that expected remittances play a role in the household allocation decision, together with earnings differentials. In line with our theoretical framework, these results imply that koranic and eldest dummies may proxy for low values of the δ_i parameter.

Finally, note that corrected and uncorrected coefficients in earnings and remittances equa-

Table 5: Individual remittance equations - OLS estimates

Dependent variable:	France/Italy		Mauritania	
Log of monthly remittances, FCFA	Uncorrected (1)	Corrected (2)	Uncorrected (3)	Corrected (4)
Migrant's earnings (/100)	0.174***	0.196***	0.278***	0.321***
	(0.000)	(0.000)	(0.001)	(0.001)
Origin household's earnings (/100)	-0.005**	-0.004**	-0.019*	-0.033*
	(0.001)	(0.001)	(0.011)	(0.017)
Male (d)	0.158*	0.247*	1.105**	1.092**
	(0.093)	(0.146)	(0.551)	(0.528)
Age	0.043**	0.040*	0.025	0.024
	(0.021)	(0.024)	(0.021)	(0.022)
Age squared (/100)	-0.102	-0.098	-0.154	-0.178
	(0.286)	(0.292)	(0.223)	(0.239)
Elementary school (d)	0.326	0.422	0.487	0.389
	(0.571)	(0.607)	(0.625)	(0.597)
Middle school (d)	0.431	0.396	0.362*	0.389*
	(0.582)	(0.457)	(0.217)	(0.212)
High school and more (d)	0.245*	0.283*	0.126	0.159
	(0.134)	(0.156)	(0.257)	(0.284)
Koranic schooling (d)	0.312**	0.348**	0.497**	0.526**
	(0.139)	(0.162)	(0.241)	(0.247)
Oldest child (d)	0.295*	0.321**	0.224**	0.248**
	(0.163)	(0.156)	(0.111)	(0.123)
Oldest brother/sister (d)	0.394	0.415*	0.436*	0.452*
	(0.229)	(0.247)	(0.259)	(0.271)
Constant	-2.128*	-2.156*	-1.057*	-0.894*
	(1.252)	(1.283)	(0.587)	(0.509)
First-best probability		-0.954**		-0.687
		(0.465)		(0.663)
First-best probability^2		1.257		0.879
		(1.356)		(1.102)
Observations	138	138	157	157
R^2	0.26	0.29	0.22	0.24
Wald test for $\lambda(p_{hij})$		5.18*		3.96
p-value		0.08		0.13

Notes: Samples are restricted to individuals aged 18-59 at the time of migrant's departure. (d) stands for dummy variables. Reference category for education is no schooling. Earnings are expressed in PPP and refer to monthly amounts. PPP refers to USD Purchasing Power Parity amounts, using the consumption conversion factor published by the World Bank (2009). Coefficients reported, bootstrapped standard errors in brackets (1000 replications) for corrected specifications.
*p<0.10; ** p<0.05; ***p<0.01
Source: MIDDAS Survey, 2009 - 2010. Authors' calculation.

tions are very close in magnitude, suggesting that the selection bias is not large. This finding is consistent with the fact that the Dahl's correction function is not significant in most of our specifications[39]. We however reject the null hypothesis for home earnings and remittances from

[39]InDahl (2002) the correction function is significant at the 5% level in only two thirds of the regressions. Similar patterns are found in Bertoli et al. (2013) and De Vreyer et al. (2010). Robustness to alternative specifications of the correction function was tested. All yield similar results so that we finally kept the one that best fits the data. Note that all earnings and remittances specifications achieve satisfactory goodness-of-fit. R^2 indeed ranges from 20% to 30%.

Europe. The third step is thus based on counterfactual earnings and remittances predictions using parameters corrected for selection in each location. Robustness to the use of uncorrected predictions is nevertheless tested.

6.3 Step 3: Structural-form model of intra-household location choices

Table 6 reports the third-step estimation results of our conditional logit model of location choices in its structural form[40]. Consistent with our theoretical framework and based on counterfactual earnings and remittances predictions from the previous step, the main independent variables of interest are imputed individual earnings differentials between home and destination countries and imputed remittances amounts.

Specifications in columns (1) and (2) investigate the respective role of expected earnings and other individual characteristics that aim at capturing the non-wage determinants of migration in the household decision. Unsurprisingly, results show that earnings differentials play a major role in shaping intra-household selection patterns. The estimated effect is indeed positive and highly significant across the two specifications, using as independent variables either uncorrected or selectivity-corrected counterfactual earnings predictions. As above mentioned, this finding accounts for the higher migration propensities of household members with middle education level to Mauritania and high education level to Europe, where they have larger returns. Consistent with our theoretical framework, this result therefore suggests that the origin household selects into migration the member with the highest comparative advantage in earnings across locations in order to maximize the total (earnings) surplus.

Yet, while controlling for earnings, most of the coefficients on individual control variables are still significant. These findings suggest that non-wage components are additional crucial determinants of intra-household migration decisions. First, men and relatively younger household members have higher probabilities of being located abroad. More importantly, the same pattern is observed for individuals with koranic education and who are the eldest child or sibling of the origin household head. Besides, the point estimates of the effect of these three variables is fairly large in comparison to that of the other controls. In line with the estimation results of remittances equations at the previous step, this central result points out the fact that, conditional

[40]We do not report coefficients on rainfall variables since they present similar patterns to those from step-1 reduced-form specification.

on earnings, individuals with a higher propensity to remit (with a low value of δ_i) have a higher probability of being selected as migrants within the household. This result is furthermore fully consistent with the predictions of our theoretical model.

However, two important limitations might challenge the latter interpretation. First, as extensively discussed in the previous sections, the reduced-form parameters on individual characteristics capture at this stage a potential simultaneous effect of tastes and remittances potentials. A possible alternative interpretation of the observed patterns of selection with respect to the koranic schooling and eldest dummy variables is that these individual characteristics account for differential costs or benefits of moving abroad[41]. For instance, religious networks at destination may lower the cost of migrating abroad and therefore foster migration of members with koranic schooling. Besides, eldest members's weight in the household decision-making process may be larger and as a consequence, they may be more likely to "self-select" or be selected as the first link in the migration chain. Hence, to disentangle the respective role of remittances potentials and tastes in the selection process, we include as additional explanatory variables imputed remittances amounts as well as interaction terms with the koranic schooling and eldest dummy variables. Indeed, as suggested by our theoretical model, to the extent that the latter variables proxy for low values of the remittances discount factor δ_i and therefore accurately capture the role of remittances potentials, their effect positively interacts with remitted amounts. We should thus empirically observe heterogeneity in the effect of remittances with respect to those individual characteristics: the lower δ_i, the higher the propensity to remit and the higher the role of remittances in determining location choices. Results are given in Table 6, columns (3) and (4). First, all the coefficients on remitted amounts and the relevant interaction terms are found to be positive and (highly) significant. Second, the point estimates of the direct effect of the koranic schooling and eldest dummy variables substantially drop and become marginally significant. Overall, even if we cannot rule out that part of the effect of our variables of interest may be due to differential tastes, these additional results lend further support to the hypothesis that the higher propensities of members with koranic schooling and being the eldest child or sibling of the household head to be located abroad are mainly explained by their higher remittances potential.

[41]Indeed, Bertoli et al. (2013) point out the fact that the inverse taste component $-x_i\phi_j$ of the household utility could alternatively be interpreted as the net cost of migration to destination j, which is allowed to vary according to migrants' characteristics. In our setting, it includes costs at both household and migrant levels.

Table 6: Intra-household location choice - Structural-form conditional logit estimates

	Uncorrected	Corrected	Uncorrected	Corrected
	(1)	(2)	(3)	(4)
Earnings differential, PPP (/100)	0.356***	0.236***	0.321***	0.215***
	(0.079)	(0.058)	(0.055)	(0.046)
Remittances, FCFA (/10,000)			0.198*	0.176*
			(0.115)	(0.103)
Remittances × Koranic			0.126***	0.118**
			(0.042)	(0.055)
Remittances × Oldest child			0.092**	0.076**
			(0.039)	(0.034)
Remittances × Oldest brother/sister			0.109*	0.096*
			(0.064)	(0.058)
France/Italy				
Male (d)	0.327**	0.395*	0.292**	0.338*
	(0.162)	(0.236)	(0.139)	(0.199)
Age	-0.012**	-0.016*	-0.010**	-0.013*
	(0.006)	(0.009)	(0.005)	(0.007)
Koranic school (d)	0.764**	0.628**	0.255**	0.276*
	(0.373)	(0.291)	(0.122)	(0.142)
Oldest child (d)	0.976***	1.271***	0.523*	0.607
	(0.374)	(0.485)	(0.311)	(0.456)
Oldest brother/sister (d)	1.078**	0.969**	0.651*	0.595*
	(0.532)	(0.478)	(0.394)	(0.307)
Mauritania				
Male (d)	0.222**	0.340*	0.116*	0.195
	(0.112)	(0.169)	(0.068)	(0.119)
Age	-0.035**	-0.042***	-0.031**	-0.046**
	(0.015)	(0.016)	(0.014)	(0.019)
Koranic school (d)	1.576***	2.058***	0.352	0.393
	(0.597)	(0.785)	(0.298)	(0.287)
Oldest child (d)	0.913***	1.302***	0.552*	0.619*
	(0.347)	(0.497)	(0.328)	(0.365)
Oldest brother/sister (d)	1.349***	1.413***	0.423*	0.486*
	(0.481)	(0.509)	(0.236)	(0.279)
Rainfall variables	no	yes	no	yes
Destination dummy	yes	yes	yes	yes
Observations	1,594	1,567	1,594	1,567

Notes: Sample is restricted to individuals aged 18-59 at the time of migrant's departure. Dependent variable is a dummy equal to 1 if member i of household h lives in country j. (d) stands for dummy variables. PPP refers to USD Purchasing Power Parity amounts, using the consumption conversion factor published by the World Bank (2009). Coefficients reported, bootstrapped standard errors in brackets (1000 replications).
*p<0.10; ** p<0.05; ***p<0.01
Source: MIDDAS Survey, 2009 - 2010. Authors' calculation.

A second limitation may arise from the role of welfare weights in our setting. Indeed, additional predictions derived from our theoretical model suggest that migration propensities are positively correlated with bargaining power, so that differential bargaining powers could be an alternative explanation of the above findings, especially as regards the two eldest dummy variables. However, two remarks allow us to credibly rule out this alternative interpretation. First, in our theoretical framework, remittances are expected to decrease with migrants' bargaining power. Therefore, if the koranic schooling and eldest dummy variables were only proxy measures of individuals' bargaining power, they should negatively affect remitted amounts, which is not what we observe from the remittances equations estimated in Table 5. Second, as mentioned in the previous sections, differential welfare weights within the household translate into additional heterogeneity in the migration decision, especially according to the effect of earnings differentials across locations. Estimations shown in Table 12 in Appendix formally test this hypothesis by adding interaction terms between predicted earnings differentials and two relevant proxies for bargaining power, namely age and gender. The results show no evidence of heterogeneity with respect to age and gender, allowing us to plausibly state that the effect of differential bargaining powers is quite negligible in our setting[42].

In line with the main predictions of our theoretical model, our results therefore support the idea that both earnings and remittances differentials play a major role in determining household members' location choices. These findings have strong implications on migrant selection within the household: households select into migration members with both the highest comparative advantages in earnings across locations and with the highest remittances potentials conditional on earnings. This feature can be observed by modelling the migration decision at the household level. It is therefore ignored by individual self-selection models whereas we show in this paper that it allows us to explain the higher migration propensities of household members with koranic schooling or being the eldest child or sibling of the origin household head although they have no obvious comparative advantage in earnings.

[42]To keep the estimation tractable, we only test heterogeneity with respect to earnings differential. Indeed, additionally testing this hypothesis with respect to remittances potential would imply the inclusion of poorly identified triple interactions in the relevant specifications.

7 Conclusion

Although it has been addressed by a large strand of the migration literature, migrant selection has only been modeled to date as the result of an individual income-maximizing strategy. However, individual selection models cannot account for most migration patterns observed in particular in developing countries where migration is part of a household welfare-maximizing strategy. Therefore, this paper aims at developing a household-based analysis of the selection process of migrants by investigating the under-explored issue of intra-household selection into migration.

We first extend the seminal Roy model of self-selection to account for a household-level decision process for migration. In our framework, a unitary household chooses where to locate its members based on the maximization of a household utility whose components include home earnings of non-migrant members and earnings and remittances of migrant members abroad. Using observed allocation choices of household members, we develop a three-step estimation procedure to estimate the respective weight on the earnings and remittances components in the structural intra-household selection decision. We provide an empirical application using survey data on a unique matched sample of Senegalese migrants in France, Italy and Mauritania and their origin household in Senegal.

Our results show that, together with earnings, remittances differentials play a significant role in shaping intra-household selection patterns. Once controlling for earnings differentials, we find that households are more likely to select into migration members with the highest remittances potential in order to maximize the household welfare. These results complement and enrich those derived from individual-level selection models which do not account for the household dimension of the migration decision and ignore the role of expected remittances on migration decisions. Our framework is especially relevant in explaining the observed higher migration propensities of individuals with koranic schooling or being the eldest child or sibling of the origin household head although they have no obvious comparative advantage in earnings

Appendices

A Optimal amount of remittances

Any optimal amount of remittances sent by the migrant member to her origin household to maximize the total household utility function should satisfy the following f.o.c:

$$\frac{\partial U_{hij}}{\partial R_{ij}} = \sum_{k \neq i} \frac{\theta_k}{(n-1)} U_k^{'} \left(\frac{\sum_{k \neq i} Y_{ks} + R_{ij}^*}{(n-1)} \right) - \theta_i \delta_i U_i^{'} \left(Y_{ij} - \delta_i R_{ij}^* \right) = 0$$

To further determine how the optimal amount R_{ij}^* varies with other exogenous parameters in the model, we can simply differentiate the above equality with respect to each component:

$$\begin{aligned} & \sum_{k \neq i} \left[\frac{1}{(n-1)} U_k^{'}(.) \right] d\theta_k + \sum_{k \neq i} \left[\frac{\theta_k}{(n-1)^2} U_k^{''}(.) \right] dY_{ks} + \sum_{k \neq i} \left[\frac{\theta_k}{(n-1)^2} U_k^{''}(.) \right] dR_{ij}^* \\ = & \left[\delta_i U_i^{'}(.) \right] d\theta_i + \left[\theta_i (U_i^{'}(.) - \delta_i R_{ij}^* U_i^{''}(.)) \right] d\delta_i + \left[\theta_i \delta_i U_i^{''}(.) \right] dY_{ij} - \left[\theta_i \delta_i^2 U_i^{''}(.) \right] dR_{ij}^* \end{aligned}$$

For any concave and twice differentiable individual utility functions, implying $U^{'}(.) > 0$ and $U^{''}(.) < 0$, it is then straightforward to show that:

$$[+]dR_{ij}^* = \sum_{k \neq i} [+]d\theta_k \quad \sum_{k \neq i} [-]dY_{ks} \quad [-]d\theta_i \quad [+]dY_{ij} \quad [-]d\delta_i$$

so that R_{ij}^* can be depicted by the following function of all exogenous parameters:

$$R_{ij}^* = R_{ij}^*(\theta_k^+, \theta_i^-, Y_{ks}^-, Y_{ij}^+, \delta_i^-) \qquad \forall i, j \quad \text{and} \quad k \neq i$$

B Optimal value of the household utility function

The (remittance) optimal value of the utility function for household h of locating member i in destination country j and all other members in the home country s writes:

$$V_{hij} = \sum_{k \neq i} \theta_k U_k \left(\frac{\sum_{k \neq i} Y_{ks} + R_{ij}^*}{n-1} \right) + \theta_i U_i \left(Y_{ij} - \delta_i R_{ij}^* \right) + T_{hij}$$

The envelope theorem states that marginal changes in the optimal value of a function with respect to exogenous parameters of that function can be accurately described by partially differentiating the objective function evaluated at its optimum. For any concave and twice differentiable individual utility functions, implying $U^{'}(.) > 0$ and $U^{''}(.) < 0$, and conditional on tastes, it is then straightforward to show that:

$$\begin{cases} \partial V_{hij}/\partial \theta_k = U_k(.) > 0 & ; \quad \partial V_{hij}/\partial \theta_i = U_i(.) > 0 \\ \partial V_{hij}/\partial Y_{ks} = [\theta_k/(n-1)] U_k^{'}(.) > 0 & ; \quad \partial V_{hij}/\partial Y_{ij} = \theta_i U_i^{'}(.) > 0 \\ \partial V_{hij}/\partial \delta_i = -\theta_i R_{ij}^* U_i^{'}(.) < 0 & \end{cases}$$

so that V_{hij} can be depicted by the following function of all exogenous parameters:

$$V_{hij} = V_{hij}(\theta_k^+, \theta_i^+, Y_{ks}^+, Y_{ij}^+, \delta_i^-) \qquad \forall i, j \quad \text{and} \quad k \neq i$$

Table 7: Sample size and composition by country

	France	Italy	Mauritania	Pooled
Stage 1: Migrant samples				
Number of eligible migrants	579	616	402	1,597
Refusal rate (%)	48.2	51.0	18.9	41.9
Number of surveyed migrants	300	302	326	928
...% of women	*24.3*	*22.9*	*36.5*	*28.1*
...% in capital/main cities	*72.3*	*48.0*	*73.0*	*64.0*
Stage 2: Origin household samples				
Number of provided contacts	158	114	266	538
Matching rate (%)				
... overall	*30.7*	*20.5*	*53.4*	*35.3*
... among provided contacts	*58.2*	*54.4*	*65.4*	*61.0*
Number of tracked households	92	62	172	326
...% in Dakar	*46.7*	*54.8*	*21.3*	*34.8*

Source: MIDDAS Survey, 2009 - 2010. Authors' calculation.

C Sample representativeness

Additional representative data sources allow us to assess the representativeness of our matched data at different levels. Using French and Italian census data, we first show that migrant samples are fairly representative of Senegalese migrant populations in these two host countries. Unfortunately, we were not able to draw the same analysis for Mauritania for lack of reliable data. A more serious concern in our setting is the potential sample selection, in both migrant and household samples, resulting from imperfect matching. Yet, using a simple probit analysis of matching success, we find no systematic difference between the matched and unmatched migrant samples, especially regarding our main variables of interest, namely age, gender, formal and koranic education, link to the origin household head, earnings and remittance amounts. Furthermore, using data from the nationally representative PSF household survey conducted in Senegal in 2007 (De Vreyer et al., 2008), we find that our matched migrant households are quite similar to Senegalese migrant households according to their basic characteristics, and in particular their size and demographic composition. Sample representativeness tables (Table 8 to 10) are provided below, and a detailed analysis of the representativeness of the matched samples can be found in Senne (2013). As a consequence, although sample selection issues may arise as a result of our survey design, they are unlikely to bias our results.

Table 8: Migrant samples' representativeness by country - Comparison with OECD data

		France		Italy	
		Census	MIDDAS	Census	MIDDAS
Gender (%)	Men	54.7	75.5	88.1	77.3
	Women	45.3	25.5	11.9	22.7
Age (%)	20-29 year	20.1	27.6	15.4	23.4
	30-39 years	22.3	35.0	49.4	40.5
	40-49 years	25.0	21.6	29.2	30.4
	50-60 years	20.4	12.6	4.4	5.7
	60+ years	12.2	3.2	1.6	0.0
Duration of stay (%)	up to 5 years	17.5	14.8	29.2	18.9
	5 to 10 years	12.2	33.8	26.7	35.1
	10+ years	70.3	51.4	44.2	46.0
Citizenship (%)	National	58.6	25.5	1.6	2.3
	Other country	41.4	74.5	98.4	97.7
Education (%)	ISCED 0/1/2	45.1	54.6	83.8	48.5
	ISCED 3/4	26.9	20.3	12.3	20.1
	ISCED 5/6	28.0	25.2	3.9	26.4
Labor force status (%)	Employed	54.8	74.8	79.5	70.5
	Unemployed	12.6	14.1	9.1	21.2
	Inactive	32.6	11.1	11.4	8.3
Observations		93,076	286	28,030	299

Notes: OECD census data records information on all individuals born in Senegal, aged 20 and above and living in an OECD country. MIDDAS sample is restricted to this sub-population population for comparison purpose. ISCED refers to the International Standard Classification of Education of UNESCO. ISCED 0/1/2 corresponds to no formal education, primary and lower secondary education; ISCED 3/4 to upper secondary, vocational and technical education; ISCED 5/6 to tertiary education.
Source: DIOC 2005/06, OECD and MIDDAS Survey, 2009 - 2010. Authors' calculation.

Table 9: Probit analysis of matching success

	France (1)	Italy (2)	Mauritania (3)	Pooled (4)
Migrant characteristics				
Age	0.013***	0.004	0.008*	0.009***
	(0.005)	(0.003)	(0.004)	(0.002)
Gender				
Male	0.016	0.043	-0.022	0.000
	(0.078)	(0.049)	(0.076)	(0.044)
Female	(ref)	(ref)	(ref)	(ref)
Ethnic group				
Wolof	-0.151**	-0.105	0.198**	-0.016
	(0.069)	(0.074)	(0.080)	(0.045)
Peul	-0.082	-0.020	0.063	-0.043
	(0.074)	(0.075)	(0.102)	(0.053)
Other	(ref)	(ref)	(ref)	(ref)
Religion/Brotherhood				
Murid	0.090	-0.064	0.109	0.014
	(0.154)	(0.143)	(0.127)	(0.080)
Tidjan	-0.015	-0.054	0.141	0.030
	(0.139)	(0.107)	(0.125)	(0.080)
Other muslim	0.015	0.206	0.166	0.062
	(0.133)	(0.264)	(0.127)	(0.081)
Other	(ref)	(ref)	(ref)	(ref)
Koranic schooling				
Yes	0.151	-0.025	0.063	0.085
	(0.091)	(0.067)	(0.089)	(0.063)
No	(ref)	(ref)	(ref)	(ref)
Formal schooling				
Elementary/Secondary	0.014	0.016	0.087	0.027
	(0.087)	(0.081)	(0.071)	(0.047)
Highschool/University	0.012	0.055	-0.064	0.027
	(0.093)	(0.084)	(0.120)	(0.056)
Vocational	-0.016	0.142	0.229*	0.056
	(0.138)	(0.172)	(0.134)	(0.085)
No formal schooling	(ref)	(ref)	(ref)	(ref)
Marital Status				
Married	-0.069	0.000	-0.062	-0.046
	(0.077)	(0.061)	(0.085)	(0.048)
Divorced/Widowed	-0.101	-0.099**	-0.068	-0.108*
	(0.095)	(0.041)	(0.132)	(0.062)
Single	(ref)	(ref)	(ref)	(ref)
Time since arrival	-0.010**	0.003	-0.006	-0.006**
	(0.004)	(0.004)	(0.005)	(0.003)
Place of residence				
Capital/Main cities	-0.052	-0.077*	0.068	-0.014
	(0.072)	(0.044)	(0.076)	(0.038)
Small cities	(ref)	(ref)	(ref)	(ref)
Labor status				
Working	0.105	0.346**	0.067	0.127
	(0.137)	(0.162)	(0.171)	(0.091)
Unemployed	0.221	0.125	0.266	0.240
	(0.176)	(0.112)	(0.182)	(0.187)
Non-working	(ref)	(ref)	(ref)	(ref)
Income				
2nd quartile	0.155	0.124*	0.149	0.139*
	(0.102)	(0.069)	(0.093)	(0.081)
3rd quartile	-0.052	0.125	0.110	0.086
	(0.110)	(0.127)	(0.101)	(0.065)
4th quartile	-0.010	0.091	0.252***	0.164**
	(0.110)	(0.132)	(0.095)	(0.070)
Missing	0.080	0.169	-0.336	0.025
	(0.201)	(0.207)	(0.298)	(0.119)
1st quartile	(ref)	(ref)	(ref)	(ref)

Table 9 (continued)

	France (1)	Italy (2)	Mauritania (3)	Pooled (4)
Origin household characteristics				
Environment				
Rural	0.089	-0.052	0.023	0.060
	(0.082)	(0.050)	(0.067)	(0.044)
Urban	(ref)	(ref)	(ref)	(ref)
Size	0.004	0.004	0.006	0.005**
	(0.003)	(0.003)	(0.005)	(0.002)
Missing size				
Yes	0.084	-0.060	-0.228	-0.046
	(0.224)	(0.068)	(0.294)	(0.115)
No	(ref)	(ref)	(ref)	(ref)
Resident spouse/child				
Yes	-0.098	-0.035	0.127*	0.016
	(0.075)	(0.048)	(0.072)	(0.042)
No	(ref)	(ref)	(ref)	(ref)
Wealth score	0.008	0.038***	0.010	0.029***
	(0.017)	(0.010)	(0.026)	(0.010)
Remittances in cash/kind				
Yes	-0.104	-0.036	0.033	0.006
	(0.111)	(0.065)	(0.082)	(0.048)
No	(ref)	(ref)	(ref)	(ref)
Remittances amounts (in euros)	0.002	0.001	0.001	0.001
	(0.002)	(0.001)	(0.005)	(0.001)
Country				
Italy				-0.117**
				(0.051)
Mauritania				0.255***
				(0.056)
France				(ref)
Observations	300	302	326	928

Note: Marginal effects at the mean for continuous variables, at 0 for dummy variables. Robust standard errors in brackets.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Source: MIDDAS survey, 2009-2010. Authors' calculation.

Table 10: Origin household samples' representativeness by migrant's location - Comparison with PSF survey

	PSF with migrants		MIDDAS				
	Out of Africa	In Africa	France/Italy	Mauritania	χ^2/Fisher/t		PSF
	(1)	(2)	(3)	(4)	(1)-(3)	(2)-(4)	without migrants
Household characteristics							
Size	10.9	10.3	12.8	11.1	1.75*	1.03	7.8
Dependency ratio	42.7	47.1	39.1	43.8	-1.55	-1.27	41.1
Proportion of (%)							
...*Male*	32.5	40.8	42.7	41.4	3.84***	0.22	47.5
...*Female*	67.5	59.2	57.3	58.6			52.5
Environment (%)							
...*Urban*	67.6	51.9	74.7	64.3	1.57	3.36	55.2
...*Rural*	32.4	48.1	25.3	35.7			44.8
Region (%)							
...*Dakar*	49.1	30.9	53.9	22.2	0.91	33.82***	35.2
...*North and East*	17.6	27.2	18.2	45.0			14.4
...*South*	4.6	27.2	3.9	4.7			9.8
...*Center*	28.7	14.8	24.0	28.1			40.5
Household head characteristics							
Age (in years)	52.8	51.8	58.2	58.1	2.81***	3.41***	49.9
Gender (%)							
...*Male*	46.3	60.5	62.3	62.0	6.62***	0.07	80.7
...*Female*	53.7	39.5	37.7	38.0			19.3
Religion (%)							
...*Murid*	31.5	14.8	28.6	26.3	0.26	4.06*	34.6
...*Other*	68.5	85.2	71.4	73.7			65.4
Education (%)							
...*None*	58.3	63.0	44.8	63.7	5.35*	0.36	62.8
...*Primary*	12.0	19.8	20.1	21.6			20.3
...*Secondary and higher*	29.6	17.3	35.1	14.6			16.9
Observations	108	81	154	174			1524

Note: χ^2/Fisher's exact tests for the equality of distributions for categorical and dummy variables, t-test for the equality of means for continuous variables, between columns (1)-(2)samples.
$p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Source: PSF survey 2006 - 2007 and MIDDAS Survey, 2009 - 2010. Authors' calculation.

Table 11: Origin household characteristics by migrant's location

	France/Italy	Mauritania
Household characteristics		
Region (%)		
...Dakar	53.9	22.1
...North/East	18.1	45.3
...South	3.9	4.7
...Center	24.1	27.9
Environment (%)		
...Urban	74.7	64.1
...Rural	25.3	35.9
Composition (%)		
...Children (18-)	33.6	38.4
...Adults (18-60)	58.9	56.1
...Elderly (60+)	7.5	5.5
Size	12.8	11.2
Number of international migrants	2.19	1.59
Household head characteristics		
Age	58.3	58.4
Gender (%)		
...Male	62.9	64.0
...Female	37.1	36.0
Ethnic group (%)		
...Wolof	40.2	61.0
...Serere	10.4	9.3
...Peul	16.9	15.1
...Soninke/Mandinka	24.7	1.7
...Diola	4.5	9.3
...Other	3.3	3.5
Religion (%)		
...Murid	28.6	26.9
...Tijani	41.6	61.1
...Other	29.8	12.0
Schooling (%)		
...No schooling	45.2	64.0
...Primary	18.9	21.5
...Middle School	18.3	9.3
...High School and more	17.6	5.2
Labour status (%)		
...Unemployed/Non-working	41.3	51.3
...Working	58.7	48.7
Monthly earnings (XOF)	154,040.2	82,545.9
Monthly earnings (PPP)	501.6	268.8
Observations	146	164

Note: Earnings in XOF for Senegal (659 XOF = 1 euro). PPP refers to USD Purchasing Power Parity amounts, using the consumption conversion factor published by the World Bank (2009).
Source: MIDDAS Survey, 2009 - 2010. Authors' calculation.

Table 12: Intra-household location choice - Structural-form conditional logit estimates with unequal bargaining powers

	Uncorrected	Corrected	Uncorrected	Corrected
	(1)	(2)	(3)	(4)
Earnings differential, PPP (/100)	0.398***	0.264***	0.364***	0.245***
	(0.091)	(0.072)	(0.083)	(0.066)
Earnings differential × Age	0.031	0.022		
	(0.023)	(0.016)		
Earnings differential × Male			0.126	0.108
			(0.139)	(0.114)
Individual controls	yes	yes	yes	yes
Rainfall variables	no	yes	no	yes
Destination dummy	yes	yes	yes	yes
Observations	1,594	1,567	1,594	1,567

Notes: Sample is restricted to individuals aged 18-59 at the time of migrant's departure. Dependent variable is a dummy equal to 1 if member i of household h lives in country j. (d) stands for dummy variables. PPP refers to USD Purchasing Power Parity amounts, using the consumption conversion factor published by the World Bank (2009). Individual controls include gender, age, koranic schooling and eldest dummies. Coefficients reported, bootstrapped standard errors in brackets (1000 replications).
*p<0.10; ** p<0.05; ***p<0.01
Source: MIDDAS Survey, 2009 - 2010. Authors' calculation.

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