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Abstract

This paper aims to provide the first evidence concerning the relationship between time and risk preferences and illegal migration in an African context. Based upon our theoretical model and using a unique data set on potential migrants collected in urban Senegal, we evaluate a measure of time and risk preferences through the individual's intertemporal discount rate and coefficient of absolute risk aversion. Remarkably, our results show that these individual preferences matter in the willingness to migrate illegally and to pay a smuggler.

Mots clés / Key Words: Illegal migration; Discount rate; Risk aversion; Africa; Senegal

Codes JEL / JEL classification: F22; O15; O16; R23

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1 Introduction

Illegal migration is a very controversial topic, with the illegal migrants flows expected to become increasingly important during the course of the 21st century. Images of "fortress Europe", with hordes of impoverished people coming from Africa and knocking at the gates, form the basis upon which many right-wing European politicians base their legitimacy. Despite the scope of illegal migration between Africa and Europe, the determinants of this phenomenon have not been studied to any significant extent. The major part of the literature is related to illegal migration between Mexico and the U.S. For instance, such studies show that illegal migrant flows are determined by economic conditions and more specifically by large wage differentials between these two countries (Hanson, 2006; Orrenius and Zavodny, 2005; Hanson and Spilimbergo, 1999) or the presence of migrant networks (Dolfin and Genicot, 2010).

This paper aims to go beyond traditional determinants of migration such as expectations or networks and study how risk and time preferences influence illegal migration intentions and the willingness to pay (WTP) a smuggler in an African context. In order to examine the role of preferences on illegal migration intentions, we conducted a survey involving 400 individuals in Dakar between November 2006 and April 2007. We chose Senegal for this study because this country has been severely affected by illegal migration. As far as we know, no comparable survey has been realized, thus rendering our study unique. During the survey, we collected information about the socio-demographic characteristics of people, their intentions and attitudes about illegal migration and their WTP a smuggler in order to attempt illegal migration.

Given our interest in the role of preferences in the willingness to migrate illegally and more specifically in the WTP a smuggler with a probability one of success, we draw on literature of the determinants of the WTP and the role of risk and time preferences on agents' decision-making. The WTP

concept is generally used in contingent valuation methods in order to evaluate the monetary value of a non-market good. These concepts have been largely studied in many areas such as environment (see for instance Hanemann, 1994; Whittington et al., 1990; Verbic and Slabe-Erker, 2009), health economics (see for instance Gustafsson-Wright et al., 2009; Protière et al., 2004; Nguessan, 2008; Dror et al., 2007) or infrastructures (Torero et al., 2003). Furthermore, the determinants of the WTP have also been studied in the field of migration. For instance, Sengupta and Hedge (2005) study the determinants of the WTP among undocumented agricultural workers from Mexico for gaining legal visas in rural Southern California. They find that this WTP is determined by the perception that the legal status is associated with both a higher wage and a reduction of the unemployment period at the beginning of the migration to the U.S. From the 1995 Bank of Italy Survey of Household Income and Wealth (SHIM), Guiso and Paiella (2004) find that risk aversion plays an important role in household decisions related to their choice of occupation, portfolio selection, investment in education, job moving decisions and exposure to chronic diseases. In the case of migration, Daveri and Faini (1999) use aggregate panel data from Southern Italy, finding that risk-aversion is a strong determinant of internal and international migration. Heitmueller (2005) argues that being risk-averse reduces the likelihood of migrating relative to being risk neutral. Moreover, risk-averse people are more likely to go to countries with high unemployment benefits because they reduce the volatility of expected payoffs of migration, whereas risk-loving people will choose countries with a high degree of income volatility, which consequently increases their utility. These results are confirmed by Nowotny (2010), who finds that being risk averse reduces the willingness to migrate and to commute, whereas a higher discount rate is associated with a higher intention to migrate.

To the best of our knowledge, this paper is the first to be interested, both theoretically and empirically, in the role of risk and time preferences on

illegal migration intention and the WTP a smuggler in an African context, where very little research has been undertaken concerning this phenomenon.

In the case of our study, we interpret the WTP a smuggler with a probability one of success as the perception of the payoff associated with a safe arrival in the destination country without being apprehended. During the survey, we ask people direct questions to elicit information about their WTP a smuggler, their degree of aversion to risk and their subjective rate of time preference. Our approach is similar to Barsky et al., (1997), who ask direct questions that involve choice in hypothetical situations, from an experimental approach with participants in the Health and Retirement Study. Their measure of risk aversion is obtained with answers concerning the willingness of people to gamble on lifetime income and their measure of intertemporal substitution, and time preferences are obtained by asking people to choose consumption profiles implicitly associated with different rates of return. In this study, we first use a theoretical model to study how preferences affect the illegal migration intention and the WTP a smuggler with a probability one of success. Subsequently, we theoretically define two expressions of time and risk preferences through the individual's intertemporal discount rate and coefficient of absolute risk aversion. We later compute a mean value of the discount rate and the coefficient of absolute risk-aversion with an associated standard deviation for each individual. Finally, we use a Heckman procedure to empirically test our theoretical predictions, because the WTP a smuggler with a probability one of success is only observed for the sample of potential illegal migrants.

Our results can be summarized as follows: first, the likelihood of an individual choosing illegal over legal migration is an increasing function of the intertemporal discount rate under some conditions, an ambiguous function of risk-aversion, an increasing function of the expected foreign wage and a decreasing function of the price of illegal migration. Second, the price that an individual is willing to pay a smuggler for an illegal migration attempt with

a probability one of success is an increasing function of the intertemporal discount rate, a decreasing function of risk-aversion, an increasing function of the expected foreign wage, an ambiguous function of the domestic wage and an increasing function of the lump sum payment necessary to induce an individual not to leave Senegal. This paper shows that in addition to determinants of migration such as the expected foreign wage, networks, immigration policies or migration prices, individual preferences matter in the formation of an illegal migration project and can explain the risky behavior of candidates regarding illegal migration.

The remainder of the paper is organized as follows: the next section presents a model of the illegal migration intention and the WTP a smuggler with a probability one of success. In Section 3, we theoretically evaluate the expressions of the individual's intertemporal discount rate and coefficient of absolute risk aversion calculated in order to make our estimations. Section 4 presents the data and the descriptive statistics obtained from our survey, before the estimation strategy and empirical results are discussed in Section 5. Finally, concluding remarks are provided in Section 6.

2 Migration intention and the willingness to pay

2.1 Migration intention

Let the monthly wage in Senegal be denoted by w, and the expected wage in the destination country by w^*. We consider that the timing of migration takes place at time zero. At this moment, we assume that both potential legal and illegal migrants have taken the final decision of migration. At time zero, potential legal migrants have the level of skills required and their decision to migrate is definitive. Their migration attempt is not a "wait and see" option. For illegal migrants, the credit constraint is released at time zero and they

get the necessary funds to finance their migration. The one-shot price of reaching the destination will be denoted by C, with associated probability of success p. Illegal migrants do not immediately make another attempt if they are apprehended and sent back home. It is very likely to assume that if they want to make another attempt, they need to find new financial resources that can take much time and make another attempt unrealizable at time 0.
Consider a simple present discounted value (PDV) calculation, in which t represents the current age of the individual, T the retirement age, and ρ the discount rate. Preferences are assumed to be represented by a utility function denoted by $u(.)$. There is no role for return migration. Subsequently, the intertemporal welfare associated with an unsuccessful attempt of leaving Senegal at time 0 , and therefore remaining there from time 0 until retirement at age T , while earning a constant monthly wage w is given by:

$$V^{UE} = u(w - C) + u(w) \sum_{\tau=1}^{\tau=T-t} \frac{1}{(1+\rho)^{\tau}} = u(w - C) + u(w) \frac{1 - (1+\rho)^{t-T}}{\rho}, \tag{1}$$

(where the superscript UE stands for unsuccessful emigration). Conversely, we assume that the attempt at emigrating is successful, costs C and results in earning the foreign wage w^* starting at $\tau = 1$. This yields an intertemporal welfare given by:

$$V^{SE} = u(w - C) + u(w^*) \frac{1 - (1+\rho)^{t-T}}{\rho}, \tag{2}$$

(where the superscript SE stands for successful emigration). In what follows, we will refer to $\frac{1-(1+\rho)^{t-T}}{\rho}$ as the individual's "intertemporal discount rate". The expected value of the attempt at emigration is therefore given by $E[V] = pV^{SE} + (1-p)V^{UE}$. Substituting from (1) and (2) yields:

$$E[V] = u(w - C) + [pu(w^*) + (1-p)u(w)] \frac{1 - (1+\rho)^{t-T}}{\rho}. \tag{3}$$

Let the intertemporal welfare associated with remaining in Senegal and earning a wage w from $t = 0$ to $t = T$ be given by:

$$\overline{V} = u(w) \frac{(1+\rho) - (1+\rho)^{t-T}}{\rho} \tag{4}$$

An individual will attempt to emigrate when $E[V] > \overline{V}$, which can be written, by substituting from (3) and (4) and simplifying the ensuing expression, as:

$$u(w - C) - u(w) + p[u(w^*) - u(w)] \frac{1 - (1+\rho)^{t-T}}{\rho} > 0. \tag{5}$$

The preceding model is extremely reminiscent of the standard approaches of Todaro (1969) and Harris and Todaro (1970).
What is the difference between legal and illegal migration in terms of the theoretical model? During the survey, we ask the questions: (1) are you willing to migrate? (2) If you are not able to migrate legally, are you willing to migrate illegally? We phrase the question in this way because we consider that if people have a high probability of succeeding with legal migration, they will attempt it. However, most people would perceive that the likelihood of succeeding in legal migration out of Senegal is significantly lower than the probability of success through illegal migration. Individuals will attempt illegal migration if they do not have any other legal possibility or if they assume that they have no chance of success in a legal migration due to their level of education and/or social condition. A second characteristic of legal migration is that the associated administrative costs are very low (usually amounting to the cost of the visa application and the accompanying documents that must be submitted), although the airfare to the potential destination country does increase the overall price, particularly when compared with the prices of illegal migration methods.

If we allow the expression given in (3) to represent the case of illegal

migration, where the expected wage in the destination country in such a case is denoted by $\underline{w}^*$, and carry out a similar PDV calculation for legal migration, where the probability of success is denoted by $q < p$, the price is denoted by K , and the expected wage is denoted by $\overline{w}^* > \underline{w}^*$, we obtain:

$$E\left[V^{illegal}\right] = u\left(w - C\right) + \left[pu\left(\underline{w}^*\right) + \left(1 - p\right)u\left(w\right)\right]\frac{1 - \left(1 + \rho\right)^{t-T}}{\rho},$$
$$E\left[V^{legal}\right] = u\left(w - K\right) + \left[qu\left(\overline{w}^*\right) + \left(1 - q\right)u\left(w\right)\right]\frac{1 - \left(1 + \rho\right)^{t-T}}{\rho}.$$

The individual will prefer illegal over legal migration when $E\left[V^{illegal}\right] > E\left[V^{legal}\right]$, which can be written explicitly as:

$$u\left(w - C\right) - u\left(w - K\right) + \left[pu\left(\underline{w}^*\right) - qu\left(\overline{w}^*\right) - \left(p - q\right)u\left(w\right)\right]\frac{1 - \left(1 + \rho\right)^{t-T}}{\rho} > 0. \tag{6}$$

Consider the two following second-order Taylor expansions:

$$u\left(w - C\right) \approx u(w) - Cu'(w) + \frac{C^2}{2}u''(w),$$
$$u\left(w - K\right) \approx u(w) - Ku'(w) + \frac{K^2}{2}u''(w).$$

Subsequently, one can rewrite (6) as:

$$\underbrace{\left(K - C\right)u'(w)\left[1 + \frac{1}{2}\left(C + K\right)\left(-\frac{u''(w)}{u'(w)}\right)\right]}_{u(w-C)-u(w-K)} +$$

$$\left[pu\left(\underline{w}^*\right) - qu\left(\overline{w}^*\right) - \left(p - q\right)u\left(w\right)\right]\frac{1 - \left(1 + \rho\right)^{t-T}}{\rho} > 0. \tag{7}$$

One can immediately establish the following Proposition by straightfor-

ward differentiation of (7):

Proposition 1 *The likelihood that an individual chooses illegal over legal emigration is: (i) an increasing function of the intertemporal discount rate* $\frac{1-(1+\rho)^{t-T}}{\rho}$ *when* $\frac{pu(\underline{w}^*)-qu(\overline{w}^*)}{p-q} > u(w)$*, (ii) an increasing function of the expected illegal migration foreign wage, (iii) a decreasing function of the expected legal migration foreign wage, (iv) a decreasing function of the price of illegal migration, (v) an increasing (decreasing) function of risk-aversion when* $K - C > (<)\ 0$.

2.2 The Willingness to pay a smuggler

We consider the WTP a smuggler with a probability of success equal to one, which we denote by C^*. This WTP is implicitly defined by the solution in C^* to the following equation:[1]

$$u(w - C^*) - u(w) + [u(w^*) - u(w)] \frac{1-(1+\rho)^{t-T}}{\rho} = 0.$$

By the same second-order Taylor expansion as above, this can be rewritten as:

$$[u(w^*) - u(w)] \frac{1-(1+\rho)^{t-T}}{\rho} - \left[u'(w)C^* - \frac{C^{*2}}{2}u''(w)\right] = 0,$$

or

$$[u(w^*) - u(w)] \frac{1-(1+\rho)^{t-T}}{\rho} - u'(w)\left[C^* + \frac{C^{*2}}{2}\left(-\frac{u''(w)}{u'(w)}\right)\right] = 0. \quad (8)$$

By the Implicit Function Theorem, one can immediately establish the following Proposition:

Proposition 2 *The price that an individual is willing to pay a smuggler for an illegal immigration attempt with probability 1 of success is: (i) an increas-*

[1] For simplicity, we revert to the earlier notation in which the foreign wage rate in the case of illegal migration is given by $\underline{w}^* = w^*$.

ing function of the intertemporal discount rate $\frac{1-(1+\rho)^{t-T}}{\rho}$*, (ii) an increasing function of the expected foreign wage, (iii) an ambiguous function of the domestic wage, (iv) a decreasing function of risk-aversion.*

Proof. See the Appendix for details. ■

The only ambiguity in the WTP a smuggler for an illegal immigration attempt with probability one of success is associated with the effect of the domestic wage. All other comparative statics results for our model are clear-cut, including the effect of risk-aversion.

3 Inferring preferences

Let the lump sum payment necessary to induce an individual not to leave Senegal be denoted by D. Therefore, indifference between remaining in Senegal and receiving the lump sum payment D at $\tau = 0$ (with associated intertemporal welfare $V^{LS} = u(w+D) + u(w)\frac{1-(1+\rho)^{t-T}}{\rho}$, where the superscript LS stands for lump sum), and the expected value of an attempt at emigration with cost C_j and probability of success p_j (with associated intertemporal welfare $E[V]$) yields $0 = E[V] - V^{LS}$, which can be expressed more explicitly as:

$$0 = u(w - C_j) + [p_j u(w^*) - p_j u(w)] \frac{1-(1+\rho)^{t-T}}{\rho} - u(w+D). \qquad (9)$$

The reason for indexing the pair (C_j, p_j) by j will become apparent in what follows. If retirement age is considered indefinitely far away by individuals ($T \to \infty$) and individuals are risk neutral ($u(w) = w$) then (9) simplifies to $D = \frac{p_j(w^*-w)}{\rho} - C_j$. Given the appropriate data, which includes various values of the cost C_j that individuals are willing to bear in order to achieve migration success with a given known probability p_j, equation (9) allows

recovering both the discount rate ρ and risk aversion in the context of the emigration decision. We show this in the following Proposition.

Proposition 3 *If the individual is willing to emigrate at cost C_j (C_k) with associated probability of success p_j (p_k), and is willing to forego emigration in return for a lump-sum payment D, then:*

(i) the individual's coefficient of absolute risk-aversion is given by

$$A(w) = 2\frac{p_j\left(C_k + D\right) - p_k\left(C_j + D\right)}{p_j\left(D^2 - C_k^2\right) - p_k\left(D^2 - C_j^2\right)};$$

(ii) the individual's intertemporal discount rate is defined by

$$\frac{1-(1+\rho)^{t-T}}{\rho} = \frac{\left(C_j + D\right)\left(C_k + D\right)\left(C_k - C_j\right)}{\Delta w^*\left[p_j\left(C_k + D\right)\left(C_k + \Delta w^* - D\right) - p_k\left(C_j + D\right)\left(C_j + \Delta w^* - D\right)\right]}.$$

Proof. The proof follows from a second-order Taylor expansion of (9), and noticing that the ensuing expression holds for any two gambles (C_j, p_j) and (C_k, p_k). See the Appendix for details. ■

For each individual, we have five gambles (C_j, p_j). Therefore, there are (4+3+2+1) possible versions of the two expressions given in Proposition 3. For each individual, we can thus compute a mean value of $A(w)$ and $\frac{1-(1+\rho)^{t-T}}{\rho}$, with an associated standard deviation.

4 Data and estimates of preferences

4.1 Data

Since there was no data available on the motivations, risk and time preferences of illegal migrants from Africa, we collected new data on potential migrants from Senegal. We conducted a field survey in Dakar between November 2006 and April 2007. Questions were related to the socio-demographic

characteristics of the individuals, their willingness to migrate and more specifically their willingness to migrate illegally, the destinations to which they would like to migrate and their WTP a smuggler. Our aim with this survey was to reach individuals with a possible willingness to migrate and conduct the analysis by comparing potential legal migrants and potential illegal migrants. Therefore, our reference population is people who are willing to migrate. We first define Dakar as the analyzed unit for its accessibility and above all the variety of its population. Second, we picked several neighborhoods[2], within which we surveyed 400 individuals. 92% of our total sample are potential migrants, thus reaching our aim of having a population of potential migrants. Among them, 367 individuals want to migrate, 222 of whom only want to migrate legally and 145 are ready to migrate illegally, which represents 40% of potential migrants.

4.2 Survey experiment and descriptive statistics

In order to compute the individual's intertemporal discount rate and the coefficient of absolute risk aversion expressed in proposition 3, we ask people direct questions about their expected wage abroad, their wage in Senegal, their lump-sum payment to not leave Senegal and their WTP associated with different probabilities of success. More specifically, we prompt them to consider hypothetical situations and ask how much they are willing to pay according to different probabilities of an illegal migration attempt succeeding.

[TABLE 1 HERE]

Table 1 presents the descriptive statistics of the WTP a smuggler associated with different probabilities of success for those who are willing to migrate illegally. We observe that the lower the probability of success, the

[2]These neighborhoods are the University Campus and its surroundings (1); Fass, Medina and Geule-Tapée (2); Guediawaye (3); Sandaga (4); Kayar, Thiaroye, Yarakh and Yoff (5).

lower the share of individuals who are willing to migrate illegally. However, this proportion remains high compared to the risk taken. Indeed, with a 5% probability of success, 53% of people are still willing to migrate illegally. Moreover, the difference between their WTP with a probability of success of one and a probability of success of 0.05 is quite low, estimated at only 216,356 Fcfa, i.e. 330 Euros. While these amounts are high in the case of Senegal, they are an indication of the high level of frustration of people that consider migration, even if it is an illegal project, as the only way to improve their bad living conditions or to succeed. Moreover, these figures are very realistic, suggesting that migrants are well informed about different prices in the illegal migration market. Thus, it is likely that if they finance their migration through a loan, for instance, they plan to repay the smuggler with their first wage earned in the host country. The average lump sum payment necessary to induce an individual not to leave Senegal (D) is equal to 1.76e+09 Fcfa (2,683, 090 Euros). This high amount indicates the large utility gap of potential migrants between migrating and remaining in Senegal. We calculate the average individual's intertemporal discount rate and coefficients of absolute risk aversion from proposition 3 of the theoretical model.

[FIGURE 1 HERE]

The average individual's intertemporal discount rate is equal to 0.91 for potential illegal migrants. When more specifically considering the distribution of this variable (Figure 1), 64% of potential migrants have an intertemporal discount rate above 0 and 28% have an intertemporal discount rate above 0.8.

[FIGURE 2 HERE]

Figure 2 shows the histogram of the mean value of the individual's coefficient of absolute risk aversion $A(w)$. We observe that the individual's coefficients of absolute risk aversion are very close to 0, which means that

the individuals are risk neutral. They do not care about their risks taken with illegal migration, which is a strong signal of their determination. In order to achieve more variability than the mean value of individual's coefficients of absolute risk aversion $A(w)$, we create a dummy equal to one if potential illegal migrants are risk-averse (the mean value of individual's coefficients of absolute risk aversion is positive) and 0 if they are risk-loving (the mean value of individual's coefficients of absolute risk aversion is negative). Accordingly, this dummy is used in the estimations.

[TABLE 2 HERE]

Table 2 summarizes the other descriptive statistics. The average expected wage of a potential migrant is 1,567,466 Fcfa per month, i.e. 2,390 Euros, whereas the average monthly wage in Senegal (approximated by monthly expenditure) is estimated at 76,055 Fcfa, i.e. 116 Euros. The monthly expenditure is used as a proxy for the wage in Senegal, because people answer more easily about their expenditure, which renders this variable more reliable than income. The average migration price is 2,220,254 Fcfa (3,385 Euros). 42% of potential migrants have a low level of education, and this proportion decreases gradually with secondary and university levels of education.

5 Econometric analysis and results

5.1 Estimation strategy

This section aims to empirically test our theoretical predictions. However, given that the individual preferences variables are only available for the potential illegal migrants, we are unable to test the theoretical predictions of the effect of these variables on the illegal migration intention, but rather only on the WTP a smuggler. Individuals will only pay a smuggler if they are willing to migrate illegally. Therefore, the WTP is observed for the part of

the sample willing to migrate illegally. In this case, we do not have a random selection. In order to avoid a selection bias and specification error, we use a Heckman procedure (Heckman, 1979). We estimate the selection equation by a probit model and the outcome equation by a linear model, giving us:

$$\text{Outcome equation: } y_i = x_i\beta + w_i\gamma + \lambda_i\eta + \alpha_r + \varepsilon_i \tag{10}$$

$$\text{Selection equation: } m_i = \begin{cases} 1 \; if \; x_i\beta + z_i\theta + \alpha_r + \mu_i > 0 \\ 0 \; if \; x_i\beta + z_i\theta + \alpha_r + \mu_i \leq 0 \end{cases} \tag{11}$$

Where:

$$y_i \text{ is observed only when } m_i = 1$$
$$\varepsilon_i \sim N(0, \sigma)$$
$$\mu_i \sim N(0, 1)$$
$$corr(\varepsilon_i, \mu_i) = \upsilon$$

In equation (10), y_i represents the logarithm of the WTP a smuggler with a probability one of success. (w_i) is the vector of interest variables. (w_i) includes the mean value of the individual's intertemporal discount rates represented by $\frac{1-(1+\rho)^{t-T}}{\rho}$ and a dummy equal to one if the individual is risk-averse. These values are calculated from the proposition 3 in the theoretical model and γ is the vector of parameters to be estimated. x_i is the vector of control variables, including those considered as triggering factors of illegal migration such as the logarithm of the foreign expected wage per capita, the logarithm of migration prices, immigration policies measured by a dummy equal to one if individuals do not renounce to migrate in the case of restrictive immigration policies, a dummy equal to one if individuals have family or friends' relatives who have migrated. This variable allows us to take network effects into account. x_i also includes the socio-demographic characteristics

such as the logarithm of the monthly wage in Senegal per capita[3], gender, age and its square, marital status, dummy equal to one if the individual has a male dependent child, home occupation status (dummy equal to one if the individual and family live in their own home), a dummy to control for those who belong to the religious brotherhood Mouride, known for their networks abroad and indicator variables for ethnic groups. β is the vector of parameters to be estimated. In order to capture unobserved regional characteristics, we control equation (10) for five neighborhood dummies (α_r).

In the selection equation (equation 11), m_i is the binary variable equal to one if the individual reports a possibility for illegal migration and 0 otherwise, x_i is the same vector of control variables included in the outcome equation and z_i is the exclusion variable represented by different levels of education. We assume that the level of education influences the intention to migrate illegally but not the WTP a smuggler with a probability one of success, given that expected returns from skills for an illegal migration are very low. First, this is due to illegal migrants generally being less skilled than legal migrants. It is shown in the literature that people tend to invest less in education due to the perspective of future migration (Mckenzie and Rapoport, 2011) and more specifically illegal migrants have a lower incentive to acquire human capital due to a higher risk of apprehension (Chiswick, 1999). Moreover, illegal migrants are paid less than legal migrants due to their shorter expected duration in the destination and the limitations of their job mobility (Kossoudji and Cobb-Clark, 2002; Rivera-Batiz, 1999). For instance, Rivera-Batiz (1999) shows that even if illegal migrants are less educated, achieve worse language proficiency and have a shorter period of residence in the U.S. than legal migrants, the gap between the earnings of illegal and legal migrants is

[3]The monthly wage in Senegal per capita is approximated by the average monthly expenditures. We divided the average monthly expenditures of the individuals by 1+ the number of dependents and also the foreign expected wage by 1 + the number of dependents to take into account the burden of responsibilities that may influence the method of migration.

predominantly explained by the illegal status of undocumented workers who are exploited by their employers. Illegal migrants generally used to work in low-paid jobs (Taylor, 1992) where their qualifications, if they exist, are not fully expoited due to their illegal status.

5.2 Results

[TABLE 3 HERE]

Table 3 reports the results of the Heckman procedure, showing that the willingness to migrate illegally is an increasing function of the foreign expected wage (Column 1), which is particularly true in the case of illegal migration. The expected wage value can often be evaluated in terms of what potential migrants think about the salaries of their relatives who have already migrated, which is confirmed by the results of the variable relatives abroad. Indeed, we find that having family and friends' relatives who have already migrated significantly increases the likelihood of migrating illegally. There is a negative relationship between migration prices and the likelihood to migrate illegally, which also confirms our theoretical predictions. The main reason is that illegal migration is an expensive project that requires significant funds.[4] Moreover, these amounts often involve taking loans or years of savings to finance migration. The result of the level of education, which represents our exclusion variable, shows that having a university level of education strongly reduces the likelihood of migrating illegally compared to having a low level of education. This variable is negative and significant at a level of 1%. One of the explanation of this result is that educated and skilled people have better living conditions and a higher likelihood of obtaining legitimate documents for legal migration.

The results of the outcome equation are reported in Column 2 of Table 3.

[4] More generally, even legal migration migration costs such as passport fees are correlated with lower migration rates (Mckenzie, 2007) and prices for illegal migration used to be higher than for legal migration.

Our empirical findings confirm our theoretical propositions, finding that the average individual's intertemporal discount rate is significantly and positively related to the WTP a smuggler with a probability one of success. If the individual's preference for the present is higher, the potential illegal migrant has a higher WTP a smuggler with a probability one of success. A legal procedure can take much time and many attempts without any guarantee of success. Consequently, individuals who are willing to engage in illegal migration are also willing to pay a smuggler more to immediately improve their living conditions. The risk aversion dummy is significant and reduces the WTP a smuggler, given that paying a smuggler induces de facto a financial risk associated with the nature of the project that only the most determined can take. Moreover, the behavior of these less risk-averse individuals can reflect a sort of signal for the smugglers to determine the most risky "clients" and raise their prices for this category of people.[5] The higher the expectations, the higher the amount that people will be willing to pay to guarantee them a successful migration. However, the wage earned in Senegal does not appear to be significant, which confirms the ambiguous function of this variable in our theoretical predictions. The migration prices become insignificant at the second step, which shows that once they are willing to migrate illegally, potential migrants are strongly motivated and the migration prices no longer constitute a constraint in their WTP a smuggler. The Inverse Mills Ratio is not significant, which means that there is no selection bias.[6]

[5] According to Pratt (1964) the risk premium is a positive monotonic function of the risk aversion. However in some cases, the WTP may negatively be related to the degree of risk aversion. A risk-neutral individual can have a higher willingness to pay than a risk-averse individual for a partial reduction of risk (Eeckhoudt et al., 1997; Langlais, 2005)

[6] The observations are 332 instead of 367 because of missing values due first to the expected foreign wage and the wage in Senegal, (even if we take the monthly expenditures as proxy of this variable that already allows us to decrease the number of missing values). Second, it is due to indetermined intertemporal discount rates and coefficients of absolute risk aversion for some individuals who decide to not migrate from a certain probability of success lower than one. For these people we cannot form all the gambles (C_j, p_j) necessary to calculate the variables of preferences.

Columns 3 and 4 present the results of the estimations with the lump sum payment necessary to induce an individual not to leave Senegal as the variable of interest. The lump sum payment is also a measure of the individual preferences because it captures the monetary value given to migration and provides an indication of the utility gap between migrating and remaining in Senegal. The lump sum payment is not significant at the first step, which means that is does not affect the likelihood to migrate illegally rather than legally. However, there is a positive relationship between the lump sum payment and potential migrants' WTP a smuggler. This result means that the higher value that potential illegal migrants place upon migration, the more they are willing to pay a smuggler in order to succeed in their illegal migration project.

6 Concluding remarks

This paper aims to show the role of time and risk preferences in the willingness to migrate illegally and to pay a smuggler. From a theoretical model, we study how these variables affect the willingness to migrate illegally and to pay a smuggler with a probability one of success. We also define theoretically two expressions of time and risk preferences used in our estimations. What further makes our paper original is that we use an original data set from a survey among potential migrants in Senegal to test our theoretical predictions.

Our comparative statistics show that, first, the likelihood to migrate illegally is an increasing function of the intertemporal discount rate under certain conditions, an ambiguous function of the risk aversion, an increasing function of the expected illegal foreign wage, a decreasing function of the expected legal foreign wage and a decreasing function of the price of illegal migration. Second, the price that an individual is willing to pay a smuggler for an illegal immigration attempt with probability one of success is an in-

creasing function of the intertemporal discount rate, a decreasing function of risk-aversion, an increasing function of the expected foreign wage, an ambiguous function of the domestic wage. We were able to empirically test all our theoretical predictions apart from the effect of the intertemporal discount rate and the risk aversion on the willingness to migrate illegally, due to the non-availability of data for potential legal migrants. All other theoretical predictions are confirmed by the empirical estimations. The empirical results also show that the WTP a smuggler is an increasing function of the lump sum payment necessary to induce an individual not to leave Senegal, which means that potential illegal migrants place a high monetary value upon migration and have a high utility gap between migrating and remaining in Senegal.
In addition to the determinants of migration such as the expectations, presence of relatives in the destination country, immigration policies or migration prices, we find that individual preferences matter in the illegal migration. Accordingly, they have to be considered in the explanation of illegal migration and also in the probable inefficiency of immigration policies that do not necessarily take into account the sense of determination and "emergency" that potential illegal migrants have in improving their living conditions.

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Table 1: Probabilities of success and willingness to pay a smuggler of potential illegal migrants

	Mean	Sd	Obs
How much are you willing to pay if p = 1?	1,480,556	2,004,192	145
If p = 0.75, are you willing to migrate?	0.85	0.36	145
If yes, how much are you willing to pay?	1,351,829	1,952,752	123
If p = 0.50, are you willing to migrate?	0.77	0.43	145
If yes, how much are you willing to pay?	1,311,261	1,994,398	111
If p= 0.25, are you willing to migrate?	0.62	0.49	145
If yes, how much are you willing to pay ?	1,315,611	1,792,507	90
If p = 0.05, are you willing to migrate?	0.53	0.50	145
If yes, how much are you willing to pay?	1,264,200	1,592,63	75

Note: 1 Euro=655.96 Fcfa

Table 2: Summary statistics

Variables	Mean	SD	Obs
Migrate illegally	0.40	0.49	367
Willingness to pay	1,480,556	2,004,192	144
Average discount rate	0.91	3.32	138
Risk aversion	0.92	0.27	138
Lump sum payment	1.76e+09	2.34e+10	294
Expected foreign wage	1,567,466	5,486,186	363
Expected foreign wage per capita	893,918	5,332,343	363
wage	76,054.93	64,698.93	343
Wage per capita	21,481.92	16,979.35	343
Restrictive immigration policies	0.68	0.47	367
Relatives abroad	0.74	0.44	367
Migration prices	2,220,254	1,756,592	367
Male	0.88	0.33	367
Age	25.96	07.18	367
Married	0.26	0.44	367
Child is male	0.84	0.37	367
Low education level	0.42	0.49	367
Secondary level	0.27	0.44	367
University level	0.16	0.37	367
Koranic school	0.15	0.36	367
Home owner	0.56	0.50	367
Mouride	0.45	0.50	367
Wolof ethnic group	0.34	0.47	367
Lebou ethnic group	0.19	0.39	367
Hal Pular ethnic group	0.11	0.32	367
Serere ethnic group	0.23	0.42	367
Diola ethnic group	0.05	0.23	367
Manjack ethnic group	0.01	0.10	367
Bambara, Mandingue and Sub-region ethnic group	0.07	0.26	367
Region of Campus	0.11	0.32	367
Region of Fass, Medina and Geule tapée	0.11	0.31	367
Region of Guédiawaye	0.36	0.48	367
Region of Sandaga	0.12	0.33	367
Region of Kayar, Thiaroye, Yarakh and Yoff	0.30	0.46	367

Notes : Prices are in Fcfa. 1 Euro= 655.96 Fcfa.

Table 3: Preferences and willingness to pay a smuggler: Heckman procedure

Variables	Selection	Outcome	Selection	Outcome
	(1)	(2)	(3)	(4)
Average discount rate		0.080***		
		(3.14)		
Risk aversion		-1.049***		
		(2.94)		
Log lump sum payment			-0.012	0.153***
			(0.22)	(3.21)
Log expected foreign wage per capita	0.229**	0.174*	0.256***	0.172*
	(2.44)	(1.89)	(2.58)	(1.77)
Log wage per capita	-0.063	0.001	-0.036	-0.131
	(0.45)	(0.01)	(0.24)	(1.07)
Restrictive immigration policies	0.583***	-0.799***	0.538**	-0.621**
	(2.64)	(3.21)	(2.25)	(2.42)
Relatives abroad	0.621**	0.008	0.434	0.186
	(2.28)	(0.02)	(1.48)	(0.63)
Migration prices	-1.016***	0.320	-1.038***	0.247
	(8.64)	(1.27)	(8.17)	(0.91)
Education level				
Secondary level	-0.166		-0.208	
	(0.73)		(0.83)	
University level	-1.592***		-1.313**	
	(3.05)		(2.28)	
Koranic school	-0.179		-0.139	
	(0.60)		(0.44)	
Individual characteristics	Yes	Yes	Yes	Yes
Inverse Mills Ratio		-0.471		-0.385
		0.96		(0.71)
Observations	332			280

Notes:Robust z-statistics in parentheses: * significant at 10%; ** significant at 5%; signficant at 1%. The reference category for the education level is low education level. Individual characteristics include gender, age and its square, a dummy equal to one if the individual has a male child dependent, a dummy equal to one if the individual or his family lives in their own house. All regressions include religious, ethnic and neighborhoods dummies.

Figure 1: Individual's intertemporal discount rate

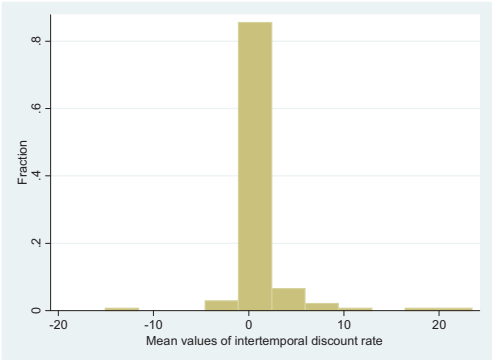
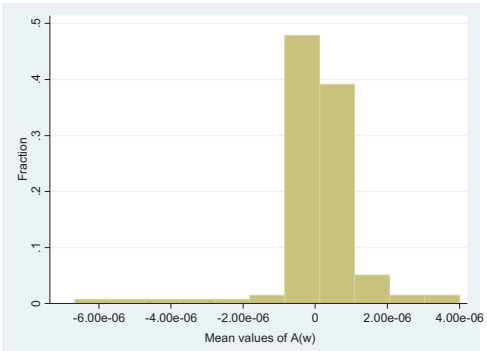


Figure 2: Individual's coefficient of absolute risk aversion



Proofs

A. Proof of Proposition 2

Applying the Implicit Function Theorem to (8) yields:

$$\frac{dC^*}{d\left(\frac{1-(1+\rho)^{t-T}}{\rho}\right)} = -\frac{u\left(w^*\right) - u\left(w\right)}{\underbrace{-\left[u'(w) - C^* u''(w)\right]}_{<0}} > 0,$$

$$\frac{dC^*}{dw^*} = -\frac{u'\left(w^*\right)\frac{1-(1+\rho)^{t-T}}{\rho}}{\underbrace{-\left[u'(w) - C^* u''(w)\right]}_{<0}} > 0,$$

$$\frac{dC^*}{dw} = -\frac{-u'\left(w\right)\frac{1-(1+\rho)^{t-T}}{\rho} - \left[u''(w)C^* - \frac{C^{*2}}{2}u'''(w)\right]}{\underbrace{-\left[u'(w) - C^* u''(w)\right]}_{<0}} \lesseqgtr 0,$$

$$\frac{dC^*}{d\left(-\frac{u''(w)}{u'(w)}\right)} = -\frac{-u'(w)\frac{C^{*2}}{2}}{\underbrace{-\left[u'(w) - C^* u''(w)\right]}_{<0}} < 0. \ [QED]$$

B. Proof of Proposition 3

Consider second-order Taylor expansions of the elements of (9): $u\left(w - C\right) \approx u(w) - Cu'(w) + \frac{C^2}{2}u''(w)$; $u\left(w^*\right) = u\left(w + \Delta w^*\right) \approx u(w) + \Delta w^* u'(w) + \frac{\Delta w^{*2}}{2}u''(w)$, $u\left(w + D\right) \approx u(w) + Du'(w) + \frac{D^2}{2}u''(w)$. Substitution into (9)

then yields:

$$0 = \underbrace{u(w) - C_j u'(w) + \frac{C_j^2}{2} u''(w)}_{u(w-C_j)}$$
$$+ \left[p_j \underbrace{\left(u(w) + \Delta w^* u'(w) + \frac{\Delta w^{*2}}{2} u''(w) \right)}_{u(w^*)} + (1-p_j)\, u\,(w) \right] \frac{1-(1+\rho)^{t-T}}{\rho}$$
$$- \left[\underbrace{u(w) + D u'(w) + \frac{D^2}{2} u''(w)}_{u(w+D)} + u\,(w)\, \frac{1-(1+\rho)^{t-T}}{\rho} \right].$$

Dividing by $u'(w)$ and letting $A(w) = -\frac{u''(w)}{u'(w)}$ allows one to simplify this expression to:

$$0 = -C_j - \frac{C_j^2}{2} A(w) + p_j \Delta w^* \left[1 - \frac{\Delta w^*}{2} A(w) \right] \frac{1-(1+\rho)^{t-T}}{\rho} - \left[D - \frac{D^2}{2} A(w) \right]. \tag{12}$$

Now this indifference relationship holds for any gamble .(C_j, p_j). It follows, for gambles (C_j, p_j) and (C_k, p_k), that $-C_j - \frac{C_j^2}{2} A(w) + p_j \Delta w^* \left[1 - \frac{\Delta w^*}{2} A(w) \right] \frac{1-(1+\rho)^{t-T}}{\rho} = -C_k - \frac{C_k^2}{2} A(w) + p_k \Delta w^* \left[1 - \frac{\Delta w^*}{2} A(w) \right] \frac{1-(1+\rho)^{t-T}}{\rho}$, and thus that:

$$0 = C_j - C_k + \left(\frac{C_j^2}{2} - \frac{C_k^2}{2} \right) A(w) + (p_k - p_j)\, \Delta w^* \left[1 - \frac{\Delta w^*}{2} A(w) \right] \frac{1-(1+\rho)^{t-T}}{\rho}. \tag{13}$$

Combining equations (12) and (13) then allows one to solve for the discount rate ρ and the coefficient of absolute risk-aversion $A(w)$ as given in the Proposition. $[QED]$