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SALE OF VISAS: A SMUGGLER'S FINAL SONG ?

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Abstract

Is there a way of eliminating human smuggling? We set up a model to simultaneously determine the provision of human smuggling services and the demand from would-be migrants. A visa-selling policy may be successful at eliminating smugglers by eroding their profits but it also increases immigration. In contrast, repression decreases migration but fuels cartelized smugglers. To overcome this trade-off we show that legalisation through selling visas in combination with repression can be used to weaken human smuggling while controlling migration flows. Our results highlight the complementarities between repression and selling visas and call into question current policies.

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Keywords : migration, human smuggling, market structure, legalisation.

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1 Introduction

Crossing borders illegally entails very high financial costs. This is true for the border from Mexico to the US or from Libya to the EU with smugglers fees ranging from $2,000 to $10,000.[1] Costs are even higher for long distance migration, which is difficult to undertake without the help of smugglers. For example, crossing to the UK from Afghanistan with fake identification costs above GBP25,000 and from China above GBP40,000.[2] This makes human smuggling a lucrative business. Total income raised by smugglers who operate between Mexico and the US is estimated around 6 billion dollars per year (UNODC 2010). The European market, which is more fragmented due to its multiple points of entries, is harder to evaluate.[3] Nevertheless it is sizable and is booming since 2015 with the surge of refugees from Syria, Afghanistan and Iraq. Over the years, human smuggling has merged with other types of illegal transnational activities such as drug shipping and prostitution (UNODC 2010). Led by international criminals organizations, sometimes in connection with terrorist organizations (Vaicius and Isacson 2003), these activities pose a threat to the rule of law in countries of origin, transit, and destination.

Although it is important for policy makers to understand how to control such criminal networks, there are surprisingly very few studies on the supply side of illegal migration (noticeable exceptions are Friebel and Guriev, 2006, Gathmann, 2008 and Tamura, 2010, 2013). Our paper contributes to this literature, first, by studying the industrial organization of smuggling, notably smugglers' pricing and supply of services. Second, by exploring what type of economic policies can be implemented to weaken smugglers and their

[1]For fees between Mexico and the US see UNODC (2010). For fees between Libya and the EU see "Smugglers use social media to lure migrants in the Mediterranean" by Christopher Miller April 25, 2015. http://mashable.com/2015/04/25/mediterranean-smugglers-facebook/.

[2]See the website http://www.havocscope.com/black-market-prices/human-smuggling-fees/ which gives references to its sources of information.

[3]Padgett (2003) reports that in 2003 smugglers earned over €4 billion in the EU and $5 billion revenues in the US.

associated criminalities.

Current migration policies, which combine quotas on visas with repression of illegal migration, are very ineffective against smugglers.[4] In fact, strong restrictions on labour mobility imply that many candidates are obliged to arrange migration with the help of intermediaries who organise air, sea or ground transportation and provide them with forged documents, clothes, food and accommodation during the trip. The market of illegal migration is large with illegal migrants representing sizeable proportions of foreign populations living in high wages countries. In the USA, 11 million of immigrants do not have legal status, representing 3.5% of the total population (Morehouse and Blomfield 2010). Most of them came across the Mexican land border and 90% of them were assisted by small scale professional smugglers, who are in large number (UNODC 2010). This market alone raises more than US$5 billion revenue annually.[5]

In Europe, the market is smaller than in the US, with an estimated 1.8 to 3.3 million irregular foreign residents living in the EU15, representing 0.46% to 0.83% of the population in 2008.[6] The market is also more fragmented. Since the routes for migration from sub-Saharan Africa to Europe are shifting in response to enforcement efforts, the smugglers are often opportunistic entrepreneurs who take advantage of the 42,672 km of coasts and 8,826 km of land borders of the Schengen area to smuggle people. And in some countries like the UK smugglers are involved in around 75% of detected cases of illegal border crossing (IND, 2001). Recently, there has been an expansion of human smuggling due to the wars in Syria, Afghanistan and Iraq, pushing more

[4]Worldwide, the International Labour Organisation estimates that 10% to 15% of migration today involves migration under irregular situations (http://www.ilo.org/public/libdoc/ilo/2006/106B09_492_engl.pdf).

[5]The Mexican Migration Project estimates that the probability of being apprehended at the border is about 20% for Mexicans. Some 661,000 Mexicans were apprehended at the border in 2008. Five times 661,000 is 3.3 million entries. If 90% of these entries are made through a smuggler and the amount paid per entry is US$2,000 on average this yields approximatively 6 billion in 2008 (UNODC 2010).

[6]See http://clandestino.eliamep.gr/ or Dustmann and Frattini, 2011.

than 1 million people to cross the Mediterranean Sea in 2015. Smugglers, who are mainly based in Libya, are packing migrants in boats for fees varying between 2,000 and 10,000 euros[7] and overload them to maximise their profits. This resulted in an estimated 4,000 people drowned while trying to cross the Mediterranean Sea in 2015.[8]

The smuggling markets on these two main routes (Latin America to the US and Africa to Europe) appear to be in the hand of many small smugglers. However, before the recent refugee crisis, it was estimated that half of the irregular migrants entering the EU were arriving by plane, either overstaying after the expiration of short term visas, or with fraudulent documentations provided by smugglers.[9] For long haul migration the smuggling market is more concentrated as it involves more sophisticated operations and requires larger and broader networks to transport illegally people over long distance (UNODC 2014). Prices are also higher.

Since repressive policies are ineffective at curtailing smuggling, this paper proposes legalisation to weaken human smuggling and its associated negative externalities. Our analysis shows that the sale of visas at smugglers' price, or higher, will not be sufficient to eliminate smugglers. Indeed prohibition creates a barrier to entry into the market. Criminal organisations rely on this legal barrier, and on violence, to cartelize the industry and to charge high prices. Smugglers will respond to the sale of visas by lowering the price they propose and still make a profit. We may also expect the high prices charged by smugglers not to affect all immigrants equally but to act as a positive selection with higher prices disproportionately reducing the flow of lower income immigrants.[10] In this context, a sale of visas will increase

[7]"Smugglers use social media to lure migrants in the Mediterranean Sea" by C. Miller April 25, 2015. http://mashable.com/2015/04/25/mediterranean-smugglers-facebook/

[8]"Migrant crisis: Migration to Europe explained in graphics" 28 January 2016 BBC News http://www.bbc.com/news/world-europe-34131911

[9]http://www.gla.ac.uk/media/media_147171_en.pdf CLANDESTINO Project, Final Report, November 2009

[10]Similar effects were reported by multiple contemporary accounts following the

migration flows and lower the average skill composition of migrants. In other contexts, in which migrants may come from the lower or middle parts of the skill distribution, we also find that a sale of visas will increase migration flows and widen their skill diversity. We then explore a policy, which combines visa pricing tools to push the smugglers out of the market and repressive tools to limit the subsequent increases in migration flows.

To be more specific, in our model the demand comes from individuals who choose to work in the foreign country or in the origin country, weighing the benefits of higher wages in foreign countries against migration costs. Migration price is determined by smugglers who maximise their profits. Policies shape the market structure. They may reinforce the market power of the smugglers by increasing their costs to operate and hence their prices, or force them to propose lower prices to compete with the visas on sale. We will see that neither traditional repressive measures nor pricing tools through the sale of visas are satisfactory policies. The former helps to control migration flows but, far from suppressing smugglers, they may even increase their market power and the price paid by the migrants for their service. The latter help to eradicate smugglers' activities at the cost of substantially increasing migration flows.

In advanced economies this outcome is difficult to sustain politically as there is a strong popular demand for migration control. For instance, a recent poll shows that immigration is now seen by European citizens as the most important issue facing the EU and 85% of all EU citizens surveyed in 2015 agree that additional measures need to be taken to fight illegal immigration from outside the EU.[11]

The paper then explores how a combination of pricing tools and repression measures can be used in a more innovative way to weaken smugglers

cartelization of the shipping industry at the turn from the 19th to the 20th century (see Deltas et al 2008).

[11]See Eurobarometer83, Spring 2015: http://ec.europa.eu/public_opinion/archives/eb/eb83/eb83_first_en.pdf

while achieving pre-defined migration targets. We do not discuss the optimality of such targets, which in our set-up can be low or high, nor the restrictive migration policies adopted by most advanced economies or their lax enforcement (for an analysis of such issues see Facchini and Testa, 2011). We simply explore how the sale of visas combined with various repressive measures may be effective at weakening smugglers, or even eradicating them depending on the objective, while controlling migration flows.

The rationing mechanism of our policy is through pricing the visas at the level that squeezes smugglers' profits. It is thus qualitatively different from current policies: it does not impose quotas on specific visas, which has the perverse consequence to generate markets for illegal services for those who are not eligible. And the visas we propose are sold at a competitive price in order to legalise migration flows by pushing smugglers out of business. These visas are thus in nature and scope very different from the "Golden Investor Visas" sold by many countries around the world, which leave a large margin for smugglers to operate on "low-costs" markets (see more details in the policy conclusions).[12]

The rest of the paper is organised as follows. The next section positions our paper in the literature. Section 3 presents the set-up of the model and the market structure for illegal migration under *status quo* (absence of legalisation). Section 4 analyses the effects of introducing pricing tools and repressive measures on smugglers' profits and migration flows. Section 5 discusses the robustness of the results and their policy implications. Section 6 concludes.

[12]This legalisation policy is also very different from exceptional amnesties, which have been repeatedly granted in the past to illegal migrants living in European countries such as Spain, Greece or in the US and pose an obvious problem of time consistency and credibility of the state. See Chau, 2001, Epstein and Weiss, 2001, Karlson et al., 2003, Solano, 2009 on the rationale and optimal design of amnesties. See Maas, 2009, on their questionable effectiveness at decreasing the number of illegal migrants.

2 Links with the literature

Despite the growing interest in human smuggling and the policy issue of migration control, there have been surprisingly very few studies on the supply side of the market for illegal migration. Friebel and Guriev (2006) model how smugglers establish labour/debt contracts with poor migrants, which force them to repay their fee. In this context, they show that deportation and border control policies do not have the same effects on illegal migration: stricter deportation policies may increase the flow of illegal immigrants and worsen the skill composition of immigrants while stricter border controls decrease overall immigration and may result in an increase in debt-financed migration. A key assumption of their model is that migrants are liquidity constrained and cannot pay upfront the fee, which gives rise to these contracts.[13] In a different context where contracts are not legally enforceable between traffickers and smuggled migrants, which leads to migrants' exploitation, Tamura (2010) shows that destination countries with limited resources may prefer to improve the apprehension of smugglers and their clients at the border rather than inland. Similarly, in a setting of asymmetric information, Tamura (2013) shows that improved inland apprehension may increase the incidence of migrants exploitation.

Our paper complements this literature by studying the industrial organisation of the smuggling industry. In particular it helps to explain where the high prices, which lead to the establishment of labour/debt contracts first analysed by Friebel and Guriev (2006) come from. Since our focus is on weakening smugglers through the sale of visas we do not detail how migrants finance migration costs. However our results apply to the market of liquidity constrained migrants who have to borrow to pay for the illegal crossing

[13]Migrants may also respond to these debt labour contracts by choosing optimally the duration of repayment period and consumption behaviour and this affects the complementarities between border controls, deportation measures and employer sanctions as studied by Djajić and Vinogradova, 2013, 2014.

(either from a bank, the family network or a smuggler). Borrowing reduces the net income liquidity constrained migrants will get out of the migration investment, as they have to reimburse their debt.[14]

Gathman (2008) models how the re-inforcement of the Mexican to US borders affects the flows of undocumented workers to the US, showing weak deterrence effects on flows but significant increases in prices charged by smugglers as their costs of operation are higher. In the same line, we investigate the effects of several types of migration policies on the price for human smuggling services and the equilibrium of the human smuggling market. Our set of policies is larger as it includes different types of repression and an innovative visa selling policy to weaken the market power of smugglers. Moreover, we leave completely flexible the degree of market concentration. Our model embeds all possible cases, encompassing the two extreme cases of monopoly and perfect competition modelled by Gathmann (2008) and the cases of oligopolistic markets organised by highly cartelised networks of smugglers documented by the literature on the economics of crime (Aronowitz, 2001; Futo and Jandl, 2007; Guerette and Clarke, 2005; Lundgren, 2008). Since cartelisation of smugglers varies across routes and may also change over time, our framework allows us to straightforwardly endogenise the number of smugglers operating on a route to capture some effects of increased repression in our general set-up of human smuggling markets.

In contrast to Gathman (2008) we are interested in individuals who can only use the services of smugglers to migrate illegally. This suits the evidence on illegal migration from Africa to Europe through the Mediterranean and on long haul migration, where the presence of several borders and geographical obstacles such as seas, generally prevent individuals from undertaking the

[14]Note that financial constraints are likely to be less binding with the introduction of visas as migrants could more easily get loans. And legalisation diminishes the scope for human trafficking as laws can be more easily enforced against exploitative smugglers (see Friebel and Guriev, 2006, on indebted migrants; Tamura, 2010, 2013 or Mahmoud and Trebesch, 2010 on trafficked migrants).

crossing by their own means. This is also consistent with the bulk of illegal migration to the USA from Mexico, where it is estimated that 90% of the illegal migrants use the services of coyotes (UNODC 2010). And regarding the design of innovative policies to erode smugglers' profits, the possibility to cross without using their services would only weaken their position as they now face competition from the two ends of their demand (on the high end from individuals who will pay for visas, on the low end from individuals using their own means to cross). If anything it makes it easier for a government to weaken them through the legalisation policy we propose.

As highlighted in our paper, the cost-effectiveness of the policies we study strongly depends on several key parameters that affect the elasticities of migration demand. The empirical literature on the effectiveness of border enforcement measures (Donato et al., 1992, Massey and Espinosa, 1997, Hanson and Spilimbergo, 1999, Hanson et al., 2002, Angelucci 2012) has focused on cross border migration between the US and Mexico and points to a small or insignificant effect of stricter deportation rules and stricter border controls after the Immigration Reform and Control Act on migration flows (for a review see Hanson, 2006). For example, using detailed data on cross-border trips of illegal workers from the Mexican Migration Project, Gathmann (2008) shows that when the price to cross the border with the help of coyotes increases, migrants may choose to migrate by their own means and forego the services of smugglers by taking additional risks to cross the border in more remote areas.

It is striking that there is no empirical work on the effectiveness of repressive measures at the workplace, as for example, sanctions towards employers of illegal migrants. Yet policies targeting the users/consumers of the illegal services have proven to be very effective on other illegal markets such as prostitution in Sweden (Waltman 2011).[15] Other studies such as

[15]see also http://www.government.se/articles/2011/03/evaluation-of-the-prohibition-of-the-purchase-of-sexual-services/

Cadena and Kovak (2016) show that low-skilled Mexican-born immigrants responded strongly to changes in local labor demand in the US during the Great Recession, suggesting that abating demand for illegal work should lead to significant decreases in illegal migration.

Also striking is the lack of evidence on the price elasticity of long haul illegal migration. All we know empirically is that long distance *legal* migration responded strongly to changes in the market structure of shipping cartels at the beginning of the 20th century. This has been tested empirically by Deltas et al (2008), who show that the existence of relatively tight, well-organized cartels restricted the flow of transatlantic migrants below what would have occurred in a more competitive environment. This suggests that if the government manages to successfully monopolise the migration market through selling visas, it may also be able to regulate migration flows.

Finally, from a technical viewpoint, the theoretical literature on illegal immigration control focuses on risk neutral agents. Following the seminal paper by Ethier (1986), which highlights the interest of combining border and domestic enforcement measures to unbundle their wage effects from their effect on the volume of immigrants, Epstein et al. (1999), Schiff (2011) and Djajić (1999, 2013) take into account more dynamic aspects, as migrants who enter legally may subsequently move into the illegal sector in order to avoid deportation. For simplicity of exposition, our results are also derived under the assumption that illegal migration entails no risk, or alternatively that migrants are risk neutral. However they still hold under the more realistic assumptions that illegal migration is risky and migrants are risk averse (see Auriol and Mesnard, 2012), which, with the noticeable exceptions of Woodland and Yoshida (2006) and Vinogradova (2010), has rarely been addressed in previous studies on illegal immigration control.

3 Migration equilibrium

This section studies the migration market equilibrium, when workers pay a migration price (fee) to the smugglers, p, to migrate illegally to a high wages destination country. We thereby assume that individuals need to hire a smuggler to migrate. For simplicity of exposition, the analysis is derived under the assumption that illegal migration entails no risk or alternatively that migrants are risk-neutral. In section 5 we discuss the robustness of our results to the introduction of risk. It turns out that they are fairly robust.

3.1 Demand for illegal migration

At the beginning of her working life of total duration 1, a worker maximises her lifetime utility. She chooses to locate either abroad or in her home country and consumes all her income.[16]

Potential candidates for illegal migration are heterogeneous according to their labour efficiency (or skill), θ, which is drawn from the distribution $F(\theta)$ with support $\left[\underline{\theta}, \overline{\theta}\right]$, $0 \leq \underline{\theta} \leq \overline{\theta}$. It is assumed that the distribution $F(\theta)$ is twice differentiable with a density function $f(\theta) > 0$. Term $\overline{\theta}$ can be interpreted as the threshold of skill/education level above which workers can apply for visas under the current system of selective migration characterising most OECD countries.

If there is no migration visa for sale, we assume that workers can only work in the illegal sector of the economy such that expected earnings abroad are $d\theta w_f$, with θw_f being the wages in the legal sector and $d < 1$. The discount factor d captures the fact that workers would have more opportunities if they worked legally rather than illegally.[17] We assume for the moment that d is

[16] As the model is static, there is no sequential decision. However would-be migrants internalize the risk of deportation and sanctions of their employers. In the risk-neutral case this translates into a lower expected wage to work in the illegal sector than in the legal sector.

[17] It is for example the case if they cannot easily change employer in the illegal sector or if they are caught in a debt-labour contract upon arrival (see Friebel and Guriev, 2006).

exogenous but we will relax this assumption in section 4.5.[18]

The worker knows the discounted income she will earn in the foreign country on the illegal market, $d\theta w_f$, which is assumed higher than the discounted income in home country θw_h:

$$dw_f > w_h$$

Note that the labour market is considered exogenous, which is justified by the fact that the number of workers on the labour market is very large as compared to the flows of migrants. [19] Earnings in the foreign country are used to pay the smuggler's fee p and to consume $\theta dw_f - p$. If the worker does not migrate, she consumes θw_h in the origin country.[20] Therefore the worker decides to migrate if her life time utility, equal to $u(\theta dw_f - p)$ in case she migrates, is higher than her utility in case she does not migrate, equal to $u(\theta w_h)$. With increasing utility functions and no risk, or risk neutrality (i.e., linear utility functions) the migration condition can be rewritten as:

$$\theta w_h < \theta dw_f - p$$

This is the simplest way to model the returns to skills leading to a positive selection of illegal migrants (i.e., a worker is more likely to migrate the higher her skill level, θ), which characterises long haul migration. Indeed "Greater distances, [...] and (for the poorest regions) the poverty constraint all imply that US and EU migrants coming from farther away should be more positively selected" (Hatton and Williamson, 2008). Accordingly, the empirical

[18]This will reflect the fact that employing undocumented workers is more costly as repression against employers is enforced.

[19]Empirical evidence shows very small or non significant impacts of immigration on wages of natives (see for instance Card 1990).

[20]She perfectly knows the wages per unit of time that she will get at home and abroad and the discount rate. She computes the net present value of her future flow of income. Since wages and discount rate are exogenous we avoid introducing separate notation and directly focus on net present values.

evidence on long haul legal migration points to positive selection (see Akee, 2010 on migrants from Federated States of Micronesia to the US during 1995-1997 or Beine et al, 2007 on migration to countries of the Organisation for Economic Cooperation and Development). Similarly, long distance illegal migration leads to a more positive selection of workers than that which has been documented for the Mexican cross border migration (see Rivera-Batiz, 2004 for a comparative analysis of Mexican and non-Mexican illegal migrants in the US and Camarota, 2012 for descriptive statistics on education and income by country of origin of both legal and illegal migrants in the US).

Modifying the assumptions of the model to capture differently the relative returns to skill in foreign/home country (see Borjas, 1987, Grogger and Hanson, 2011) only affects the type of workers self-selecting through migration but does not not change the main results of the paper.[21] Appendix E shows this for one case of negative selection and a similar reasoning can be extended to the case of an intermediary selection due to liquidity constraints in line with the mixed evidence on cross-border migration from Mexico to the US (Chiquiar and Hanson 2005, Orrenius and Zavodny 2005, Moraga 2011, Kaestner and Malamud, 2011, Angelucci 2013).

Solving for the skill level such that an individual is indifferent between migrating illegally or not, we obtain the illegal migration threshold θ^I written as:

$$\theta^I := \frac{p}{dw_f - w_h} \tag{1}$$

And aggregating over the distribution of skills, we obtain the demand for illegal migration as a function of migration price p:

$$D^I(p) = \int_{\theta^I}^{\overline{\theta}} f(\theta)d\theta = 1 - F(\theta^I) = 1 - F(\frac{p}{dw_f - w_h}) \tag{2}$$

[21] The sale of visas used as the only policy instrument leads to larger flows of migrants and increases their diversity (see Proposition 2). And the mechanism design of the combination of different instruments to achieve a double objective characterised in Proposition 3 remains the same whatever the type of selection or heterogeneity we may consider.

As θ^I increases with p and decreases with d, the demand for migration is higher the lower the migration price, p, and the higher the wage differential $dw_f - w_h$ between the two countries. It is worth noting that when individuals are risk averse and illegal immigration involves risk, there is a more positive selection of migrants, in the sense that the lower skill threshold of migrants lies above the one defined in (1) for risk neutral individuals (see Auriol and Mesnard 2012). This is an intuitive result. Since illegal migration involves risk, risk averse individuals are less willing to undertake the risky journey than risk neutral ones.

3.2 Supply of services

Because legal restrictions constitute barriers to market entry, the smuggling business is not competitive. A few criminal networks actually provide the service (see Aronowitz, 2001; Futo and Jandl, 2007; Guerette and Clarke, 2005, Lundgren, 2008). The longer the distances and the more complex the smuggling operations are, the more concentrated the sector is likely to be. However for other routes, such as the crossing of the Mediterranean Sea or of the land border between Mexico and the USA, there is a larger number of small enterprises. To take into account these different market structures we model the oligopolistic market for illegal migration as a generalized Cournot competition. We focus on symmetric equilibrium (i.e., each smuggler has the same market share). The generalized Cournot price with N smugglers, p^N, is such that:

$$\frac{p^N - c}{p^N} = \frac{1}{N}\frac{1}{\varepsilon_{D^I,p}} \tag{3}$$

where c represents their marginal costs, $\varepsilon_{D^I,p}$ is the price elasticity of demand and N is an integer greater than 1. The generalized Cournot competition demand, $D^I(p^N)$, is between the two extreme cases: $D^I(p^m) \leq D^I(p^N) \leq D^I(c)$ for all $N \geq 1$ where $p^m \equiv p^1$ in the monopoly case (when $N = 1$) and $p^\infty = c$ in the competitive case when $N \to \infty$. The detail of the computation

and an illustration in the case of uniform distribution is given in Appendix A.

Note that, in a more dynamic perspective, one could easily endogenise N, the number of smugglers on the market. Denoting K the level of sunk costs to enter this market, the number of smugglers N is the integer part of n such that $\pi(n) = K$ where $\pi(n) = (p^n - c)D^I(p^n)/n$ is the firm rent. Therefore any repressive measure increasing c or K reduces the number of smugglers on the market, N, thereby increasing the price they charge for their services, as captured by equation (3) above.

It is also worth noting that the smugglers might face different populations of migrants. Some of them might be more price sensitive and less risk averse than other. For instance, illiterate candidates from rural areas are different from educated workers from urban centers. If the oligopolistic smugglers can identify them, they will apply different prices to these different populations. As is standard with third degree price discrimination, groups endowed with the largest price elasticity will get the smallest price. In contrast captive migrants (i.e., groups with low price elasticity) face higher prices.[22]

4 Policies

Illegal activities linked to human smuggling entail large negative externalities for societies.[23] In Mexico for example, human smuggling is integrated with

[22] Assume that they are J different pools of migrants identified by $j = 1, ..., J$. The skill parameter of workers in group j are distributed identically and independently according to the density function $f_j(\theta)$ and distribution $F_j(\theta)$ over $\left[\underline{\theta}_j, \overline{\theta}_j\right]$. Their wages might also be type dependent: $\{w_{fj}, w_{hj}\}$. The demand for migration in group j is $D_j^I(p) = \int_{\theta_j^I(p)}^{\overline{\theta}_j} f_j(\theta)d\theta = 1 - F_j(\theta_j^I(p))$, where $\theta_j^I(p) = \frac{p}{dw_{fj} - w_{hj}}$. The optimal smuggler prices determined by (3) vary from one group to the other according to the price elasticity of its demand $\varepsilon_{D_j^I,p} = -\frac{pD_j^{I\prime}(p)}{D_j^I(p)}$.

[23] Trafficking victims coming from 127 countries have been found in 137 countries around the world. It is estimated that there are at least 2.4 million persons who are the victims of trafficking at any time. Approximately 79% of these victims are trafficked for sexual

the drug business and other criminal activities, which lead to high insecurity and became recently one of the main electoral concerns.[24] This is also true for OECD countries, where governments spend considerable resources in an attempt to eradicate this business. For example, Sweden and Australia have recently adopted strict policies against such criminal networks.[25] Similarly, in reaction to the most recent tragedy in the Mediterranean Sea the extraordinary EU summit on 23 April 2015 adopted a 10-point plan. This plan includes the reinforcement of EU border control operations (Triton and Poseidon) in the Mediterranean Sea with more equipment and an extension of the EU operation area. It also proposes a systematic effort to fight against smugglers by capturing and destroying their vessels. Finally, in the United States, billions are spent each year to protect the Mexican border from human smugglers (see the discussion in section 5.3).

One concern with the actual restrictive policies is that they never explicitly internalize the cost of the negative externalities (loss of human life, corruption, money laundering, violence, terrorism, slavery, etc) imposed by the criminal activities that emerge as a result of the prohibition. The policy makers who decide on the repression simply assume that it will work, while the police is dealing with the criminality in a separate way. From an economic perspective this is not efficient. Internalizing the costs of crime implies that the size of the illegal migration business has to be downsized. Whatever the migration target is, we study the optimal way to weaken these criminal networks. Before exploring different government policies in the next

exploitation and the rest for forced labour. They generate an estimated profit of over US$30 billion every year (UNODC 2012).

[24]The Economist, June 30, 2011. Time Magazine, August 12, 2003 : http://www.time.com/time/magazine/article/0,9171,474582-2,00.html

[25]In its budget 2011-2012 the Australian Government has for instance specifically earmarked "$292 million to support a new Regional Cooperation Framework that will help put people smugglers out of business and prevent asylum seekers making the dangerous journey to Australia by boat." See the Webpage of the Australian Government:
http://www.ag.gov.au/Publications/Budgets/Budget2011/Mediareleases/Pages/
Strengtheningourbordersthroughregionalcooperation.aspx

subsections, it is necessary to study how the illegal sector will react to various attempts to legalise the migration business.

To determine the pricing scheme for legal migrants the government, a Stackelberg leader, needs to take into account that the smugglers will react to its policy.[26] The model is thus solved by backwards induction.

4.1 Smugglers' reaction to sale of visas

In order to weaken smugglers the government might try to push them out of business by legalising the market for migration. To do so, it can create a permit to migrate permanently that people can buy. A simple idea would be to create a permit that will cost the same price, p^L, as the price imposed by the smugglers to illegal migrants, denoted p^I : $p^L = p^I$.[27] However, this policy will increase migration flows. Comparing the legal migration threshold, written as $\theta^L = \frac{p}{w_f - w_h}$, with (1), it is easy to see that, for any given migration price p, the legal migration threshold is always lower than the illegal one: $\theta^L(p) < \theta^I(p)$ $\forall p > 0$**.** This is because migration pay-offs are higher under legal than illegal migration, which increases the wage differential between foreign and home countries. More importantly such a pricing policy of legal migration will not eradicate smuggling.

By comparing the payoffs if an individual of type θ migrates legally, $\theta w_f - p^L$, with the payoffs if she migrates illegally, $d\theta w_f - p^I$, we can determine the threshold type, θ^L, defined as :

$$\theta^L := \frac{p^L - p^I}{(1-d)w_f} \tag{4}$$

such that any individual above this threshold prefers to migrate legally than

[26]Once the government announces its policy, it must stick to it to be credible. The smugglers adjust their prices in reaction to the legal offer.

[27]For simplicity, we consider that this price represents the total costs including migration costs paid by migrants to enter legally the foreign country since migration costs are typically small and depend strongly on the type of travel chosen.

illegally. We can easily check that $\partial\theta^L/\partial d > 0$. This simply says that the larger the income differential between the legal and illegal sectors, the more individuals prefer to migrate legally than illegally.

Using (1), we can write the threshold type $\theta^I = \frac{p^I}{dw_f - w_h}$ above which an individual prefers to migrate illegally through the smugglers than to stay in her origin country. If $\theta^L < \theta^I$ nobody chooses to migrate illegally. A constraint for the smugglers is to fix their price low enough as compared to the price of a legal permit in order to attract the workers of type between θ^I and θ^L.

This constraint can be written as : $\frac{p^I}{dw_f - w_h} < \frac{p^L - p^I}{(1-d)w_f}$ or, equivalently, as:

$$p^I < \frac{dw_f - w_h}{w_f - w_h} p^L \tag{5}$$

This shows that the lower the relative payoffs of illegal migration as compared to legal migration, captured by the ratio $\frac{dw_f - w_h}{w_f - w_h}$, and the lower the legal price of migration, p^L, the more difficult it is for the smugglers to satisfy this constraint.

Under this constraint, the demand faced by the smugglers is:

$$D^I(p^I, p^L) = \int_{\frac{p^I}{dw_f - w_h}}^{\frac{p^L - p^I}{(1-d)w_f}} f(\theta) d\theta. \tag{6}$$

Let $p^N(p^L)$ be the solution of (3) computed with the direct price elasticity of demand (6), $\varepsilon_{D^I, p^I} = -\frac{\partial D^I(p^I, p^L)}{\partial p^I} \frac{p^I}{D^I(p^I, p^L)}$, which depends on p^L . The price reaction function of the smugglers is the solution of the following equation:[28]

$$p^I(p^L) = \begin{cases} p^N(p^L) & \text{if } \; c \leq p^N(p^L) < \frac{dw_f - w_h}{w_f - w_h} p^L \\ \varnothing & \text{otherwise} \end{cases} \tag{7}$$

This shows that the reaction price of the smugglers is increasing in the

[28] Appendix C presents the closed form solution obtained in the uniform distribution case (see equation (26)).

marginal costs for smugglers to operate, c, in the price of visa, p^L, in the wage differential between foreign and home countries, $w_f - w_h$, and decreasing in the number of smugglers, N.

We are now ready to study how different economic tools can be used to weaken criminality and their effects on the migration market. We start with the limit case of the full eradication of the smugglers. This policy is optimal when the negative externalities generated by the mafias are very large.

4.2 Eliminating smugglers through selling visas

We first consider a policy, which aims at breaking all incentives to smuggle by selling visas at a low enough price, such that the smugglers will have non positive profits. This requires that the reaction price is pushed below the marginal costs, i.e. $p^I(p^L) \leq c$.

The threshold price, denoted $\underline{p}^L$, below which the smugglers exit the market is such that $\theta^L = \theta^I$ defined respectively in equations (4) and (1) for $p^I = c$. That is, $\underline{p}^L$ is such that: $\frac{\underline{p}^L - c}{(1-d)w_f} = \frac{c}{dw_f - w_h}$. This yields:

$$\underline{p}^L = \frac{w_f - w_h}{dw_f - w_h} c \tag{8}$$

In other words, the government that wants to push smugglers' reaction price down until their mark-up vanishes has to apply the price $\underline{p}^L$. Note that this result applies to any initial structure of the market for smugglers: monopolist, oligopolistic or competitive. Irrespective of the initial market conditions, if the government wants to eradicate smugglers by selling visas it has to apply $\underline{p}^L$ such that the smugglers end up reaching their marginal costs pricing.[29]

Comparing $\underline{p}^L = \frac{w_f - w_h}{dw_f - w_h} c$ and $p^\infty = c$ we can establish, since $d < 1$, that the price imposed by the government to eliminate the smugglers is higher than

[29]The same reasoning also holds irrespective of the way the competition between the smugglers is modelled in quantity, as modelled in the present paper, or in price.

the price imposed by smugglers under perfect competition. Nevertheless, the migration demand, which is now legal, can be written as:

$$D^L(\underline{p}^L) = \int_{\frac{c(\frac{w_f - w_h}{dw_f - w_h})}{w_f - w_h}}^{\overline{\theta}} f(\theta) d\theta$$

$$D^L(\underline{p}^L) = 1 - F\left(\frac{c}{dw_f - w_h}\right) \tag{9}$$

This demand is exactly the same as the demand for illegal migration under perfect competition of smugglers: $D^L(\underline{p}^L) = D^I(c)$. This is because, for a given migration price, more workers are willing to migrate legally than illegally. This result, which, as explained in Section 5, is robust to the introduction of risk aversion, is summarized in the next proposition.

Proposition 1 *The highest-price policy that reduces the number of illegal migrants to zero through the sale of visas yields the same level of migration as under perfect competition among smugglers.*

It is not possible to empirically test the predictions of Proposition 1 since no country has, so far, used such a pricing scheme to eradicate human smuggling. However, the theoretical framework, which is quite general, applies to other markets with positive demand and legal prohibition. The theory predicts that eliminating smugglers by legalising their activity will inevitably increase the demand of the formerly prohibited product or service. It is thus useful to look at other products and services, such as alcohol or sexual services, that are, or have been, successively prohibited and legalised to assess the relevance of Proposition 1. For example Miron and Zwiebel (1991) find that the consumption of alcohol fell sharply during the Prohibition in the US (1920-1933) and Poulin (2005) claims that the legalisation of prostitution in countries such as the Netherland, Germany or Australia, has generated an expansion of this industry.

It is clear that more empirical studies are called to understand the consequences of legalisation through a sale of visas. Yet, based on the theory and on the available empirical evidence on other illegal markets, we predict a sharp increase in migration flows if visas are sold at the price that drive the smugglers out of business. The higher the initial market concentration the larger the increase following the legalisation.

4.3 The policy trade-off: controlling migration flows

Such increases may not be acceptable in most OECD countries, where there is a strong popular demand for controlling migration flows (see section 1). As we mentioned earlier we do not discuss here the optimality of such an objective but simply analyse whether standard economic instruments can help to reach it. We thus study what happens if the government sells visas to control migration flows. A constraint for the government is that the price of these visas, p^L, has to be lower than $\overline{p}_L$, the threshold price above which no worker will migrate legally. This threshold is the minimum value of two constraints. The first one is such that someone at least prefers to migrate legally than stay at home. In principal-agent literature this type of constraint is referred to as individual rationality constraint (IR). The second threshold is such that someone at least prefers to migrate legally than illegally, referred to as the incentive compatibility constraint (IC).

- (IR) $\quad p^L \leq \overline{\theta}(w_f - w_h)$
- (IC) $\quad p^L \leq \overline{\theta}(1-d)w_f + p^I$

The legal migration is positive if and only if $p^L \leq \min\left\{\overline{\theta}(w_f - w_h), \overline{\theta}(1-d)w_f + p^I\right\}$. Since by assumption, $dw_f > w_h$ it is easy to check that the (IC) constraint is binding whenever the smugglers are active. Indeed $\overline{\theta}(w_f - w_h) > \overline{\theta}(1-d)w_f + p^I$ is equivalent to $p^I < \overline{\theta}(dw_f - w_h)$, which, by virtue of (1), necessarily holds when the smugglers are active. We deduce that

$\overline{p}^L = \overline{\theta}(1-d)w_f + p^I$. Since the smugglers price, $p^I(p^L)$, is endogenously determined in equation (7), the threshold $\overline{p}^L$ is a fixed point such that:

$$\overline{p}^L = \overline{\theta}(1-d)w_f + p^I(\overline{p}^L) \tag{10}$$

Under the assumption that $\frac{\partial^2 D^I(p^I,p^L)}{\partial p^I \partial p^L} \geq 0$, which is true as long as $f'(\theta) \leq 0$ (e.g., with a uniform distribution of skills $\frac{\partial^2 D^I(p^I,p^L)}{\partial p^I \partial p^L} = 0$), one can check that $\frac{dp^I(p^L)}{dp^L} > 0$ (see Appendix B). This implies that $\overline{p}^L$ exists and is unique. Indeed if $p^L = 0$ then $\overline{\theta}(1-d)w_f + p^I(0) > 0$, while $\overline{\theta}(1-d)w_f + p^I(+\infty) = \overline{\theta}(1-d)w_f + p^N < +\infty$ where p^N is defined in equation (3). We deduce that p^L and $\overline{\theta}(1-d)w_f + p^I(p_L)$ cross once and only once at $\overline{p}^L > 0$. It is worth noting that, contrary to $\underline{p}^L$ which is invariant, $\overline{p}^L$ decreases in N the number of smugglers active in the market, an intuitive result.

We want to study the objective function of a government that would aim at minimizing the increase in migration flows following the introduction of sale of visas. Since the status quo level of immigration is independent of the new policy to sell visas, this objective is equivalent to minimizing migration flows following this scheme. By using (1) the objective function is :

$$\min_{p^L \leq \overline{p}^L} \int_{\frac{p^I(p^L)}{dw_f - w_h}}^{\overline{\theta}} f(\theta)d\theta = \min_{p^L \leq \overline{p}^L} \left[1 - F\left(\frac{p^I(p^L)}{dw_f - w_h}\right)\right] \tag{11}$$

where the government internalizes the reaction function of the smuggler $p^I(p^L)$ in (7). Since $\frac{dp^I(p^L)}{dp^L} > 0$ differentiating equation (11) with respect to p^L yields $-\frac{1}{dw_f - w_h} f\left(\frac{p^I(p^L)}{dw_f - w_h}\right) \frac{dp^I(p^L)}{dp^L} \leq 0$. A government, which aims at minimizing migration flows, will fix the highest possible price for its visas $\overline{p}^L$.

The migration demand under such policy is higher than in the case of an unconstrained smuggler oligopoly. Indeed when $\overline{p}^L \leq p^L \leq \overline{\theta}(w_f - w_h)$, the smugglers are the only ones to be active on the market as nobody wants to migrate legally if the smugglers apply their optimal reaction price $p^I(p^L)$. However they cannot apply the unconstrained oligopoly price p^N of equation

(3) as some migrants would then choose legal migration, lowering the smugglers' profit. This entails larger migration flows even though no visa is sold in such case.[30]

Figures 1 and 2 illustrate this result in the uniform example. Figure 1 shows the price reaction function charged by smugglers, $p^I(p^L)$, as defined by (7) where the slope of the active part of the reaction function, $p^N(p^L) = \frac{p^L}{N+1}\frac{dw_f - w_h}{w_f - w_h} + \frac{N}{N+1}c$, decreases with $N \geq 1$ (see equation (26) in the appendix). It becomes flat when N goes to infinity (i.e. it converges to the constant value of c).[31] Figure 2 shows the corresponding total demand for migration, which is clearly higher when visas are on sale (on the left of the picture) as compared to the situation of unconstrained smugglers. These Figures illustrate that, for a given level of investment in repression, the government has the choice between different policies. One extreme policy represented on the left of the pictures is to sell visa at a price below $\underline{p}^L$ such that the smugglers are eradicated and only legal migrants are entering the country. In this case (total) migration flows are the largest. At the other end (on the right side) migration flows are minimized but the smugglers are making the highest possible rents as they behave unconstrained. For intermediate situations, the smugglers are weakened (their profits are smaller) but flows are larger. Depending on its objectives a government may choose any outcome varying in the feasible range.

Moreover, larger migration flows following a sale of visas lead to increasing the skill diversity of migrants. This effect is stronger if one takes into account that individuals are risk averse and illegal immigration involves risk, which

[30] Smugglers are unconstrained to apply the oligopolistic price only if $p^L > \overline{\theta}(w_f - w_h)$.

[31] With the uniform distribution example, replacing $p^I(p^L) = \frac{p^L}{N+1}\frac{dw_f - w_h}{w_f - w_h} + \frac{N}{N+1}c$ into (10) the upper limit for the visa price satisfies: $\overline{p}^L = [Nc + (1+N)(1-d)w_f]\frac{w_f - w_h}{(1-d)w_f + N(w_f - w_h)}$. Comparing the reaction smugglers price $p^I(\overline{p}^L)$ with the unconstrained smugglers' oligopoly price p^N defined in (3) it is straightforward to check that $p^I(\overline{p}^L) \leq p^N$ if and only if $dw_f - w_h \geq c$, which is the necessary condition for the smugglers being active in the first place (see Appendix C).

increases the demand for visas as compared to the situation where they are risk-neutral. This implies that, in the context of positive selection observed through long haul migration, the buyers of visas will be drawn from a larger pool of workers. This will decrease migrants' average skill level and the reverse is true with negative selection. The next proposition, which is robust to the introduction of risk-aversion, summarizes the main findings of the section:

Proposition 2 *A sale of visas necessarily increases the total number of migrants and increases their skill diversity.*

Proposition 2 implies that a government that aims at minimizing the demand for migration, cannot do better than an unconstrained monopoly smuggler. So, if the objective is to decrease the total number of migrants, there are more effective policies than selling migration visas.

4.4 Controlling migration flows through increased repression

Using our previous results it is straightforward to check that any instrument that either increases the costs for smugglers to operate, c, or to enter the market, K, or decreases the benefits gained by illegal migrants, d, decreases migration demand.

However, the analysis of smugglers pricing behavior outlines that repressive policy measures may have very different effects depending on whether they directly affect the smuggling business or the demand for their services: any measure which increases the marginal costs for smugglers to operate, c, such as increased border enforcement, or which increase the costs to enter the market, K, will necessarily increase their cartelisation and increase the fees paid by would be migrants. This has been documented by Roberts et al (2010) who show that the increase in enforcement on the Southwest border of the US accounted for all of the increase in smuggling costs during

2006-2008 and half of it during 2004-2008. They also note that rising smuggling prices during 2004-2008 also "indicate increased demand for smuggling services whose supply is limited, or changing characteristics of the marketplace such as the formation of cartels by smugglers". In contrast, measures, which decrease the benefits of illegal migration through a decrease in d, such as sanctions to employers of illegal workers that are transmitted into lower wages paid to illegal migrants, decrease the fees charged by smugglers (see for example equation (18) in Appendix).

4.5 Migration control through sale of visas

So far we have considered two types of policies: one policy relies on visa pricing schemes to eliminate smuggling, while the other policy is essentially repressive and aims at controlling illegal migration flows. Both solutions are politically unsatisfactory. The former leads to an increase in migration flows, while the latter does not eradicate smugglers and increases their market power (i.e., market concentration). In what follows we explore how a combination of both types of approaches might help to simultaneously fight the smugglers and control migration flows. This is perhaps not surprising as two policy instruments are generally needed to achieve a double objective (see for example Ethier, 1986).

We start from the status quo situation where the marginal cost to smuggle is c and the discount rate to work as an illegal workers is d. The government can allocate funds to increase the smugglers' marginal costs by reinforcing "external" (or border) controls. We denote $c(R_1)$ the marginal costs that the smugglers face when the government invests $R_1 \geq 0$ in additional repression. We assume that, in the absence of additional investment, the marginal costs of the smuggler are the status quo level: $c(0) = c$. Moreover we assume that $c'(R_1) > 0$ and $c''(R_1) < 0$. The concave shape indicates decreasing returns to scale in the fight against smugglers.

Similarly, the government can allocate funds to increase "internal" con-

trols at worksites and enforce the sanctions paid by the employers of illegal migrants. We denote $d(R_2)$ the illegal migrant wage discount factor resulting from increased enforcement measures. Here again we assume that, in the absence of additional investment $d(0) = d$, and that $d'(R_2) < 0$[32] and $d''(R_2) > 0$. The convex shape indicates decreasing returns to scale in the fight against illegal employment.

Replacing c by $c(R_1)$ and d by $d(R_2)$ in (8), we can determine the new legal migration price such that smugglers do not have any interest to operate given their inflated marginal costs and reduced migrant wages:

$$\underline{p}^L(R_1, R_2) = \frac{w_f - w_h}{d(R_2)w_f - w_h} c(R_1) \tag{12}$$

We deduce that the increase in demand following the introduction of the sale of visas for legal migration would be defined in (9) with the price $\underline{p}^L$ being replaced by $\underline{p}^L(R_1, R_2)$:

$$D^L(R_1, R_2) = 1 - F\left(\frac{c(R_1)}{d(R_2)w_f - w_h}\right) \tag{13}$$

Finally, the government chooses the investments R_1 and R_2 so as to minimise the increase in migration flows following the introduction of visas, under its budget constraint B as follows:

$$\min_{R_1, R_2} D^L(R_1, R_2) \qquad \text{s.t.} \qquad R_1 + R_2 \leq B. \tag{14}$$

Focusing on interior solutions the optimal allocation of resources, which is derived in Appendix D, is summarized in the next proposition.[33]

[32] See Woodland and Yoshida (2006) for a theoretical foundation of this assumption and Cobb-Clark et al. (1995) for empirical evidence.

[33] Depending on the functions $c(.)$ and $d(.)$ it may be the case that the optimal solution involves increasing c only (i.e., $R_2 = 0$) or decreasing d only (i.e., $R_1 = 0$). However, in other cases there will be an interior solution defined in (15) and so that $R_1 + R_2 = B$.

Proposition 3 *A government with a budget constraint of $B > 0$ that aims at dismantling smugglers while limiting the increase in migration flows following the legalisation invests the amounts (R_1^*, R_2^*), solution of $R_1 + R_2 = B$ and of the following equation:*

$$\frac{c'(R_1)}{c(R_1)} = \frac{-d'(R_2)w_f}{d(R_2)w_f - w_h} \tag{15}$$

Under the government budget constraint, the optimal allocation of the budget for repression is such that the marginal impact of R_1 on D^L is equal to the marginal impact of R_2 on D^L, as shown by (15). In other words, whatever its migration target, the government should equalize the marginal impact of investment in reinforcing border controls and in employers' sanctions on the demand for legal migration.

Since the demand for visas is a normal good and since $c'(R_1) > 0$ (alternatively $d'(R_2) < 0$) it is straightforward to check that $\frac{dD^L(R_1,R_2)}{dR_1} < 0$ (and that $\frac{dD^L(R_1,R_2)}{dR_2} < 0$). When repression against smugglers increases, the marginal cost of their activity, c, increases, which is transmitted to the smugglers' price. Similarly, when sanctions are enforced against employers of illegal migrants, this is transmitted to the payoffs of migrants through a decrease in d. As a result the government can raise the price of visas that eliminates smugglers from the market. This policy enables the government to control migration flows without relying on the help of smugglers. Indeed, by construction, such policy pushes smugglers out of the market by eroding their profits.

The optimal allocation of investment between internal and external repression defined in (15) is very general. It does not depend on the government migration target, nor on the amount of ressources the government is willing to allocate to repression. As a special case, we consider a policy where the funds raised from the sale of the legal permits are used to finance the additional investments in repression. If the government does not want to

increase the budget deficit, it will have to use the resources from the visas sale to fund the additional investments in repression such that the budget constraint becomes:

$$R_1 + R_2 = D^L(R_1, R_2)\underline{p}^L(R_1, R_2). \tag{16}$$

Proposition 3 is still valid but now $R_1 + R_2 = B$ is replaced by (16), where the budget B is endogenously defined. Moreover, enforcing the fines paid by employers of undocumented workers may contribute to raising funds in addition to the sale of visas, which could easily be embedded into our model by adding a term (increasing with R_2) on the right hand side of the budget constraint in (16).

Alternatively we consider the objective to keep constant the level of migration (or any other quantitative objective) following the legalisation scheme by allocating scarce resources into different types of repression. The problem is technically very similar. To see how it concretely works, let assume that the skill distribution is uniform. The demand for illegal migration is $\frac{N}{N+1}\left(1 - \frac{c}{dw_f - w_h}\right)$ (see Appendix A). If the government aims at keeping migration constant following legalisation through the sale of visa it must choose repression levels so that $D^L(R_1, R_2) = 1 - \frac{c(R_1)}{d(R_2)w_f - w_h} = \frac{N}{N+1}\left(1 - \frac{c}{dw_f - w_h}\right)$. This equation and equation (15) determine the level of investments R_1^* and R_2^*, and hence the budget, which allows the government to reach the objective of zero migration increase under the legalisation scheme.

5 Robustness and Policy Implications

5.1 Robustness to risk

So far we have considered either situations entailing no risk or risk neutral individuals. These assumptions are not realistic. As migrating illegally entails important risks and individuals are risk averse, this may be of sig-

nificance to determine the number and type of migrants. It is important to check the robustness of our basic results to the introduction of risk and risk aversion. We conduct this robustness check exercise in Auriol and Mesnard (2012). We extend the base model by introducing standard CARA utility function $u(x) = 1 - exp(-ax)$, where a is the absolute risk aversion parameter. We also assume that illegal migration entails a risk: once migrants pay the sunk costs to the smugglers and reach the destination country, they may stay abroad with probability $1 - q$, but have a probability q of being deported and sent back to their home country. With risk averse migrants the government has one more instrument to raise the visa price that drives the smugglers out of business and, hence, limit migration flows. By investing in repression it can, as before, increase marginal costs for smugglers to operate (e.g., through borders' controls), or decrease the benefits of working as an illegal worker (e.g., through employers' controls). In addition, it can also increase the probability of deportation q (e.g., through internals' controls). This new instrument is relevant only under risk aversion.

Compared to the risk-neutral case the introduction of risk aversion tends to lower the demand for illegal migration, an intuitive result. On the one hand, in the absence of legal pricing schemes, illegal migration flows are lower if individuals are risk averse than if they are risk neutral. On the other hand, selling visas decreases illegal migration flows even further since risk-averse individuals are less willing to bear the risk of deportation. As a result the visa price, which drives the smugglers out of business, is higher with risk (when individuals are risk averse and illegal immigration involves risk) than without. Apart from this straightforward changes of the equilibrium thresholds the exercice shows that the results in Proposition 1 and 2 are robust to the introduction of risk. Proposition 3 is modified to integrate the new repressive tool q, which is the probability of deportation. The logic of Proposition 3 is maintained throughout. The government allocates its budget between border controls, employers' sanctions and deportations of illegal migrants, to

equalise their marginal effect on demand for illegal migration. We also find that the amount of investment in deportation is higher than the investment allocated to minimise expected earnings from illegal migration. This result, in line with Becker (1968), simply states that since individuals are risk averse, they respond more strongly to a change in the probability of deportation than to a "compensated" change in their earnings, which would leave equal their expected earnings from migrating illegally.

5.2 Policy implications

The robustness exercise with risk also highlights the strong complementarities between different types of instruments used to control migration flows and the proposed policy of selling visas to squeeze smuggler's profits. For example the additional investments in internal/external controls required to legalise and limit the subsequent increases in migration flows decrease with the probability of deportation. Intuitively, as risk to migrate illegally increases, smugglers have to lower their margin to be able to attract risk-averse migrants. It is therefore easier to drive them out of business and keep migration demand constant following the legalisation policy we propose through a sale of visas.

This relates to the cost-effectiveness of the policy: how effective is this legalisation policy at limiting the increase in migration flows without weighing too much on public finances? The answer depends also strongly on the elasticities of the functions $c(R_1)$ and $d(R_2)$. Policy makers have to take into account that these elasticities vary from one country to the other. For example, when there is a physical border between two countries it is difficult to rise smugglers' costs by increasing repression as documented for the Mexico -US migration. Hence, the elasticity of the function $c(R)$ is likely to be low. By contrast, in the case of long-haul migration, it might be easier to increase smugglers' costs by reinforcing external controls. Similarly, the elasticity of the function $d(R)$ to an increase in internal repression (for example through

controls at the workplace which increase the costs to employ illegal workers) is presumably different in countries with a large informal sector than in countries with a small informal economy. With inelastic functions $c(R_1)$ and $\delta(R_2)$ the equilibrium price of migration visas will be quite low. Such a policy of legalisation will be ineffective at limiting migration flows, unless investments into additional repression are extremely large. This may pose a policy trade-off: high burden on public finances or large increase in migration flows, which will be hard to sustain politically.

Moreover, in practice, the way the repressive policy is set up is very important. The goal is to raise the smugglers' costs to increase their concentration, and not necessarily to dismantle existing cartels. Breaking established smugglers networks might give rise, through the emergence of several smaller smuggler networks, to more competition in the illegal migration business and, hence, to lower prices and higher demand.[34]

5.3 Links with current policies

The idea of selling visas has already fed many debates in the general press and blogs, and policy proposals have discussed different ways of implementing it, notably through auctions (Simon, 1989, Becker, 1992, the Becker-Posner blog of 31rst July 2005, Freeman, 2006, Saint Paul, 2009, Orrenius and Zavodny 2010, The Economist, 24 June 2010).[35] Despite the controversy, selling visas

[34]The failure of the "war on drugs" launched in the United States in the 1980s has been partly explained by such effects. The US authorities decided to infiltrate the drug mafia to dismantle it. The infiltration operation, which was very costly, was successful. The dismantling of the well organized cartels which followed gave rise to the emergence of many smaller drug networks fighting fiercely in price to gain market share. As a result, the consumption of cocaine increased in the US (see Poret 2002).

[35]The proponents argue that selling visas allows a government to both collect money and better control migration flows. The opponents argue that the sale of visas may generate a new type of bonded labour between indebted migrants and their employers and that the market does not necessarily allocate resources efficiently. However these arguments are even more compelling for the illegal migration market, on which candidates are less likely to get formal loans to pay the high smugglers' fees. With the same aim of designing

to eliminate the smuggling industry and regulate the migration market has not yet been analysed. Our approach allows us to derive tractable results on the effects of a large set of policy measures - sale of visas versus more traditional repressive policies through border enforcement, deportation or employers' sanctions - on the equilibrium of the market for smuggled migrants. Our results show that only a combination of them may be effective at both weakening smugglers' businesses and controlling migration flows. Selling visas also limits the increases in budget deficit entailed by stricter controls.

It is common to oppose these two types of public intervention, legalisation and repression, in political debates. In the US for example, people on the right and Republicans are typically accusing Democrats of being soft on the issue of illegal migration: "While Democrats believe in supporting a path to citizenship for illegal immigrants, Republicans support stronger border patrols and stronger repercussions for those caught in the U.S. illegally, as well as those who employ them or help them falsify documentation."[36] Yet our analysis shows that legalisation of migration through the sale of visas and significant investment in repression are complementary. Recently, many of the proposed changes to immigration policy in the US have reflected a hybrid approach, presented in the Comprehensive Immigration Reform of 2013 as a compromise combining some legalisation alongside stricter enforcement of the border. Our analysis shows that pushing further this mix of legalisation and repression policies is more than a political compromise: it is efficient.

Moreover our results regarding the complementarities of instruments call into question the rationale of current policies. In the past decades border controls have been constantly reinforced in spite of very small effects, at the margin, on migration flows and there are large discrepancies in most OECD

market tools to control migration flows, Moraga and Rapoport (2013) have set up a model where host countries trade immigration quotas.

[36]In Democratic View on Immigration October 2014 by republicanviews.org http://www.republicanviews.org/democratic-view-on-immigration/

countries between the amounts invested in border control versus employer's sanctions. For example, in 2008 in France, only 1706 labour inspectors were employed for more than 3.8 million firms.[37] Among those firms, only 1.6 million, the largest ones, were eligible for a control although many illegal migrants work in small construction firms and in restaurants.[38] At the same time France has spent hundred of millions of euros on repression measures such as dismantling illegal immigrants' camps, police enforcement at the borders and deportation measures. Similarly in the US, there is very little enforcement against illegal immigration at worksites (Hanson, 2007). Between 1999 and 2003, the number of man hours US immigration agents devoted to worksite inspections declined from 480,000 to 180,000 hours and few US employers who hire illegal immigrants are detected or prosecuted.[39] But considerable amounts have been constantly invested in the controls of the US borders.[40] For instance the Border Patrol, which was increased from 9,000 agents in 2001 to 20,000 in 2009, costs an estimated $4 billion annually.

Given these discrepancies and the availability of new technologies, reinforcing systematic controls of undocumented workers at the workplace may offer a more efficient means of dampening illegal labour migration flows than reinforcing border controls. It is striking that despite several attempts to

[37]See the report "L'inspection du travail en France en 2008", Ministère du travail, des relations sociales, de la famille, de la solidarité et de la ville, Direction générale du travail Service de l'animation territoriale de la politique du travail et de l'action de l'inspection du travail.

[38]With only 22590 controls to check for illegal workers, an eligible firm is inspected on average once every 70 years, or alternatively faces a 1.42% probability of being inspected each year and smaller firms face a 0 probability of inspection.

[39]The number of US employers paying fines of at least $5.000 for hiring unauthorized workers was only fifteen in 1990, which fell to twelve in 1994 and to zero in 2004 (see "Immigration Enforcement : Preliminary Observations on Employment Verification and Worksite Enforcement" GAO-05-822T June 21, 2005, cited by Hanson 2007, p19.)

[40]The Washington Post, July 18, 2010 reported that more than 670 miles of border fences, walls, bollards and spikes that Congress decreed in 2006 at an estimated cost of $4 billion (plus future maintenance) had been almost completed. Similarly the number of man hours spent policing the US-Mexico border increased by 2.9 times between 1990 and 2005.

mandate participation by all U.S. employers in the E-Verify program, an Internet-based system designed to check the employment authorization status of employees, participation is still voluntary, with limited exceptions. Small businesses and agricultural employers are strongly opposed to mandatory E-Verify and actively lobby against it.[41] Similarly, within the European Union, representatives of Business Europe are opposed to the Commission's idea that employers should check the validity of residence permits to avoid the risk of being excluded from public contracts and, under certain circumstances, penalised by temporary or permanent closure of their companies in case of failure (Bertozzi, 2009).

6 Conclusion

This paper has addressed a simple question: is it possible to eliminate human smuggling by selling visas and regulate migration flows?

The answer is nuanced. The model shows that eliminating smugglers by using only one policy instrument, a sale of visas at a low enough price, would be at the cost of increasing migration flows. This would also increase the skill diversity of migrants. Hence there is a trade-off between suppressing smugglers or having fewer migrants in the economy. So if the goal is to control migration, flows are the lowest with a monopolistic smuggler. Increasing cartelisation of the market through repression contributes to controlling migration flows. However, such policy is not satisfactory either, as it favors the emergence of a dominant criminal network. Current policies are designed to severely restrict legal migration channels by imposing eligibility criteria-specifying the types of workers eligible for work visas or of individuals eligible for family reunion- or other rationing devices such as auctions to obtain

[41]The American Farm Bureau Foundation stated in a note entitled "2015 Agricultural Labor Reform" that it "could have a significant, negative impact on US farm production, threatening the livelihoods of many farmers and ranchers in labor intensive agriculture." see https://www.pfb.com/policy-pfb/issues/899-2013-agricultural-labor-reform

visas. Far from eliminating the smuggling business, these rationing mechanisms generate a market for illegal migration since many candidates are not eligible for these legal channels and are willing to pay high fees to human smugglers.

The paper proposes instead to combine different types of repression measures with pricing tools to dismantle the smugglers while limiting the increase in migration flows following the legalisation. Our results highlight the complementarities between pricing tools and different types of repression measures, which, in practice, target different groups: the smugglers, the illegal migrants or the firms which employ them.

Since a policy mix using traditional instruments combined with innovating pricing tools would be more efficient to eliminate smugglers while regulating migration, a question that remains largely open is why this has not yet been implemented. Although answering this question is beyond the scope of the paper, we may consider a few hypotheses that are worth investigating in future work and other fields of social sciences.

In countries like France one immediate answer is that introducing such pricing schemes in the field of migration may be considered as unethical or violating human rights.[42] Moreover, their implementation would surely generate many complicated issues such as the feasibility of pricing visas differently depending on the country of origin of the applicants or the duration of the permit.

It is, however, not clear that transparent pricing tools are less ethical than the existing policy of visa rationing, which creates "rents" to the lucky applicants, generates important monetary hidden costs, such as briberies, paid by all applicants, and feeds all kinds of illegal activities. And, from a practical viewpoint, selling visa is both consistent with the law of most countries and possible. In fact, many countries already sell visas at high

[42]Moreover, people may not be willing to trade a sacred value such as the right to immigrate for money -what psychologist Philip Tetlock (2007) refers to as a "taboo tradeoff".

prices to entrepreneurs or investors in order to boost businesses, capital investments or simply attract revenues. This is for instance the case in Malta (650 000 euros), Australia, United Kingdom (1.5 millions dollars in bonds), United-State of America, (visa EB-5 in exchange of 500 000 dollars productive investment), Singapore (2 million dollars), Netherland, Mauritius, Spain (500 000 euros investment in real estate), Greece (250 000 euros investment in real estate), Portugal (500 000 euros investment in real estate), France (10 million euros), various Caribbean island...Since these prices are very high, smugglers can compete by offering "low-costs" services to candidates who are not financially able to pay for the "Golden Investor visas". At the other end of the spectrum of the migration market, some countries such as Israel, Cyprus and Lebanon have been regulating long distance migration of cheap labour through local agencies located in South-East Asian countries such as Philippines and Sri Lanka. These legal intermediaries screen the candidates and organise their shipment for a relatively low price, which is also co-financed by employers to compensate for shortages in labour.[43] Yet, migration through this channel is rationed, which again generates an illegal market for those who are not eligible and those who are overstaying their temporary visas.

A second hypothesis is that natives may prefer to have lowly paid illegal immigrants rather than a larger number of legal workers, who would enjoy a more complete set of rights. Moreover, although reinforcing sanctions paid by employers of illegal migrants would be a more cost-effective way to combine legalisation with migration control than reinforcing border controls, such policy would typically encounter strong resistance from powerful lobbies. The status quo reflects complex political-economy issues with some people benefitting more than others from lax enforcement. These considerations may

[43]Canada also offers visas for temporary workers, which are highly successful. In 2011, more than 192,000 foreign workers entered Canada under this Program, see Fact Sheet http://www.cic.gc.ca/english/resources/publications/employers/temp-foreign-worker-program.asp

explain why, under current policies, a large number of illegal migrants still bear the costs of being exploited in destination areas and face the constant risk of being deported.

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Appendix

Appendix A: Market Equilibrium and an illustration in the case of uniform distribution

We model the oligopolistic market for illegal migration as a generalized Cournot competition. We focus on symmetric equilibrium (i.e., each smuggler has the same market share). Let $P^I(Q) = (dw_f - w_h)F^{-1}(1-Q)$ denote the inverse demand function for illegal migration. Smuggler $j = 1, .., N$ maximises with respect to quantity Q^j the profit function:

$$\pi^j(Q^j, Q^{-j}) = \left[P^I(Q^j + Q^{-j}) - c\right] Q^j$$

where $Q^{-j} = \sum_{k \neq j} Q^k$ is the offer made by the competitors of $j = 1, ..., N$. The first order condition is sufficient under the assumption that the demand function is not too convex. In a symmetric equilibrium $Q^j = \frac{Q}{N}$ and the generalized Cournot price with N smugglers, p^N, is such that (3) holds.

We next illustrate the market equilibrium with the example of a uniform distribution of skills over $[0, 1]$, which gives easily tractable closed form solutions. From (1) and (2) we can write explicitly the demand for illegal migration as:

$$D^I(p) = 1 - \frac{p}{dw_f - w_h} \tag{17}$$

In the case of a generalized Cournot competition, we can use (3) to establish that the price is as follows:

$$p^N = \frac{dw_f - w_h + Nc}{N+1} \tag{18}$$

such that $p^m (= p^1) = \frac{dw_f - w_h}{2} + \frac{c}{2}$ and $p^\infty (= \lim_{N \to +\infty} p^N) = c$. We deduce that the generalized Cournot demand is

$$D^I(p^N) = \frac{N}{N+1}\left(1 - \frac{c}{dw_f - w_h}\right)$$

Depending on the degree of competitiveness of the market, measured by N, the demand is between the demand on monopolistic market $D^I(p^m) = \frac{1}{2} - \frac{c}{2(dw_f - w_h)}$, and the demand in perfect competition $D^I(c) = 2D^I(p^m)$.

Appendix B : Proof of $\frac{dp^I(p^L)}{dp^L} > 0$

To show that $\frac{dp^I(p^L)}{dp^L} > 0$ we totally differentiate (3) where the direct price elasticity of demand, which is derived from (6), is parameterized by p^L. We obtain that

$$\frac{dp^I(p^L)}{dp^L} = -\frac{(p^I - c)\frac{\partial^2 D^I(p^I,p^L)}{\partial p^I \partial p^L} + \frac{1}{N}\frac{\partial D^I(p^I,p^L)}{\partial p^L}}{\frac{N+1}{N}\frac{\partial D^I(p^I,p^L)}{\partial p^I} + (p^I - c)\frac{\partial^2 D^I(p^I,p^L)}{\partial p^{I2}}} \tag{19}$$

Second order condition of the oligopoly optimization problem implies that the denominator is negative. Since the two commodities are substitutes (i.e., $\frac{\partial D^I}{\partial p^L} \geq 0$), a sufficient condition for the numerator to be positive is that $\frac{\partial^2 D^I(p^I,p^L)}{\partial p^I \partial p^L} \geqslant 0$. Using equation (6) we can easily show that this is always true as long as $f'(\theta) \leq 0$, which characterises for example the case with a uniform distribution ($f'(\theta) = 0$ over the support). By virtue of equation (20) below with a uniform distribution we get $\frac{\partial^2 D^I(p^I,p^L)}{\partial p^I \partial p^L} = 0$. It is also true when the density function is strictly decreasing as in developing countries where the vast majority of people do not have any education and are thus low skilled. QED

Appendix C: Uniform Distribution Example for Proposition 2

This section develops Proposition 2 in the case of a uniform distribution of skills distributed over 0 and 1. The demand faced by the smugglers when the government proposes a (legal) migration price, p^L, is:

$$D^I(p^I, p^L) = \int_{\frac{p^I}{dw_f - w_h}}^{\frac{p^L - p^I}{(1-d)w_f}} f(\theta)d\theta = \int_{\frac{p^I}{dw_f - w_h}}^{\frac{p^L - p^I}{(1-d)w_f}} d\theta = \frac{p^L - p^I}{(1-d)w_f} - \frac{p^I}{dw_f - w_h} \tag{20}$$

We deduce that the inverse demand function faced by the smugglers is:

$$P^I(Q, p^L) = \frac{dw_f - w_h}{w_f - w_h}(p^L - (1-d)w_f Q) \tag{21}$$

Smuggler $j = 1, .., N$ maximises with respect to q^j the profit function:

$$\pi^j(q^j, Q^{-j}) = \left[P^I(q^j + Q^{-j}, p^L) - c\right] q^j$$

where c represents the marginal costs for the smuggler and $Q^{-j} = \sum_{k \neq j} q^k$ is the offer made by the competitors of $j = 1, ..., N$. In a symmetric equilibrium $q^j = \frac{Q}{N}$ so that the Cournot quantity Q^N is such that:

$$P^I(Q^N, p^L) - c + \frac{\partial P^I(Q^N, p^L)}{\partial Q^N}\frac{Q^N}{N} = 0 \tag{22}$$

Symmetrically the generalized Cournot price with N smugglers, p^N, is such that:

$$\frac{p^N - c}{p^N} = \frac{1}{N}\frac{1}{\varepsilon_{D^I, p^I}} \tag{23}$$

Second order condition requires that

$$\frac{\partial^2 P^I(Q, p^L)}{\partial Q^2}\frac{Q}{N} + 2\frac{\partial P^I(Q, p^L)}{\partial Q} \leq 0 \tag{24}$$

which is always true with the uniform distribution example (see (21)). Substituting (21) in the equation (22) we deduce that

$$Q^N(p^L) = \frac{N}{N+1}(p^L - c\frac{w_f - w_h}{dw_f - w_h})\frac{1}{(1-d)w_f} \tag{25}$$

or, alternatively, that

$$P^N(p^L) = P^I(Q^N(p^L), p^L) = \frac{p^L}{N+1}\frac{dw_f - w_h}{w_f - w_h} + \frac{N}{1+N}c \tag{26}$$

We now turn to showing that such reaction smugglers price is smaller than the price imposed by the smugglers under unconstrained oligopoly. With the uniform distribution example, replacing (26) into (10) the upper limit for the visa price satisfies:

$$\overline{p}^L = [Nc + (1+N)(1-d)w_f] \frac{w_f - w_h}{(1-d)w_f + N(w_f - w_h)} \tag{27}$$

Comparing the reaction smugglers price $p^I(\overline{p}^L)$ with the unconstrained smugglers' oligopoly price $p^N = \frac{dw_f - w_h + Nc}{N+1}$ defined in (18) it is straightforward to check that $p^I(\overline{p}^L) \leq p^N$ if and only if $dw_f - w_h \geq c$, which is a necessary condition for the smugglers to be active in the first place. Indeed from (1), we obtain that: $dw_f - w_h > p^I$ otherwise there is no illegal migrant. Moreover, necessarily $c < p^I$ otherwise smugglers do not operate. Therefore, when smugglers operate, the condition $c < dw_f - w_h$ is necessarily satisfied, which implies that $p^I(\overline{p}_L) < p^N$. QED

Appendix D: Proof of Proposition 3

Let $\underline{p}^L(R_1, R_2) = \frac{w_f - w_h}{d(R_2)w_f - w_h} c(R_1)$ be the price which pushes smugglers out of business and let $D^L(R_1, R_2) = 1 - F\left(\frac{\underline{p}^L(R_1,R_2)}{w_f - w_h}\right)$ the legal demand for visas associated with this price. The problem (14) the government aims to solve is equivalent to:

$$\max_{R_1,R_2} \underline{p}^L(R_1, R_2) \qquad \text{s.t.} \qquad R_1 + R_2 \leq B \tag{28}$$

The Lagrangian of this optimization problem is :

$$L = \underline{p}^L(R_1, R_2) + \lambda\Big\{B - (R_1 + R_2)\Big\} \tag{29}$$

The Lagrangian derivatives are for $k = 1, 2$:

$$\frac{\partial L}{\partial R_k} = \frac{\partial \underline{p}^L}{\partial R_k} - \lambda \tag{30}$$

Focusing on interior solutions, the optimal combination of (R_1, R_2) satisfies necessarily $\frac{\partial L}{\partial R_1} = \frac{\partial L}{\partial R_2}$, such that:

$$\frac{\partial \underline{p}^L}{\partial R_2} = \frac{\partial \underline{p}^L}{\partial R_1}$$

, which yields equation (15). And the Lagrangian derivative with respect to λ yields that the budget constraint is equalised.

Considering the special case when the government funds the investments in repression with the sale of visas, the problem (14) the government aims to solve becomes:

$$\max_{R_1,R_2} \underline{p}^L(R_1, R_2) \qquad \text{s.t.} \qquad R_1 + R_2 \leq D^L(R_1, R_2)\underline{p}^L(R_1, R_2) \tag{31}$$

The Lagrangian of this optimization problem is :

$$L = \underline{p}^L(R_1, R_2) + \lambda\Big\{D^L(R_1, R_2)p^L(R_1, R_2) - (R_1 + R_2)\Big\} \tag{32}$$

The Lagrangian derivatives are for $k = 1, 2$:

$$\frac{\partial L}{\partial R_k} = \frac{\partial \underline{p}^L}{\partial R_k}\Big(1 + \lambda D^L(R_1, R_2)\Big) + \lambda \underline{p}^L(R_1, R_2)\frac{\partial D^L}{\partial R_k} - \lambda \tag{33}$$

Focusing on interior solutions, the optimal combination of (R_1, R_2) satisfies necessarily $\frac{\partial L}{\partial R_1} = \frac{\partial L}{\partial R_2}$, which yields:

$$\frac{\partial \underline{p}^L}{\partial R_2}\Big(1 + \lambda D^L(R_1, R_2)\Big) + \lambda \underline{p}^L(R_1, R_2)\frac{\partial D^L}{\partial R_2}$$

$$= \frac{\partial \underline{p}^L}{\partial R_1}\Big(1 + \lambda D^L(R_1, R_2)\Big) + \lambda \underline{p}^L(R_1, R_2)\frac{\partial D^L}{\partial R_1}$$

Simplifying this expression by noting that $\frac{\partial D^L}{\partial R_k} = -\frac{\frac{\partial p^L}{\partial R_k}}{w_f - w_h} f\left(\frac{\underline{p}^L(R_1,R_2)}{w_f - w_h}\right)$, the optimal combinaison of (R_1, R_2) is such that $\frac{\partial \underline{p}^L}{\partial R_1} = \frac{\partial \underline{p}^L}{\partial R_2}$, which yields equation

(15). And the Lagrangian derivative with respect to λ yields that the budget constraint is equalised in (16). These two equations determine the optimal combination of repression (R_1, R_2).

We now check with a simple example that the set of functions supporting an interior solution is not empty.

An example: Let's assume that $w_h \simeq 0$ and that $c(R) = c\frac{1+2R}{1+R}$ and $d(R) = \frac{d}{1+R}$. Consistently with the model assumptions $c(R)$ is increasing and concave and $d(R)$ is decreasing and convex. Let's note $k(R) = \frac{c'(R)}{c(R)} = \frac{1}{(1+R)(1+2R)}$ and let $g(R) = \frac{-d'(\overline{R}-R)}{d(\overline{R}-R)} = \frac{1}{1+\overline{R}-R}$ for all $R \in [0, \overline{R}]$ with $\overline{R}$ being a fixed point such that $\overline{R} = D^L(R, \overline{R}-R)\underline{p}^L(R, \overline{R}-R)$. The interior solution of our problem is determined by that: $k(R) = g(R)$.[44]

$$R_2^*(\overline{R}) = \overline{R} - R_1^*(\overline{R}) = \overline{R} + 1 - \sqrt{1 + \frac{\overline{R}}{2}} \tag{34}$$

It is easy to check that both $R_1^*(\overline{R})$ and $R_2^*(\overline{R})$ take their value between $[0, \overline{R}]$. They constitute an interior solution of the optimisation problem.

Let $p^L(\overline{R}) = \underline{p}^L(R_1^*(\overline{R}), R_2^*(\overline{R}))$ and $D^L(\overline{R}) = D^L(R_1^*(\overline{R}), R_2^*(\overline{R}))$. To complete the proof we need to show that there exists a fixed point, $\overline{R} > 0$, such that $\overline{R} = D^L(\overline{R})p^L(\overline{R})$.

The assumption $w_h \simeq 0$ implies that $p^L(\overline{R}) = \frac{c(R_1^*)}{d(R_2^*)} = \frac{c}{d}\frac{1+2R_1^*}{1+R_1^*}(1 + R_2^*)$. Substituting R_1^* and R_2^* by their value from (34) and rearranging the expression we get

$$p^L(\overline{R}) = \frac{c}{d}\Big(\sqrt{2(2+\overline{R})} - 1\Big)^2 \tag{35}$$

We deduce that $\overline{R}$ is the solution to:

$$R = \frac{c}{d}\big(\sqrt{2(2+R)} - 1\big)^2\Big(1 - \frac{c}{dw_f\overline{\theta}}\big(\sqrt{2(2+R)} - 1\big)^2\Big) \tag{36}$$

[44]It is easy to check that $k'(R) < 0$ and that $g'(R) > 0\ \forall R \in [0, \overline{R}]$. Since $k(R)$ is strictly decreasing and $g(R)$ is strictly increasing for all $R \in [0, \overline{R}]$, and since $g(0) < k(0)$, and $g(\overline{R}) > k(\overline{R})\ \forall \overline{R} > 0$, there exists an unique interior solution to $k(R) = g(R)$.

The demand is defined if $1 \geq \frac{c}{dw_f\overline{\theta}}\left(\sqrt{2(2+R)}-1\right)^2$, which is equivalent to $R \leq R^{max} = 0.5\left(1+\sqrt{\frac{dw_f\overline{\theta}}{c}}\right)^2 - 2$. We deduce that $R^{max} > 0$ if and only if

$$\frac{dw_f\overline{\theta}}{c} > 1 \tag{37}$$

Note that this assumption is always verified whenever there is some human smuggling: $c < dw_f\overline{\theta}$. Therefore $R^{max} > 0$ and it is straightforward to check that $\overline{R}$ exists. Indeed when $R = 0$ the left hand side of equation (36) is equal to $LHS(0) = 0$, while the right hand side is equal to $RHS(0) = \frac{c}{d}\left(1 - \frac{c}{dw_f\overline{\theta}}\right) > 0$ under (37). Symmetrically the left hand side of equation (36) when $R = R^{max}$ is equal to $LHS(R^{max}) = R^{max} > 0$ under (37), while $RHS(R^{max}) = 0$. Since both functions are continuous they cross necessarily at least once at $\overline{R} \in (0, R^{max})$. Moreover, after noting that:

$$RHS'(R) = 2\frac{c}{d}\left[\frac{\sqrt{2(2+R)}-1}{\sqrt{2(2+R)}}\right]\left\{1 - \frac{c}{dw_f\overline{\theta}}2(\sqrt{2(2+R)}-1)^2\right\}$$

we can check that $RHS'(R) < 0 \Leftrightarrow dw_f\overline{\theta} < 2c(\sqrt{2(2+R)}-1)^2$, which is for instance true if $2 > \frac{dw_f\overline{\theta}}{c} > 1$. In this case the function $LHS(.)$ is increasing and $RHS(.)$ is decreasing: they cross only once. QED

Appendix E: The case of negative selection

Since our main focus is to design a policy to eliminate smugglers, which are primarily used in long haul migration, we assumed in the presentation of the model that workers self-select positively through migration according to their skill level. This generates interesting findings as a government will compete with smugglers to attract the highest skilled of the candidates for illegal migration by selling migration visas. However, depending on the relative returns to skill in the origin and destination countries the case of negative self-selection of workers through illegal migration cannot be ruled

out, in particular for low-costs cross-border migration.

To give the intuition of how the results would change in the case of negative selection, we adopt the extreme assumption that workers working in the illegal sector of the destination country are paid at a flat rate, $d\underline{\theta}w_f$ which does not depend on their skill. After writing the migration condition as $\theta w_h < d\underline{\theta}w_f - p^I$, we can solve for the skill threshold, denoted θ^I, *below* which an individual prefers to migrate illegally than not to migrate:

$$\theta^I = \frac{d\underline{\theta}w_f - p^I}{w_h} \tag{38}$$

After aggregating over the distribution of skills, we obtain the demand for illegal migration as a function of migration price p^I:

$$D^I(p^I) = \int_{\underline{\theta}}^{\theta^I} f(\theta)d\theta = F(\theta^I) \tag{39}$$

As θ^I decreases with p^I and w_h and increases with d and w_f, it is easy to show that, once again, the demand for illegal migration is higher the lower the migration price, p^I, and the higher the difference between the income earned as an illegal migrant, $d\underline{\theta}w_f$, and the income in the home country, w_h.

We next study what happens if the government enters the migration market by selling visas. We consider the case where wages of legal migrants are independent of their skills. This is for example the case of migrants hosted by destination countries to work on specific work contracts in sector where there is a shortage of low skilled labour, such as immigrants working in agriculture in California. If the government sells visas at price p^L, migration candidates prefer to migrate legally rather than illegally as long as $\underline{\theta}w_f - p^L \geq \underline{\theta}dw_f - p^I$. If the government wants to eradicate smugglers through a pricing policy it has to sell visas at the price

$$\underline{p}^L = c + (1-d)\underline{\theta}w_f. \tag{40}$$

As in the case of positive selection, the only way to eliminate the smugglers through a "pure" sale of visas is to push their reaction price below their marginal costs. With such a pricing strategy the marginal migrant, indifferent between migrating legally and staying at home, is such that:

$$\theta^L = \frac{\underline{\theta} w_f - \underline{p}^L}{w_h}. \tag{41}$$

Replacing $\underline{p}^L$ by its value from (40) yields $\theta^L = \frac{d\underline{\theta} w_f - c}{w_h}$, which is the threshold in (38) evaluated at $p^I = c$. In other words, a policy that reduces the number of illegal migrants to zero through the sale of visas yields the same level of migration as under perfect competition among smugglers. Therefore Proposition 1 holds true under negative selection. It is also easy to show that the main message of proposition 2 still holds, such that whenever the government enters the market by selling visas, migration demand increases. One difference, however, is that selling visas leads, in this case, to an improvement of the skill composition of migrants since $\theta^L > \theta^I$.

Since the average skill of migrants increases (respectively, decreases) following the policy when the self-selection of workers through illegal migration is negative (positive), we have also shown that the policy increases the skills diversity of migrants in all cases.

Studying $\theta^L = \frac{d\underline{\theta} w_f - c}{w_h}$, it is easy to show that, as in the case of positive selection, the only way a government can control migration following a legalisation policy through the sale of visas is to increase repression. This reinforces our main message showing that policy makers must combine strict repression with sale of visas if the aim is to both legalise migration and control migration demand.

Figures

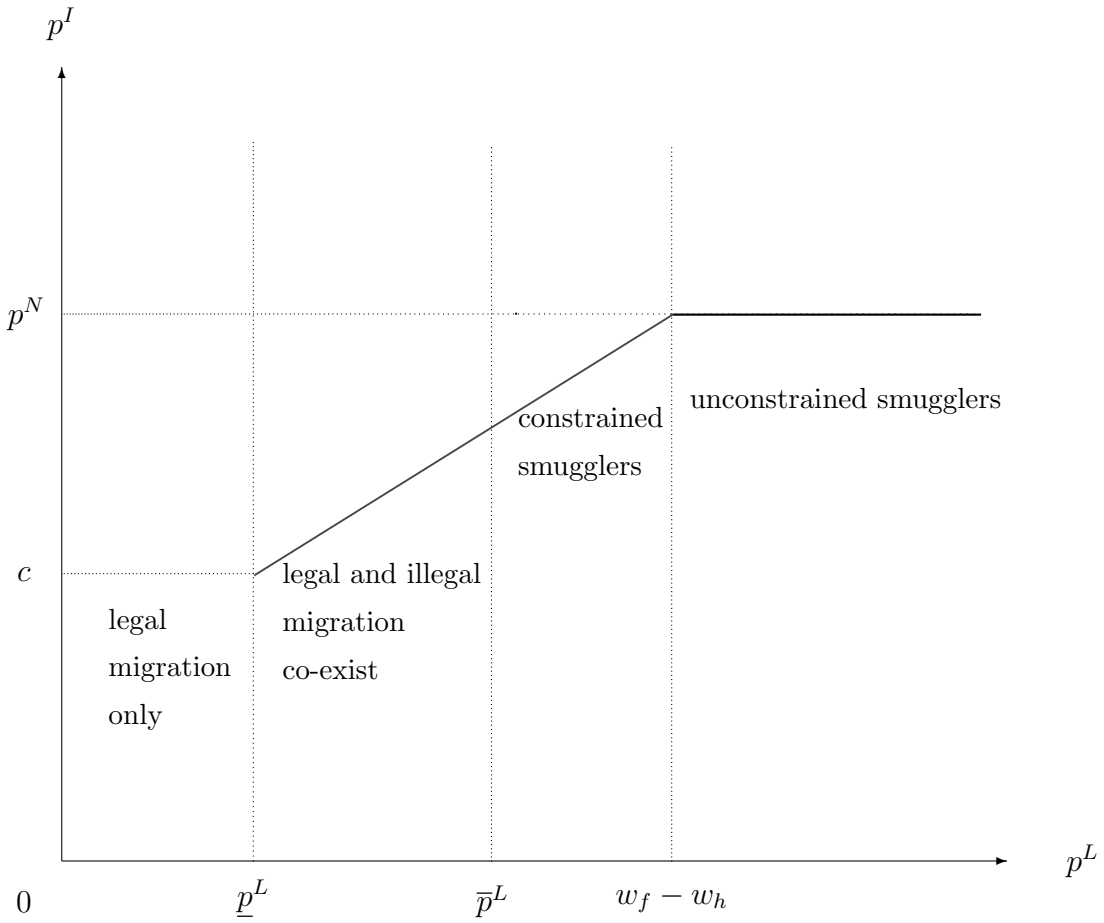

Figure 1: Pricing scheme of the smugglers $p^I(p^L)$ as a function of the price of visas in the uniform example

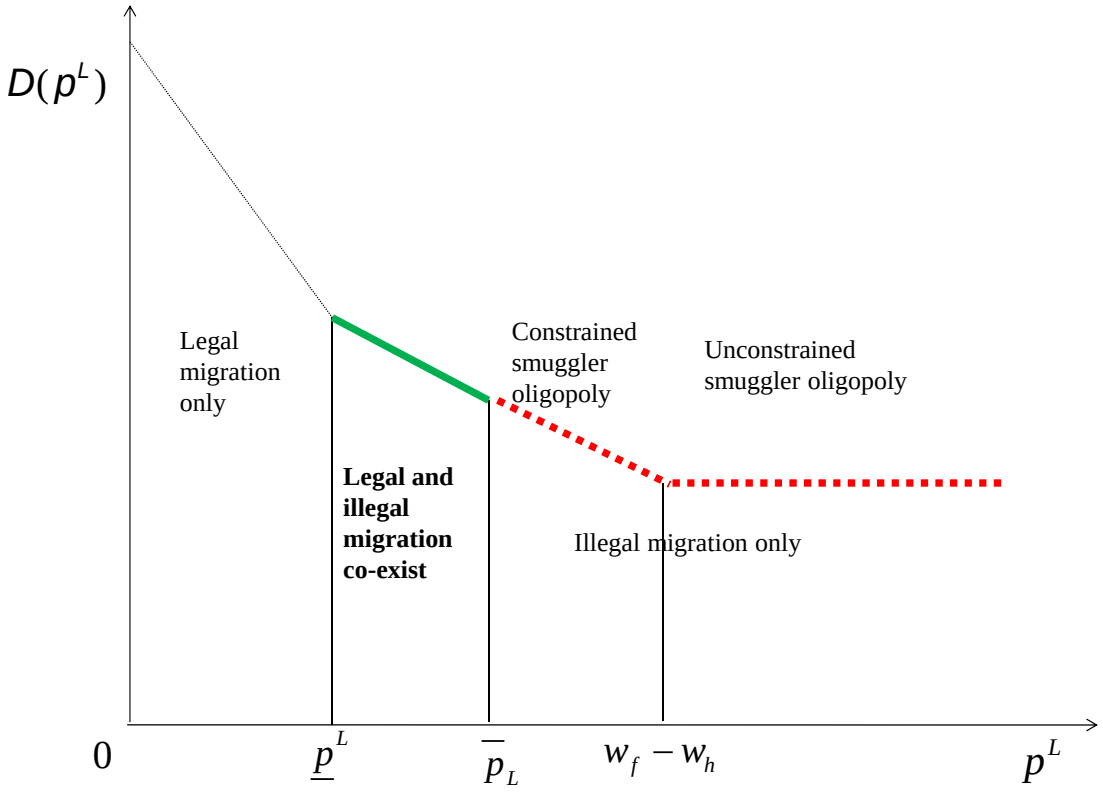

Figure 2 : Migration Demand as a function of price of visas in the uniform example