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JEL Classification: F22, I18, L51, O15

Keywords: Immigration, Human Smuggling, market structure, legalization

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Abstract

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1 Introduction

Concerns about immigration have reinforced populism in most OECD countries and are threatening some core institutions of the European Union such as the Schengen Area.[1] However, when regular and irregular migrants are considered separately, public opinion is much more concerned about irregular migration than about regular migration.[2] Reducing irregular migration is clearly a priority for electorates and the governments.[3]

We propose a framework to address jointly two important concerns for the public, which are often considered as policy trade-offs. The first is how to control migration flows: by this we mean how to control the number of migrants crossing borders to reach a higher wage destination country, as well as their legal status. The second is how to tackle human smuggling. We present a novel system of temporary visas for economic migrants, which competes with the services offered by human smugglers to attract low-skilled migrants.

One way to undermine human smuggling would be to simply open the borders. Although scholars predict large overall economic gains (see for example Clemens, 2011), it is not favored by the majority of citizens, especially in high wage countries. Fears of massive inflows of migrants make such a solution politically unacceptable, at least in the current context.

In response to these fears, most OECD countries have been strengthening border controls over the last decades, but current policies, which combine quotas on visas with reinforced border controls, are fairly ineffective at stopping undocumented migration. Their main consequence is to increase demand for smugglers. Strong restrictions on labor mobility mean that migrants seek assistance from smugglers who organize air, sea or ground transportation. They may offer a large range of other services, lending money and helping migrants to find accommodation and jobs at their destination. Such illegal activities cost the lives of thousands of individuals each year and lead to exploitation and abuses of all kinds (for example, forced labor, child trafficking, and sexual coercion). Moreover, with more than 2.5 million people smuggled around the world each year, the human smuggling market brings billions in revenue to powerful criminal networks, which are increasingly organized and, in some countries like Mexico, pose a real threat to the rule of law.[4]

[1] Even outside this area, the perceived lack of immigration control by the public has been one of the main drivers for Brexit, with a majority of citizens in the UK endorsing reducing immigration at the time of Brexit (Blinder and Richards, 2017).

[2] For example, in 2013, 80 (70) percent of respondents in the UK (France) are concerned about illegal immigration, compared to 40 (32) percent about legal migration (Transatlantic Trends surveys, cited in Hatton, 2017)

[3] The Eurobarometer (May 2015) indicates that, on average, 87% of respondents in Europe support additional measures against illegal immigration, with a minimum support of 72% in Romania and maximum support of 94% in Cyprus (Hatton, 2017).

[4] A low estimate of economic returns worldwide is around USD5.5-7 billion in 2016 (UNODC, 2018).

For all of these reasons, ending human smuggling has become an urgent topic. The integration of migrants and migration policies has even found its way in the Agenda for Sustainable Development, with specific reference to ending human trafficking and respecting the labor rights of migrant workers (see UNCTAD, 2018, p. 20).[5] There is also a widespread recognition that controlling migration flows through effective public policies calls for a better understanding of both the supply side and the demand side of the market (OECD, 2015).

On the supply side, information on the operations of smugglers is hard to collect systematically. However, reviews of past policies show that investments in border controls between Mexico and the US following the Immigration Reform Control Agreement (1986) pushed smugglers on the Mexico to US route to reorganize their operations. Smugglers increased their cartelisation and the prices they charge to migrants from Mexico (Roberts et al., 2010).

On the demand side, enhanced border controls have exacerbated the risks taken by migrants, while leaving the demand for smugglers' services unchanged (Gathmann, 2008). This is largely driven by the sizable economic opportunities for undocumented workers in high wage countries (Clemens et al., 2019).

Is there a more proactive way to recruit low-skill labor from abroad than using the labor force of irregular migrants who have either successfully crossed borders undetected, or overstayed their work permits? And can this throttle the market for human smuggling? We discuss whether current and past systems of Temporary Foreign Work Permits (TFWPs), which were not designed with this objective, would reduce human smuggling activity.

Our framework takes into account the response of smugglers, who react to migration policies by adjusting their fees to maximize profits. Simultaneously we model the response by workers of different skill levels who are willing to migrate from low-wage to high-wage countries. In the status quo there is no legal channel to migrate such that they turn to the smugglers' services. This leads to an equilibrium in which smugglers share the illegal market profits. We study what happens to the equilibrium after temporary work permits offering legal channels to migrate are introduced. Workers can choose between legal and illegal channels, which pushes down smugglers' fees. We are particularly interested in policies to drive smugglers out of business. This can be achieved by setting the price of visas low enough, at the "eviction" level, such that smugglers can no longer make positive profits after they compete with low-costs services. An important finding is that a policy mix combining enforcement of internal and external controls with the TFWPs allows adjustment in this

[5]Specifically, target 10.7 of the 2030 Sustainable Development Goals calls on countries to facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well managed migration policies. Other migration-related targets in the 2030 Agenda include retaining health workers in developing countries; providing scholarships for study abroad; ending human trafficking; respecting the labor rights of migrant workers, in particular women migrants; reducing the costs of transferring remittances and providing legal identity for all.

eviction price to reach predetermined migration targets. This demonstrates how the joint modeling of the supply and demand sides of the migration market enables a government to regulate economic migration flows.

Legal channels have the advantage of offering safe journeys to would-be migrants, who may otherwise fail to reach their destination or be deported when they arrive. Even visas that cost more than smugglers' fees may compete with the services of smugglers. Risk is a key element in the decision to migrate, particularly when there are few legal options, and a growing empirical literature is investigating risk attitudes of migrants (see for example Arcand and Mbaye, 2013; Bah and Batista, 2018). As the considerable risks taken by irregular migrants are sometimes difficult to explain using standard expected utility theory, our framework allows for distortions in how migrants perceive risk and make their decisions, in stark contrast to previous literature on visa design.[6]

Another key element in the design of workable temporary work permits is to take into account migrants' incentives to comply with the visa rules, to prevent overstays. This can be achieved by enforcing deportation and embedding economic incentives in the scheme. Our analysis highlights the challenges of enforcing timely return of guest-workers on South-North routes, where economic disparities are typically large, enforcement of deportation is lax and protection of migrants' rights is strong. We show why it is more feasible to regulate migration flows on South-South routes with the help of TFWPs.

By modeling how smugglers interact with migrants and respond to policies, we show that there is not necessarily a trade-off between undermining human smuggling and controlling migration flows. However, this requires enforcing sanctions against illegal activities (especially employment of undocumented workers), which should be carefully combined with the implementation of the legal market for temporary visas. To ensure timely return migration of temporary guest workers, governments in advanced economies may adopt different combinations of enforcement measures, such as harsh punishment against employers of undocumented workers, awarding points towards more settled status in the future, or preservation of future eligibility for visas, as practiced in Canada.

The schemes we propose will support the recruitment of low-skilled workers in short supply in some sectors of the economy, as highlighted during the COVID-19 crisis in the UK and in France.[7] Our schemes can also be fine-tuned to attract missing key workers in a country and meet broader labor market needs. These are hard to meet with current policies that are tilted towards the recruitment of high-skilled economic migrants (Fasani

[6] Our results are qualitatively robust to using expected utility and prospect theory frameworks but their magnitude varies.

[7] For example, more than 900 workers from Morocco have been flown to Corsica in October 2020 to rescue Clementine crops. See https://www.lci.fr/population/travailleurs-saisonniers-en-corse-un-pont-aerien-avec-le-maroc-pour-sauver-la-saison-2166720.html

and Mazza, 2020).

The rest of the paper is organized as follows. In section 2 we review different proposals to multiply legal channels to migrate and their limits. In section 3 we describe the illegal migration market under the *status quo*, where smugglers compete to maximize their profits and migrants respond by weighing economic opportunities of illegal migration against price and risk factors. In section 4 we describe how the migration market responds to the implementation of temporary visa schemes. In section 5 we study price setting strategies to throttle smugglers' businesses and show how external and internal controls can be optimally combined with temporary visa schemes to reach predetermined economic objectives. In section 6 we present numerical applications on two smuggling routes to discuss the policy implications of the model, before concluding in section 7.

2 Legal channels for economic migrants: a critical review

Globally, 86% of countries in the world have an official migration policy, which in most cases is set to meet labor market needs.[8] In contrast, concerning emigration, the majority of governments have either no explicit policy (36%) or seek to lower current levels (32%). This means that matching demand and supply for immigrants is largely left to individuals' initiative and the unregulated market.

In many high wage countries, immigration policies have increasingly targeted high-skilled migrants with very limited possibilities for low-skilled workers.[9] One unintended consequence of such policies is to feed the illegal markets for non eligible workers. In contrast, large systems of temporary foreign worker permits (TFWPs) have been put in place in the past, then largely dismantled in the US and the EU, following economic downturns and severe criticism. This section is an overview of the policies of the last eighty years, designed to address labor market needs for low-skilled workers in high wage countries. We highlight some of their pitfalls before turning to recent proposals.

[8] 61% seek to maintain current levels of legal immigration, while 12% have policies to increase it. Only 13% have policies to lower it, the rest have no official policy or do not seek to influence it (UNDESA, 2017). Among all regions, Europe has the highest proportion of countries seeking to raise immigration levels (32%), followed by Asia (10%). Among countries that aim to decrease immigration, Asia has the highest share of countries seeking to reduce current levels of immigration (23%), followed by Africa (13%).

[9] For example, presenting to the UK parliament its new points-based system, the Home Office (2020) states: "We will reduce overall levels of migration and give top priority to those with the highest skills and the greatest talents: scientists, engineers, academics and other highly-skilled workers. [...] We will not introduce a general low-skilled or temporary work route."

2.1 Temporary Foreign Worker Permits

Past experiences show that designing effective policies to meet labor market needs and control immigration is not trivial.

After the two world wars (WW), most European countries used TFWPs to meet labor shortages and to reconstruct their economies. For instance in France firms and their representatives set up the General Society of Immigration (SGI) in 1924 to bring in thousands of immigrants in sectors experiencing labor shortage after WWI. In 1945, the French government decided to set up the national office of immigration (ONI) to manage and stimulate immigration to help with the reconstruction of the country after WWII. During WWII the "bracero" program in the US was set up to recruit Mexican workers in the agricultural sector on a temporary basis.

Although most of these systems were dismantled in the 70s, following rising unemployment problems, they have since been replaced by more sector-specific recruitment policies for temporary workers.[10] Some countries rely on issuing large numbers of seasonal and TFWPs. In Canada for example, TFWPs of less than three years duration have in some periods outnumbered other types of work visas, with 338,000 TFWPs granted in 2013 up from 101,000 in 2001 (Gross, 2014). In recent decades in the UK, large numbers of workers have been recruited through temporary visa schemes, such as the now discontinued Seasonal Workers Agricultural Schemes (SAWS) and the Sectors Based Scheme (SBS). The threat posed by post-Brexit restrictions on labor inflows from European countries has revived discussions about how to multiply temporary work permits to recruit foreign workers.[11] However, the recent points-based system proposed by the government does not open a route for low-skilled migrants, apart from a quota of 10,000 seasonal workers in agriculture (Home Office, 2020).

In other countries, the unsatisfied demand for low-wage workers in specific sectors of the economy has led to patchy responses. For example, every year since 2006, France has issued Exceptional Authorizations of Stay (AES) so that workers in the underground economy could legalize their situation. In practice the AES are granted to workers in sectors "sous tension", where there is a mismatch between the demand for labor and the number of legal workers willing to take "hard" jobs in catering, construction or social care. These AES workers are overwhelmingly men in their thirties in low wage jobs, coming from African countries such as Mali, Morocco and Tunisia, and having overstayed in France for, on average, 8 to 10 years (OECD, 2017).

[10] see a comparison across European countries in López Sala et al. (2016)

[11] In 2018, this led to the Immigration White Paper proposals to create a seasonal workers pilot in agriculture, accompanied by a 12-month temporary migration program to bring workers at any skill level, and a Youth Mobility Scheme (YMS) to admit young people from certain non-EEA countries to work for up to 2 years (UK Government, 2018).

Further, there has been an unprecedented expansion of TFWPs in other parts of the world, in the states of the Arabian Peninsula following the increase in the price of oil in 1973 and, more recently, with the rapid economic growth in East Asian countries and the increasing political and economic interconnectedness between states in the ASEAN region (Kaur, 2010).

These systems of TFWPs are subject to two types of criticisms. Firstly, because the 'temporary' aspect of work permits is not enforced, irregular migration by overstaying "guest workers" is higher.[12] Overstaying has been exacerbated by increased migration restrictions, which have the unintended effect of discouraging circular migration and of lengthening the time spent abroad, as documented in Mexico-to-US migration (Angelucci, 2012).

The second criticism relates to the frequent violations of labor and human rights by employers of temporary foreign workers, as identified by non governmental organizations,[13] international organizations (technical report of Palumbo and Sciurba, 2018), as well as scholars in political sciences, sociology and law (Clark, 2017; Cohen, 206; Vanyoro, 2019) and the press.[14]

Forms of bonded labor are more likely to occur when foreign workers rely on their employers for a large range of services such as transport, health care, subsistence and accommodation, and when they do not have enough legal protection or time to be informed of their rights before being repatriated in case of disagreement. There is hence a tension between the arguments of efficiency put forward by economists in favor of foreign temporary work permits, and the rights-based criticisms of the current systems, which are often abused (Sumption and Fernandez Reino, 2018).

2.2 Missing migration markets

Given the very large potential economic gains for migrants to reach high wage countries (Clemens et al., 2019), there has been an increasing recognition that restrictions on international migration generate strong incentives for undocumented migration. There have been several proposals to create a legal market for economic migrants, rather than leaving the market to exploitative smugglers.

A much-discussed proposal is to sell visas to regulate migration flows. Following the prominent proposal by Becker to auction visas,[15] different implementations have been de-

[12] Noticeable exceptions are the East Asian countries we discuss below, which adopted very strong enforcement policies against undocumented migrants.

[13] see for example FLEX (2019); Human Rights Watch (2011)

[14] Annie Kelly, 2019. "Rape and abuse: the price of a job in Spain's strawberry industry?" *The Guardian*. April 14. https://www.theguardian.com/global-development/2019/apr/14/rape-abuse-claims-spains-strawberry-industry

[15] Gary S. Becker, 1992. "An Open Door for Immigrants – the Auction". *Wall Street Journal*, October 14. Becker, Gary S., and Edward P. Lazear. 2013. "A Market Solution to Immigration Reform." Wall

bated in the press and blogs. (Simon et al., 1999; Freeman, 2006; Saint-Paul and Cahuc, 2009; Orrenius and Zavodny, 2010). The main argument in favor of this idea is that selling visas allows a government to raise revenues that would otherwise be captured by illegal migrants, their employers and smugglers. These revenues can be used to compensate native workers who would lose from the competition with migrants (Weinstein, 2002). Moreover, migrants or their employers with the highest economic gains are likely to win the bids. Lokshin and Ravallion (2019) push this idea one step further by exploring how to complete incomplete immigration markets through the implementation of a decentralized market for work permits. Their original idea is that citizens in high wage countries can rent out their right to work to foreign workers, and spend their time on other activities (e.g., child care, studying, investment in new human capital or in hobbies). This proposal should limit the opposition to immigration from native low-wage workers, who are the most likely to rent their right to work. Other market-based mechanisms have been proposed by Moraga and Rapoport (2014, 2015) to allocate refugees across destination countries through an efficient tradable system of quotas.

As they are based on the creation of formal migration markets, these proposals require a tight monitoring of informal labor markets, including for natives. They could be difficult to implement in some countries—such as the United States, France, Spain and Italy—where there are large informal labor markets, leaving space for unregulated providers to continue making large profits. There would still be opportunities to undercut the market by attracting poorer migrants via lower-cost services.

It is thus important for the policy design to take the supply-side response into account. Auriol and Mesnard (2016) propose to sell permanent visas at the "eviction" price, such that smugglers can no longer respond to the policy without losing money. However, they show that in a risk neutral environment such a price setting mechanism does not limit the increase in migration flows, unless the scheme is accompanied by robust efforts to enforce the sanctions against the smugglers, migrants and their employers, which may be costly to implement. Moreover, regulating migration flows through this policy mix implies selling visas at a relatively high price, which attracts high-skilled economic migrants and leaves unmet the demand for low-skilled workers.

In contrast, our proposal departs from the existing legal frameworks of TFWPs. It adapts them to defeat human smuggling while controlling the flow of migrants, including those who overstay their visas.

We show that these two concerns are intertwined: both require strong measures to fight against smugglers and employment of undocumented workers, which are complementary to

Street Journal, March 1. and Becker, Gary S. 2010. "The price of entry". *The Economist*, June 24. https://www.economist.com/finance-and-economics/2010/06/24/the-price-of-entry

the visas scheme we propose. In practice it will also be more feasible for a government to enforce external and internal border controls and to sanction employers of undocumented workers if there are sufficient legal channels to employ foreign workers in the host economy. In contrast to previous proposals, this scheme targets employers of undocumented workers, and not necessarily the whole informal labor market.

3 Smuggling market

When legal migration is restricted under the *status quo*, we assume that workers from poor countries need to hire smugglers to migrate, at price p^I.[16]

In line with the literature on criminality applied to the smuggling market (Aronowitz, 2001; Futo and Jandl, 2007; Guerette and Clarke, 2005; Lundgren, 2008; Auriol and Mesnard, 2016), services are provided by N smugglers, who compete *à la Cournot*.[17] This determines the generalized Cournot price, p^I, as solution to the following equation:

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

where c represents their marginal operating costs, ε_{D^I,p^I} is the price elasticity of the demand for smugglers' services and N is an integer greater than 1. The generalized Cournot competition demand, $D^I(p^I)$, is between the two extreme cases: $D^I(p^m) \leq D^I(p^I) \leq D^I(c)$ where p^m is the monopoly price ($N = 1$) and the price under perfect competition is equal to the marginal costs c ($N \to \infty$). Other than this price, the important factors to determine the demand for smugglers' services are the economic gains from migration and the risk of crossing borders irregularly, which are studied below.

3.1 Economic gains from irregular migration

Potential candidates for irregular migration are heterogeneous according to their labor efficiency (or skill), θ, which is drawn from the distribution $F(\theta)$ with support $\mathbb{R}_+$. It is assumed that the distribution $F(\theta)$ is twice differentiable with a density function $f(\theta) > 0$.

Returns to skills in the home country are given by $\Delta_h(\theta)$, where $\Delta_h : \mathbb{R}_+ \to [1, +\infty)$

[16] Although figures vary a lot across destination countries, reliance on smugglers to enter high wages countries is stronger when it is difficult to migrate through legal channels, when border controls are enforced and when geographical borders do not exist between origin and destination countries. In the UK for example, smugglers are involved in around 75% of detected cases of irregular border crossing (Home Office, 2001).

[17] This model is more flexible than Bertrand competition, which, with a fixed entry cost K, always leads to a monopoly. Cournot can yield both a monopolistic equilibrium and a more competitive equilibrium depending on the number of smugglers N, which is easily endogenized in an equilibrium with free entry and a fixed cost K. Other models of imperfect competition, such as horizontal differentiation, lead to the same type of results, as the smugglers end up reaching marginal cost pricing in all cases.

is continuous, increasing and concave. Earnings of individual of type θ are then given by $\Delta_h(\theta)w_h$ where w_h is the expected wage of an unskilled individual in her home country.[18]

When a worker succeeds in crossing a border irregularly, she takes on jobs in the undocumented labour market where she does not benefit from returns to her skills, and receives a discounted wages of the minimum wages in the foreign country, dw_f with $d < 1$[19], which is higher than what she would earn at home w_h.

Assuming no return to skill in the undocumented sector of the destination country, we characterize the demand for workers in labor intensive sectors of the economy such as construction, domestic care, sweatshops, hospitality, or agriculture, where the skills of undocumented workers are not recognized such that they are paid at a flat rate, which is lower than minimum wages. As will become clear below, this results in a negative selection of irregular migrants and is in line with recent evidence on irregular flows of workers from non conflict areas in Africa and Middle East to Europe (Aksoy and Poutvaara, 2019).[20]

3.2 Migration decision under high risk of failure

The way we model migration decisions from risk averse individuals is fairly general and encompasses both advances in cumulative prospect theory (CPT) following Tversky and Kahneman (1992) and the more standard expected utility theory (EUT).[21] CPT postulates that individuals compare lottery outcomes rather than final wealth and allows for them to be risk-seeking for losses and risk-averse for gains through more flexibility in S-shaped value functions. It also leaves flexible the use of non linear weighting functions of risk, which may result in individuals over-estimating the odds of rare salient events – e.g. a successful illegal migration – and under-estimating those of more common events – e.g. a failed migration. This accounts for behavioral traits that are hard to explain using EUT, such as the fact that undocumented migrants take on a high risk of their migration failing, with large sunk costs. This motivated our choice of the CPT framework to present our results, but all results are robust to using either framework, as shown in the appendices.

If irregular migrants are intercepted by border guards, with probability q, we assume

[18] This is consistent with the large body of empirical research on returns to skills (see Lemieux, 2006), where earnings take the form of a Mincer (1970) equation. One would simply postulate $\Delta_h(\theta) = e^{D_h\theta}$, $D_h > 0$.

[19] See Kossoudji and Cobb-Clark, 2002 for the US and Monràs et al., 2020 for Spain

[20] The model can be extended to the case of a more positive selection of undocumented migrants, which has been observed in other settings with severe liquidity constraints or large positive returns to skills if there is a possibility of obtaining legal status in the host country (Grogger and Hanson, 2011; Orrenius and Zavodny, 2005). To be attractive to higher skilled individuals, the type of visa must give access to jobs with positive returns to skills in the destination country, for example working as middle men on building sites or as health workers, but the pricing mechanism of visas is similar to what we develop below.

[21] More detail on CPT and on the functions specified and calibrated by Tversky and Kahneman (1992) can be found in appendices A and H.

that they are sent back to their home country and lose the money paid to smugglers.[22] Earnings in the foreign country are used to pay the smuggler's fee p^I and for consumption $dw_f - p^I$.

A worker deciding whether to risk irregular migration faces the following lottery $\mathcal{L}_{illegal} = \left[dw_f - p^I, \Delta_h(\theta)w_h - p^I; 1-q, q\right]$ and compares it with the certain payoff she receives when she does not migrate, $\Delta_h(\theta)w_h$. The migration condition is written as: $\omega^+(1-q)u\left(dw_f - p^I - \Delta_h(\theta)w_h\right) + \omega^-(q)u\left(-p^I\right) > 0$,[23] with the probability weighting functions $\omega^+(.)$ accounting for individuals' distorted perceptions of probabilities.[24]

Studying the threshold such that an individual is just indifferent between an undocumented migration or not migrating, the marginal type θ^I is the solution of the following equation:

$$\omega^+(1-q)u\left(dw_f - p^I - \Delta_h(\theta)w_h\right) + \omega^-(q)u\left(-p^I\right) = 0 \tag{2}$$

Since u and Δ_h are monotonous functions, as long as at least one individual (i.e. the type 0) decides to migrate – which is mathematically written as $\omega^+(1-q)u\left(dw_f - w_h - p^I\right) + \omega^-(q)u\left(-p^I\right) > 0$ – there exists a unique $\theta^I > 0$.[25] This condition shows that if the risk of failure, q, or the price of irregular migration, p^I, is too high relative to the economic gains, then no worker is willing to migrate illegally.[26]

Aggregating over the distribution of skills, we obtain the demand for irregular migration as a function of migration price p^I through θ^I, defined implicitly in (2):

$$D^I(p^I) = \int_0^{\theta^I} f(\theta)d\theta = F(\theta^I) \tag{3}$$

The demand for irregular migration is higher the lower the migration price, p^I, the lower the risk, q, the higher the discounted wages earned abroad as an irregular migrant, dw_f, and the lower the wages in the home country, w_h. These results, shown in appendix B, are intuitive since workers compare the costs and economic benefits from irregular migration.

[22] In practice, given the large amounts at stake, the final payment may be partially locked in a bank account or under the control of the migrant's network until there is proof of success (UNODC, 2018), but many migrants lose their down-payments.

[23] Under EUT it becomes: $1-q)u\left(dw_f - p^I\right) + qu\left(\Delta_h(\theta)w_h - p^I\right) > u\left(\Delta_h(\theta)w_h\right)$.

[24] These functions are simply increasing mappings $w : [0,1] \mapsto [0,1]$, such that $w(0) = 0$, $w(1) = 1$, and for x in the neighborhood of 0 $w(x) \geq x$ (respectively $w(x) \leq x$ for x close to 1). More detail in appendix A.

[25] This result holds both under CPT and EUT (see appendix B).

[26] Without risk ($q = 0$), this existence condition becomes $dw_f - w_h > p^I$.

4 Implementing a market for Temporary Foreign Work Permits

In this section we study the equilibrium when a government enters the migration market by selling temporary visas of duration τ, to foreign workers willing to take on low paid jobs. These are designed to attract workers in specific sectors with low returns to skills and labor shortage, such as agriculture in Spain and Canada, or domestic care and hospitality in Cyprus. Foreign workers recruited through these schemes earn $\Delta_f(\theta)w_f$ for a duration τ and spend the rest of their working life $(1-\tau)$ in their country of origin where they earn $\Delta_h(\theta)w_h$ per unit of time.

The function $\Delta_f : \mathbb{R}_+ \to [1, +\infty)$ is continuous, differentiable, increasing and concave. To capture that returns to skills in the destination country are lower than in the origin country with a lower level of economic development,[27] we assume that $\Delta_f(\theta) < \Delta_h(\theta)$ for all $\theta > 0$. We further postulate that the income differential between the home and host country decreases with worker's skill level: $\Delta'_f(\theta)w_f < \Delta'_h(\theta)w_h$. This characterizes low-paid jobs abroad, which are the focus of this paper. These jobs do not recognize foreign workers' skills even though workers can work in jobs where their skills are recognized in their home countries. These assumptions imply that legal migration under the TFWP scheme selects individuals negatively.

A workable temporary visa market needs to satisfy three constraints. The *individual rationality constraint* is that some workers prefer to migrate temporarily rather than stay in their home country. The *incentive compatibility constraint* is that some workers prefer to migrate temporarily under these schemes than enter a country without a visa. The *enforceability constraint* is that temporary workers do not overstay their visa duration. Moreover, to set the price and duration of temporary visas, the government, a Stackelberg leader,[28] takes into account that the smugglers will adjust their price in response to the legal offer.

4.1 Demand for temporary visas

The *individual rationality constraint* determines the skill threshold θ^L under which a worker prefers to migrate under the temporary visa scheme (p^L,τ) than stay at home, which is the unique solution to:

$$\Delta_f(\theta)w_f - \Delta_h(\theta)w_h = \frac{p^L}{\tau}. \tag{4}$$

[27] This is in line with cross-country evidence on returns to education and skills (Psacharopoulos and Patrinos, 2018; Hanushek and Zhang, 2009).

[28] Once the government announces its policy, it must stick to it to be credible.

Individuals under this skill threshold have migration gains, equal to $\tau(\Delta_f(\theta)w_f - \Delta_h(\theta))$, larger than the costs they pay to migrate legally, p^L. For legal migration to occur, this threshold, θ^L must be higher than 0, which is satisfied if and only if $w_f - w_h > \frac{p^L}{\tau}$. This condition guarantees that at least the lowest skilled individual is willing to migrate under the temporary visa scheme (see all proofs in appendix C).

The *incentive compatible constraint* determines the skill threshold, θ^{LI}, such that any individual above this threshold prefers to migrate temporarily with work permits rather than illegally. Appendix D shows that θ^{LI} is the unique solution to the following equation:

$$\begin{aligned}\omega^+(1-q)u\left[(d-\tau\Delta_f(\theta))\,w_f-(1-\tau)\Delta_h(\theta)w_h-p^I+p^L\right]\\ +\omega^-(q)u\left[\tau\left(\Delta_h(\theta)w_h-\Delta_f(\theta)w_f\right)-p^I+p^L\right]=0\end{aligned} \tag{5}$$

Note that this threshold may be below the minimum skill level of workers ($\theta^{LI} < 0$), in which case no worker will migrate irregularly using a smuggling' service following the implementation of the scheme.

Comparative statics in appendices C and D intuitively show that more individuals are willing to migrate legally with a temporary visa than to stay at home or migrate illegally as the migration duration increases, the price of visa decreases and the income differential between origin and host countries increases. Moreover when illegal migration persists, fewer individuals prefer to migrate illegally than legally as the benefit of illegal migration decreases (i.e., as the income differential between the legal and illegal sectors increases, the price of smugglers increases, and the risk associated with migrating irregularly increases).[29]

4.2 Enforceable temporary visas

Opponents of guest-worker programs typically question whether temporary visas are enforceable, as workers could be tempted to overstay in the host country and work illegally. To address this, the government could offer incentive compatible guest-worker programs by withholding a share, s, of the income earned abroad and returning it to the worker upon completion of the visa after he/she returns to the home country. Enforcement can be strengthened by deporting workers who overstay and take on undocumented work. We note δ the probability of being deported if a worker overstays.

4.2.1 Overstaying constraint

Migrants facing the decision to overstay to work illegally compare the payoff they derive from the lottery $\mathcal{L}_{overstay} = [\tau(1-s)\Delta_f(\theta)w_f + (1-\tau)dw_f - p^L, \tau(1-s)\Delta_f(\theta)w_f + (1 -$

[29] That is, $\partial\theta^{LI}/\partial d > 0$, $\partial\theta^{LI}/\partial w_f > 0$, $\partial\theta^{LI}/\partial p^I < 0$, $\partial\theta^{LI}/\partial\tau < 0$, $\partial\theta^{LI}/\partial w_h < 0$, $\partial\theta^{LI}/\partial q < 0$ and $\partial\theta^{LI}/\partial p^L > 0$ (see appendix D).

$\tau)\Delta_h(\theta)w_h - p^L; 1-\delta, \delta]$, with their payoff if they comply with the rules of the guest worker program, $\tau\Delta_f(\theta)w_f + (1-\tau)\Delta_h(\theta)w_h - p^L$. They decide to return to work in their origin country upon completion of the visa if and only if:

$$\begin{aligned}\omega^+(1-\delta)u\left[(1-\tau)\big(dw_f - \Delta_h(\theta)w_h\big) - s\tau\Delta_f(\theta)w_f\right] \\ +\omega^-(\delta)u\left[-s\tau\Delta_f(\theta)w_f\right] \leq 0\end{aligned} \tag{6}$$

Since the left hand side of the *enforceability constraint* (6) decreases with θ, we find that skilled workers have more incentive to comply with the visa rules than low-skilled workers. This is because skilled individuals have higher returns to their skills in their origin country. In other words, giving more incentives for workers to return upon completion of their visas helps to avoid a negative selection of overstayers.[30]

The following proposition establishes that it is always possible, by combining different policy instruments, to set up a program of TFWPs satisfying the "self-enforceability" constraint (i.e. so that workers do not choose to overstay).

Proposition 1 *For any $\tau, s, d \in (0,1)$, there exists a minimum deportation rate $\underline{\delta}(\tau, s, d) < 1$, decreasing with the share of wages retained s and the duration of visa τ, and increasing with the benefit of undocumented sector employment d, such that temporary migration visas are self-enforceable.*

Proof. See appendix E. ■

The enforceability constraint (6) is easier to satisfy as the relative benefits of overstaying to work in the undocumented sector decrease (through a lower d, a lower $\frac{\Delta_f(\theta)w_f}{\Delta_h(\theta)w_h}$ or a larger visa duration, τ) and as the enforcement instruments are strengthened.[31] The latter can be implemented through workplace inspections (a lower d), through increasing the costs of overstaying, entailed by a larger share s of wages retained abroad or by a longer visa duration τ, and through enforcement of deportation (a larger δ). For example, after replacing $\delta = 1$ in (6), it is easy to check that the enforceability constraint is always satisfied. Symmetrically, when $\delta = 0$, the condition (6) becomes:

$$(1-\tau)(dw_f - \Delta_h(\theta)w_h) \leq s\tau\Delta_f(\theta)w_f \tag{7}$$

[30] Note that in case a worker decides to overstay, she decides to stay in the foreign country for the rest of her working life. After the visa expires, if she does not make a timely return to her home country, she loses the retained income. Hence overstaying the visa but returning before the end of her working life is even more costly.

[31] We assume for simplicity that the discount rate equals the interest rate such that withdrawing a share of wages and giving back later is neutral. If the interest rate is higher than the discount rate one could compensate guest-workers by paying interest on the withheld share.

so that unless the retention rate s and visa duration τ are very large, the guest worker program will not be self-enforceable when deportation measures are never enforced.

4.2.2 Enforceable short-term visas in practice

Proposition 1 shows the complementarities between the policy instruments and the importance of carefully combining the implementation of a market of temporary visas with other policy instruments. In practice, most countries already rely on some of these measures to manage labor migration. They combine sticks and carrots to ensure timely return of guest workers.

Large retention fees (large s) and enforced deportation (large δ): In East Asian countries, low rates of guest workers overstaying are enforced through harsh deportation measures and large retention fees (sticks). Employers can withhold substantial parts of the wages and/or can require a large contract-completion deposit, sometimes up to USD$10,000$ as in Japan, which is paid back to workers upon timely return (Bélanger et al., 2011; Djajić, 2013). There are other ways to enforce compliance with visa rules, such as fines, sometimes even jail sentences, and an exit tax to migrants who would like to leave the host country after the date of compliance (Djajić and Vinogradova, 2015).

Harsh punishment against undocumented work (low d): Alternatively, strict controls of employers and harsh punishment against firms that would employ undocumented migrants decrease d and, therefore, ease the enforceability of temporary migration visas. Condition (6) is indeed always true when $d = 0$. In countries with limited informal labor markets, it is always possible to design self-enforceable temporary migration visas.

Eligibility for future temporary visas (larger τ): Finally, host countries may put in place a system of credits to gain eligibility for future visa applications if a migrant returns home before the work visa expires. This additional instrument has been implemented in Canada.

Limits to TFWP self-enforceability: As a corollary, it is not always possible to enforce the temporary stay of workers by retaining a share of earnings abroad. With low deportation rates (low δ) and thriving informal labor markets for undocumented workers (large d), visas need to be unrealistically long and retention shares arbitrarily large to incentivize workers to return to their home country upon completion of the visa. Indeed visa duration and retention share interact to increase financial losses in case of default.[32] As a consequence, with lax enforcement of deportation and the existence of large informal labor markets for undocumented workers, as in Southern Europe and the USA, substantial numbers of migrants may overstay illegally. This problem will be illustrated in section 6, which studies the required levels of enforcement needed for workable temporary visas on two (i.e., South-North and South-South) routes.

[32] Equation (7) presents this constraint in the extreme case in which the deportation is not enforced.

For the remainder of this section and section 5, we consider a set of contracts for which the self-enforceability constraint is not binding, such that the exact design of the incentives to prevent overstaying does not affect the results.

4.3 Smugglers' reaction to the sale of temporary visas

When visas can be bought legally, the individual of type θ compares the lottery $\mathcal{L}_{illegal} = \left[dw_f - p^I, \Delta_h(\theta)w_h - p^I; 1-q, q\right]$ with the payoff she retrieves from migrating legally, $\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h$. A constraint for the smugglers is to fix their price low enough relative to the price of a legal permit, to attract the workers of type between 0 and θ^{LI}. This requires that $\theta^{LI} > 0$. Since $\omega^-(q)u\left[\tau\Delta_h(\theta)w_h - \tau\Delta_f(\theta)w_f - p^I + p^L\right] + \omega^+(1-q)u\left[dw_f - \tau\Delta_f(\theta)w_f - (1-\tau)\Delta_h(\theta)w_h - p^I + p^L\right]$ is decreasing in θ, a necessary condition is that the comparison of the lottery must be positive for the lowest skilled worker:

$$\begin{aligned}\omega^+(1-q)u\left[(d-\tau)w_f - (1-\tau)w_h - p^I + p^L\right] \\ +\omega^-(q)u\left[p^L - p^I - \tau\left(w_f - w_h\right)\right] > 0\end{aligned} \tag{8}$$

This condition is more likely to be satisfied with a higher visa price, a lower smugglers' fee and a shorter visa duration, which all make legal migration less attractive relative to illegal migration.

Under condition (8), the demand faced by the smugglers is:

$$D^I(p^I, p^L) = \int_0^{\theta^{LI}} f(\theta)d\theta = F(\theta^{LI}) \tag{9}$$

Let $p^N(p^L)$ be the solution of (1) computed with the direct price elasticity of demand (9), $\varepsilon_{D^I,p^I} = -\frac{\partial D^I(p^I,p^L)}{\partial p^I}\frac{p^I}{D^I(p^I,p^L)}$, which depends on p^L. The price reaction function of the smugglers is the solution of the following equation:

$$p^I(p^L) = \begin{cases} p^N(p^L) & \text{if } \ c \leq p^N(p^L) \\ \varnothing & \text{otherwise} \end{cases} \tag{10}$$

This shows that the reaction price of the smugglers is increasing in their marginal operating costs, c and in the price of a visa, p^L, and decreasing in the number of smugglers, N.

5 Eliminating smugglers through a sale of visas

Taking into account the three constraints of workable schemes and the smugglers' response to the implementation of temporary visas, the government can determine its optimal pricing

strategy by backward induction, which will depend on its economic priorities.

5.1 Setting the eviction price

We consider schemes designed to eliminate the incentive to smuggle by selling visas at a low price that leaves zero profit for smugglers. This requires that their reaction price is pushed below their marginal cost, i.e. $p^I(p^L) \leq c$.

We establish the following result.

Proposition 2 *The eviction price $\underline{p}^L(\tau)$ of temporary visas of duration τ below which smugglers exit the market is implicitly defined by*

$$\begin{aligned} \omega^+(1-q)u\left[(d-\tau)w_f-(1-\tau)w_h-c+\underline{p}^L\right] \\ +\omega^-(q)u\left[\underline{p}^L-c-\tau\left(w_f-w_h\right)\right]=0 \end{aligned} \tag{11}$$

The eviction price increases with τ, c, q and decreases with d.

Proof. see appendix F. ■

Appendix F shows that the eviction price is such that $\theta^{LI} = 0$ for $p^I = c$. In other words, a government that wants to push smugglers' reaction price down until their mark-up vanishes has to apply the price $\underline{p}^L(\tau)$ solution to (11) hereafter called the "eviction" price for a visa of duration τ. Note that this result applies to any initial structure of the market for smugglers: monopolist, oligopolist or competitive. Irrespective of the initial market conditions, if a government wants to eradicate smugglers by selling visas it has to apply $\underline{p}^L(\tau)$ such that the smugglers end up reaching their marginal cost pricing.[33]

Intuitively, the eviction price is increasing in the duration of visa τ: as temporary visas become more valuable, it is easier to throttle the smugglers by introducing legal options to migrate. It is also increasing in the marginal operating costs for smugglers c and in the risk associated with irregular migration q, which both make smugglers' services less attractive. Similarly, if pay-offs to work in the illegal sector decrease relative to the legal sector, pushing down d, the eviction price can be set higher.

Furthermore, there is a minimum duration of temporary visas, $\underline{\tau}$, above which the eviction price is positive. This is summarized in the following corollary:

Corollary 3 *The minimum duration of temporary visa, $\underline{\tau}$, required to set a positive eviction price decreases with q and c, and increases with d.*

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

Proof. see appendix F. ■

If the duration of the temporary visa τ is lower than $\underline{\tau}$, then $\underline{p}^L$ is negative (it is a subsidy). Workers will need to be paid to migrate legally under this scheme as the illegal option, enabling a longer stay in the high wage country, becomes more attractive. This is less likely to be the case when there is a high probability that irregular migration will fail, high marginal costs for smugglers to operate (increasing their fees) and low returns to irregular migration.

Occasionally migrants have been subsidized to move to advanced economies to work, for example in the sixties in Europe. However, with the higher risks of irregular migration, temporary permits become more attractive to migrants and the eviction price can be set higher. In countries that have large temporary work permits programs, such as the Gulf countries, Jordan or East-Asian countries, the cost is generally strictly positive and the programs are accompanied by strict enforcement policies.

As the (legal) migration demand decreases with the visa price (see equation 4) it follows that, at the eviction price $\underline{p}^L$, the legal migration demand, $F\big(\theta^L(\underline{p}^L)\big)$, decreases with the illegal migration risk, q.

In other words, fighting illegal migration by increasing q, the risk of not managing to cross the border, through reinforced controls, can be used as an instrument to control migration flows of temporary workers following the introduction of the visa scheme. Similarly, increasing the marginal operating costs for smugglers, c, through repression against smugglers or decreasing the discounted value of working illegally, d, through enforcement of fines against employment of undocumented workers, can also be used as policy instruments to increase the eviction price and to decrease the flows of legal migrants. As a consequence of corollary 3 the flow of temporary workers under this scheme decreases with sanctions against illegal activities.

5.2 Skill diversity of foreign workers

An important aspect of the visa policy aimed at eradicating smugglers is its impact on the skill composition of the migrant population. Voters may, for example, oppose the legalization scheme if it brings workers with a less diverse pool of skills.

The next proposition characterizes the visa duration $\tilde{\tau}$ and the associated eviction price $\underline{p}^L(\tilde{\tau})$ such that the pool of migrants' skills remains the same after the sale of visas, compared to the status quo with illegal migration.

Proposition 4 *The visa scheme sold at eviction price $\underline{p}^L(\tau)$ increases the skill diversity of*

migrants if the visa duration τ *does not exceed* $\tilde{\tau}(q,c,d) \in [0,1]$ *solution to*

$$\frac{\underline{p}^L(\tilde{\tau})}{\tilde{\tau}} = \Delta_f(\theta^I)w_f - \Delta_h(\theta^I)w_h \tag{12}$$

where θ^I *is defined by equation* (2) *and* $\underline{p}^L(\tau)$ *by equation* (11). *The threshold* $\tilde{\tau}(q,c,d)$ *decreases with* q *and* c *and increases with* d.

Proof. see appendix G. ■

A decreased (increased) visa length attracts a smaller (larger) pool of migrants, the price remaining constant. However, in an eviction framework, it entails a lower (higher) eviction price, which increases (decreases) the demand for legal visas ($\frac{\partial \theta^L}{\partial p} < 0$). This effect overrides the effect driven by the change in the visa duration.

When introducing a new scheme to meet labor market needs, the government faces a trade-off between the duration of the temporary visas, τ, and the average skill level of migrants recruited: a longer duration implies a pool of temporary migrants with lower skills on average. This result, which as far as we know, is new to the literature, is important for policy purposes. It implies that when a country seeks to recruit migrants to fill positions in low pay, low status jobs (e.g., in agriculture, construction, social care), the longer the work permit, the less qualified the candidates for these jobs will be. For instance a student might wish to travel to a rich country for a few months to pick fruits and vegetables as a way to to finance their studies or to accumulate capital to start a business at home. But they might not want to commit to a stay of several years as their human capital would be wasted on such low pay occupation. A relatively short term visa scheme, with low prices, makes it possible to recruit a wider range of workers, enlarging the skill pool of foreign workers.

This establishes that temporary foreign workers on short term visas may come with a larger pool of skills, compared to a pool of undocumented migrants under the *status quo*. However, since they only stay for a limited period, τ, the number of foreign workers living abroad at a given time (i.e. the stock) may decrease following this scheme, provided that the workers do not overstay.[34]

Indeed, such short-stay temporary visas are hard to enforce without substantial investment in deportation combined with wage retention while abroad (sticks) or other incentives, such as giving points to migrants for future visa eligibility or paying them to return to their home country. The latter has been implemented for example in France with "Aides au

[34]The total effect of the policy on the stock of foreign workers in the host country depends on how $F(\theta^I)$ under the *status quo* compares to $\tau F(\theta^L)$ under the new scheme. Computing the variation in the number of migrants in the economy following the introduction of the visa scheme, $\Delta N = \frac{\tau F(\theta^L) - F(\theta^I)}{F(\theta^I)}$, it is easy to show that ΔN is negative if and only if: $\frac{F(\theta^L)}{F(\theta^I)} < \frac{1}{\tau}$.

Retour" or at the EU level with the EU-IOM joint initiative for migrant protection and reintegration (carrots).[35]

5.3 Cost-effective policies to regulate labor migration

Our results so far highlight the very strong complementarities between (external and internal) controls and workable temporary visa schemes against smuggling. As internal and external controls are costly to enforce, we now turn to studying the optimal combination of these policy instruments for a cost-effective regulation of labor migration.

We depart from the *status quo* situation where marginal costs to smuggle is c, the risk of failing illegal migration is q and the wage discount factor for undocumented workers is d, and we determine the government's allocation of additional resources to enforce external and internal controls. We denote $c(I_1)$ the marginal costs that the smugglers face when the government invests $I_1 \geq 0$ additional resources to fight against smugglers and assume that $c'(I_1) > 0$ and $c''(I_1) < 0$. Similarly, the government may also multiply the controls by investing in additional man hours at the border to prevent irregular border crossings. We denote $q(I_3)$ the probability a migrant fails the crossing when the government invests $I_3 \geq 0$ additional resources and assume that $q'(I_3) > 0$ and $q''(I_3) < 0$. The concave shapes of the functions indicate decreasing returns to scale of external controls. Finally, the government can allocate funds to increase internal controls at work-sites and enforce the sanctions paid by the employers of undocumented migrants. We denote $d(I_2)$ the wage discount factor resulting from these enforcement measures and assume that $d'(I_2) < 0$[36] and $d''(I_2) > 0$. The convex shape of the function indicates decreasing returns to scale in the fight against illegal employment.

Note that we do not embed in the policy instruments the visa duration τ. The work permit duration is more realistically determined by the type of occupation targeted (i.e. seasonal in agriculture, hospitality, or longer term for personal care jobs) or by other priorities such as the targeted skill diversity of workers – in line with proposition 4 – or the legal framework in destination country.[37]

Replacing c by $c(I_1)$, d by $d(I_2)$ and q by $q(I_3)$ in (11), we can determine the eviction price of temporary visas of duration τ, $\underline{p}^L$, such that smugglers are pushed out of business given their inflated marginal costs, the reduced payoff to undocumnented employment and the increased risk of border crossings. The demand for temporary visas following this policy mix, combining the sale of temporary foreign work permits with enforced controls, can be

[35] 'Seehttps://www.migrationjointinitiative.org/

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

[37] If we consider visa duration to be flexible, it is easy to determine its optimal level simultaneously with the other instruments by adding one first order condition in Proposition 5: $\tau f(\theta^L)\frac{\partial \theta^L}{\partial \tau} + F(\theta^L) = 0$

written as:

$$D^L(I_1, I_2, I_3) = F\left(\theta^L\right) \tag{13}$$

with θ^L solution of :

$$\Delta_f(\theta)w_f - \Delta_h(\theta)w_h = \frac{p^L}{\tau}. \tag{14}$$

The government chooses the optimal investments I_1, I_2, and I_3 that minimize their overall costs while reaching the target of recruiting T equivalent permanent foreign workers (i.e. T/τ temporary workers), as follows:

$$\min I_1 + I_2 + I_3 \qquad \text{s.t.} \qquad \tau D^L(I_1, I_2, I_3) = T \tag{15}$$

Focusing on interior solutions, the optimal allocation of resources is summarized in the next proposition.[38]

Proposition 5 *To dismantle smugglers through a cost-effective sale of temporary visas of duration τ and meet the labor market needs for T permanent equivalent workers, a government should invest the amounts $\{I_1^*, I_2^*, I_3^*\}$ in internal and external controls, solutions of the following equations:*

$$\tau F(\theta^L) = T \tag{16}$$

$$c'(I_1)\frac{\partial \theta^L}{\partial c} = d'(I_2)\frac{\partial \theta^L}{\partial d} = q'(I_3)\frac{\partial \theta^L}{\partial q} \tag{17}$$

with θ^L solution of equation (14).

The optimal allocation of resources into different measures to enforce internal and external controls is such that their marginal effects on the migration demand are equalized, as shown by (17). In other words, whatever the migration target T, the government should equalize the marginal impact of investments in external and internal controls on migration flows to minimize the enforcement costs of the policy.

Since the demand for visas is a normal good and since $c'(I_1) > 0$, $d'(I_2) < 0$ and $q'(I_3) > 0$ we can check that $\frac{dD^L(I_1,I_2,I_3)}{dI_k} < 0$, for $k = 1, 2, 3$. When repression against smugglers increases, the marginal cost of their activity, c, and the probability of failure when crossing the border, q, increase. This enables a government to price out smugglers through higher eviction prices. Similarly, when sanctions are enforced against employers of undocumented migrants, this is transmitted to illegal migration payoffs through a decrease

[38] Depending on the functions $c(.)$, $d(.)$, and $q(.)$, it may be the case that the optimal solution involves increasing c only (i.e. $I_2 = 0$ and $I_3 = 0$), increasing q only (i.e. $I_2 = 0$ and $I_1 = 0$), decreasing d only (i.e.$I_1 = 0$ and $I_3 = 0$) or any combination of the three instruments. However, in other cases there will be an interior solution defined in (17) and such that $\tau D^L(I_1, I_2, I_3) = T$.

in d. As a result, a government can set higher eviction prices for visas. These measures, optimally combined to minimize the costs, enable a government to control migration flows and reach its target number of foreign workers recruited through the scheme. In stark contrast to the situation in the *status quo*, the regulation of migration flows is done without relying on the abusive power of smugglers, who are driven out of business.

6 Policy Implications

Our numerical applications focus on two routes: a South-North route from Senegal to Spain and a South-South route from the Democratic Republic of the Congo (DRC) to South Africa. The results are not fully fledged policy simulations, since we abstract from other changes that may occur in the rest of the economy.[39] However they do illustrate the complementarities between selling temporary visas and other policy instruments in the fight against illegal migration and the constraints of the policy mix.

Estimates of the fees paid by irregular migrants, the marginal costs for smugglers to operate, the failure rate of illegal migration and the discounted wage to work as an undocumented worker are retrieved from different surveys and testimonies (see in table 1). The minimum wage in Spain is from ILO statistics, while we use GDP and Gini coefficients of the World Data Indicators to calibrate low-skill wages in the DRC, Senegal and South Africa (see detail in appendix H.1).

6.1 Visa prices

To predict migrants' decisions under high risk of failure, we use the CPT functional forms by Tversky and Kahneman (1992), which are consistent with agents' behavior while considering risky gambles (for a literature review see Rabin, 1998; Barberis and Thaler, 2003).[40]

Using equation (11), the eviction price $\underline{p}^L(\tau)$ takes the following closed-form expression:

$$\underline{p}^L(\tau) = c + \tau(w_f - w_h) + \left(1 + \left(\lambda \frac{\omega^-(q)}{\omega^+(1-q)}\right)^{\frac{1}{\alpha}}\right)^{-1} (w_h - dw_f) \tag{18}$$

[39] In particular, labor markets may adjust following larger inflows of documented workers, which may dampen the initial incentives to migrate and, in turn, lead to smaller changes in migration flows than the ones we calibrate. However, Clemens et al. (2018) show very limited effects of the withdrawal of the BRACERO program on the US labor market.

[40] Tversky and Kahneman (1992) generalize the seminal paper by Kahneman and Tversky (1972), which was one of the first to show that individuals have a poor ability to assess probabilities. In particular, this theory provides realistic predictions for individual behavior when confronted with risky choices, both inside (Glöckner and Betsch, 2008) and outside (Barberis et al., 2016) the lab.

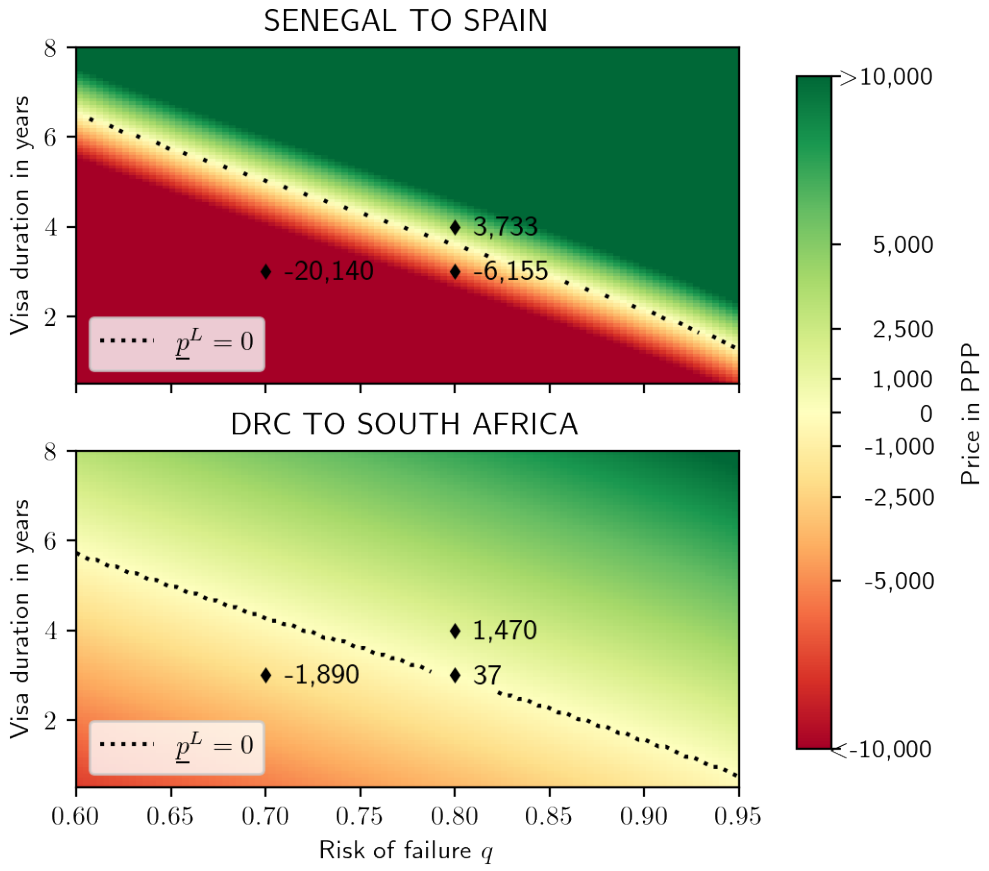

Figure 1: Eviction prices and variations in the share of migrants for the two benchmark scenarios

Table 1: Benchmark parameter values

Parameter	Value		Year	Source
Wages (monthly)				
DRC	36 PPP	32,806 FC	2020	20th percentile of computed distribution
Senegal	88 PPP	21,666 Fcfa	2007	20th percentile of computed distribution
South Africa	155 PPP	1,074 R	2020	20th percentile of computed distribution
Spain	857 PPP	694 €	2007	International Labour Organization (2008)
d	0.8			Monràs et al. (2020); Rivera-Batiz (1999); Kossoudji and Cobb-Clark (2002)
Marginal costs				
Senegal to Spain	1,150 PPP	266,666 Fcfa	2007	Mbow and Tamba (2007)
DRC to South Africa	830 PPP	408 USD	2020	inferred from Tshimpaka and Inaka (2020)
Smuggling prices				
Senegal to Spain	1,690 PPP	391,981 Fcfa	2007	Mbaye (2014)
DRC to South Africa	1,220 PPP	600 USD	2020	Tshimpaka and Inaka (2020)

Conversion rates between PPP and LCU, for private consumption, were retrieved from World Bank (2020).

[1] Statement of 9 February 2021, http://www.labour.gov.za/employment-and-labour-minister-tw-nxesi-announces-minimum-wage-increases?platform=hootsuite

Eviction prices on the two routes are represented in figure 1 by different colors as functions of the visa duration in years (on vertical axis),[41] and risk of failure, q (on horizontal axis). The dashed lines represent isoquants of level 0, i.e. combinations of risk of failure q and visa duration such that eviction prices are zero. Points in green, North-East of the 0-isoquant, are positive eviction prices. The darker the color, the higher the price. In the opposite direction, points in red represent negative eviction prices.

Starting from a realistic risk of failure around 80% [42] and a short term visa of 4 years, the eviction price is around 3,733 PPP on this route, as compared to 1,470 PPP on the route from the DRC to South Africa. Reducing the visa duration decreases eviction prices substantially: for the same risk, a 3-year visa should be subsidized at -6,155 PPP on the Senegal-Spain route (priced at +37 PPP on the DRC-South Africa route). Similarly, a decrease in the risk of failure decreases sharply the eviction price. With a risk around 70%, a 3-year visa from Senegal to Spain should be subsidized as much as -20,140 PPP (-1,890 PPP for a 3-year visa from the DRC to South Africa).

Eviction prices on the Senegal-Spain route are much more dispersed than on the DRC-South Africa route. The area in dark red color for the Senegal to Spain route indicates that, for a large range of parameter values (q, τ), large subsidies above 10,000 PPP should be

[41] Using the model's notations, visa duration in years is equal to $40 \times \tau$.
[42] See discussion in appendix H.1 and Bah et al. (2019)

given to migrants in order to erode smugglers' profits on this route, an unrealistic scenario. This is because wages in low-wage jobs (in PPP) in Spain are still approximately 10 times the wages in Senegal. This ratio is twice as large on this route compared to the DRC to South Africa route. Due to this difference, individual prospects are more sensitive to the risk of failing illegal migration and to the visa duration on the South-North route.

Note that this does not imply that a host country should offer a menu of visas set at different prices for migrants from different origin countries. For example, setting visa prices below eviction prices on all routes to the same destination country will drive smugglers out of business, and has yet limited effects on increasing the share of workers choosing to migrate through TFWPs compared to the share of undocumented migrants under the status quo. Appendix I illustrates this with an example of a visa scheme priced at the equivalent current embassy costs charged for visa applications from the DRC to South Africa and an example of TFWPS priced at the average smugglers' fees observed on this route.

However, since little information is available on illegal migration and since risks of crossing illegally vary a lot over time (see discussion in appendix H.1), the exacerbated sensitivity makes price-setting strategies particularly challenging on South-North routes.

6.2 Self-enforceability

A strong constraint on the success of temporary work permit schemes is the compliance of workers with their rules. Since the left hand side of the self-enforceability constraint (6) decreases with θ, low-skilled workers have more incentives to overstay their visa duration than higher skilled workers. This implies that if (6) is satisfied for $\theta = 0$, then it is also satisfied for any worker of skill level $\theta > 0$. As the left hand side of (6) also decreases in s, we define the threshold share of income retention $\bar{s}$ above which workers of all skill levels will not have economic incentives to overstay, as the solution of the following equation:

$$\omega^{+}(1-\delta)u\left[(1-\tau)(dw_f - w_h) - s\tau w_f\right] + \omega^{-}(\delta)u\left[-s\tau w_f\right] = 0 \tag{19}$$

For deportation rates ranging between 25% and 90%, we compute the minimum share of income retention required to incentivize workers' compliance. Results for each route are presented in figure 2. Dark colored areas represent combinations of visa duration, τ, and level of deportation, d, which require a high level of income retention to be enforceable. Lighter colored areas show that the minimum share of income retention is a decreasing function of the deportation rate and of the visa duration. This illustrates the complementarity of policy instruments (proposition 1).

White areas are sets of visa duration and deportation rate such that visas are not enforceable ($s > 100\%$). The top panels show that such schemes may simply not work when

the parameter d takes the benchmark value 0.8., especially where the wages differential is too large (top left figure) and deportations are not enforced. In most OECD destination countries deportation rates – although difficult to estimate– are relatively low. The European Commission estimates the fraction of "returnees" among the undocumented migrants ordered to leave Europe in 2019 to be around 29% on average.[43] This suggests that enforcing the policy to reach the required deportation rate will be difficult to implement in most EU countries and very costly.[44]

Even when theoretically feasible (colored areas in the top panel), incentivizing short-term visa compliance would require retaining more than 50% of the income earned abroad (as highlighted in blue-green shaded areas) for a large range of deportation values. This may constrain migrants to over-accumulate savings abroad. Although the empirical evidence points to very uneven shares of annual income remitted to families of origin across routes, it rarely reaches 50% of the annual earnings.[45] Accordingly, retention shares that are too high are likely to reduce the welfare of migrants and their families, in particular if these funds are otherwise used to consume while abroad or/and insure each other against negative income shocks.[46]

So is there another way forward? A tool often underused by policy makers is to strengthen the sanctions against employers of undocumented migrants by multiplying work-site controls and enforcing penalties. Increasing the costs of employing undocumented migrants would lead to an equilibrium with lower relative earnings of undocumented workers, driving down the parameter d. As shown in the center and bottom heat maps in figure 2, for which d is set to 0.6 and 0.4 respectively, the self-enforceability constraint is largely relaxed: the minimum shares of income retention decline significantly at any given set of policy parameters (deportation-visa duration) such that the colored areas with feasible policies are significantly extended.

[43] This statistic is an overestimate of the deportation rate for the overall population of undocumented migrants, since many of them are not caught and ordered to leave, and it varies a lot across countries. See Eurostat Statistics on migration to Europe, available online at https://ec.europa.eu/info/strategy/priorities-2019-2024/promoting-our-european-way-life/statistics-migration-europe_en#illegalbordercrossings.

[44] Estimates of overall costs of deporting are around USD12,500 per person in the US in 2011, £11,000 per person in the UK (BBC 2009) and NOK 50,000 (USD 9000) in Norway in 2013 (Djajić and Vinogradova, 2015).

[45] For example, workers from Senegal (respectively Morocco) remit from Spain 49.9% (resp.30.8%) of their earnings (Groenewold and Bilsborrow, 2004), while workers from Senegal (resp. Morocco) remit from France 11.2% (resp. 10.4%) of their earnings (Wor, 2009). See also Yang (2011).

[46] On the other hand, locking some earnings on a foreign bank account could be beneficial to migrants if the main motive for remittances is future consumption and investment after return. This would give migrants more control over their savings accumulated abroad, higher return to their savings and greater investment opportunities in the origin country once the funds, plus interest, are transferred back.

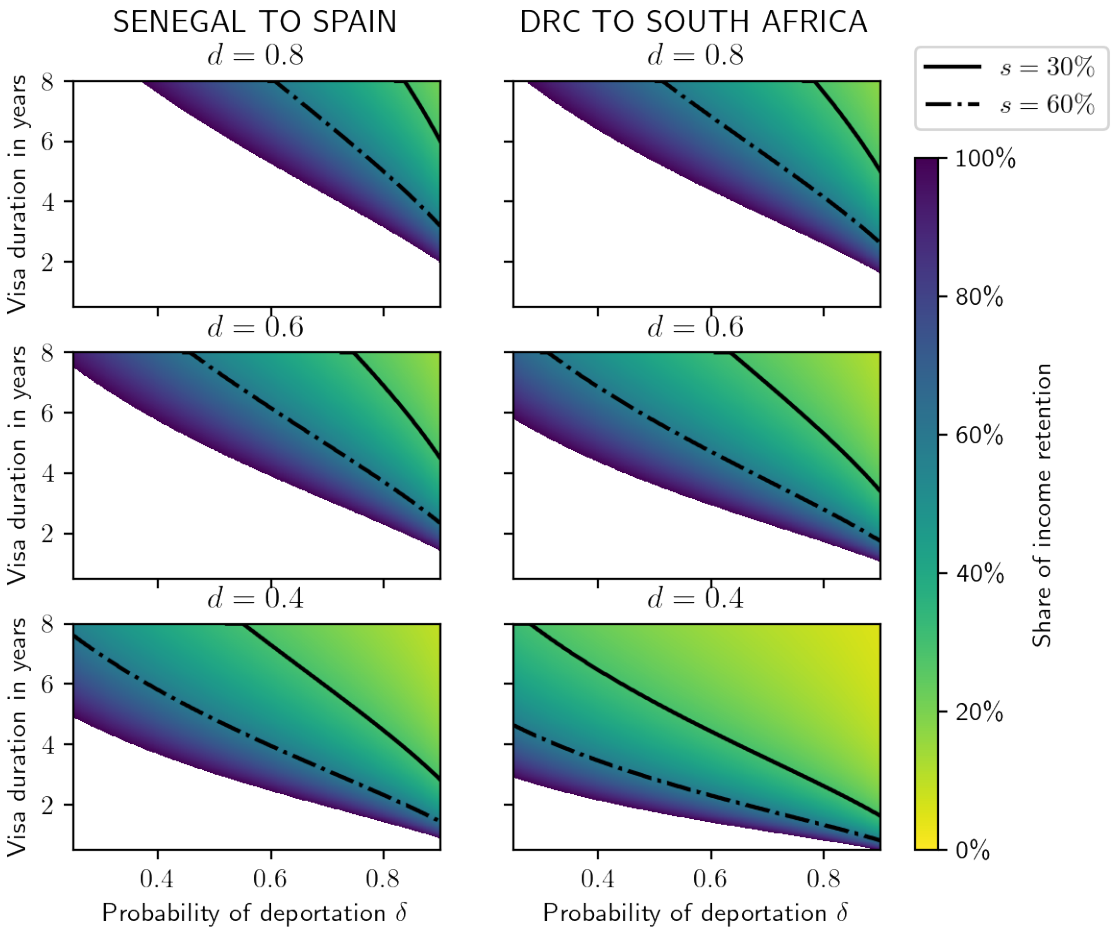

Figure 2: Self-enforceability constraint for temporary migration on the benchmark routes

7 Conclusion

We show how a system of temporary work visas enables a government to overcome the legalization-migration control trade-off. Politically appealing for governments in destination countries, these temporary visas are designed to meet labor market needs, to dry-up the illegal markets, and to decrease the number of foreign workers staying illegally in high wage countries, where they are negatively perceived by citizens, or used as a target by populists to build political support.

The main mechanism is to sell visas at an eviction price, which will drive smugglers out of business and can be adjusted to reach migration targets, if combined with appropriate enforcement of external and internal controls. Compared to more permanent visas, an advantage of selling TFWPs is that they are more affordable to poor workers from low income countries. Yet, their limited duration and their positive price limit their attractiveness, which regulates the flows of legal migrants. However a system of visas against smuggling will need to address the two main weaknesses of past TFWPs: overstays and abuses of migrants' rights.

Regarding the first problem, our analysis shows that the larger the wage differential between the origin and the destination country, the harder it is to incentivize guest workers to return home when their visa expires. For this reason, regulating South-South migration flows with the help of TFWP may be feasible, as illustrated by our numerical applications to the DRC-South Africa route. In contrast, systems of self-enforceable TFWPs for migrants from low-wage countries to high-wage countries require very high levels of investment in policy enforcement and high retention shares on wages earned abroad. Our simulations for Senegalese workers migrating to Spain illustrate that the level of incentives needed to enforce the scheme may be too constraining. Where there are large economic disparities combined with lax enforcement of deportation and strong protection of migrants' rights, guest workers are likely to feed the undocumented labor market in host country.

These results illustrate the practical challenge of discouraging over-stayers. They also help to explain why very large TFWP programs flourish in the Gulf and Asian countries. First, the wage gap between origin and destination countries is smaller than in Europe or the US, which cushions the incentives to overstay. Second, enforcement of visa schemes through repressive measures is more effective in those parts of the world where states have strong authoritarian traditions and offer flimsy legal protection to foreign workers, who can be easily deported and sanctioned if caught working without a permit. This often leads to abuse of migrants' rights and the second criticism commonly addressed to TFWPs.

In response to these legitimate concerns we argue that socially just TFWPs built around migrant agency (Consterdine and Samuk, 2018) have the potential to promote rights-based

policies, offering migrants safe passage and access to legal labor markets in high wage countries, with better legal protection than if they are left at the mercy of smugglers and illegal employers. To ensure timely return of the temporary guest workers, governments in advanced economies may adopt different combinations of enforcement measures, such as harsh punishment against employers of undocumented workers, the awarding of points toward more settled status in the future or preservation of future eligibility for visas, as seen in Canada.[47] Further, other important factors influence temporary workers' return to their home country: migrants may have preferences to consume in their home country, higher purchasing power, and better investment opportunities, which help insure the circularity of labor migration (Djajić, 2013; Djajić and Vinogradova, 2015; Mesnard, 2004). Embedding these additional factors in our framework of analysis would improve economic prospects in the origin country and relax the self-enforceability constraint.

Even though TFWPs have been implemented with varying levels of success in the past, they have not yet been designed to erode smugglers' profits, nor to promote migrants' rights. Given that migrant workers under this scheme would be employed legally as opposed to illegally under current policies, their living conditions and rights can be more easily protected. Carefully designed active labor recruitment policies from low income countries to high income countries have multiple economic and social benefits for migrants themselves, and for destination, transit and origin countries. This should be considered in the design of future migration policies.

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[47] Our framework provides an intuition for the effect of eligibility points awarded upon timely return. In our simple static model, this is captured by increasing the visa duration τ, which relaxes the enforceability constraint.

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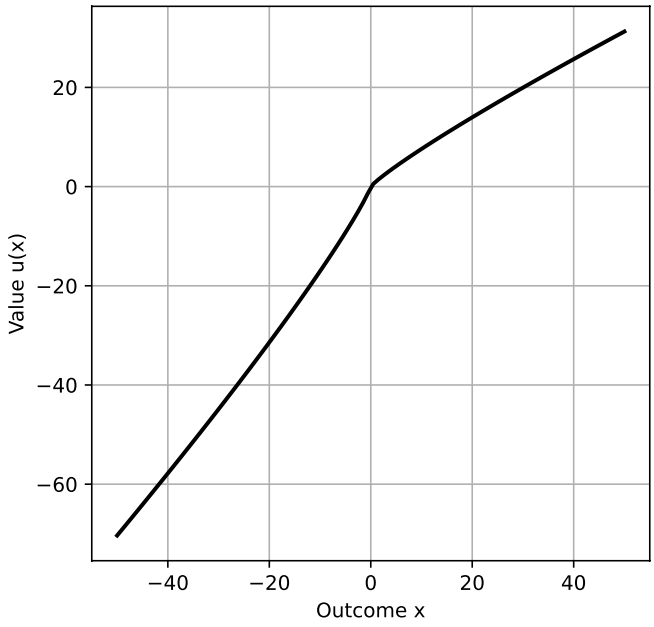
Appendix

A Some detail on cumulative prospect theory

Tversky and Kahneman (1992) build a model featuring loss aversion, as well as both diminishing sensitivity for gains and losses, and diminishing sensitivity regarding probabilities.

Agents' appreciation for gains and losses is represented by a value function $u(x)$, which is S-shaped with an inflection point in zero. This reflects individuals being empirically risk-averse for gains and risk-seeking for losses; which Kahneman and Tversky (1972) denote as the *reflection effect*.

Figure 3: Value function as calibrated by Tversky and Kahneman (1992)



Note: $\alpha = 0.88$, which explains the apparent low curvature of function u.

More specifically, the authors calibrate the following functional form for the value function:

$$u(x) = \begin{cases} x^{\alpha} \text{ , if } x > 0 \\ -\lambda(-x)^{\beta} \text{ , if } x \leq 0 \end{cases} \tag{20}$$

where $\alpha, \beta \in (0, 1)$ reflect the curvature and indicate the degree of risk preference; i.e. the degree of risk-aversion for gains and the degree of risk-seeking in the domain of losses. $\lambda \geq 1$ is the *coefficient of loss aversion*, which reflects that the decrease in utility from a loss is greater than the increase in utility from a gain of the same amount. In line with Tversky

and Kahneman (1992) estimates, we assume $\alpha = \beta$.

Since empirically $\alpha = \beta$, we assume in Section 6 that $\alpha = \beta$, which eases computation.

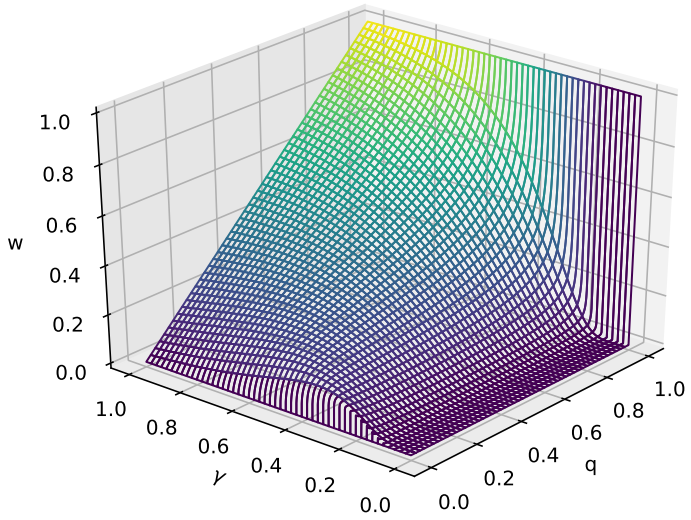
Probability weighting under CPT is cumulative. Consider the lottery $\mathcal{L} = [x_{-m}, ..., x_0, ..., x_n; p_{-m}, ..., p_0, ..., p_n]$, where $x_0 = 0$, $x_i < x_j$ for $i < j$, and $\sum_{i=-m}^{n} p_i = 1$. The value attributed to the lottery $\mathcal{L}$, when it is compared to the certain outcome x_c, is given by

$$\sum_{i=-m}^{n} \pi_i u(x_i - x_c)$$

where

$$\pi_i = \begin{cases} \omega^+(p_n) & \text{, for } i = n \\ \omega^-(p_{-m}) & \text{, for } i = -m \\ \omega^+(p_i + ... + p_n) - \omega^+(p_{i+1} + ... + p_n) & \text{, for } 0 \leq i \leq n-1 \\ \omega^-(p_{-m} + ... + p_i) - \omega^-(p_{-m} + ... + p_{i-1}) & \text{, for } 1-m \leq i < 0 \end{cases}$$

Figure 4: Probability weighting functions for $\gamma \in (0, 1]$



These weighting functions w^+, for gains, w^-, for losses are concave near 0 and convex near 1 to capture diminishing sensitivity for probabilities. For example Tversky and Kahneman (1992) specify the weighting functions as follows:

$$\omega(q) = \frac{q^\gamma}{(q^\gamma + (1-q)^\gamma)^{\frac{1}{\gamma}}} \tag{21}$$

where the parameter $\gamma \in (0,1]$ may slightly differ for the two weighting functions. The form of these weighting functions is represented on figure 4.

For $\gamma = 1$, $w^x : q \mapsto \frac{q^\gamma}{(q^\gamma+(1-q)^\gamma)^{\frac{1}{\gamma}}}$ is the identity. The closer γ is to 0, the more distorted the probability weights. When $\gamma \to 0$, the function w^x has an L-shape.

Our model offers only two possible outcomes (success/failure) for an individual choosing to migrate irregularly. Therefore, without any loss of generality, we directly apply the probability weights $\omega^+(1-q)$ and $\omega^-(q)$ to these two outcomes.

B Characterizing the marginal type of migrant indifferent between migrating illegally and not migrating

Under EUT

An individual deciding between irregular migration or staying in origin country compares the expected utility from the lottery $\mathcal{L}_{illegal}$, $(1-q)u\left(dw_f - p^I\right) + qu\left(\Delta_h(\theta)w_h - p^I\right)$, to the utility derived from staying in origin country, $u\left(\Delta_h(\theta)w_h\right)$, where the utility function u is increasing and concave. Therefore, the type θ^I of the individual indifferent between these two options is solution of the following equation.

$$(1-q)u\left(dw_f - p^I\right) + qu\left(\Delta_h(\theta)w_h - p^I\right) = u\left(\Delta_h(\theta)w_h\right) \tag{22}$$

Let us define $V_0(\theta) := (1-q)u\left(dw_f - p^I\right) + qu\left(\Delta_h(\theta)w_h - p^I\right) - u\left(\Delta_h(\theta)w_h\right)$. Since $V_0'(\theta) = w_h\Delta_h'(\theta)\left(qu'\left(\Delta_h(\theta)w_h - p^I\right) - u'\left(\Delta_h(\theta)w_h\right)\right)$, for $q < \frac{u'(\Delta_h(\theta)w_h)}{u'(\Delta_h(\theta)w_h - p^I)} \equiv \tilde{q}$, V is decreasing. This condition is satisfied if the probability of failure is not too high relatively to the price of irregular migration. The necessary condition for some migration to occur is $\theta^I > 0$, which implies $V_0(0) > 0$. As we have $\lim_{\theta\to\infty} V(\theta) = -\infty$, equation (22) admits a unique solution.

Taking the total differential of equation (22) yields

$$\alpha_\theta \mathrm{d}\theta + \alpha_q \mathrm{d}q + \alpha_d \mathrm{d}d + \alpha_{w_f}\mathrm{d}w_f + \alpha_{p^I}\mathrm{d}p^I + \alpha_{w_h}\mathrm{d}w_h = 0$$

where, for $q < \tilde{q}$,

$$\begin{aligned}
\alpha_\theta &= \Delta_h'(\theta)w_h\left[qu'\left(\Delta_h(\theta)w_h - p^I\right) - u'\left(\Delta_h(\theta)w_h\right)\right] &< 0\\
\alpha_q &= -u\left(dw_f - p^I\right) + u\left(\Delta_h(\theta)w_h - p^I\right) &< 0\\
\alpha_d &= (1-q)w_f u'\left(dw_f - p^I\right) &> 0\\
\alpha_{w_f} &= (1-q)du'\left(dw_f - p^I\right) &> 0
\end{aligned}$$

$$\alpha_{p^I} = -(1-q)u'\left(dw_f - p^I\right) - qu'\left(\Delta_h(\theta)w_h - p^I\right) \quad < 0$$
$$\alpha_{w_h} = \Delta_h(\theta)\left[qu'\left(\Delta_h(\theta)w_h - p^I\right) - u'\left(\Delta_h(\theta)w_h\right)\right] \quad < 0$$

This implies that the threshold θ^I increases in d and w_f and decreases in q, p^I and w_h.

Under CPT

The marginal type θ^I is the solution of the following equation:

$$V_1(\theta) := \omega^+(1-q)u\left(dw_f - p^I - \Delta_h(\theta)w_h\right) + \omega^-(q)u\left(-p^I\right) = 0$$

The function V_1 is clearly decreasing. Besides, for any irregular migration to occur, the condition $V_1(0) > 0$ must be satisfied and $\lim_{\theta\to\infty} V_1(\theta) = -\infty$; which guarantees the existence and uniqueness of the threshold θ^I. Since V_1 increases with d and w_f and decreases in p^I and w_h, so does θ^I. Besides, the marginal value with respect to q is given by $V_{1q}(\theta) = -\omega'^+(1-q)u\left(dw_f - p^I - \Delta_h(\theta)w_h\right) + \omega'^-(q)u\left(-p^I\right) < 0$: θ^I decreases with q.

C Characterizing the marginal type of migrant indifferent between migrating legally and not migrating

Legal migration and staying in origin country are not subject to risk. An individual choosing between these options compares their payoffs and migrates legally if and only if

$$\tau\Delta_f(\theta)w_f + (1-\tau)\Delta_h(\theta)w_h - p^L > \Delta_h(\theta)w_h \Leftrightarrow \Delta_f(\theta)w_f - \Delta_h(\theta)w_h > \frac{p^L}{\tau}$$

We assume

$$\forall\theta \in \mathbb{R}_+^*,\ \Delta_f'(\theta)w_f < \Delta_h'(\theta)w_h \tag{23}$$

In other words, the quantity $\Delta_f(\theta)w_f - \Delta_h(\theta)w_h$ decreases with θ. This monotony assumption guarantees the threshold θ_L is unique, if it exists, and is implicitly determined by the following equation:

$$\Delta_f(\theta)w_f - \Delta_h(\theta)w_h = \frac{p^L}{\tau} \tag{4}$$

Condition (23) implies that legal migration selects individuals negatively – i.e. by individuals of type $\theta < \theta^L$ – if θ^L exists.

Legal migration occurs if and only if the threshold θ^L is higher than 0, that is $\Delta_f(0)w_f - \Delta_h(0)w_h > w_f\Delta_f(\theta^L)w_f - \Delta_h(\theta^L)w_h$; equivalently,

$$w_f - w_h > \frac{p^L}{\tau} \tag{24}$$

This condition insures that, for the legal visa scheme (τ, p^L), θ^L exists.

We show that the threshold θ^L increases with w_f and τ and decreases with w_h and p^L by differentiating equation (4):

$$\left(\Delta'_f(\theta)w_f - \Delta'_h(\theta)w_h\right)\mathrm{d}\theta + \Delta_f(\theta)\mathrm{d}w_f - \Delta_h(\theta)\mathrm{d}w_h - \frac{1}{\tau}\mathrm{d}p^L + \frac{p^L}{\tau^2}\mathrm{d}\tau = 0.$$

D Characterizing the marginal type of migrant indifferent between migrating legally and illegally

When visas can be bought legally, the individual of type θ compares the lottery $\mathcal{L}_{illegal}$ with the payoff she retrieves from migrating legally, $\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h$.

Under EUT

In the EUT framework, the marginal type of migrant θ^{LI} indifferent between migrating through legal channels and irregularly is characterized by the following equation.

$$(1-q)u\left(dw_f - p^I\right) + qu\left(\Delta_h(\theta)w_h - p^I\right) = u\left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right) \quad (25)$$

Let us define $W_0(\theta) = (1-q)u\left(dw_f - p^I\right) + qu\left(\Delta_h(\theta)w_h - p^I\right) - u\left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)$.

Since u is S-shaped, for $\tau < \frac{\Delta'_h(\theta)w_h}{\Delta'_f(\theta)w_f - \Delta'_h(\theta)w_h}\frac{qu'\left(\Delta_h(\theta)w_h - p^I\right) - u'\left(\Delta_f(\theta)w_f - p^L\right)}{u'\left(\Delta_f(\theta)w_f - p^L\right)}$, we have

$$\begin{aligned} W'_0(\theta) =& \Delta'_h(\theta)w_h qu'\left(\Delta_h(\theta)w_h - p^I\right) \\ & - \left[\tau\Delta'_f(\theta)w_f + (1-\tau)\Delta'_h(\theta)w_h\right]u'\left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right) \\ & < 0 \end{aligned}$$

For some irregular migration to occur, we necessarily have $W_0(0) > 0$. Besides, since $\Delta_f(\theta)w_f > \Delta_h(\theta)w_h$ and $\lim_{\theta\to\infty}\Delta_f(\theta) = \lim_{\theta\to\infty}\Delta_h(\theta) = +\infty$, $\lim_{\theta\to\infty} W_1(\theta) = -\infty$

Therefore, when the probability of deportation is low enough – leaving room for irregular migration – equation (25) determines implicitly the threshold type, θ^{LI}, such that any individual above this threshold prefers to migrate legally than undocumented.

Taking the total differential of equation (25) yields

$$\alpha_\theta\mathrm{d}\theta + \alpha_q\mathrm{d}q + \alpha_d\mathrm{d}d + \alpha_{w_f}\mathrm{d}w_f + \alpha_{p^I}\mathrm{d}p^I + \alpha_{w_h}\mathrm{d}w_h + \alpha_\tau\mathrm{d}\tau + \alpha_{p^L}\mathrm{d}p^L = 0$$

where, in the neighborhood of θ^{LI}, for $q < \hat{q}$,

$$\begin{aligned}
\alpha_\theta =& \Delta_h'(\theta)w_h q u'\left(\Delta_h(\theta)w_h - p^I\right) \\
&- \left[\tau\Delta_f'(\theta)w_f + (1-\tau)\Delta_h'(\theta)w_h\right] u'\left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right) && < 0 \\
\alpha_q =& -u\left(dw_f - p^I\right) + u\left(\Delta_h(\theta)w_h - p^I\right) && < 0 \\
\alpha_d =& \, w_f(1-q)u'\left(dw_f - p^I\right) && > 0 \\
\alpha_{w_f} =& \, d(1-q)u'\left(dw_f - p^I\right) && > 0 \\
\alpha_{p^I} =& -(1-q)u'\left(dw_f - p^I\right) - qu'\left(\Delta_h(\theta)w_h - p^I\right) && < 0 \\
\alpha_\tau =& -\left(\tau\Delta_f(\theta)w_f + (1-\tau)\Delta_h(\theta)w_h\right) u'\left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right) && < 0 \\
\alpha_{p^L} =& \, u'\left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right) && > 0 \\
\alpha_{w_h} =& \, \Delta_h(\theta)\left[u'\left(\Delta_h(\theta)w_h - p^I\right) - (1-\tau)u'\left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right]
\end{aligned}$$

This shows that $\partial\theta^{LI}/\partial q < 0$, $\partial\theta^{LI}/\partial d > 0$, $\partial\theta^{LI}/\partial p^I < 0$, $\partial\theta^{LI}/\partial\tau < 0$ and $\partial\theta^{LI}/\partial p^L > 0$.

Under CPT

In the CPT framework, the the marginal type of migrant θ^{LI} indifferent between migrating legally and irregularly is characterized by the following equation.

$$\begin{aligned}
&\omega^+(1-q)u\left[dw_f - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right] \\
&+\omega^-(q)u\left[\Delta_h(\theta)w_h - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right] = 0
\end{aligned} \tag{5}$$

Let us define $W_1(\theta) = \omega^+(1-q)u\left[dw_f - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right] + \omega^-(q)u\left[\Delta_h(\theta)w_h - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right]$.

The value of irregular migration with respect to legal migration, $W_1(\theta)$, is decreasing as long as

$$\begin{aligned}
&\left(\tau\Delta_f'(\theta)w_f + (1-\tau)\Delta_h'(\theta)w_h\right) \\
&\omega^+(1-q)u'\left[dw_f - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right] \\
>&\tau\left(\Delta_h'(\theta)w_h - \Delta_f'(\theta)w_f\right) \\
&\omega^-(q)u'\left[\Delta_h(\theta)w_h - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right]
\end{aligned}$$

This inequality is verified under the following sufficient condition

$$\tau < \frac{\omega^+(1-q)u'\left[dw_f - \Delta_h(\theta)w_h - p^I\right]}{\omega^+(1-q)u'\left[dw_f - \Delta_h(\theta)w_h - p^I\right] + \omega^-(q)u'\left[-p^I\right]} < 1 \tag{26}$$

This involves that, if irregular migration does not always select individuals negatively, at least there exists a threshold value for τ under which it does.

Assume the function W_1 is decreasing.

A necessary condition for some irregular migration to occur is that $W_1(0) > 0$. Besides, since $\theta^L > \theta^I$, $W_1(\theta^L) = \omega^+(1-q)u\left[dw_f - p^I - \Delta_h(\theta^L)w_h\right] + \omega^-(q)u\left[-p^I\right] < 0$. This implies that, when an illegal market exists, equation (5) determines implicitly the threshold type, θ^{LI}, such that any individual above this threshold prefers to migrate legally rather than irregularly.

Taking the total differential of equation (5) yields

$$\alpha_\theta \mathrm{d}\theta + \alpha_q \mathrm{d}q + \alpha_d \mathrm{d}d + \alpha_{w_f} \mathrm{d}w_f + \alpha_{p^I} \mathrm{d}p^I + \alpha_{w_h} \mathrm{d}w_h + \alpha_\tau \mathrm{d}\tau + \alpha_{p^L} \mathrm{d}p^L = 0$$

where we already saw that $\alpha_\theta = W_1'(\theta) < 0$ and it is quite straightforward that,

$$\begin{aligned}
\alpha_q =& -\omega'^+(1-q)u\left[dw_f - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right] \\
&+ \omega'^-(q)u\left[\Delta_h(\theta)w_h - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right] && < 0 \\
\alpha_d =& w_f\omega^+(1-q)u'\left[dw_f - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right] && > 0 \\
\alpha_{w_f} =& d\omega^+(1-q)u'\left[dw_f - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right] && > 0 \\
\alpha_{p^I} =& -\omega^+(1-q)u'\left[dw_f - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right] \\
&- \omega^-(q)u'\left[\Delta_h(\theta)w_h - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right] && < 0 \\
\alpha_\tau =& \left(\Delta_h(\theta)w_h - \Delta_f(\theta)w_f\right) \\
&\times \{\omega^+(1-q)u'\left[dw_f - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right] \\
&+ \omega^-(q)u'\left[\Delta_h(\theta)w_h - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right]\} && < 0 \\
\alpha_{p^L} =& -\alpha_{p^I} && > 0
\end{aligned}$$

Besides, under the sufficient condition (26),

$$\begin{aligned}
\alpha_{w_h} =& -(1-\tau)\Delta_h(\theta)\omega^+(1-q)u'\left[dw_f - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right] \\
&+ \tau\Delta_h(\theta)\omega^-(q)u'\left[\Delta_h(\theta)w_h - p^I - \left(\tau\Delta_f(\theta)w_f - p^L + (1-\tau)\Delta_h(\theta)w_h\right)\right] \\
<& -(1-\tau)\Delta_h(\theta)\omega^+(1-q)u'\left[dw_f - \Delta_h(\theta)w_h - p^I\right] + \tau\Delta_h(\theta)\omega^-(q)u'\left[-p^I\right] \\
<& 0
\end{aligned}$$

This yields $\partial\theta^{LI}/\partial q < 0$, $\partial\theta^{LI}/\partial d > 0$, $\partial\theta^{LI}/\partial w_f > 0$, $\partial\theta^{LI}/\partial p^I < 0$, $\partial\theta^{LI}/\partial\tau < 0$, $\partial\theta^{LI}/\partial p^L > 0$ and $\partial\theta^{LI}/\partial w_h < 0$.

E Self-enforceability of return migration

Migrants facing the decision to overstay to work undocumented compare the payoff they derive from the lottery $\mathcal{L}_{overstay} = [\tau(1-s)\Delta_f(\theta)w_f + (1-\tau)dw_f - p^L, \tau(1-s)\Delta_f(\theta)w_f + (1-\tau)\Delta_h(\theta)w_h - p^L; 1-\delta, \delta]$, with their payoff if they comply with the rules of the guest worker program, $\tau\Delta_f(\theta)w_f + (1-\tau)\Delta_h(\theta)w_h - p^L$.

We show, in both EUT and CPT frameworks, that for any migration contract of duration τ and positive share of wages retention, s, there exists a minimum probability of deportation such that temporary migration visas are self enforceable.

Under EUT

Let us define the function $\phi(\delta)$ as:

$$\begin{aligned}\phi(\delta) = (1-\delta)u\left[\tau(1-s)\Delta_f(\theta)w_f + (1-\tau)dw_f\right] \\ +\delta u\left[\tau(1-s)\Delta_f(\theta)w_f + (1-\tau)\Delta_h(\theta)w_h\right] \\ -u\left(\tau\Delta_f(\theta)w_f + (1-\tau)\Delta_h(\theta)w_h\right)\end{aligned}$$

The derivative of ϕ is simply given as

$$\begin{aligned}\phi'(\delta) =& u\left[\tau(1-s)\Delta_f(\theta)w_f + (1-\tau)\Delta_h(\theta)w_h\right] \\ &- u\left[\tau(1-s)\Delta_f(\theta)w_f + (1-\tau)dw_f\right]\end{aligned}$$

Since $dw_f > \Delta_h(\theta)w_h$, it is quite straightforward that $\phi'(\delta) < 0$.
Besides, if $s > 0$, $\phi(1) < 0$.
Two cases arise:

- if $\phi(0) < 0$ then, by continuity, the enforceability constraint is always satisfied;
- if $\phi(0) > 0$, there exists a unique threshold deportation probability $0 < \underline{\delta} < 1$, above which the temporary visas are self-enforceable.

This threshold is the implicit solution of $\phi(\underline{\delta}) = 0$.

Under CPT

The level of deportation $\underline{\delta}$ such that the individual of type θ is indifferent between overstaying or complying with the visa rules is the solution of the following equation

$$\begin{aligned}\omega^+(1-\delta)u\left[\tau(1-s)\Delta_f(\theta)w_f + (1-\tau)dw_f - (\tau\Delta_f(\theta)w_f + (1-\tau)\Delta_h(\theta)w_h)\right] \\ +\omega^-(\delta)u\left[\tau(1-s)\Delta_f(\theta)w_f + (1-\tau)\Delta_h(\theta)w_h - (\tau\Delta_f(\theta)w_f + (1-\tau)\Delta_h(\theta)w_h)\right] = 0\end{aligned} \tag{27}$$

which can be rewritten as follows

$$\omega^{+}(1-\delta)u\left[-\tau s\Delta_f(\theta)w_f+(1-\tau)\left(dw_f-\Delta_h(\theta)w_h\right)\right]+\omega^{-}(\delta)u\left[-\tau s\Delta_f(\theta)w_f\right]=0$$

The function $\phi(\delta) := \omega^{+}(1-\delta)u\left[-\tau s\Delta_f(\theta)w_f+(1-\tau)\left(dw_f-\Delta_h(\theta)w_h\right)\right]+\omega^{-}(\delta)u\left[-\tau s\Delta_f(\theta)w_f\right]$ is decreasing in δ. [48]

Since $\phi(0)>0$ and $\phi(1)<0$, the equation (27) admits a unique solution, which is the threshold deportation probability $\underline{\delta}$, above which the temporary visas are self-enforceable.

With a similar reasoning we can show that it is not always possible to enforce a temporary stay of workers by retaining a share of earnings abroad. Let us define the function $\psi(s) := \omega^{+}(1-\delta)u\left[-\tau s\Delta_f(\theta)w_f+(1-\tau)\left(dw_f-\Delta_h(\theta)w_h\right)\right]+\omega^{-}(\delta)u\left[-\tau s\Delta_f(\theta)w_f\right]$.

It is straightforward to show that this continuous function is decreasing in s and that $\psi(0)>0$.Two cases arise:

- if the income in the home country is too low, relative to the income obtained as undocumented worker in the foreign country, and $\psi(1)>0$, then for the level of deportation δ enforced, temporary visas are not self-enforceable;
- otherwise, if $\psi(1)<0$, there exists a threshold share of earnings retained $\underline{s}$ under which temporary visas are not self-enforceable.

F Characterizing the eviction price

The threshold price, denoted $\underline{p}^L$, below which smugglers are driven out of business is such that $\theta^{IL}=0$ for $p^I=c$.

Under EUT

Using (25), the threshold price is defined implicitly as follows:

$$(1-q)u\left(dw_f-c\right)+qu\left(w_h-c\right)=u\left(\tau w_f-\underline{p}^L+(1-\tau)w_h\right)$$

which is equivalent to

$$\underline{p}^L=\tau w_f+(1-\tau)w_h-u^{-1}\left[(1-q)u\left(dw_f-c\right)+qu\left(w_h-c\right)\right]$$

Since u is increasing and $dw_f>w_h$, the eviction price is increasing in the probability of arrest q, the duration of the migration visa τ, and the marginal cost for smugglers to operate c. It is decreasing in the discount factor d.

[48] As $\phi'(\delta)=-\omega'^{+}(1-\delta)u\left[-\tau s\Delta_f(\theta)w_f+(1-\tau)\left(dw_f-\Delta_h(\theta)w_h\right)\right]+\omega'^{-}(\delta)u\left[-\tau s\Delta_f(\theta)w_f\right]<0$.

Moreover, $\underline{p}^L > 0$ if and only if $\tau > \underline{\tau} \equiv \frac{u^{-1}\left[(1-q)u\left(dw_f-c\right)+qu(w_h-c)\right]-w_h}{w_f-w_h}$. Note that, since $dw_f - c > w_h - c$ and u^{-1} is increasing, the threshold $\underline{\tau}$ decreases in q. It is also straightforward to establish that it decreases in c and increases in d.

Under CPT

The eviction price is defined implicitly as follows

$$\begin{aligned}\omega^+(1-q)u\left[dw_f - c - \left(\tau w_f - \underline{p}^L + (1-\tau)w_h\right)\right] \\ +\omega^-(q)u\left[w_h - c - \left(\tau w_f - \underline{p}^L + (1-\tau)w_h\right)\right] = 0,\end{aligned} \tag{11}$$

which simplifies to:

$$\begin{aligned}\omega^+(1-q)u\left[(d-\tau)w_f - (1-\tau)w_h - c + \underline{p}^L\right] \\ +\omega^-(q)u\left[\underline{p}^L - c - \tau\left(w_f - w_h\right)\right] = 0\end{aligned} \tag{28}$$

Taking the total differential of the above equation yields

$$\alpha_{\underline{p}^L}\mathrm{d}\underline{p}^L + \alpha_q \mathrm{d}q + \alpha_d \mathrm{d}d + \alpha_{w_f}\mathrm{d}w_f + \alpha_{p^I}\mathrm{d}p^I + \alpha_{w_h}\mathrm{d}w_h + \alpha_\tau \mathrm{d}\tau = 0$$

We can sign straightforwardly:

$$\begin{aligned}
\alpha_{\underline{p}^L} =& \omega^+(1-q)u'\left[(d-\tau)w_f - (1-\tau)w_h + \underline{p}^L - c\right] \\
&+ \omega^-(q)u'\left[\tau(w_h - w_f) + \underline{p}^L - c\right] && > 0 \\
\alpha_d =& w_f\omega^+(1-q)u'\left[(d-\tau)w_f - (1-\tau)w_h + \underline{p}^L - c\right] && > 0 \\
\alpha_{w_f} =& d\omega^+(1-q)u'\left[(d-\tau)w_f - (1-\tau)w_h + \underline{p}^L - c\right] && > 0 \\
\alpha_c =& -\omega^+(1-q)u'\left[(d-\tau)w_f - (1-\tau)w_h + \underline{p}^L - c\right] \\
&- \omega^-(q)u'\left[\tau(w_h - w_f) + \underline{p}^L - c\right] && < 0 \\
\alpha_{w_h} =& -(1-\tau)\omega^+(1-q)u'\left[dw_f - c - \left(\tau w_f - \underline{p}^L + (1-\tau)w_h\right)\right] \\
&+ \tau\omega^-(q)u'\left[w_h - c - \left(\tau w_f - \underline{p}^L + (1-\tau)w_h\right)\right] && < 0
\end{aligned}$$

$$\begin{aligned}
\alpha_\tau =& (w_h - w_f)\left\{\omega^+(1-q)u'\left[(d-\tau)w_f - (1-\tau)w_h + \underline{p}^L - c\right]\right. \\
&\left. + \omega^-(q)u'\left[\tau(w_h - w_f) + \underline{p}^L - c\right]\right\} && < 0
\end{aligned}$$

If legal migration occurs, the rationality constraint is satisfied such that: $\underline{p}^L < \tau(w_f - w_h)$. Besides, if irregular migration persists for a legal price higher than the eviction price, necessarily the payoffs in case of success of irregular migration must be positive for the

lowest skilled worker such that: $(d-\tau)w_f-(1-\tau)w_h+\underline{p}^L-c>0$. This implies that:

$$\begin{aligned}\alpha_q =& -\omega'^{+}(1-q)u\left[(d-\tau)w_f-(1-\tau)w_h+\underline{p}^L-c\right]\\ &+\omega'^{-}(q)u\left[\tau w_h-\tau w_f+\underline{p}^L-c\right] \qquad <0\end{aligned}$$

This shows that the eviction price is increasing in the probability of failing irregular migration q, the duration of the migration visa τ, and the marginal cost for smugglers to operate c. It is decreasing in the discount factor d.

In particular,

$$\frac{\partial \underline{p}^L}{\partial \tau}=-\frac{\alpha_\tau}{\alpha_{\underline{p}^L}}=w_f-w_h \tag{29}$$

which we use later in appendix G.

Note that $\tau>\frac{dw_f-w_h}{w_f-w_h}-\frac{c}{w_f-w_h}$ is a sufficient condition for the eviction price to be positive.

Indeed, by definition of $\underline{p}^L$,

$$\begin{aligned}&\omega^{+}(1-q)u\left[dw_f-c-\left(\tau w_f-\underline{p}^L+(1-\tau)w_h\right)\right]\\ &+\omega^{-}(q)u\left[w_h-c-\left(\tau w_f-\underline{p}^L+(1-\tau)w_h\right)\right]=0\end{aligned} \tag{11}$$

Moreover we can show easily that: $\tau>\frac{dw_f-w_h}{w_f-w_h}-\frac{c}{w_f-w_h}$ assures that

$$\omega^{+}(1-q)u\left[dw_f-w_h-c-\tau(w_f-w_h)\right]+\omega^{-}(q)u\left[-c-\tau\left(w_f-w_h\right)\right]<0$$

This yields

$$\begin{aligned}&\omega^{+}(1-q)u\left[dw_f-c-\left(\tau w_f-\underline{p}^L+(1-\tau)w_h\right)\right]\\ &+\omega^{-}(q)u\left[w_h-c-\left(\tau w_f-\underline{p}^L+(1-\tau)\ w_h\right)\right]\\ >&\omega^{+}(1-q)u\left[dw_f-c-(\tau w_f+(1-\tau)w_h)\right]\\ &+\omega^{-}(q)u\left[w_h-c-(\tau w_f+(1-\tau)w_h)\right]\end{aligned}$$

Yet, since $\omega^{+}(1-q)u\left[dw_f-c-\left(\tau w_f-\underline{p}^L+(1-\tau)w_h\right)\right]+\omega^{-}(q)u\left[w_h-c-(\tau w_f-\underline{p}^L+(1-\tau)w_h)\right]$ increases with $\underline{p}^L$, the above inequality is equivalent to $\underline{p}^L>0$.

Hence, there exists a threshold $\underline{\tau}\leq\frac{dw_f-w_h}{w_f-w_h}-\frac{c}{w_f-w_h}$, such that for any $\tau>\underline{\tau}$, $\underline{p}^L>0$.

This threshold is implicitly defined by equation (11) for $\underline{p}^L=0$ as:

$$\omega^{+}(1-q)u\left[dw_f-w_h-c-\underline{\tau}(w_f-w_h)\right]+\omega^{-}(q)u\left[-c-\underline{\tau}\left(w_f-w_h\right)\right]=0 \tag{30}$$

Yet the expression $\omega^{+}(1-q)u\left[dw_f-w_h-c-\underline{\tau}(w_f-w_h)\right]+\omega^{-}(q)u\left[-c-\underline{\tau}\left(w_f-w_h\right)\right]$ decreases with q, c, and $\underline{\tau}$ and increases with d. Therefore, differentiating equation (30)

yields that the threshold $\underline{\tau}$ decreases with q and c and increases with d.

G Proof of Proposition 4

Let us show that the function $z(\tau) = \frac{\underline{p}^L(\tau)}{\Delta_f\left(\theta^I_{p^I}\right)w_f - \Delta_h\left(\theta^I_{p^I}\right)w_h}$ has a unique fixed point on the interval $(0,1)$, which decreases with q. Since $\Delta_f\left(\theta^I_{p^I}\right)w_f - \Delta_h\left(\theta^I_{p^I}\right)w_h$ does not depend on τ, this is equivalent to showing that $\underline{p}^L(\tau)$ has a unique fixed point (decreasing in q) on the interval $\left(0, \Delta_f\left(\theta^I_{p^I}\right)w_f - \Delta_h\left(\theta^I_{p^I}\right)w_h\right)$.

Under EUT

One can show directly $\underline{p}^L$ admits a unique fixed point decreasing in q, since u is increasing and $dw_f > w_h$.

$$\begin{aligned}
&\tilde{\tau}w_f + (1-\tilde{\tau})w_h - u^{-1}\left[(1-q)u\left(dw_f - c\right) + qu\left(w_h - c\right)\right] - \tau = 0 \\
\Leftrightarrow &\tilde{\tau} = \frac{u^{-1}\left[(1-q)u\left(dw_f - c\right) + qu\left(w_h - c\right)\right] - w_h}{w_f - w_h - 1}
\end{aligned}$$

This shows that $\tilde{\tau}$ is decreasing in q and in c and increasing in d.
Since $z(\tau) > 0$, $\tilde{\tau} > 0$; which also involves $\Delta_f\left(\theta^I_{p^I}\right)w_f - \Delta_h\left(\theta^I_{p^I}\right)w_h > w_f - w_h > 1$.
Besides,

$$\begin{aligned}
&\tilde{\tau}w_f + (1-\tilde{\tau})w_h - u^{-1}\left[(1-q)u\left(dw_f - c\right) + qu\left(w_h - c\right)\right] \\
=&\left[u^{-1}\left[(1-q)u\left(dw_f - c\right) + qu\left(w_h - c\right)\right] - w_h\right]\frac{1}{w_f - w_h - 1} \\
<&\frac{dw_f - w_h - c}{w_f - w_h - 1}
\end{aligned}$$

Yet, as long as $1 - c < (1-d)w_f$, $\frac{dw_f - w_h - c}{w_f - w_h - 1} < 1$.

Under CPT

Recall that $\underline{p}^L$ is implicitly defined by equation (11):

$$\begin{aligned}
&\omega^+(1-q)u\left[dw_f - c - \left(\tau w_f - \underline{p}^L + (1-\tau)w_h\right)\right] \\
&+\omega^-(q)u\left[w_h - c - \left(\tau w_f - \underline{p}^L + (1-\tau)w_h\right)\right] = 0
\end{aligned}$$

We showed in appendix F that $\underline{p}^L$ is increasing in τ ($\frac{\partial \underline{p}^L}{\partial \tau} = w_f - w_h > 0$) and positive for $\tau > \frac{dw_f - w_h}{w_f - w_h} - \frac{c}{w_f - w_h}$.

Besides, for $\tau = 1$, equation (11) becomes

$$\omega^{+}(1-q)u\left[dw_f - c - \left(w_f - \underline{p}^L\right)\right] + \omega^{-}(q)u\left[w_h - c - \left(w_f - \underline{p}^L\right)\right] = 0$$

and in this case $\underline{p}^L_{\tau=1} < w_f - w_h < \Delta_f\left(\theta^I_{p^I}\right)w_f - \Delta_h\left(\theta^I_{p^I}\right)w_h$.[49]

The function $\underline{p}^L(\tau)$ admits a unique fixed point $\tilde{\tau}$ on $\left(0, \Delta_f\left(\theta^I_{p^I}\right)w_f - \Delta_h\left(\theta^I_{p^I}\right)w_h\right)$.

Since $\underline{p}^L$ increases with q and c and decreases with d (see appendix F), $\tilde{\tau}$ decreases with q and c and increases with d.

H Detail on numerical applications

H.1 Benchmark values

Smuggling fees According to the survey that Mbaye (2014) did among migrants in Dakar before they undertook their dangerous trip to Europe or the United States, the price charged to reach Spain by sea was around 391,981 Fcfa on average in 2007, which corresponds to 1,690 PPP. Congolese (undocumented) migrants living in South Africa, surveyed by Tshimpaka and Inaka (2020), mention smuggling prices of 600 USD, i.e. approximately 1,220 PPP in 2020 DRC, for a an overland journey.

Marginal costs to operate Human smuggling is a highly differentiated illegal activity, which makes its profitability challenging to assess (Sanchez, 2017). In particular, data on operating costs is scarce. As a benchmark for the marginal costs of smugglers' operations, c, we rely on the costs for a captain to reach Spain from Senegal with a typical dingy carrying 30 people, which were estimated in 2007 to be around 8,000,000 Fcfa, i.e. around 267,000 Fcfa per person (Mbow and Tamba, 2007), or 1,150 PPP in international dollars. This corresponds to a profit margin of 32%. Assuming smugglers on the Congo-South Africa route have a similar profit margin, the marginal cost on this route would be around 830 PPP.

Failure rate of illegal migration The failure rate of illegal migration is difficult to estimate and highly volatile: according to the Washington Post, while the success rate of the central Mediterranean route was around 95% between 2015 and 2017, it fell to 45% in 2018.[50] This increase in the risk of failure is also documented by Bah et al. (2019)

[49] Indeed $\omega^{+}(1-q)u\left[dw_f - c - \left(w_f - \underline{p}^L\right)\right] + \omega^{-}(q)u\left[w_h - c - \left(w_f - \underline{p}^L\right)\right]$ is decreasing in $\underline{p}^L$ and $\omega^{+}(1-q)u\left[dw_f - w_h - c\right] + \omega^{-}(q)u\left[-c\right] < \omega^{+}(1-q)u\left(dw_f - c - e^{\Delta_h\theta^I_c}w_h\right) + \omega^{-}(q)u\left(-c\right) = 0$.

[50] Chico Harlan, 2018. "Fewer migrants are making it to Europe. Here's why." The Washington Post, July 23.

who report the high risks of failure, including death, expected by undocumented migrants from Gambia travelling to Europe. The risk of failure has increased further due to Covid-19 border closures and severe mobility restrictions in most countries. Accordingly, our numerical applications allow for a large range of parameters q.

Relative earnings of informal labor Monràs et al. (2020) estimate the wage ratio between undocumented and legal workers in similar types of jobs in Spain, d, to be around 0.8, which we use in our simulations.[51] This is also in line with evidence from the US labor market (Rivera-Batiz, 1999; Kossoudji and Cobb-Clark, 2002).

Minimum wages Finally, in line with the large body of empirical research on returns to skills (see Lemieux, 2006, for a detailed literature review), we specify the income X_{ij} of an individual i working legally in country $j = h, f$ using a Mincer (1970) equation:

$$\ln X_{ij} = \ln w_j + \tilde{\Delta}_j \theta_i \tag{31}$$

where $\tilde{\Delta}_j \geq 0$ denotes the returns to skills θ in country j.
To calibrate the income distributions in origin and destination countries we assume that X_{ij} follows a log-normal distribution $\ln X_{ij} \sim \mathcal{N}\left(\mu_j, \sigma_j^2\right)$. We use GDP data and Gini coefficients from the World Development Indicators (WDI) database to estimate the parameters μ_j and σ_j^2.[52]
Many countries either do not enforce minimum wage regulations or they have a large informal sector. In Senegal for example, 9 workers out of 10 and 97% of companies belong to the informal sector (International Labour Organization, 2020). Since the minimum wage set by law is not likely to reflect the wage of low-skilled workers, we follow Grogger and Hanson (2011) to calibrate the low-skill wage, which is set to the 20th percentile of the income distribution. We follow the same approach regarding the DRC, where the informal sector accounts for 80% of the economy and where the minimum wage, the *salaire minimum interprofessionnel garanti*, was drastically re-evaluated in 2018.[53]

[51] Using wages data from the *Encuesta Nacional de Immigrantes*, they find a remarkably robust ratio, irrespective of the subgroups of workers considered.

[52] The standard deviation can be written as $\sigma_j = \sqrt{2}\Phi^{-1}\left(\frac{\Gamma_j+1}{2}\right)$ where Φ^{-1} is the reciprocal of the standard normal cumulative density function and Γ_j is the Gini coefficient of income inequality in country j. The expected value of income, $E(X_j)$, is given by $E(X_j) = \exp\left(\mu_j + \frac{\sigma_j^2}{2}\right)$.

[53] Article 91 of the DRC Labor Code, decree # 18/017 of 22 May 2018 stipulates that the *salaire minimum interprofessionnel garanti* should adjust to 7,075 FC daily from 1 July 2019 – instead of 1,680 FC prior 2018. On a basis of 25 workdays, this yields a 176,875 FC monthly wage.

H.2 Functional forms

In line with Tversky and Kahneman (1992) the weighting function $w^+(1-q)$ (respectively $w^-(q)$) applied to probabilities associated with positive (respectively negative) outcomes is:

$$w^t(q) = \frac{q^{\gamma^t}}{\left(q^{\gamma^t} + (1-q)^{\gamma^t}\right)^{\frac{1}{\gamma^t}}} \qquad \text{with } t = +, -. \tag{32}$$

and the value function is:

$$u(x) = \begin{cases} x^{\alpha} \text{ , if } x > 0 \\ -\lambda(-x)^{\alpha} \text{ , if } x \leq 0 \end{cases} \qquad \text{with } \alpha \in (0,1) \text{ and } \lambda \geq 1. \tag{33}$$

As benchmark values, we choose the parameters calibrated by Tversky and Kahneman (1992): $\lambda = 2.25$, $\alpha = 0.88$, $\gamma^+ = 0.61$ and $\gamma^- = 0.69$.

Using these functional forms and equation (11), the eviction price $\underline{p}^L(\tau)$ takes the closed-form expression (18).

Assuming the log-linearity of income $\ln X_{ih}$ in skill level θ_i (Mincer, 1970), the variation in the share of population who migrates is the variation in the log-income of this population if they work in the origin country.

Formally,

$$\frac{F\left(\theta^L\right) - F\left(\theta^I\right)}{F\left(\theta^I\right)} = \frac{G\left(\ln X_h^L\right) - G\left(\ln X_h^I\right)}{G\left(\ln X_h^I\right)} \tag{34}$$

where G denotes the cumulative density function of the distribution $\mathcal{N}\left(\mu_h, \sigma_h\right)$, while $X_h^L = \Delta_h(\theta^L) w_h$ and $X_h^I = \Delta_h(\theta^I) w_h$ are the incomes of individuals θ^L and θ^I in the home country.

Using the Tversky and Kahneman (1992) functional forms, equation (2) yields

$$X_h^I = dw_f - p^I - \left(\lambda \frac{\omega^-(q)}{\omega^+(1-q)}\right)^{\frac{1}{\alpha}} p^I \tag{35}$$

Focusing on foreign work permits paid at minimum wages, for which there are no returns to skills, we set $\tilde{\Delta}_f = 0$. In this case, the rationality constraint (4) becomes $w_f - e^{\tilde{\Delta}_h \theta} w_h = \frac{p^L}{\tau}$ and under the scheme $\left(\tau, \underline{p}^L(\tau)\right)$, the marginal migrant with skill θ^L earns in home country:

$$X_h^L = w_f - \frac{\underline{p}^L(\tau)}{\tau} \tag{36}$$

Using equations (34) (35) (36) and (18) we compute the variation in the share of population who migrates following the sale of temporary visas for low-wage jobs ($\underline{p}^L(\tau)$,τ).

I Setting temporary visas at embassy or smuggling prices: the case of the DRC to South Africa

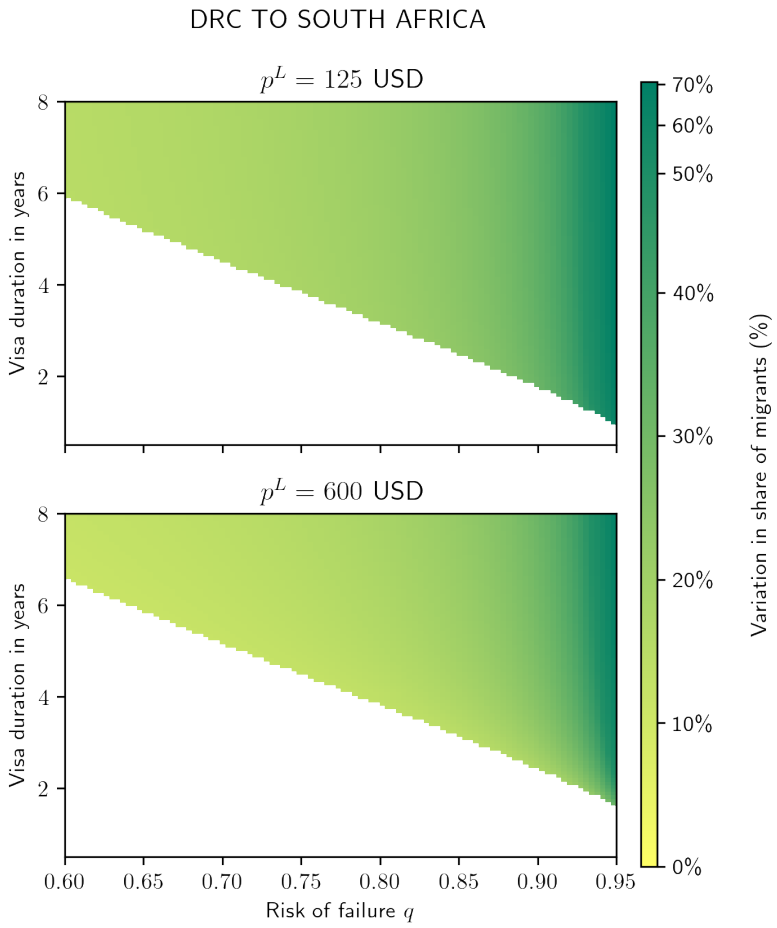


Figure 5: Variation in the share of migrants for temporary visas priced at 125 USD and 600 USD, on the route from the DRC to South Africa

In section 6 we characterized the maximum eviction price set to drive smugglers out of business on each route. This would result in a destination country pricing visas differently, depending on migrants' origin countries. A more feasible policy we consider here is to sell visas at a low price, which could be benchmarked to current embassy prices or to smugglers' prices on some important route to the destination country. As an example for South-Africa, which is an important destination for economic migrants in Africa, it could be set around USD 125, the embassy price,[54] or around USD 600, the smugglers' price to reach South

[54]South African Embassy in Kinshasa, DRC. retrieved online December 1, 2021. http://www.dirco.gov.

Africa from the DRC (see the survey led by Tshimpaka and Inaka, 2020). Figure 5 presents in different colors the variations in the share of workers from DRC who would be willing to migrate to South-Africa under these schemes relatively to the status quo.

In the colored areas, the visa price under such schemes (USD 125 at the top and, resp. USD 600 at the bottom) is below the maximum eviction price, such that smugglers would be driven out of business. As shown by light shaded areas, the predicted increases in migration flows would still be limited for a large set of policy parameters (q, τ).

The white areas correspond to combinations of policy parameters (q, τ) such that the smuggling market would persist as human smugglers could still make profits after responding to these schemes by lowering their prices.

za/kinshasa/consularservices.html