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MANAGING MIGRATION THROUGH CONFLICTING POLICIES: AN OPTION-THEORY PERSPECTIVE

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Managing Migration through Conflicting Policies: an Option-theory Perspective

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Abstract

We try to determine whether it is better for a government to tighten or relax limits for immigrants in order to control migration inflows. To this end, we use a real option approach to migration choice that assumes that the decision to migrate can be described as an irreversible investment decision. Our results show that promoting uncertainty over migration limit may improve the government's control on migration inflows (quotas). In particular, we show that if the government controls the information related to the immigration stock it may delay the mass entry of immigrants, maintaining the required stock in the long run and controlling the flows in the short run.

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1 Introduction

Although barriers to international trade and capital mobility have been largely removed, labour markets are still the most tightly regulated areas of economic activity (Faini et al., 1999). In this regard, Boeri and Brücker (2005), studying European migration, showed that rules for legal immigration into the EU from third countries are becoming increasingly stringent: "since 1990 there have been 92 reforms of national migration policies into the EU-15, that is, more than five reforms per year. Most of these reforms are marginal in that they adjust specific provisions rather than revising the overall regulatory framework. Furthermore, seven reforms out of ten tighten regulations, for example, by increasing procedural obstacles faced by those applying for visas, reducing the duration of work permits or making family reunification more difficult", or by introducing an immigration quota system[1]. In particular, this latter immigration policy has been adopted by certain European countries (Austria, France, Greece, Italy, Portugal, Spain, UK) to control migration inflows better, and it was suggested at the meeting of the EU Justice and Home Affairs ministers in Stratford-upon-Avon in late October 2006 [2]. Nevertheless, despite this evidence, another aspect related to migration policy has revealed a peculiar paradox of migration policies. Since 1990, there have been 26 (39 since 1973) one-shot regularization programs in 10 EU countries (Jachimowicz et al., 2004; Sunderhaus, 2007). Therefore, on the one hand, as a result of increased labour market competition and concerns about terrorism, the trend of recent legislation on immigration has been the increased closure of frontiers (OECD 1999, 2001). On the other hand, there are more regularization programs which, as anticipated by immigrants, reduce the control over the total quantity of immigrants admitted and make European policies less tight.

What, therefore, is the effect of this ambiguity in European migration policies? Is it better to tighten or to relax limits on migration stocks? As many countries have adopted two kinds of conflicting immigration policies simultaneously, it seems, at first glance, that the legislator has no clear idea about the matter. Moreover, this uncertainty reduces information about the migration stocks accepted by the authorities in each country: this entails that potential immigrants do not exactly know whether or not the ceiling is binding. Our aim in this paper is to answer these questions by investigating the conflicting immigration policies in European immigration legislation within a unified framework.

By using a recent approach to migration choice, which assumes that the decision to migrate can be described as an investment decision (Sjaastad, 1962), we address the above question by extending recent results obtained by Bartolini[3] (1993; 1995). Bartolini shows that a competitive market reacts to limit[4] aggregate investment by generating recurrent runs as the total investment approaches its ceiling. That is, the existence of limits on aggregate investment may induce endogenous and recurrent asset runs so that the stock limits are immediately filled. Specifically, the aggregate investment evolves smoothly over time, driven by market conditions, until it reaches an upper threshold where it exhibits a jump that fills the stock.

We show that, on introducing uncertainty concerning the stock of immigrants allowed to enter a competitive migration market, the entry run tends to vanish. Because each agent is unable to perfectly foresee the true upper limit, he acts as if the limit did not exist. The entry process tends to be smooth and has no jumps. The ambiguity concerning the true limit reduces the entry runs by potential immigrants, allowing the government to obtain, in the long run, the required immigration stock and to control flow in the short run (i.e., the migration quota accepted each year). In this context, the presence of regularization programs that make agents unable perfectly to foresee the limit is no longer a paradox, but it may be useful for the planner in controlling immigration inflow.

This paper is related to past research that applies the real option approach to migration phenomena. In this regard, Burda (1995) showed that individuals prefer to wait before migrating, even if the present value of the wage differential is positive, because of the uncertainty and the sunk costs associated with migration. Subsequently, Khwaja (2002) and Anam et al. (2007) developed Burda's approach by describing the role of uncertainty in the migration decision. Another study that uses real option on migration is Feist (1998), in which the author analyses the option value for low-skilled workers of escaping to the unofficial sector if welfare benefits come too close to the net wage in the official sector. Three recent papers (Moretto and Vergalli, 2008; Vergalli, 2007; Vergalli, 2008) have applied the real option framework to the analysis of migration dynamics, focussing on the role of communities and networks in explaining mass migration.

Hence, in what follows we use real option theory to determine whether it is better for a government to tighten or relax limits on immigrants in order to control migration inflows. Specifically, we study what happens in migration decisions when a government is unable to define with certainty the maximum total number of immigrants that can enter the host country, and we compare this with the case with certain limits. Our results show that promoting uncertainty over migration limit may improve the government's control over migration inflows (quotas). In particular, we show that if the government controls the information related to the immigration stock it can delay the mass entry of immigrants, maintaining the required stock in the long run and controlling the flows in the short run.

In the first part of this paper, we describe what happens in migration dynamics if the authority gives total information about the target number of immigrants it has in mind. This assumption means that the government adopts a policy in only one direction: in particular, it imposes a determined and known limit on the stock of the immigration entries, and this ceiling is known to all potential immigrants. In the second part, we show that the introduction of noise on the limit delays mass entry (i.e., flows). This uncertainty can be created either by announcing policies followed by different action by the government or by introducing different policies relaxing or tightening the conditions for immigration. In both cases this uncertainty may also depend on the unstable majorities of governments, probably expressed in counterbalancing migration policies[5]. This fact may also explain why recent legislation on immigration has moved in the two counterbalancing directions explained above. The result is that in this case, the migration inflow becomes smooth regardless of the particular policy adopted.

The paper is organised as follows. Section 2 summarises the evolution of national immigration policies. Section 3 presents the model and the basic assumptions. Section 4 develops the theoretical framework with a known upper limit on immigrants. Section 5 develops the theoretical framework with unknown limits on the stock and sets out the main results. Section 6 summarises the conclusions. Finally, the Appendix contains the proofs omitted in the text.

2 Evolution in National Immigration Policies

Immigration policies can be tightened by using different criteria. In this regard, Boeri and Brücker (2005) developed an aggregate policy index that describes "the trend in migration policies". The index is shown in Figure 1 and is obtained by taking the average of the following seven indicators: 1) admission requirements; 2) number of administrations involved; 3) length of first stay; 4) quotas; 5) residence requirement; 6) years to obtain a permanent permit; 7) asylum policy[6]. According to Boeri and Brücker's analysis national immigration policies are becoming tighter[7].

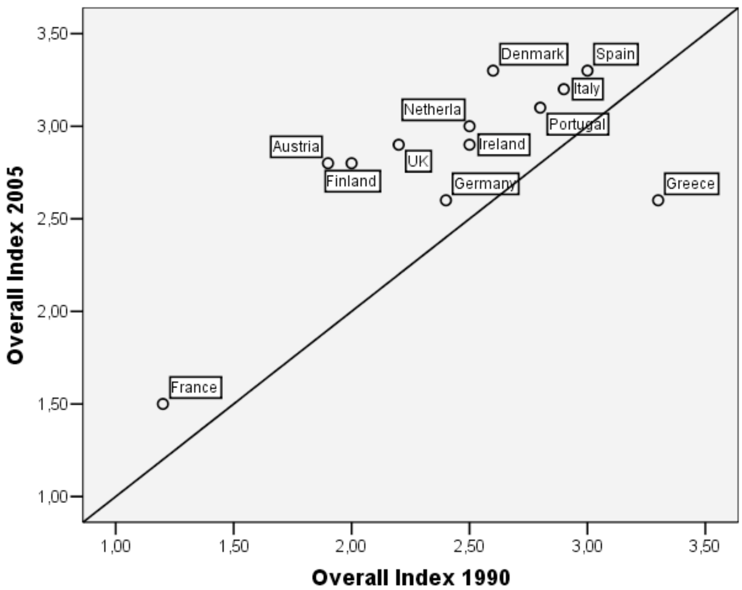

Figure 1: Boeri and Brücker immigration policy index. Comparison between 1990 and 2005

In order to specify policies of this kind in depth, in table 1 we show the European countries that have recently introduced immigration quota systems, namelyg Austria, Czech Republic, France, Greece, Italy, Portugal, Slovenia, Spain, Switzerland and the United Kingdom[8]. As table 1 shows, many European countries plan to spread quotas over several years (i.e. three/two-period quotas for France, Spain and Czech Republic). Since a quota is defined as "a share of the total immigrants allowed to enter the host country", this means that the governments use year quotas to distribute the total stock of immigrants they have programmed over some years.

Country	Quota	Source
Austria	∞ In 1990, a quota for the employment of foreigners was introduced, defined as a maximum share of foreign workers in the total workforce. ∞ The Residence Act 1993 has the objective to control immigration . It defines the quantitative and qualitative criteria for the potential residence of different groups of foreigners: definition of quotas for certain sub-groups of immigrants (family members). ∞ The Aliens Law 1997 (Fremdengesetz) came into effect in 1998. It regulates the conditions for entry and residence in the country. The key concept of the reform is: "Integration Before New Immigration". Reduction of immigration quotas. ∞ The Aliens Law 2002 changes the conditions of entry and residence in the country, it provides for a stricter system of immigration control and it tightens the quota system. Key professional are not subject to quotas, don't have to fulfill the integration agreement and can obtain a residence permit with the authorization to work.	Federal Ministry for Internal Affairs, Migration Information Source, European Migration Network, Fondazione Rodolfo De Benedetti
Czech Republic	∞ The Czech government launched in 2002 a pilot programme for the active selection of the qualified foreign workers. The quotas were established for the first two years – 600 and 1200 persons for 2003 and 2004 respectively	OECD
France	∞ In 2006, the government has been required to submit to parliament an annual report specifying the number and kind of residency permits to be authorized over a three-year period. The draft bill avoids using the word "quotas," but critics say the provision amounts to a quota-system". ∞ In 2007 the government decided to adopt decrees on immigration quotas "by profession, category and, naturally, by regions of the world"	Work Permits
Greece	∞ The Law 1975/1991 defines for the first time the legal situation of migrants and refugees. It's an attempt to modernize the relevant legislation on issues of entrance, exit, stay, settlement, employment and expulsion of aliens. ∞ The Law 2910/2001 reorganizes the procedure concerning work permits: the Manpower Employment Organization at the end of every year prepares a report recording the current needs in Greek labour market, a resolution based on this report shall set forth the maximum number of work permits to be granted every year.	European Migration Network
Italy	∞ The Law 39/1990 (Martelli Law) regulates the entry and the residence of non-EU citizens: migration begins to be considered as a stable phenomenon. The law defines the conditions to grant entry permits for working reasons: the Government has to draw up a yearly plan instead of referring to pre-defined criteria. This is the first law that bruits the idea of quotas. ∞ With ministry of Employment's decree 15 February 2006, were defined the non-EU immigrant quotas.	European Migration Network, Fondazione Rodolfo De Benedetti Sopemi – OECD MAVITRA, www.mavitra.org
Portugal	∞ The Decree-Law 34/2003 introduces a system of quotas to regulate the entry of migrants. Every year, depending on economic and labour market condition, the maximum number of foreigners allowed to enter the country is fixed by the Government.	Fondazione Rodolfo De Benedetti
Slovenia	∞ The Employment and Work of Aliens Act is the main act regulating the economic migration in Slovenia. It sets the policy priorities as well as the maximum quotas of admitted workers	OECD
Spain	∞ The quota system is the basic mechanism used in managing the labour immigration in Spain. It was used in the years 1993-1995, 1997-1999 and since 2002. The aim of the quotas was to direct the immigrants to the labour market sectors which suffered from shortages.	Migration Information Surce, Fondazione Rodolfo De Benedetti Sopemi - OECD
Switzerland	∞ The Swiss government relaxed its immigration laws on 01 June 2007. Quotas will remain in place for these countries until at least 2011. The previous system allowed 15,000 permanent residence permits to be granted annually for people who had a job contract for more than one year. This quota was quickly exhausted each year. Short term permits, allocated at 115,000 per year, were less popular, with only 55%-90% being used.	Workpermits
United Kingdom	For unskilled workers: ∞ Working Holiday Makers – around 46,000 young people from Commonwealth countries (17-27 years old) are allowed to come to Britain and take up non-professional job for up to 2 years; ∞ seasonal agricultural workers – for students, mainly form Central and Eastern Europe, who arrive within a set quota (Food Manufacturing Fish and Meat sector in the context of Sector Based Scheme Pemits); ∞ Au pairs – around 15,000 per annum; ∞ Domestic workers – around 15,000 per annum (Spencer 2002).	Work Permits, World Bank, OECD

Table 1: immigration quota system adopted in some countries

To complete the analysis of migration policies, we must add another instrument that governments can use to control migration: regularization programs which, by definition, relax the effect of limits on the stock and at the same time modify immigrant flows and stocks. Hence, inspection of European legislation (see Figure 1 and table 1), shows that several countries impose both admission requirements and quotas to reduce entry. Nevertheless, they also adopt frequent regularization programs. Table 2 shows the regularization programs adopted in Europe since 1973[9]. Since 1990, there have been 26 (39 since 1973) one-shot regularization programs in 10 EU countries.

Country	Regularizations	Years
Belgium	3	1974-1975, 1995-1999, 2000
France	5	1973, 1979, 1981-1982, 1991, 1997-1998
Germany	2	1996, 1999
Greece	2	1997-1998, 2001
Italy	6	1982, 1987-1988, 1990, 1996, 1998-1999, 2002
Luxembourg	1	2001
Netherlands	5	1964, 1975, 1978-1979, 1991-1994, 1996
Portugal	3	1992-1993, 1996, 2001
Spain	7	1985-1986, 1991, 1994, 1996, 2000, 2001, 2005
United Kingdom	5	1974-1978, 1977, 1987, 1998-1999, 2004
Total	39	

Table 2: Regularization Programs in 10 EU countries.

There is no doubt that all these seven policies mirror European immigration policy. Nevertheless, for some of these policies we should also distinguish between short and long term in regard to their effects on migration flows and/or migration stocks[10]. For example, consider what happens when a government has in mind a given target for the total number of immigrants that should enter and it announces immigration policies that tighten the admission requirements (this can be done by exacerbating some of the indicators shown above). This policy announcement reveals whether or not the immigrant stock is close to its upper limit. Therefore, if there is a tightening of migration policies, the potential immigrants believe that the "open door" of migration is closing and they may decide to run to enter. We thus have two counterbalencing effects of a migration limit: on the one hand the limits may be able to control migration stocks in the long run (if the authority does not change the target stock by relaxing the ceilings afterwards), on the other hand it may trigger run-entry mechanisms that may thwart any control of inflow and its speed. That is, limits on the stock are useful for controlling, at least in the long run, the total number of immigrants (stock) but not the entry speed (flow). In particular in the EU there has been a tightening of immigration policies supported by the increase of immigration quotas. Moreover, this effect is stronger when the limit on the stock is perceived by immigrants as their last chance to enter: they all hurry to enter the host country.

3 The Model

3.1 The basic assumptions

For simplicity, the model uses the familiar terminology of an agent's entry decision under uncertainty[11]. Consider the immigration decision of individuals in a host country subject to an uncertain wage gap. Let us summarize the main assumptions:

1. At any time t, a potential immigrant may decide to migrate ("entry"). Individuals are risk-neutral and discount future income at the constant discount rate ρ.

2. Each individual can migrate by committing irrevocably to a flow cost w or undertaking a single irreversible investment which requires an initial sunk cost $K = w/\rho$.[12]

3. n_t is the number of individuals in the host country at time t. Each yields a net[13] flow of income[14]:

$$\pi(\theta_t, n_t) \equiv u(n_t)\,\theta_t \tag{1}$$

where θ is a multiplicative labour market-specific shock. We can consider, in a simpler setting, $u(n_t)$ as the inverse demand function (Dixit and Pindyck, 1994, ch. 9; Bartolini, 1993; Nielsen, 2002) or as a reduced form of a more general benefit function (Dixit and Pindyck, 1994, ch. 11; Dixit, 1995; Grenadier, 2002; Moretto and Vergalli 2008). Time is continuous, $t \in [0, \infty)$, and suppressed if not necessary.

4. The function $u(n)$ is continuously differentiable in n with the usual properties.

$$u(n) > 0, \;\; u'(n) < 0$$

$$\lim_{n \to 0} u(n) = +\infty \qquad \text{and} \qquad \lim_{n \to \bar{N}} u(n) = \underline{u} > 0$$

where $\bar{N} \leq \infty$ can be interpreted as the upper saturation level of the ethnic community in the host country[15]. Hence, a positive reserve "utility" $\underline{u}$ means that for each immigrant the benefits from migration (even in the worst case) are higher than the costs (in the wider sense) of migrating.[16]

5. All individuals are identical and their size dn_t is infinitesimally small with respect to the labour market in the host country.

6. The labour market-specific shock follows a geometric diffusion process[17]:

$$d\theta_t = \alpha\theta_t dt + \sigma\theta_t dW_t \qquad \text{with} \;\; \theta_0 = \theta \text{ and } \;\alpha, \sigma > 0 \tag{2}$$

where $\alpha < \rho$ and dW_t is the increment to a Wiener process, satisfying $E(dW_t) = 0$ and $Var(dW_t) = dt$[18].

In the next section, we assume that the limit on the stock is known to the immigrants. The existence of a ceiling on the aggregate level of migration induces an externality among the benefit functions of different immigrants which causes a possible divergence between the socially-optimal and profit-maximizing policies. Then, in section 4 we relax this assumption by assuming that the immigrants may not know the true stock.

3.2 Solution when the upper limit on the total immigrants is known

For the first result we have added the following assumption:

7. There exists an exogenously determined limit on the stock $N < \bar{N}$ on n, which is announced by the government and is known to all the potential immigrants.

To determine the migrant's optimal entry policy, the first thing to do is to find his/her value, given each individual's optimal future entry policy. Let us consider the value of an immigrant $V(\theta, n, N)$, who is active in the market, as the expected discounted stream of income:

$$V(\theta, n, N) = \max_{\tau} E_0 \left[\int_0^{\infty} e^{-\rho t} \pi(\theta_t, n_t)\, dt - J_{[t=\tau]} K \mid n_0 = n, \; \theta_0 = \theta \right] \tag{3}$$

where $J_{[t=\tau]}$ is the indicator function[19] and the expectation is taken considering that the number of active immigrants may change over time because of new entry. The solution to (3) can be obtained by starting within a time interval in which no new entry occurs. Over this interval the number of immigrants n is fixed and $V(\theta, n, N)$ must satisfy the no-arbitrage requirement[20] where time is suppressed if not necessary:

$$\pi(\theta, n) + E[dV(\theta, n, N)/dt] = \rho V(\theta, n, N) \tag{4}$$

Assuming $V(\theta, n, N)$ to be a twice-differentiable function with respect to θ and using Itô's Lemma to expand $dV(\theta, n, N)$, the solution of (3) is given by the following differential equation (Dixit and Pindyck, 1994, p. 179-180):[21]

$$\frac{1}{2}\sigma^2 V_{\theta\theta}(\theta, n, N) + \alpha V_\theta(\theta, n, N) - \rho V(\theta, n, N) + \pi(\theta, n) = 0 \tag{5}$$

The general solution of (5):

$$V(\theta, n, N) = B(n, N)\theta^\beta + \frac{\theta u(n)}{\rho - \alpha} \tag{6}$$

where the last term $\left(\frac{\theta u(n)}{\rho-\alpha}\right)$ represents the value of migration in the absence of new entry[22]. Then $B(n, N)\theta^\beta$ is the correction of the migration's value due to the new entry and $B(n, N)$ must therefore be negative. Obviously, a last boundary condition applies to the value of the N^{th} entry. The value of the N^{th} entry should converge to the value of a migration calculated by keeping the number of immigrants fixed at N, i.e. $V(\theta, n, N) = \frac{\theta u(N)}{\rho-\alpha}$. This implies that:

$$B(N, N) = 0. \tag{7}$$

If the benefit value function (6) is known, the optimal migration policy implies that the return from migration must be at least equal to cost K at the entry point. In other words, we need to find the trigger value $\theta^*(n)$ (i.e. the value of the labour demand shock) at which the nth migrant is indifferent between immediate entry or waiting another instant. This trigger should be calculated bearing in mind that N is the upper limit and that above this limit no new entry is allowed.[23] This is defined in the following proposition:

Proposition 1 *The benefit-maximizing entry policy in a market with a limit N is given by:*

$$\theta^*(n) = \frac{\beta}{\beta - 1}(\rho - \alpha)\frac{K}{u(n)} \qquad for\ n = (0, n^*] \tag{8}$$

$$\theta^*(n^*) = \theta^*(N) \qquad for\ n = [n^*, N] \tag{9}$$

where $\theta^*(N) = (\rho - \alpha)\frac{K}{u(N)}$.
Proof. *See Bartolini (1993) and the Appendix.* ■

By Proposition 1, the entry policy is efficient until a number $n^* < N$ of individuals has entered the market. At that point a migration run takes place and the residual stock is instantly filled. As proved by Bartolini (1993), n^* is determined by the fact that it splits the interval $(0, N]$ into two subintervals. In the first interval, the individuals enter by following the usual matching value and smooth pasting conditions, i.e. $V(\theta^*(n), n, N) = K$ and $V_\theta(\theta^*(n), n, N) = 0$, so that $\frac{d\theta^*(n)}{dn} > 0$ (see the Appendix) ; in the second interval, the individuals migrate by a "run" until the whole stock is instantly filled, i.e. $\frac{d\theta^*(n)}{dn} = 0$, while, from (8) and (9), n^* is given by:

$$\frac{u(n^*)}{u(N)} = \frac{\beta}{\beta - 1} \tag{10}$$

The insights from Proposition 1 are shown in Figure 2, below. In particular:

i) In the first quadrant on the left, on the abscissa, stands the entry value for different θ and n levels. The migration value of the first n^* immigrants follows the S-shaped curve typical of the model of investment hysteresis (Dixit and Pindyck, 1994, p. 220). These curves are tangential to the barrier (i.e., the entry cost) K and describe the value of migration as long as it fluctuates under the K level. The last $(N - n^*)$ curves cross the level K, and all of them must cross K at the same level of fundamentals θ.[24] Whenever $V(\theta, n, N)$ reaches K, the number of immigrants increases, shifting the current curve rightwards. When n reaches n^*, a large change in n shifts the current curve from $V(\theta, n^*, N)$ to $V(\theta, N, N)$.

ii) The second quadrant on the right shows the threshold levels for different numbers of immigrants. Below or to the right of the curve no migration occurs because at a given level $\theta(n) < \theta^*(n)$, the benefit for each potential immigrant is lower than the cost of migrating. This means that above the curve it is optimal to migrate. A wave of migrants will enter in a lump to move the benefit level immediately to the threshold curve. In the region below the curve the optimal policy is inaction. But the shock can cross the trigger for different numbers of individuals, n. To appreciate the explanation of Figure 1, let us consider a sequential entry starting at $n < n^*$. If the initial size of the community is $n < n^*$, we can expect migration to work in the following way. For any fixed n, if the benefits climb to a certain level $\pi^* = u(n)\theta^*(n)$, migration becomes feasible, the network size increases from n to $n + dn$ and the benefits go downwards along the function $u(n)$.[25] If the size of the community is $n^* \leq n \leq N$, when the shock hits the threshold $\theta^*(n)$, the stock is instantaneously filled, a mass $(N - n)$ of individuals enter and the benefits climb to $\pi^* = u(N)\theta^*(N)$. Therefore, until n^* the individuals migrate in a smooth manner, but between n^* and N they enter in a mass because for $(N - n^*)$ individuals the threshold level is the same.

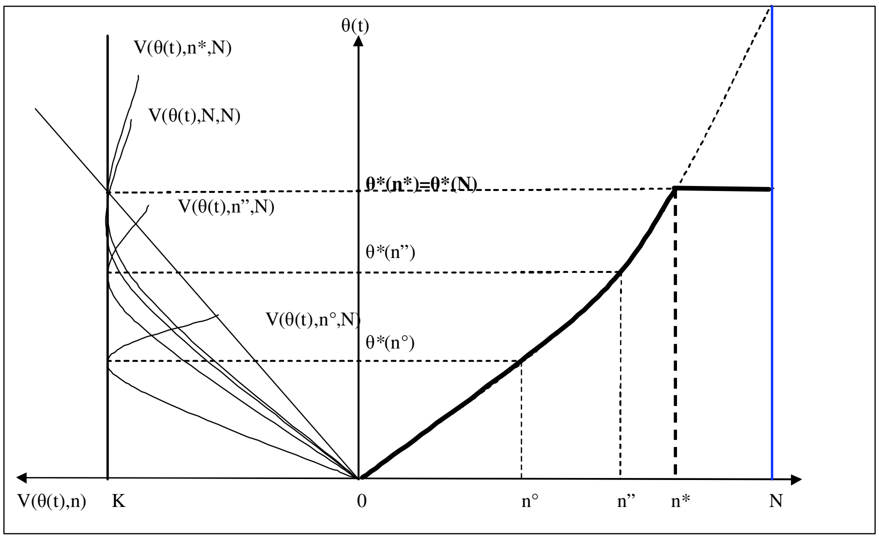

Figure 2: Optimal threshold levels with known stock N

Summarizing, with free entry, labour market competition generates a run that fills the stock when a fraction n^*/N has been filled. Until then, the entry policy is identical to the case without a limit. Immigrants initially enter at the optimal pace, knowing that all the potential benefits will be dissipated by the early entry of the last $(N - n^*)$ individuals.

4 Solution when the upper limit on total immigrants is unknown

So far we have analysed the optimal policy with a fixed known limit on the stock of the number of individuals admitted to the host country. But what happens if the limit is perceived to be uncertain by immigrants? To introduce uncertainty on the limit, we replace assumption (7) with the following assumption:

8 Each individual does not know the exact limit on the stock imposed by the government [26]. However he/she knows that the limit is continuously distributed and drawn from a common distribution function $F(N) = \Pr(\mathcal{N} < N)$ which is strictly increasing in the interval $[0, \bar{N}]$, where $\bar{N}$ is the upper support of the distribution of $\mathcal{N}$, and it has a continuous differentiable density $f(N)$[27].

Further, we assume that each individual makes rational conjectures about the distribution of $\mathcal{N}$ over time. More specifically, as new individuals decide to migrate, the individual will update his/her conjecture about $\Pr(\mathcal{N} < N)$. As time goes by and n increases, the potential immigrant learns that the probabilty of hitting the limit is higher. The individual then observes the realization of the state variable n and updates his/her conjecture by using $G(N; n) = \Pr(\mathcal{N} < N) \mid \mathcal{N} > n) = \frac{F(N)-F(n)}{1-F(n)}$ which is strictly increasing in the interval $[n, \infty)$, with density $g(N; n) = \frac{f(N)}{1-F(n)}$.

Since the individuals now do not know the true limit, the value of their decision cannot be defined by (6). In particular, the last boundary condition (7) calculated by keeping the number of immigrants fixed at N should be substituted by:

$$\lim_{n \to \bar{N}} E(B(n)) = 0 \tag{11}$$

where the expectation operator is taken with respect to the random variable $\mathcal{N}$.

As before, also in this case, we should find the threshold level $\theta^*(n)$ that corresponds to the optimal entry process. Taking condition (11) into account, we can prove the following proposition:

Proposition 2 *The benefit-maximizing entry policy in a market with an unknown stock is given by:*

$$\begin{aligned} \theta^*(n) &= \frac{\beta}{\beta-1}(\rho-\alpha)\frac{K}{u(n)} \qquad \textit{for} \quad n=(0,n^{**}] \qquad (12) \\ \theta^*(n^{**}) &= \frac{\beta}{\beta-1}(\rho-\alpha)\frac{K}{u(n^{**})} \qquad \textit{for all } n > n^{**} \qquad (13) \end{aligned}$$

where $n^* < n^{**}$.

Proof. see the Appendix. ■

Proposition 2 states that the entry policy is efficient until a number n^{**} of immigrants has entered the market. At that point, a migration run starts until the true (unknown) stock is reached. That is, since the true limit is unknown, the migration run continues until the government stops entries because the predefined limit has been reached. In addition, it is evident from (12) and (13) that the optimal trigger n^{**} is obtained by considering all supports of the distribution $F(N)$, i.e., each individual acts as if the limit does not exist and the utility of staying out of the country is close to zero:

$$\frac{u(n^{**})}{\underline{u}} = \frac{\beta}{\beta-1} \qquad (14)$$

nally, from direct inspection of (10) and (14), it is immediate obvious that $n^{**} > n^*$ as long as $u(N) > \underline{u}$.

To interpret these results, consider Figure 3. In particular, in the quadrant on the left we have the value of the immigrants on the horizontal axis and the threshold level on the vertical axis. In the quadrant on the right, we have the threshold level on the vertical axis, and the number of immigrants in the host country on the horizontal axis. The red line represents the optimal trigger as a function of the number of immigrants. By comparing Figure 2 and Figure 3, we can see that while, without uncertainty, the optimal threshold level flattens at n^*, under uncertainty the competitive run starts at $n^{**} > n^*$ and continues until the true (unknown) limit is reached.

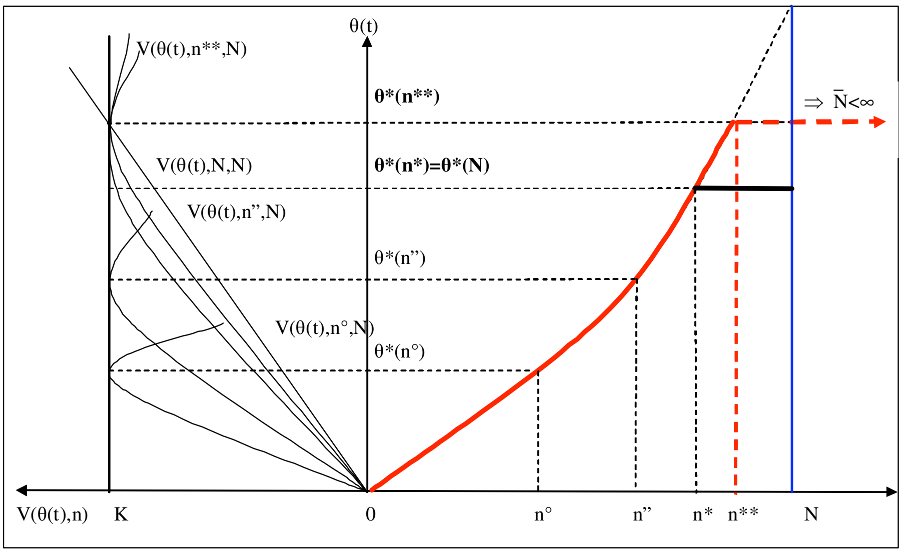

Figure 3: Optimal threshold levels with unknown stock

Therefore, if different political parties alternate in the government of a country, they probably express different and conflicting migration policies. This ambiguity concerning the tightening (by exacerbating quotas or admission requirements) or the relaxing (by using regularization programs) of the limit on stocks, may increase especially in countries with unstable majorities. The result is that, in this case, the migration inflow becomes smooth independently of the particular policy adopted.

A policy remark about this result is in order. Comparing the two rules (10) and (14) yields:

$$\frac{u(n^{**})}{u(n^{*})} = \frac{\underline{u}}{u\,(N)} \tag{15}$$

which means that the ratio between n^{**} and n^{*}, does not depend on the distribution of the stock $F(N)$ but only on the ratio between $\underline{u}$ and $u(N)$. If by adopting repeated regularization programs a country is able to generate noise over the true limit N, and instill the idea in immigrants that the labour market's saturation level may increase, the entry jump is moved forward. That is, the entry run happens at a higher size n^{**}, corresponding to a higher benefit level $u(n^{**})\theta^{*}(n^{**})$, which means that the stock is fulfilled later. In other words, if the government wants to delay migration waves and smooth entries, it can do so by controlling information on the immigration stock.

5 The effect of labour market uncertainty and integration policies

Our model allows for deeper study of both the effect of uncertainty concerning labour demand and some integration policies, aimed at reducing the entry cost K, on the migration decision as well as on the optimal triggers n^{*} and n^{**}. As far as the uncertainty is concerned, from (8) (or 12), (10) and (14) we can show that:[28]

$$\frac{d\theta^{*}\,(n)}{d\sigma} > 0 \tag{16}$$

and

$$\frac{dn^*}{d\sigma} < 0 \quad \text{and} \quad \frac{dn^{**}}{d\sigma} < 0 \tag{17}$$

As anticipated by the Real Option Theory, an increase in the labour demand volatility (σ) increases the $\frac{\beta}{\beta-1}$ ratio which, in turn, raises the threshold of $\theta^*(n)$ for any given number of immigrants n. In this sense, greater uncertainty implies less willingness to migrate. However, as shown by (17), greater uncertainty magnifies the competitive effect, reducing the size that triggers the entry run. Therefore, depending on what kinds of effect prevail, we may get two entry patterns, as shown in Figure 4.[29] If the uncertainty effect is soft, then the competition effect deriving from a decrease in the crucial level $n^{**\prime} < n^{**}$ is stronger than the entry delay caused by the raising of the threshold level (lower bold dotted line in figure). Entry is pushed forward because of the decrease of competition and, although we observe a reduction in immigration flow, the average time taken to reach the government's predefined limit can be substantially reduced. By contrast, if the effect of uncertainty is strong, the time delay of migration entry (higher bold dotted line in figure 4) is stronger than the reduction of competition: in this case there is a reduction in migration inflow and an increase in the average time taken to reach the government's predefined stock.

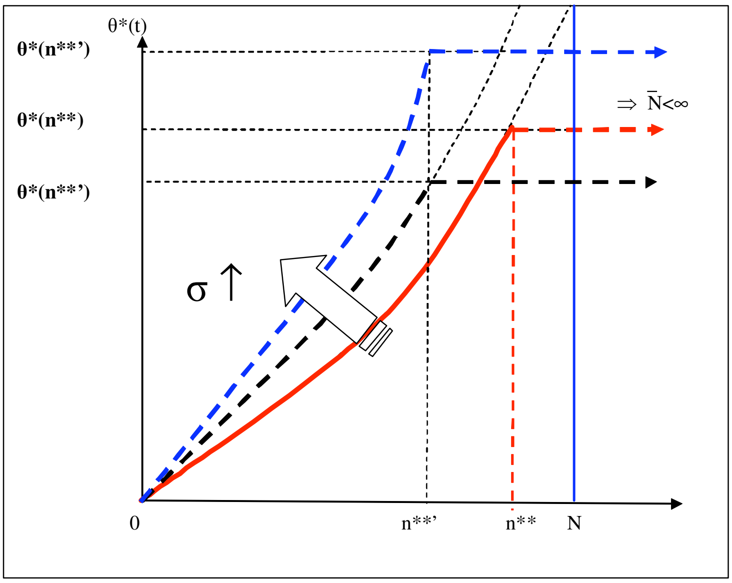

Figure 4. Undetermined limit on the stock: threshold levels for increasing variance

Further, since one way to to improve integration of immigrants in the host country is to reduce the entry cost (i.e. by improving labour market access, family reunion, long-term residence[30], teaching host language courses, enhancing social proximity (Fafchamps, 2009) and generous welfare transfers (De Giorgi and Pellizzari, 2009), figure 5 shows the effect of a reduction of K with respect to the entry threshold. In particular, from (8) (or 12) and (9) (or 13), we are able to show that:

$$\frac{d\theta^*(n)}{dK} > 0 \tag{18}$$

and

$$\frac{dn^*}{dK} = \frac{dn^{**}}{dK} = 0 \tag{19}$$

On looking at figure 5, we observe and must distinguish two effects. On the one hand the entry threshold decreases with the sunk costs (lower K makes $V(\theta, n)$ higher and then $\theta^*(n)$ smaller); on the other hand, the mass entry n^* (n^{**}) does not change. This latter result is due to the fact that the migrant benefit that triggers entry, $\pi^* = u(n)\theta^*(n)$, is affected in equal manner by K both for $n < n^*$ and for $n > n^*$. That is, the sunk cost entails only a scale effect on π^* without altering the size that starts the migration run. We may conclude that the only effect of an integration improving policy aimed at reducing the cost of entry is that migration occurs earlier but without altering (and in particular delaying) the dynamic of mass entry.

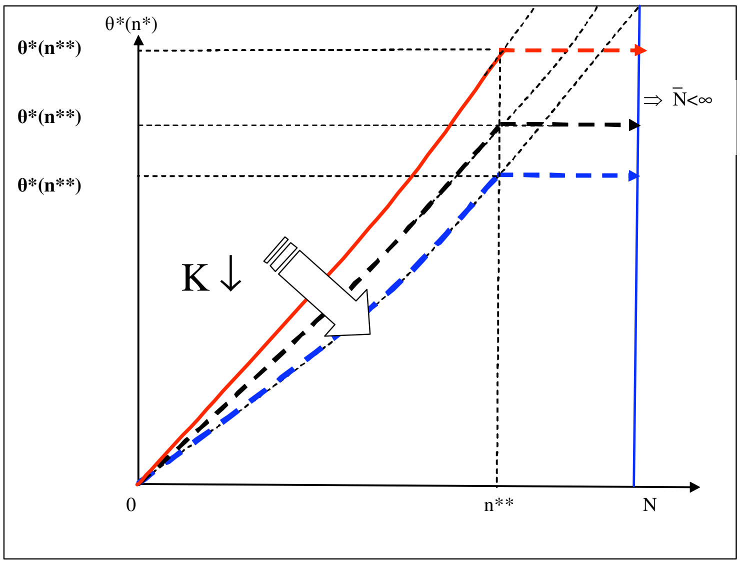

Figure 5. Threshold levels for increasing sunk costs

6 Conclusion

Recent European legislation on immigration reveals a peculiar paradox in migration policies. On the one hand, as a result of increased labour market competition and concerns about terrorism, the trend of recent legislation on immigration points to increasing frontier closure (OECD 1999, 2001). On the other, there is an increase in regularization: that is, European policies have become less tight. We have examined these conflicting policies by using a real option approach to migration choice which assumes that the decision to migrate can be described as an irreversible investment decision (Burda, 1995; Moretto and Vergalli, 2008). The model has focused on the government's desired immigrant stock and the policies adopted to control it. If a government adopts policies that go in the direction of tightening admission requirements by imposing quotas on the stock, it is as if that government announces its stock target, which becomes perfectly predictable by potential immigrants. In this case our results agree with the economic literature (Bartolini, 1993) and show that potential immigrants may rush towards the host country because they are afraid of being excluded.

However, if a government is ambiguous about its migration programme, for example by adopting conflicting policies like alternating a tightening of admission requirements with regularization programs, this makes it difficult for a potential immigrant to predict the true stock target. In this case, we have shown that the government may be able to delay the mass entry of immigrants by improving its control over migration inflows (quotas). If this is the case then the counterbalancing immigration policies used by European countries are not paradoxical. They may be useful in indirectly delaying migration waves. Moreover, if certain governments have unstable majorities, which is probably expressed in counterbalancing migration policies, the migration inflow may become smooth regardless of the particular policy adopted, but also as a consequence of this political ambiguity. Furthermore, if a goverment's aim is to delay entry migration waves, it can control them by causing noise on information relating to the limit on immigration stock. In conclusion, there exists a third policy between the two policies adopted (tightening or reducing the rules for legal immigration): namely, an alternation of tightening and reduction which may facilitate control over entry.

A Proof of proposition 1

A family of solutions of (5) is given by:

$$V(\theta, n, N) = A(n, N)\,\theta^{\gamma} + B(n, N)\,\theta^{\beta} + \hat{V}(\theta, n) \tag{20}$$

where β and γ are the positive and negative roots of the quadratic equation in $\lambda:\ \left(\sigma^2/2\right)\lambda(\lambda-1) + \alpha\lambda - \rho = 0$ with $1 < \beta < \frac{\rho}{\alpha}$ and $A(n, N)$ and $B(n, N)$ are the two families of integration constants; $\hat{V}(\theta, n)$ is chosen as the discounted expectation of flow payoff calculated by keeping the number of immigrants fixed at n:

$$\hat{V}(\theta, n) = E_0\left[\int_0^{\infty} \pi(n, \theta)\, e^{-\rho t} dt \mid \theta_0 = \theta\right] = \frac{\theta u(n)}{\rho - \alpha} \tag{21}$$

Because the probability of entry tends to zero as θ tends to zero, one boundary condition is that $\lim\limits_{\theta\to 0} V(\theta, n, N) = 0$; this implies that $A(n, N) = 0$, and then the equation:

$$V(\theta, n, N) = B(n, N)\,\theta^{\beta} + \frac{\theta u(n)}{\rho - \alpha} \tag{22}$$

in the text. The coefficient $B(n, N)$ can be determined by using the following suitable set of boundary conditions:

1. First, by competitive pressure, the value-matching condition requires the value of being entered is equal to the entry cost K at $\theta = \theta^*(n)$, i.e., in equilibrium immigrants expect zero profit at entry (Dixit and Pindyck, 1994, ch.8).
$$V(\theta^*(n), n, N) = K \tag{23}$$
2. Second, as long as each individual rationally forecasts the future development of the whole market and new entries by competitors at the optimal entry threshold, we get (Bartolini, 1993; proposition 1; Grenadier, 2002, p. 699).:
$$V_n(\theta^*(n), n, N) = 0 \tag{24}$$
3. Third, on (6) for $n = N < \bar{N}$, yields (8) and $B(N, N) = 0$.

Next, differentiating (23) totally with respect to n and using (24) we get:

$$\begin{aligned} 0 &= \frac{dV(\theta^*(n), n, N)}{dn} = V_{\theta}(\theta^*(n), n, N)\,\frac{\partial\theta(n)^*}{\partial n} \\ &= \left[\frac{u(n)}{\rho - \alpha} + B(n, N)\,\beta\left(\theta(n)^*\right)^{\beta-1}\right]\frac{\partial\theta(n)^*}{\partial n} \end{aligned} \tag{25}$$

This *smooth pasting condition* states that either each individual exercises his/her entry option at the level of θ at which the value is tangent to the entry cost, i.e., $V_{\theta}(\theta^*, n, N) = 0$, or the optimal trigger $\theta^*(n)$ does not change with n. While the former means that the value function is smooth at entry and the trigger is a continuous function of n, the latter indicates that an individual would benefit from marginally anticipating or delaying his/her entry decision. In particular if $V_{\theta}(\theta^*, n, N) < 0$ it means that the value of migrating is expected to increase if θ drops. On the contrary if $V_{\theta}(\theta^*, n, N) > 0$ means that an individual would expect to make losses versus a future drop in θ. In both situations (25) is satisfied by imposing $\frac{\partial\theta^*}{\partial n} = 0$.

Condition (25) splits $[0, N]$ into intervals where one of the following two conditions must hold:

$$\left[\frac{u(n)}{\rho-\alpha}+B(n,N)\,\beta\,(\theta^{*})^{\beta-1}\right]=0 \tag{26}$$

or

$$\frac{\partial\theta^{*}(n)}{\partial n}=0 \tag{27}$$

Since $B(N, N) = 0$ and $\frac{u(N)}{\rho-\alpha} > 0$, then (26) cannot hold at $n = N$. Therefore, it must be (27) that holds at $n = N$ and by (23):

$$\theta^{*}(N)=(\rho-\alpha)\,\frac{K}{u(N)}. \tag{28}$$

Now, define n^* as the largest $n \leq N$ that satisfies (26). For all $n^* \leq n \leq N$, we have $\frac{\partial\theta^*(n)}{\partial n} = 0$, so that all immigrants in the range $[n^*, N]$ must enter at $\theta^*(N)$. In addition, since for the range $n < n^*$ (26) holds, applying this to the general solution (22), gives as optimal range:

$$\theta^{*}(n)=\frac{\beta}{\beta-1}\,(\rho-\alpha)\,\frac{K}{u(n)} \tag{29}$$

Finally, the solution $n^* < N$ is obtained by combining (28) and (29), i.e.,

$$\theta^{*}(n^{*})=\theta^{*}(N)\Longrightarrow\frac{\beta}{\beta-1}\,(\rho-\alpha)\,\frac{K}{u(n^{*})}=(\rho-\alpha)\,\frac{K}{u(N)}$$

Let us now demonstrate the uniqueness of n^*. First, by $B(N, N) = 0$, at N, $V(\theta, N, N)$ equals the discounted income stream with benefit fixed at $u(N)$:

$$V(\theta,N,N)=\hat{V}(\theta,N)\equiv\frac{\theta(t)\,u(N)}{\rho-\alpha} \tag{30}$$

Then, to obtain $B(n, N)$, substitute (22) into (24): $B_n(n, N) = -(\theta^*)^{1-\beta}\,u'(n)/(\rho-\alpha)$ and integrating between n and N, gives:

$$\int_{n}^{N}B_{q}(q,N)\,dq=-\int_{n}^{N}(\theta^{*})^{1-\beta}\,\frac{u'(q)}{\rho-\alpha}dq \tag{31}$$

Using (1), $B(N, N) = 0$, and changing the integration variable on the right-hand of (31), gives

$$B(n,N)=\frac{\pi^{*1-\beta}}{\beta(\rho-\alpha)}\left[u^{\beta}(N)-u^{\beta}(n)\right]<0 \tag{32}$$

with $\lim_{n\to N} B(n, N) = 0^-$. Substituting (32) into (25), we can define the condition (26) as the function:

$$H(n)=\frac{u(n)}{\rho-\alpha}+(\frac{\pi^{*}}{\theta^{*}})^{1-\beta}\frac{1}{(\rho-\alpha)}\left[u^{\beta}(N)-u^{\beta}(n)\right] \tag{33}$$

with $H(N) > 0$. If H is still positive for a $N - y$ (where y may be infinitesimally small), with $\frac{\pi^*}{\theta^*} = u(N)$ we ought to obtain $\frac{d\theta^*}{dn} = 0$. This procedure continues until we obtain y^* (defined by $n^* = N - y^*$) such that $H(n^*) = 0$. Let us take the first derivative with respect to y

$$
\begin{aligned}
\frac{dH(N-y)}{dy} &= -\frac{u'(N-y)}{\rho-\alpha}+(\frac{\pi^*}{\theta^*})^{1-\beta}\frac{1}{(\rho-\alpha)}\beta u^{\beta-1}(N-y)\,u'(N-y) \qquad (34)\\
&= \frac{u'(N-y)}{\rho-\alpha}\left[(\frac{\pi^*}{\theta^*})^{1-\beta}\beta u^{\beta-1}(N-y)-1\right]\\
&= \frac{u'(N-y)}{\rho-\alpha}\left[(u(N))^{1-\beta}\beta u^{\beta-1}(N-y)-1\right]\\
&= \frac{u'(N-y)}{\rho-\alpha}\left[\beta(\frac{u(N-y)}{u(N)})^{\beta-1}-1\right]<0
\end{aligned}
$$

Q.E.D. (Quod erat demonstrandum) if y increases (moving from N to 0) there exists a value of n^* (i.e. y^*) such that $H(n^*)=0$.

B Proof of Proposition 2.

With uncertainty over stock N, equation (32) becomes:

$$
\begin{aligned}
E(B(n)) &= \frac{\pi^{*1-\beta}}{\beta(\rho-\alpha)}\left[\int_n^{\bar{N}} u^\beta(N)\,g(N;n)\,dN-u^\beta(n)\right] \qquad (35)\\
&= \frac{\pi^{*1-\beta}}{\beta(\rho-\alpha)}\left[\frac{\int_n^{\bar{N}} u^\beta(N)\,f(N)dN}{1-F(n)}-u^\beta(n)\right]<0
\end{aligned}
$$

which is negative because it is worth $u^\beta(n)>u^\beta(N)$ for any $N>n$. Furthermore, the limit of $E(B(n))$, yields:

$$
\begin{aligned}
\lim_{n\to\bar{N}} E(B(n)) &= \frac{\pi^{*1-\beta}}{\beta(\rho-\alpha)}\left[\frac{\int_n^{\bar{N}} u^\beta(N)\,f(N)dN}{1-F(n)}-u^\beta(n)\right]\\
&= \frac{\pi^{*1-\beta}}{\beta(\rho-\alpha)}\left[\frac{-u^\beta(n)\,f(n)}{-f(n)}-u^\beta(n)\right]\\
&= \frac{\pi^{*1-\beta}}{\beta(\rho-\alpha)}\left[u^\beta(n)-u^\beta(n)\right]=0^-
\end{aligned}
$$

which is consistent with (11).[31]

The smooth pasting condition strongly depends on $E(B(n))$:

$$
\begin{aligned}
E(H(n)) &= \frac{u(n)}{\rho-\alpha}+\beta\theta^{*^{\beta-1}}E(B(n)) \qquad (36)\\
&= \frac{u(n)}{\rho-\alpha}+(\frac{\pi^*}{\theta^*})^{1-\beta}\frac{1}{(\rho-\alpha)}\left[\frac{\int_n^{\bar{N}} u^\beta(N)\,f(N)dN}{1-F(n)}-u^\beta(n)\right]
\end{aligned}
$$

Since when $n\to\bar{N}$ we get $E(B(n))=0$, the smooth pasting reduces to $E(H(\bar{N}))=\frac{u}{\rho-\alpha}>0$ which requires that $\frac{d\theta^*}{dn}=0$[32].

For the uniqueness of n^{**}, assuming that $E\left(H\left(\bar{N}-y\right)\right)>0$ so that $\frac{d\theta^*}{dn}=0$ and the optimal trigger is $\frac{\pi^*}{\theta^*}=\underline{u}$, we need to show that $d\frac{E(H(\bar{N}-y))}{dy}<0$. Substituting $\bar{N}-y$ into (36), we get:

$$
E(H(\bar{N}-y))=\frac{u(\bar{N}-y)}{\rho-\alpha}+(\underline{u})^{1-\beta}\frac{1}{(\rho-\alpha)}\left[\frac{\int_{\bar{N}-y}^{\bar{N}} u^\beta(x)\,f(x)dx}{1-F(\bar{N}-y)}-u^\beta(\bar{N}-y)\right]
$$

Taking the derivative:

$$d\frac{E(H\left(\bar{N}-y\right))}{dy} = -\frac{u'\left(\bar{N}-y\right)}{\rho-\alpha} + (\underline{u})^{1-\beta}\frac{1}{(\rho-\alpha)}\times$$

$$\times\left[\frac{-u^{\beta}\left(\bar{N}-y\right)f(\bar{N}-y)(1-F(\bar{N}-y)-\int_{\bar{N}-y}^{\bar{N}}u^{\beta}\left(x\right)f(x)dxf(\bar{N}-y)}{(1-F(\bar{N}-y))^2}\right.$$
$$\left.+\beta u^{\beta-1}\left(\bar{N}-y\right)u'(\bar{N}-y)\right]$$

$$=\left[-\frac{u^{\beta}\left(\bar{N}-y\right)f(\bar{N}-y)}{(1-F(\bar{N}-y)} - \frac{\int_{\bar{N}-y}^{\bar{N}}u^{\beta}\left(x\right)f(x)dxf(\bar{N}-y)}{(1-F(\bar{N}-y))^2} + \beta u^{\beta-1}\left(\bar{N}-y\right)u'(\bar{N}-y)\right]$$

$$d\frac{E(H\left(\bar{N}-y\right))}{dy} = \frac{u'\left(\bar{N}-y\right)}{\rho-\alpha}\left[-1+(\underline{u})^{1-\beta}\beta u^{\beta-1}\left(\bar{N}-y\right)\right]+$$

$$+(\underline{u})^{1-\beta}\frac{1}{(\rho-\alpha)}\left[-\frac{u^{\beta}\left(\bar{N}-y\right)f(\bar{N}-y)}{(1-F(\bar{N}-y))} - \frac{\int_{\bar{N}-y}^{\bar{N}}u^{\beta}\left(x\right)f(x)dxf(\infty-y)}{(1-F(\bar{N}-y))^2}\right]=$$

$$d\frac{E(H\left(\bar{N}-y\right))}{dy} = \frac{u'\left(\bar{N}-y\right)}{\rho-\alpha}\left[\beta\frac{u^{\beta-1}\left(\bar{N}-y\right)}{(\underline{u})^{\beta-1}}-1\right]+ \tag{37}$$

$$+(\underline{u})^{1-\beta}\frac{1}{(\rho-\alpha)}\left[-\frac{u^{\beta}\left(\bar{N}-y\right)f(\bar{N}-y)}{(1-F(\bar{N}-y))} - \frac{\int_{\bar{N}-y}^{\bar{N}}u^{\beta}\left(x\right)f(x)dxf(\bar{N}-y)}{(1-F(\bar{N}-y))^2}\right]<0$$

There thus exists a value $n^{**}=\bar{N}-y^{**}$ such that $E(H\left(n^{**}\right))=0$.

Finally we need to show that $n^{**}<n^{*}$. To do so we need to show two conditions:

1. The value of $H(N-y)$ is greater than the value of $E[H(\bar{N}-y)]$ for any $y>y^{*}$.
2. The function (36) increases more rapidily than (33), i.e., the derivative (34) is *greater* than (37).

Condition 2 combined with condition 1 implies that the two functions do not intersect and that there exists a y^{**} such that $E[H(\bar{N}-y^{**})]=0$. For the first condition, stressing the analysis with respect to any point y greater than y^{*}, we can show that (36) evaluated at $N-y$ (i.e. assuming N as the upper limit of the stock) is lower than (33) if and only if:

$$\frac{\int_{N-y}^{N}u^{\beta}\left(x\right)f(x)dx}{1-F(N-y)}<0$$

which follows using the neoclassical properties. For the second condition, comparing (34) with (37) evaluated at $N-y$, we can show that:

$$\frac{dH(N-y)}{dy}>d\frac{E(H\left(N-y\right))}{dy}$$

This result can be shown in the following figure 6:

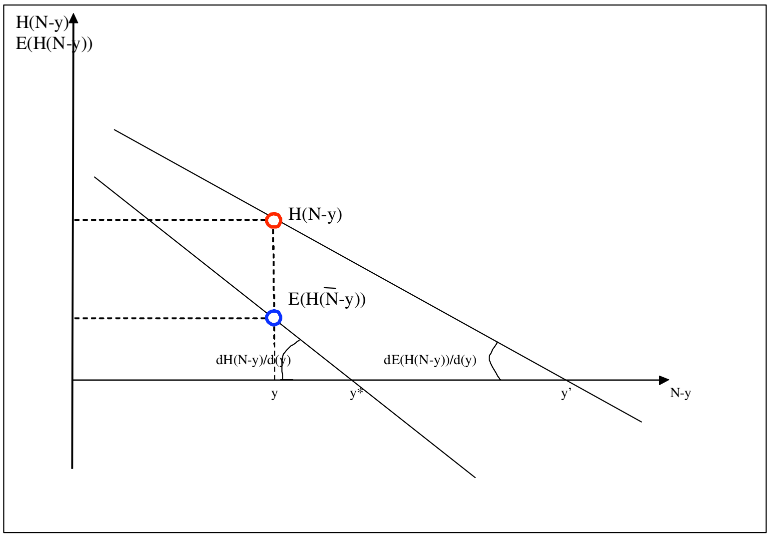

Figure 6: Graphic Solution

Notes

[1]We must stress a first caveat concerning the definition of "quota". In SOPEMI International Migration Outlook (2006) "quota" is defined as the share of total immigrants that is assigned to a particular group. Therefore, for any given group, it quantifies the percentage of the total stock admitted in a lapse of time.

[2]"Schäuble-Sarkozy suggested that EU asylum policy should be centralised, that long-term economic immigration should be managed by quotas and that short-term immigration should be regulated by temporary visas", Editorial of Intereconomics, (2006).

[3]Bartolini (1993, 1995), develops a general model that considers the investment decision of decentralized profit-maximizing agents who face investment adjustment costs in a market with stochastic returns and a limit on aggregate investment. The model is consistent with equilibrium models of asset pricing under uncertainty but differs from the mainstream assumption of constant investment cost by assuming that, for technological or institutional reasons, the investment cost is constant only until an investment ceiling becomes binding. At that point, in fact, Bartolini shows that cost becomes infinite. His paper shows that a competitive market reacts to this type of externality by generating recurrent runs as aggregate investment approaches its limit.

[4]The existence of limits seems to be idiosyncratic with respect to various aspects of the economic approach. Particularly, it can be used not only to study migration phenomenon, by also concerning foreign investment or also the adoption of licenses regulating the market. We can find many examples in which bounds assume an important role in the market. Capital controls are often imposed to prevent a country's net credit position from exceeding some acceptable levels; central banks face limits on the amount of foreign reserves that can be used to enforce an exchange rate target; firms in a fast-growing industry or in a developing economy may be competing for extended periods for a small number of qualified managers or highly skilled workers; entry of firms is restricted in many industries by regulations aimed at containing market size or by technological constraints on the use of a scarce resource. Similar approaches arise for taxi and liquor licences, fishing and costal trade rights, the number of polluting trade permits or ecolabelling permits (Dosi and Moretto, 2001).

[5]Indeed, as stressed in the OECD International Migration Outlook (2006), "In practice, however, the national limits and associated quotas have been less than the numbers requested by employers and have proven to be significantly under actual labour market needs, if the extent of regularisations of persons with employment contracts is any indication [...] the regular lack of concordance between the programmed migration levels and labour market needs meant that in practice, the levels had become almost irrelevant. Employers may well have become accustomed to a situation in which they could hire outside legal channels with relative impunity, with a reasonable probability that the hiring would be formally recognised a few years hence through regularisation".

[6]The indexes from 1 to 6 were defined by Fondazione Rodolfo Debenedetti (see www.frdb.org for details) and the index 7 was defined by Hatton (2004).

[7]"*All countries except Greece, [...] denote a tightening in regulations*", see Boeri and Brücker, 2005, page 634.

[8]We have compiled Table 1 by drawing on European immigration databases and sources. Table 1 concerns Europe in the geographical sense.

[9]Table 2 is our elaboration on Jachimowicz et al. (2004, pages 36-40) and Sunderhaus, (2007).

[10]In their broadest sense, regularization programs offer those migrants who are in a country without authorization the opportunity to legalize their status. Irregular migrants, also referred to as "undocumented," "unauthorized," or "illegal," are defined by most states as those migrants who have either entered a country legally and then fallen out of legal status — such as students, temporary workers, rejected asylum seekers, or tourists — or those who have entered illegally, either by crossing a border undetected or with false documents. In either case, irregular migrants do not have a legal right to residence in the state to which they have migrated.

[11]See Dixit-Pindyck (1994, pag. 253); Bartolini (1993); Moretto (2008) and Moretto and Vergalli (2008).

[12]In economic literature the fixed costs represent travel costs (Schwartz, 1973; Urrutia, 2001) and a wider basket of socio-economic elements; like broken family or friend ties (see Burda, 1995; Bencinverga and Smith, 1997; Moretto and Vergalli, 2008) "*to include not merely the airfare or bus ticket and time in transit, but the full costs of relocating and adjusting both consumption and labor market activities from the origin to the destination* " (Chiswick, 1990).

[13]This means that we take the differential wages into account. Hence equation (1) is in line with this definition, as also shown by other recent papers (Vergalli; 2008; Moretto and Vergalli, 2008).

[14]As stressed by Epstein and Nitzan (2006), "empirical evidence from the EU countries shows that immigration had at most a very small impact on wages and employment opportunities of natives". Moreover, "most of the evidence on the effect of immigrants on wages (and employment) for the US is also ambiguous in the sense that some studies show small positive effects and others small negative effects". In line with this empirical evidence we study the migration process without taking account of the crossed effect on natives' wages and unemployment level.

[15]On this see Bauer, Epstein and Gang, (2002), Epstein and Gang (2004), Moretto and Vergalli (2008), and Vergalli (2007).

[16]In other words, the reserve value $\underline{u}$ measures the level of "desperation" of the potential immigrants.

[17]For details on the process, see Dixit and Pindyck (1994, pag. 71).

[18]In this case we assume that the shock is homogeneous for all immigrants. If the shock were individual-specific, the model should change by considering the immigrants as they had different skills (i.e., they could perceive different wage gaps). The result would be a change of scale in the trigger levels and a self-selection of immigrants, but the theoretical result would not change. For more details, see Vergalli (2007), page 12. Therefore, we use a homogeneous shock as a general model.

[19]The indicator function states that, by competition among migrants, the value function of a migrant in the host country, at the time of a new entry, must be equal to the entry cost.

[20]That is, the sum of the instantaneous dividend (benefit) flow and the expected capital gain equals normal profits (Dixit and Pindyck, 1994, p. 185).

[21]Where $V_\theta = \frac{\partial V}{\partial \theta}$ and $V_{\theta\theta} = \frac{\partial^2 V}{\partial \theta^2}$.

[22]That is, the discounted present value of the benefit flows over an infinite horizon starting from θ (Harrison 1985, p. 44). See equation (21) in the Appendix.

[23]This condition is familiar in the real option theory with the name of matching value condition (see Dixit and Pindyck, 1994).

[24]See condition (25) in the Appendix.

[25]It is worth noting that the "utility" threshold that triggers migration for individual immigrants is identical to that of the individual that correctly anticipates the other immigrants' strategies. This property, discovered first by Leahy (1993), has an important operative implication; i.e., the optimal migration policy of each individual need not take account of the effect of rivals' entry. He/she can behave competitively as if he/she is the last to enter. In other words, when an individual decides to enter, by pretending to be the last to migrate, he/she is ignoring two things: 1) He/she is thinking that his/her benefit flow is given by $u(n)\theta$, with n held fixed forever. Thus, as $u'(n) < 0$, he/she is ignoring that future entry by other members, in response to a higher value of θ, will reduce "utility". All things being equal, this would make entry more attractive for the migrant that behaves myopically. 2) He/she is unaware that the prospect of future entry by competitors reduces the option value of waiting. That is, pretending to be the last to migrate, the individual also believes he/she still has a valuable option of waiting before making an irreversible decision. All things being equal, this makes the decision to enter less attractive. The two effects offset each other, allowing the migrant to act as if in isolation (see Dixit and Pindyck, 1994, p. 291).

[26]Obviously, a government sets the stock in line with the supply-demand gap of the labour market. Indeed, "the selection of candidates for immigration can be made by the receiving country itself [...] In this case, potential immigrants are screened on the basis of certain characteristic, deemed to contribute to, and facilitate, integration in the host country, such

as [...] having an occupation deemed to be in shortage and having a prior job offer from an employer in the host country" (Sopemi, 2006, page 114).

The ambiguity concerning the quota can exist when the government adopts confused immigration policies. This may be due to many causes: for example, when different political parties alternate in the government of a country, probably expressing different and contradictory policies; or when the authority imposes an exacerbation of admission requirements and regularization programs at the same time.

[27]The upper support of the distribution can be set to $\hat{N} \leq \bar{N}$. Without losing generality we assume that $\hat{N} = \bar{N}$.

[28]This is due to the fact that $\frac{d\frac{\beta}{\beta-1}}{d\sigma} > 0$ and $\frac{du(n)}{dn} < 0$.

[29]We concentrate the analysis on the case of an unknown quota. Obviously, we have the same effect with a known quota.

[30]In line with Migration Integration Policy indEX (MIPEX). MIPEX "measures policies to integrate migrants in 25 EU Member States and three non-EU countries. It uses over 140 policy indicators to create a rich, multi-dimensional picture of migrants' opportunities to participate in European societies.

MIPEX covers six policy areas which shape a migrant's journey to full citizenship:

- Labour market access

- Family reunion

- Long-term residence

- Political participation

- Access to nationality

- Anti-discrimination" (http://www.integrationindex.eu)

[31]Note that $\lim_{n\to\infty} E\left(B\left(n\right)\right) = 0$ even if $u\left(n\right) \rightarrow \underline{u} \geq 0$.

[32]Note that this result always holds for $\underline{u} > 0$, but it is also true for $\underline{u} \geq 0$ by using limit definition. In this case for each real number $\varepsilon > 0$ infinitesimely small, there exists a value $n\prime$ such that for $n > n\prime$ the difference

$$E(H\left(n'\right)) - E(H\left(\infty\right)) < \varepsilon$$

Nevertheless, because now $E\left(H\left(\infty\right)\right) = 0$, we are able to find a value n' such that:

$$E(H\left(n'\right)) - 0 < \varepsilon$$

If $\varepsilon \rightarrow 0$ it follows that n' is the right value we are searching.

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