E C O N O M I C S   B U L L E T I N

Timing of migration

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Abstract

The purpose of this paper is to determine the optimal timing of migration from an individual point of view. In addition to the economic differences between the countries, the optimal migration age also depends on social factors, in particular, the preference for the country of birth and the migration network established in the host country. The model shows that it could be optimal to delay the departure time instead of migrating immediately.

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1. Introduction

A lot of literature has been dedicated to migration from an economic perspective. Most of the papers have focused on the effects of immigration on welfare in the host country and, recently, in the source country. However, it is individuals and families, not nations or governments, who make the decision to move. To our point of view, a study of migration should be able to answer two questions: should the individual stay or should he go? and if he decides to emigrate, what is the best moment?. In order to answer the first question, the benefits and the costs of this decision have to be considered. To answer the second question, the influence of the timing of migration on the benefits and costs has to be measured.

Most papers have focused on the first question, because it is usually the difference between the salaries of the host and home countries that a potential emigrant considers. However, Faini (1996) introduces a parameter that reflects the preference for the country of birth, obtaining the migration rate as an endogenous variable that depends on both the salary gap and this preference. We also take into account this parameter of preference although the purpose of this paper is different from Faini's work. We also assume heterogeneity of the individuals in their preference for the country of origin, but we concentrate on the choice of the timing of migration.

There is little theoretical literature about the timing of migration[1]. Hartog and Winkelmann (2003) study the effect of age, but in an empirical way. To find the optimum planned migration age, they compare the estimated marginal benefit of increasing the migration age with the marginal cost of later migration. They find that, depending on the exchange rate of the currencies, the best decision is to emigrate immediately or never to migrate.

We offer a different perspective, considering socioeconomic factors in the homeland and in the country of destination, so that the individual compares between the utility from emigrating and that of staying at home, instead of comparing only the economic benefits. We use a two-stage optimal control technique, which permits us to determine the optimal timing of migration theoretically. Using a deterministic framework, we introduce the fact that the costs of migration depend on the timing of the decision to migrate as a consequence of the preference for living in the country of birth and the existence of migration networks.

From a social point of view, the individual who emigrates suffers the loss of relationships in his homeland and must make a great effort to adapt to the new culture (Faini, 1996). Logically, this social cost of migration will be higher the longer the individual remains in his country of birth. On the other hand, previous migration facilitates future population movements, a phenomenon called network migration. This migration provides information about the host region labor market and helps new migrants in the settlement process. Darvish-Lecker (1990) shows that the cost of migration decreases with a larger migration network. We introduce this evidence into our model.

We also take into account the economic conditions. The market is formed by two countries, the home country and the host country. As usual, there is an economic asymmetry between them in the sense that the home country has a lower level of technology than the host country.

The model provides the migration age chosen optimally by each individual. Contrary to the extended belief that migration should take place at the youngest possible age, our framework shows that there may be incentives to wait. For some values of the parameters of preference for the country of birth and of the migration networks, the range of optimal departure age oscillates between the twenties and the thirties, depending on the technological difference. Individuals with less preference for their country of origin migrate earlier and those who have deeper home roots prefer to wait until the first emigrants establish a better network.

The rest of the paper is organized as follows. The characteristics of the problem faced by the individuals and the main elements of the economy are presented in Section 2. Section 3 establishes the conditions for the emigrant to leave his home country. If the emigrant effectively decides to abandon his country of birth, we characterize the timing. Finally, Section 4 closes the paper with a review of the main conclusions.

2. The model

The model is developed in a context of continuous time. The utility of an individual in each period is logarithmic with an element of intertemporal discount ρ *(0<ρ<1)*:

$$\int_0^{T_j} \theta_j \; u(C(t))e^{-\rho t} dt \tag{1}$$

where *u(.)* is increasing and strictly concave and T_j is the life expectancy of individual j. The parameter θ_j indicates individual j's preference for his country of birth, reflecting the heterogeneity of the natives in their preference. For simplicity, we assume that it takes the value one when the individual emigrates and a greater value when the individual lives in his country of origin. In this latter case we assume that the parameter has the following form:

$$\theta_j(t) = e^{1-\gamma t_1+\phi_j(t-t_1)} \qquad \text{for } 0 \le t \le t_1 \tag{2}$$

where t_1 is the departure time of the potential emigrant. This expression (2) shows the effects derived from a delay in the timing of migration on utility. The parameter ϕ_j incorporates the fact that there is heterogeneity in the preference for the country of birth for each individual worker, in the sense that the greater the parameter, the lower the preference for the country of birth[2]. Furthermore, for the same individual and, thus, the same ϕ_j, the longer the individual remains in his country of birth, that is to say t-t_1 gets lower, the greater is the preference for this country. In other words, the decision to migrate implies social and psychological costs derived from the loss of relationships and the effort needed to adapt to the new culture. The more people live in a certain environment, the greater these types of costs become. On the other hand, we also take into account the effect due to the consolidation of migration networks in the host country. These networks give important help in arranging transportation and finding housing and jobs. The parameter γ shows that the delay in the timing of migration makes the consolidation of networks possible. Whatever the choice of the individual as to the departure time, there is always a loss in the utility of emigrating, that is to say, $\theta_j(t) > 1$, implying that the parameters must satisfy the condition, $\frac{1}{\gamma+\phi_j} > T_j$[3].

The production function is AK where A > 0 is the marginal productivity of capital and is different between the home and host countries. We denote A_1 as the marginal productivity in the home country and A_2 as that of the host country. Capital accumulation, assuming that the capital depreciation rate is nil, takes the following form:

$$\dot{K} = AK(t) - C(t) \tag{3}$$

A dot over the variable indicates its variation in time. We also assume that $K(0) = K_0$ is given but $K(T) \geq 0$ is free.

Therefore, the potential emigrant faces two possibilities. He can live in his country of origin where the utility obtained from consumption is greater because of the preference for the country of birth, but with a lower marginal productivity of capital ($A_1 < A_2$) or he can migrate, paying the social and psychological cost, but having a more efficient capital goods sector. Thus, the accumulation of capital is:

$$\dot{K} = A_1 K(t) - C(t) \quad \text{if} \quad 0 \leq t \leq t_1 \tag{4}$$

$$\dot{K} = A_2 K(t) - C(t) \quad \text{if} \quad t_1 < t \leq T \tag{5}$$

In the following section we establish the conditions that determine the decision to emigrate and we characterize the timing. We use the two-stage optimal control approach.

3. Optimal departure time

The optimal control problem is: max $U(C,t_1) = \int_0^{t_1} \theta(t) u(C(t)) e^{-\rho t} dt + \int_{t_1}^{T} u(C(t)) e^{-\rho t} dt$

subject to (3) and (4), where K_0 is given but $K(T) \geq 0$ is free. Note that this objective function rewrites function (1). The two-stage optimal control method[4] solves the problem as a sequence of two Pontryagin problems:

1. The period in which the emigrant has left his country of birth $t_1 < t \leq T$.
2. The period in which the potential emigrant stays at home $0 \leq t \leq t_1$.

1. In order to solve the first problem, we establish the following optimal control problem:

$$\max_{C} \; U_2(C,t_1) = \int_{t_1}^{T} \ln(C(t)) e^{-\rho t} dt \tag{6}$$

subject to $\dot{K} = A_2 K(t) - C(t)$ with K_1 given but $K(T) \geq 0$ free. The corresponding Hamiltonian is $H_2(K,C,t,\lambda_2) = u(C(t))e^{-\rho t} + \lambda_2(t)(A_2 K(t) - C(t))$, where $\lambda_2(t)$ is the costate variable. By solving the standard first order necessary conditions we derive the following results:

$$K(t) = e^{A_2 t}\left[\frac{a_2}{\rho}(e^{-\rho t} - e^{-\rho t_1}) + K_1 e^{-A_2 t_1}\right] \tag{7}$$

$$C(t) = a_2 e^{(A_2 - \rho)t} \tag{8}$$

Including the transversality conditions $\lambda_2(T) \le 0$ and $K(T)\lambda_2(T) = 0$ it can be found that:

$$a_2 = \frac{K_1\rho}{e^{-\rho t_1} - e^{-\rho T}} e^{-A_2 t_1} \tag{9}$$

Therefore, at departure time (t_1):

$$C(t_1) = \frac{K_1\rho}{e^{-\rho t_1} - e^{-\rho T}} e^{-\rho t_1} \tag{10}$$

$$\lambda_2(t_1) = \frac{e^{-\rho t_1} - e^{-\rho T}}{K_1\rho} \tag{11}$$

Equation (9) allows us to calculate the present value of the welfare during the period in which the emigrant remains in the host country, in terms of t_1 and $K_1 = K(t_1)$.

$$U_2^*(K_1, t_1) = \int_{t_1}^{T} \ln\left[\frac{K_1\rho}{e^{-\rho t_1} - e^{-\rho T}} e^{-\rho t_1} e^{(A_2-\rho)(t-t_1)}\right] e^{-\rho t} dt \tag{12}$$

2. In the second step we establish the following optimal control problem:

$$\max_C \; U_1(C, t_1) = \int_0^t \theta(t) \ln(C(t)) e^{-\rho t} dt + U_2^*(K_1, t_1) \tag{13}$$

subject to $\dot{K} = A_1 K(t) - C(t)$, $0 \le t \le t_1$, with K_0 given but $K_1 = K(t_1)$ free and $\theta(t) = e^{1-\gamma t_1 + \phi(t-t_1)}$. The first order conditions give us the following relations:

$$K(t) = \frac{a_1}{\rho - \phi}\left[e^{(\phi-\rho)t_1} - 1\right] e^{A_1 t_1} + K_0 e^{A_1 t_1} \tag{14}$$

$$C(t) = a_1 e^{(A_1+\phi-\rho)t} \tag{15}$$

Including the continuity condition $\lambda_1^*(t_1^*) = \lambda_2^*(t_1^*)$, it can be found that:

$$\lambda_1(t_1) = \frac{e^{-\rho t_1} - e^{-\rho T}}{K_1\rho} \tag{16}$$

$$a_1 = \frac{K_1\rho}{e^{-\rho t_1} - e^{-\rho T}} \frac{e^{1-(\gamma+\rho)t_1}}{e^{(A_1+\phi-\rho)t_1}} \tag{17}$$

$$C(t_1) = \frac{K_1\rho}{e^{-\rho t_1} - e^{-\rho T}} e^{1-(\gamma+\rho)t_1} \tag{18}$$

$$K(t_1) = \frac{K_0 e^{A_1 t_1}}{1 - \dfrac{\left[e^{1+(\phi-\rho)t_1} - e\right]\rho}{(\rho-\phi)(e^{-\rho t_1} - e^{-\rho T})e^{(\gamma+\phi)t_1}}} \tag{19}$$

These expressions allow us to answer the two main questions related to migration: does the individual decide to emigrate? and, if he decides to emigrate, what is the best moment?

3.1 Does the individual decide to emigrate?

It is clear that the individual decides to emigrate if his welfare during the period in which he remains in the host country (in terms of utility) is greater than the corresponding welfare in his home country, in other words, if the benefits from the technological gap and the migration networks in the host country compensate the individual migration cost. Otherwise, he stays at home. From (10) and (18) it is possible to observe that migration provokes a discontinuity in consumption. The consumption ratio of the country of birth in terms of that of the host country at time t_1 for the potential emigrant is given by:

$$\theta(t_1) = e^{1-\gamma t_1} > 1 \tag{20}$$

That means that the consumption in the country of birth is greater than the consumption in the host country at the time of migration. Furthermore, in terms of utility, the difference is even greater because of the preference for the country of origin. This break in the consumption path is due to the fact that migration costs always exist. But, this gap is partially controlled by the potential emigrant choosing the departure time. Expression (20) shows that the longer the delay, the lower the drop in consumption. The reason is that the delay makes the consolidation of networks possible, reducing the migration costs.

However, to delay departure has another effect on migration costs. The postponement of the moment of migration increases the relationships established in the country of birth and, therefore, increases the social migration costs for the emigrant. This effect is reflected in the consumption growth rate. In the birth country it is $A_1+\phi-\rho$ (see expression 15) whereas in the host country is $A_2-\rho$ (see expression 8). The possible growth advantage of migration depends on the technological parameters (A_1 and A_2) and the growth of the social relations (ϕ) .

We have seen that the decision to migrate provokes a fall in consumption only at the time of migration. It is clear that if the difference in consumption growth ($A_2 - A_1 - \phi$) is negative, there will be no advantage in migrating and the individual will decide to stay at home. On the other hand, if there is a growth advantage in the host country, the individual will decide to emigrate only if this growth advantage is enough to compensate the fall in consumption at the time of migration. Clearly, the optimal timing of migration matters, given that this fall depends precisely on the departure time. The general intuition is that migration is best undertaken at the youngest possible age, but our analysis indicates that it could be optimum to delay the timing of migration. In the following section we find an interior solution for the migration age of the individual.

3.2 When does the emigrant leave his country?

The incentive that makes it possible that the emigrant prefers to wait is the progressive consolidation of migration networks. What discourages the delay is the consolidation of relationships in his homeland and the fall in consumption. An interior solution could emerge if the process of network consolidation is strong enough to compensate the migration costs. Therefore, there is an interior solution for $0<t_1^*<T$, if and only if

$$\rho\, t_1 e^{-\rho t_1} - e^{-\rho t_1}\ln\left(\frac{\rho K(t_1)}{e^{-\rho t_1}-e^{-\rho T}}\right) - \frac{e^{-\rho T}-e^{-\rho t_1}}{\rho}\left(\frac{\frac{\partial K(t_1)}{\partial t_1}}{K(t_1)} - A_2\right) + e^{-\rho t_1} +$$
$$\frac{(\gamma+\phi)e^{1-\gamma t_1-\phi t_1}-(\gamma+\rho)e^{1-\gamma t_1-\rho t_1}}{\phi-\rho}\left(\ln\left(\frac{\rho K(t_1)}{e^{-\rho t_1}-e^{-\rho T}}\right)+(1-\gamma t_1-\rho t_1)-\frac{\phi-\rho+A_1}{\phi-\rho}\right)+$$
$$\frac{-e^{1-\gamma t_1-\phi t_1}+e^{1-\gamma t_1-\rho t_1}}{\phi-\rho}\left(\frac{\frac{\partial K(t_1)}{\partial t_1}}{K(t_1)}-\gamma-\rho\right)-\frac{\phi-\rho+A_1}{\phi-\rho}e^{1-\gamma t_1-\phi t_1}((1-\gamma t_1-\phi t_1)=0 \tag{21}$$

The character of the equation makes it impossible to determine the interior solution explicitly. Because of this, we resort to simulating the result, which allows us to show the existence of the interior solution and, at the same time, that it is an absolute maximum. This simulation could be considered a local proof because of the Implicit Function Theorem. Expression (21) defines a $C^{(1}$ function and if we have a solution, then we have a neighbourhood of the points that are solutions to the equation.

In order to display the solution, we set the following values for the parameters: $\rho = 0.03$, $\phi = 0.003$, $K_0 = 1$, $\gamma = 0.0069$, $\mathrm{T} = 100$, $A_1 \in [0,1]$ and $A_2 \in [2,3]$. Graph 1 shows the solutions that fulfil the necessary condition.

[Insert Graph 1]

The verification of the sufficient condition is given by Graph 2, where the negative points show the solutions to Equation (21) that are maximum.

[Insert Graph 2]

This graph shows that the optimal age of migration is in the twenties and the thirties. This result is in agreement with the empirical data. Table 1 shows the migration age in the USA from the year 2000 to 2004.

[Insert Table 1]

We can observe that the timing of migration for the foreign-born population in the USA is principally between twenty and forty years old. These cohorts represent almost sixty percent of the total immigrants, without including the children that they probably bring.

The elements which determine the optimal timing of migration are A_1, A_2, γ, ϕ and ρ. The parameters A_1 and A_2 reflect the economic conditions of the country of birth and the host country, respectively. The study of comparative static[5] shows a positive relation of t_1 with A_1 and a negative link between t_1 and A_2. In our model, migration provides an improvement in terms of consumption growth. If the economic conditions of the country of birth improve, without changes in the other variables, the advantage in terms of consumption growth, A_2-A_1-ϕ, will be reduced and, as a consequence, the migrant will postpone his decision to migrate in order to mitigate the fall in consumption at the moment of migration. On the other hand, an increase in the growth rate of the host country implies an increment in the difference in consumption growth rate which encourages earlier migration.

The analysis of parameters γ and ϕ reveals interesting insights. It shows that parameter γ has an important influence on the timing of migration. Parameter γ represents the ease of the settlement process provided by previous migration. A high value of γ reflects a faster consolidation of the migration network. Therefore, the expected result is that the potential migrant will not need to delay his departure very much. This is confirmed in our framework. We know that the model shows a drop in consumption at the moment of migration. This drop gets smaller if migration is delayed and if there is an increase in parameter γ. The greater the value of parameter γ, the less significant the migration costs and, hence, the shorter the delay in migrating. If we concentrate on parameter ϕ_j, a high value of this parameter corresponds to a low preference for the home country. Accordingly, an increase in this parameter will reduce the difference in terms of utility derived from the consumption in the host and birth countries, which shortens the delay in migrating. This means that individuals with a lower predilection for their home country find it optimal to migrate earlier, making it possible to establish and consolidate networks which could encourage other compatriots with a greater preference for their country of birth to take the decision to migrate later.

Finally, the comparative static shows a negative link between the intertemporal discount of consumption and the migration age. The reason is that a lower value of the intertemporal discount parameter ρ is associated to a smooth consumption trajectory. That is to say, a reduction in this parameter will imply a greater desire of the individual to reduce the fall in consumption at the moment of migration. The way to smooth the consumption path is precisely by delaying the moment of migration.

4. Conclusions

We have built a framework in which it is possible to determine the optimal timing of migration. The introduction of both social and economic factors related to migration allows us to detect different forces, some of which bring forward the moment of migration and others which delay it. The increase of affective relationships when living in the home country increases the psychological cost of migration and the best strategy is to migrate as soon as possible. An increase in the economic advantage in terms of consumption growth in the host country also encourages immediate migration. However, delaying the moment of migration could permit the consolidation of networks that reduce the cost of migration. The combination of these forces leads to the possibility of an interior solution in which the optimal individual decision is to delay the departure time until a certain age.

In this paper we have analyzed the decisions made by individuals at a micro level, but they have consequences for macroeconomic performance. To analyze this extension is on our research agenda.

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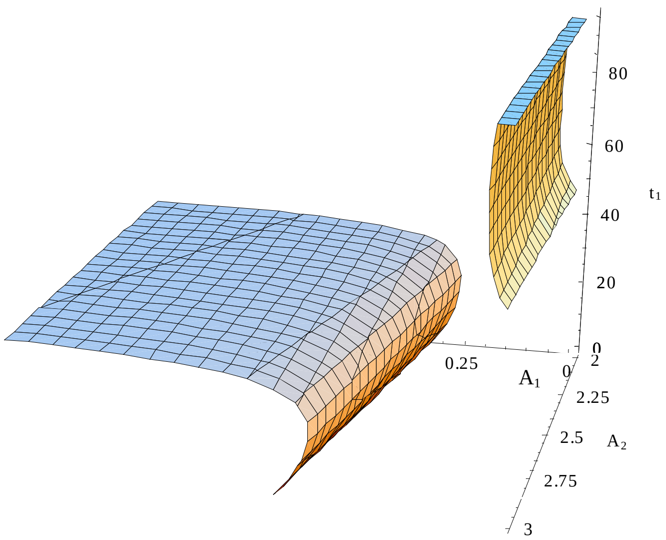
Graph 1. *Necessary condition.*



Graph 2. *Sufficient condition.*

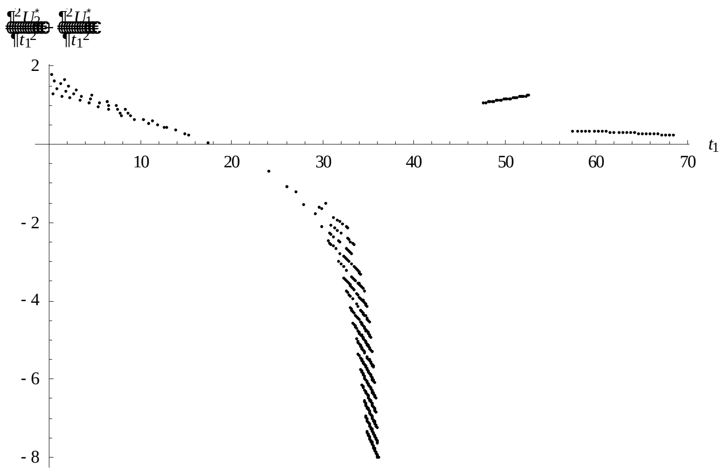


Table 1. *Foreign-born population in USA by age between the years 2000 and 2004*

(Numbers in thousands)

AGE	YEAR OF ENTRY 2000 - 2004	
	Number	Percent
Total	6.052	100,0
.0 to 4 years	321	5,3
.5 to 9 years	410	6,8
.10 to 14 years	387	6,4
.15 to 19 years	496	8,2
.20 to 24 years	**1.002**	**16,6**
.25 to 29 years	**1.095**	**18,1**
.30 to 34 years	**828**	**13,7**
.35 to 39 years	**556**	**9,2**
.40 to 44 years	327	5,4

.45 to 49 years	230	3,8
.50 to 54 years	135	2,2
.55 to 59 years	73	1,2
.60 to 64 years	59	1,0
.65 to 69 years	51	0,8
.70 to 74 years	36	0,6
.75 to 79 years	32	0,5
.80 to 84 years	6	0,1
.85 years and over	9	0,1

Endnotes

[1] Dustman and Kirchkamp (2002) explain, in a context of temporal migration, the optimal migration duration in the host country, but our purpose is to determine the optimal departure time.
[2] It can be checked that $t-t_1$ is negative.
[3] To facilitate the notation we drop the individual index in what follows.
[4] The two-stage optimal control technique is described in Tomiyama and Rossana (1989) and Boucekkine, Saglam and Vallée (2004).
[5] This study is also carried out using simulations.