The role of the demographic transition in the formation of the trans-Mediterranean and trans-Saharan migration systems

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1. Introduction

Although migration is not mentioned in the original formulation of the demographic transition theory (Thompson 1929; Landry 1934; Davis 1943; Notestein 1945), several authors (Davis 1963; Zelinsky 1971; Chesnais 1992; Skeldon 1997; Hatton and Williamson 1998; de Haas 2009) have later pointed out the historical coincidence between its onset and the upsurge of migratory flows (urbanization and international migration). But the studies focusing on the connections between the demographic transition and migration are still rare.

Current theorizations of migration processes tend to give little emphasis to population growth in the sending countries, and population growth itself is seen as a consequence of economic development (Massey and others 1998:11). In a seminal paper, Easterlin (1961) showed that population growth can foster migration in later years, when the increased number of newborns (now surviving to adulthood) reaches the typical migration ages, between 20 and 30, but the empirical researches that have addressed this issue have yielded contradictory results. Those that focused on the macro demographic characteristics of sending countries (e.g. Zlotnik 2004; Malberg 2006; de Haas 2009) in most cases concluded that neither population growth nor fertility exert any significant effect on international migration. Zlotnik (2004:25), for instance, is categorical: "In sum, the relation between net migration and natural increase according to the only global set of estimates available does not seem to be strong enough to merit further exploration".

In the same collection of essays, however, Adepoju (2004:59) comes to the opposite conclusion: population growth is one of the main determinants of African emigration. Besides, using the same data as Zlotnik, but with a different methodology and over a longer time period, Bo Malberg (2006) claims that cohort growth has a strong predictive power on net migration.

In the economic field, results are at least as contradictory: several researches indeed seems to confirm the absence of any significant effect of population growth on international migration: this holds, for instance, for the migration flows from 79 sending countries to 14 OECD nations in 1980-1995[3] (Mayda 2009), for the migration flows towards the US between 1971 and 1998 (Hatton and Williamson 2007), for the Italian emigration before WWI (Faini and Venturini 1994b), and for the emigration from Southern Europe after WWII (Faini and Venturini 1994a).

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[3] Actually, Mayda's (2009) paper presents nine models. In the first eight models, there emerges only a weak statistical association between the share of the young in the population and migration rates. It is only in the ninth, and last, model, where some interaction terms try to capture the effect of migration policy, that the connection between the two variables (share of the young and policy) becomes highly significant..

In other instances, however, a significant, or even highly significant, effect of population growth on international migration can be detected: the US between 1970 and 2004 (Hatton and Williamson, 2009); Europe during the late XIX and the early XX century (Hatton and Williamson 1998); Southern Europe during the late XIX and the early XX century (Hatton and Williamson 1998); contemporary Sub-Saharan Africa (Hatton and Williamson 2004), and Central America (Bean 1990).

Why these contradictory results? In part, this may depend on the choice of the key demographic variables: sometimes it is the current or the lagged rate of natural increase; in other cases, the proportion of population aged 15-25 or 20-25 or 20-30; more rarely, total fertility, or the crude birth rate, or some other *ad hoc* indices. On the left side of the equation, "migration" sometimes means gross, sometimes net emigration rates, and sometimes their logs. But the importance of this purely technical explanation should not be exaggerated, because several of these variables are correlated. Can there be other reasons?

The first answer that we will suggest in this paper is that these contradictions arise from the difficulty in disentangling the short from the long term dynamics of migration. In the short term, variability of migration rates is high, with fluctuations correlated with the differentials in the economic cycle between the sending and the receiving countries. But there is also an underlying long-term pattern, sometimes referred to as the "migration hump": a long historical phase, of 30 to 90 years[4], during which emigration rates first increase and then decline. What we contend is that econometric analysis of migration is too narrowly focused on the short-term dynamics rather than on the long-term one. This conclusion may be confirmed by looking at some of the results generally achieved in econometric analysis of migration.

The most popular methodology currently used in econometric analysis is that of fixed effects, by which a region-specific dummy variable is inserted in the regression in order to capture the effects of all the omitted, time-independent variables that influence migration. And, indeed, these dummy variables generally account for most of the variability of the phenomenon[5], implying that time-independent variables are more important than time-dependent ones in explaining migration. This result may be explained by noticing that the series employed in such type of analysis are generally much shorter than the migration hump. Under this condition the effect of population growth (and of all longer term determinants) may well not prove significant, for its effect may be (mis)interpreted as a fixed (i.e. country-specific) effect. The same results achieved by econometric analyses suggest, therefore, the possibility that the role of long-term determinants of migration may have been overlooked.

The short-term bias that, we venture, affects econometric analyses of migration may be at the roots of another recurrent result: the apparent predominance of pull over push factors, i.e. the fact that the economic conditions of the receiving country usually turn out to be a much better predictor than those of the sending country (Mayda 2009). If our conjecture is correct, the structural conditions of the sending countries dominate in the long run, but are slow to change, and for this reason their role is underestimated in fixed effects analysis.

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4 It was about 30 years in the South Korean migration transition, and about 90 in the case of the historical migration from Europe to the Americas (Massey 2003:17).

5 One example of this is given by Maida's (2009) research on bidirectional migration flows directed toward 14 OECD countries. Here a first set of fixed effect models with a dummy variable for each country bring to a R^2 of about 0.25; this entails that the overall variance explained by the pooled model is smaller than 25%. Subsequently Maida adds one dummy variable for each country pair: in this case the value of R^2 rise to the value of 0.85. Other researches like those of Hatton and Williamson (2009) seems confirming that the pooled model of bidirectional flows can explain less than 25% of the overall variance.

In this paper, we will attempt to reintroduce in the analysis of migration a longer term component. We propose that migration stems from two different sets of determinants: A first set includes the long-term transformation undergone in the sending countries. A second set includes the differential trends in economic cycle and the process of chain migration that orientate the evolution of migration in the short-term.

The long term component of our model is basically an attempt to synthesize the progressive transformation of traditional, peasant societies into modern economies: ancient customary rights on land and forests are progressively lost because of privatization, new and more effective agricultural techniques are introduced, the arable land is extended, agricultural production becomes more strictly linked to the market, educational levels increase, etc. As for the explanation of all this, two lines of thought can be discerned.

In the first one (e.g. Massey 1988), peasant societies are mainly seen as immobile, devoted to self-conservation, but the time eventually comes when they are just swept away by the spreading of capitalism, and migration is affected, in at least two ways. First, the modernization of the rural economy requires investments, and one way to accumulate the necessary resources is to send some of the peasant family members to town or abroad (Stark and Lucas 1988). Second, the rise in productivity that follows the introduction of new agricultural techniques means that several of the previous land laborers are now in excess: urbanization and international migration thus ensue. Unfortunately, as we will show later, in our analysis we find only weak evidences of this process.

The alternative explanation underlines the effects produced in a rural society, by population growth (Boserup 1965). This phenomenon creates in peasant societies two different forms of imbalances: between population and arable land, and between generations. The inheritance system becomes more problematic, and so does the process of family formation, for which the availability of land is a necessary precondition. Increasing land productivity, or colonization of new lands are possible answers. During this process, as Caldwell (1968) reports for Ghana, young sons may be sent to school, so as to be ready for rural-urban, or even international, migration. In this perspective, therefore, phenomena as different as the increase in the total amount of arable lands, the reduction of the fallow periods, the introduction of new agricultural techniques, the rise in land productivity, rural-urban migration, international migration, the rise of educational level, and a lower fertility may constitute the different facets of the response to the problems originated by population growth.

Responses to population growth can, and indeed do, differ in the rural world, sometimes with interactions that have gone unnoticed in the literature. For instance, with a large availability of free land, a population may prefer to extend the cultivated land rather than emigrate. In contrast, if land is scarce, but a modern sector is developing quickly, there may be urbanization without international migration; and so on. As Davis pointed out back in 1963, any given response R_i to population increase tends to depress some other response R_j. This means that emigration is not the only possible consequences to population increase: it may or may not take place, depending also on several other conditions. This is in our opinion the most important reason why the analyses on the connection between population growth and migration yielded so contradictory results.

This paper is subdivided in three sections. The first one will briefly address the basic chronology of the main demographic events experienced by Northern and Western Africa in the last century. In the second section, we will present the data and the methodology that we have employed for our analysis. In the third section we will present and discuss the results of our research.

2. A look at the region

Western and Northern Africa form a highly heterogeneous region: culturally and historically, the latter belongs to the Arab world, while the former is rather close to Sub-Saharan countries. Exchanges of goods and slaves were formerly common between these two regions, but, at the end of XIX century, the borders and barriers traced by the European colonization weakened and eventually severed this traditional commercial and cultural connection. At the end of the XX century, the ancient tracks connecting Western with Northern Africa started to be used again, by the migrants coming from Sub-Saharan countries and heading towards the Mediterranean (Bredeloup and Pliez 2011; Fargues 2009; de Haas 2008; Collyer 2007; Balwin-Edwards 2006; Adepoju 2005; Bensaad 2003; Pliez 2000). It is still unclear whether this type of movement is a transit towards Europe, or a migration directed towards Northern Africa: in all cases, since the beginning of the '90s, that is since Libya first opened its borders to this type of migration, a new migration system between Sub-Saharan and North Africa has taken shape (de Haas 2009). This process has coincided with some important transformations in the two other migration systems of the region: from the Maghreb (Mauritania, Morocco, Algeria, Tunisia, and Libya) to Europe, and from the Machrek (especially Egypt) to the Gulf Arab States.

As for the migration system connecting the Maghreb and Europe, since the early '80s, the flows have progressive shifted: originally (in the '60s and '70s) oriented towards France and, perhaps less importantly, towards Belgium and Germany, after the oil crisis of 1973-1974 and the ensuing tightening of admittance policies, these flows were slowly redirected towards Southern Europe, where a large informal sector could still absorb several migrant workers.

As for the Gulf Arab States, the opposite is true: after the rising of oil prices, they started to attract an increasing number of migrants from the Machrek region, Egypt in the first place. This epoch more or less ended in the second part of the '80s, when Egyptian migrants started to head more and more towards Southern Europe, and especially Italy.

Ultimately, this complex evolution caused the emergence of a new migration system, affecting Sub-Saharan and Western Africa, Maghreb, Egypt and Southern Europe.

In our interpretation, the origin of such new system dates back to the first decade of the XX century, with the beginning of population increase. Unfortunately for our theory, data availability is limited: mortality decline, for instance, has a long and well documented story only in Egypt and Algeria (Fargues 1986). The mortality transition in these two countries probably date back to the second half of XIX century, when the average growth rate of the population was close to 10‰ (practically the same as in several European populations in the same epoch). In the other countries of Northern Africa, mortality started to decline later, probably in the 1920s (Fargues 1986). In Sub-Saharan states reliable data on mortality exist normally only after WWII, but in most of these countries the onset of the mortality transition had already taken place by then (Tabutin and Schoumaker 2004: 532-533). Besides, historical research suggests that population growth rates in Western African started to increase already in the 1920s (Biraben 2003; Cordell 2001; Tabutin and Schoumaker 2004: 529). In short, we will assume that mortality in Western Africa started to decline between the 1920s and WWII.

The second important demographic event of this region is the beginning of urbanization. In both Northern and Western Africa, the cities started to increase in the 1920s (although with a temporary interruption in the 1930s). After the political troubles of the 1950s (Independence), the rural exodus resumed and continued through the 1980s (Strenand and Halfani 2001: 467; Fargues 1995; Sabatello 1990; Sahli 1990;

Awad 1964). The expansion of cities was strongly linked to the process of decolonization, with the increasing importance of new bureaucracies and new urban economic activities. This process continued during all the 1960s and the 1970s, but it halted in the 1980s (Becker and Morrison 1988), probably because of the debt crisis of the epoch and the ensuing World Bank-sponsored structural adjustment programs (Becker and Morrison 1999: 1718), that cut down public spending. Rural-urban migration has considerably slowed down since then, or even reversed, as in Cote d'Ivoire and Burkina Faso (Henry et al. 2004; Beauchemin 2005).

As for international migration towards Europe, it started in the early '60s from Northern Africa, and somewhat later from Western Africa, in the early '90s. Between the '50s and the '80s, Western Africa has nonetheless witnessed a significant regional mobility, especially along a North-South direction, from the Sahel region (Burkina Faso, Mali, Niger) to the Atlantic coast (Ghana, Senegal, Cote d'Ivoire, Nigeria). However, the destinations of these regional flows have changed repeatedly in the past fifty years (Adepoju 2008; Adepoju et al. 2008), and it is not clear if they should be interpreted as international migration or internal (circular?) mobility, favored by the high porosity of the borders of the region.

The fourth, and last, important demographic change in the region is the onset of the fertility transition, between the '70s and the '90s, with Western Africa starting somewhat later than Northern Africa. In the 1960's, the total fertility rate in all the Northern African Countries still oscillated between 7 and 8 children per woman. Then, in 1965-1970, Tunisia and Egypt experienced their fertility transition, (Eltigani 2001; Rashad 2000; Courbage 1999; Fargues 2000, 1989, 1986), but with a different path. In Tunisia, it stalled briefly (at the beginning of the 70s) and then proceeded regularly, so that Tunisia appears today as a leader in the region. In Egypt, instead, a sudden reversal in fertility trends took place in the '70s, and it is not until the second part of the '80s that a new phase of fertility decline takes place. Morocco was the third Northern African country that entered the phase of the fertility transition, in 1970-75 (Courbage 1999), followed by Algeria and Libya in the second half of the '80s.

As for the fertility transition, Western Africa can be subdivided into two major areas. Fertility in the coastal region (Ghana first, and then Senegal, Nigeria, Cote d'Ivoire, Nigeria) started to decline in the early '90s. (Montgomery and Cohen 1998:13). In contrast, fertility is still very high in the more internal regions of the Sahel strip (Mali, Niger, Burkina Faso): crude birth rates are still close to 45-50‰, while the crude mortality rate has generally already fallen below 20‰ (Tabutin and Schoumaker 2004: 532-533).

Of course, there is also a lag in the onset of fertility transition between rural and urban populations. This lag is normally of about 10 years (Garenne and Joseph 2002) but it can be longer in some cases, as, for instance, in Ghana and Togo (25 years of lag).

What does this chronology suggest? In our view, the following general, very schematic, pattern of adjustments to population growth: first, rural-urban migration; then, outmigration and, somewhat later, fertility decline. With some caution, and allowing for some overlapping, these three phases seem to us to catch the essentials of the process, as we will try to show in the next pages.

3. The data and the model

We want to test the effects of population growth on international migration in several countries from various regions: Southern Europe (5 countries: Spain, France, Italy, Greece and Portugal), Northern Africa

(4: Morocco, Algeria, Tunisia, Egypt) and Western Africa (8: Senegal, Mali, Côte d'Ivoire, Burkina Faso, Ghana, Benin, Nigeria, Cameroon). Because of limitations in data availability and quality (especially in Western African), our analysis cannot span more than 35 years, from 1970 to 2005. This is not bad with respect to the length of the periods covered in most migration studies, but it is still barely sufficient in our case, since we want to test the effect on migration of the lagged values (- 15 years) of the natural increase of populations.

Our regression models, with fixed effects and lagged variables, are applied to the quinquennial demographic series of net migration rate, urban agglomeration growth and natural increase, as estimated by the UN World Population Prospects (2008) and World Urban Prospect (2009). Economic time series of GDP (Maddison 2004), educational levels (World Bank 2009), land productivity (FAO 2009), refugees and asylum seekers (UNHCR 2009) are also included in the analysis.

Our data are unfortunately far from perfect. The estimates produced by the Population Division, for instance, are of three types: 1) the data of the developed countries are based solely on official statistics produced by the national statistic offices; 2) for less developed regions, estimates are frequently based on indirect estimation and models; 3) in some rare cases, when no (reliable) data are available, the estimates are based on the demographic evolution of countries with "similar socio-economic profile". The second strategy applies to the African countries considered in this paper, and to the best of our knowledge, there is no way of measuring the bias introduced by the UN procedures (see also Reher 2004).

The rate of net migration, our dependent variable, has been calculated by the Population Division by difference: total population growth minus natural population increase. The notion of net migration has been harshly criticized e.g. by Rogers (1990), but in practice researchers have continued to refer to it (Jennissen 2003), in part because alternatives are sometime not available and in part because this variable seems to us to make sense at the aggregate (not individual) level. Its main shortcoming is that it is obtained by difference, and it therefore incorporates all possible measurement errors. Its main advantage is that it allows us to cover a longer time span, which is essential for our analysis.

In our model there are 6 different sets of independent variables (see Table 1 for further details):

- $N_{t-15,c}$ indicates the mean lagged value of natural increase during the period t-15—t-20 in a country C. The coefficient α of this variable is of central interest for our analysis: we expect it to be negative in case of net migration (a strong natural increase today leads to outmigration tomorrow).

- $I_{t,c,i}$, i.e. the potential *inhibitors*, are supposed to inhibit the effects arising from natural growth on migration. In the present analysis we consider five such inhibitors: 1) increasing per capita food supply; 2) increasing per capita arable land; 3) Increasing number of tractors (a proxy for agricultural mechanization); 4) urbanization; 5) Per capita GDP growth.

- $N_{t-k,c} \times I_{t,c,i}$ are the *interactions* between alternative responses to population growth. The problem of interactions was tackled by cross multiplying the inhibitors with population growth. The general idea behind this procedure is that the interaction terms can capture the interplay between population growth and agricultural development. Suppose, for instance, that the extension of the overall arable land $L_{t,c}$ reduces the effect of current population growth on international migration $M_{t,c}$. The proper regression model could be, for instance,

$$M_{t,c} = \beta_0 + \beta_1 N_{t-k,c} + \beta_2 L + \beta_3 (N_{t-k,c} \times L_{t,c}) + \epsilon_{t,c}$$

The terms of this equation can then be rearranged as follow:

$$\mathrm{M}_{\mathrm{t,c}} = \beta_0 + (\boldsymbol{\beta_1}+\boldsymbol{\beta_3}\mathbf{L_{t,c}}) \times \mathbf{N_{t-k,c}} + \beta_2 L + \epsilon_{\mathrm{t,c}}$$

in order to show that an increase in per capita land ($\mathrm{L}_{\mathrm{t,c}}$) can reduce the effect of population increase on emigration if the coefficient β_3 is negative.

In this framework, the coefficient β_1 indicates the effect produced by population growth (N) only when per capita land growth (L) is 0. More in general, the marginal effect of natural increase can be calculated as:

$$\frac{\partial M}{\partial N} = \beta_1 + \beta_3 L$$

And the standard error of this marginal effect can be estimated as:

$$\hat{\sigma}_{\frac{\partial M}{\partial N}} = \sqrt{var(\hat{\beta}_1) + L^2 var(\hat{\beta}_3) + 2Lcov(\hat{\beta}_1 \hat{\beta}_3)}$$

This applies to the case in which the model has only one interaction term. With multiple interaction, as in our model, the formulas become more complicate (Braumoeller 2004; Brambor et al. 2006).

- $E_{t,c,j}$ are the *economic variable*. These are, in principle, the variables customarily included in econometric models (e.g. GDP per capita or GDPpc, GDPpc^2, GDPpc growth, Exports growth and Education growth, etc.). However, because of collinearity, after various attempts we eventually decided to retain only GDPpc.

- $P_{t,c}$ stand for *political tension*. Basically, we have added to the model two further variables, the share of refugees and the share of asylum seekers on total population, in order to take into account the effect produced on migration by a political crisis in neighboring countries.

- Finally, we have inserted in the model an AR(1) correction for the presence of *serial correlation* in the residuals, in order to identify possible processes of chain migration.

Ultimately our models of international migration can be formalized through eq. 1:

Table 1. Description of the variables employed in the model

Classification	Variable	Description	Source
Dependent variable	$M_{t,c}$	Mean rate of net migration in country *c* during the period *t, t+5*. Rate of net migration = population growth - natural increase.	World Population Prospects
Key independent variable	$N_{t-15,c}$	Mean rate of natural increase in country *c* during the period *t-15, t-20*. Difference between gross birth rate and gross death rate	World Population Prospects
Inhibitors ($I_{t,c}$)	$F_{t,c}$	Per capita daily Food supply growth. Growth in the number of kilocalories per day per individual during the period t, t+5	FAO
	$L_{t,c}$	Per capita arable land permanent crops growth. Growth in the ratio between total arable land and rural population during the period t, t+5	FAO
	$T_{t,c}$	Growth in the number of tractors during the period t, t+5	FAO
	$U_{t,c}$	Growth in the proportion of population living in urban agglomerations during the period t, t+5. Urban agglomeration “refers to the de facto population contained within the contours of a contiguous territory inhabited at urban density levels without regard to administrative boundaries”	World Urban Prospect
Interactions ($N_{t,c}$ x $I_{t,c}$)	$N_{t,c}$ x $F_{t,c}$	Rate of natural increase times per capita daily Food supply growth	/
	$N_{t,c}$ x $L_{t,c}$	Rate of natural increase times per capita arable land permanent crops growth	/
	$N_{t,c}$ x $T_{t,c}$	Rate of natural increase times growth in the number of tractors	/
	$N_{t,c}$ x $U_{t,c}$	Rate of natural increase times growth in the proportion of population living in urban agglomerations	/
Economic ($E_{t,c}$)	$GDPpc_{t,c}$	Per capita GDP	Maddison
	ΔGDPpc	Per capita GDP growth	Maddison
Political tensions ($P_{t,c}$)	$R_{t,c}$	Mean rate of refugees during the period t, t+5.	UNHCR
	$A_{t,c}$	Mean rate of asylum seekers during the period t, t+5	UNHCR

1) $\ln(M_{t,c}) = \alpha N_{t-k,c} + \sum_i \beta_i \Delta I_{t,c,i} + \sum_k \theta_k (N_{t-k,c} \times I_{t,c,k}) + \sum_j \gamma_j E_{t,c,j} + \theta P_{t,c} + \epsilon_{t,c}$

where M stands for net migration.

4. Interactions matter

Our reconstitution of the principal phases of the demographic evolution in Northern and Western Africa allows us to identify an important inconsistency in the theory linking population increase and migration: both these regions indeed knew an early onset of mortality transition, between the 1920s and WWII (and even earlier in Egypt and Algeria), but migration outflows have generalized only after the 1960s in Northern Africa and after the 1990s in Western Africa. We can thus argue that migration flows are absent during the epoch of more intense population growth and started to increase roughly in coincidence with the onset of the fertility transition, that is when population increase slows down.

The hypothesis that we want to test in this paragraph is that the timing of the process of mass migration in Northern and Western Africa can be explained by the action of some forces that have inhibited for several decades the effect of population growth on international migration. In order to test this hypothesis we will first present an analysis in which the connection between population increase and net migration is tested without taking into account the interactions with our "inhibitors" (see Table 1). After that, a second analysis will follow that includes the interactions between population increase and the inhibitors. The comparison between the two should reveal how relevant the inhibitors are.

Table 2 presents the estimates of three different models *not including any interaction term*. These models attempt to investigate the link between natural increase and net migration from three different perspectives: the first one has been estimated through the so called *between estimator* and thus analyzes the cross-sectional variability of our sample. The second one is a *pooled model* in which both the cross-sectional and the longitudinal variability of our sample are simultaneously taken into account. The third one was estimated through the so called *within estimator* and thus focuses only on the longitudinal variability of our sample.

Whatever the perspective adopted to look at the phenomenon (cross-sectional, pooled, longitudinal), the conclusion presented by our first three models is always the same: population increase reduce emigration. The coefficient associated with natural increase is however significant only in the pooled and in the longitudinal analysis. As we have already seen, this conclusion is consistent with the results of our previous analysis on the timing of mass migration in this area.

Table 2. The link between natural increase and migration without considering interactions

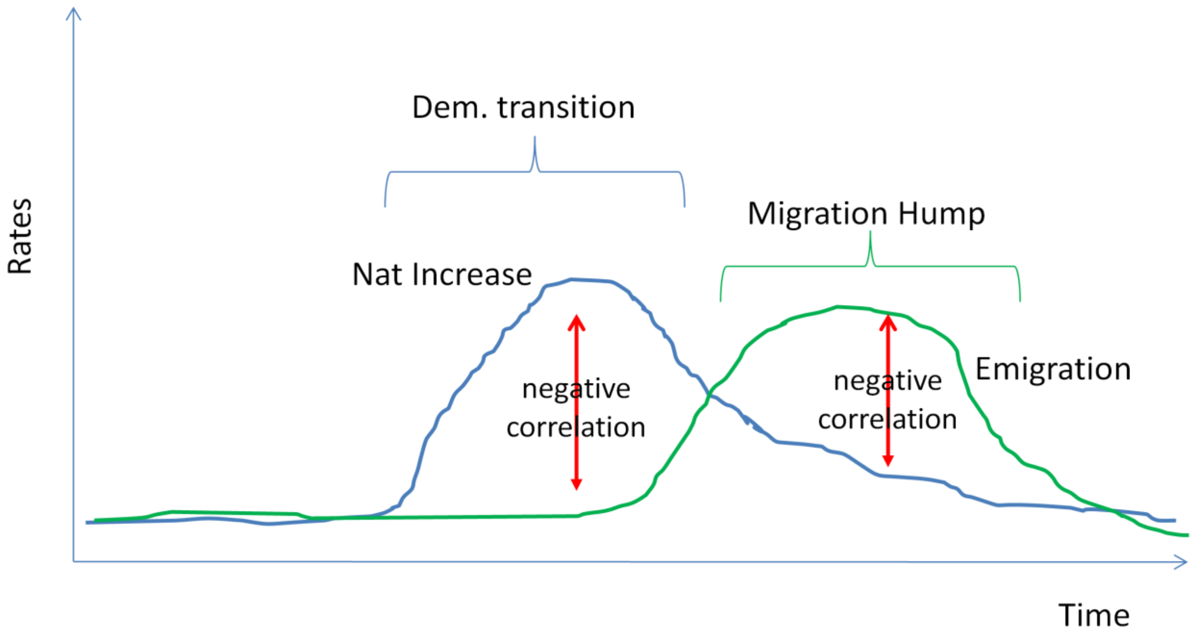
	Between	Pooled		Within	
	Dependent variable: log(Net Migr Rate + 1)				
Variables	Coeff.	Coeff.		Coeff.	
Intercept	0.003624	-0.00334	**		
NI_{t-15}	**2.59E-05**	**0.000165**	·	**0.000222**	*
U(rbanization)	-0.00069	0.006845	*	0.00652	*
GDPcp	3.04E-07	6.72E-07	*	6.57E-07	*
ΔGDPcp	-0.01652	-0.00363	·	-0.00205	
F(ood)	-0.03852	-1.98E-05		0.000109	
L(and)	-0.00242	-0.00068		8.48E-05	
T(ractors)	-0.00017	6.97E-05		2.56E-05	
R(efugees)		-0.00032		-0.00023	
A(sylum)		0.000122	·	1.97E-05	
AR(1)		0.893	***	0.575*	
N observations	17	119		119	
Log Likelihood	35.62	549.42		571.57	

+ The fixed effects models (within estimator) were estimated trough generalized least squares and log-likelihood maximization. The serial correlation structure was modeled trough a first order autoregressive process AR(1).

++. Three dummy variables were added to the "pooled" and the "within" model: Spain 2000; Greece 1995; Greece 1990; Cote d'Ivoire 2000.

+++The stars indicates different degree of significance: · <0.1; * < 0.05 ; ** < 0.01; *** < 0.001

Figure 1. General relationship between demographic and migratory transition (without interactions)



In Figure 2 we have tried to represent schematically the reason why the relationship between population increase and migration has a negative sign, contrary to what Easterlin's (1961) theory predicts: the reason is that the time lag between the onset of the mortality transition and the onset of the migration hump is by far too long to be explained by a lagged effect of population growth on emigration.

The introduction of the interactions terms in the model produces some major changes in the understanding of the phenomenon. In Table 3 we show the results of two different estimations of the same *interaction model*: the first model has been estimated on the original series of our data set. In this first model, therefore, the coefficient associated with natural increase reflects the effect of population growth on migration when the inhibitors are all equal to zero. This means that the first model describes a condition in which no urbanization process is occurring and population growth doesn't produce any decrease in per capita land availability or per capita food supply. In this rather unusual condition the coefficient associated to natural increase is negative (population growth fosters emigration) but not significant. This result may be simply summarized by saying that if population increase is compensated by a parallel growth in land and food, no significant effect can be detected on emigration.

The second model of Table 3 was estimated after adding a constant to some of the original series of our data set. Basically we added the value of 0.1 to each value of our series concerning the growth in food supply and in arable land. In this way when the new transformed series show a value equal to zero, this means in reality that food supply growth or arable land growth have undergone a decrease of 10 % during a given quinquennium. Because the coefficient associated with natural increase describes the effect of population growth on migration when the inhibitors are equal to zero, we are now able (thanks to the transformation of our series) to assess the effects of population growth on migration when food supply growth and arable land growth are not fully compensating population increase: Under these new conditions the effect of population increase on international migration is negative and significant.

It is worth noticing that the transformation of our series produces a change only in the degree of significance of the coefficient on natural increase, but leaves the other parameters of the model unchanged. This means that the two estimates in Table 3 have actually been produced by the same model that has been employed to describe two different facets of the same multidimensional problem.

Only three up to five inhibitors considered in our model turn out to be significant: food supply growth, arable land growth and urbanization. Our estimates show that all these variables significantly reduce the effect of population growth on international migration. We now want to investigate in a more systematic way the effect produced by different combinations of these variables in order to assess what are the scenarios in which population growth can trigger international migration. In Figure 2 we have attempted to show the results of such analysis.

The two panels of Figure 2 show the marginal effect of population growth on international migration for different values of arable land growth, food supply growth and urbanization. In each panel, the oblique plan indicates the marginal effect of population growth on international migration for any given value of urbanization. In each oblique plan the negative values (positive effect on emigration) have been highlighted in red while the positive ones have been colored in blue. We used, moreover, darker colors in order to highlight those points on the plane significant at a 5% or at a 1% threshold. In order to facilitate the reading of the graphics we also projected on the floor of each graph in different grey scales the degree of significance of the estimated coefficients.

Two main conclusions emerge from Figure 2:

- without a significant reduction in land and food availability population growth doesn’t produce any significant effect on international migration.
- even in case of a significant reduction in land and food availability urbanization may counter the process of international migration by absorbing the bulk of rural exodus.

We believe that these two features may explain much of what has been observed in international migration in Northern and Western Africa.

Initially, from the 1950s through the 1970s, urbanization was very strong in all Africa. During this phase the extension of arable land and of rural productivity likely reduced the effects of population growth on migration, while cities intercepted the largest fraction of rural mobility. The 1980s constituted however a turning point in this evolution because the saturation of urban spaces, the debt crisis and the ensuing structural adjustment programs eventually halted urbanization. The different panels of Figure 2 help us understand what effects may stem from the sudden interruption of urbanization in a condition of rapid population growth: the switch from rural-urban to international migration flows. In short: the long lag between the onset of the mortality transition and the migration hump may be justified by the inhibiting role exerted by urbanization between 1950 and 1980. And, later on, the upsurge of a mass migration from Western Africa to Northern Africa dating back to the 90s may be explained by the interruption of urbanization following the debt crisis and the structural adjustment programs.

Table 3. The link between natural increase and migration including interactions

Within + Interactions			**Within + Interactions** Variables have been re-centered		
Variables	Coeff.		Variables	Coeff.	
NI_{t-15}	**-4.70E-05**		**NI_{t-15}**	**-0.00036**	*
U(rbanization)	0.011494	**	U(rbanization)	0.011494	**
GDPcp	2.94E-07		GDPpc	2.94E-07	
ΔGDPcp	-0.0043		ΔGDPpc **- 0.1**	-0.0043	
F(ood)	0.0089	*	F(ood) **+ 0.1**	0.0089	*
L(and)	0.006342	·	L(and) **+ 0.1**	0.006342	·
T(ractors)	-0.00068		T(ractors) **- 0.15**	-0.00068	
R(efugees)	-0.00028		R(efugees)	-0.00028	
A(sylum)	6.20E-06		A(sylum)	6.20E-06	
NI_{t-15}: F(ood)	**0.002134**	***	**NI_{t-15} : (F(ood) + 0.1)**	**0.002134**	***
NI_{t-15}: U(rbanization)	**0.001065**	**	**NI_{t-15} : U(rbanization)**	**0.001065**	**
NI_{t-15}: L(and)	**0.000975**	**	**NI_{t-15} : (L(and) + 0.1)**	**0.000975**	**
NI_{t-15}: T(ractors)	**-0.00018**		**NI_{t-15} : (T(ractors) -0.15)**	**-0.00018**	
NI_{t-15}: ΔGDPcp	**-0.00021**		**NI_{t-15} : (ΔGDPpc - 0.1)**	**-0.00021**	
AR(1)	0.023			0.023	
N observations	119			119	
Log Likelihood	596.03			596.03	

+ The fixed effects models (within estimator) were estimated trough generalized least squares and log-likelihood maximization. The serial correlation structure was modeled trough a first order autoregressive process AR(1).

++. Three dummy variables were added to the model: Spain 2000; Greece 1995; Greece 1990; Cote d'Ivoire 2000.

The stars indicates different degree of significance: · <0.1; * < 0.05 ; ** < 0.01; *** < 0.001

Figure 2. Marginal effect of population growth on international migration under different scenarios

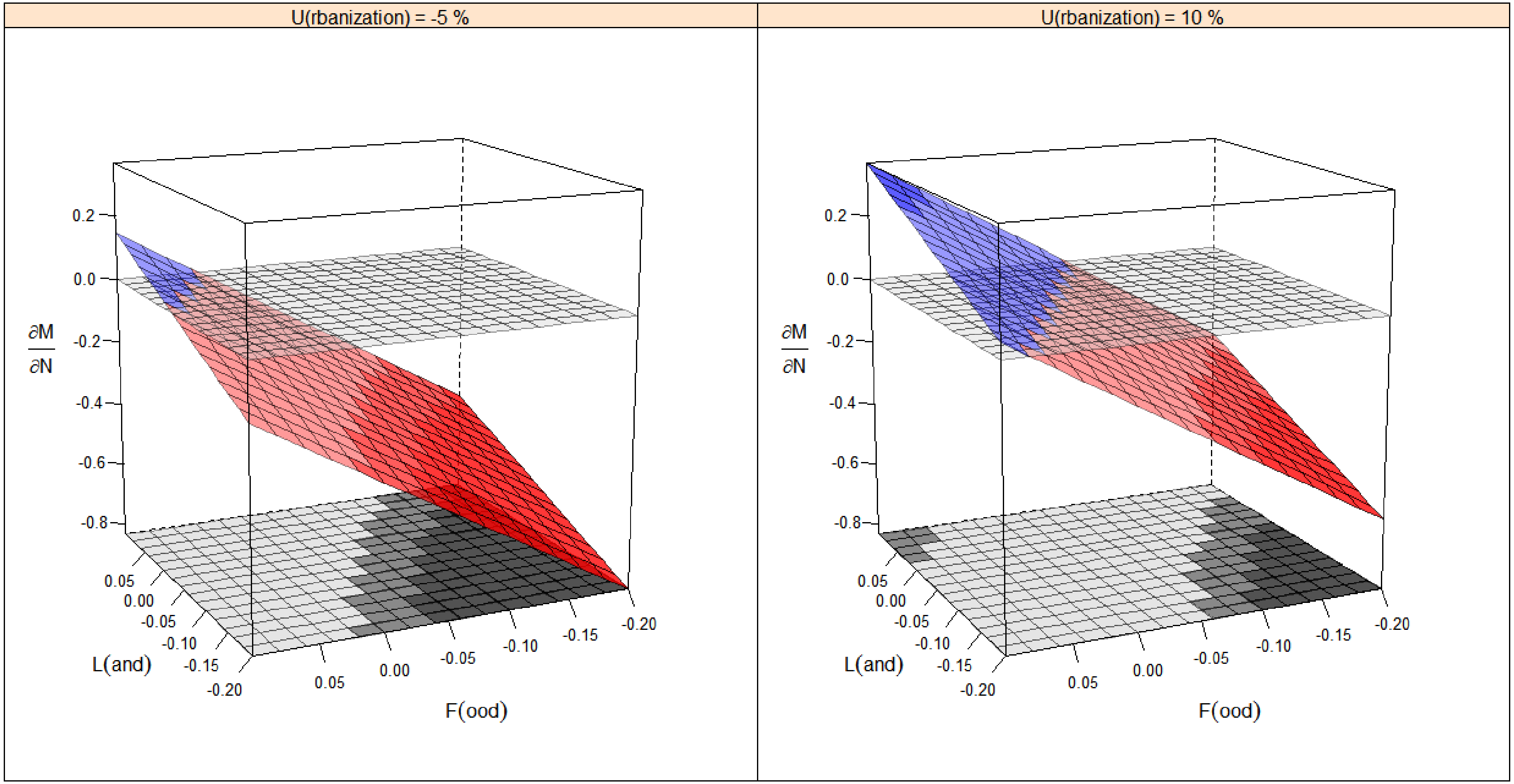
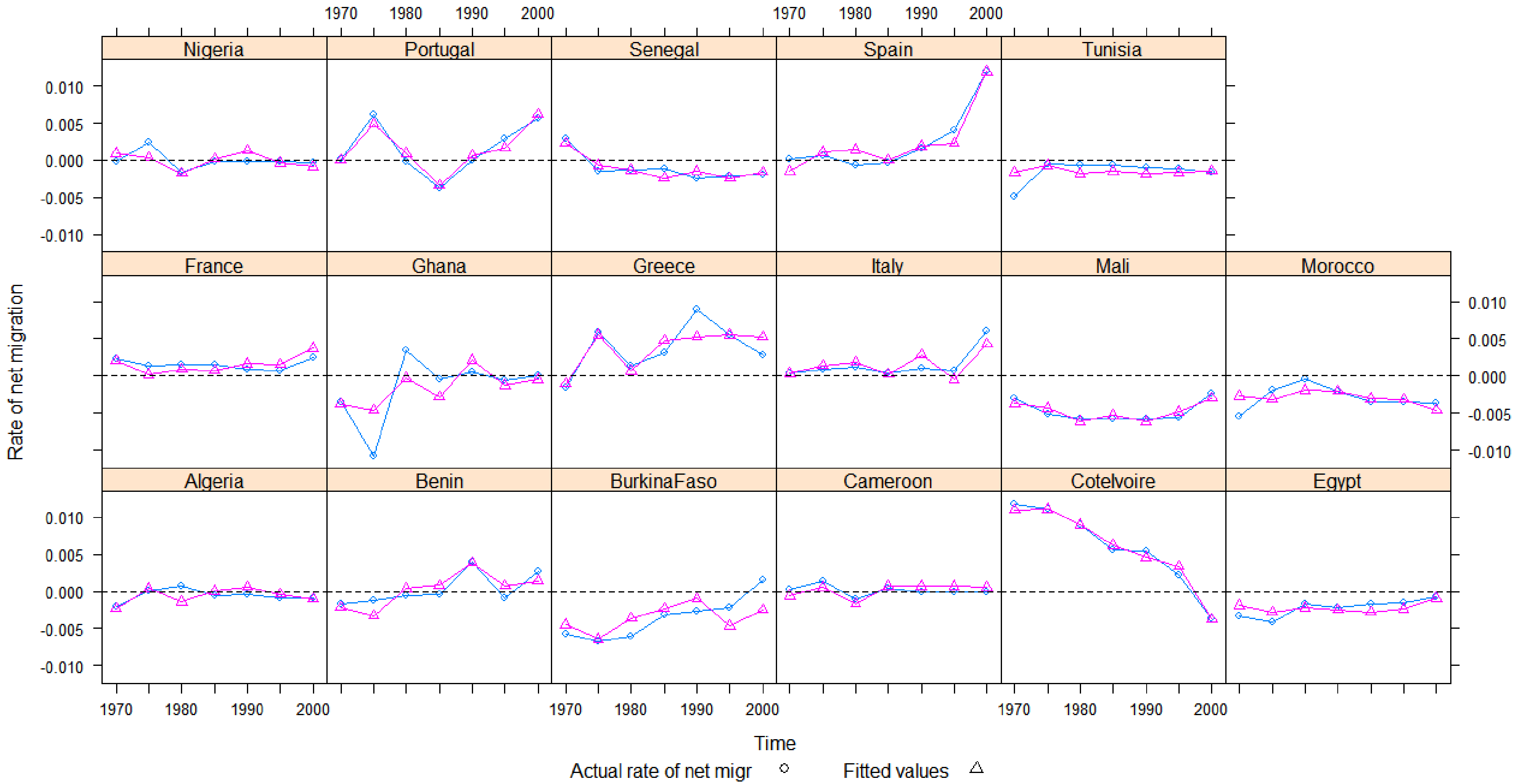


Figure 3. Actual and predicted values of net migration rate



In Figure 3 we show that our full model (with interactions) predicts satisfactorily the dynamic of net migration in the region under scrutiny in the past 35 years. We have tested the robustness of the interaction model by changing the extent of the period covered by our analysis, by excluding the countries belonging to Southern Europe, and by changing the lag with which natural increase is supposed to affect international migration (none of which is shown here). We found that only when the analysis is limited to a very short time period (less than 15 years) all coefficients lose their significance. In all other cases, the coefficients preserve their sign and their degree of significance.

5. Conclusions

In our paper we have tried to investigate the role of population growth on migration. We have suggested in the beginning that the highly contradictory results yielded by the previous researches on this topic stemmed by two main reasons: 1) the underestimation of the long-term determinants of migration caused by the lack of long time series and; 2) the omission of the interactions between different responses to population growth.

Our analysis has tried to employ the longest time series available, that of net migration rate, and to focus on a migratory system whose formation was relatively recent, the trans-Saharan system. As a consequence of the particular experiment design that we have adopted, population growth resulted as one of the most important determinant of migration among those covered by our analysis.

The emergence of population growth as the fundamental force at stake was allowed, ultimately, by the identification of a set of determinants whose role was that of inhibiting the effect of population growth on migration. To these forces we likely owe the specific trend that the migration hump assumes in the different contexts. The complex interactions between the responses triggered by population growth seems therefore to offer an explication also for the stall, the resistances, the acceleration and the different temporal extension characterizing this phenomenon.

References

Adepoju A. (2004). Trends in International Migration in and from Africa. In D. Massey and J. E. Taylor (eds), *International Migration: Prospects and Policies in a Global Market*, Oxford, Oxfrod University Press.

Adepoju A. (2005). *Migration in West Africa*. Paper prepared for the Policy Analysis and Research Programme of the Global Commission on International Migration.

Adepoju A. (2008). Migration in Sub-Saharan Africa. *Current African Issues*, 37:1-36.

Adepoju A., van Naerssen T. and Zoomers A. (2008). *International Migration and National Development in Sub-Saharan Africa. Viewpoints and Policy Initiatives in the Countries of Origin*, Brill, Leiden and Boston.

Awad, H. (1964). Morocco's Expanding Towns. *The Geographical Journal*, 130(1):44-64.

Baldwin-Edwards, M. (2006). 'Beetwen a Rock and a Hard Place': North Africa as a Region of Emigration, Immigration and Transit Migration. *Review of African Political Economy*, 33(108):311-324.

Bauchemin, C. (2005), Pour une relecture des tendances migratoires entre villes et campagnes: une étude comparé Burkina Faso-Cote d'Ivoire. *African Population Studies*, 20(1) :141-165.

Becker C. and Morrison R. (1988). The Determinants of Urban Population Growth in Sub-Saharan Africa. *Economic Development and Cultural Change*, 36(2):259-278.

Becker C. and Morrison A. (1999). Urbanization in transforming economies. In pp. 1675-1768. In Cheshire, P. and Mills E.S. (ed.), *Handbook of Regional and Urban Economics*, Elsevier.

Bean, F., Harley L. B. and W. Parker Frisbie (1990), Post IRCA Changes in the volume and composition of undocumented migration to the United States: an assessment based on apprehensions data. In Bean and others (eds), *Undocumented Migration to the United States: IRCA and the Experience of the 1980s*, Urban Institute Press, Washington, DC pp. 111-159.

Bensaad, A. (2008), Les migrations subsahariennes en Algérie, Robert Schuman Centre for Advanced Studies, Carim Rapports de recherce 01.

Bensaad, A. (2003). Agadez, Carrefour migratoire sahélo-maghrébin. *Revue Européenne des Migrations Internationales*, 19(1) :7-28.

Biraben, J-N. (2003). L'évolution du nombre des hommes. *Population et Sociétés*, vol. 339.

Boserup, E. (1965). *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure*, London, Aldine.

Braumoller B. F. (2004), Hypothesis Testing and Multiplicative interaction Terms. *International Organization* 58(3):807-820.

Brambor T., Clark W. R. and Golder M. (2006), Understanding Interaction Models: Improoving Empirical Analyses. *Political Analysis*, 14:63-82.

Bredeloup S. and Pliez O. (2011), The Libyan Migration Corridor, paper prepared for the European project "Improving EU and Us Immigration Systems", European University Institute, forthcoming.

Caldwell, J. C. (1968). Determinants of Rural- Urban Migration in Ghana. *Population Studies*, 22(3):361-377.

Chesnais J. C. (1992). *The Demographic Transition: Stages, Patterns and Economic Implications: A Longitudinal Study of Sixty-Seven Countries Covering the Period 1720-1984*, Oxford, Clarendon Press.

Clark, X., Hatton T. J. and Williamson, G. (2007). Explaining U.S. Immigration, 1971-1998. *The Review of Economics and Statistics*, 89(2):359-373.

Collyer, M. (2007). In-Between Places: Trans-Saharn Transit Migrants in Morocco and the Fragmented Journey to Europe. *Antipode*, 2007.

Cordell, D. (2001). Population and demographic dynamics in Sub-Saharan Africa in the Second Millennium. In IUSSP, *The History of Population in the Second Millennium*, Florence.

Cohen, B. (2003). Urban Growth in Developing Countries: A review of Current Trends and Caution Regarding Existing Forecast. *World Development*, 32(1):23-51.

Courbage Y. (1999), Economic and Political Issues of Fertility Transition in the Arab World: Answer and Open Questions, *Population and Environment*, Vol. 20, No. 4, pp. 353-380.

Davis, K. (1943), World Population in Transition. *Annales of the American Accademy of Political and Social Science*, 237.

Davis, K. (1963). The Theory of Change and Response in Modern Demographic History, *Population Index*, 29:4, pp. 345-366.

de Haas, H. (2009), Trans-Saharan and Trans-Mediterranean Migration. Questioning the transit hypothesis. Paper presented at the EFS SCSS Exploratory Workshop, Amsterdam, Netherlands, 25-27 October 2009.

de Haas, H. (2008), *Irregular Migration from West Africa to the Maghreb and the European Union. An Overview of Recent Trends*. IOM Migration Research Series n. 32.

de Haas, H. (2007). North African Migration Systems: Evolution, Transformation and Development Linkages. *International Migration Institute* Working Paper n. 6.

Easterlin A. (1961). Influences in European Overseas Emigration before World War I. *Economic Development and Cultural Change*, 9(3):331-351.

Eltigani E. E. (2001). Childbearing in Five Arab Countries. *Studies in Family Planning*, 32(1):17-24.

Faini R. and Venturini, A. (1994a). Migration and Growth: The experience of Southern Europe. Centre for Economic Policy Research Discussion Paper 964, CEPR, London.

Faini R. and Venturini, A. (1994b). Italian Emigration in the Pre-War Period. In Hatton, T. J. and Williamson, J. G. (eds), *Migration and the International Labor Market 1850-1939*, Routledge, London and New York.

FAO (2009). FAOSTAT. http://faostat.fao.org/site/339/default.aspx.

Fargues Ph. (1986), Un siècle de transition démographique en Afrique méditerranéenne 1885-1985, *Population*, 41(2):205-232.

Fargues, Ph. (1989). The Decline of Arab Fertility. *Population: An English Selection*, 44(1):147-175.

Fargues, Ph. (1995). L'urbanisation du monde arabe: un éclairage démographique, http://ema.revues.org/index599.html.

Fargues, Ph. (2000). *Générations Arabes*. *L'alchimie du Nombre*. Paris, Fayard.

Fargues, Ph. (2009). Work, Refuge, Transit: An Emerging Pattern of Irregular Immigration South and East of the Mediterranean. *International Migration Review*, 43(3):544-577.

Garenne, M. and Joseph, V. (2002). The Timing of the Fertility Transition in Sub-Saharan Africa. *World Development*, 30(10):pp.1835-1843.

Hatton, T. J. and Williamson, J. G. (1998). *The Age of Mass Migration*. New York and Oxford, Oxford University Press.

Hatton, T. J. and Williamson, J. G. (1998). Emigration in the long run: evidences from two global centuries. Asian Pacific Economic Litterature.

Henry S., Schoumaker B., Beauchemin C. (2004), The impact of Rainfall on the First Out-Migration: A Multi-level Event-History Analysis in Burkina Faso. *Population and Environment*, 25(5):423-460.

Jennissen, R. (2003). Economic Determinants of Net International Migration in Western Europe. *European Journal of Population* 19:171-198.

Landry, A. (1934). *La Revolution Demographique*, Paris.

Maddison, A. (2004). *Historical Statistics*. www.ggdc.net/Maddison/index.htm.

Massey, D. S. (1988). Economic Development and international Migration in Comparative Perspective. *Population and Development Review*, 14(3):383-413.

Massey, D. S., Arango J., Hugo, G, Kouaouci A., Pellegrino A. and Taylor E. (1998). *Worlds in Motion. Understanding International Migration at the End of the Millenium*, Oxford, Claredon Press.

Massey, D. S. (2003). *Patterns and Processes International Migration in the 21st Century*. Paper presented for the Conference on African Migration in Comparative Perspective, Johannesburg, South-Africa, 4-7 June, 2003.

Mayda, A. M. (2009). International Migration: a panel data analysis of the determinants of bilateral flows. *Journal of Population Economics* 23:1249-1274.

Malmberg, B. (2006). The Boom and Bust of Net Migration? A 40 years Forecast. In Tamas K. and Palme, J. (ed.). *Globalizing Migration Regimes*. Ashgate, Burlignton.

Montgomery, M. R. and Cohen, B. (1998). *From Death to Birth*. National Academy Press, Washington.

Notestein, F. (1945), Population: The Long view. In T. Schultz (ed.), *Food for the World*, Chicago, 1945, pp. 36-57.

Pasquali, G. (1934). *Storia della tradizione e critica del testo*. Firenze, Le Lettere.

Pliez O. (2000), Le Sahara libyen dans les nouvelles configurations migratoires. *Revue Européenne de migrations internationales*, 16(3) :165-181.

Reher, D. (2004). The Demographic Transition Revisited as a Global Process. *Population, Space and Place*, 10:19-41.

Rashad H. (2000), Demographic Transition in Arab Countries, *Journal of Population Research*, 17(1):83-97.

Rogers, A. (1990). Requiem for the net migrant. *Geographical Analysis*, 22:283-300.

Sabatello, E. F. (1990). Croissance démographique et urbanisation au Maghreb et dans la Péninsule Arabique. In AIDELF, *Croissance Démographique et Urbanisation : Politique de Peuplement et aménagement du territoire*, Seminaire International de Rabat 15-17 mai 1990.

Sahli, A.-M. (1990), Alger : evolution, revolution et permanence. In AIDELF, *Croissance Démographique et Urbanisation : Politique de Peuplement et aménagement du territoire*, Seminaire International de Rabat 15-17 mai 1990.

Skeldon, R. (1997). *Migration and Development: A Global Perspective*. Essex, Longman.

Stark O. and Lucas R. B. (1988). Migration, Remittances and the Family. *Economic Development and Cultural Change* 36(3):465-481.

Stren R. and Halfani M. (2001). The cities of Sub-Saharan Africa: From Dependency to Marginality. In Paddison R. (ed.), *Handbook of Urban Studies*, SAGE, London, pp. 466-485.

Tabutin, D. and Schoumaker B. (2004). La démographie de l'Afrique au sud du Sahara des années 1950 aux années 2000. Synthèse des changements et bilan statistique. *Population* 59(3/4):521-621.

Thomas, B. (1954). *Migration and Economic Growth*. London, Cambridge University Press.

Thompson, W. S. (1929). Population. *American Journal of Sociology*, 34 :959-975.

UNHCR (2009). UNHCR Statistical Online Population Database. http://www.unhcr.org/49c3646c4d6.html.

United Nations (2008). *World Population Prospects: The 2008 Revision*. New York, United Nations. (www.un.org./esa/population/).

United Nations (2009). *World Urbanization Prospects: The 2009 Revision*. New York, United Nations. (www.un.org./esa/population/).

World Bank (2009). World Development Indicators. http://data.worldbank.org/indicator.

Zelinsky, Z. (1971). The Hypothesis of the Mobility Transition. *Geographical Review* 61:219-249.

Zlotnik, H. (2004). Population Growth and International Migration. in D. Massey and J. E. Taylor (eds), *International Migration: Prospects and Policies in a Global Market*, Oxford, Oxfrod University Press.