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一橋通雙方：以社會成本與不完全信息討論雙邊移民

A Bridge Goes Both Ways: A Two-Way Migration Model with Social Capital and Incomplete Information

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Forward

When I came to the Economics Department at National Taiwan University after my American undergraduate studies in political science, a friend warned me that studying economics is a lot harder than reading The Economist. He was right. I wish to express my gratitude for the generous time and attention that both teachers and classmates gave me during my studies at NTU. In particular, I would like to thank Professor Hung-Ju Chen for her excellent thesis advising, her reading and commenting on a finite but large number of drafts, her practical advice during my applications to graduate programs, and her arrangement of opportunities for me to make connections in the academic world. This thesis also benefitted from the helpful comments of Professor Hung-Jen Wang, Professor Been-Lon Chen, Professor Jang-Ting Guo, Professor David de la Croix, and Petek Jinkins. The usual disclaimer applies.

摘要

有關移民與社會成本的過往文獻對於雙邊移民的了解不夠深刻。本文之貢獻於用風險趨避與不完全信息建構一個同時具有雙邊移民與重返移民的模型。此模型的基本概念係社會網絡和信息的關係。社會網絡越大，討厭風險的個人對異國薪水的信息越完整。較完整的信息助於降低風險，讓個人更有可能選擇移民。本模型以個人對異國薪水猜測的分配和信心調整風險。在數字分析內本模型每期都具有雙邊移民和重返移民。

關鍵詞：移民，社會網絡，風險趨避，重返移民，雙邊移民

Abstract

The literature on social capital and migration has not given adequate attention to two-way migration. This paper shows that by using the concepts of incomplete information and risk aversion to model social capital, we can get both two-way and return migration. The basic idea behind the model is that as networks grow, risk-averse individuals have better information about foreign wages. Better information mitigates risk, which makes individuals more likely to migrate. Risk is modeled by adjusting the distribution and confidence individuals have in their guesses about foreign wages. In a numerical analysis the model exhibits both two-way and return migration in every period.

Keywords: migration, social network, risk aversion, return migration, two-way migration

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A Bridge Goes Both Ways: A Two-Way Migration Model with Social Capital and Incomplete Information

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1. Introduction

The ease and safety of travel in the modern world has led to a steep increase in migration. In 1271, it took Marco Polo three and a half years to travel from Venice to Beijing. In 1852, a clipper ship named Marco Polo was the first to circumnavigate the globe in less than six months. Today one can wake up in the same Venice neighborhood in which Marco Polo was born and fall asleep in Beijing. Migration continues to follow its upward trend. Table 1 shows that all major OECD countries saw an increase in foreign born population between 1997 and 2006, and all except Mexico saw an increase in foreign-born population as a percentage of total population. The foreign born populations in Spain, Ireland, and the Slovak Republic more than doubled over this period.

Moreover, modern migration is more complex than early theorists anticipated. Migration is not only from less developed to more developed countries as simple models would suggest. Most countries are both source and host countries at the same time. Figure 1 is compiled using data from the British International Passenger Survey, and shows rough estimates of British born and foreign born migrants to and from Britain. The survey considers a migrant to be an individual with the intent to reside in another country for more than 12 months. This data shows that there is British migration to foreign countries as well as foreign migration to Britain each year. A second phenomenon visible in Figure 1 is return migration. Every year some British born move both to and from each location, and some people born in each location move both to and from Britain. Dustmann et al. (1996) presents data showing return migration in several European countries, which I have included as Figure 2. To be clear about terminology that has not been consistent in previous literature, in what follows two-way migration will refer to simultaneous population exchange of natives of two different countries. Return migration will refer to natives return to their country of origin.

Although two-way migration is an empirically observable phenomenon, it has largely been ignored in the theoretical literature. Many well-known theoretical studies of migration focus on individual migration decisions in source countries or areas (Sjaastad (1962), Todaro (1969), Stark and Levhari

(1982), Stark and Taylor (1991)). Other important studies focus on the effects of migration on source countries (Lucas and Stark (1985), Stark et al. (1997), Beine et. al. (2001)), and still others on migration effects in host countries (Borjas (1994), Chen and Fang (2008)). In recent years return migration has become an area of intense theoretical interest with a number of important papers (Pessino (1989), Stark (1995), Massey (2003), Mushi (2003), Dustmann (2003), etc.). To my knowledge there are only three theoretical studies which contain two-way migration as I have defined it, and then only implicitly. Silvers (1977) creates a static wage maximization model in which individuals with incomplete information make migration decisions, causing some to go from high wage areas to low wage areas. Galor (1985) and Giannetti (2003) create deterministic models in which capital stock and heterogeneous skills respectively can cause two-way migration with low skilled workers moving in one direction and high skilled workers moving in the other.

Over the last decade, researchers have become interested in the relationship between social capital and migration (Carrington et al. (1996), Helmenstein and Yegerov (1998), Singer and Massey (1998), Guzman et al. (2004), Colussi (2008)). The model developed in this paper builds on this literature. In previous literature, social capital has generally referred to the tendency for the costs of migration to fall as the group of migrants living in the host country grows. Instead of costs, however, the model developed in this paper considers the informational aspect of social capital. As the group of migrants living in the host country grows, the information about the host country available in the source country improves. The first contribution of this study is to show that by introducing this informational aspect of social capital along with utility maximization into the wage maximization model of Carrington et al. (1996) we can get both return and two-way migration. Furthermore, when two-way migration is allowed in all periods, equilibrium and transition dynamics are much more volatile than the smooth, monotonic dynamics of Carrington's original model. This aspect of my model provides insight into why real migration movements like those shown in Figure 2 and Figure 2 are so volatile.

My model's second contribution is the development of a new way for social capital to affect the path of migration over time. Specifically, social capital enters the model through increasing the accuracy and confidence of source country individuals' estimates about wages abroad. This idea is a dynamic analogue of that found in the static model of Silvers (1977). This method of modeling social capital is intuitively plausible, as individuals in a source country have incomplete information about potential earnings abroad. If an individual knows someone abroad, however, he will often be able to obtain more accurate information about his own potential wages. If an individual is risk averse, then more complete information will make him more likely to migrate. This method of modeling social capital is distinct from those employed in the previous social capital and migration literature mentioned above.

This paper develops a theoretical framework for migration in which there are two countries, North and South. At the beginning of each period, both Northern and Southern individuals maximize expected lifetime utility by making a decision to either stay where they are or move to the other location. Migration decisions are influenced by wage levels, the cost of migration, individual specific wage guesses, and by uncertainty about foreign wages. The accuracy of guesses increases and uncertainty decreases as more same type individuals move to the opposite location. For example, as more

Southerners move to the North, those Southerners who remain in the South are able to increase the accuracy and lessen the uncertainty of their guesses about Northern wages.

Individuals in the model assume that wages are fixed at the same level as their initial guess which itself might be incorrect. This assumption gives the model volatile dynamics, similar to those found by previous studies involving myopic expectations (Michel and de la Croix (2000), Chen et al. (2008)). Migrants in the real world often have such expectations. It is well known, for instance, that migrants will often take work in a host country that they would consider embarrassing or menial in their home country. Some of the relative deprivation literature has explained this fact by positing that migrants reference themselves to their source country (Massey 1994). I contend that in many cases, the reason migrants engage in work they would not consider in their source country is mistaken expectations. Predictions about opportunities abroad are often not born out upon arrival. Consider the extreme case of a gold rush. Vaught (2007) describes the progression of the great gold rush in California beginning in 1848. When a few prospectors struck it rich, news spread of their success and people from all over the world migrated to California to mine for gold. However, with the passage of time the average returns per miner fell quickly and steadily. Soon prospectors who had given up everything to make the arduous journey to California had to look for other ways to make ends meet upon arrival. This story is consistent with the assumptions made about expectations in this paper. Hearing about the success of the original prospectors, people all over the world expected the gold fields of California to continue to yield up their riches. Upon arrival, these potential prospectors found that the best claims were taken, and there was little money to be made.

Gold rushes provide evidence that migrants may expect wages to stay constant as time passes. There is also evidence that migrants make incorrect estimates about the level of wages and quality of work abroad. The extreme case is that of human trafficking. Sulaimanov (2006) describes a number of ways in which women in the former soviet bloc are led to believe they are going to do standard work abroad. Only upon arrival in a foreign country do these women discover that their only option is low-paid prostitution. Less extreme examples exist as well. McKenzie et al. (2007) conducts an empirical study of Tongans expectations about employment probability and wages in New Zealand, and finds that people generally underestimate in both regards. This is further evidence that the expectations of migrants are inaccurate.

I prove that these incorrect foreign wage guesses give rise to two-way migration in every period. I also show that if an individual with a certain level of risk aversion chooses to migrate, then all things equal an individual with a lower level of risk aversion will also migrate. Similarly, if an individual with a certain level of optimism about foreign wages migrates, all things equal those individuals more optimistic will also migrate. Finally, I show that under certain conditions a positive rate of net migration to one country cannot increase from one period to the next. This is because positive net migration causes wages to fall in the host country and causes wages to rise in the source country. All of these results are what we would intuitively expect.

In a numerical experiment with an explicit functional form, this paper's model exhibits dynamics which are significantly different from those of Carrington's model. As in the real world, there is always migration from both North to South and South to North among natives of both countries. Individuals in both locations migrate in every period, even at equilibrium. Equilibrium can be either stable, or fluctuate between even and odd periods. Perhaps most strikingly, the transition path of Northern and Southern populations is nearly always oscillatory, and some equilibriums exhibit oscillations as well. The oscillatory dynamics of this paper's model have a clear, well documented interpretation as streams and counterstreams of migration. Such counterstreams were first observed by Ravenstein (1867), whose third law of migration is that "each main current [of migration] produces a counter current of feebler strength." One can see waves of migration in the year to year fluctuations exhibited in Figures 1 and 2. Stream and counter-streams have been frequently observed in the literature. Lee (1967) develops the stream counter-stream idea using push and pull factors, and many studies have subsequently discovered similar phenomena (Wardwell and Brown (1980), Vining and Pallone (1982), Fuguitt and Beale (1996), Plane et. al (2005), etc.).

The remainder of this paper will be organized as follows: Section 2 will provide a review of relevant literature. Section 3 will describe the general model and dynamics. Section 4 gives quantitative results under specifications for both homogenous and heterogeneous risk aversion. Section 5 discusses the paper's main results, and Section 6 concludes.

2. Literature Review

This paper was originally motivated by the social capital model developed in Carrington et al. (1996). Carrington explained 20th century black migration from the Southern part of the United States to the Northern part by creating a model in which moving costs diminish as people migrate. Carrington's model does not, however, attempt to describe return migration. Once an individual migrates, he will never return to the South. As discussed in the introduction, return migration is an important feature of actual migration.

The literature has been rich in theoretical and empirical studies of return migration. Massey (2003) argues that Mexican immigrants to the United States commonly return home to spend saved income. Mushi (2003) gives strong evidence that networks improve job outcomes for migrants, but also finds evidence of return migration. Colussi (2004) uses Mexican migration data to estimate a DSGE model with network effects including return migration. Dustmann (2003) develops a model in which duration of migration is endogenous, and finds that increases in host and source country economic disparity may actually lead to shorter migration durations. Stark (1995) models return migration by considering host country employers' lack of information about migrants' skills prior to hiring. Near the end of his study, Stark briefly discusses various types of models that may exhibit return migration. One of his ideas is a cobweb model in which individuals wage guesses differ from the actual wages which they earn once moving abroad. This is to some degree an anticipation of the model developed in this paper.

A second feature of Carrington's model is that although all individuals are able to migrate, in practice only Southerners choose to migrate to the North. To achieve this end, Carrington must implicitly assume that before migration begins every individual perfectly predicts the future course of migration and wages. This assumption also entails a coordination problem in which each individual migrant must rely on a social planner to make his migration decision. In Appendix 2 I discuss this issue in more detail. My model avoids this issue by specifying expectations such that there is North to South migration in every period.

More generally, social scientists have recognized the importance of social capital in information transfer for some time. Festinger et al. (1950) describes a study in which a rumor was planted in two families of a housing development on one day. The next evening, interviews were conducted to ascertain the how far and to whom the rumor had transferred. I have reproduced a map from the study showing its results in Appendix 1. Although its argument are framed in terms of "influence" rather than information transfer, Katz and Lazarsfeld (1955) shows how information is passed from "opinion leaders" interested in fashion or politics to others in their community. For a broad summary of more recent research in this area, see Haythornthwaite (2002).

The social capital literature also contains several theoretical papers which examine the effect of social capital on migration. Guzman et. al (2004) considers social capital as an analogue of physical capital in which migrants can invest and then receive transfer payments in their old age from later migrants. Helmenstein and Yegerov (1998) creates a stochastic model in which some migrants are "pushed" out of the source country by exogenous factors, then each of these migrants attracts a fixed number of "chain" migrants to the host country. Singer and Massey (1998) develops a hypothesis about the role of social capital in undocumented border crossing and tests the hypothesis empirically.

Alongside social capital research, there has been a surge of interest in economic studies of migration in the last forty years. The first wave was started by Todaro (1969). In a break from previous literature which had considered only raw wage differentials, Todaro modeled migration under uncertain employment potential. An interesting side note is that in Todaro's model, all things equal, an increase in migration makes it more difficult for migrants to find work. Some of the social capital literature including Carrington et al. (1996) makes the exact opposite assumption. Beginning in the 1980's, the voluminous literature of Oded Stark also shaped and changed the direction of economic studies into migration. Among the topics to which Stark has made important contributions are migration as risk reduction (Stark and Levhari (1982)), remittances (Lucas and Stark (1985)), relative deprivation (Stark and Taylor (1991)), and migration under asymmetric information (Stark (1995)).

Massey et al. (1993) famously groups migration theories into four categories: Neoclassical, the New Economics of Migration, Dual Labor Market, and World Systems. Neoclassical theories take individuals as agents, and model migration as agents maximizing wages minus migration costs. The New Economics of Migration on the other hand considers families as units which send members abroad to hedge risks and build capital. Dual Labor Market theory focuses on the differences between native and migrant jobs, the latter often being of low quality and stigmatized by natives. One American example would be a slaughterhouse job, and a Taiwanese example would be a live-in nanny. World Systems theory considers the world to be composed of a core and a periphery. As values of the core enter the periphery, economic relationships within the periphery change. Marginalized individuals may choose to or be forced to migrate. This paper uses elements from both the Neoclassical and the New Economics of Migration category. While each agent makes decisions for himself, the risk of moving is an important part of his migration decision. In short, he maximizes expected utility under risk rather than risk-free wages.

3. Model

We have two locations, North and South, with populations of one each in period zero. Individuals from the North are type N and individuals from the South are type S, regardless of where they live. Population in a given period is given by adding net migration to the population in the previous period:

$$P_t^N = P_{t-1}^N - M_t^{N,\to S} - M_t^{S,\to S} + M_t^{N,\to N} + M_t^{S,\to N}. \tag{1}$$

$$P_t^S = P_{t-1}^S + M_t^{N,\to S} + M_t^{S,\to S} - M_t^{N,\to N} - M_t^{S,\to N}. \tag{2}$$

Where P_t^j is the population of location j in period t, and $M_t^{m,\to n}$ is the number of type m individuals who decide to migrate to location n in period t. To illustrate this notation with a concrete example, the term $M_t^{N,\to S}$ should be read "Northerners migrating to the South in period t." Since this model considers increasing information instead of diminishing moving costs, Carrington's infinite period utility simplifies to standard instant utility (see Appendix 3). The reason this simplification is possible is expectations. Carrington's agents can predict the future perfectly, so that the exact path of future wages and moving costs enters into their decisions each period. In my model, agents expect wages to remain as they predict them in the current period, so the utility that matters to them is a simple discounted instant utility. Put simply, a native Southern individual living in the South will move when he expects the discounted future utility of living in the North to be greater than the utility cost of moving in the present period. This relationship is described below:

$$\frac{1}{1-\delta}\left[E\left(u\left(W_t^N, \varepsilon_i, \sigma_t^{S,S}, \rho_i\right)\right) - u\left(W_t^S, \rho_i\right)\right] \geq E\left(u\left(W_t^N, \varepsilon_i, \sigma_t^{S,S}, \rho_i\right)\right) - E\left(u\left(W_t^N - B^N, \varepsilon_i, \sigma_t^{S,S}, \rho_i\right)\right). \tag{3}$$

Here W_t^S is the Southern wage at in period t. Wages are a diminishing function of a country's population, and I assume that technology/capital stock is different between North and South so that there is a wage gap in period 1. The parameter ρ_i is individual i's risk aversion, and B^N is the fixed cost of moving to the North for a Southern native. I assume that it is costless for natives to return home. ε_i is an individual's "optimism", or the distance his guess about foreign wages is away from the true wage level in standard deviations. The parameter $\sigma_t^{S,S}$ represents the "confidence" that natives of the South living in the South have about the accuracy of their predictions of foreign wage level. I assume ε_i and

$\sigma_t^{S,S}$ have continuous infinite distributions. Variances of these distributions are diminishing in the number of individuals with the same nationality living abroad. This specification is such that guesses about foreign wages become more accurate and confidence in guesses increases as social capital grows. The RHS of (3) represents the utility costs of moving, and the LHS is the total present discounted utility gains. Similar inequalities exist for (4) Northerners living in the North, (5) Southerners in the North, and (6) Northerners in the South. Inequalities (5) and (6) are simpler as there is no utility cost in return migration:

$$\frac{1}{1-\delta}\left[E\left(u\left(W_t^S,\varepsilon_i,\sigma_t^{N,N},\rho_i\right)\right)-u\left(W_t^N,\rho_i\right)\right] \geq E\left(u\left(W_t^S,\varepsilon_i,\sigma_t^{N,N},\rho_i\right)\right)-E\left(u\left(W_t^S-B^S,\varepsilon_i,\sigma_t^{N,N},\rho_i\right)\right). \tag{4}$$

$$E\left(u\left(W_t^S,\varepsilon_i,\sigma_t^{S,N},\rho_i\right)\right)\geq u\left(W_t^N,\rho_i\right). \tag{5}$$

$$E\left(u\left(W_t^N,\varepsilon_i,\sigma_t^{N,S},\rho_i\right)\right)\geq u\left(W_t^S,\rho_i\right). \tag{6}$$

The following three propositions show that in this model as long as there is optimism (individuals have heterogeneous wage guesses) there is always migration when there are some people living in both countries. Furthermore, if an individual of a certain optimism and risk aversion migrates, then all people with higher optimism and lower risk aversion also migrate.

Proposition 1 *If both locations have positive population, and the variance of the distribution of* ε *is not zero, then there is migration from both North to South and South to North in every period.*

Proof: By contradiction. If the South has non-zero population, and there is no migration from South to North in period t, it must be true that (7) holds for all Southerners:

$$\frac{1}{1-\delta}\left[E\left(u\left(W_t^N,\varepsilon_i,\sigma_t^{S,S},\rho_i\right)\right)-u\left(W_t^S,\rho_i\right)\right] < E\left(u\left(W_t^N,\varepsilon_i,\sigma_t^{S,S},\rho_i\right)\right)-E\left(u\left(W_t^N-B^N,\varepsilon_i,\sigma_t^{S,S},\rho_i\right)\right). \tag{7}$$

The standard utility property $\lim_{x\to\infty}u'(x)=0$ also implies that:

$$\lim_{\varepsilon_i\to\infty}\left(E\left(u\left(W_t^N,\varepsilon_i,\sigma_t^{S,S},\rho_i\right)\right)-E\left(u\left(W_t^N-B^N,\varepsilon_i,\sigma_t^{S,S},\rho_i\right)\right)\right)=0. \tag{8}$$

Due to (8), given any $\mu>0$, there is an $M\in\mathbb{R}$ such that $\varepsilon_i\geq M$ implies that $E\left(u\left(W_t^N,\varepsilon_i,\sigma_t^{S,S},\rho_i\right)\right)-E\left(u\left(W_t^N-B^N,\varepsilon_i,\sigma_t^{S,S},\rho_i\right)\right)<\mu$. Furthermore, since the first term of the LHS of (7) is a strictly increasing function of ε_i and the second term is a constant, there is an $F\in\mathbb{R}$ such that $\varepsilon_i\geq F$ implies that $\frac{1}{1-\delta}\left[E\left(u\left(W_t^N,\varepsilon_i,\sigma_t^{S,S},\rho_i\right)\right)-u\left(W_t^S,\rho_i\right)\right]>\mu$. To complete the proof, choose $\varepsilon_i\geq max(M,F)$. Since ε_i takes on any value with positive probability, there is a Southern individual with this level of ε, and for this individual (7) does not hold. This is a contradiction. The same proof works for North to South migration as well.

Proposition 2 *Holding ρ constant, and with standard assumptions about utility, for all $\varepsilon' \leq \varepsilon$, if an individual with ε' migrates, all individuals with ε will migrate at t.*

Proof: By contradiction, if there is some Southern individual with optimism level ε' who is better off migrating, then it must be true that:

$$\frac{1}{1-\delta}\left[E\left(u\left(W_t^N, \varepsilon', \sigma_t^{S,S}, \rho\right)\right) - u(W_t^S, \rho_i)\right] \geq E\left(u\left(W_t^N, \varepsilon', \sigma_t^{S,S}, \rho\right)\right) - E\left(u\left(W_t^N - B^N, \varepsilon', \sigma_t^{S,S}, \rho\right)\right). \quad (9)$$

If there is another potential migrant with $\varepsilon \geq \varepsilon'$ who is better off staying in the South, then:

$$\frac{1}{1-\delta}\left[E\left(u\left(W_t^N, \varepsilon, \sigma_t^{S,S}, \rho\right)\right) - u(W_t^S, \rho_i)\right] < E\left(u\left(W_t^N, \varepsilon, \sigma_t^{S,S}, \rho\right)\right) - E\left(u\left(W_t^N - B^N, \varepsilon, \sigma_t^{S,S}, \rho\right)\right). \quad (10)$$

But because utility is increasing in ε and $\varepsilon \geq \varepsilon'$, the LHS in (10) must be greater than the LHS in (9), and by the concavity of utility, the RHS in (10) must be less than the RHS in (9). This is a contradiction.

Proposition 3 *Holding ε constant, for all $\rho \leq \rho'$ if an individual with ρ' migrates and:*

$$E\left(u\left(W_t^N, \varepsilon, \sigma_t^{S,S}, \rho\right)\right) - E\left(u\left(W_t^N, \varepsilon, \sigma_t^{S,S}, \rho'\right)\right) \leq E\left(u\left(W_t^N - B^N, \varepsilon, \sigma_t^{S,S}, \rho\right)\right) - E\left(u\left(W_t^N - B^N, \varepsilon, \sigma_t^{S,S}, \rho'\right)\right). \quad (11)$$

then all individuals with ρ will migrate at t.

Proof: As above, if there is some Southern individual with risk aversion of ρ' who is better off migrating, then it must true that:

$$\frac{1}{1-\delta}\left[E\left(u\left(W_t^N, \varepsilon, \sigma_t^{S,S}, \rho'\right)\right) - u(W_t^S, \rho')\right] \geq E\left(u\left(W_t^N, \varepsilon, \sigma_t^{S,S}, \rho'\right)\right) - E\left(u\left(W_t^N - B^N, \varepsilon, \sigma_t^{S,S}, \rho'\right)\right). \quad (12)$$

If there is another individual with $\rho \leq \rho'$ who chooses not to migrate, then for this individual:

$$\frac{1}{1-\delta}\left[E\left(u\left(W_t^N, \varepsilon, \sigma_t^{S,S}, \rho\right)\right) - u(W_t^S, \rho)\right] < E\left(u\left(W_t^N, \varepsilon, \sigma_t^{S,S}, \rho\right)\right) - E\left(u\left(W_t^N - B^N, \varepsilon, \sigma_t^{S,S}, \rho\right)\right). \quad (13)$$

Since in both inequalities the LHS is a riskless term subtracted from a risky term, all else held constant lower risk aversion leads to a LHS value higher in (13) than in (12). The RHS of (3.13) is lower than the RHS of (13) (12) by (11). This is a contradiction.

Condition (11) is a weak restriction on the functional form of utility. In words, it says that people with more money are willing to wager as much or more than people with less money on the same amount of risk. Since this is a standard and intuitively plausible part of the risk aversion literature, we should not be surprised that standard risk aversion utility functions fulfill the condition (CRA gives equality, and CRRA holds with inequality).

3.1 Migration Dynamics with Homogenous Risk Aversion

Proposition 2 tells us that if we can find the individual with the lowest guess about foreign wages $(\underline{\varepsilon})$ that chooses to migrate, then we know that all individuals with higher guesses will also migrate. We can find the number of people who migrate, then, by finding the percentage of individuals with guesses higher than $\underline{\varepsilon}$, and multiplying this percentage by the appropriate population. Mathematically, this is shown for Southerners in the South below:

$$M_t^{S,\to N} = \left(P_{t-1}^S - F_{t-1}^S\right) \int_{\varepsilon_t{}^{S,S}}^{\infty} f(x)dx \text{ , where } \varepsilon_t{}^{S,S} = \frac{\underline{\varepsilon}^{S,S}}{\vartheta\left(F_{t-1}^N\right)}. \tag{14}$$

We get $\underline{\varepsilon}$ by solving (3) for equality. $\vartheta(\cdot)$ is the variance of ε's distribution. $\vartheta(\cdot)$ is decreasing in the number of same type individuals living in the other location, which again means that wage guesses improve as more same type individuals accumulate abroad. In the case of Southerners living in the South, $\vartheta(\cdot)$ is a decreasing function of F_{t-1}^N, the population of Southerners living in the North. We find the *percentage* of Southerners living in the South that migrate by integrating over $f(x)$, the PDF of ε with unit variance. We can then find the *number* of Southerners living in the South that migrate, $M_t^{S,\to N}$, by multiplying the percentage migrating by the number of Southerners living in the South in period t-1. The number of (15) Northerners in the North, (16) Southerners in the North, and (17) Northerners in the South that migrate can be found in the same way:

$$M_t^{N,\to S} = \left(P_{t-1}^N - F_{t-1}^N\right) \int_{\varepsilon_t{}^{N,N}}^{\infty} f(x)dx \text{ , where } \varepsilon_t{}^{N,N} = \frac{\underline{\varepsilon}^{N,N}}{\vartheta\left(F_{t-1}^S\right)}. \tag{15}$$

$$M_t^{S,\to S} = \left(F_{t-1}^N\right) \int_{\varepsilon_t{}^{S,N}}^{\infty} f(x)dx \text{ , where } \varepsilon_t{}^{S,N} = \frac{\underline{\varepsilon}^{S,N}}{\vartheta\left(P_{t-1}^S - F_{t-1}^S\right)}. \tag{16}$$

$$M_t^{N,\to N} = \left(F_{t-1}^S\right) \int_{\varepsilon_t{}^{N,S}}^{\infty} f(x)dx \text{ , where } \varepsilon_t{}^{N,S} = \frac{\underline{\varepsilon}^{N,S}}{\vartheta\left(P_{t-1}^N - F_{t-1}^N\right)}. \tag{17}$$

Without specifying the functional forms of utility and production, and the evolution of ϑ and σ we cannot find an exact law of motion mapping one period's Northern population directly onto the next period's Northern population. However, we can identify the way in which shocks work through the system. To illustrate this point, let us look at the way that moving some Northerners from the South to the North in one period affects the change in Northern population in the next period. A complete list of relevant equations is given in Appendix 4, but every effect can be illustrated with the four following equations derived from the above model:

$$\frac{\partial \Delta P_t^N}{\partial P_{t-1}^N} = -\frac{\partial M_t^{S,\to S}}{\partial P_{t-1}^N} - \frac{\partial \mathbf{M}_t^{\mathbf{N},\to \mathbf{S}}}{\partial \mathbf{P}_{t-1}^{\mathbf{N}}} + \frac{\partial M_t^{N,\to N}}{\partial P_{t-1}^N} + \frac{\partial M_t^{S,\to N}}{\partial P_{t-1}^N}. \tag{18}$$

$$\frac{\partial \mathbf{M_t^{N,\to S}}}{\partial \mathbf{P_{t-1}^N}} = \int_{\varepsilon_t{}^{N,N}}^{\infty} f(x)dx - (P_{t-1}^N - F_{t-1}^N) f(\varepsilon_t{}^{N,N}) \frac{\partial \boldsymbol{\varepsilon_t}^{\mathbf{N,N}}}{\partial \mathbf{P_{t-1}^N}}. \tag{19}$$

$$\frac{\partial \boldsymbol{\varepsilon_t}^{\mathbf{N,N}}}{\partial \mathbf{P_{t-1}^N}} = \frac{1}{\vartheta\left(1-(P_{t-1}^N - F_{t-1}^N)\right)} \left[\frac{\partial \underline{\boldsymbol{\varepsilon}}^{\mathbf{N,N}}}{\partial \mathbf{P_{t-1}^N}}\right] + \frac{\vartheta'\left(1-(P_{t-1}^N - F_{t-1}^N)\right)}{\left(\vartheta\left(1-(P_{t-1}^N - F_{t-1}^N)\right)\right)^2} \underline{\varepsilon^{N,N}}. \tag{20}$$

$$\frac{\partial \underline{\boldsymbol{\varepsilon}}^{\mathbf{N,N}}}{\partial \mathbf{P_{t-1}^N}} = -\frac{\partial W_S}{\partial P_{t-1}^N} + \frac{\frac{\partial u}{\partial W_N}}{\frac{\partial Eu}{\partial W_S} + (1-\delta)\left[\frac{\partial Eu}{\partial W_S} - \frac{\partial EuB}{\partial W_S}\right]} \frac{\partial W_N}{\partial P_{t-1}^N} - \frac{\frac{\partial Eu}{\partial \sigma^{N,N}} + (1-\delta)\left[\frac{\partial Eu}{\partial \sigma^{N,N}} - \frac{\partial EuB}{\partial \sigma^{N,N}}\right]}{\frac{\partial Eu}{\partial W_S} + (1-\delta)\left[\frac{\partial Eu}{\partial W_S} - \frac{\partial EuB}{\partial W_S}\right]} \frac{\partial \sigma^{N,N}}{\partial P_{t-1}^N}. \tag{21}$$

Each of these equations is intuitively plausible. In this paragraph, I describe the effects present in the above equalities. Equation (18) says that any change in population must stem from migration. The first term in the RHS of (19) is the analogue of the income effect. It says that more native Northerners means that the same percentage migration will include more migrants. The second term in (19) is similar to the substitution effect. Moving Northerners from the South skews incentives and leads to different migration decisions. Just how the incentives are skewed is shown by (21). Again, $\underline{\varepsilon^{N,N}}$ is the lowest foreign wage guess (optimism) for which an individual chooses to migrate. The first term of (21) shows that pulling Northerners out of the South leads to higher Southern wages, which in turn causes more Northerners to migrate. The second term shows the utility adjusted effect on Northern home wages. Again, lower home wages encourage more Northerners to migrate. The “EuB” and “Eu” terms are the expected utility with and without border costs. Note that when there are no border costs the delta term is eliminated. The last term of (21) is the utility adjusted effect on uncertainty of pulling Northerners out of the South. Northerners in the North are more uncertain of Southern wages, which discourages migration. Thus the overall sign of (21) is ambiguous. The first term of equation (20) is no effect at all, just a normalization based on the variance of foreign wage guesses among Northerners in the North. The second term of (20) gives the effect of increased guess variance on migration, which either encourages or discourages migration depending on the sign of $\underline{\varepsilon^{N,N}}$. Intuition and charts describing this last result are presented in Appendix 5.

3.2 Equilibrium and Heterogeneous Risk Aversion

There are two possible types of equilibrium—stable and oscillating. A stable equilibrium occurs when the number of people migrating from the North to the South equals the number of people migrating from the South to the North in every period:

$$M^{N,\to S} + M^{S,\to S} = M^{N,\to N} + M^{S,\to N}. \tag{22}$$

An oscillating equilibrium occurs when the migration in all odd periods is equal and that in all even periods is equal. In both types of equilibrium there is migration in every period and among all four location-type pairs.

To obtain the results from heterogeneous risk aversion, we simply integrate (14)-(17) over the distribution of risk aversion for each type and location of worker. I assume that in each period, the distribution of risk aversion over each type of individual is the same. In other words, even if only the least risk averse individuals migrate from the South to the North in a given period, in the next period risk aversion is again distributed identically over Southern workers in the South and Southern workers in the North. This assumption can be justified by assuming that each period represents a generation and that risk aversion is not hereditarily passed on to children, or alternatively by assuming that peoples risk aversion varies over their lifetimes (the young, say, are less risk averse than the old).

4. Quantitative Results

4.1 Homogenous Risk Aversion

If I specify the functional form of utility and production, I can derive exact laws of motion for the Northern population and the Northern foreign population (Southerners living in the North). To this end, I assume CRA (power) utility, which due to Sargent (1987) can be written as mean-variance utility, so that:

$$E(-e^{-\rho W}) = W - \frac{\rho}{2}\sigma_W. \tag{23}$$

Where W is consumption, ρ is risk aversion, and $\sigma_W$is the variance of consumption with a normal distribution. I also assume neoclassical production and exponentially decreasing information barriers. All variables with distributions are assumed to be normal. To simplify the discussion, I first consider homogenous risk aversion:

$$P_t^N = P_{t-1}^N - (P_{t-1}^N - F_{t-1}^N)\int_{\varepsilon_t{}^{N,N}}^{\infty} f(x)dx - (F_{t-1}^N)\int_{\varepsilon_t{}^{S,N}}^{\infty} f(x)dx + \left(1 - (P_{t-1}^N - F_{t-1}^N)\right)\int_{\varepsilon_t{}^{N,S}}^{\infty} f(x)dx + (1 - F_{t-1}^N)\int_{\varepsilon_t{}^{S,S}}^{\infty} f(x)dx. \tag{24}$$

$$F_t^N = F_{t-1}^N + (1 - F_{t-1}^N)\int_{\varepsilon_t{}^{S,S}}^{\infty} f(x)dx - (F_{t-1}^N)\int_{\varepsilon_t{}^{S,N}}^{\infty} f(x)dx. \tag{25}$$

With:

$$\varepsilon_t{}^{N,N} = \frac{1}{\vartheta_0 e^{-\left(1-(P_{t-1}^N - F_{t-1}^N)\right)}}\left[\frac{G_0{}^N}{(1+P_{t-1}^N)^\gamma} - \frac{G_0{}^S}{(3-P_{t-1}^N)^\gamma} + (1-\delta)B + \frac{\rho}{2}\sigma_0 e^{-\left(1-(P_{t-1}^N - F_{t-1}^N)\right)}\right]. \tag{26}$$

$$\varepsilon_t{}^{S,N} = \frac{1}{\vartheta_0 e^{-(1-F_{t-1}^N)}}\left[\frac{G_0{}^N}{(1+P_{t-1}^N)^\gamma} - \frac{G_0{}^S}{(3-P_{t-1}^N)^\gamma} + \frac{\rho}{2}\sigma_0 e^{-(1-F_{t-1}^N)}\right]. \tag{27}$$

$$\varepsilon_t{}^{N,S} = \frac{1}{\vartheta_0 e^{-(P_{t-1}^N - F_{t-1}^N)}}\left[\frac{G_0{}^S}{(3-P_{t-1}^N)^\gamma} - \frac{G_0{}^N}{(1+P_{t-1}^N)^\gamma} + \frac{\rho}{2}\sigma_0 e^{-(P_{t-1}^N - F_{t-1}^N)}\right]. \tag{28}$$

$$\varepsilon_t{}^{S,S} = \frac{1}{\vartheta_0 e^{-F_{t-1}^N}}\left[\frac{G_0{}^S}{(3-P_{t-1}^N)^\gamma} - \frac{G_0{}^N}{(1+P_{t-1}^N)^\gamma} + (1-\delta)B + \frac{\rho}{2}\sigma_0 e^{-F_{t-1}^N}\right]. \tag{29}$$

In the remainder of this section, I describe the way the most important parameters affect the model. First consider a baseline model with perfect information. Northern wages are initially higher than Southern wages, there are no border costs and individuals are perfectly confident in guesses that are always correct. Because $\frac{1}{\vartheta}(C) \to +\infty$ as $\vartheta \to 0$ and $\frac{1}{\vartheta}(-C) \to -\infty$ as $\vartheta \to 0$, all Southerners and no Northerners will migrate in period one. In subsequent periods there are two possibilities. If Northern wages stay higher than Southern wages, then there is no subsequent migration. If the gap between Northern and Southern wages is low enough that migration of all Southerners to the North causes Southern wages to rise above Northern wages, then in every other period all individuals migrate from one country to the other. This second situation is represented in Table 3 Row 1 (Table 3 is plotted in Figure 3).

There are three important parameters in the model related to individual decision making: border costs (B), confidence (σ_0), and variance of optimism (ϑ_0). Of these, border costs and confidence in wage guesses are proxies for home wages. If optimism vanishes as above, then if the sum of the border cost term and Southern wages is higher than Northern wages there will be no migration. The σ_0 term works in a similar way. Even if expected wages are higher in the North, if Southerners (of a certain level of risk aversion) aren't very confident about the true level of Northern wages, they will judge migration too risky and stay home. The dynamics of variance in optimism ϑ_0 are a bit more complicated. If ϑ_0 is high relative to the wage gap, then Northern and Southern migration is similar in the first period, since nearly half of Northerners will guess that wages are higher in the South, and nearly half of Southerners will guess that wages are higher in the North. On the other hand, if ϑ_0 is low relative to the wage gap, guesses are fairly accurate so nearly all Southerners will migrate, and very few Northerners will migrate. Table 2 shows first period migration in the baseline model under various initial values of ϑ_0.

If ϑ_0 is positive, migration after the first period will generally follow an oscillating path as in Table 3 Row 2. Migration today causes wages in the host country to fall and wages in the source country to rise. This wage change discourages migration tomorrow. This logic is captured formally by Proposition 4 below:

Proposition 4 *If there is complete confidence and crossing the border is costless ($\sigma_0, B = 0$), an increase in period t Northern population implies that in period t+1 Northern population will either fall or grow less than it did in period t.*

For Proof see Appendix 6. In a related point, a very large ϑ_0 implies that individuals are making very diverse guesses about foreign wages. In other words, half of all individuals imagine extremely high wages abroad, and half guess that wages abroad are extremely low. In Table 3 Row 3, we see that if guesses are widely distributed enough, in equilibrium almost half of individuals choose to migrate in every period. As we would expect, increasing the wage gap between the North and South encourages migration. This situation is shown in Table 3 Row 4.

In each of the settings discussed above, there has been more migration than we would expect to see in the real world. Thus far, however, we have only considered separately the three important elements of the homogenous risk aversion model (confidence, border costs, and optimism). If we combine them, we can get more realistic results. Consider the case represented in Table 3 Row 5. At equilibrium Northern population is 24% higher than the initial settings, wages are $250 higher in the North, and 8% of the world population migrates every period.

4.2 Heterogeneous Risk Aversion

This section discusses the effects of altering the mean and variance of risk aversion in the explicit model developed above. Table 4 and Figure 4 display model characteristics under various risk aversion means, with other model settings identical to those in Table 3 Row 5. The effect of raising mean risk aversion is exactly what we would expect. Ceteris paribus, higher mean risk aversions discourage migration, as individuals are less willing to take the risk of migrating. By the time mean risk aversion reaches five, for example, there is relatively little migration.

The effects of raising risk aversion variance are more complicated. Table 5 and Figure 5 show the results of raising risk aversion variance on model parameters, with other settings from Table 3 Row 5 and a mean risk aversion of ½. Up to a point, raising risk aversion causes more volatility in migration and population. When variance is high enough, however, the model again settles down, and migration and population levels are more constant.

The key insight to understanding the effect of raising risk aversion variance is that increases in variance encourage migration. Intuitively, an increase in variance makes half of all individuals more likely to migrate and half less likely to migrate. Consider individuals who choose not to migrate when there is no variance in risk aversion. Adding variance can only cause more migration in this group. The opposite is true among individuals who choose to migrate when there is no risk aversion. Increasing variance can only cause individuals from this group to choose not to migrate. Since in our example the group of people who initially choose not to migrate is much larger than those who initially choose to migrate, however, raising risk aversion will result in a net increase in migration.

The increase in migration due to more variance causes the system to take longer to settle into equilibrium. There is another force working in the opposite direction, however. As variance in risk aversion becomes large, the wage gap and expectations become less important. Many individuals are extremely risk loving and also many are also extremely risk averse. Regardless of the size of wage gaps, all the extreme risk lovers will migrate, and all the extremely risk averse will choose to stay. The waves of migration which the model exhibits are contingent upon the effects that migration has on the various parameters of the model. When these parameters become unimportant due to extreme variance in risk aversion, the waves become less volatile.

5. Discussion

5.1 Comparison with the Carrington Model

As discussed in the introduction, Carrington's model does not describe return or two-way migration. Carrington et al. (1996) partially presents its theoretical results in two phase diagrams reproduced here as Figures 6 and 7. Because migration is only one-directional, the M_t in Carrington's figures represents (unity plus) Northern population. In Figure 6, Carrington presents the basic dynamics of his model. Northern population increases smoothly and monotonically, and the rate of migration slows with time. Eventually, the model converges to a steady state at which migration ceases. In Figure 8 Carrington presents the possibility for his model to exhibit multiple steady states. In this case migration still follows a monotonic path, but it can converge to either one of the non-trivial steady states.

For the purpose of comparison, I have used settings from the model developed in this paper to create several Northern population phase diagrams similar to those presented by Carrington. In order to get a simple two-dimensional phase diagram, I use the assumptions in Proposition 4 to create Figure 8. While Carrington's model creates a steady smooth increase in migration, the model developed in this paper creates a cobweb, with population levels varying as individuals of all types migrate and return in every period. If the settings of the model lead to a stable equilibrium as in Figure 8, then the cobweb converges to a point. If the equilibrium is oscillatory, then the cobweb settles into a non-degenerative rectangle. Finally, because there are two state variables in my general model—foreign and total Northern population—I present a three dimensional phase diagram in Figure 9. In this figure the top panel is an overall view of the phase plane, and the bottom panel is an up close view of the same plane in which the migration dynamics are more clearly visible. In the top panel, the origin is at the lower-right corner. The two horizontal axes from the origin are respectively foreign and total Northern population at period t-1. The vertical axis is the Northern population at period t. As in the simplified Figure 8, the migration path of this general model is a cobweb, with population levels alternatively rising and falling in each period. As above, the path of migration converges to a point in the event of a stable equilibrium and a rectangle in the case of an oscillatory equilibrium.

5.2 Comparison with Real World Data

The most important contribution of the model developed in this paper is that it explains two-way and return migration using information and social capital effects, but the model predicts more than just the existence of these two kinds of migration. It anticipates several other aspects of migration shown in the data. For instance, the model predicts that migration will be volatile. According to the model, migration should take place in cycles or waves as opposed to the fairly smooth dynamics of standard migration models. Consider the settings of Table 3 Row 5 which were calibrated to have relatively realistic dynamics. Estimating with the seventeen periods beginning with period four, we get standard deviations ranging from 16-24% of average migration levels over the same periods. In Figure 10 I have plotted the model predictions described above as well as the path of each type of British-EU15 migration over the seventeen years from 1991-2007. A simple calculation shows that British-EU15 migration has standard deviations ranging from 22-28% of average migration for each nationality and location. If we consider a linear time trend, standard deviations still reach 20-24% of average migration. These levels of volatility are similar to those predicted by this paper's model.

A second prediction of the model is that during years in which many natives of a country leave, relatively few natives should return. In other words, native primary and return migration should be negatively correlated. This relationship is shown in the case of Britain in the top left panel of Figure 1. Over the period from 1991-2007 British born primary and return migration exhibited strong negative correlation (-0.6). This relationship confirms the prediction of the model.

Not every puzzle in the data is completely resolved by this paper's model, however. The model predicts that if many foreigners migrate to a country in a certain period, relatively few natives should leave in that period. This is intuitively plausible, as we would expect boom years to attract foreigners while inducing natives to stay home. The data, on the other hand, show that during the same years that relatively many foreign born migrants come to Britain, relatively many British depart. British born out migration and foreign born in migration are strongly positively correlated (.62). The solution to this puzzle may lay in long term technological changes in migration. Over the long term, falling migration costs may lead to a general increase in migration, while in the short term incomplete information may lead to the migration in more than one direction. Evidence for this hypothesis can be seen in Figure 11. Once the data has been linearly detrended, foreign born in and British born out migration become weakly negatively correlated (-.23).

6. Conclusion

The model developed in this paper presents one method to obtain two-way migration theoretically. In order to generate the model's two-way dynamics, I have created the concepts of optimism and confidence. The model can be broken down as follows: The expectation structure of individuals leads to return migration. Risk aversion and confidence provide a method through which individuals make heterogeneous migration decisions even within the same type. Finally, differing wage guesses or optimism of individuals leads to two-way migration in every period. There are several stylized facts about migration which provide support for further predictions of the model.

This paper could be extended in several directions. While it seems likely that the concepts of optimism and confidence reflect one of the ways in which social capital enters migration decisions, Carrington's original idea about falling costs and other considerations in the literature are probably important in such decisions as well. In future research, I would like to examine the actual expectation and information structure of migrants, and estimate a more complex model including both information and other social capital effects.

Bibliography

Beine, Michel; Docquier, Frédéric; and Rapoport, Hillel. "Brain Drain and Economic Growth: Theory and Evidence." *Journal of Development Economics.* 2001 (64) pp. 275-289

Borjas, George. "The Economics of Migration." *Journal of Economic Literature,* Dec, 1994 (32(4)), pp. 1667-1717

Brown, David L. and Wardwell, John M. *New Directions in Urban-Rural Migration.* Academic Press, 1980

Carrington, William; Detragiache, Enrica; and Vishwanath, Tara. "Migration and Endogenous Moving Costs." *American Economic Review,* 1996, 86(4), pp. 909-930

Chen, Hung-Ju and Fang, I-Hsiang. "Migration, Social Security, and Economic Growth: A Host Country Perspective." *working paper (accessed Nov. 2008)*

Chen, Hung-Ju; Li, Ming-Chia; and Lin, Yung-Ju. "Chaotic Dynamics in an Overlapping Generations Model with Myopic and Adaptive Expectations." *Journal of Economic Behavior and Organization.* Jul, 2008 (67(1)), pp. 48-56

Coleman, James S. "Social Capital in the Creation of Human Capital."*American Journal of Sociology,* 1988, 94(S1), pp. S95-S120

Colussi, Aldo. "An Estimable Model of Mexican Illegal Migration." *working paper (accessed Sept. 2008)*

Dustmann, Christian; Bentolila, Samuel; and Faini Ricardo. "Return Migration: The European Experience." *Economic Policy,* Apr, 1996, (11(22)) pp. 213-250

Dustmann, Christian. "Return Migration, Wage Differentials, and the Optimal Migration Duration."*European Economic Review, Apr,* 2003, (47(2)), pp. 353-369

Festinger, Leon; Schachter, Stanley; and Back, Kurt. *Social Pressures in Informal Groups.* Stanford University Press, 1950

Fuguitt, Glenn V. and Beale, Calvin L. "Recent Trends in Nonmetropolitan Migration: Toward a New Turnaround?"*Growth and Change,* Spring, 1996 (27), pp. 156-174

Galor, Oded. "Time Preference and International Migration." *Journal of Economic Theory.* Feb, 1986 (38(1)), pp. 1-20

Giannetti, Mariassunta. "On the Mechanics of Migration Decisions: Skill Complementarities and Endogenous Price Differentials." *Journal of Development Economics,* 2003, (71) pp. 329-349

Guzman, Mark G.; Haslag, Joseph H.; and Orrenius, Pia M. "Accounting for Fluctuations in Social Network Usage and Migration Dynamics." *Federal Reserve Bank of Dallas Research Department Working Paper No. 0402*

Haythornthwaite, Caroline. "Social Network Analysis: An Approach and Technique for the Study of Information Exchange." *Library & Information Science Research,* Autumn, 1996 (18(4)), pp. 323-342

Helmenstein, Christian and Yegerov, Yury. "The Dynamics of Migration in the Presence of Chains." *Journal of Economic Dynamics and Control,* Feb, 2000 (24(2)), pp. 307-324

Katz, Elihu and Lazarsfeld, Paul F. *Personal Influence.* Transaction Publishers, 1955 (reprint 2006)

Lee, Everett S. "A Theory of Migration." *Demography,* 1966 (3(1)), pp. 47-57

Lucas, Robert and Stark, Oded. "Motivations to Remit: Evidence from Botswana." *The Journal of Political Economy,* Oct, 1985 (93(5)), pp. 901-918

Massey, Douglas; Arango, Joaquin; Hugo, Graeme; Kouaouci, Ali; Pellegrino, Adelo, and Taylor, J. Edward. "Theories of International Migration: a Review and Appraisal."*Population and Development Review*. Sep, 1993 (19(3)) , pp. 431-466

Massey, Douglas; Arango, Joaquin; Hugo, Graeme; Kouaouci, Ali; Pellegrino, Adelo, and Taylor, J. Edward. *Worlds in Motion: Understanding International Migration at the End of the Millennium.* Oxford University Press, 1998

Massey, Douglas. *Beyond Smoke and Mirrors.* Russell Sage Foundation Publications, 2003

McKenzie, David; Gibson, John; and Stillman, Steven. "A Land of Milk and Honey with Streets Paved of Gold: Do Emigrants have Over-Optimistic Expectations about Incomes Abroad?" *World Bank Policy Research Working Paper No. 4141*

Michel, Philippe and de la Croix, David. "Myopic and Perfect Foresight in the OLG Model." *Economic Letters.* Apr, 2000 (67(1)), pp. 53-60

Munshi, Kaivan. "Networks in the Modern Economy: Mexican Migrants in the US Labor Market."*Quarterly Journal of Economics*. 2003 (118(2)), pp. 549-599

OECD. *International Migration Outlook-2008 Edition.* OECD Press, 2008

Pessino, Carola. "Sequential Migration: Theory and Evidence from Peru." *Journal of Development Economics.* Jul, 1991 (36), pp. 55-87

Plane, D. A.; Henrie, C.J.; and Perry, M.J. "Migration Up and Down the Urban Hierarchy and Across the Life Course." *PNAS*, Oct, 2005 (102(43)) , pp. 15313-15318

Ravenstein, Ernest G. "The Laws of Migration." *Journal of the Statistical Society of London*, Jun, 1885 (48(2)) , pp. 167-235

Sulaimanova, Sultanat. "Trafficking in Women from the Former Soviet Union for the Purposes of Sexual Exploitation." In **Beeks, Karen and Amir Delila.** *Trafficking and the Global Sex Industry.* Lexington Books, 2006

Sargent, Thomas. *Macroeconomic Theory.* Academic Press, 1987 (2nd Edition)

Silvers, Arthur. "Probabilistic Income-Maximizing Behavior in Regional Migration." *International regional Science Review.* 1977 (2(1)), pp. 29-40

Singer, Audrey and Massey, Douglas."The Social Process of Undocumented Border Crossing among Mexican Migrants."*International Migration Review*, Aug, 1998 (32(3)), pp. 561-592

Sjastaad, Larry. "The Costs and Returns of Human Migration." *Journal of Political Economy,* Oct, 1962 (70(S5)), pp. 80-93

Stark, Oded. "Return and Dynamics: The Path of Labor Migration when Workers Differ in their Skills and Information is Asymmetric." *The Scandinavian Journal of Economics,* Mar, 1995 (97(1)), pp. 55-71

Stark, Oded. *The Migration of Labor.* Blackwell Publishers, 1991

Stark, Oded and Levhari, David. "On Migration and Risk in LDCs." *Economic Development and Cultural Change*, Oct, 1982 (31(1)), pp.191-196

Stark, Oded and Taylor, J. Edward. "Migration Incentives, Migration Types: The Role of Relative Deprivation." *The Economic Journal,* Sep, 1991 (101(408)), pp. 1163-1178

Stark, Oded. "Return and Dynamics: The Path of Labor Migration when Workers Differ in their Skills and Information is Asymmetric." *Scandinavian Journal of Economics.* Mar, 1995 (97(1)), pp. 55-71

Stark, Oded; Helmenstein, Christian; and Prskawetz, Alexia. "A Brain Gain with a Brain Drain." *Economic Letters.* Aug, 1997 (55(2)), pp. 227-234

Thom, Kevin. "Repeated Circular Migration: Theory and Evidence." *working paper (accessed Sept. 2008)*

Todaro, Michael. "A Model of Labor Migration and Urban Unemployment in Less Developed Countries." *The American Economic Review*, 1969 (59(1)), pp. 138-148

Vaught, David. *After the Gold Rush: Tarnished Dreams in the Sacramento Valley.* The John Hopkins University Press, 2007

Vining, Daniel R. and Pallone, Robert Jr. "Migration Between Core and Peripheral Regions: a Description and Tentative Explanation of the Patterns in 22 Countries."*Geoforum*, 1982 (13(4)), pp. 339-410

Appendix

APPENDIX 1

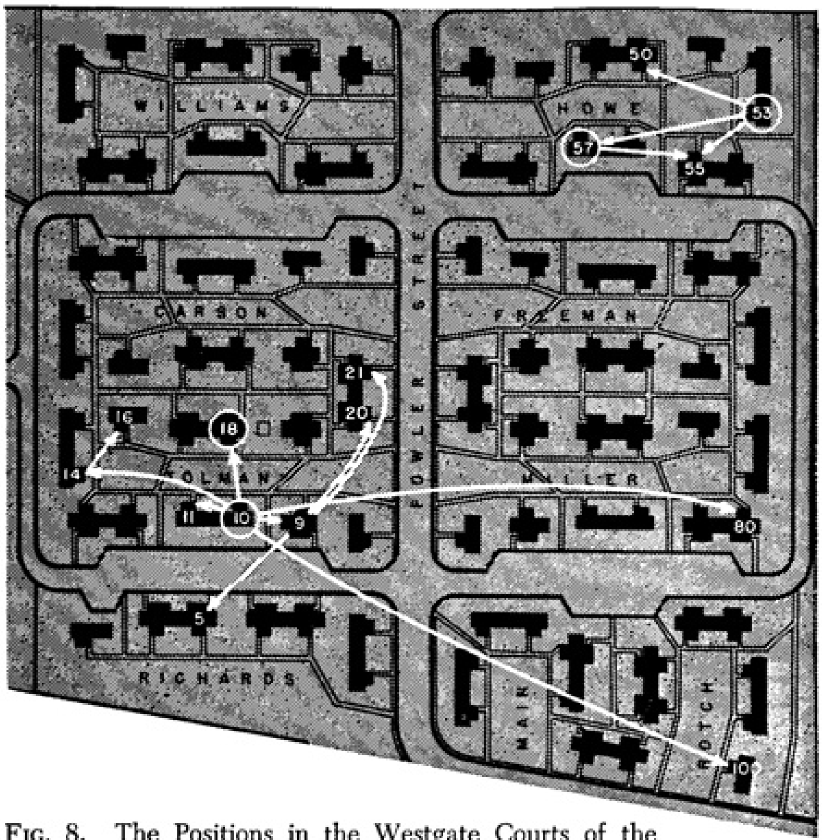


FIG. 8. The Positions in the Westgate Courts of the People Who Heard and Told Either of the Two Items of Information

Festinger conducted a small experiment in the Westgate community at M.I.T. to measure the importance of spatial position and social cohesion in the transfer of information. Having previously conducted a series of interviews for other research in the community, Festinger chose two areas with different social characteristics for the planting of rumors. The residents of Tolman Court, one of Festinger's chosen areas, had many friends and were very active in the community. The opposite was true of resident's of Howe Court, Festinger's other choice. Researchers pretending to be representatives from a broadcasting company and a well-known magazine interviewed two randomly selected families in each area, telling them Westgate was going to be featured in an upcoming story. Beginning on the evening of the day after the information was planted and continuing until the next evening, researchers conducted interviews throughout the community to ascertain to whom the rumor had been passed and from whom to whom. In the above figure, the circled homes indicate where a rumor was planted, and the white arrows show where and how the rumor was passed. Unsurprisingly, the more socially cohesive and active Tolman Court residents passed the rumor more quickly and widely than those of Howe court.

APPENDIX 2

To paraphrase Carrington's Lemma 1, since migration is costless, if a Northern migrant decides to migrate to the South in period t+1, then it means that wages in the South are higher in period t+1. Since we know that this migrant was in the North at period t, wages must have been higher in the North in period t or else he would have migrated to the South after period t-1. In an environment with perfect information, there can only be migration towards the location with higher wages in each period, so only Northerners will move in period t+1. But since Southern wages depend only on the number of workers in the South, if only Northerners move to the South, wages cannot be higher in t+1. This is a contradiction.

Carrington allows North to South migration in the first period, however. It is important to notice that the above proof makes implicit assumptions about expectations, and the order in which migration decisions are made. For example, imagine that workers expect wages in period t+1 to be the same as they are in t. Then it is possible that in t-1 wages are higher in North, so many Southerners migrate in period t, while all Northerners stay in the North. Let's say that so many Southern workers migrated that in t Northern wages drop below Southern wages. Since migration from the North to the South is costless, in period t+1 everyone in the North migrates to the South, and so on.

Carrington makes the implicit assumption that everyone perfectly predicts migration and wages, so that in period 0 every individual already knows what wages will be in both the North and South in each future period. If this is the case, however, we have a coordination problem. Since all decisions are made at the same time at the beginning of each period, how do we know who moves? For instance, let's say that in the first period Southern wages are higher. Since migration is costless, Northerners know that just the right number of Northerners will move to the South to make the wages equal, but how does one individual Northerner know whether to move or not without a social planner?

It is also possible that each individual in the North agrees to make migration decisions one after another. This way Northerners can observe the effect of each migration on wages. Migration would continue until wages were equal, and then migration would cease. But then the Northerners that migrated first would be able to make higher wages while the choice process was in progress, and everyone would want to migrate first. Once again, a coordination problem develops concerning deciding who gets to make the first choice and, unless we have a migration decision order lottery, we need a social planner.

APPENDIX 3

Carrington's utility is based on a value function, the analogue to which in this paper is as follows (for individual i choosing to stay in the South for period t):

$$V_t^{S,S}(\cdot) = u(W_t^S, \rho_i) + \delta \max\left[E\left(V_{t+1}^{S,N}(\{W_t\}, \varepsilon_i, B^N, \sigma_t^{S,S}, \rho_i\right), E\left(V_{t+1}^{S,S}(\{W_t\}, \varepsilon_i, B^N, \sigma_t^{S,S}, \rho_i)\right)\right]. \quad \text{A3.1}$$

With $\{W_t\}$ representing both Southern and Northern wages, and $V_{t+1}^{m,n}$ being the value function of a type m individual going to or staying in location n in period t+1. Assuming that this individual expects wage levels in period t to be permanent, she will choose to migrate when

$$\begin{aligned} &E\left(u\left(W_t^N - B^N, \varepsilon_i, \sigma_t^{S,S}, \rho_i\right)\right) \\ &+ \delta \max\left[E\left(V_{t+1}^{S,N}(\{W_t\}, \varepsilon_i, B^N, \sigma_t^{S,S}, \rho_i\right), E\left(V_{t+1}^{S,S}(\{W_t\}, \varepsilon_i, B^N, \sigma_t^{S,S}, \rho_i)\right)\right] \\ &\geq u(W_t^S, \rho_i) + \delta \max\left[E\left(V_{t+1}^{S,N}(\{W_t\}, \varepsilon_i, B^N, \sigma_t^{S,S}, \rho_i\right), E\left(V_{t+1}^{S,S}(\{W_t\}, \varepsilon_i, B^N, \sigma_t^{S,S}, \rho_i)\right)\right]. \end{aligned} \quad \text{A3.2}$$

Because of their wage expectations, people expect to never migrate if they do not migrate in period t, and expect to never come back if they do migrate, we can rewrite A3.2 as:

$$\begin{aligned} &\sum_{i=0}^{\infty}\left[\delta^i E\left(u\left(W_t^N, \varepsilon_i, \sigma_t^{S,S}, \rho_i\right)\right)\right] - \sum_{i=0}^{\infty}\left[\delta^i u(W_t^S, \rho_i)\right] \\ &\qquad \geq E\left(u\left(W_t^N, \varepsilon_i, \sigma_t^{S,S}, \rho_i\right)\right) - E\left(u\left(W_t^N - B^N, \varepsilon_i, \sigma_t^{S,S}, \rho_i\right)\right). \end{aligned} \quad \text{A3.3}$$

Or:

$$\begin{aligned} &\frac{1}{1-\delta}\left[E\left(u\left(W_t^N, \varepsilon_i, \sigma_t^{S,S}, \rho_i\right)\right) - u(W_t^S, \rho_i)\right] \\ &\qquad \geq E\left(u\left(W_t^N, \varepsilon_i, \sigma_t^{S,S}, \rho_i\right)\right) - E\left(u\left(W_t^N - B^N, \varepsilon_i, \sigma_t^{S,S}, \rho_i\right)\right). \end{aligned} \quad \text{A3.4}$$

APPENDIX 4

This appendix explains the derivation of (18)-(21), and presents all other relevant equations. In short, I took the partial derivative with respect to P_{t-1}^N of (1), (3)-(6), and (14)-(17), assuming that F_{t-1}^N is exogenous. In words, I increased the Northern population in period t-1 by pulling Northerners from the South back to the North, but leaving all native Southerners were they were. It is also important for the derivation to note that marginal increases in wage and wage guesses affect expected utility in the exactly the same manner, so that $\frac{\partial Eu}{\partial \underline{\varepsilon}^{N,N}} = \frac{\partial Eu}{\partial W_S}$ and so forth. This is true because individuals cannot tell the difference between what is true income what is merely their individual guess. If they could, then they would instantly adjust their expectations to the true wage level abroad. All relevant equations are given below:

$$\frac{\partial \Delta P_t^N}{\partial P_{t-1}^N} = \frac{\partial M_t^{S,\to N}}{\partial P_{t-1}^N} + \frac{\partial M_t^{N,\to N}}{\partial P_{t-1}^N} - \frac{\partial M_t^{N,\to S}}{\partial P_{t-1}^N} - \frac{\partial M_t^{S,\to S}}{\partial P_{t-1}^N}. \quad \text{A4.1}$$

Northerners in the North:

$$\frac{\partial M_t^{N,\to S}}{\partial P_{t-1}^N} = \int_{\varepsilon_t{}^{N,N}}^{\infty} f(x)dx - (P_{t-1}^N - F_{t-1}^N) f(\varepsilon_t{}^{N,N}) \frac{\partial \varepsilon_t{}^{N,N}}{\partial P_{t-1}^N}. \quad \text{A4.2}$$

$$\frac{\partial \varepsilon_t{}^{N,N}}{\partial P_{t-1}^N} = \frac{1}{\vartheta\left(1-(P_{t-1}^N - F_{t-1}^N)\right)} \left[\frac{\partial \underline{\varepsilon}^{N,N}}{\partial P_{t-1}^N}\right] + \frac{\vartheta'\left(1-(P_{t-1}^N - F_{t-1}^N)\right)}{\left(\vartheta\left(1-(P_{t-1}^N - F_{t-1}^N)\right)\right)^2} \underline{\varepsilon}^{N,N}. \quad \text{A4.3}$$

$$\frac{\partial \underline{\varepsilon}^{N,N}}{\partial P_{t-1}^N} = -\frac{\partial W_S}{\partial P_{t-1}^N} + \frac{\frac{\partial u}{\partial W_N}}{\frac{\partial Eu}{\partial W_S} + (1-\delta)\left[\frac{\partial Eu}{\partial W_S} - \frac{\partial EuB}{\partial W_S}\right]} \frac{\partial W_N}{\partial P_{t-1}^N} - \frac{\frac{\partial Eu}{\partial \sigma^{N,N}} + (1-\delta)\left[\frac{\partial Eu}{\partial \sigma^{N,N}} - \frac{\partial EuB}{\partial \sigma^{N,N}}\right]}{\frac{\partial Eu}{\partial W_S} + (1-\delta)\left[\frac{\partial Eu}{\partial W_S} - \frac{\partial EuB}{\partial W_S}\right]} \frac{\partial \sigma^{N,N}}{\partial P_{t-1}^N}. \quad \text{A4.4}$$

Southerners in the South

$$\frac{\partial M_t^{S,\to N}}{\partial P_{t-1}^N} = -(1 - F_{t-1}^N) f(\varepsilon_t{}^{S,S}) \frac{\partial \varepsilon_t{}^{S,S}}{\partial P_{t-1}^N}. \quad \text{A4.5}$$

$$\frac{\partial \varepsilon_t{}^{S,S}}{\partial P_{t-1}^N} = \frac{1}{\vartheta(F_{t-1}^N)} \left[\frac{\partial \underline{\varepsilon}^{S,S}}{\partial P_{t-1}^N}\right]. \quad \text{A4.6}$$

$$\frac{\partial \underline{\varepsilon}^{S,S}}{\partial P_{t-1}^N} = -\frac{\partial W_N}{\partial P_{t-1}^N} + \frac{\frac{\partial u}{\partial W_S}}{\frac{\partial Eu}{\partial W_N} + (1-\delta)\left[\frac{\partial Eu}{\partial W_N} - \frac{\partial EuB}{\partial W_N}\right]} \frac{\partial W_S}{\partial P_{t-1}^N}. \quad \text{A4.7}$$

Northerners in the South

$$\frac{\partial M_t^{N,\to N}}{\partial P_{t-1}^N} = -\int_{\varepsilon_t{}^{N,S}}^{\infty} f(x)dx - \left(1 - (P_{t-1}^N - F_{t-1}^N)\right) f(\varepsilon_t{}^{N,S}) \frac{\partial \varepsilon_t{}^{N,S}}{\partial P_{t-1}^N}. \quad \text{A4.8}$$

$$\frac{\partial \varepsilon_t{}^{N,S}}{\partial P_{t-1}^N} = \frac{1}{\vartheta(P_{t-1}^N - F_{t-1}^N)} \left[\frac{\partial \underline{\varepsilon^{N,S}}}{\partial P_{t-1}^N}\right] - \frac{\vartheta'(P_{t-1}^N - F_{t-1}^N)}{\left(\vartheta(P_{t-1}^N - F_{t-1}^N)\right)^2} \underline{\varepsilon^{N,S}}. \quad \text{A4.9}$$

$$\frac{\partial \underline{\varepsilon^{N,S}}}{\partial P_{t-1}^N} = -\frac{\partial W_N}{\partial P_{t-1}^N} + \frac{\frac{\partial u}{\partial W_S}}{\frac{\partial Eu}{\partial W_N}} \frac{\partial W_S}{\partial P_{t-1}^N} - \frac{\frac{\partial Eu}{\partial \sigma^{N,S}}}{\frac{\partial Eu}{\partial W_N}} \frac{\partial \sigma^{N,S}}{\partial P_{t-1}^N}. \quad \text{A4.10}$$

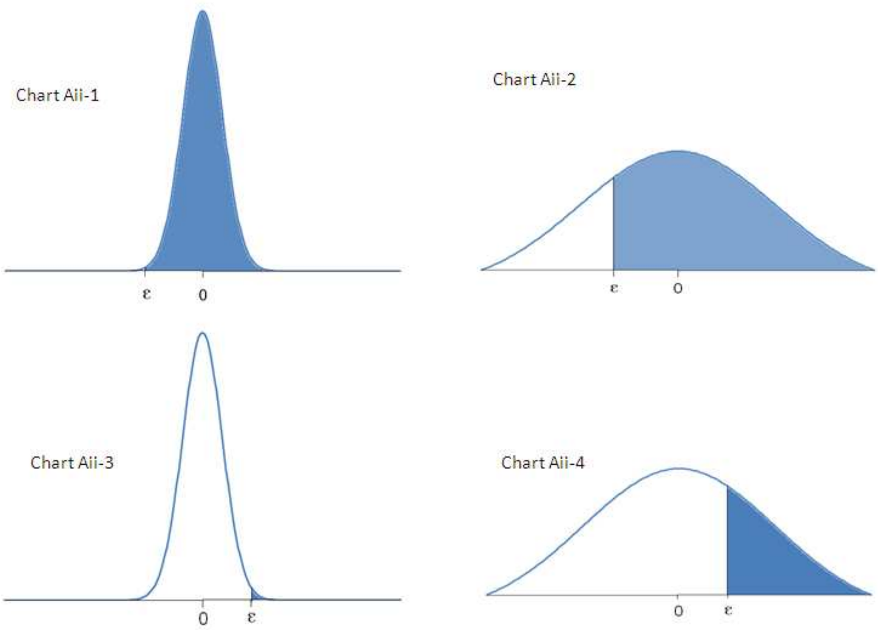
Southerners in the North

$$\frac{\partial M_t^{S,\to S}}{\partial P_{t-1}^N} = -F_{t-1}^N f(\varepsilon_t{}^{S,N}) \frac{\partial \varepsilon_t{}^{S,N}}{\partial P_{t-1}^N}. \quad \text{A4.11}$$

$$\frac{\partial \varepsilon_t{}^{S,N}}{\partial P_{t-1}^N} = \frac{1}{\vartheta(1 - F_{t-1}^N)} \left[\frac{\partial \underline{\varepsilon^{S,N}}}{\partial P_{t-1}^N}\right]. \quad \text{A4.12}$$

$$\frac{\partial \underline{\varepsilon^{S,N}}}{\partial P_{t-1}^N} = -\frac{\partial W_S}{\partial P_{t-1}^N} + \frac{\frac{\partial u}{\partial W_N}}{\frac{\partial Eu}{\partial W_S}} \frac{\partial W_N}{\partial P_{t-1}^N}. \quad \text{A4.13}$$

APPENDIX 5



This appendix describes why the effect of increased foreign wage guess variance depends on the sign of $\underline{\varepsilon}^{N,N}$. As explained earlier, $\underline{\varepsilon}^{N,N}$ is the lowest foreign wage guess at which Northerners choose to migrate. Thus, all those with guesses greater than $\underline{\varepsilon}^{N,N}$ migrate. The four charts above represent the distribution of Northerners over their foreign wage guesses. The shaded area represents the population that chooses to migrate. In charts Aii-1 and Aii-2, note that epsilon is less than zero. When there is little variance in guesses as in Aii-1, nearly everyone chooses to migrate. When variance is more substantial in Aii-2, many people do not migrate. In charts Aii-3 and Aii-4, epsilon is greater than zero. When there is little variance between wage guesses, almost no one migrates. With a little more variance, a number of individuals do choose to migrate in Aii-4. Thus, the effect of increased variance depends on the sign of epsilon, as we intended to show.

APPENDIX 6

First note that if we are not considering confidence and border costs, we can rewrite the first period equations as follows:

$$P_1^N = 1 - \int_{\varepsilon_1{}^{N,N}}^{\infty} f(x)dx + \int_{\varepsilon_1{}^{S,S}}^{\infty} f(x)dx. \qquad \text{A6.1}$$

$$F_1^N = \int_{\varepsilon_1{}^{S,S}}^{\infty} f(x)dx. \qquad \text{A6.2}$$

$$\varepsilon_1{}^{N,N} = \frac{1}{\vartheta_0}\left[\frac{G_0{}^N}{(2)^\gamma} - \frac{G_0{}^S}{(2)^\gamma}\right]. \qquad \text{A6.3}$$

$$\varepsilon_1{}^{S,S} = \frac{1}{\vartheta_0}\left[\frac{G_0{}^S}{(2)^\gamma} - \frac{G_0{}^N}{(2)^\gamma}\right]. \qquad \text{A6.4}$$

It immediately follows that if ϑ_0 is very large, A6.3 and A6.4 will be very close to zero, so Northern population will change little after first period migration. Notice that A6.3 is exactly the opposite of A6.4. Since in the first period ε is distributed identically over the Northern and Southern populations, Northern migration will exactly equal unity minus Southern migration. In subsequent periods (t > 1), we have to consider return migration, as well as the effect of migration on the $\vartheta_0$terms, so keeping in mind $F_t^N = \frac{1}{2}P_t^N$, and that regardless of type everyone in a given location makes the same migration decision, the relevant equations are as follows:

$$P_t^N = P_{t-1}^N + (2 - P_{t-1}^N)\int_{\varepsilon_t{}^S}^{\infty} f(x)dx - P_{t-1}^N \int_{\varepsilon_t{}^N}^{\infty} f(x)dx. \qquad \text{A6.5}$$

$$\varepsilon_t{}^N = \frac{1}{\vartheta_0 e^{-\left(1-\frac{1}{2}P_{t-1}^N\right)}}\left[\frac{G_0{}^N}{(1+P_{t-1}^N)^\gamma} - \frac{G_0{}^S}{(3-P_{t-1}^N)^\gamma}\right]. \qquad \text{A6.6}$$

$$\varepsilon_t{}^S = \frac{1}{\vartheta_0 e^{-\frac{1}{2}P_{t-1}^N}}\left[\frac{G_0{}^S}{(3-P_{t-1}^N)^\gamma} - \frac{G_0{}^N}{(1+P_{t-1}^N)^\gamma}\right] = \left(-e^{-(1-P_{t-1}^N)}\right)\varepsilon_t{}^N. \qquad \text{A6.7}$$

Notice that we now have $P_t^N = f(P_{t-1}^N)$.

Pf(Prop. 4): As with the other proofs in this paper, the result follows simply from comparing signs. I want to show that if $P_t^N > P_{t-1}^N$, then $P_t^N - P_{t-1}^N > P_{t+1}^N - P_t^N$.

Since $P_t^N > P_{t-1}^N$, both the following inequalities hold: $e^{-\left(1-\frac{1}{2}P_{t-1}^N\right)} < e^{-\left(1-\frac{1}{2}P_t^N\right)}$ and $\frac{{G_0}^N}{\left(1+P_{t-1}^N\right)^\gamma} - \frac{{G_0}^S}{\left(3-P_{t-1}^N\right)^\gamma} > \frac{{G_0}^N}{\left(1+P_t^N\right)^\gamma} - \frac{{G_0}^S}{\left(3-P_t^N\right)^\gamma}$. Thus ${\varepsilon_t}^N > {\varepsilon_{t+1}}^N$, and $\int_{{\varepsilon_t}^N}^{\infty} f(x)dx < \int_{{\varepsilon_{t+1}}^N}^{\infty} f(x)dx$. Moreover, $\int_{{\varepsilon_t}^S}^{\infty} f(x)dx > \int_{{\varepsilon_{t+1}}^S}^{\infty} f(x)dx$ holds in a similar way. We can then write:

$$(2 - P_{t-1}^N)\int_{{\varepsilon_t}^S}^{\infty} f(x)dx - P_{t-1}^N \int_{{\varepsilon_t}^N}^{\infty} f(x)dx > (2 - P_t^N)\int_{{\varepsilon_{t+1}}^S}^{\infty} f(x)dx - P_t^N \int_{{\varepsilon_{t+1}}^N}^{\infty} f(x)dx. \qquad \text{A6.8}$$

Noting that the LHS of A6.8 is $P_t^N - P_{t-1}^N$ and the RHS is $P_{t+1}^N - P_t^N$, the proof is finished.

Stocks of Foreign-Born Population in Selected OECD Countries

(thousands)

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	% Inc. over period
Australia	4 314.5	4 332.1	4 369.3	4 412.0	4 482.1	4 565.8	4 655.6	4 736.3	4 840.7	4 956.9	15%
% of total population	23.3	23.2	23.1	23.0	23.1	23.2	23.4	23.6	23.8	24.1	3%
Austria	..	895.7	872.0	843.0	893.9	873.3	923.4	1 059.1	1,100.5	1,151.5	29%
% of total population	..	11.2	10.9	10.5	11.1	10.8	11.4	13.0	13.5	14.1	26%
Belgium	*1 011.0*	*1 023.4*	*1 042.3*	1 058.8	1 112.2	1 151.8	1 185.5	1 220.1	1 268.9	1 319.3	30%
% of total population	*9.9*	*10.0*	*10.2*	10.3	10.8	11.1	11.4	11.7	12.1	12.5	26%
Canada	*5 082.5*	*5 165.6*	*5 233.8*	*5 327.0*	5 448.5	*5 600.7*	*5 735.9*	*5 872.3*	*6 026.9*	6 187.0	22%
% of total population	*17.7*	*17.8*	*18.0*	*18.1*	18.4	*18.7*	*19.0*	*19.2*	*19.5*	19.8	12%
Czech Republic	..	*440.1*	*455.5*	*434.0*	448.5	*471.9*	*482.2*	*499.0*	*523.4*	*566.3*	*29%*
% of total population	..	*4.3*	*4.4*	*4.2*	*4.4*	*4.6*	*4.7*	*4.9*	*5.1*	*5.5*	*29%*
Denmark	276.8	287.7	296.9	308.7	321.8	331.5	337.8	343.4	350.4	360.9	30%
% of total population	5.2	5.4	5.6	5.8	6.0	6.2	6.3	6.3	6.5	6.6	27%
Finland	118.1	125.1	131.1	136.2	145.1	152.1	158.9	166.4	176.6	187.9	59%
% of total population	*2.3*	*2.4*	*2.5*	2.6	2.7	2.8	2.9	3.2	3.4	3.6	55%
France	..	..	4 306.0	*4 384.6*	*4 477.9*	*4 588.3*	*4 710.6*	*4 837.6*	4 958.5	*5 078.3*	*18%*
% of total population	..	..	7.3	*7.4*	*7.5*	*7.7*	*7.8*	*8.0*	8.1	*8.3*	*13%*
Germany	*9 918.7*	*10 002.3*	*10 172.7*	10 256.1	*10 404.9*	*10 527.7*	*10 620.8*	..	..	..	*7%*
% of total population	*12.1*	*12.2*	*12.4*	12.5	*12.6*	*12.8*	*12.9*	..	..	..	*6%*
Greece	..	..	..	..	1 122.9	..	..	..	..	..	..
% of total population	..	..	..	..	10.3	..	..	..	..	..	..
Hungary	284.2	286.2	289.3	294.6	300.1	302.8	307.8	319.0	331.5	344.6	21%
% of total population	2.8	2.8	2.9	2.9	3.0	3.0	3.0	3.2	3.3	3.4	22%
Ireland	*271.2*	*288.4*	*305.9*	*328.7*	*356.0*	390.0	*428.9*	*468.6*	*526.6*	601.7	122%
% of total population	*7.4*	*7.8*	*8.2*	*8.7*	*9.3*	10.0	*10.8*	*11.6*	*12.7*	14.4	95%
Italy	..	..	..	..	1 446.7	..	..	..	..	..	..
% of total population	..	..	..	..	2.5	..	..	..	..	..	..
Luxembourg	*134.1*	*137.5*	*141.9*	*145.0*	144.8	*147.0*	*148.5*	*150.0*	*154.0*	*159.7*	*19%*
% of total population	*31.9*	*32.2*	*32.8*	*33.2*	32.8	*32.9*	*33.0*	*33.2*	*33.8*	*34.8*	*9%*
Mexico	..	..	..	406.0	..	..	..	..	434.6	..	7%
% of total population	..	..	..	0.5	..	..	..	..	0.4	..	-20%
Netherlands	1 469.0	1 513.9	1 556.3	1 615.4	1 674.6	1 714.2	1 731.8	1 736.1	1 734.7	1 732.4	18%
% of total population	9.4	9.6	9.8	10.1	10.4	10.6	10.7	10.6	10.6	10.6	13%
New Zealand	*620.8*	*630.5*	*643.6*	*663.0*	698.6	*737.1*	*770.5*	*796.7*	*840.6*	*879.5*	42%
% of total population	*16.4*	*16.5*	*16.8*	*17.2*	18.0	*18.7*	*19.2*	*19.6*	*20.5*	*21.2*	29%
Norway	257.7	273.2	292.4	305.0	315.2	333.9	347.3	361.1	380.4	405.1	57%
% of total population	5.8	6.1	6.5	6.8	6.9	7.3	7.6	7.8	8.2	8.7	49%
Poland	..	..	..	..	..	776.2	..	..	..	..	..
% of total population	..	..	..	..	..	1.6	..	..	..	..	..
Portugal	*523.4*	*516.5*	*518.8*	*522.6*	651.5	*699.1*	*705.0*	*714.0*	*661.0*	*649.3*	*24%*
% of total population	*5.3*	*5.1*	*5.1*	*5.1*	6.3	*6.7*	*6.7*	*6.8*	*6.3*	*6.1*	*16%*
Slovak Republic	..	..	..	..	119.1	*143.4*	*171.5*	207.6	*249.4*	*301.6*	*153%*
% of total population	..	..	..	..	2.5	*2.7*	*3.2*	3.9	*4.6*	*5.6*	*124%*
Spain	1 173.8	1 259.1	1 472.5	1 969.3	2 594.1	3 302.4	3 693.8	4 391.5	4 837.6	5 250.0	347%
% of total population	3.0	3.2	3.7	4.9	6.4	8.0	8.8	10.3	11.1	11.9	302%
Sweden	954.2	968.7	981.6	1 003.8	1 028.0	1 053.5	1 078.1	1 100.3	1 125.8	1 175.2	23%
% of total population	10.8	11.0	11.8	11.3	11.5	11.8	12.0	12.2	12.4	12.9	19%
Switzerland	*1 512.8*	*1 522.8*	*1 544.8*	1 570.8	*1 613.8*	*1 658.7*	*1 697.8*	*1 737.7*	*1 772.8*	*1 811.2*	*20%*
% of total population	*21.3*	*21.4*	*21.6*	21.9	*22.3*	*22.8*	*23.1*	*23.5*	*23.8*	*24.1*	*13%*
Turkey	..	..	..	1 278.7	..	..	..	..	..	..	..
% of total population	..	..	..	1.9	..	..	..	..	..	..	..
United Kingdom	*4 222.4*	*4 335.1*	*4 486.9*	*4 666.9*	4 865.6	*5 075.6*	*5 290.2*	*5 552.7*	*5 841.8*	*6 116.4*	*45%*
% of total population	*7.2*	*7.4*	*7.6*	*7.9*	8.2	*8.6*	*8.9*	*9.3*	*9.7*	*10.1*	*39%*
United States (revised)	*29 272.2*	*29 892.7*	*29 592.4*	31 107.9	*32 341.2*	*35 312.0*	*36 520.9*	*37 591.8*	*38 343.0*	*39 054.9*	*33%*
% of total population	*10.7*	*10.8*	*10.6*	11.0	*11.3*	*12.3*	*12.6*	*12.8*	*12.9*	*13.0*	*21%*

Note: Estimated figures are in italic. Data for Canada, France, Ireland, New Zealand, the Slovak Rep., the United Kingdom and the United States are estimated with the parametric method (PM). Data for Belgium (1995-1999), Czech Republic, Germany, Luxembourg, Portugal and Switzerland are estimated with the component method (CM).
For details on estimation methods, please refer to http://www.oecd.org/els/migration/foreignborn.
For details on definitions and sources, refer to the metadata at the end of Tables B.1.4.

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Table 1

Table 2: First Period Migration by Initial θ Value		
Initial θ	Southern Migration	Northern Migration
0.005	≈100%	≈0%
500	98%	2%
1000	84%	16%
2000	69%	31%
3000	63%	37%
5000	58%	42%
10000	54%	46%
Note: Initial Wage Gap 11000-10000 = 1000		

Table 3: Homogenous Risk Aversion Examples									
Row No.	North Wage	South Wage	Θ	σ	Border Cost	Eq. Type	Northern Eq. Pop.	Eq. Wage Gap	Eq. Migration
1	11000	10000	1E-05	0	0	Oss	(0,2)	(4688,-2571)	2
2	11000	10000	3500	0	0	Oss	(0.65,1.65)	(2112,-1148)	1.15
3	11000	10000	4500	0	0	Stable	1.15	524	0.99
4	17000	10000	3500	0	0	Stable	1.79	3756	0.42
5	11000	10000	1000	2000	1000	Stable	1.24	250	0.16

Table 4: Homogenous Risk Aversion Means					
Row No.	$\overline{\rho}$	Eq. Type	Northern Eq. Pop.	Eq. Wage Gap	Eq. Mig.
1	0	Oss	(2.00,.06)	(4384,-2570)	1.94
2	.5	Stable	1.24	250	0.16
3	1	Stable	1.24	248	0.06
4	3	Stable	1.23	279	0.00
5	5	Stable	1.01	972	0.00

Table 5: Heterogeneous Risk Aversion Variance (mean RA=.5, settings from Chart 5)					
Row No.	$\sigma^2(\rho)$	Eq. Type	Northern Eq. Pop.	Eq. Wage Gap	Eq. Migratn
1	0	Stable	1.24	250	0.16
2	.5	Stable	1.24	253	0.21
3	1	Oss	(.49,1.84)	(2689,-1891)	1.36
4	3	Stable	1.19	413	0.66
5	5	Stable	1.15	533	0.78

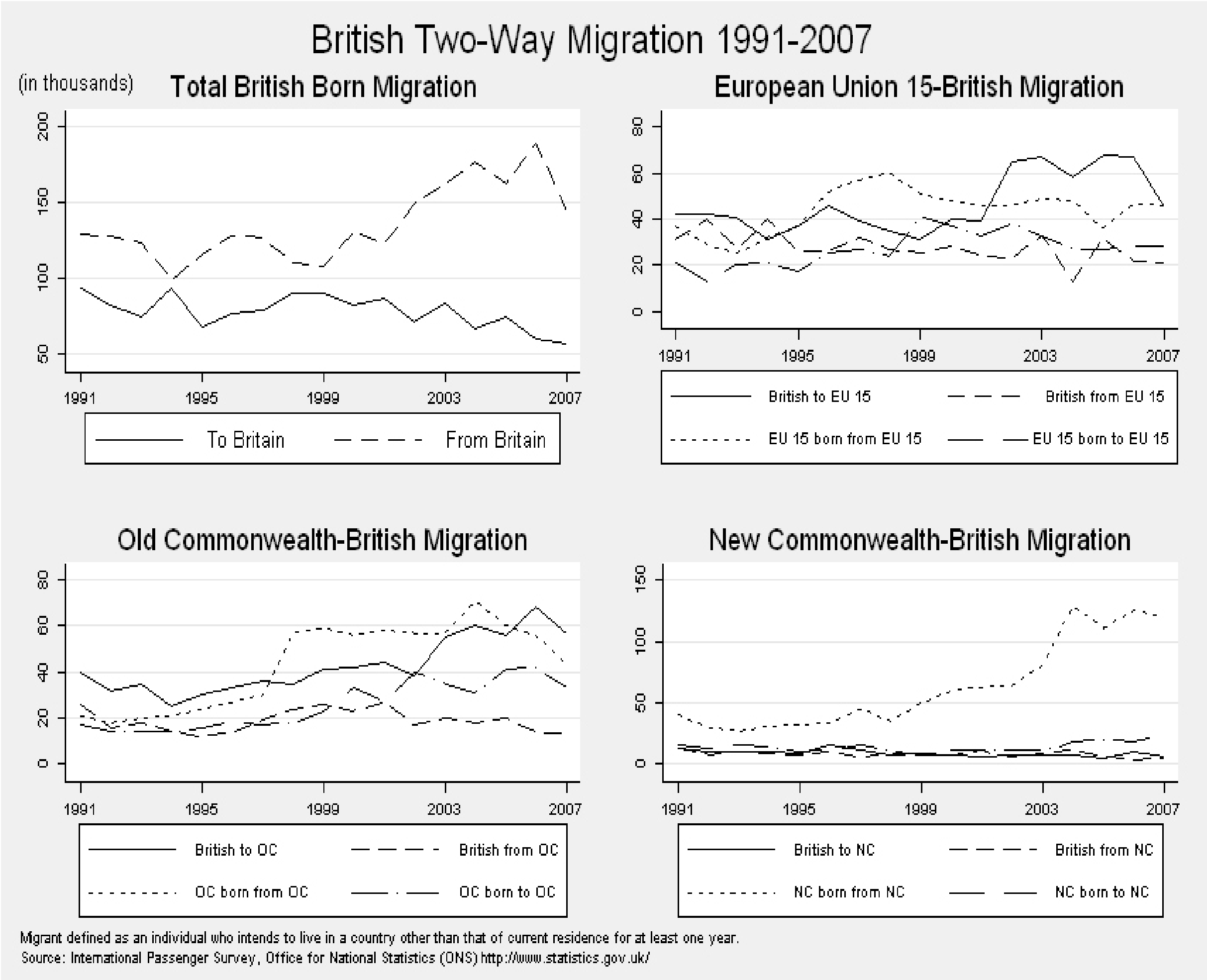

British Two-Way Migration 1991-2007
(in thousands)
Total British Born Migration
To Britain
From Britain
European Union 15-British Migration
British to EU 15
British from EU 15
EU 15 born from EU 15
EU 15 born to EU 15
Old Commonwealth-British Migration
British to OC
British from OC
OC born from OC
OC born to OC
New Commonwealth-British Migration
British to NC
British from NC
NC born from NC
NC born to NC
Migrant defined as an individual who intends to live in a country other than that of current residence for at least one year.
Source: International Passenger Survey, Office for National Statistics (ONS) http://www.statistics.gov.uk/

Figure 1

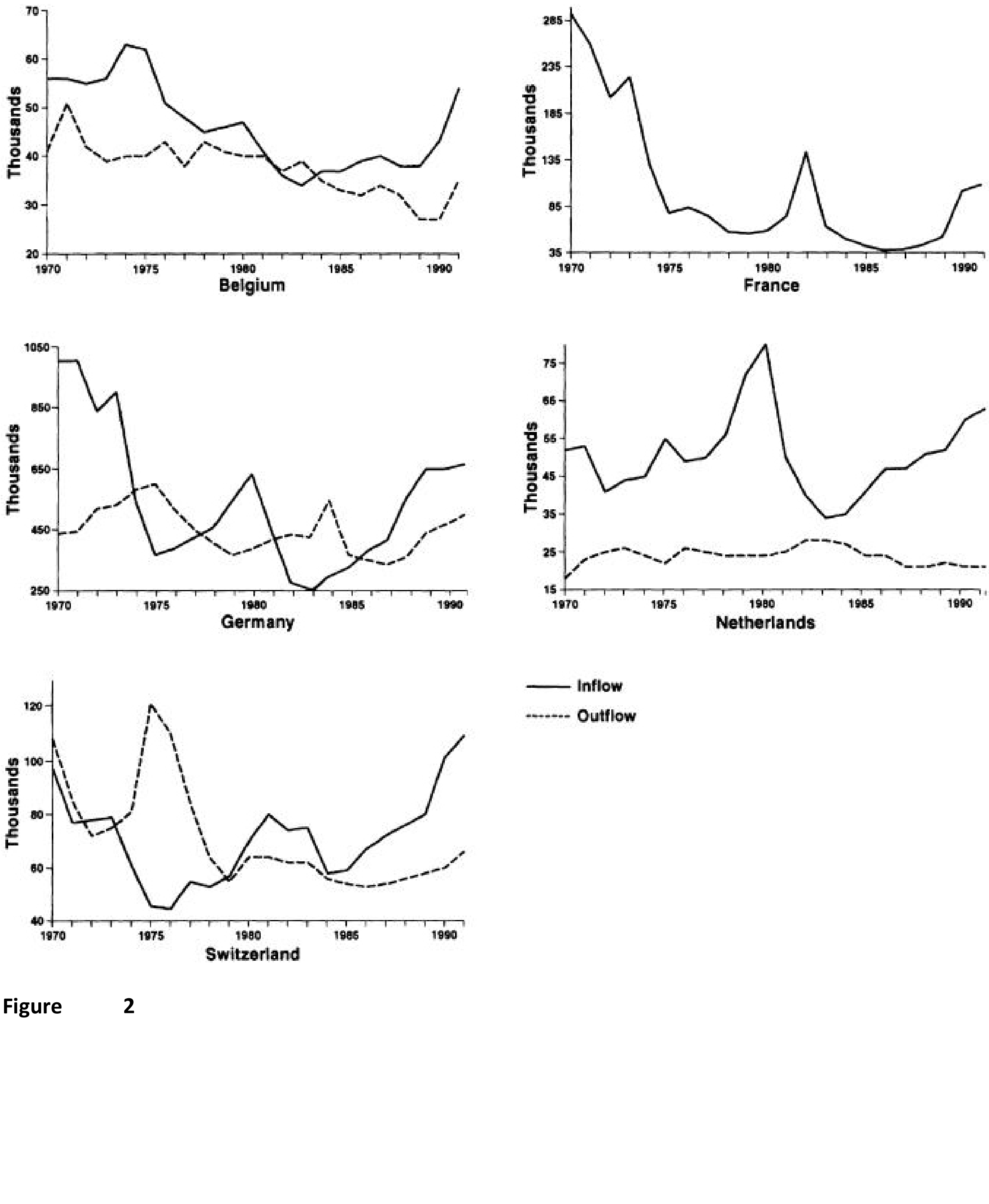
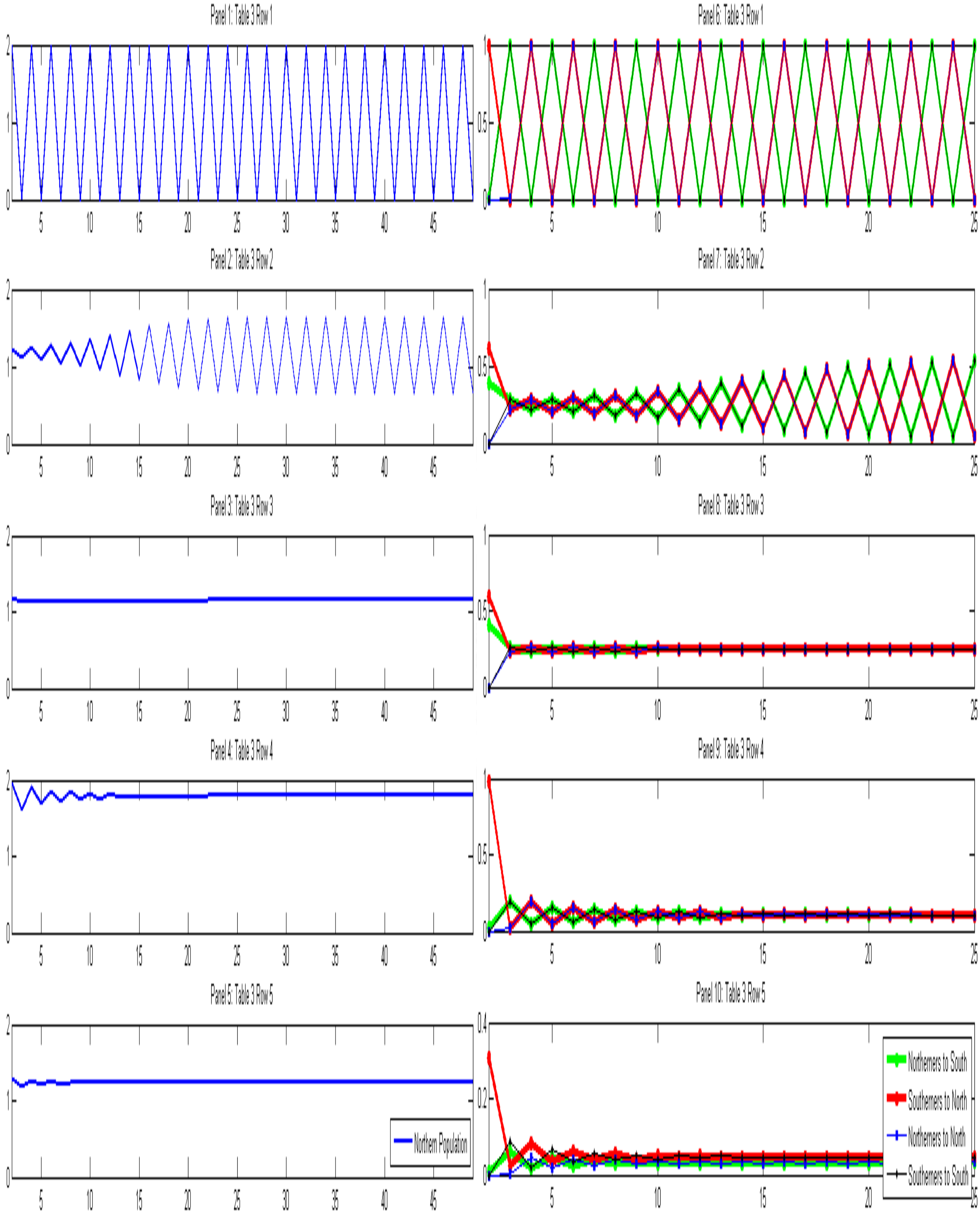

Thousands
1970
1975
1980
1985
1990
Belgium
France
Germany
Netherlands
Switzerland
Inflow
Outflow

Figure 2



Panel 1: Table 3 Row 1
Panel 6: Table 3 Row 1
Panel 2: Table 3 Row 2
Panel 7: Table 3 Row 2
Panel 3: Table 3 Row 3
Panel 8: Table 3 Row 3
Panel 4: Table 3 Row 4
Panel 9: Table 3 Row 4
Panel 5: Table 3 Row 5
Panel 10: Table 3 Row 5
Northern Population
Northerners to South
Southerners to North
Northerners to North
Southerners to South

Figure 3

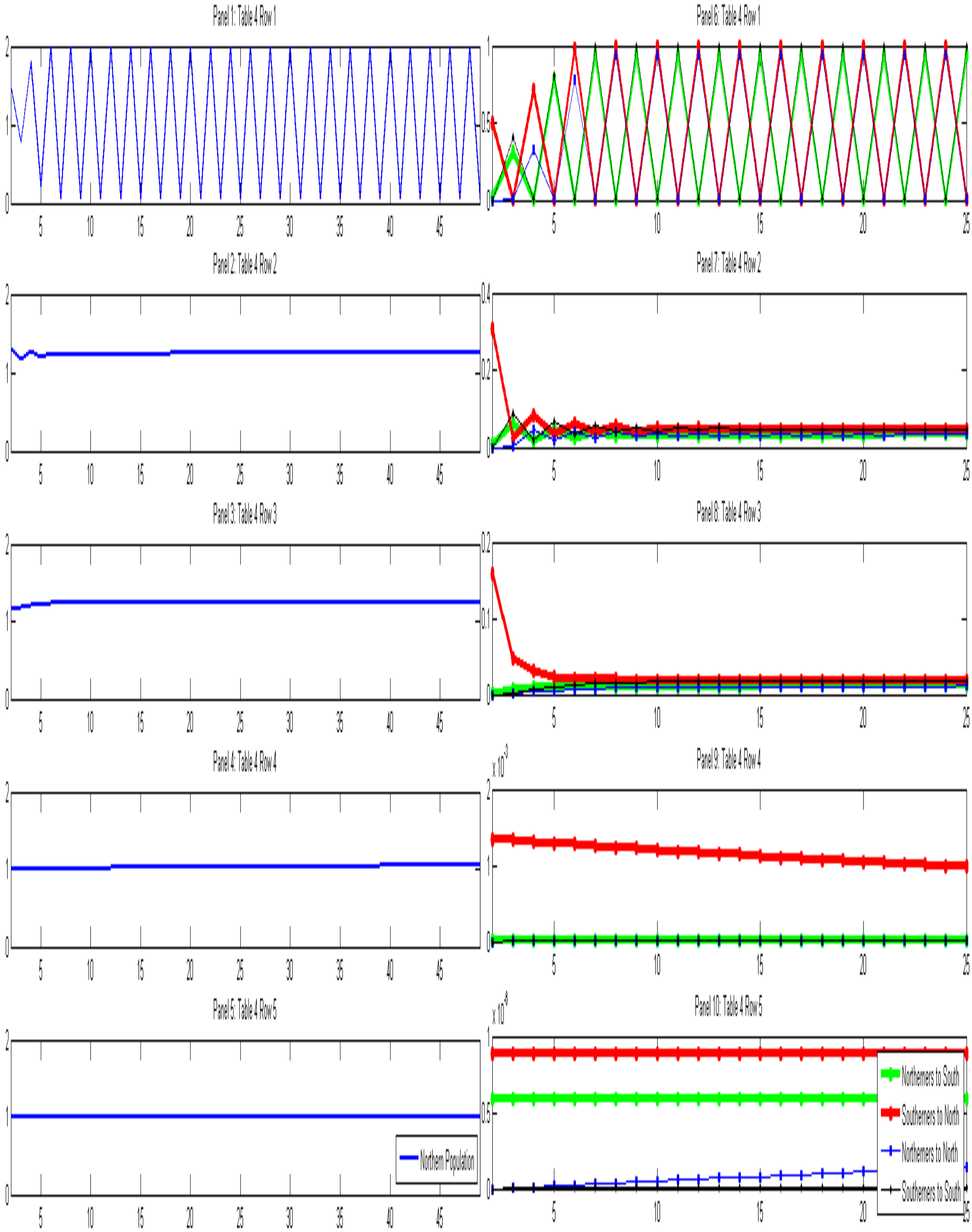

Panel 1: Table 4 Row 1
Panel 6: Table 4 Row 1
Panel 2: Table 4 Row 2
Panel 7: Table 4 Row 2
Panel 3: Table 4 Row 3
Panel 8: Table 4 Row 3
Panel 4: Table 4 Row 4
Panel 9: Table 4 Row 4
Panel 5: Table 4 Row 5
Panel 10: Table 4 Row 5
Northern Population
Northerners to South
Southerners to North
Northerners to North
Southerners to South

Figure 4

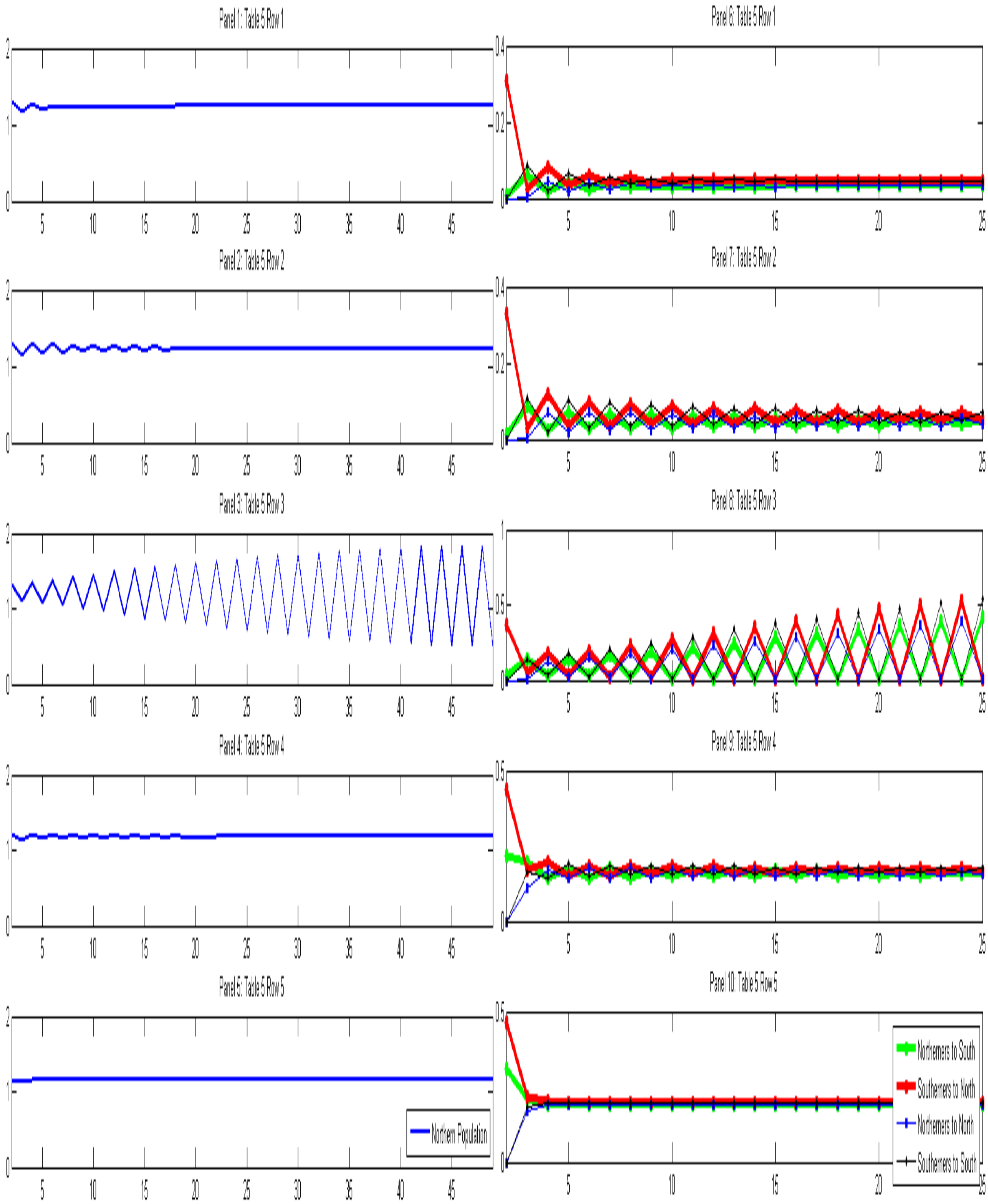

Panel 1: Table 5 Row 1
Panel 6: Table 5 Row 1
Panel 2: Table 5 Row 2
Panel 7: Table 5 Row 2
Panel 3: Table 5 Row 3
Panel 8: Table 5 Row 3
Panel 4: Table 5 Row 4
Panel 9: Table 5 Row 4
Panel 5: Table 5 Row 5
Panel 10: Table 5 Row 5
Northern Population
Northerners to South
Southerners to North
Northerners to North
Southerners to South

Figure 5

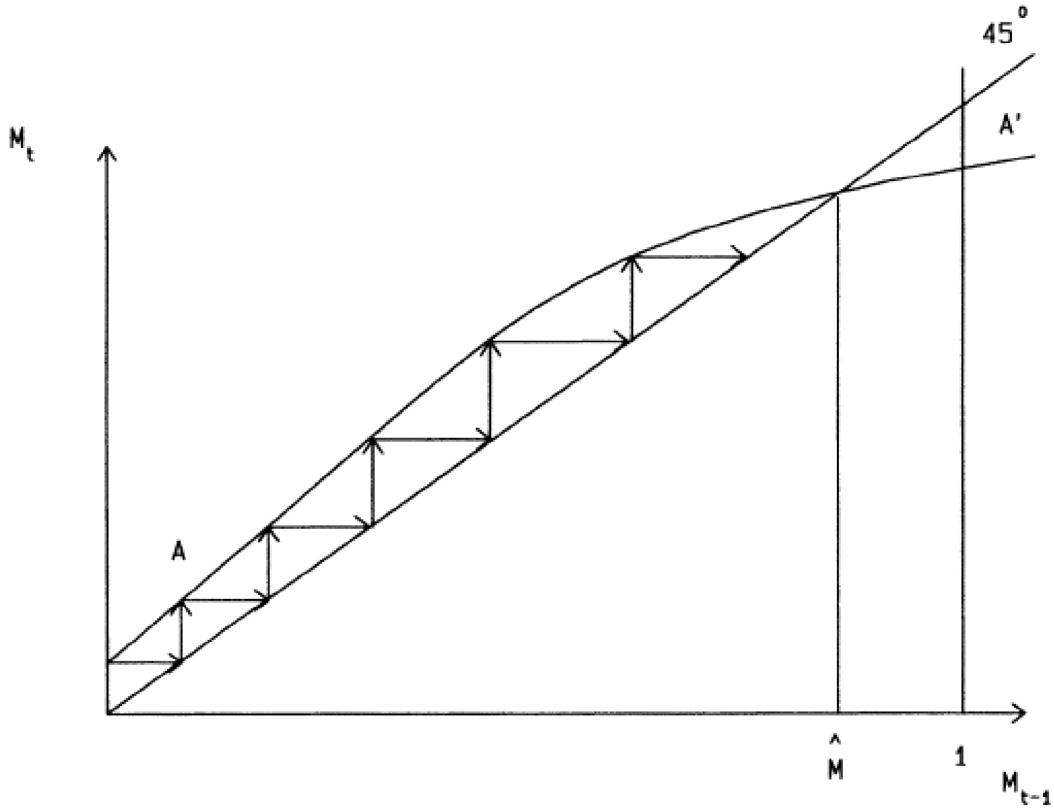


FIGURE 2. PHASE DIAGRAM OF THE CASE WHERE THE STOCK OF MIGRANTS CONVERGES TO A STEADY-STATE VALUE $M < 1$

Notes: The above graph is based on the following numerical example. The inverse labor demand functions are $\gamma^N(M_t) = 0.80$ and $\gamma^S(M_t) = 0.80 - 0.05(1 - M_t)^2$, the discount factor $\delta = 0.75$, the distribution of types is given by $F(h) = (h)^{0.125}$, so that $F^{-1}(M_t) = \phi(M_t) = M_t^8$, and the cost of moving $c[M_{t-1}, \phi(M_t)] = 3.8 - M_{t-1} + 2M_t^8$.

Figure 6

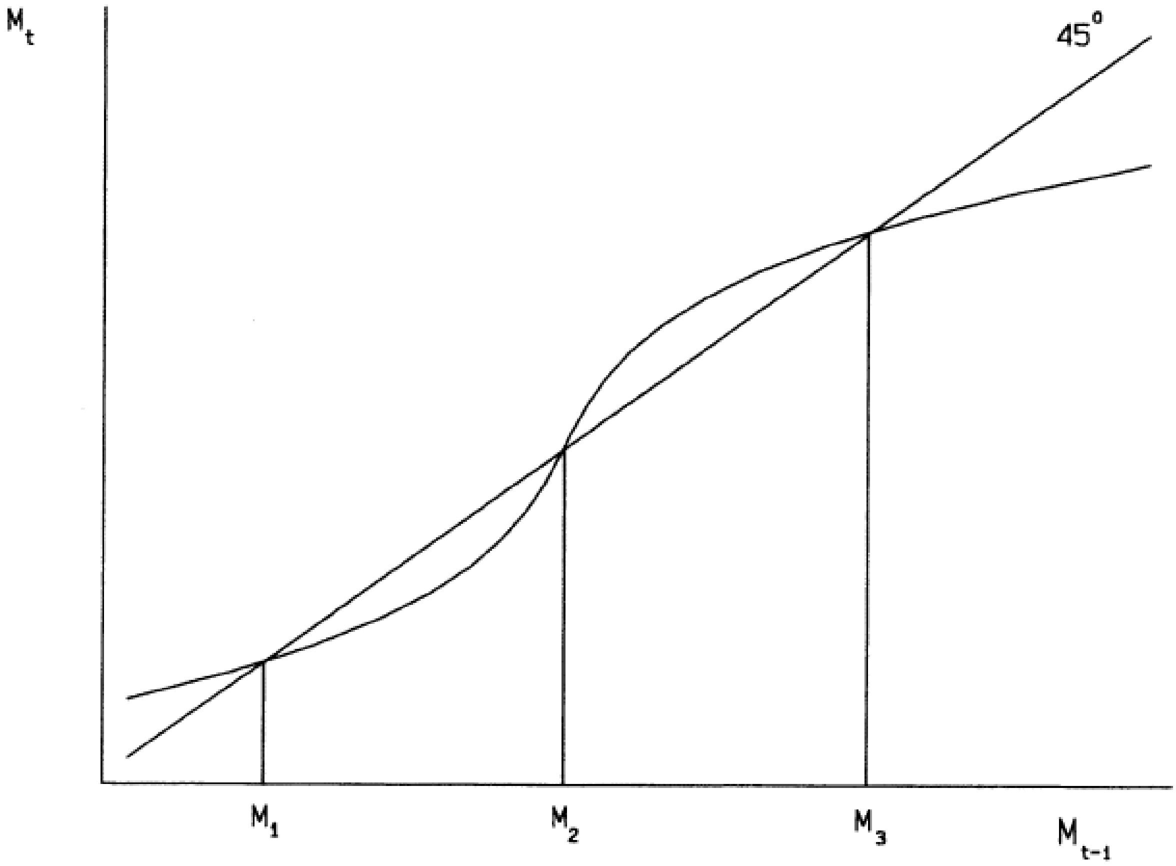


FIGURE 3. PHASE DIAGRAM OF THE CASE WITH MULTIPLE STEADY STATES

Notes: The above graph is based on the following numerical example. The inverse labor demand functions are $\gamma^N(M_t) = 14.61 - 7\,(1 + M_t)^2$ and $\gamma^S(M_t) = 3 - 0.05\,(1 - M_t)^2 + 4\,(1 - M_t)^3$, the discount factor $\delta = 0.95$, the distribution of types is given by $F(h) = (h)$, so that $F^{-1}(M_t) = \phi(M_t) = M_t$, and the cost of moving $c[M_{t-1}, \phi(M_t)] = -M_{t-1} + \phi(M_t)$.

Figure 7

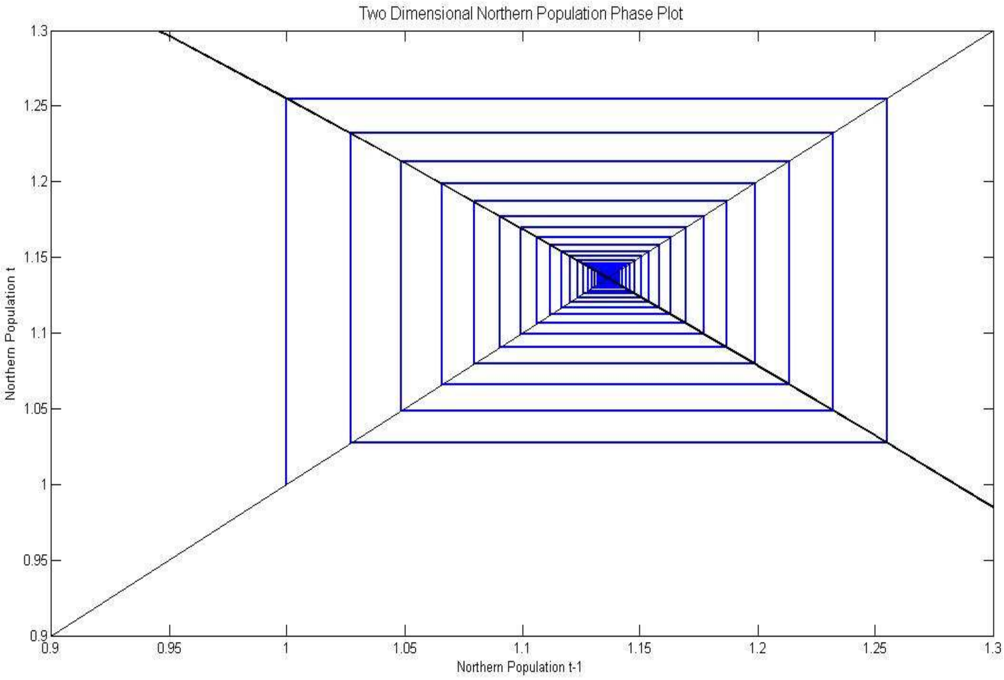
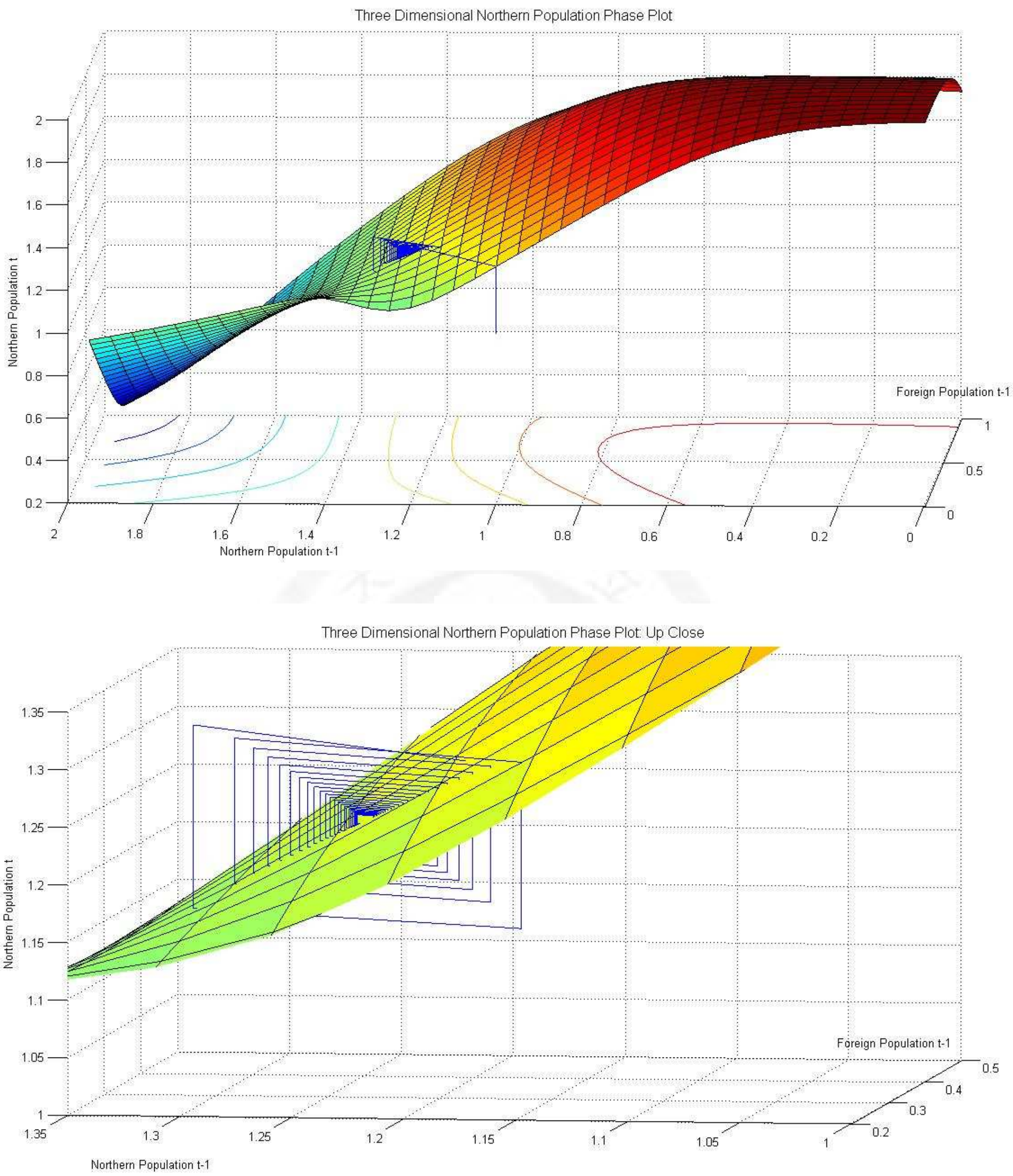

Two Dimensional Northern Population Phase Plot
Northern Population t
Northern Population t-1
1.3
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
0.9
0.95
1
1.05
1.1
1.15
1.2
1.25
1.3

Figure 8



(Settings from Table 5 Row 2)

Figure 9

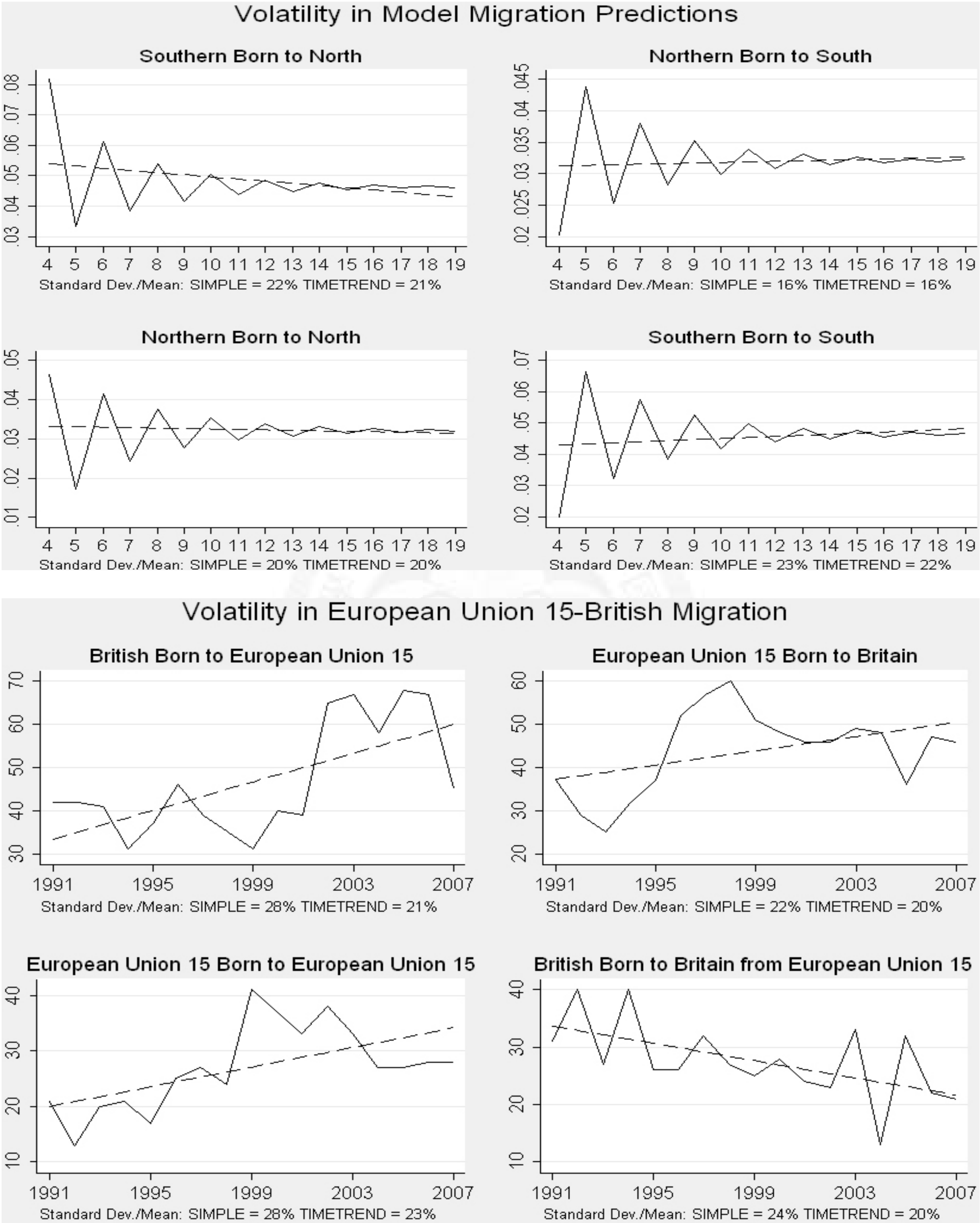

Volatility in Model Migration Predictions
Southern Born to North
Standard Dev./Mean: SIMPLE = 22% TIMETREND = 21%
Northern Born to South
Standard Dev./Mean: SIMPLE = 16% TIMETREND = 16%
Northern Born to North
Standard Dev./Mean: SIMPLE = 20% TIMETREND = 20%
Southern Born to South
Standard Dev./Mean: SIMPLE = 23% TIMETREND = 22%
Volatility in European Union 15-British Migration
British Born to European Union 15
Standard Dev./Mean: SIMPLE = 28% TIMETREND = 21%
European Union 15 Born to Britain
Standard Dev./Mean: SIMPLE = 22% TIMETREND = 20%
European Union 15 Born to European Union 15
Standard Dev./Mean: SIMPLE = 28% TIMETREND = 23%
British Born to Britain from European Union 15
Standard Dev./Mean: SIMPLE = 24% TIMETREND = 20%

Figure 10

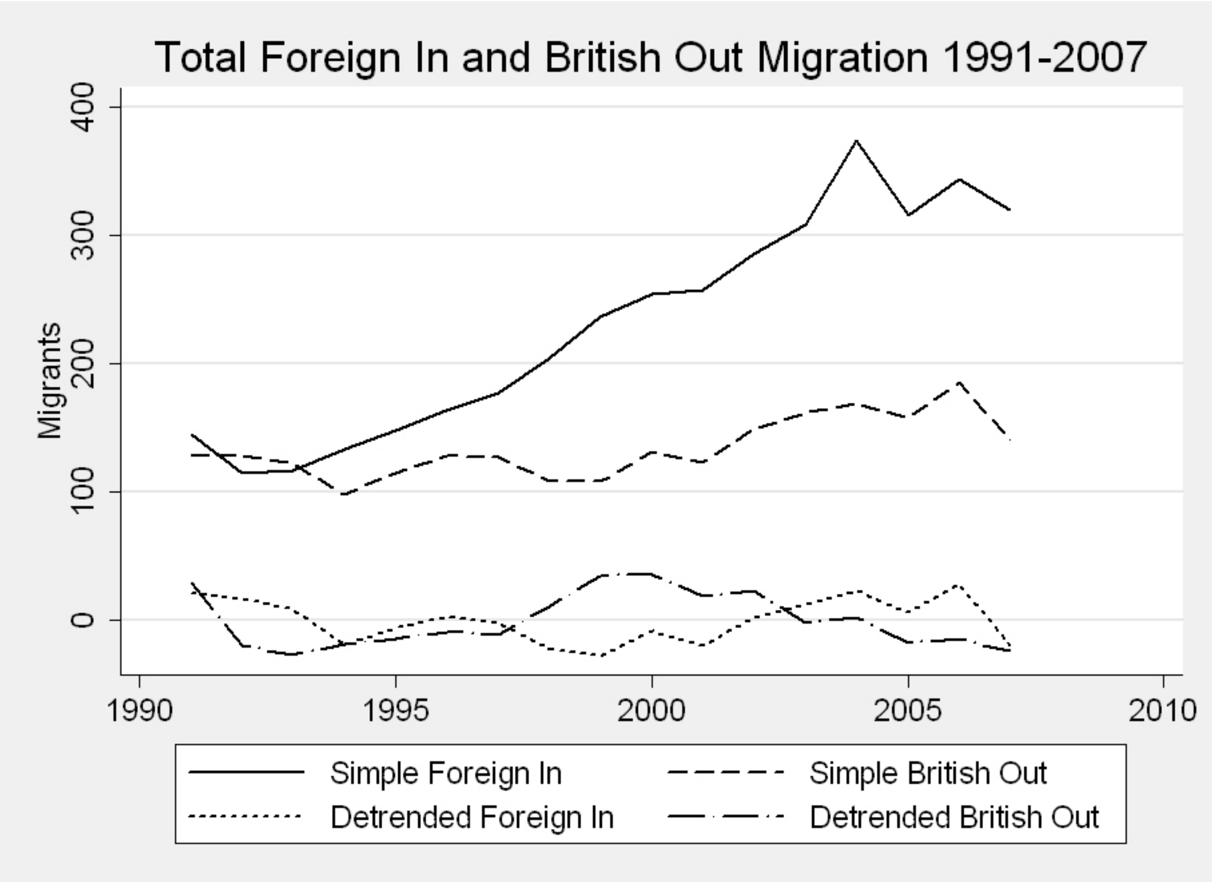

Total Foreign In and British Out Migration 1991-2007
Migrants
0
100
200
300
400
1990
1995
2000
2005
2010
Simple Foreign In
Simple British Out
Detrended Foreign In
Detrended British Out

Figure 11