# Uncertainty and International Migration: An Option cum Portfolio Model

Mahmudul Anam, Shin-Hwan Chiang, Lieng Hua[*†]

April 2005

**Abstract**

Real option theory suggests that migration may be delayed beyond the Marshallian trigger since the option value to waiting may be sufficiently positive in the face of uncertainty. Intuition, as is well known from the pioneering work of Dixit and Pindyk (1994), is that waiting may resolve uncertainty and thus enable avoidance of downside risk of an irreversible investment. Burda (1993,1995) was the first to use real option theory to explain slow rates of migration from East to West Germany despite a large wage differential. This literature on migration, however, is confined to models where individual is the decision-maker. By contrast, in this paper we present a model where a multi-member family rather than the individual is the decision- making unit. The introduction of the family in the context of a stochastic migration model create the interesting possibility that migration may be partly driven by a portfolio motive, the desire by the family to diversify the location of its members in order to reduce risk. We develop a two-period model incorporating both the option and the portfolio motive as the triggers determining family's optimum timing of migration. The optimum delay before migration is shown to depend on the uncertainty parameters of the model including risk aversion and income correlation between origin and destination countries. A novelty of our model is that the portfolio motive may induce migration of some family members when option value alone would have called for delay. Using aggregate Canadian data on immigrant visa issuance and landing, we employ correlation method to infer average waiting period before the option to migrate appear to have been exercised for migrants from Hong Kong, Italy and India.

[*]Department of Economics, York University, Toronto, Ontario, Canada M3J 1P3.

[†]We are indebted to two anonymous referees, Andrea Ichino, Beland Nicolas, and the seminar participants of 2005 ASSA and 2004 CEA meetings for their very helpful comments and suggestions.

# 1 Introduction

It is not uncommon for potential migrants to procrastinate before they finally settle in a new country such as Canada. In the context of Canada this procrastination can manifest itself in a couple of ways. Firstly, migrants upon issuance of the immigrant visa, which typically carries a validity of up to one year, often wait until close to the expiry date of the visa before they land. Secondly, after landing, the migrant family (or some of its members) may return to the place origin, thereby postponing the decision to permanently migrate to a future date. Until recently, in Canada, permanent residents were allowed to stay out of country for six months in a given year. Many landed immigrants are known to have taken advantage of this regulation by simply making two trips to Canada in a year and maintain their status without settling. Alternatively, with a returning resident permit, out of country stay could be extended up to a year. These permits themselves could be renewed at least a couple of times. Recent reform in immigration policy requires that permanent residents spend three years in a five-year cycle to maintain their status. Effectively this allows a migrant, upon landing, two years before they must decide on permanent residence in Canada.

That migrants often prefer to take advantage of the time allowed before they must make a final decision is not surprising. There are logistical impediments to closing one's ties to the source country and settle in a new one. However, beyond that, the preference for more time to exercise the option to migrate is undoubtedly driven by uncertainty. This is now well recognized in the new literature on migration that applies the real options theory to the problem of migration. The intellectual origin of this approach is the classic papers by Dixit (1989, 1992), and Dixit and Pyndyck (1994) where they demonstrate that when future profits are uncertain delaying an irreversible investment can carry positive option value. The intuition being that waiting may help resolve some of the uncertainty and thereby the avoidance of downside risk. Borrowing some of the insights of this literature Burda (1993, 1995) was the first to apply the option value framework to the context of migration. Absent uncertainty, migration is driven by so-called Marshallian trigger, the point at which the present value of the benefits exceeds the cost of migration. However, using internal migration in Germany as an example Burda points out that migration rates from East to West Germany were too slow in the face of a large wage differential to be consistent with the deterministic models of migration. Applying the real options theory, Burda shows that the lethargy of the potential migrants is perfectly rational given uncertainty and the consequent positive option value of waiting.[1] This theme is further extended by O'Connell (1997) who also demonstrates that uncertainty about future conditions at home and abroad can delay migration. But on the other hand, uncertainty about current condition abroad can encourage speculative or the so-called "try your luck" type migration. Along the

[1] Ambiguous effects of the wage gap on migration propensity can also arise for reasons other than uncertainty and option value effect. For example, unemployment (Harris and Todaro (1970)), wage dispersion (Borjas (1991)) and permant income and human capital aspect of migration (Sjaastad (1962) have all been shown to be reasons why current earning differentials may not adequately summarize the incentive to migrate. Along the same line, Xu (1992) shows that the presence of risk may lead to insufficient rural-urban migration, causing an urban labour shortage and lower, than desirable, economic growth. The relatively rich rural dwellers tend to move to the cities whilst the relatively poor rural households migrate to more affluent rural locations (rural-to-rural migration), despite the presence of higher wage rates in the cities.

same line, Wang and Wirjanto (2004) show that migration timing may depend on individual risk as well as markets conditions in source and destination regions.

Migration models incorporating real options theory have, however, been confined to the case of individual migrants. There are alternative models of migration in which the decision making unit is the extended family rather than individual members (see, e.g., Stark (1991), Anam and Chiang (2002), and Chen et al. (2003)). The new insight created by family-based migration model is that when markets are uncertain and potentially correlated, it may be optimal for a risk-averse family to split and diversify. Despite the obvious psychological cost of separation there is anecdotal evidence that many immigrant families to Canada particularly from the oil-rich middle-eastern region, separate with the principal applicant continuing employment in the source country with the rest of the family residing in Canada. In our view, this behavior is consistent with a portfolio motive of diversifying the income source in the face of uncertainty. The objective of our paper is to analyze a family-based, stochastic model of migration combining the real options and portfolio theories. We develop a two-period stochastic model of family migration and demonstrate that the portfolio motive may induce migrant families to hasten migration of some of its members when option value alone would have called for delay. The net effect on the timing of migration in the face of uncertainty is shown to depend on the combined effect of option value and diversification effects. Therefore, the comparative static results of our option cum portfolio model can potentially deviate from models based exclusively on either of the two effects. Because migration is now partly driven by diversification motive, risk aversion and income correlation play a significant role in determining the optimum timing of migration.

The empirical motivation of the model comes partly from the experience of Hong Kong emigrants during the nineties. Faced with uncertainties created by the impending reunification with China, Hong Kong families, in our view, faced the kind of trade off presented in our model in determining the timing of migration.

The organization of the paper is as follows. Section 2 presents the basic two-period stochastic model of family migration. Section 3 examines the family migration decision when both domestic and foreign markets are uncertain and stochastically correlated. Section 4 works out the comparative static implications of the model. Section 5 applies the simple correlation method to track co-movement of visa and landing data for Canadian immigrants from Hong Kong, Italy and India. We also use a simple regression model to test robustness of our theoretical results. Finally, Section 6 is concluding remarks.

# 2 The Basic Model

Consider a family of $n$ homogenous members, making its migration decision in a two-period setting. Migration can take place either in period 1 or 2. In period 1, home and foreign wages, denoted by respectively, are assumed to be deterministic.[2] In period 2, both home and foreign markets are subject to some idiosyncratic

[2] Needless to say, the non-monetary factors (such as environment, air quality, etc.) may play important roles in migration decisions. However, our analysis can be readily extended to incorporate these factors.

shocks. Let home and foreign wages be $h + \gamma_h e_h$ and $f + \gamma_f e_f$ respectively, where $e_h$ and $e_f$ are random variables. To simplify our analysis, assume that

$$e_f = \rho e_h + x$$

where $E(e_h) = E(x) = 0$, $Var(e_h) = Var(x) = 1$, and $e_h$ and $x$ are orthogonal, i.e., $E(e_h x) = 0$. Hence, $Cov(e_f,\, e_h) = E(e_f e_h) = \rho$, $Var(h + \gamma_h e_h) = \gamma_h^2$, and $Var(f + \gamma_f e_f) = \gamma_f^2(\rho^2 + 1)$. Note that $\gamma_h$ and $\gamma_f$ capture the degree of market variability. Without loss of generality, assume that home income risk is greater than foreign income risk, i.e., $\gamma_h^2 > \gamma_f^2(\rho^2 + 1)$. This implies that $\gamma_h > \gamma_f > \gamma_f \rho$.

Migration decisions are made in both periods. In period 1, the household decision maker decides to allocate $m$ members of the family to the foreign country at an up-front cost of $c(m)$, with $c'(m) > 0$ and $c''(m) < 0$.[3] This part of migration cost is family-based and may include information costs, psychological costs (e.g., the stress for leaving behind the region of familiarity), and the cost associated with the need to adopt to different culture and linguistic traditions.[4] Other than such up-front costs, there is an individual-based cost (e.g., transportation costs), denoted by $t$ per member.

When $e_h$ and $e_f$ become known in period 2, further migration decision will be made regarding the remaining $n - m$ members. Clearly, the family will migrate the rest of its members only if $f + \gamma_f e_f - t > h + \gamma_h e_h$, or $e_0 = (f - t - h + \gamma_f x)/(\gamma_h - \gamma_f \rho) > e_h$. Note that the probability of migrating the remaining $n - m$ member in period 2 is $P = \int_{-\infty}^{\infty} \int_{-\infty}^{e_0} k(e_h) de_h g(x) dx$, where $k(e_h)$ and $g(x)$ are the density functions for the random variables $e_h$ and $x$, respectively. Their distribution functions are $K(e_h)$ and $G(x)$.

We assume that the family acts as a homogenous unit which maximizes a family utility function. In many patriarchal societies, the families are led by a dominant head (usually the father). In these cases, it is reasonable to assume that there exists an authoritative head or benevolent dictator in the family who controls the migration decision of its members based on some aggregate measure of utility. Assume that the family preference is characterized by the Von Neumann-Morgenstein utility, $u(I)$ with $u^{'} > 0$ and $u^{''} \leq 0$. The head of the household chooses $m$ to solve the following maximization problem:

$$\begin{aligned} Max_m \ EU_h &= u(I_1) + \frac{1}{1+\delta}\left[\int_{-\infty}^{\infty}\int_{-\infty}^{e_0} u(I_{21}) dK(e_h) dG(x) \right. \\ &\left. + \int_{-\infty}^{\infty}\int_{e_0}^{\infty} u(I_{22}) dK(e_h) dG(x)\right] \\ &= u(I_1) + \frac{1}{1+\delta}[A + B] \\ s.t.\ n &\geq m \geq 0 \end{aligned}$$

where

[3] For simplicity, it is assumed that no return migration is possible.
[4] For details, see Daveri and Faini (1999).

$$
\begin{aligned}
A &= \int_{-\infty}^{\infty}\int_{-\infty}^{e_0}[u(I_{21})-u(I_{22})]dK(e_h)dG(x)\\
B &= \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}u(I_{22})dK(e_h)dG(x)\\
I_1(m) &= m(f-t)+(n-m)h-c(m);\\
I_{21}(m;\ e_h,x) &= n[f+\gamma_f(\rho e_h+x)]-(n-m)t;\\
I_{22}(m;\ e_h,x) &= m[f+\gamma_f(\rho e_h+x)]+(n-m)(h+\gamma_h e_h).
\end{aligned}
$$

In period 1, the family earns $I_1$. In period 2, the family earns $I_{21}$ when $e_h < e_0$ and $I_{22}$ when $e_h \geq e_0$. Note that $u(I_{21})-u(I_{22})$ represents the difference in period-2 utility between two scenarios: migrating all remaining $n-m$ members abroad or keeping them home. If the family is not given an option to wait (i.e., no migration will occur in period 2), the family income in period 2 would be $I_{22}$, which yields the second-period expected utility, $B$. Conversely, with an option to move some or all of $n-m$ members in period 2, the expected second-period utility becomes $A+B$, which exceeds $B$ by $A$. In this sense, $A$ can be viewed as the expected utility gain that results from information revelation. Notice that the option value gain arises from the ability by the family to postpone migration of $n-m$ members who are held back after $m$ members have been moved to capture the diversification gain. In the absence of this flexibility, then $A=0$. In this case, the expected utility of the family is $B$ only. The decomposition of $EU_h$ into $A$ and $B$ allows us to clearly see the interaction between the option value effect and the diversification effect in our analysis below.

# 3 Migration Decisions

The Lagrangian function associated with the above maximization program is

$$L = u(I_1)+[A+B]/(1+\delta)+\lambda_1(n-m)+\lambda_2 m.$$

where $\lambda_1$ and $\lambda_2$ are the Lagrangian multipliers for $n-m \geq 0$ and $m \geq 0$, respectively. The first-order necessary conditions are[5]

$$
\begin{aligned}
\frac{\partial L}{\partial m} &= u'(I_1)[f-t-h-c'(m)]+\frac{1}{1+\delta}[\frac{\partial A}{\partial m}+\frac{\partial B}{\partial m}]-\lambda_1+\lambda_2=0; && (1)\\
\frac{\partial L}{\partial \lambda_1} &= n-m>0;\ \frac{\partial L}{\partial \lambda_1}\lambda_1=\lambda_1(n-m)=0; && (2)\\
\frac{\partial L}{\partial \lambda_2} &= m>0;\ \ \frac{\partial L}{\partial \lambda_2}\lambda_2=\lambda_2 m=0. && (3)
\end{aligned}
$$

where $\partial A/\partial m = \int_{-\infty}^{\infty}\int_{-\infty}^{e_0}[u'(I_{21})t - u'(I_{22})(f+\gamma_f(\rho e_h+x)-h-\gamma_h e_h)]dK(e_h)dG(x)$ and $\partial B/\partial m = E[u'(I_{22})][f+\gamma_f(\rho e_h+x)-h-\gamma_h e_h]$.

[5] The derivative of $A$ contains one extra term: $(\partial e_0/\partial m)\int_{-\infty}^{\infty}[u(I_{21}(e_0))-u(I_{22}(e_0))]k(e_0)g(x)dx$, which is zero since $u(I_{21}) = u(I_{22})$ at $e_h = e_0$. .

## 3.1 No Migration vs Complete Migration

In this subsection, we examine the conditions under which no/complete migration takes place. Note that $u'(I_{21})t - u'(I_{22})(f + \gamma_f(\rho e_h + x) - h - \gamma_h e_h) < 0$ since $f + \gamma_f(\rho e_h + x) - h - \gamma_h e_h > t$ for $e_h < e_0$ and $I_{22} < I_{21}$. Therefore, $\partial A/\partial m < 0$. However, $\partial B/\partial m$ is ambiguous. To determine its sign, we employ the Taylor series by rewriting $\partial B/\partial m$ as

$$\partial B/\partial m \cong u'(I_{22}^0)\{f - h - R_a[m\gamma_f^2 + (m\gamma_f + (n-m)\gamma_h)(\gamma_f\rho - \gamma_h)]\},$$

where $I_{22}^0 = I_{22}(m, 0, 0) = mf + (n-m)h$ and $R_a = -u''(I)/u(I)$ (absolute risk aversion index).[6] Evidently, $\partial B/\partial m > 0$ if $R_a$ is sufficiently high and $H(m) = m\gamma_f^2 + [m\gamma_f + (n-m)\gamma_h](\gamma_f\rho - \gamma_h) < 0$. For $H < 0$, $\gamma_f$ ($\gamma_h$) has to be sufficiently small (large). Thus, $\partial B/\partial m > 0$ when (i) $\gamma_f$ is sufficiently small and $R_a$ is sufficiently high; or (ii) $\gamma_h$ is sufficiently large and $R_a$ is sufficiently high. Under Condition (i) or (ii), $\partial B/\partial m$ is positive and its value may outweigh $|\partial A/\partial m|$. When this occurs, (1) implies that $-\lambda_1 + \lambda_2 < 0$, or $\lambda_1 > 0$ and $\lambda_2 = 0$. Hence, $m^* = n$. The family migrates all family members to the foreign country. Conversely, $\partial B/\partial m$ is negative if $H(m) > 0$ and $f - h$ be sufficiently small in magnitude. For $H(m) > 0$, it requires that $\gamma_h$ be relatively small. When $\gamma_h$ and $f - h$ are relatively small in magnitude such that $(|\partial B/\partial m| + |\partial A/\partial m|)/(1 + \delta) > u'(I_1)[f - t - h - c'(m)]$ holds, we obtain from (1) that $-\lambda_1 + \lambda_2 > 0$, or $\lambda_1 = 0$ and $\lambda_2 > 0$. This implies that $m^* = 0$. To summarize, we have

**Proposition 1** *Complete migration results if the home (foreign) market is sufficiently unstable (stable) and the family is highly risk averse; No migration takes place if the home market is relatively stable and the foreign-domestic wage gap is small in magnitude.*

When the home (foreign) market is relatively volatile (stable) and the family is highly risk-averse, migration involves the entire family. The intuition is straightforward. When the home (foreign) market is volatile (stable), the highly risk-averse family would prefer to allocate its members in a safer environment (i..e, the foreign country in this case). Complete migration is thus the result of risk avoidance. In this case, the option value effect is entirely dominated by the diversification effect. This leads to an immediate migration—a result that is in sharp contrast to a delay predicted by the option value theory. Conversely, when the foreign market is relatively volatile and the foreign-domestic wage gap is sufficiently small in magnitude, no migration results. This is because higher foreign volatility discourages the risk-averse family from moving its members abroad. Moreover, it pays the family to wait since there are more to gain because of option value effect but less to lose because of a small wage difference between the two countries. In sum, $m^* = 0$ if the option value effect dominates the diversification effect and $m^* = n$ if the converse is true.

[6] This can be obtained by substituting $u'(I_{22}) = u'(I_{22}^0) + u''(I_{22}^0)[m\gamma_f(\rho e_h + x) + (n-m)(\gamma_h e_h)] + ....$into $\partial B/\partial m$. Here, we implicitly assume that the utility is quadratic. Pratt (1964) and Arrow (1971) reject quadratic utility because it implies increasing absolute risk aversion. Some studies, however, have found empirical evidence of absolute risk aversion; see for example Eisenhauer (1997) and Eisenhauer and Halek (1999).

### 3.2 Interior Solution

There are a wide range of $(\gamma_h, \gamma_f)$ such that the constraints are not binding. The optimal level of migration is then determined according to

$$\frac{\partial EU}{\partial m} = u'(I_1)[f - t - h - c'(m)] + \frac{1}{1+\delta}[\frac{\partial A}{\partial m} + \frac{\partial B}{\partial m}] = 0, \tag{4}$$

provided that the second-order condition is satisfied.[7]

As noted above, $\partial A/\partial m < 0$ follows from the fact that $f + \gamma_f(\rho e_h + x) - h - \gamma_h e_h > t$ and $I_{22} < I_{21}$ for $e \leq e_0$. The existence of an interior solution therefore requires that $\partial B/\partial m$ or $f - t - h - c'(m)$ be sufficiently positive. Note that $H(0) = n\gamma_h(\gamma_f\rho - \gamma_h) < 0$ since $\gamma_f\rho - \gamma_h < 0$. This implies that $\partial B/\partial m|_{m=0} \cong u'(I_{22}^0)[(f-h) - R_a H(0)] > 0$ if $\gamma_h$, $R_a$ and $n$ are sufficiently large. That is, sufficiently large family size, high risk aversion, and high volatility at home will induce the family to migrate some of its members. Interestingly, even when the foreign wage is relatively lower (i.e., $f - h < 0$), there is still an incentive for the family to migrate some members to the foreign country for the purpose of risk diversification. The motive to diversify runs counter to the option value effect, $\partial A/\partial m < 0$. The level of migration is set to balance these two offsetting forces. As shown in (4), migration may in fact take place even if there is an immediate loss (i.e., $f - t - h - c'(0) < 0$).[8] Put differently, relatively lower foreign wage does not necessarily implies no migration. This possibility arises when the diversification effect is strong relative to the option value effect. The explanation is straightforward. With weak option value effects, it does not pay the family to postpone migration until information is fully revealed since information is less valuable in this case.

It is also evident from $H(0)$ that the intention to migrate part of the family is strengthened as markets are negatively correlated (i.e., $\rho < 0$). This is because the diversification effect is enhanced as the market correction becomes more negative. In the other limiting case where $m \to n$, then $H(n) = n\gamma_f[\gamma_f + \rho(\gamma_f\rho - \gamma_h)] > 0$ if $\rho \leq 0$. Thus, $\partial B/\partial m|_{m=n} \cong u'(I_{22}^0)\{(f-h) - R_a H(n)\} < 0$ if $\rho \leq 0$, and $R_a$ or $n$ is sufficiently large. These conditions ensure that migration is not complete. To summarize, we have

**Proposition 2** *There are two offsetting effects at work. Option value effect encourages the family to postpone migration, while the diversification effect induces immediate migration. The diversification effect is enhanced as markets are negatively correlated. Migration may take place even if members earn less in the foreign country and this arises when $\gamma_h$, $R_a$ and $n$ are sufficiently large.*

## 4 Comparative Statics

In this section, we conduct the comparative static analysis. For tractability, we rewrite $\partial A/\partial m$ and $\partial B/\partial m$ as:[9]

[7] It is assumed that the second-order condition holds, i.e., $\frac{\partial^2 EU}{\partial m^2} = u''(I_1)[f - t - h - c'(m)]^2 - u'(I_1)c''(m) + \frac{1}{1+\delta}\int_{-\infty}^{\infty}\int_{-\infty}^{e_0} u''(I_{21})t^2 k(e_h)de_h g(x)dx + \frac{1}{1+\delta}\int_{-\infty}^{\infty}\int_{e_0}^{\infty} u''(I_{22})[f + \gamma_f(\rho e_h + x) - h - \gamma_h e_h]^2 k(e_h)de_h g(x)dx < 0$.

[8] For this possibility to occur, $\partial B/\partial m|_{m=0}$ must be sufficiently positive, which requires $\gamma_h$, $R_a$ and $n$ to be sufficiently large.

[9] Here, we employ the Taylor expansion up the second order by rewriting $u'(I_{21})$ and $u'(I_{22})$ as

$$
\begin{aligned}
\frac{\partial A}{\partial m} &= \int_{-\infty}^{\infty}\int_{-\infty}^{e_0}\{u'(I_{21})t - u'(I_{22})(f+\gamma_f(\rho e_h + x) - h - \gamma_h e_h)\}dK(e_h)dG(x) \\
&= \int_{-\infty}^{\infty}\int_{-\infty}^{e_0}\{u'(I_{21}^0)[1 - R_a n\gamma_f(\rho e_h + x)]t \\
&\quad -u'(I_{22}^0)[1 - R_a m\gamma_f(\rho e_h + x) - R_a(n-m)\gamma_h e_h][f+\gamma_f(\rho e_h + x) - h - \gamma_h e_h]\}dK(e_h)dG(x) \\
\frac{\partial B}{\partial m} &= u'(I_{22}^0)\{f - h - R_a[m\gamma_f^2 + (m\gamma_f\rho + (n-m)\gamma_h)(\gamma_f\rho - \gamma_h)]\}
\end{aligned}
$$

where $I_{21}^0 = I_{21}(m;0,0) = nf-(n-m)t$, and $I_{22}^0 = I_{22}(m;0,0) = mf+(n-m)h$. Let $\Omega = -[\partial^2 EU_h/\partial m^2]/(1+\delta) > 0$ (the second-order condition assumed to be satisfied). The effect of $\gamma_h$ on optimal $m^*$ can be obtained by taking the total differentiation of (4) with respect to $m$ and $\gamma_h$, which yields[10]

$$
\begin{aligned}
\frac{\partial m^*}{\partial \gamma_h} &= \frac{1}{\Omega}\int_{-\infty}^{\infty}\int_{-\infty}^{e_0} u'(I_{22}^0)\{R_a(n-m)[f+\gamma_f(\rho e_h + x) - h - \gamma_h e_h] \\
&\quad +[1 - R_a m\gamma_f(\rho e_h + x) - R_a(n-m)\gamma_h e_h]\}e_h dK(e_h)dG(x) \\
&\quad +\frac{1}{\Omega}R_a u'(I_{22}^0)\{2m(\gamma_f\rho - \gamma_h) + n(2\gamma_h - \gamma_f\rho)\}. \qquad (5)
\end{aligned}
$$

When $R_a \to 0$, (5) is reduced to $\partial m^*/\partial\gamma_h = \frac{1}{\Omega}u'(I_{22}^0)\int_{-\infty}^{\infty}\int_{-\infty}^{e_0} e_h dK(e_h)dG(x) < 0$. This implies that if the family is risk neutral or moderately risk averse, higher degree of uncertainty at home will discourage migration. Intuitively, higher domestic uncertainty increases the information value, thus strengthening the option value effect. At the same time, higher home uncertainty exposes the family to risk and therefore the incentive to move is strengthened. The option value effect provides incentives for the family to delay migration, while the diversification effect induces immediate relocation. The former provides incentives for the family to delay migration, while the latter induces immediate relocation. Lower degree of risk aversion marginalizes the diversification effect, leaving the option value effect as a sole factor determining migration, thus resulting in $\partial m^*/\partial\gamma_h < 0$. When $R_a > 0$, higher risk makes the family value jobs in the home market less, thus reducing the magnitude of option value effect. Moreover, the intention to diversify risk will begin to impact the migration decision. Thus, higher uncertainty at home may result in more migration. To see this, consider a special case where $\gamma_f = 0$. Then, $\partial m^*/\partial\gamma_h = \frac{1}{\Omega}u'(I_{22}^0)[R_a(n-m)(f-h)+1]\int_{-\infty}^{e_0} e_h dK(e_h) + \frac{2}{\Omega}\gamma_h u'(I_{22}^0)R_a(n-m)[1 - \int_{-\infty}^{e_0} e_h^2 dK(e_h)] > 0$ if $R_a > 0$ and $\gamma_h$ is sufficiently large.[11] Sufficiently high volatility in the home market ensures that the diversification effect is stronger than the option value effect. This yields $\partial m^*/\partial\gamma_h > 0$.

---

$$
\begin{aligned}
u'(I_{21}) &= u'(I_{21}^0) + u''(I_{21}^0)n\gamma_f(\rho e_h + x) + \ldots = u'(I_{21}^0)[1 - R_a n\gamma_f(\rho e_h + x)] \\
u'(I_{22}) &= u'(I_{22}^0) + u''(I_{22}^0)[m\gamma_f(\rho e_h + x) + (n-m)\gamma_h e_h] + \ldots = u'(I_{22}^0)[1 - R_a m\gamma_f(\rho e_h + x) - R_a(n-m)\gamma_h e_h].
\end{aligned}
$$

[10] The comparative static result should contain another term $(\partial e_0/\partial r_h)[u'(I_{21})t - u'(I_{22})(f+\gamma_f(\rho e_0 + x) - h - \gamma_h e_0)$, which vanishes since $I_{21} = I_{22}$ and $f+\gamma_f(\rho e_h + x) - h - \gamma_h e_h - t = 0$ at $e_h = e_0$. For the comparative static results reported below, the terms with double integrals are the option value effect, while the remaing terms belong to the diversification effect.

[11] Given that $Var(e_h^2) = E(e_h^2) = 1$, it is easy to verify that $[1 - \int_{-\infty}^{e_0} e_h^2 dK(e_h)] > 0$.

Following the same procedure, the effect of higher foreign uncertainty on $m$ is given by

$$\begin{aligned}\frac{\partial m^*}{\partial \gamma_f} &= \frac{1}{\Omega}\int_{-\infty}^{\infty}\int_{-\infty}^{e_0}\{-u'(I_{21}^0)R_a nt + u'(I_{22}^0)R_a m[f+\gamma_f(\rho e_h + x) - h - \gamma_h e_h] \\ &\quad -u'(I_{22}^0)[1 - R_a m\gamma_f(\rho e_h + x) - R_a(n-m)\gamma_h e_h]\}(\rho e_h + x)dK(e_h)dG(x) \\ &\quad -\frac{1}{\Omega}R_a u'(I_{22}^0)\{2m\rho(\gamma_f\rho - \gamma_h) + n\gamma_h\rho + 2m\gamma_f\}. \end{aligned} \tag{6}$$

When $R_a \to 0$, (6) becomes $\partial m^*/\partial\gamma_f = [-u'(I_{22}^0)/\Omega]\int_{-\infty}^{\infty}\int_{-\infty}^{e_0}(\rho e_h + x)dK(e_h)dG(x) < 0$. This says that if the family is risk neutral or moderately risk-averse, an increase in foreign uncertainty reduces migration. As explained earlier, higher degree of uncertainty raises the value of information, thus strengthening the option value effect. Regardless of the source of uncertainty, this basic principle applies to the present case as well. With lower risk aversion, the diversification effect is weak and hence, the volume of migration is determined by the option value alone. That is, $\partial m^*/\partial\gamma_f < 0$. When $R_a > 0$, the diversification begins to take effect and this is captured by the last term of (6). Let $\Delta_1 = -\frac{1}{\Omega}R_a u'(I_{22}^0)\{2m\rho(\gamma_f\rho - \gamma_h) + n\gamma_h\rho + 2m\gamma_f\} \gtreqless 0$ if $m[\rho(\gamma_f\rho - \gamma_h) + \gamma_f] \lesseqgtr -n\gamma_h\rho/2$. It is evident that when $\rho = 0$, $\Delta_1 < 0$. The diversification effect will therefore reinforce the option value effect. Thus, $\partial m^*/\partial\gamma_f < 0$ even if the family is risk averse. Nevertheless, $\Delta_1 > 0$ may arise when $\rho$ is sufficiently negative and $\gamma_h$ is sufficiently large. When this occurs, the option value effect is weaker than the diversification effect. Higher domestic uncertainty together with negative market correlation may therefore persuade the risk-averse family to speed up the migration process for the sake of risk avoidance. The reason behind this is that negative market correlation motivates the family to diversify and such an effect is intensified when the domestic market is sufficiently volatile. This may overturn the migration flow, thus resulting in $\partial m^*/\partial\gamma_f > 0$.

The effect of market correlations on migration is

$$\begin{aligned}\frac{\partial m^*}{\partial \rho} &= \frac{1}{\Omega}\int_{-\infty}^{\infty}\int_{-\infty}^{e_0}\{-u'(I_{21}^0)R_a n\gamma_f t \\ &\quad +u'(I_{22}^0)R_a m\gamma_f[f+\gamma_f(\rho e_h + x) - h - \gamma_h e_h] \\ &\quad -u'(I_{22}^0)[1 - R_a m\gamma_f(\rho e_h + x) - R_a(n-m)\gamma_h e_h]\gamma_f\}e_h dK(e_h)dG(x) \\ &\quad -\frac{1}{\Omega}R_a u'(I_{22}^0)\gamma_f[2m(\gamma_f\rho - \gamma_h) + n\gamma_h]. \end{aligned} \tag{7}$$

Clearly, the effect of market correlations on migration hinges on risk aversion, family size, market correlation, and the number of members that have already been migrated. In a special case where $R_a \to 0$, (7) is reduced to $\partial m^*/\partial\rho = -\frac{1}{\Omega}u'(I_{22}^0)\int_{-\infty}^{\infty}\int_{-\infty}^{e_0} e_h dK(e_h)dG(x) > 0$. Higher market correlations thus encourages migration. With risk neutrality, the only force at work is the option value effect. Intuitively, when the market correlation is positive (negative), foreign and domestic markets stochastically move in the same (opposite) directions. The realized relative wage gap between the two countries tends to be smaller (larger). This would mean smaller (higher) potential gains from delaying, thus causing no delay (delay) in migration. This result remains valid even if the family is moderately risk averse since the diversification effect in this case remains insignificant relative to the option value effect. Hence, $\partial m^*/\partial\rho > 0$ results. As the family becomes more risk averse, the diversification effect begins to dictate the migration process. To see this, let $\Delta_2 = -\frac{1}{\Omega} R_a u'(I_{22}^0)\gamma_f[2m(\gamma_f\rho - \gamma_h) + n\gamma_h] \gtreqless 0$ if $m \gtreqless n\gamma_h/2(\gamma_h - \gamma_f\rho)$. Thus, the diversification may enhance or dampen the option value effect, depending on the number of family members that have already been moved. Before explaining this result intuitively, first consider the effect of market correlation on the diversification effect, $B$. Clearly, $\partial B/\partial\rho = 2u''(I_{22}^0)[m\gamma_f\rho + (n-m)\gamma_h]m\gamma_f \gtreqless 0$ if $m \gtreqless n\gamma_h/(\gamma_h - \gamma_f\rho)$. An increase in market correlation $\rho$ will reduce (raise) the family utility if $m < (>)\ n\gamma_h/(\gamma_h - \gamma_f\rho)$. If $\rho = 0$ (the benchmark value), then $\partial B/\partial\rho < 0$ since $m \leq n\gamma_h/(\gamma_h - \gamma_f\rho) = n$. That is, an increase in $\rho$ from its benchmark value will always reduce the family utility and therefore it is a bad for the family. Next, examine the effect of market correlation on the marginal utility that is related to the diversification effect $B$. Calculate $\partial^2 B/\partial m\partial\rho = -u'(I_{22}^0)R_a\gamma_f[2m(\gamma_f\rho - \gamma_h) + n\gamma_h] \gtreqless 0$ if $m \gtreqless n\gamma_h/2(\gamma_h - \gamma_f\rho)$.[12] Thus, the effect of $\rho$ on $\partial B/\partial m$ depends on the magnitude of $m$. Specifically, an increase in market correlation from zero will enhance (reduce) the incentive to migrate when $m > (<)\ n/2$. Given these, the reason that underlies (7) is straightforward. If the majority of the family has already moved abroad (i.e., $m > n/2$), then an increase in market correlation from zero will increase the incentive to migrate because sending more members abroad (increasing $m$) will further increase the total family utility. Conversely, if the substantial number of the family stays home (i.e., $m < n/2$), then an increase in market correlation will decrease the incentive to migrate because sending more members abroad will further decrease the total family utility. For the former, the diversification will reinforce the option value effect. Therefore, $\partial m^*/\partial\rho > 0$. For the latter, two effects move in the opposition directions. A sufficiently strong diversification effect (i.e., $\Delta_2$ is sufficiently negative) would ensure a decrease in migration, i.e., $\partial m^*/\partial\rho < 0$.

The effect of wage differential on migration is given by

$$\begin{aligned}
\frac{\partial m^*}{\partial(f-h)} = {} & \frac{1}{\Omega}u'(I_1)\{1 - u(I_1)R_a m[f - t - h - c'(m)]\} \\
& + \frac{1}{\Omega}\int_{-\infty}^{\infty}\int_{-\infty}^{e_0} u'(I_{22}^0)\{R_a m[1 - R_a m\gamma_f(\rho e_h + x) - R_a(n-m)\gamma_h e_h]\cdot \\
& [f + \gamma_f(\rho e_h + x) - h - \gamma_h e_h] \\
& - [1 - R_a m\gamma_f(\rho e_h + x) - R_a(n-m)\gamma_h e_h]\}dK(e_h)dG(x) \\
& + \frac{1}{\Omega}u'(I_{22}^0)\{1 - R_a m[f - h - R_a[m\gamma_f^2 + (m\gamma_f\rho + (n-m)\gamma_h)(\gamma_f\rho - \gamma_h)]]\}. \qquad (8)
\end{aligned}$$

When $R_a \to 0$, (8) is reduced to $\partial m^*/\partial(f-h) = \{u'(I_1) + [1 - \int_{-\infty}^{\infty}\int_{-\infty}^{e_0} dK(e_h)dG(x)]u'(I_{22}^0)\}/\Omega > 0$. That is, when the family is risk neutral or moderately risk averse, the level of migration increases with relative wage differentials between the two countries. This can be understood as follows. Risks are of no significant

[12] Note that $n\gamma_h/2(\gamma_h - \gamma_f\rho) = n/2$ at $\rho = 0$.

concern for a risk-neutral (or less risk-averse) family. Hence, the wage gap between the two countries is the main driving force determining the level of migration. Higher $f-h$ implies higher level of migration (i.e., $\partial m^*/\partial(f-h)>0$), confirming the conventional result that an increase in $f-h$ intensifies migration. As the family becomes more risk averse, risk begins to play a role. Higher wage gap raises the cutoff point, $e_0$, thus raising the likelihood of migrating all remaining members in period 2. This consequently reduces income variability. Reduced risk is more valuable for more risk averse families and its magnitude can be further maximized by delaying the migration process since income variability increases with the number of family members remaining in the home country. With sufficient risk aversion, the benefit that results from risk reduction may exceed the cost of doing so. A paradoxical result, $\partial m^*/\partial(f-h)<0$, may therefore emerge. To see this, let $\Delta_3 = 1 - R_a m\{f-h-R_a[m\gamma_f^2+(m\gamma_f\rho+(n-m)\gamma_h)(\gamma_f\rho-\gamma_h)]\}$ (the term related to the diversification effect). Clearly, $\Delta_3<0$ if $R_a>0$, and both $f-h$ and $\gamma_f$ are sufficiently small. In this case, waiting appears to be an optimal strategy for the risk averse family. To summarize, we have

**Proposition 3** *(i) The level of migration in period 1 decreases with $\gamma_h$ when (a) $R_a$ is sufficiently small, or (b) $R_a>0$, $\gamma_f=0$, and $\gamma_h$ is sufficiently small. But, it increases with $\gamma_h$ when $R_a>0$, $\gamma_f=0$, and $\gamma_h$ is sufficiently large; (ii) The level of migration in period 1 decreases (increases) with $\gamma_f$ when $R_a$ is sufficiently small (when $\rho$ is sufficiently negative and $\gamma_h$ or $R_a$ is sufficiently large); (iii) The level of migration in period 1 increases with market correlation $\rho$ when $R_a$ is sufficiently small. However, when $R_a$ is sufficiently large, the diversification effect outweighs the option value effect. Specifically, an increase in market correlation will lead to less (more) migration if $m<n\gamma_h/2(\gamma_h-\gamma_f\rho)$ ($m>n\gamma_h/2(\gamma_h-\gamma_f\rho)$); (iv) The level of migration in period 1 increases (decreases) with $f-h$ when $R_a$ is sufficiently small (when $R_a$ is sufficiently positive, and both $f-h$ and $\gamma_f$ are sufficiently small).*

# 5 Empirical Evidences

Empirical studies of the real options theory of migration have focused on decision making by East and ethnic Germans from East European countries migrating to West Germany following the fall of the iron curtain. It began with Burda (1993) and Burda et al. (1998) who noted that despite a large wage differential between East and West Germany and a relatively high rate of unemployment in the East, the rate of East-West migration remained relatively low. Using German Socioeconomic Panel (GSOEP) survey data on migration intentions, the author estimated the option value implicit in waiting to migrate. Locher (2001, 2004) focused on migration of ethnic Germans from Eastern European countries to Germany and finds that those who attribute the highest value to the option to migrate are those in the middle with respect to migration costs[13], as predicted by the real options theory.

[13] With individuals who have lower migration costs than those who have no intention to migrate and higher than those who want to leave.

There is no empirical study, however, of international migration incorporating the role of option value and diversification motives. The main reason behind this is the lack of panel data, similar to GSOEP, in the context of international migration. An important difference between internal and international migration is that the latter is almost always controlled by a visa process. Thus while, in the case of internal migration, everyone holds an option to migrate, only those granted an immigration visa legally has that option when it comes to international migration. We utilize this fact to set up our empirical model. Conceptually, we assume that once the family has acquired the visa it holds the option to migrate similar to holding a stock option. The task then is to see if the timing of migration (i.e, the exercise of the option) is explained by the uncertainty environment as predicted by our model. Here again, we are limited by data. There are no panel data on how long individual families wait before exercising their visa option. The only data that we were able to generate is the aggregate number of immigration visas issued each month by a number of Canadian consulates abroad and aggregate number of monthly landings by immigrants from these countries. For this exercise we chose three countries, Hong Kong, Italy and India. They constitute the largest source of Canadian immigration population. We then utilize a correlation method, described more fully in the next section, to estimate the average lag between visa issue and landing. The method in effect suggests that if a surge of visa issue produces a similar surge in landings x months later, then x is a good estimate of the waiting time to migrate. Since the uncertainty environment across the three source countries presumably are not identical, an indirect test of our model is to see if the estimated differences in the waiting period is consistent with the known pattern of uncertainty. We follow this empirical model up with a regression model for Hong Kong, chosen because of the unique uncertain environment it faced prior to and after reunification with China. In the model, we attempt to test the effect of income variance and covariance parameters on landings by visa holders. Since our comparative static model suggests particular sign patterns for the coefficients of these variables, we are able to infer the presence or absence of an underlying diversification motive in addition to the option factor. Some of the limitations of our empirical model, beyond the use of macro data to explain micro decision making, are obvious. For example, we are not able to take into account the waiting that occurs prior to applying for the immigration visa. Furthermore, some waiting after visa issue is clearly logistical rather than uncertainty-driven. Finally, initial landing does not necessarily imply permanent migration. As we have noted in the introduction, some immigrants are known to land and then return to the point of origin, thereby postponing the date of final move. In effect, in these cases, option to migrate is extended, rather than exercised.

Migration from Hong Kong, India and Italy between 1980 and 2002 accounts for approximately 17 percent of aggregate Canadian immigration[14]. For the last two decades, migration flow from Hong Kong to Canada for the most part has been on a rising trend. This trend continued until 1997. We see a similar trend on the number of immigrants from India. It becomes more prominent in the 1990s. In contrast, a downward trend

[14] 4,162,149 from all source countries; 374,576 from Hong Kong; 319,698 from India; and 19,114 from Italy. (Source: Statistics Canada)

can be found for immigrants from Italy. These trends are summarized in Figure 1.

## 5.1 Data and Procedures

To generate the estimated migration time lag for immigrations from a country over a time interval, two data sets are used: (i) records of immigration visas issued by representative consulate in the source country (data set X) and (ii) records of individuals physically landed in the destination country as immigrants (data set Y). Then, we adopt the correlation coefficient method used by Stock and Wattson (1998) to identify the comovement of two distinct time series.

Data availability restricts the time interval from January 1980 to December 2002, containing 276 observations for each data set. We adopt the correlation coefficient approach to estimate the average migration time lag over the period of 1980 to 2002 for immigrants from Hong Kong, India and Italy. We implement the usual formula

$$\rho_k = \frac{\sum_{t=1}^{T-k}(x_t - \bar{x})(y_{t+k} - \bar{y})}{\sqrt{\sum_{t=1}^{T-k}(x_t - \bar{x})^2(y_{t+k} - \bar{y})^2}} \tag{9}$$

where $x_t$ denotes the number of immigrant visas issued by the representative Canadian Consulate to residents of source country $l$ in period $t$, and $y_t$ denotes the number of individuals from country $l$ physically landed in Canada as immigrants. Subsequently, $\rho_k$ is the cross-autocorrelation when time lag of migration is $k$ $(= 0, 1, 2, 3...)$ months for a group of immigrants arrived in Canada during a certain time interval consists of $T$ number of months.

According to the Canadian Citizenship & Immigration Resource Center (CCIRC) Inc. Law office of Colin R. Singer "*...In most cases, an applicant will have approximately 9-10 months to physically land in Canada after visa issuance. As well it will take approximately 2-3 months to receive visas once a medical examination and related statutory undertakings have been approved.* " Based on these information, we conclude that waiting time generally falls within 10 months following visa issuance. Using this assessment, for every case of migration time lag estimation we generate eleven cross-autocorrelations, $\rho_k$ where $k = 0, 1, 2, ...10$. The highest $\rho_k$ for $k = j$ indicates that the migration time lag for the considered group of immigrants is $j$ month(s). Generated correlation coefficients are found in Figures 1 - 4.

## 5.2 Migration Lags

Judging by the highest correlation coefficient from Figures 1 - 4, we can conclude that migration time lag for immigrants from Hong Kong over the interval from 1980 to June 1997 approached 6 months, and from July 1997 to 2002 approached 2 months. For immigrants from India, migration time lag over the interval from 1980 to 2002 is about 2 months and that for immigrants from Italy is zero month. The results imply, therefore, that immigrants from Hong Kong prior to unification had a greater tendency to postpone migration, whereas immigrants from India and Italy and immigrants from Hong Kong after unification appear to have migrated rather quickly. These results are roughly consistent with the predictions of option theory of migration. Since Hong Kong migrants prior to unification, clearly, faced the greater uncertainty, waiting would be expected to carry significant option value for them. It is interesting to note also that despite significant domestic uncertainty, waiting time for Hong Kong migrants prior to unification did not appear to extend to the maximum limit. This would be consistent with a diversification motive that pulled the migration timing the other way. Shorter migration time lags for migrants from Italy and India appear to be largely driven by wage differentials. Option value effect plays a minor role for migrants from these two countries.

### 5.3 Some Regression Results

In this subsection, a simple OLS approach is employed to investigate the influence of option value and diversification effects on migration timing decision. The uncertain nature facing Hong Kong immigrants before 1997 makes it the ideal choice to test the theoretical analysis presented in this paper. Immigrants from Hong Kong during the past few decades faced various levels of uncertainties generated by the anticipated reunification with China that took place in 1997, which in turns influenced the characteristics of immigrants from Hong Kong. For our study, we consider two groups of immigrants from Hong Kong, those arrived before reunification and those arrived after. For the first group, especially those who migrated during the 1980s and early 1990s were mostly well-to-do migrants. They were the wealthy entrepreneurs who generally relocated family members to manage their invested properties abroad. These immigrants made up the largest group from Hong Kong. However, those arriving after 1997 were largely professionals, middle-class individuals.

For our empirical investigation, we employ the following regression model:[15]

$$m(t) = \alpha_1 + \alpha_2\sigma_{HK}(t) + \alpha_3\sigma_{CAN}(t) + \alpha_4\rho(t) + \alpha_5 l(t-s) + e(t) \tag{10}$$

where $m$ is the number of immigrants landed in Canada as immigrants, $\sigma_{HK}$ ($\sigma_{CAN}$) is the standard deviation of per capita GDP in Hong Kong (Canada) for the last 5 years, $\rho$ is the market correlations between Hong Kong and Canada for the last 5 years based on per capita GDP, $l(t-s)$ is the number of visa issued at time $t-s$, where $s$ represents the number of months migrants took to land after obtaining their immigration visas, and $e$ is the error term. Our correlation-model reveals that for the the period from January 1980 to June 1997, migrants from Hong Kong to Canada took an average of 6 months (i.e., 2 quarters) to land. However, for the period from July 1997 to December 2002, the migration time lag is 2 months or approximately 1 quarter. Moreover, from January 1980 to December 2002, the average lag is shown to be 6 months. We incorporate these lag structures in our regression analysis. That is, $s = 2$ for January1980-June 1997 and January 1980-December 2002, while $s = 1$ for July1997-December 2002.

Variance of GDP per capita is used as a proxy for market variability.[16]. Per capita GDP data are available

[15] We omit the wage-differential variable, $f-h$, in our regression model, since the coefficients are generally insignificant for Hong Kong.

[16] Due to data availability, we use quarterly data for this empirical task.

from Hong Kong Statistics and Statistics Canada. All figures are in Canadian dollars, using 2002 base year. Market volatilities are reflected in the series of standard deviations computed using per capita GDP over the last 5 years (or 20 quarters). Similarly, market correlations are reflected in the series of correlation coefficients computed using per capita GDP of home and source countries over the last 5 years[17].

The regression results are reported in Table 1. As expected, market volatilities significantly influence migration intention. The impacts of higher domestic market uncertainty on migration are positive for all three periods ($\alpha_2 = 2.07$ for 1980-2002, $\alpha_2 = 3.21$ for 1980-1997, and $\alpha_2 = 6.32$ for 1997-2002). The coefficients are significant at the 95% level. These results suggest that the diversification effect (which encourages immediate migration) is stronger than the option value effect (which causes a delay), thus resulting in a positive net effect. On the other hand, the effects of increased foreign uncertainty on migration are negative until 1997, suggesting that the diversification effect is weak and the option value effect is the dominant force. After 1997, however, the coefficients turn positive, implying that the diversification effect now outweighs the option value effect.

The interesting results is the influence of market correlations on migration intention. As shown earlier, higher market correlations may encourage or reduce migration depending on whether $m$ is greater or less than than $n/2$. Our casual observation suggests that migrants in the 1980s and early 1990s are mostly wealthy entrepreneurs who may have moved some members long before 1980. For those families, $m > n/2$ may hold. That is, high market correlations will lead to higher migration. Conversely, those who arrived after 1997 were mostly professionals. For them, the converse is likely to be true. Thus, high market correlations may end up reducing migration. As shown in Table 1, the market correlation has a positive impact on migration ($\alpha_4 = 2806$) for the period from 1980 to June 1997, while it has a negative effect ($\alpha_4 = -758.73$) afterward . These results are, therefore, consistent with our theory.

The number of visas issued generally has a positive impact on migration. The coefficients are significant at the 99% level between 1980 and 1997 and also between 1980 and 2002 ($\alpha_5 = 0.72$ and 0.87, respectively). These empirical results indicate that the tendency to delay for migrants from Hong Kong to Canada is a robust phenomenon.

Since the presence of $\rho$ as an explanatory variable appears to generate multicollinearity, we also run our regression model excluding $\rho$. Both sets of regression results are presented in Table 1. The impacts of parameters on migration remain largely unaffected.

# 6 Conclusion

When markets are uncertain, families can gain by delaying migration due to the option value effect. This has been recognized in the new migration literature. However, uncertainty can also induce a diversification motive if families are risk averse in the manner well known in the portfolio theory of financial economics. Whether

[17] This method to measure market correlations can be found in Daveri and Faini (1999). The authors consider a more comprehensive set of data to test the influence of market correlations on the decision to relocate between multiple destinations.

the portfolio motive hastens or delays migration of family members depends, not surprisingly, on the degree of risk aversion as well as market variances and covariances. We develop a simple model by incorporating both domestic and foreign market uncertainty to capture the interaction between the option and the portfolio effect in determining when and how many family members migrate. Aside from fixing basic ideas underlying the problem, our claim is that the model captures the decision problem facing potential migrant families from Hong Kong in the eighties and early nineties as the country moved towards reunification with China. The significant new intuition arising out of our model is that portfolio motive may induce families to hasten migration of its members despite significant market volatility, a scenario which would have otherwise called for delay on account of the option motive alone. How long potential migrants take to move and settle in the host country is an important piece of information for the immigration policy of countries like Canada which depends significantly on migrant labor. The importance of our model is that it identifies some of the parameters that determine the outcome when migration is a family rather than an individual decision. Panel data, based on surveys of immigrant families, would allow us to test some of the propositions of our model. Unfortunately such a data set is currently unavailable. Using immigrant visa issue and subsequent landing data we are able to indirectly infer apparent average waiting time for immigrants to Canada from Hong Kong, Italy and India. The results are generally consistent with intuition. Moreover, the simple OLS results suggest that the effects of option value and diversification effects on migration timing decision are significant. At the aggregate level, our empirical findings are largely in line with the theoretical predictions.

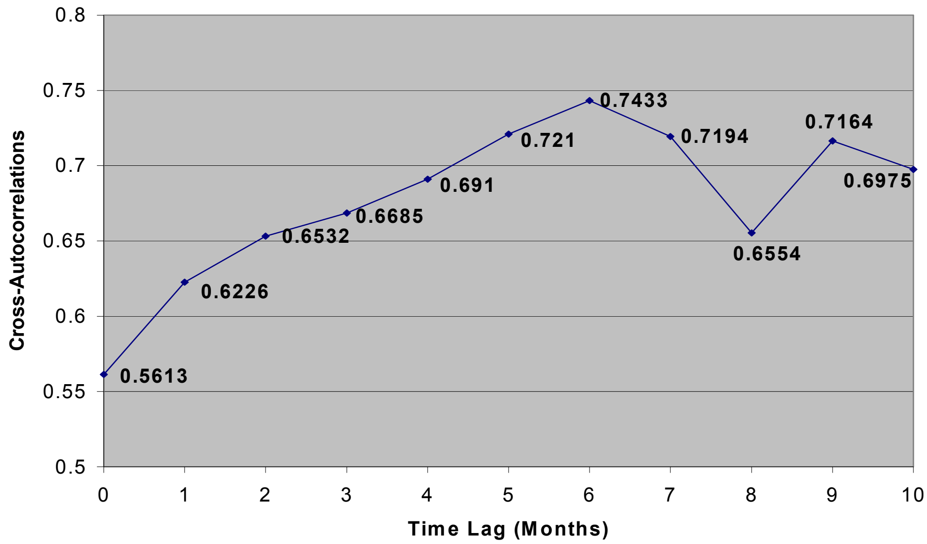


Figure 1: Hong Kong - Visa Issuance-Landing Cross-Autocorrelation, 1980 - June 1997

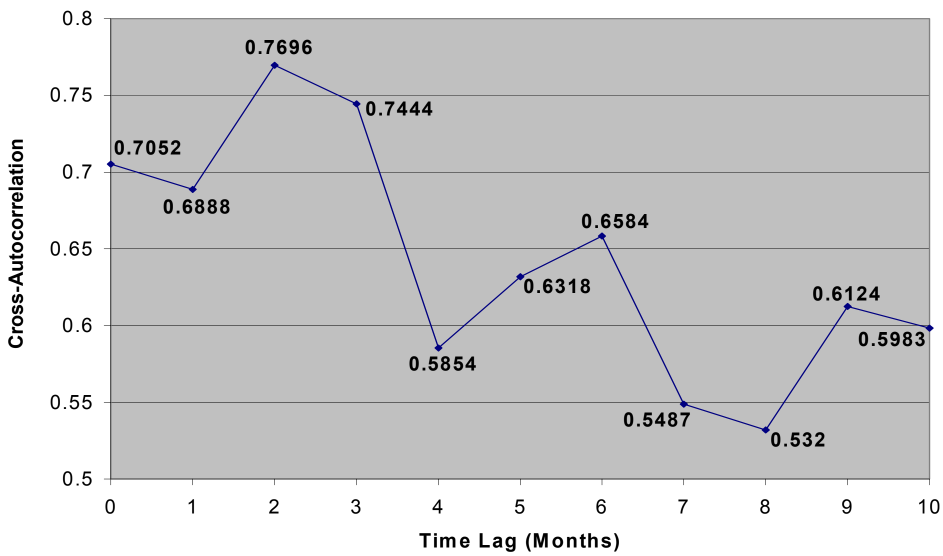


Figure 2: Hong Kong - Visa Issuance-Landing Cross-Autocorrelation, July 1997 - 2002

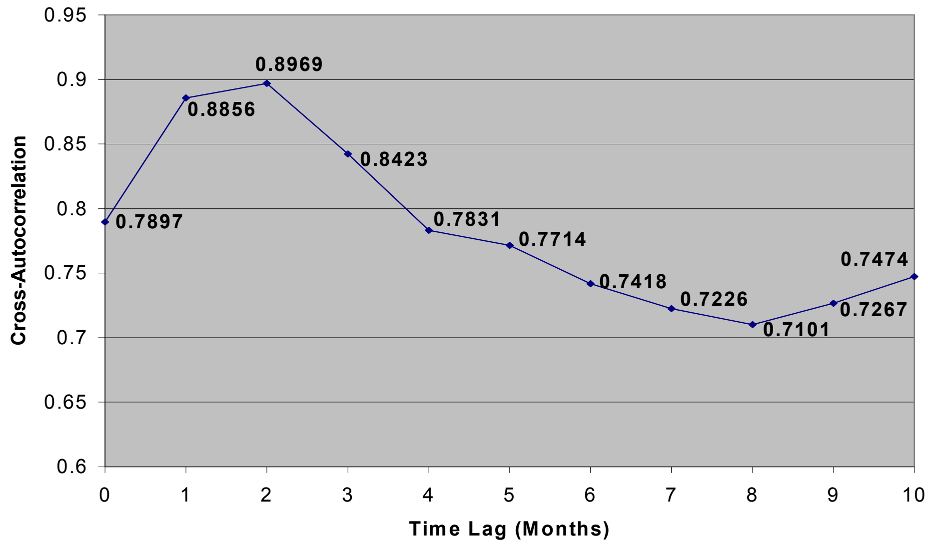


Figure 3: India - Visa Issuance-Landing Cross-Autocorrelation, 1980 - 2002

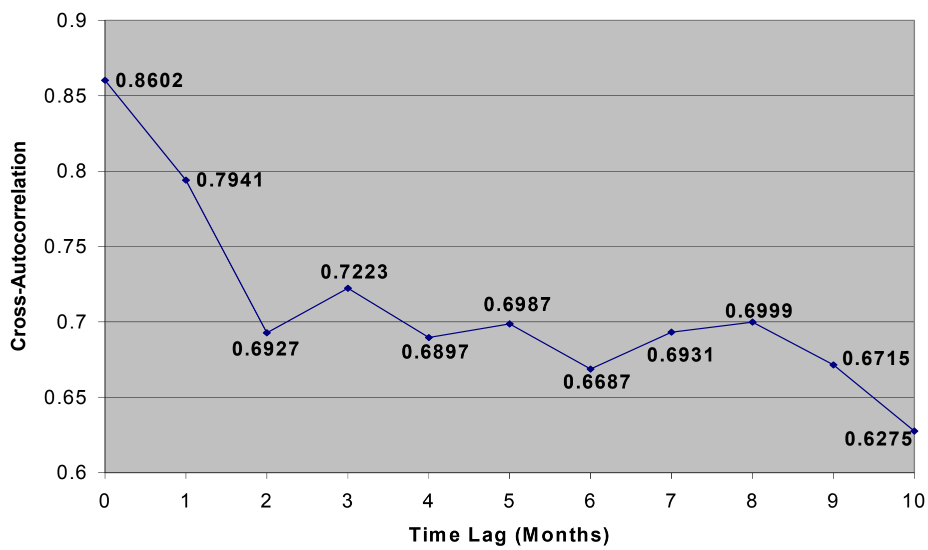


Figure 4: Italy - Visa Issuance-Landing Cross-Autocorrelation, 1980 - 2002

**Table 1: Regression Results**

| | *Hong Kong* 1980 − 2002 $s = 2$ | *Hong Kong* 1980 − 2002 $s = 2$ | *Hong Kong* 1980 − 6/1997 $s = 2$ | *Hong Kong* 1980 − 6/1997 $s = 2$ | *Hong Kong* 7/1997 − 2002 $s = 1$ | *Hong Kong* 7/1997 − 2002 $s = 1$ |
|---|---|---|---|---|---|---|
| *Intercept* | 2897.66 | 2071.03 | 1148.6 | 2750.53 | −3376.85 | −3864.82 |
| | (2.04) | (2.03) | (0.34) | (2.04) | (−3.66) | (−4.22) |
| $\sigma_{HK}$ | 2.07 | 2.33 | 3.21 | 3.28 | 6.32 | 5.23 |
| | (2.59) | (3.18) | (3.1) | (3.21) | (5.99) | (6.07) |
| $\sigma_{CAN}$ | −6.15 | −5.36 | −9.17 | −6.68 | 0.86 | 2.46 |
| | (−3.24) | (−3.26) | (−1.69) | (−2.79) | (0.65) | (2.57) |
| $\rho_{HK,CAN}$ | −452.06 | | 2806 | | −758.73 | |
| | (−0.84) | | (0.51) | | (−1.64) | |
| $Visa(t-s)$ | 0.87 | 0.86 | 0.75 | 0.72 | 0.41 | 0.39 |
| | (11.55) | (11.61) | (6.28) | (7.09) | (1.8) | (1.60) |
| $Adj - R^2$ | 0.84 | 157.25 | 0.82 | 0.82 | 0.88 | 0.87 |
| $F - Statistics$ | 117.71 | 0.84 | 76.44 | 103.02 | 38.91 | 46.34 |

# References


[1] Anam, M. and S. H. Chiang, 2002. Rural Urban Migration of Family and Labor: A Portfolio Model. mimeo.

[2] Borjas, G., 1991. Immigration and Self-selection. In: J. Abowd and R. Freeman (ed), Immigration, Trade, and the Labor Market. University of Chicago Press, 29-76.

[3] Burda, M. C., 1993. The Determinants of East-West German Migration: Some First Results. European Economic Review 37, 452-461.

[4] Burda, M. C., 1995. Migration and the Option Value of Waiting. The Economic and Social Review 27, 1-19.

[5] Burda, M. C., W. Härdle, M. Müller, and A. Werwatz, 1998. Semi-parametric Analysis of German East-West Migrations: Facts and Theory. Journal of Applied Econometrics 13, 525-541.

[6] Chen, K. P., Chiang, S. H., and S. F. Leung, 2003. Migration, Family, and Risk Diversification. Journal of Labor Economics 21, 353-380.

[7] Daveri, F. and R. Faini, 1999. Where Do Migrants Go?. Oxford Economic Papers 51, 595-622.

[8] Dixit, A. K., 1989. Entry and Exit Decisions under Unertainty. Journal of Political Economy 87, 620-638.

[9] Dixit, A. K., 1992. Investment and Hysteresis. Journal of Economic Perspectives 6, 107-132.

[10] Dixit, A. K. and R. S. Pindyck, 1994. Investment Under Uncertainty. Princeton University Press.

[11] Eisenhauer, J. G., 1997. Risk Aversion, Wealth, and the DARA Hypothesis: A New Test. International Advancesin Economic Research 3, 46-53.

[12] Eisenhauer, J. G. and M. Halek, 1999. Prudence, Risk Aversion, and the Demand for Life Insurance. Applied Economics Letters 6, 239-242.

[13] Harris, J. and M. Todaro, 1970. Migration, Unemployment, and Development: a Two-sector Analysis. American Economic Review 60, 126-142.

[14] Locher, L., 2001. Testing for the Option Value of Migration. mimeo.

[15] —, 2004. Immigration from the former Soviet Union to Israel: Who is Coming When?. European Economic Review 48, 1243-1255.

[16] O'Connell, P. G. J., 1997. Migration Under Uncertainty: 'Try Your Luck' Or 'Wait and See'. Journal of Regional Science 37, 331-347.

[17] Sjaastad, L., 1962. The Costs and Returns of Human Migration. Journal of Political Economy 70, 80-93.

[18] Stark, O., 1991. The Migration of Labour. Basil Blackwell, Cambridge.

[19] Stock, J. H. and M. W. Wattson., 1998. Business Cycle Fluctuation in U.S. Macroeconomic Time Series. NBER Working Papers No. 6528.

[20] Wang, T. and T. S. Wirjanto, 2004. The Role of Risk and Risk Aversion in an Individual's Migration decision. Stochastic Models 20, 129-147.

[21] Xu, C., 1992. Risk Aversion, Rural-Urban Wage Differentiation and Migration. Centre for Economic Performance Discussion Paper No. 108.