The Effect of Migrant Networks on Mexican Migration

Su-Hsin Chang
Department of Economics
Johns Hopkins University

June 6, 2009
The Econometric Society
North American Summer Meeting
Boston
Migrant Networks? Important to the migrants?

Web of social ties that link the potential migrants in the sending country to the people who have migration experience

- Acquire information
- Provide temporary accommodation and employment opportunities
- Share same culture and language
- Reduce riskiness of migration and increase the migration probability
Motivation

- Explore the factors affecting migration opportunities
  - Individual characteristics
e.g. educational attainments, skill levels, gender, land, property, and business holdings, ...
  
  - Macroeconomic and policy factors
e.g. unemployment rates, US immigration policies
  
  - Network effects
Motivation

- Explore the factors affecting migration opportunities
  - Individual characteristics
    e.g. educational attainments, skill levels, gender, land, property, and business holdings, ...  
  - Macroeconomic and policy factors
    e.g. unemployment rates, US immigration policies  
  - Network effects

- How important and through what channels do the migrant networks influence the Mexican migrants?
  - Direct network effect  
  - Indirect network effect
Motivation

- Explore the factors affecting migration opportunities
  - Individual characteristics
e.g. educational attainments, skill levels, gender, land, property, and business holdings, ...
  - Macroeconomic and policy factors
e.g. unemployment rates, US immigration policies
  - Network effects

- How important and through what channels do the migrant networks influence the Mexican migrants?
  - Direct network effect
  - Indirect network effect

- Econometric problems
  - Sample selection problems
  - Omitted variable problems
Preview: Contribution and Results

- **Mexican migration**
  - Significant network effects
  - Less educated, unskilled, males with no land/property/business holdings are more likely to migrate
  - Negative effects of the macroeconomic and policy factors
  - Positive duration dependence
  - Family members’ migration is rather substitutional

- **Model and Estimation**
  - Micro-level variables and data $\leftrightarrow$ Munshi (2003)
  - Nonlinear model $\leftrightarrow$ Ibarraran and Lubotsky (2005)
  - Tackling econometric problems while no IVs are needed
    - Endogenous family member’s migration $\leftrightarrow$ Orrenius (1999)
    - Correlation between family members’ migration
  - Error components $\leftrightarrow$ Massey and Garcia España (1987)
  - Taking advantage of time-to-event information
Preview: Contribution and Results

- **Mexican migration**
  - Significant network effects
  - Less educated, unskilled, males with no land/property/business holdings are more likely to migrate
  - Negative effects of the macroeconomic and policy factors
  - Positive duration dependence
  - Family members’ migration is rather substitutional

- **Model and Estimation**
  - Micro-level variables and data \(\leftrightarrow\) Munshi (2003)
  - Nonlinear model \(\leftrightarrow\) Ibarra-Man and Lubotsky (2005)
  - Tackling econometric problems while no IVs are needed
    - Endogenous family member’s migration \(\leftrightarrow\) Orrenius (1999)
      - Correlation between family members’ migration
    - Error components \(\leftrightarrow\) Massey and Garcia España (1987)
  - Taking advantage of time-to-event information
Preview: Contribution and Results

- **Mexican migration**
  - Significant network effects
  - Less educated, unskilled, males with no land/property/business holdings are more likely to migrate
  - Negative effects of the macroeconomic and policy factors
  - Positive duration dependence
  - Family members’ migration is rather substitutional

- **Model and Estimation**
  - Micro-level variables and data \(\rightsquigarrow\) Munshi (2003)
  - Nonlinear model \(\rightsquigarrow\) Ibarraran and Lubotsky (2005)
  - Tackling econometric problems while no IVs are needed
    - Endogenous family member’s migration \(\rightsquigarrow\) Orrenius (1999)
    - Correlation between family members’ migration
  - Error components \(\rightsquigarrow\) Massey and García España (1987)
  - Taking advantage of time-to-event information
Preview: Contribution and Results

- **Mexican migration**
  - Significant network effects
  - Less educated, unskilled, males with no land/property/business holdings are more likely to migrate
  - Negative effects of the macroeconomic and policy factors
  - Positive duration dependence
  - Family members’ migration is rather substitutional

- **Model and Estimation**
  - Micro-level variables and data \(\rightsquigarrow\) Munshi (2003)
  - Nonlinear model \(\rightsquigarrow\) Ibarraran and Lubotsky (2005)
  - Tackling econometric problems while no IVs are needed
    - Endogenous family member’s migration \(\rightsquigarrow\) Orrenius (1999)
    - Correlation between family members’ migration
  - Error components \(\rightsquigarrow\) Massey and García España (1987)
  - Taking advantage of time-to-event information
Preview: Contribution and Results

- **Mexican migration**
  - Significant network effects
  - Less educated, unskilled, males with no land/property/business holdings are more likely to migrate
  - Negative effects of the macroeconomic and policy factors
  - Positive duration dependence
  - Family members’ migration is rather substitutional

- **Model and Estimation**
  - Micro-level variables and data \(\mapsto\) Munshi (2003)
  - Nonlinear model \(\mapsto\) Ibarraran and Lubotsky (2005)
  - Tackling econometric problems while no IVs are needed
    - Endogenous family member’s migration \(\mapsto\) Orrenius (1999)
    - Correlation between family members’ migration
  - Error components \(\mapsto\) Massey and Garcia España (1987)
  - Taking advantage of time-to-event information

\(\mapsto\) Orrenius (1999)
Preview: Contribution and Results

- Mexican migration
  - Significant network effects
  - Less educated, unskilled, males with no land/property/business holdings are more likely to migrate
  - Negative effects of the macroeconomic and policy factors
  - Positive duration dependence
  - Family members’ migration is rather substitutional

- Model and Estimation
  - Micro-level variables and data  \(\rightarrow\) Munshi (2003)
  - Nonlinear model  \(\rightarrow\) Ibarraran and Lubotsky (2005)
  - Tackling econometric problems while no IVs are needed
    - Endogenous family member’s migration  \(\rightarrow\) Orrenius (1999)
      \(\Rightarrow\) Correlation between family members’ migration
    - Error components  \(\rightarrow\) Massey and Garcia España (1987)
  - Taking advantage of time-to-event information
Preview: Contribution and Results

- **Mexican migration**
  - Significant network effects
  - Less educated, unskilled, males with no land/property/business holdings are more likely to migrate
  - Negative effects of the macroeconomic and policy factors
  - Positive duration dependence
  - Family members’ migration is rather substitutional

- **Model and Estimation**
  - Micro-level variables and data $\leftrightarrow$ Munshi (2003)
  - Nonlinear model $\leftrightarrow$ Ibarraran and Lubotsky (2005)
  - Tackling econometric problems while no IVs are needed
    - Endogenous family member’s migration $\leftrightarrow$ Orrenius (1999)
    - Correlation between family members' migration
    - Error components $\leftrightarrow$ Massey and Garcia España (1987)
  - Taking advantage of time-to-event information

\[\text{Orrenius (1999)}\]
Contribution and Brief Results

Preview: Contribution and Results

- Mexican migration
  - Significant network effects
  - Less educated, unskilled, males with no land/property/business holdings are more likely to migrate
  - Negative effects of the macroeconomic and policy factors
  - Positive duration dependence
  - Family members’ migration is rather substitutional

- Model and Estimation
  - Micro-level variables and data \(\leftrightarrow\) Munshi (2003)
  - Nonlinear model \(\leftrightarrow\) Ibarraran and Lubotsky (2005)
  - Tackling econometric problems while no IVs are needed
    - Endogenous family member’s migration \(\leftrightarrow\) Orrenius (1999)
    - Correlation between family members’ migration
    - Error components \(\leftrightarrow\) Massey and Garcia España (1987)
  - Taking advantage of time-to-event information
Preview: Contribution and Results

- **Mexican migration**
  - Significant network effects
  - Less educated, unskilled, males with no land/property/business holdings are more likely to migrate
  - Negative effects of the macroeconomic and policy factors
  - Positive duration dependence
  - Family members’ migration is rather substitutional

- **Model and Estimation**
  - Micro-level variables and data \(\rightarrow\) Munshi (2003)
  - Nonlinear model \(\rightarrow\) Ibarraran and Lubotsky (2005)
  - Tackling econometric problems while no IVs are needed
    - Endogenous family member’s migration \(\rightarrow\) Orrenius (1999)
    - Correlation between family members’ migration
    - Error components \(\rightarrow\) Massey and Garcia España (1987)
  - Taking advantage of time-to-event information

- Contribution and Brief Results
Economic Model of Migration

Economic Model

A potential migrant’s value function:

\[
\mathcal{V}(\Omega_t) = \max U_t + \beta(\tau) \mathbb{E}_{\Omega_{t+\tau}} \left[ \max \left\{ \mathcal{V}(\Omega_{t+\tau}), \mathcal{V}^d(\Omega^d_{t+\tau}) \right\} \right] | \Omega_t
\]

- \( \mathcal{V}(\Omega_t) \): the expected present value of the future utilities
- \( U_t \): utility function incurred by staying in home country in time \( t \)
- \( \Omega_t \): the individual’s information set in time \( t \)
- \( \beta(\tau) \): time preference factor; \( d \): destination country

A probabilistic rate at which individual chooses to migrate

\[
\theta = \zeta \left[ 1 - \omega(\nu^d_{t0}) \right]
\]

- \( \zeta \): migration opportunity arrival rate
- \( \omega \): the cumulative density function for \( \Omega^d \)
- \( \nu^d_{t0} \): a threshold value considering to migrate
Econometric Model of Migration

Econometric Model

\[ \theta_f( T_f = t \mid x_f, z_f, v_f, \psi_f ) = \lambda_f(t) v_f e^{\psi_f x_f' \beta_f + z_f' \eta_f} \]

The (family) network hazard

\[ \theta_h( T_h = t \mid x_h, z_h, v_h, \psi_h, t_f ) = \lambda_h(t) v_h e^{\psi_h x_h' \beta_h + z_h' \eta_h} e^{\delta \cdot I\{t + \bar{t} > t_f\}} \left[ 1 - \omega(\nu_{t0}) \right] \]

- \( T_f \): the duration from the individual’s birth to the time when one of the close family members migrates
- \( T_h \): the duration from school completion until migration
- \( X \): individual’s characteristics, macro and policy factors
- \( Z \): relatives and friends having migration experience
- \( V \): unobserved heterogeneity ex. preference for traveling
- \( \Psi \): family factors
- \( \delta \): direct network effect; \( \eta_h \): indirect network effect
- \( I\{age = t_h + \bar{t} > t_f\} \): indicator function
- \( \bar{t} \): age upon completing school
A typical Migrating Individual

An individual migrates at age 32, starts school at age 7, and completes school at age 10 ($\bar{t} = 10$).

- The first close family member migrates at the individual’s age of 15.

$t_f = 15$

$t_h = 22$

$\bar{t} = 10$
A typical Migrating Individual

An individual migrates at age 32, starts school at age 7, and completes school at age 10 ($\bar{t} = 10$).

- The first close family member migrates at the individual’s age of 15.
- The first close family member migrates at 40.

$t_f = 40$
$t_h = 22$
$\bar{t} = 10$
A typical Migrating Individual

An individual migrates at age 32, starts school at age 7, and completes school at age 10 ($\bar{t} = 10$).

- The first close family member migrates at the individual’s age of 15.
- The first close family member migrates at 40.
- The first close family member migrates before the individual is born.

$t_f = 0$
$t_h = 22$
$\bar{t} = 10$
Data

Mexican Migration Project (MMP118)

- Detailed microdata (since 1982)
- Random samples in communities located in various states throughout Mexico
- Data include information on the household heads and spouses.
- 19,726 households are contained.
Data

Mexican Migration Project (MMP118)

- Detailed microdata (since 1982)
- Random samples in communities located in various states throughout Mexico
- Data include information on the household heads and spouses.
- 19,726 households are contained.
## Summary Statistics

<table>
<thead>
<tr>
<th>Number of observations: 4,993</th>
<th>Max</th>
<th>Min</th>
<th>Mean</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Individual characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration from school completion to migration ($T_h$)</td>
<td>31</td>
<td>1</td>
<td>8.3301</td>
<td>5.4698</td>
</tr>
<tr>
<td>Age</td>
<td>48</td>
<td>11</td>
<td>22.7107</td>
<td>5.5358</td>
</tr>
<tr>
<td>Education ($X_1$)</td>
<td>25</td>
<td>0</td>
<td>9.6512</td>
<td>4.0693</td>
</tr>
<tr>
<td>Occupation$^1$ ($X_2$)</td>
<td>3</td>
<td>0</td>
<td>2.0790</td>
<td>0.8734</td>
</tr>
<tr>
<td>Gender$^2$ ($X_3$)</td>
<td>1</td>
<td>0</td>
<td>0.9325</td>
<td>0.2509</td>
</tr>
<tr>
<td>Relationships$^3$ ($X_4$)</td>
<td>1</td>
<td>0</td>
<td>0.0739</td>
<td>0.2616</td>
</tr>
<tr>
<td>Land holdings ($X_5$)</td>
<td>3</td>
<td>0</td>
<td>0.0168</td>
<td>0.1461</td>
</tr>
<tr>
<td>Property holdings ($X_6$)</td>
<td>2</td>
<td>0</td>
<td>0.0068</td>
<td>0.0870</td>
</tr>
<tr>
<td>Business holdings ($X_7$)</td>
<td>2</td>
<td>0</td>
<td>0.0210</td>
<td>0.1476</td>
</tr>
<tr>
<td><strong>Macroeconomic and policy factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US unemployment rate ($X_8$)</td>
<td>0.0971</td>
<td>0.0397</td>
<td>0.0717</td>
<td>0.0129</td>
</tr>
<tr>
<td>Mexico unemployment rate ($X_9$)</td>
<td>0.0800</td>
<td>0.0220</td>
<td>0.0525</td>
<td>0.0159</td>
</tr>
<tr>
<td>IRCA$^4$ ($X_{10}$)</td>
<td>1</td>
<td>0</td>
<td>0.9031</td>
<td>0.2959</td>
</tr>
<tr>
<td>IA$^4$ ($X_{11}$)</td>
<td>1</td>
<td>0</td>
<td>0.8269</td>
<td>0.3784</td>
</tr>
<tr>
<td><strong>Migrant network variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timing of first close family members migration$^5$ ($T_f$)</td>
<td>49</td>
<td>0</td>
<td>17.2291</td>
<td>11.0432</td>
</tr>
<tr>
<td>Number of relatives$^6$ ever been to the U.S.$^7$ ($Z_1$)</td>
<td>233.1429</td>
<td>0</td>
<td>4.9767</td>
<td>9.2700</td>
</tr>
<tr>
<td>Number of friends ever been to the U.S.$^7$ ($Z_2$)</td>
<td>173.5849</td>
<td>0</td>
<td>2.1704</td>
<td>6.4215</td>
</tr>
</tbody>
</table>

1. 0: unemployed; 1: unskilled blue collar workers; 2: skilled blue collar workers; 3: white collar workers.
2. 0: female; 1: male.
3. 0: not in any form of relationships; 1: married, consensus union, divorced, separated upon school completion.
4. 0 if the household head’s migration takes place before the policy is enacted; 1, otherwise.
5. The timing of the first close family members migration is equal to the individual’s age when the first close family member migrates. And if the first close family member migrates before the individual is born, the value is set to be zero.
6. Relatives include other family members, such as uncles, aunts, cousins, nieces, nephews, sibling-in-laws, children-in-laws, and parent-in-laws.
7. The numbers are adjusted by the ages upon school completion divided by the ages in survey years.
Empirical Migration Model

\[ \theta_f(t \mid v_f, \psi_f) = \lambda_f(t)v_f e^{\psi_f} \]
\[ \theta_h(t \mid x, z, v_h, \psi_h, t_f) = \lambda_h(t)v_h e^{\psi_h + x' \beta + z' \eta + \delta^1 \{age > t_f\}} \]

- **Duration dependence**

\[
\lambda_f(t) = \tilde{\lambda}_f; \quad \lambda_h(t) = \begin{cases} 
\tilde{\lambda}_h1, & 0 \leq age < 18 \\
\tilde{\lambda}_h2, & 18 \leq age < 30 \\
\tilde{\lambda}_h3, & age \geq 30 
\end{cases}
\]

- **Unobserved heterogeneity**

\[ V_j \sim \text{Gamma}(1, 1) \Rightarrow G_j = 1 - e^{-v_j}, \quad j = f, h \]
Family Factor Specification

- Correlated family members’ migration

\[ \text{Prob}(\Psi_f = \psi_f^a, \Psi_h = \psi_h^a) = p_1, \text{Prob}(\Psi_f = \psi_f^a, \Psi_h = \psi_h^b) = p_2, \]
\[ \text{Prob}(\Psi_f = \psi_f^b, \Psi_h = \psi_h^a) = p_3, \text{Prob}(\Psi_f = \psi_f^b, \Psi_h = \psi_h^b) = p_4. \]

\[ \implies \text{Cov}(\Psi_f, \Psi_h) = (p_1p_4 - p_2p_3)(\psi_h^a - \psi_h^b)(\psi_f^a - \psi_f^b) \]

- Extreme cases
  1. Family members share common propensity towards emigration: \( \Psi_f = \Psi_h = \Psi \)
  2. Perfect substitution between family members’ migration

\[ \Psi_h = -\Psi_f = \Psi \]

\[ \Psi = \begin{cases} \psi_l' & w.p. p \\
\psi_u & w.p. 1 - p \end{cases} \]
Correlated Migration Behavior

Correlated Migration Behavior $\rho = -0.67$

<table>
<thead>
<tr>
<th>Estimates</th>
<th>T</th>
<th>Estimates</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>$-1.82$</td>
<td>Occupation</td>
<td>$-8.24$</td>
</tr>
<tr>
<td>Male</td>
<td>$12.99$</td>
<td>Relationship</td>
<td>$-14.27$</td>
</tr>
<tr>
<td>Land</td>
<td>$-2.64$</td>
<td>Property</td>
<td>$-3.14$</td>
</tr>
<tr>
<td>Business</td>
<td>$-4.60$</td>
<td>US unem. rate</td>
<td>$-20.47$</td>
</tr>
<tr>
<td>Mex unem. rate</td>
<td>$-43.70$</td>
<td>IRCA</td>
<td>$-8.03$</td>
</tr>
<tr>
<td>IA</td>
<td>$-40.13$</td>
<td>Network ($\delta$)</td>
<td>$0.80$</td>
</tr>
<tr>
<td>Relatives</td>
<td>$10.99$</td>
<td>Friends</td>
<td>$5.81$</td>
</tr>
<tr>
<td>$\rho_1$</td>
<td>$0.94$</td>
<td>$\rho_2$</td>
<td>$0.00$</td>
</tr>
<tr>
<td>$\rho_3$</td>
<td>$0.35$</td>
<td>$\rho_4$</td>
<td>$0.03$</td>
</tr>
<tr>
<td>$\psi^a_f$</td>
<td>$-3.65$</td>
<td>$\psi^b_f$</td>
<td>$4.97$</td>
</tr>
<tr>
<td>$\psi^a_h$</td>
<td>$2.71$</td>
<td>$\psi^b_h$</td>
<td>$1.60$</td>
</tr>
<tr>
<td>$\lambda_f$</td>
<td>$0.61$</td>
<td>$\lambda_{h1}$</td>
<td>$1.00$</td>
</tr>
<tr>
<td>$\lambda_{h2}$</td>
<td>$13.74$</td>
<td>$\lambda_{h3}$</td>
<td>$33.55$</td>
</tr>
</tbody>
</table>
Correlated Migration Behavior

Family Factor Specification

- Correlated family members’ migration

\[
\begin{align*}
\text{Prob}(\psi_f = \psi_f^a, \psi_h = \psi_h^a) &= p_1, \\
\text{Prob}(\psi_f = \psi_f^a, \psi_h = \psi_h^b) &= p_2, \\
\text{Prob}(\psi_f = \psi_f^b, \psi_h = \psi_h^a) &= p_3, \\
\text{Prob}(\psi_f = \psi_f^b, \psi_h = \psi_h^b) &= p_4.
\end{align*}
\]

\[\implies \text{Cov}(\psi_f, \psi_h) = (p_1p_4 - p_2p_3)(\psi_h^a - \psi_h^b)(\psi_f^a - \psi_f^b)\]

- Extreme cases

1. Family members share common propensity towards emigration: \(\psi_f = \psi_h = \psi\)

2. Perfect substitution between family members’ migration

\[\psi = \begin{cases} \\
\psi^f, & w.p \quad p \\
\psi^u, & w.p \quad 1 - p
\end{cases}\]
Extreme Cases

\[ \delta = 0.80(122\%) \text{ in the correlated family factor case.} \]
Two Interesting Questions

▶ What if family factors are ignored?

▶ How do close family members connect the individual to the migrant networks?
  ▶ Does the first migrating family member’s timing \((Age - T_f)\) matter?
  ▶ Does the individual connected to the migrant networks through the individual’s father, mother, or siblings matter?
  ▶ Does the individual’s family members’ green card status make any difference?
No Family Factors Specification

\[ \psi_f = \psi_h = 1 \]

<table>
<thead>
<tr>
<th></th>
<th>Estimates</th>
<th>T</th>
<th></th>
<th>Estimates</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>-1.27</td>
<td>(-21.38)</td>
<td>Occupation</td>
<td>-2.22</td>
<td>(-39.37)</td>
</tr>
<tr>
<td>Gender</td>
<td>7.01</td>
<td>(27.77)</td>
<td>Relationship</td>
<td>-7.87</td>
<td>(-29.32)</td>
</tr>
<tr>
<td>Land</td>
<td>-1.64</td>
<td>(-50.41)</td>
<td>Property</td>
<td>-1.64</td>
<td>(-55.01)</td>
</tr>
<tr>
<td>Business</td>
<td>-2.14</td>
<td>(-46.81)</td>
<td>US unem. rate</td>
<td>-10.76</td>
<td>(-26.28)</td>
</tr>
<tr>
<td>Mex unem. rate</td>
<td>-19.27</td>
<td>(-23.04)</td>
<td>IRCA</td>
<td>-5.87</td>
<td>(-9.08 )</td>
</tr>
<tr>
<td>IRCA</td>
<td>-37.97</td>
<td>(-47.09)</td>
<td>Network ((\delta))</td>
<td>0.65</td>
<td>(10.92 )</td>
</tr>
<tr>
<td>Relatives</td>
<td>5.57</td>
<td>(36.05)</td>
<td>Friends</td>
<td>3.21</td>
<td>(48.68 )</td>
</tr>
<tr>
<td>(\lambda_f)</td>
<td>0.02</td>
<td>(-2101.10)</td>
<td>(\lambda_{h1})</td>
<td>1.00</td>
<td>(- - -)</td>
</tr>
<tr>
<td>(\lambda_{h2})</td>
<td>13.08</td>
<td>(40.65)</td>
<td>(\lambda_{h3})</td>
<td>22.59</td>
<td>(14.23 )</td>
</tr>
</tbody>
</table>

- Likelihood ratio tests: reject all null hypothesis
- The direct network effect: \(\delta = 0.65\) (91%) v.s \(\delta = 0.80\) (122%) in correlated migration behavior case
No Family Factors Specification

\( \psi_f = \psi_h = 1 \)

<table>
<thead>
<tr>
<th></th>
<th>Estimates</th>
<th>T</th>
<th></th>
<th>Estimates</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>-1.27</td>
<td>(-21.38)</td>
<td>Occupation</td>
<td>-2.22</td>
<td>(-39.37)</td>
</tr>
<tr>
<td>Gender</td>
<td>7.01</td>
<td>(27.77)</td>
<td>Relationship</td>
<td>-7.87</td>
<td>(-29.32)</td>
</tr>
<tr>
<td>Land</td>
<td>-1.64</td>
<td>(-50.41)</td>
<td>Property</td>
<td>-1.64</td>
<td>(-55.01)</td>
</tr>
<tr>
<td>Business</td>
<td>-2.14</td>
<td>(-46.81)</td>
<td>US unem. rate</td>
<td>-10.76</td>
<td>(-26.28)</td>
</tr>
<tr>
<td>Mex unem. rate</td>
<td>-19.27</td>
<td>(-23.04)</td>
<td>IRCA</td>
<td>-5.87</td>
<td>(-9.08)</td>
</tr>
<tr>
<td>IRCA</td>
<td>-37.97</td>
<td>(-47.09)</td>
<td>Network (( \delta ))</td>
<td>0.65</td>
<td>(10.92)</td>
</tr>
<tr>
<td>Relatives</td>
<td>5.57</td>
<td>(36.05)</td>
<td>Friends</td>
<td>3.21</td>
<td>(48.68)</td>
</tr>
<tr>
<td>( \lambda_f )</td>
<td>0.02</td>
<td>(-2101.10)</td>
<td>( \lambda_{h1} )</td>
<td>1.00</td>
<td>(- -)</td>
</tr>
<tr>
<td>( \lambda_{h2} )</td>
<td>13.08</td>
<td>(40.65)</td>
<td>( \lambda_{h3} )</td>
<td>22.59</td>
<td>(14.23)</td>
</tr>
</tbody>
</table>

- Likelihood ratio tests: reject all null hypothesis
- The direct network effect: \( \delta = 0.65 \) (91\%) v.s \( \delta = 0.80 \) (122\%) in correlated migration behavior case
Network Effect Analysis

How do close family members connect the individual to the migrant networks?

<table>
<thead>
<tr>
<th></th>
<th>Estimates</th>
<th>T</th>
<th></th>
<th>Estimates</th>
<th>T</th>
<th></th>
<th>Estimates</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edu</td>
<td>$-1.22$</td>
<td>$(-0.29)$</td>
<td>IA</td>
<td>$-31.93$</td>
<td>$(-2.09)$</td>
<td>$p_3$</td>
<td>$0.04$</td>
<td>$(0.53)$</td>
</tr>
<tr>
<td>Occ</td>
<td>$-0.39$</td>
<td>$(-0.42)$</td>
<td>$AGE - T_f$</td>
<td>$-1.80$</td>
<td>$(-4.57)$</td>
<td>$p_4$</td>
<td>$0.02$</td>
<td>$(0.27)$</td>
</tr>
<tr>
<td>Gender</td>
<td>$11.02$</td>
<td>$(2.12)$</td>
<td>Father</td>
<td>$29.05$</td>
<td>$(2.43)$</td>
<td>$\psi^a_f$</td>
<td>$-3.64$</td>
<td>$(1.32)$</td>
</tr>
<tr>
<td>Re</td>
<td>$-12.58$</td>
<td>$(-2.17)$</td>
<td>Mother</td>
<td>$10.10$</td>
<td>$(3.45)$</td>
<td>$\psi^b_f$</td>
<td>$3.99$</td>
<td>$(0.02)$</td>
</tr>
<tr>
<td>Land</td>
<td>$-1.43$</td>
<td>$(-3.54)$</td>
<td>Siblings</td>
<td>$26.97$</td>
<td>$(2.09)$</td>
<td>$\psi^a_h$</td>
<td>$-0.65$</td>
<td>$(0.14)$</td>
</tr>
<tr>
<td>Prop</td>
<td>$-2.66$</td>
<td>$(-2.62)$</td>
<td>Legal</td>
<td>$7.69$</td>
<td>$(3.58)$</td>
<td>$\psi^b_h$</td>
<td>$-2.78$</td>
<td>$(0.62)$</td>
</tr>
<tr>
<td>Bus</td>
<td>$-2.60$</td>
<td>$(-2.52)$</td>
<td>Relatives</td>
<td>$9.47$</td>
<td>$(2.34)$</td>
<td>$\lambda_f$</td>
<td>$0.60$</td>
<td>$(2.41)$</td>
</tr>
<tr>
<td>US U</td>
<td>$-14.57$</td>
<td>$(-2.27)$</td>
<td>Friends</td>
<td>$4.84$</td>
<td>$(2.52)$</td>
<td>$\lambda_{h1}$</td>
<td>$1.00$</td>
<td>$(--)$</td>
</tr>
<tr>
<td>Mex U</td>
<td>$-33.30$</td>
<td>$(-2.23)$</td>
<td>$p_1$</td>
<td>$0.91$</td>
<td>$(1.19)$</td>
<td>$\lambda_{h2}$</td>
<td>$20.39$</td>
<td>$(0.37)$</td>
</tr>
<tr>
<td>IRCA</td>
<td>$-4.85$</td>
<td>$(-2.33)$</td>
<td>$p_2$</td>
<td>$0.02$</td>
<td>$(0.20)$</td>
<td>$\lambda_{h2}$</td>
<td>$58.46$</td>
<td>$(1.69)$</td>
</tr>
</tbody>
</table>
Conclusion

- The signs of the estimates confirm with previous literature.
- Positive duration dependence.
- Family members’ migration is substitutional.
- The substitution effect outperforms the common propensity effect.
- Family (direct) network effect is significant.
- Failing to consider the family factors will bias the estimates.
- The earlier the first close family member’s migration, the less the effect on the individual’s migration decision.
- The model controls for the endogeneity and circumvents the problems of finding appropriate and available IV.
Definition of Network Effects

The influence of the migrant networks on the individual’s migration decision when he/she is connected/exposed to the networks through DIRECT and INDIRECT means.

- Direct: when one of his/her close family members migrates.
- Indirect: via other family members’ (relatives') and/or friends’ migration.

\(^1\) Sometimes direct network effect is termed FAMILY network effect

\(^2\) Close family members: parents and siblings

\(^3\) Relatives: uncles, aunts, cousins, nieces, nephews, sibling-in-laws, children-in-laws, and parent-in-laws
Data Processing

- Merge HOUSE, MIG, SPOUSE data files
- Delete missing data
- Delete school completion year earlier than 1975
- Delete people migrating before $\bar{t} + 1$
- Delete data $age = t_f$ where $age = t_h + \bar{t}$
- Treat union of all types as married
- Adjust the number of relatives and friends ever been to the U.S.