On the joint consumption and labor supply effects of migration on those left behind

Supplementary Materials

Elie Murard

1 Additional results

| Table S.1 – Effect of migration on farm inputs in the short and long-run |
|---------------------------------------------------------------|

### Panel A: Variation in the use of farm inputs between 2002 and 2005

| Dep. var : Use of | Fertilizers | Improved seeds or pesticides | Other farm inputs (tractor, yoke, irrigation) |
|------------------|------------|-----------------------------|---------------------------------------------|
|                  | (1)        | (2)                         | (3)                                         |
| $\Delta \text{MigUS}_h$ | -0.001     | 0.014                       | 0.024                                       |
|                   | (0.027)    | (0.025)                     | (0.025)                                     |
| $\Delta \text{MigUS}_h$ *Poor household | 0.017     | 0.042                       | 0.026                                       |
|                   | (0.035)    | (0.033)                     | (0.033)                                     |
| $\Delta \text{MigUS}_h$ *Rich household | -0.055   | -0.046                      | 0.008                                       |
|                   | (0.039)    | (0.037)                     | (0.037)                                     |
| N                 | 2,605      | 2,605                       | 2,602                                       |
| 2002 average outcome | .135    | .135                       | .108                                        |

### Panel B: Variation in the use of farm inputs between 2002 and 2009

| Dep. var : Use of | Fertilizers | Improved seeds or pesticides | Other farm inputs (tractor, yoke, irrigation) |
|------------------|------------|-----------------------------|---------------------------------------------|
|                  | (1)        | (2)                         | (3)                                         |
| $\Delta \text{MigUS}_h$ | 0.006     | 0.062**                     | 0.058**                                     |
|                   | (0.029)    | (0.027)                     | (0.027)                                     |
| $\Delta \text{MigUS}_h$ *Poor household | 0.024   | 0.081**                     | 0.084**                                     |
|                   | (0.037)    | (0.035)                     | (0.034)                                     |
| $\Delta \text{MigUS}_h$ *Rich household | -0.014 | 0.045                      | 0.027                                       |
|                   | (0.042)    | (0.040)                     | (0.039)                                     |
| N                 | 2,507      | 2,507                       | 2,508                                       |
| 2002 average outcome | .135    | .135                       | .108                                        |

**Notes:** The table reports estimates of the effects of out-migration. The unit of observation is the household. $\Delta \text{MigUS}_h$ is a binary variable equal to one if the household sends a migrant to the U.S. between 2002 and 2005. Dependent variables are variation in binary variables between 2002 and 2005, or between 2002 and 2009. The dependent variable "other inputs" is a binary taking one if the household has had any expenditures on tractor rental, fuels, irrigation, yoke or others. "Poor" households are defined as those with initial 2002 consumption per capita below the sample median. "Rich" households are those with above-median initial consumption. Standard errors in parentheses (). Std. errors clustered at the household level. Significance level: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Controls of the regressions include: municipality fixed effects, household size and demographic composition, highest education attained in the household, the amount of public transfers, extended family networks in the U.S. and returnees living in the household. All controls are measured at baseline in 2002.

1. Murard@iza.org. IZA - Institute for the Study of Labor Schaumburg-Lippe-Str. 5-9, 53113 Bonn, Germany. Phone: +49 228 3894-508, Web: http://www.iza.org
### Table S.2 – Short- and longer-term effects of U.S. migration on household durable assets and consumption

#### Panel A - Dependent var: Variation in household durable assets between 2005 and 2002

| Ownership of:          | Financial assets | Bicycle | Motorized vehicle | Electronic appliances (radio, TV, computer..) | Washing & cooking furniture | Domestic appliances (blender, microwave) | Draft animal (horse, mule, donkey) | Product animal (cows, pigs, goats, poultry) |
|------------------------|------------------|---------|-------------------|-----------------------------------------------|-----------------------------|---------------------------------------------|--------------------------------|---------------------------------------------|
| \( \Delta \text{MigUS}_h \) | 0.057**          | -0.062  | 0.004             | 0.040*                                        | 0.018                       | -0.037                                      | 0.060**                         | -0.012                                      |
| \( \text{N} \)         | 2,604            | 2,491   | 2,578             | 2,514                                         | 2,474                       | 2,499                                       | 2,580                           | 2,529                                       |
| \( \mathbb{E}[Y_{ih,2002} | \Delta \text{MigUS}_h = 0] \) | 0.127   | 0.515             | 0.279                                         | 0.926                        | 0.861                                       | 0.853                           | 0.183                                       | 0.479                                       |

#### Panel B - Dependent var: Variation in household durable assets between 2009 and 2002

| Ownership of:          | Financial assets | Bicycle | Motorized vehicle | Electronic appliances (radio, TV, computer..) | Washing & cooking furniture | Domestic appliances (blender, microwave) | Draft animal (horse, mule, donkey) | Product animal (cows, pigs, goats, poultry) |
|------------------------|------------------|---------|-------------------|-----------------------------------------------|-----------------------------|---------------------------------------------|--------------------------------|---------------------------------------------|
| \( \Delta \text{MigUS}_h \) | 0.053*           | 0.039   | 0.027             | 0.054**                                       | 0.037                       | -0.011                                      | 0.089***                       | 0.065                                       |
| \( \text{N} \)         | 2,514            | 2,397   | 2,490             | 2,384                                         | 2,380                       | 2,400                                       | 2,482                           | 2,447                                       |

#### Panel C - Dependent var: Variation in household non-durable expenditures between 2009 and 2002

| Expenditures category | Financial expenditures | Non-food expenditures | Total expenditures |
|-----------------------|------------------------|-----------------------|--------------------|
| \( \Delta \text{MigUS}_h \) | 105.023***             | 31.275*               | 128.983***         |
| \( \text{N} \)         | 2,415                  | 2,444                 | 2,404              |

**Notes:** The table reports estimates of the effects of out-migration. The unit of observation is the household. \( \Delta \text{MigUS}_h \) is a binary variable equal to one if the household sends a migrant to the U.S. between 2002 and 2005. Draft animals are horses, mules or donkeys. Production animals are cows, pigs, goats or poultry. In panels A and B, the regressions do not include the wealth index in the controls because it is calculated using the initial 2002 value of the dependent variable (assets and durable goods). \( \mathbb{E}[Y_{ih,2002} | \Delta \text{MigUS}_h = 0] \) is the average of the outcome in 2002 among households without U.S. migrants. Standard errors in parentheses (\( \cdot \)). Std. errors clustered at the household level. Significance level: * \( p < 0.10 \), ** \( p < 0.05 \), *** \( p < 0.01 \). Controls of the regressions include: municipality fixed effects, household size and demographic composition, highest education attained in the household, the amount of public transfers, extended family networks in the U.S. and returnees living in the household. All controls are measured at baseline in 2002.
TABLE S.3 – Labor reallocation effects among household members left behind

Dependent var : Non-migrant individuals’ labor supply (variation betw. 2005 and 2002)

|                       | Any work | Non-agricultural jobs | Agricultural jobs | Self-employed work | Household farm work |
|-----------------------|----------|-----------------------|-------------------|--------------------|---------------------|
|                       | (1)      | (2)                   | (3)               | (4)                | (5)                 |

Panel A1 : Participation among individuals aged 15-25

|                      | MigUSh *male | MigUSh *female | 2002 average outcome |
|----------------------|--------------|----------------|----------------------|
| ∆MigUSh *male        | 0.084        | -0.061         | 2.058                |
|                      | (0.074)      | (0.059)        | (2,058)              |
| ∆MigUSh *female      | -0.051       | -0.053         | 2.047                |
|                      | (0.074)      | (0.051)        | (2,047)              |
| N                    | 2,058        | 2,047          | 2,047                |
| 2002 average outcome | .465         | .255           | .102                 |

Panel A2 : Weekly hours among individuals aged 15-25

|                      | MigUSh *male | MigUSh *female | 2002 average outcome |
|----------------------|--------------|----------------|----------------------|
| ∆MigUSh *male        | 6.210        | -3.807         | 19.418               |
|                      | (4.045)      | (2.676)        | (1,999)              |
| ∆MigUSh *female      | -3.697       | -3.034         | 11.33                |
|                      | (3.592)      | (2.362)        | (1,996)              |
| N                    | 1,999        | 1,996          | 1,996                |
| 2002 average outcome | 11.101       | 4.305          | 19.418               |

Panel B1 : Participation among individuals older than 26

|                      | MigUSh *male | MigUSh *female | 2002 average outcome |
|----------------------|--------------|----------------|----------------------|
| ∆MigUSh *male        | 0.033        | 0.067**        | 4.955                |
|                      | (0.033)      | (0.030)        | (4,955)              |
| ∆MigUSh *female      | 0.002        | 0.001          | 4.946                |
|                      | (0.034)      | (0.018)        | (4,946)              |
| N                    | 4,955        | 4,946          | 4,946                |
| 2002 average outcome | .569         | .221           | .237                 |

Panel B2 : Weekly hours among individuals older than 26

|                      | MigUSh *male | MigUSh *female | 2002 average outcome |
|----------------------|--------------|----------------|----------------------|
| ∆MigUSh *male        | -2.108       | 1.611          | 24.138               |
|                      | (2.237)      | (1.341)        | (24,138)             |
| ∆MigUSh *female      | 1.856        | -0.126         | 4.861                |
|                      | (1.763)      | (0.847)        | (4,861)              |
| N                    | 4,864        | 4,861          | 4,861                |
| 2002 average outcome | 9.882        | 4.762          | 9.504                |

Notes: The table reports estimates of the effects of out-migration on the labor supply of non-migrant individuals older than 15. The unit of observation is the individual. ∆MigUSh is a binary equal to one if the household sends a migrant to the U.S. between 2002 and 2005. Dependent variables are all variation over time between 2005 and 2002 in the participation or hours in diverse types of work: non-agricultural and agricultural salary work (jobs), self-employed work (on household-owned plot or in non-agricultural business), or household farm work (e.g. weeding, sowing, raising livestock in family farm or garden). E[y_{i,2002}|ΔMigUSh = 0] is the average of the outcome in 2002 among households without U.S. migrants. Standard errors in parentheses ( ). Std. errors clustered at the household level. Significance level: *p < 0.10, **p < 0.05, ***p < 0.01. Controls of the regressions include: municipality fixed effects, individual age, sex and education, household size and demographic composition, highest education attained in the household, a quadratic form of wealth index, the amount of public transfers, extended family networks in the U.S. and returnees living in the household. All controls are measured at baseline in 2002.
### TABLE S.4 – The impact of migration on the education of those left behind

| Dependent var: | Individuals’ education (variation betw. 2005 and 2002) |
|----------------|-------------------------------------------------------|
|                | Years of education | School attendance |
|                | (1)                | (2) |

#### Panel A: Children between 6 and 14

|                  |                  |                  |
|------------------|------------------|------------------|
| $\Delta \text{Mig}_{USh}$ *male | $0.018$          | $-0.015$         |
|                  | $(0.133)$        | $(0.033)$        |
| $\Delta \text{Mig}_{USh}$ *female | $0.083$          | $0.000$          |
|                  | $(0.121)$        | $(0.030)$        |
| N                | $3,181$          | $3,126$          |
| 2002 average outcome | $3.298$          | $0.947$          |

#### Panel A: Young adults between 15 and 25

|                  |                  |                  |
|------------------|------------------|------------------|
| $\Delta \text{Mig}_{USh}$ *male | $0.030$          | $-0.057$         |
|                  | $(0.250)$        | $(0.055)$        |
| $\Delta \text{Mig}_{USh}$ *female | $0.304^*$        | $0.052$          |
|                  | $(0.175)$        | $(0.036)$        |
| N                | $2,117$          | $2,066$          |
| 2002 average outcome | $7.823$          | $0.285$          |

**Notes:** The table reports estimates of the effects of out-migration on the education of non-migrant individuals. The unit of observation is the individual. $\Delta \text{Mig}_{USh}$ is a binary equal to one if the household sends a migrant to the U.S. between 2002 and 2005. Dependent variables are all variation over time between 2005 and 2002. Standard errors in parentheses (). Std. errors clustered at the household level. Significance level: $^* p < 0.10$, $^** p < 0.05$, $^*** p < 0.01$. Controls of the regressions include: municipality fixed effects, individual age, sex and education, household size and demographic composition, highest education attained in the household, a quadratic form of wealth index, the amount of public transfers, extended family networks in the U.S. and returnees living in the household. All controls are measured at baseline in 2002.
TABLE S.5 – Non-family workers hired in the household farm and business

Dependent var.: Non-family workers in the household production (Variation betw. 2005 and 2002)

|                      | Workers on the land | Workers in the non-agri. business |
|----------------------|---------------------|-----------------------------------|
|                      | At least one Number | At least one Number               |
|                      | (1) (2)             | (3) (4)                           |
| $\Delta \text{MigUS}_h$ | 0.043 (0.028)       | -0.002 (0.017)                    |
| $N$                  | 2,608               | 2,608                             |
| $\mathbb{E}[Y_{ih,2002}|\Delta \text{MigUS}_h = 0]$ | .139                 | .04                               |

Notes: The table reports estimates of the effects of out-migration. The unit of observation is the household. $\Delta \text{MigUS}_h$ is a binary equal to one if the household sends a migrant to the U.S. between 2002 and 2005. The dependent variables are variation over time in the number of workers who are not household members and who worked either in the household farm (column 1 and 2) or in the household non-agricultural business (column 3 and 4). $\mathbb{E}[Y_{ih,2002}|\Delta \text{MigUS}_h = 0]$ is the average of the outcome in 2002 among households without U.S. migrants. Standard errors in parentheses (). Std. errors clustered at the household level. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Controls of the regressions include: municipality fixed effects, household size and demographic composition, highest education attained in the household, the amount of public transfers, extended family networks in the U.S. and returnees living in the household. All controls are measured at baseline in 2002.

TABLE S.6 – Time devoted to household tasks by non-migrant individuals

Dependent var.: Hours per week (Variation betw. 2005 and 2002)

|                      | Household chores | Caring for children and elderly |
|----------------------|------------------|---------------------------------|
|                      | (1)              | (2)                             |
| $\Delta \text{MigUS}_h$ | 0.238 (0.844)   | 0.953 (0.959)                   |
| $N$                  | 5,834            | 5,728                           |
| $\mathbb{E}[Y_{ih,2002}|\Delta \text{MigUS}_h = 0]$ | 14.733            | 9.285                           |

Notes: The table reports estimates of the effects of out-migration on the time use of non-migrant individuals. $\Delta \text{MigUS}_h$ is a binary equal to one if the household sends a migrant to the U.S. between 2002 and 2005. The dependent variables are variation over time in weekly hours. Household chores include collecting water and firewood, cooking and preparing food, washing clothes and cleaning the house. Caring for children and elderly include time spent in taking care of elder, sick people, children and helping any home member to study or complete homework. $\mathbb{E}[Y_{ih,2002}|\Delta \text{MigUS}_h = 0]$ is the average of the outcome in 2002 among households without U.S. migrants. Standard errors in parentheses (). Std. errors clustered at the household level. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Controls of the regressions include: municipality fixed effects, individual age, sex and education, household size and demographic composition, highest education attained in the household, a quadratic form of wealth index, the amount of public transfers, extended family networks in the U.S. and returnees living in the household. All controls are measured at baseline in 2002.
2 Pre-trend analysis using the ENOE survey

**Figure S.1** – Pre-migration time trends in labor supply using ENOE data

Average differences between households with and without U.S. migrants by quarters preceding migration

**(a) Participation**

**(b) Weekly hours**

**Notes**: The data come from the rural sample of the ENOE survey in 2005, 2006 and 2007, interviewing the same households for five consecutive quarters. The sample is made of about 40,000 different households interviewed for five quarters, constituting a total of about 575,000 person-quarters observations. Every quarter, a little more than 1% of the households send at least one member to the U.S. The graph plots the 95% confidence interval and the point estimate \( \hat{\delta}_k \) of the difference in labor allocation between households with and without U.S. migrant against the number of quarters \( k \) before migration, using the following regression:

\[
Y_{ihq} = \sum_{k=1}^{4} \delta_k M_{hq}^k + \eta_{p,q} + u_{ihq}
\]

with \( Y_{ihq} \) the labor supply of individual \( i \) in household \( h \) at time \( q \) and \( M_{hq}^k \) a dummy equal 1 if, at time \( q \), the household sends a migrant \( k \) quarter later – which means between 0 and 3 months later if \( k = 1 \) and between 9 and 12 months if \( k = 4 \). The vector \( \eta_{p,q} \) consists of municipality and time fixed effects.
TABLE S.7 – Test of parallel pre-migration trends in labor supply and labor income using ENOE data

| Dependant variable: | Any work | Non-agricultural jobs | Agricultural jobs | Non-agricultural self-employment | Agricultural self-employment | Individual monthly earnings |
|--------------------|----------|------------------------|-----------------|-------------------------------|-----------------------------|---------------------------|
|                    | part.    | hours                  | part.           | hours                         | part.                       | hours                     |
|                    | (1)      | (2)                    | (3)             | (4)                           | (5)                         | (6)                       |
| U.S. migration 4 quarters later $M_{hq}^4$ | ref.     | ref.                   | ref.             | ref.                          | ref.                        | ref.                      |
|                    | -0.018   | -0.373                 | -0.006          | -0.112                        | 0.002                       | 0.223                     |
|                    | (0.013)  | (0.641)                | (0.010)         | (0.456)                       | (0.009)                     | (0.368)                   |
| U.S. migration 3 quarters later $M_{hq}^3$ | -0.002   | 0.680                  | -0.017          | -0.385                        | 0.003                       | 0.035                     |
|                    | (0.014)  | (0.633)                | (0.011)         | (0.526)                       | (0.009)                     | (0.342)                   |
| U.S. migration 2 quarters later $M_{hq}^2$ | -0.000   | 0.993                  | -0.004          | -0.009                        | -0.002                      | 0.153                     |
|                    | (0.014)  | (0.654)                | (0.011)         | (0.502)                       | (0.009)                     | (0.396)                   |
| U.S. migration 1 quarter later $M_{hq}^1$ | 0.546    | 22.573                 | 10.192          | 0.068                         | 2.818                       |
|                    | 561,616  | 561,616                | 561,616         | 561,616                       | 561,616                     | 561,616                   | 474,681                   |

Notes: The data come from the rural sample of the ENOE survey in 2005,2006,2007, interviewing the same households for five consecutive quarters. The sample is made of about 40,000 different households interviewed for five quarters, constituting a total of about 575,000 person-quarters observations. Every quarter, a little more than 1% of the households send at least one member to the U.S. on average. I test whether households with and without U.S. migrant have different pre-migration time trends across the four quarters preceding migration by estimating:

$$Y_{ihq} = \eta_i + \sum_{k=1}^{3} \alpha_k M_{hq}^k + \eta_{p,q} + u_{ihq}$$

with $Y_{ihq}$ the outcome of individual $i$ in household $h$ at time $q$ and $M_{hq}^k$ a dummy equal 1 if, at time $q$, the household sends a migrant $k$ quarter later. $\eta_{p,q}$ are municipality and time fixed effects. Importantly, the vector of individual fixed effects $\eta_i$ controls for time-invariant heterogeneity. In this specification, households that send a migrant four quarters earlier, i.e. for which $M_{hq}^4 = 1$ are in the reference group. Coefficients $\alpha_k$ estimates whether the difference in outcomes between households without and without migrants significantly varies over time between the fourth and the 4th quarter preceding migration. Testing the nullity of $\alpha_k$, amounts to testing parallel trends. The outcomes $Y_{ihq}$ are either labor force participation (part.) or weekly hours (hours), or individual earnings per month (column 11).
3 Robustness analysis

I evaluate the robustness of the results by looking at the sensitivity of the estimates to the set of controls included in the regression. Table S.8 in appendix shows how estimates fluctuate when, starting from the simple bivariate regression, different household and individual controls are added. The main specification’s estimates are presented in the last column 5, when the full list of controls is included. The estimates of the consumption and labor supply effects of migration are very stable across the different specifications. One exception is the bivariate regression estimates (column 1) who generally provide smaller coefficient relative to the specifications with municipality fixed-effects. However, given that municipalities covered by the MxFLS are geographically very distant and heterogeneous in terms of economic conditions and migration networks, the bivariate regression is unlikely to yield consistent estimates and should not be given too much importance.

Another possible concern may be attrition. The attrition rate is low — about 3.5% at the household level — and might be partly driven by whole-household migration to the U.S. Nonetheless, households that leave no members behind are not relevant here because my interest is in the population of households staying in the same community of origin in Mexico in the two rounds of the surveys. Among this population, there is no reason to expect that not being recorded in the second round of interview is systematically correlated with the out-migration of a household member to the U.S.
# Table S.8 – Robustness checks: sensitivity to the set of regression controls

| Panel A - Dependent var: | Household total expenditures per adult equivalent (variation between 2005 and 2002) |
|-------------------------|-----------------------------------------------------------------------------------|
| ∆MigUS\(_h\)           | (1)                        (2)                        (3)                        (4)                        (5)         |
|                         | 118.205***                | 163.845***                | 180.563***                | 178.522***                | 181.650*** |
|                         | (41.413)                  | (42.810)                  | (43.722)                  | (43.389)                  | (43.730)   |
| N                       | 2,495                     | 2,495                     | 2,495                     | 2,495                     | 2,495      |
| R2                      | .0037                     | .0984                     | .1085                     | .114                      | .1155      |
| Municipality Fixed-Effects | ✓                          | ✓                          | ✓                          | ✓                          | ✓          |
| Household demographics  | ✓                          | ✓                          | ✓                          | ✓                          | ✓          |
| Wealth and non-labor income | ✓                        | ✓                          | ✓                          | ✓                          | ✓          |
| Migration Networks      | ✓                          | ✓                          | ✓                          | ✓                          | ✓          |

| Panel B - Dependent var: | Participation in self-employed work (variation between 2005 and 2002) |
|-------------------------|------------------------------------------------------------------------|
| ∆MigUS\(_h\)           | (1)                        (2)                        (3)                        (4)                        (5)         |
|                         | 0.062***                   | 0.055**                    | 0.056**                   | 0.056**                   | 0.056**    |
|                         | (0.021)                   | (0.021)                   | (0.022)                   | (0.022)                   | (0.022)    |
| N                       | 6,993                     | 6,993                     | 6,993                     | 6,993                     | 6,993      |
| R2                      | .0017                     | .0279                     | .0298                     | .0307                     | .0309      |
| Municipality Fixed-Effects | ✓                          | ✓                          | ✓                          | ✓                          | ✓          |
| Household and indiv. demographics | ✓                        | ✓                          | ✓                          | ✓                          | ✓          |
| Wealth and non-labor income | ✓                        | ✓                          | ✓                          | ✓                          | ✓          |
| Migration Networks      | ✓                          | ✓                          | ✓                          | ✓                          | ✓          |

| Panel C - Dependent var: | Weekly hours in self-employed work (variation between 2005 and 2002) |
|-------------------------|-----------------------------------------------------------------------|
| ∆MigUS\(_h\)           | (1)                        (2)                        (3)                        (4)                        (5)         |
|                         | 1.440                      | 1.817*                     | 1.841*                     | 1.837*                     | 1.804*     |
|                         | (0.900)                   | (0.990)                   | (1.021)                   | (1.019)                   | (1.019)    |
| N                       | 6,857                     | 6,857                     | 6,857                     | 6,857                     | 6,857      |
| Municipality Fixed-Effects | ✓                          | ✓                          | ✓                          | ✓                          | ✓          |
| Household and indiv. demographics | ✓                        | ✓                          | ✓                          | ✓                          | ✓          |
| Wealth and non-labor income | ✓                        | ✓                          | ✓                          | ✓                          | ✓          |
| Migration Networks      | ✓                          | ✓                          | ✓                          | ✓                          | ✓          |

| Panel D - Dependent var: | Weekly hours in farm work (variation between 2005 and 2002) |
|-------------------------|----------------------------------------------------------------|
| ∆MigUS\(_h\)           | (1)                        (2)                        (3)                        (4)                        (5)         |
|                         | 0.753                      | 1.279**                    | 1.452**                    | 1.447**                    | 1.385**    |
|                         | (0.659)                   | (0.619)                   | (0.628)                   | (0.629)                   | (0.625)    |
| N                       | 5,898                     | 5,898                     | 5,898                     | 5,898                     | 5,898      |
| R2                      | .0003                     | .0406                     | .0435                     | .0443                     | .0452      |
| Municipality Fixed-Effects | ✓                          | ✓                          | ✓                          | ✓                          | ✓          |
| Household and indiv. demographics | ✓                        | ✓                          | ✓                          | ✓                          | ✓          |
| Wealth and non-labor income | ✓                        | ✓                          | ✓                          | ✓                          | ✓          |
| Migration Networks      | ✓                          | ✓                          | ✓                          | ✓                          | ✓          |

**Notes:** The table reports estimates of the effects of out-migration. The unit of observation is the household in panel A and the individual in panel B, C, and D. ∆MigUS\(_h\) is a binary equal to one if the household sends a migrant to the U.S. between 2002 and 2005. Dependent variables are all variation over time between 2005 and 2002 in: the total household expenditure per month divided by the adult equivalence scale used in? (panel A); participation and weekly hours in self-employed work (panel B and panel C); weekly hours in self-employed farm work (panel D). Significance level: *p < 0.10, **p < 0.05, ***p < 0.01. Household demographics controls include household size, nb children younger than 13 yold, nb. elderly older than 55 yold, nb. male 14-35 and highest education attained in the household. Individual demographics are age, sex and education. Wealth and non-labor income include a quadratic form of wealth index and the amount of public transfers. Migration Networks include a binary indicating whether the household has extended family networks in the U.S. and another binary taking one if there are US returnees living in the household. All controls are measured at baseline in 2002.
The chart shows the Kernel density of the agricultural wages per hour in three datasets: (i) the Mexican Life Survey (MxFLS) (ii) the 2000 Mexican Census (iii) the Labor Force Survey (ENOE, 2005, 2006, 2007). All wages are deflated or inflated so that they represent 2002 nominal values. Hourly wages are computed as monthly wages of agricultural worker in rural areas (municipalities of less than 15,000 inhabitants) divided by 4.5×number of hours per week. For the 2000 Mexican Census, I use only wages of workers living in the same municipalities as those covered by the MxFLS survey. To avoid outliers, I trim each distribution by dropping wages with values above the 95th percentile and below the 5th percentile.
### TABLE S.9 – Density of agricultural hourly wages in three data sources

Moment of the distribution (in pesos per hour):

|                    | MxFLS survey | Population Census | Labor Force survey |
|--------------------|--------------|-------------------|--------------------|
| 10th percentile    | 3.17         | 3.45              | 5.22               |
| Median             | 7.9          | 6.92              | 9.74               |
| Average            | 9.09         | 8.79              | 10.6               |
| 90th percentile    | 14.81        | 13.84             | 15.67              |
| Nb of observations | 669          | 19,527            | 41,372             |

Notes: The table reports some moment of density of the agricultural wages per hour in three datasets: (i) the Mexican Life Survey (MxFLS) (ii) the 2000 Mexican Census (iii) the Labor Force Survey (ENOE, 2005, 2006, 2007). All wages are deflated or inflated so that they represent 2002 nominal values. Hourly wages are computed as monthly wages of agricultural worker in rural areas (municipalities of less than 15,000 inhabitants) divided by 4.5+number of hours per week. For the 2000 Mexican Census, I use only wages of workers living in the same municipalities as those covered by the MxFLS survey. To avoid outliers, I trim each distribution by dropping wages with values above the 95th percentile and below the 5th percentile.
5 Theoretical Model

5.1 Setting

Consider a household with two members. Member 1 is the only potential migrant in the family. Each family member $i$ allocates his time endowment $T_i$ between farm work $L^F_i$, off-farm wage work $L^O_i$ and leisure $l_i$. Each household member’s wage labor $L^O_i$ is remunerated at a given rate $w_i$. Family members’ labor supplies are substitutes in the household farm production $F(L)$ which exhibits diminishing marginal productivity: $F'>0$, $F''<0$ and $F'(0)=+\infty$. Moreover, $y$ is the non labor income of the family (e.g. public transfers).

The family maximizes a Bergson-Samuelson joint welfare function:

$$U(c_1,c_2,l_1,l_2) = (1-\theta)U^1(c_1,l_1)+\theta U^2(c_2,l_2)$$

noting $c_i$ member $i$’s consumption. I assume the complementarity between consumption and leisure in individual utilities, i.e $U^{i}_{c,l,i} \geq 0$, as well as the concavity of the utilities. I also assume that each member devotes at least one unit of time to work, i.e. $L^F_i + L^O_i > 0$. Finally, the household does not hire in non-family labor in the farm. I relax this assumption in appendix A3.

When member 1 stays home, the family’s allocation of time is described by the following program:

$$
\begin{align*}
\text{NOMIG} & \quad \max_{c_1,c_2,L^F_1,L^O_1,L^F_2,L^O_2} U(c_1,c_2,T_1-L^F_1-L^O_1,T_2-L^F_2-L^O_2), \\
\text{subject to} & \quad c_1 + c_2 = F(L^F_1 + L^F_2) + w_1L^O_1 + w_2L^O_2 + y \\
& \quad \forall i = 1,2 : 0 \leq L^F_i, 0 \leq L^O_i, L^F_i + L^O_i \leq T_i 
\end{align*}
$$

Member 1 can migrate and earn a wage $w^*_1$ in the foreign labor market. Once he has left home, he can no longer work in the family farm. When member 1 is abroad, the family’s allocation of time is described by:

$$
\begin{align*}
\text{MIG} & \quad \max_{c_1,c_2,L^F_1,L^O_1,L^F_2,L^O_2} U(c_1,c_2,T_1-L^O_1,T_2-L^F_2-L^O_2), \\
\text{subject to} & \quad c_1 + c_2 = F(L^F_2) + w^*_1 L^O_1 + w_2L^O_2 + y \\
& \quad 0 \leq L^F_2, 0 \leq L^O_i, L^F_2 + L^O_2 \leq T_2, L^O_1 \leq T_1
\end{align*}
$$

The family decides to engage in migration if and only if the indirect utility of family is strictly higher in the migration regime than in the non-migration regime: $V_{MIG} > V_{NOMIG}$.

5.2 The case where $w_1 > w_2$

I first assume that the potential migrant can earn a higher wage in the local labor market than the non-migrant: $w_1 > w_2$. I will examine the opposite case in section 3.
5.3 Optimal allocation of labor before migration

Consider first the non migration regime. Drawing on Sadoulet, De Janvry and Benjamin (1998)’s agricultural household model with imperfect labor markets, I derive the conditions of membership to different labor regimes. A first immediate result is that, because \( w_1 > w_2 \) and household member’s labor are substitute in the farm, member 2 specializes in farming.

**Proposition 1 : if member 1 works in the farm \( (L^F_1 > 0) \), member 2 does not work off-farm \( (L^O_2 = 0) \).**

Proof.
The FOCs of the maximization program \( NOMIG \) are the following (also sufficient because of the concavity if the utility) :

\[
\begin{align*}
F'U_{c_1} - U_{l_1} + \mu_1 &= 0, \quad \mu_1 L^F_1 = 0, \quad \mu_1 \geq 0 \\
F'U_{c_2} - U_{l_2} + \mu_2 &= 0, \quad \mu_2 L^F_2 = 0, \quad \mu_2 \geq 0 \\
w_1 U_{c_1} - U_{l_1} + \lambda_1 &= 0, \quad \lambda_1 L^O_1 = 0, \quad \lambda_1 \geq 0 \\
w_2 U_{c_2} - U_{l_2} + \lambda_2 &= 0, \quad \lambda_2 L^O_2 = 0, \quad \lambda_2 \geq 0 \\
U_{c_1} &= U_{c_2}
\end{align*}
\]

Subtracting the first from the third equation, as well as the second from the fourth gives :

\[
(F' - w_1)U_{c_1} = \lambda_1 - \mu_1
\]

\[
(F' - w_2)U_{c_2} = \lambda_2 - \mu_2
\]

If \( L^F_1 > 0 \), then \( \mu_1 = 0 \) and \( F' \geq w_1 \). Since \( w_1 > w_2 \), \( \lambda_2 \geq \mu_2 > 0 \) which implies \( L^O_2 = 0 \).

Since the farm always demands a positive amount of labor and corner solutions \( L^F_i = L^O_i = 0 \) are excluded, it follows from proposition 1 that member 2 always devotes some time in farming activities. \( L^F_2 \) is always positive. The household allocates its time between farm-work and wage work depending on the relative marginal product of labor in these activities. Four different labor regimes are possible :

- (SF) The household is self-sufficient in labor. No one works off-farm.
- (HO) The household hires out. Member 1 works both on and off the farm. Member 2 cultivates the land but does not participate in the labor market.
- (OFF) Member 1 works off-farm only and member 2 cultivates alone. Member 2 does not work off-farm.
- (OFL) The same regime as (OFF) except that member 2 works both in the farm and off-farm.

Define now the shadow wage \( \Omega(y, T_1, T_2) \) as the marginal productivity of farm labor in the self-sufficiency regime (at the optimum). When the household in self-sufficient, the optimal marginal product of farm labor is only a function of \( y, T_1 \) and \( T_2 \). Define also the shadow wage \( \Omega_2 \) as the marginal productivity of member 2’s farm labor when he is the only worker in the farm. \( \Omega_2 \) is a function of \( y, w_1, T_1 \) and \( T_2 \). I assume that the the mapping \( \pi : w \mapsto \Omega_2(y, w, T_1, T_2) \) has a unique fixed point \( \tilde{w}^\dagger \).

**Proposition 2 : The membership to the different labor regimes is completely characterized by the following inequalities :**
\[(\text{SF}) : L_1^F > 0, L_1^O = 0, L_2^O = 0 \iff w_1 \leq \Omega(y, T_1, T_2)\]

\[(\text{HO}) : L_1^F > 0, L_1^O > 0, L_2^O = 0 \iff \Omega(y, T_1, T_2) < w_1 < \overline{\omega}_T(y, T_1, T_2)\]

\[(\text{OFF}) : L_1^F = 0, L_1^O > 0, L_2^O = 0 \iff \overline{\omega}_T(y, T_1, T_2) \leq w_1 \text{ and } w_2 < \Omega_2(y, w_1, T_1, T_2)\]

\[(\text{OFL}) : L_1^F = 0, L_1^O > 0, L_2^O > 0 \iff \overline{\omega}_T(y, T_1, T_2) \leq w_1 \text{ and } w_2 > \Omega_2(y, w_1, T_1, T_2)\]

---

**Proof.**

**Lemma 1:** it can be shown (see Appendix A2) that

\[
\begin{align*}
\frac{\partial \Omega}{\partial y} > 0, \frac{\partial \Omega}{\partial T_1} < 0 \text{ and } \frac{\partial \Omega}{\partial T_2} < 0 \\
\frac{\partial \Omega}{\partial y} > 0, \frac{\partial \Omega}{\partial w_1} > 0, \frac{\partial \Omega}{\partial T_1} > 0 \text{ and } \frac{\partial \Omega}{\partial T_2} < 0
\end{align*}
\]

Note $\Lambda$ the total family labor input in the farm and by $L^*$ its optimal amount. If the household is self-sufficient in labor (SF), it is clear from the FOCS that $\lambda_1 = (F_1 - w_1)U_{c_1} \geq 0$. By definition, $F'(L^*) = \Omega(y, T_1, T_2)$ in this labor regime, so $\Omega(y, T_1, T_2) \geq w_1$. If member 1 works both in the farm and in the labor market, $F'(L^*) = w_1$, and the Hiring-out regime (HO) can be written as:

\[
\begin{cases}
F'U_{c_2} = U_{l_2} (c_1, c_2, T_2 - L_2^F, T_1 - L_1^O - L_1^T) \\
F'U_{c_1} = U_{l_1} \\
0 + w_1 L_1^O + y \\
\Omega(L^*) = \Omega(y, w_1, T_1, T_2) \text{, by definition}
\end{cases}
\]

Using lemma 1, it results that $w_1 > \Omega(y, T_1, T_2)$ is a necessary condition for member 1's participation in labor market. If member leaves the farm and works only in the labor market, the Off-farm regimes can be written with the following system of equations, depending on whether member 2 participates in off-farm wage work:

**OFF if $L_2^O = 0$**

\[
\begin{align*}
F'U_{c_2} &= U_{l_2} (c_1, c_2, T_2 - L_2^F, T_1 - L_1^O) \\
w_1 U_{c_1} &= U_{l_1} \\
c_1 + c_2 &= F(L_2^F) + w_1 L_1^O + y \\
\mu_1 &= (w_1 - F')U_{c_1} \geq 0 \Rightarrow w_1 \geq F' \\
\lambda_2 &= (F' - w_2)U_{c_2} \geq 0 \Rightarrow w_2 \leq F' \\
F'(L^*) &= \Omega_2(y, w_1, T_1, T_2) \text{, by definition}
\end{align*}
\]

**OFL if $L_2^O > 0$**

\[
\begin{align*}
F'U_{c_2} &= U_{l_2} (c_1, c_2, T_2 - L_2^F - L_2^O, T_1 - L_1^O) \\
w_1 U_{c_1} &= U_{l_1} \\
w_2 U_{c_2} &= U_{l_2} \\
c_1 + c_2 &= F(L_2^F) + w_1 L_1^O + w_2 L_2^O + y \\
F'(L^*) &= \Omega_2(y + w_2 L_2^O, w_1, T_1, T_2 - L_2^O) = w_2
\end{align*}
\]

From lemma 1, it follows that if $L_2^O > 0$ then $w_2 > \Omega_2(y, w_1, T_1, T_2)$. Consequently, $w_2 > \Omega_2(y, w_1, T_1, T_2)$ is a necessary and sufficient condition for the participation of member 2 in the local labor market (when member does not work in the farm). Furthermore, if member 1 decides to stop working in the farm it is necessary that $w_1 \geq \Omega_1(y, w_1, T_1, T_2)$. Coming back to the case where member 1 works simultaneously on and off the farm, the Hiring out regime (HO) can also be rewritten in this way:

\[
\begin{cases}
F'(L)U_{c_2} = U_{l_2} (c_1, c_2, T_2 + L_2^F - L, T_1 - L_1^F - L_1^O) \\
w_1 U_{c_1} = U_{l_1} \\
c_1 + c_2 &= F(L) + w_1 L_1^O + y \\
F'(L^*) &= \Omega_2(y, w_1, T_1 - L_1^F, T_2 + L_2^F) = w_1
\end{cases}
\]

It follows that in the labor regime (HO), $w_1 < \Omega_2(y, w_1, T_1, T_2)$. For the moment, I have proven that:

- $L_1^F > 0, L_1^O = 0 \Rightarrow w_1 \leq \Omega(y, T_1, T_2)$
- Using the contrapositive of the previous implications, $L_1^F > 0, L_1^O > 0 \iff \Omega < w_1 < \Omega_2(y, w_1, T_1, T_2)$
- $L_1^F = 0, L_1^O > 0 \Rightarrow \Omega_2(y, w_1, T_1, T_2) \leq w_1$

**Lemma 2:** $\overline{\omega}_T > \Omega_2(y, T_1, T_2)$ and w, w - $\overline{\omega}_T$ and $\pi(w) - w$ have opposite sign.

The proof is the following. By contraposition, we know that \{w > $\Omega(y, T_1, T_2)$ and $\pi(w) \leq w$ = $L_1^F = 0, L_1^O > 0$ and \{w ≤ $\Omega(y, T_1, T_2)$ and $\pi(w) > w$ \}= $L_1^F > 0, L_1^O = 0$. Since $\pi$ is increasing and assumed to be infinitely differentiable, $\pi(w) - w$ have constant opposite sign over the interval $[0, \overline{\omega}_T]$ and $[\overline{\omega}_T, +\infty]$. If $\Omega > \overline{\omega}_T$, $\pi(w) - w$ has the same sign over $[\Omega, +\infty]$. If it is negative, the Hiring out (HO) regime is never optimal, as soon as member 1 starts working in the labor market, it stops working the farm. If it is positive, the Off-farm regimes (OFL or OFF) are never optimal, member 1 never leaves the farm no matter how high is the off-farm wage. Both cases are absurd, so $\Omega(y, T_1, T_2) < \overline{\omega}_T$.
that at the optimum, member 1 continues to work in the farm when outside wages are $w''$ but stop farming and exclusively work off-farm as the wages drop from $w''$ to $w'$. This is economically absurd. Hence, $w - w' \pi$ and $\pi(w) - w$ must have the same sign.

According to lemma 2, $w_1 \leq \Omega(y, T_1, T_2) \Rightarrow w_1 < \Omega_2(y, w_1, T_1, T_2)$, which shows that $L_F^I > 0, L_O^I = 0 \iff w_1 \leq \Omega(y, T_1, T_2)$. According to lemma 2, $\Omega_2(y, w_1, T_1, T_2) \leq w_1 \Rightarrow \Omega(y, T_1, T_2) < w_1$, which shows that $L_F^I = 0, L_O^I > 0 \iff \Omega_2(y, w_1, T_1, T_2) \leq w_1$. This completes the demonstration.
5.4 Effects of migration

**Proposition 3:** If member 1 migrates, then:

- The non-migrant’s wage labor in the local labor market decreases (or remains null).
- Total family labor $L_1^F + L_2^F$ in the farm declines (except in one case where it remains unchanged).
- If the migrant does not work in the farm before migration, the non-migrant reduces his work in the farm (except in one case where it remains unchanged).

**Proof.**

The migration regime corresponds the Off-farm labor regime (OF) where member 1’s wage has increased to $w_1^*$. Consequently, in this regime, member 2 participates in the local labor market if and only if $w_2 > \Omega_2(y, w_1^*, T_1, T_2)$. Furthermore, if member 2 works only in the farm, his optimal amount of labor is such that $F'(L_2^F) = \Omega_2(y, w_1^*, T_1, T_2)$.

If the initial (pre-migration) is the self-sufficiency regime, member 1 may migrate only if the foreign wage $w_1^*$ is higher than the marginal productivity of farm labor $\Omega$. From lemmas 1 and 2, I can derive that $\Omega_2(y, w_1^*, T_1, T_2) \geq \Omega_2(y, T_1, T_2)$. This means that the non migrant’s farm labor after migration is lower than the sum of migrant’s and non migrant’s farm labor before migration.

If before migration the migrant works both on and off the farm, $F'(L) = w_1$. A necessary condition for migration is $w_1^* > w_1$.

**Proposition 4:** If member 1 migrates, then:

- The non-migrant’s consumption increases
- The non-migrant’s utility $U^2$ increases as well.

**Proof.**

When member 1 does not work in the farm (regime OFF or OFL), any increase in his wage $w_1$ is transferred to member 2. The consumption of member 2 increases with $w_1$, as I show formally in appendix A2. According to proposition 3, the labor supply of member 2 (either in the farm or off-farm) remains constant or decreases with $w_1$. As a result, the welfare of member 2 is increasing with $w_1$.

When member 1 works both in the labor market and in the farm (regime HO), the maximization program is equivalent to:

$$\max_{c_1, c_2, L_1^O, L_2^F, \theta} (1 - \theta)U^1 (c_1, T - L_1^F - L_1^O) + \theta U^2 (c_2, T_2 - L_2^F)$$

subject to $c_1 + c_2 = F(L_1^F + L_2^F) + w_1L_1^O + y$

$$\iff$$

$$V_1(R, L_2^F) = \max_{c_1, L_1^F, \theta} U^1 (c_1, T - L_1^F - L_1^O)$$

subject to $c_1 = F(L_1^F + L_2^F) + w_1L_1^O + y - R$

and

$$\max_{\theta} (1 - \theta)V_1(R, L_2^F) + \theta U^2 (R, T_2 - L_2^F)$$

Using the envelop theorem, it is easy to show that the optimal $R$ and $L_2^F$ must satisfy that $\theta U^2_1 (R, T_2 - L_2^F) = (1 - \theta)U^1_1 (R, L_2^F)$.
and also that \( U^2_{2}(R_{1}, T_{2} - L^{F}_{2}) = w_{1}U^{2}_{1}(R_{1}, T_{2} - L^{F}_{2}) \). Keeping \( L^{F}_{2} \) constant, it can be derived that:

\[
\frac{\partial R}{\partial w_{1}} = \frac{(1 - \theta) \frac{\partial U^{1}_{1}}{\partial w_{1}}}{\frac{\partial U^{2}_{2}}{\partial l_{2}} - (1 - \theta) \frac{\partial U^{1}_{1}}{\partial R}} > 0
\]

because \( \frac{\partial U^{1}_{1}}{\partial w_{1}} < 0 \) and \( \frac{\partial U^{1}_{1}}{\partial R} > 0 \). Indeed, noting \( a_{1} = U^{1}_{1} - w_{1}U^{1}_{1} > 0 \) and \( b_{1} = w_{1}U^{1}_{1} - U^{1}_{1} > 0 \), and \( D_{1} = U^{1}_{2} - U^{1}_{1} - U^{1}_{1} > 0 \) (because \( U^{1} \) is concave), it can be shown that \( \frac{\partial U^{1}_{1}}{\partial R} = \frac{b_{1}U^{1}_{1} - a_{1}U^{1}_{1}}{a_{1}b_{1}U^{1}_{1}} \) and that \( \frac{\partial U^{1}_{1}}{\partial w_{1}} = -a_{1}U^{1}_{1} - w_{1}U^{1}_{1} \).

When \( w_{1} \) increase, member 1 reallocates this labor away from the farm to the labor market, which increase his earnings. Member 1 transfers a part of this income gain to member 2. Because member 1 reduces his labor in the farm, the marginal productivity of agricultural labor for member 2 increases. Therefore, before changing his labor supply, member 2 benefits from higher unearned income and from higher marginal productivity. Whether member 2 increases or not his farm labor, it is certain that his consumption must increase (as I formally show in Appendix A2). Member 2 may increase his farm labor, but his welfare will always improve because the productivity of this labor has risen and because he receives more transfers from member 1. I show this formally in Appendix A2.

In conclusion, the consumption and welfare of member 2 increase with \( w_{1} \) in all the regime HO, OFF and OFL. Since member 1 migrates only if \( w_{1}^{1} \) is higher than the Mexican wage \( w_{1} \), the consumption and welfare of non-migrants increases with migration.

### 5.5 The case where \( w_{1} \leq w_{2} \)

In this case, by symmetry of proposition 1, member 1 always devotes some time in the farm initially. The foreign wage \( w_{1}^{1} \) has to be at least higher than \( w_{2} \) to induce member 1 to migrate.

**Proposition 5:** If member 1 migrates, then:

- **Total family labor** \( L^{F}_{1} + L^{F}_{2} \) *in the farm declines (or remains unchanged).*

- **The non-migrant’s wage labor in the local labor market decreases (or remains null).**

- **The non-migrant’s consumption increases**

- **The non-migrant’s utility** \( U^{2} \) *increases as well.*

**Proof.**

I first demonstrate that the total family labor in the farm decreases or remains constant with migration. If initially \( w_{2} \leq \Omega \), no one works off-farm and \( F'(L) = \Omega(y, T_{1}, T_{2}) \). In this case, member 1 only if at least \( w_{1}^{1} \geq \Omega \) which implies that in the migration regime \( \Omega_{2}(y, w_{1}^{1}, T_{1}, T_{2}) > \Omega_{2}(y, T_{1}, T_{2}) \geq \Omega \) (lemmas 1 and 2). This shows that in the migration regime, member 2’s farm labor is lower than the initial total labor input in the farm. If initially \( w_{2} \geq \Omega \), we know that \( F'(L) \leq w_{2} \) in the non-migration regime. After migration, we also know that member 2’s farm labor \( L^{F}_{2} \) will always be lower than \( F^{-1}(w_{2}) \). So \( F'(L^{F}_{2}) \geq w_{2} \geq F'(L) \), the marginal productivity of farm labor before migration. This proves that the total farm labor input decrease with migration, or remains constant.

Second, I show that member 2’s consumption and welfare increases with migration and that his/her off-farm work decreases. Initially, before migration, as long as member 2 works in the farm, member 1 never works off-farm, and therefore the allocation of time and consumption does not depend on the wage \( w_{1} \). If member 2 does not work in the farm then the allocation can be described by:

\[
\begin{align*}
V_{1}(R) &= \max_{c_{1}, l_{1}^{O}, l_{1}^{F}, c_{2}, l_{2}^{O}, l_{2}^{F}} U^{1} \text{ subject to } c_{1} + c_{2} = F(L^{F}_{1}) + w_{1}L^{O}_{1} + w_{2}L^{F}_{2} + y \text{ and } \max_{R}(1 - \theta)V_{1}(R) + \theta V_{2}(R)
\end{align*}
\]

It is easy to show formally that \( R \) is an increasing function of \( w_{1} \). This implies that an increase in \( w_{1} \) leads to a higher unearned income for member 2. Therefore, the consumption and the welfare of member 2 increases with \( w_{1} \) and his off-farm work \( L^{O}_{2} \) decreases with \( w_{1} \). Since migration occurs only if the foreign \( w_{1}^{1} \) is higher than the initial Mexican wage \( w_{1} \), this proves the proposition.
5.6 Model Appendix

Proof lemma 1

The utility $U$ is assumed to be concave and $U_{c_t} > 0$. Necessary conditions for concavity are:

$$U_{c_t} > 0, \ U_{t_t} > 0 \ and \ D_t = U_{c_t} U_{t_t} - U_{t_t}^2 > 0$$

Note also:

$$\delta_1 = 2w_1U_{t1c1} - U_{t1} - w_1^2U_{c1c1} > 0$$

$$\delta_2 = 2F'U_{c2c2} - U_{c2} - F'w_2U_{c1c2} - F''U_c > 0$$

$$\Delta = \delta_2D_1 + \delta_1(D_2 + F''U_cU_{c2c2}) > 0$$

$$D = U_{c1c1}U_{c2} + U_{c2c2}U_{t1t1} - 2U_{c1c1}U_{c2}$$

$$\Theta = D_1(b_2 + F''a_2 - F''U_c) + D_2(b_1 + F'a_1 - F''U_c) - F''U_c + D$$

with $a_1 = U_{t1c1} - F'U_{c1c1} > 0; \ a_2 = U_{c2c2} - F'U_{c2c2} > 0; \ b_1 = F'U_{t1c1} - U_{t1} > 0; \ b_2 = F'U_{c2c2} - U_{c2} > 0$.

As $D_1$ and $D_2$ are positive, it results that:

$$D > U_{c1c1}U_{c2} + U_{c2c2}U_{t1t1} - 2\sqrt{U_{c1c1}U_{t1t1}U_{c1c1}U_{c2c2}} = (\sqrt{U_{c1c1}U_{c2}} - \sqrt{U_{c2c2}U_{t1t1}})^2$$

and hence, $\Theta > 0 > 0$.

It can shown that:

$$\frac{\partial \Omega}{\partial \nu} = F'' \left[ -D_2(U_{c1c1} - F'U_{c1c1}) - D_1(U_{c2c2} - F'U_{c2c2}) \right] > 0$$

$$\frac{\partial \Omega}{\partial T_1} = \frac{\partial \Omega}{\partial T_2} = F'' \left[ D_2(U_{c1c1} - U_{t1}) + D_1(U_{c2c2} - U_{c2}) \right] < 0$$

$$\frac{\partial \Delta}{\partial \nu} = \frac{\partial \Omega}{\partial T_1} > 0$$

$$\frac{\partial \Delta}{\partial \nu} = \frac{\partial \Omega}{\partial T_2} > 0$$

$$\frac{\partial \Delta}{\partial w_1} = \frac{\partial \Omega}{\partial w_1} > 0$$

Proof that $\frac{\partial L_0^0}{\partial w_1} < 0$ in the Off-farm labor regime (OFL) when $L_2^0 > 0$

With additional notations:

$$\delta^* = 2w_1U_{t1c} - U_{t1} - w_1^2U_{c1c1} > 0$$

$$\Delta^* = \delta_2D_1 + \delta_1D_2 > 0$$

It can shown that:

$$\frac{\partial L_0^0}{\partial w_1} = \frac{1}{\Delta} \left[ U_{c2c2} - w_2U_{c2c2} \right] \left[ -D_1L_1^0 - U_c(U_{t1c1} - w_1U_{c1c1}) \right] < 0$$

Proof that $\frac{\partial c_2}{\partial w_1} > 0$ in the OFF or OFL regime (when $L_1^F = 0, L_1^0 > 0, L_2^F > 0$)

$$\frac{\partial c_2}{\partial w_1} = \frac{1}{\Delta} \left[ (F'(U_{c2c2} - U_{c2}) - F''U_c)(D_1L_1^0 + (U_{t1c1} - w_1U_{c1c1})U_c) \right] > 0$$

Proof that $\frac{\partial c_2}{\partial w_1} > 0$ in the HO regime (when $L_1^F > 0, L_1^0 > 0, L_2^F > 0, L_2^0 = 0$)

$$E = D_2\delta_1 + D_1[2w_1U_{c2c2} - U_{c2} - w_1^2U_{c2c2}] > 0$$

$$\frac{\partial c_2}{\partial w_1} = \frac{1}{E} \left[ (w_1U_{c2c2} - U_{c2})D_1L_1^0 + U_c((w_1U_{c2c2} - U_{c2})(U_{t1c1} - w_1U_{c1c1}) + \delta_1U_{c2c2} + w_1D_1) \right] > 0$$
Proof that \( \frac{\partial U^2}{\partial w_1} > 0 \) in the HO regime (when \( L^F_1 > 0, L^O_1 > 0, L^F_2 > 0, L^O_2 = 0 \))

\[
\frac{\partial U^2}{\partial w_1} = \frac{\partial c_2}{\partial w_1} U_{c_2} - \frac{\partial L^F_{w_1}}{\partial w_1} U_{l_2} = (\frac{\partial c_2}{\partial w_1} - w \frac{\partial L^F_{w_1}}{\partial w_1}) U_{c_2}
\]

\[
\frac{\partial U^2}{\partial w_1} = -\frac{U_{c_2}}{E} \left[ (U_{c_2}w^2 + U_{l_2} - 2wU_{l_2}c_2)D_1L^O_{1} + (U_{l_1}U_{l_2}c_2 + U_{l_2}U_{l_1}c_1 - wU_{c_1}U_{l_2}c_2 - wU_{c_2}U_{l_1}U_{l_2}c_1)U_{c_2} \right] > 0
\]

Extension: Hiring in of non-family workers in the farm

Suppose now that the family can hire workers in the farm at unit cost \( w_h \). The labor of non-family workers is also assumed to be a perfect substitute of family labor in the farm. The family solves then the following program before migration:

\[
\text{NOMIG} \begin{cases} 
\max_{c_1, c_2, L^F_1, L^O_1, L^F_2, L^O_2, L_h} & U \left( c_1, c_2, T_1 - L^F_1 - L^O_1, T_2 - L^F_2 - L^O_2 \right) \\
\text{subject to} & c_1 + c_2 = F(L^F_1 + L^F_2 + L_h) - w_h L_h + w_1 L^O_1 + w_2 L^O_2 + y \\
& \forall i = 1, 2 : 0 \leq L^F_i, 0 \leq L^O_i, L^F_i + L^O_i \leq T_i, 0 \leq L_h 
\end{cases}
\]
Lemma 4: if \( w_i > w_h \), member \( i \) never works in the farm \( (L_i^F = 0) \). If \( w_i < w_h \), member \( i \) and non family workers never work simultaneously in the farm \( (L_h > 0 \Rightarrow L_i^F = 0) \).

Proof.

Restaurant the equations gives that \( \forall i : F'U_{c_i} - U_{l_i} + \mu_i = 0 \), \( \mu_i L_i^F = 0 \), \( \mu_i \geq 0 \)

\[
\begin{align*}
L_i^F = 0 & \Rightarrow \mu_i = 0,
\end{align*}
\]

Rearranging the equations gives that \( \forall i : F'U_{c_i} - U_{l_i} + \lambda_i = 0 \), \( \lambda_i L_i^O = 0 \), \( \lambda_i \geq 0 \)

\[
U_{c_i} = U_{c_2}
\]

\[
(F' - w_h)U_{c_i} + \mu_h = 0 \text{, } \mu_h L_h = 0 \text{, } \mu_h \geq 0
\]

Proposition 6: Three different cases are possible.

\( w_h < w_2 < w_1 \)

Family members never work in the farm. The migration of member 1 does not affect the amount of non-family labor hired in the farm. The non-migrant member reduces his wage labor.

\( w_2 < w_h < w_1 \)

The total labor input in the farm decreases with migration, or remains unchanged. The left-behind member reduces his farm labor (or does not modify it in one case) and may hire more non-family farm labor. His wage labor also decreases or remains null.

\( w_2 < w_1 < w_h \)

The total labor input in the farm decreases or remains unaffected by migration. The wage labor of the non-migrant decreases or remains null.

Proof.

Consider the first case \( w_h < w_2 < w_1 \). As lemma 4 shows, then \( L_i^F = L_2^F = 0 \). Since the first unit of farm labor are infinitely productive, \( L_h > 0 \) and \( F'(L_h) = w_h \) at the optimum. Migration of member 1 does not affect \( L_h \). As shown previously, \( L_2^O \) is decreasing with \( w_1 \). So left-behinds reduce their wage labor as member 1 migrates to benefit from higher earnings.

Consider now the second case \( w_2 < w_h < w_1 \). Member 1 never works in the farm. As previously, it can be shown that member 2 participates on the labor market if and only if \( w_2 > \Omega_2(y,w_1,T_1,T_2) \). In addition, the household hires non farm labor if and only if \( \Omega_2(y,w_1,\overline{T}_1,\overline{T}_2) > w_h \). Indeed, if \( L_h > 0 \), then the FOCs are the following (noting \( L = L_h + L_i^F \)):

\[
\begin{align*}
\left\{ \begin{array}{l}
F'(L)U_{c_2} = U_{l_2} (c_1, c_2, T_1 - L_1^O, T_2 + L_h - L) \\
L_1 U_{c_1} = U_{l_1} \\
c_1 + c_2 = F(L) + w_1 L_1^O + y - w_h L_h \\
F'(L) = \Omega_2(y - w_h L_h, w_1, \overline{T}_1, \overline{T}_2 + L_h) = w_h
\end{array} \right.
\]

Using lemma 1, I conclude that \( \Omega_2(y,w_1,\overline{T}_1,\overline{T}_2) > w_h \) if \( L_h > 0 \). The converse is easy, since if \( L_h = 0 \), \( F'(L) \geq \Omega_2(y,w_1,T_1,T_2) \). The necessary condition for migration is \( w_1^* > w_1 \). If before migration, \( \Omega_2 > w_h > w_2 \), then \( F'(L_h + L_i^F) = \Omega_2(y - w_h L_h, w_1, T_1, T_2 + L_h) = w_h \). The total input of labor in the farm is not affected by migration. However, as \( w_1 \) jumps to \( w_1^* \), \( L_h \) necessarily increases and \( L_2^O \) decreases consequently. If before migration, \( w_2 < \Omega_2 < w_h \), the migration-induced increase in \( w_1 \) reduce the non-migrants’ farm labor and may prompt the hiring of non family farm workers if \( w_1^* \) is high enough (i.e. if \( \Omega_2(y,w_1^*,T_1,T_2) > w_h \)). If before migration, \( \Omega_2 < w_1 < w_h \), the non-migrant works off-farm, \( L_h = 0 \) and \( F'(L_i^F) = w_h \). Migration may not modify the non-migrant input of farm labor if \( \Omega_2(y,w_1^*,T_1,T_2) < w_h \). However, as shown previously, it reduces the wage labor of members left behind.

Consider the last case \( w_2 < w_1 < w_h \). It can be shown that the household hires non family workers if and only if \( \Omega(y,T_1,T_2) > w_h \). If before migration, \( \Omega(y,T_1,T_2) \leq w_h \) then \( L_h = 0 \) and the same results as before apply. If \( w_1^* \) is high enough (i.e. if \( \Omega_2(y,w_1^*,T_1,T_2) > w_h \)), the family may start hiring in non family workers. If before migration, \( \Omega(y,T_1,T_2) > w_h \) then \( L_h > 0 \), \( L_i^O = L_2^O = 0 \) and \( F'(L) = w_h \). A necessary condition for migration is that \( w_1^* > \Omega(y,T_1,T_2) > w_h \). From lemma 1 and lemma 2, I know that \( \Omega_2(y,w_1^*,T_1,T_2) > \Omega_2(y,w_h,T_1,T_2) > w_h \). As a result, after migration the household keeps hiring in non family labor in the farm and \( F'(L) = w_h \). Total input of labor in the farm does not change with migration.