Learning about Comparative Advantage in Entrepreneurship: Evidence from Thailand

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Motivation

- Non-agricultural household enterprise is an important part of economic livelihood in developing countries
  - Entrepreneurship proposed as important driver of growth \((e.g.\ Foster & Rosenzweig (2004))\)
  - Policy and public resources focused on encouraging entrepreneurship and improving business prospects \((\text{microfinance, training, consulting, etc.})\)
  - Townsend Thai Data: over 40% of households own a non-agricultural enterprise each year
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- Few household businesses grow to represent primary income source or employ non-household members
  - roughly 1/4 of enterprise households generate at least 50% of household income from business
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- What are the returns to entrepreneurship?
- Does everyone face the same returns?
- Do households know their returns?
- Which households sort in/out of entrepreneurship?
- What factors predominantly drive this sorting?
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  - gross return (ability/productivity)
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- **Theoretical:**
  - Credit constraints keep (high return) households from starting businesses (e.g. Banerjee & Newman (1993, 1994); Paulson, Townsend, & Karaivanov (2006))
  - Maybe not so simple (Buera (2009); Buera, Kaboski, & Shin (2011); Midgrigan & Xu (2011))

- **Empirical/Experimental:**
  - Mixed results on role of finance, insurance, regulatory infrastructure (Partial review: McKenzie (2010))
  - No effects of loan offers on business starts in Morocco (Crepon, Devoto, Dutia & Pariente (2011))
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  - performance and growth of existing enterprises (e.g. Bloom et al (2011); Karlan & Valdivia (2011); Bruhn et al (2011); Drexler et al (2011); de Mel et al (2012))

- Review reveals issues (McKenzie & Woodruff (2012))
  - attrition, selective survival, and start-up in sample → high frequency switching of enterprise status
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Model Hypothesis

- Households sort into the entrepreneurial sector on expected comparative advantage
  - expectations of relative ability in business over agriculture drive choice more than do financial constraints in this setting

- Over time, households
  - learn about their comparative advantage
  - switch in and out of the entrepreneurial sector
  - converge to the optimal sector choice
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Descriptive Evidence: Trends

Figure I
Trends in Savings, Self-reported Constraints, and Entrepreneurship

0.2

Constrained - scatter
Constrained - fitted curve

Entrepreneurship - scatter
Entrepreneurship - fitted curve

Trends

0.4

Savings - scatter
Savings - fitted curve

Year

2000

2002

2004

2006

2008

2010

0.6

0.8
Descriptive Evidence: Switching

Trends in Entrepreneurship and Switching

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
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<tbody>
<tr>
<td>Entrepreneurship - scatter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entrepreneurship - fitted line</td>
<td></td>
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Descriptive Evidence: Switching by Age of HH

Figure II
Panel B: Trends in Entrepreneurship and Switching by Age of Household

- Year
- Entrepreneurship - Older
- Switching - Older
- Entrepreneurship - Younger
- Switching - Younger
Preview of Results

- Large positive average returns to entrepreneurship
- Sorting on heterogeneous returns (marginal return is low)
  - Households with high earnings in default sector have low returns to entrepreneurship
- Evidence of dynamics from learning about return rather than saving out of financial constraints
  - Households switch into enterprise after low productivity realization in agriculture
- Validate model predictions and structural estimates using data on expected incomes by enterprise history
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Model: Setup

- 2 sectors: farm (default) and enterprise \( j \in \{F, E\} \)
  - Farm: cropping (wage labor too)
  - Enterprise: shop, trading, restaurant, etc.
  - Cobb-Douglas production functions with sector-specific
    - productivity
    - capital input
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- 2 components to productivity:
  - mean productivity, $\beta_t^j$
  - household-specific deviation from mean, $\eta_i^j$

- Household chooses in each period:
  - optimal capital input level for each sector
  - entrepreneurship status by comparing optimized profits across sectors

Details
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Model: Comparative Advantage (*Roy (1951), Lemieux (1998) and Suri (2011)*)

- Household-specific, sector-specific productivities ($\eta_i$) can be expressed in terms of
  - $\tau_i$, represents absolute advantage (skills valued equally across sectors)
  - $\eta_i$, represents comparative advantage in entrepreneurship (skills valued differentially)
  - $(1 + \phi)$, represents correlation of market’s value of $\eta_i$ across sectors
- Entrepreneurship decision driven by comparative advantage, $\eta_i$
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Entrepreneurship decision driven by comparative advantage, $\eta_i$

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  - average return to entrepreneurship \((\beta_t^E - \beta_t^F)\)
  - return to capital \(\rho^E \approx \rho^F \equiv \rho\)
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  - Imperfect information about \(\eta_i \rightarrow (\eta_i + \varepsilon_{it})\)
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Model: Learning Intuition

- Comparative advantage in entrepreneurship, $\eta_i$
  - example: ratio of marketing skill to physical strength
  - Household knows $(1 + \phi)$:
    - entrepreneurship values marketing skill more
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- Initial belief $\eta_i \sim N(m_{i0}, \sigma^2 = 1/h)$
- Observe output each period
- Calculate productivity signal independent of current entrepreneurial status ($\eta_i + \varepsilon_{it}$)
- Martingale law of motion: $m_{i,t} = m_{i,t-1} + \xi_{it}$
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Learn about relative ability in entrepreneurship in either sector

- low yield on farm, but good at selling crops → switch to enterprise
- bad at trading, but able to work long hours → switch to farming

Different from learning-by-doing

not new technology (livestock, trader, shop, etc.)
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- Include one form of constraint: limited liability
- Estimation of returns robust to alternate forms
  - additional variables (e.g., assets, interest rates) only effect output through capital and sector
  - address endogeneity in sector and input decisions
  - interpretation and predicted signs of other structural parameters differ
- Distinguish ability from financial constraint in results

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Empirical Strategy

Let us consider $T = 2$

$$y_{it} = \alpha_t + \beta_t D_{it} + \rho k_{it} + (\eta_i + \varepsilon_{it})(1 + \phi D_{it}) + \tau_i + \zeta_{it} \quad (1)$$

- $\alpha_t \equiv \beta_t^F$ and $\beta_t \equiv (\beta_t^E - \beta_t^F) = \beta$ $\forall t$
- $k_{it} \equiv k_{it}^F + (k_{it}^E - k_{it}^F)D_{it}$ and remember $\rho^F \approx \rho^E = \rho$
- measurement error $\zeta_{it}$ is assumed mean independent of $D_{it}$ and $k_{it}$ conditional on $\eta_i$ and $\tau_i$
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- $\alpha_t \equiv \beta_t^F$ and $\beta_t \equiv (\beta_t^E - \beta_t^F) = \beta \quad \forall t$

- $k_{it} \equiv k_{it}^F + (k_{it}^E - k_{it}^F)D_{it}$ and remember $\rho^F \approx \rho^E = \rho$

- Measurement error $\zeta_{it}$ is assumed mean independent of $D_{it}$ and $k_{it}$ conditional on $\eta_i$ and $\tau_i$
Empirical Strategy

▶ Let us consider $T = 2$

$$y_{it} = \alpha_t + \beta_t D_{it} + \rho k_{it} + (\eta_i + \varepsilon_{it})(1 + \phi D_{it}) + \tau_i + \zeta_{it} \quad (1)$$

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$y_{it} = \alpha_t + \beta D_{it} + \rho k_{it} + (\eta_i + \varepsilon_{it})(1 + \phi D_{it}) + \tau_i + \zeta_{it}$

- $D_{it}$ and $k_{it}$ are chosen endogenously based on $m_{i,t-1}$
- OLS estimate of $\beta$ and $\rho$ will be biased
- $(1 + \phi)$ is of interest (correlation between earnings across sectors)
Empirical Strategy

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Empirical Strategy: Learning

\[ m_{i,t} = m_{i,t-1} + \xi_{it} \Rightarrow m_{i,t-1} = m_{i0} + \sum_{k=1}^{t-1} \xi_{ik}, \]

- \( m_{i0} \) will affect choices in all periods
- Updates, \( m_{i}^{t-1} \equiv \sum_{k=1}^{t-1} \xi_{ik} \), are orthogonal to \( m_{i0} \)
- \( m_{i}^{t-1} \) will only affect choices in period \( t \) and onward
- \( \eta_i + \epsilon_{it} = m_{i0} + m_{i}^{t-1} + \varphi_{it} \)
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- \( m_{i,t} = m_{i,t-1} + \xi_{it} \implies m_{i,t-1} = m_{i0} + \sum_{k=1}^{t-1} \xi_{ik} \),
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Empirical Strategy: Learning

\[
y_{it} = \alpha_t + \beta D_{it} + \rho k_{it} + (m_{i0} + m_{it}^{t-1} + \varphi_{it})(1 + \phi D_{it}) + v_{it}, \quad (2)
\]

- \( v_{it} \equiv \tau_i + \zeta_{it} \) and \( \varphi_{it} \) orthogonal to \( D_{it} \)

- All information to be used in entrepreneurship decision at time \( t \) is fully summarized in \( m_{i0} \) and \( m_{it}^{t-1} \)
$$y_{it} = \alpha_t + \beta D_{it} + \rho k_{it} + (m_{i0} + m_{i}^{t-1} + \varphi_{it})(1 + \phi D_{it}) + \nu_{it}, \quad (2)$$

- $\nu_{it} \equiv \tau_i + \zeta_{it}$ and $\varphi_{it}$ orthogonal to $D_{it}$
- All information to be used in entrepreneurship decision at time $t$ is fully summarized in $m_{i0}$ and $m_{i}^{t-1}$
Empirical Strategy: Dynamic CRC

- Building on Chamberlain (1982, 1984), can project $m_{i0}$ and $m_{i}^{t-1}$ onto history of choices

- Purge composite error of correlation with $D_{it}$ and $k_{it}$

- Project $m_{i0}$ on 3 entrepreneurship histories, 2 capital choices, and 6 interactions of capital and sector choices

$$m_{i0} = \Lambda_0(\lambda; D_i, k_i) + \psi_{i0} \quad (3)$$

- Project $m_{i}^{t-1}$ on choices in period $t$ onward, no interactions

$$m_{i}^{t-1} = \Theta_{t-1}(\theta_{t-1}; D_{i}^{t}, k_{i}^{t}) + \psi_{i,t-1} \quad (4)$$
Empirical Strategy: Reduced Form

\[ y_{it} = \alpha_t + \left[ \Lambda_0(\lambda; D_i, k_i) + \Theta_{t-1}(\theta_{t-1}; D_i^t, k_i^t) \right] (1 + \phi D_{it}) + \beta D_{it} + \rho k_{it} + (\psi_{i0} + \psi_{i,t-1} + \varphi_{it})(1 + \phi D_{it}) + \nu_{it}, \]  

\[ (5) \]

- \( y_{it} \) as a function of entire history of entrepreneurship decisions
- Estimate these equations using seemingly unrelated regressions (SUR)
- Recover 22 reduced form coefficients
Empirical Strategy: Reduced Form

\[ y_{it} = \alpha_t + \left[ \Lambda_0(\lambda; D_i, k_i) + \Theta_{t-1}(\theta_{t-1}; D_{it}, k_{it}) \right] (1 + \phi D_{it}) + \beta D_{it} + \rho k_{it} + (\psi_{i0} + \psi_{i,t-1} + \varphi_{it})(1 + \phi D_{it}) + v_{it}, \quad (5) \]

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+ \beta D_{it} + \rho k_{it} + (\psi_{i0} + \psi_{i,t-1} + \varphi_{it})(1 + \phi D_{it}) + v_{it}, \quad (5) \]

- \( y_{it} \) as a function of entire history of entrepreneurship decisions
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- Recover 22 reduced form coefficients
Empirical Strategy: Structural MD Estimates

- Model imposes relationship between 22 reduced form coefficients and 17 structural parameters
- 11 $\lambda$’s estimate heterogeneity in initial beliefs
- 3 $\theta$’s estimate heterogeneity in belief update that drives switching
- $\beta$, $\rho$, and $\phi$ from model
- Estimate these structural parameters using minimum distance (MD)
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β is average return to entrepreneurship

ρ is average return to capital

$(1 + \phi)$ is correlation of earnings across sectors

- if $\phi > 0$, good farmers are good at enterprise
- if $\phi < 0$, less income inequality
Empirical Strategy: Parameter Interpretation

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- $\rho$ is average return to capital
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Empirical Strategy: Identification

- Compare conditional sample means of income across households and time
  - Condition on household’s entire history of choices
  - Identified from within household switching of entrepreneurship status and input expenditure

Threats to Identification
Empirical Strategy: Identification

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Threats to Identification
Data

- Townsend Thai Project data from 2005 and 2008
- 4 provinces: 2 from rural Northeast region and 2 from urban Central region
- Balanced panel includes 1103 households

- Sum Stats
Data

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Data

- Information on income and expenditure in agriculture, wage labor, and enterprise
- Information on expected income next year, savings and self-reported credit constraints
- Over 40% of HHs have enterprises in each wave
- Over 20% of HHs switch enterprise status

▸ Sum Stats  ▸ Labor
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Sum Stats  Labor
3 main types of businesses (in order of prevalence):

- shop (convenience store, food store, noodle shop / restaurant, repair shop, barber, etc.)
- trader
- fish/shrimp and other livestock

- roughly 22% of enterprise households get majority of income from business
- roughly 11% of enterprise households hire paid employees
Data

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Sum Stats
## Structural Estimates

<table>
<thead>
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<th>CRE</th>
<th>DCRE</th>
<th>CRC</th>
<th>DCRC</th>
</tr>
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<tr>
<td>(\rho)</td>
<td>0.0595***</td>
<td>0.0638***</td>
<td>0.0671***</td>
<td>0.0726***</td>
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<td>(0.0087)</td>
<td>(0.0098)</td>
<td>(0.0102)</td>
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<td>(\beta)</td>
<td>0.1858***</td>
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<td>(0.0607)</td>
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<td>(\phi)</td>
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<td>-0.4614**</td>
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<td></td>
<td>(0.2113)</td>
<td>(0.2149)</td>
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<td>(\chi^2)</td>
<td>85.1951</td>
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### Structural Estimates (Village x Time Dummies)

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<th>CRC</th>
<th>DCRC</th>
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<td>$\rho$</td>
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<td>0.0610***</td>
<td>0.0641***</td>
<td>0.0686***</td>
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<td>(0.0084)</td>
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<td>(0.0095)</td>
<td>(0.0119)</td>
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<tr>
<td>$\beta$</td>
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<td>0.1688***</td>
<td>0.2287**</td>
<td>0.3512***</td>
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<tr>
<td></td>
<td>(0.0519)</td>
<td>(0.0631)</td>
<td>(0.1138)</td>
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<tr>
<td>$\phi$</td>
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<td>-0.5512*</td>
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Notes: Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Price controls.
Perceived Gains \( (\beta + \phi m_{i,t-1}) \)
Learning: Expected Income Next Year By Entrepreneurship History

![Chart showing expected net income over time by entrepreneurship history. The chart includes lines for Stay Out, Switch Out, Switch In, and Stay In, with data points for years 2004 to 2009.]
Learning: Real vs. Expected Income By Entrepreneurship History

Figure IX
Comparison of Expected and Real Incomes

100000 150000 200000 250000

2004 2005 2006 2007 2008 2009

Stay Out - Expected Switch Out - Expected
Switch In - Expected Stay In - Expected
Stay Out - Real Switch Out - Real
Switch In - Real Stay In - Real
Learning: Real vs. Expected Income - Older Households

Figure IX
Comparison of Expected and Real Incomes by Average Age of Household

Above Median Average Age in Household

<table>
<thead>
<tr>
<th>Year</th>
<th>Stay Out - Expected</th>
<th>Switch In - Expected</th>
<th>Stay Out - Real</th>
<th>Switch In - Real</th>
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<td>2005</td>
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<td>2008</td>
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<tr>
<td>2009</td>
<td></td>
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</tr>
</tbody>
</table>
Learning: Real vs. Expected Income - Younger Households

![Graph showing expected vs. realized net income for younger households over the years 2004 to 2009. The graph compares stay out and switch in expected and realized net income, with expected net income lines in blue and realized net income lines in black.](image)
Summary of Results

- Large average return to entrepreneurship
- Households sort on heterogeneous returns (marginal return is low)
  - Households with high earnings in default sector have low returns to entrepreneurship
- Suggestive evidence of learning about heterogeneous return
- Households learn about comparative advantage in entrepreneurship from
  - Negative shocks in default sector
  - Positive shocks in entrepreneurial sector
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Comparison of Alternate Models

Empirical facts to be matched:

1. Stable aggregate enterprise participation
2. High frequency switching of enterprise status
3. Negative shocks drive switching
4. Persistence of productivity innovations
5. Reduced switching over time
Households save out of financial constraints:

1. Stable aggregate enterprise participation **Fail**
2. High frequency switching of enterprise status **Pass**
3. Negative shocks drive switching **Fail**
4. Persistence of productivity innovations **Pass**
5. Reduced switching over time **Pass**
Financial Constraints By Entrepreneurship History

Figure VIII
Self-reported Financial Constraints Over Time by Entrepreneurship History

Year
Stay Out Switch Out
Switch In Stay In
Savings By Entrepreneurship History

Figure VII
Savings Over Time by Entrepreneurship History

Year
2004 2005 2006 2007 2008 2009
Stay Out Switch Out Switch In Stay In

Savings
.75 .8 .85 .9 .95 1

Legend:
- Stay Out
- Switch Out
- Switch In
- Stay In
Comparison of Alternate Models

Heterogeneous returns, learning-by-doing:

1. Stable aggregate enterprise participation **Fail**
2. High frequency switching of enterprise status **Pass**
3. Negative shocks drive switching **Fail**
4. Persistence of productivity innovations **Pass**
5. Reduced switching over time **Pass**
Comparison of Alternate Models

Persistent shocks to $\eta_i$, no learning:

1. Stable aggregate enterprise participation \textbf{Pass}
2. High frequency switching of enterprise status \textbf{Pass}
3. Negative shocks drive switching \textbf{Pass}
4. Persistence of productivity innovations \textbf{Pass}
5. Reduced switching over time \textbf{Fail}
Related Work: Switching and Smoothing

- Health and enterprise in Tanzania (with Ach Adhvaryu)
  - Households use enterprise activity to weather acute health shocks
  - Extensive margin (entry) and intensive margins (capital and labor allocations)
  - Entire household (both sick and non-sick members) shifts labor allocation
  - Apparent complementarity in labor inputs emphasizes importance of access to alternate technologies
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Related Work: Switching and Smoothing

- Agricultural profitability and enterprise (with Ach Adhvaryu and Namrata Kala)
  - coffee price down: some households switch into enterprise
  - coffee price up: some divest, reduce or discontinue enterprise activity; others expand enterprises
  - can we predict differential response from observable baseline characteristics of household (e.g. demographic composition, schooling or cognitive skills) or enterprise (employment, contribution to household income, proportion of labor hours)?
  - help to target the earnest entrepreneurs
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Related Work: Switching and Smoothing

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The End

▶ Thanks!
Policy Implications

- Marginal non-entrant has low gross return to (low ability in) entrepreneurship
  - allocation of financial resources to lowering his cost might not be welfare-enhancing
  - improving his entrepreneurial skill might be a better endeavor
  - improving skills of labor force might improve long-run growth of enterprises
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Model: Production Functions

\[ D_{it} = 0 : \quad Y_{it}^F = e^{\beta_F} K_{iFt}^{\rho_F} \epsilon_{ni}^F, \quad (6) \]

\[ D_{it} = 1 : \quad Y_{it}^E = e^{\beta_E} K_{iEt}^{\rho_E} \epsilon_{ni}^E, \quad (7) \]

- \( D_{it} \) is a dummy for household \( i \) producing in entrepreneurial sector in period \( t \)
- \( K_{iFt}^F \) and \( K_{iEt}^E \) are capital inputs in the two sectors
- \( \rho^F \) and \( \rho^E \) are factor loadings on capital in the two sectors
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- \( \eta_i^F \) and \( \eta_i^E \) are heterogeneous components of productivity in the two sectors
Model: Production Functions

\[ D_{it} = 0 : \quad Y^F_{it} = e^{\beta^F_t K^F_{iF} e^{\eta^F_i}}, \]

\[ D_{it} = 1 : \quad Y^E_{it} = e^{\beta^E_t K^E_{iE} e^{\eta^E_i}}. \]

- \( \beta^F_t \) and \( \beta^E_t \) are mean productivities in the two sectors
- \( \eta^F_i \) and \( \eta^E_i \) are heterogeneous components of productivity productivities in the two sectors

Back
Assuming cost of capital is $r$; no adjustment cost.

In each sector $j \in \{E, F\}$, household solves

$$\max_{K_{ijt}} \left[ e^{\beta_j} K_{ijt} e^{\eta_i^j} - rK_{ijt} \right]$$  \hspace{1cm} (8)

Household’s period $t$ optimal input in sector $j$ is

$$K_{ijt}^* = \kappa(\eta_i^j; r, \rho^j)$$  \hspace{1cm} (9)
Model: Sectoral Choice

- Then, $D_{it} = 1$ iff
  \[ e^{\beta_t^E K_{iEt}^E e_{i}^E} - r K_{iEt}^* > e^{\beta_t^F K_{iFt}^F e_{i}^F} - r K_{iFt}^* \]

- Substitute in for $K_{iEt}^*$ and $K_{iFt}^*$

- Make simplifying assumption $\rho^E \approx \rho^F \equiv \rho$

- Household $i$ will choose to produce in the entrepreneurial sector iff:

  \[ e^{(\eta_i^E - \eta_i^F)} > e^{(\beta_t^F - \beta_t^E)} \quad (10) \]
Model: Comparative Advantage (Roy (1951), Lemieux (1998) and Suri (2011))

- Sectoral choice depends on \( (\eta_i^E - \eta_i^F) \)
- Only the relative magnitude of \( \eta_i^F \) and \( \eta_i^E \) can be identified
- Project \( \eta_i^F \) and \( \eta_i^E \) onto relative productivity in entrepreneurship over default production, \( (\eta_i^E - \eta_i^F) \)

\[
\eta_i^F = b_F(\eta_i^E - \eta_i^F) + \tau_i \tag{11}
\]

\[
\eta_i^E = b_E(\eta_i^E - \eta_i^F) + \tau_i \tag{12}
\]
Model: Comparative Advantage *(Roy (1951), Lemieux (1998) and Suri (2011))*

- Household’s absolute advantage is represented by $\tau_i$
- $\tau_i$ has the same effect on the household’s productivity in both sectors

\[
\eta_i^F = b_F(\eta_i^E - \eta_i^F) + \tau_i
\]

\[
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\]
Model: Comparative Advantage \((\text{Roy (1951), Lemieux (1998) and Suri (2011)})\)

- Defining household’s **comparative advantage**
  \[ \eta_i \equiv b_F (\eta_i^E - \eta_i^F) \]

- Defining \( \phi \equiv b_E / b_F - 1 \)

\[ \eta_i^F = \eta_i + \tau_i \quad (13) \]

\[ \eta_i^E = (1 + \phi) \eta_i + \tau_i \quad (14) \]
Model: Generalized Output Equation

- Substituting in and taking logs:

\[ y_{it}^F = \beta_t^F + \rho k_{it}^F + \eta_i + \tau_i \]  \hspace{1cm} (15)

\[ y_{it}^E = \beta_t^E + \rho k_{it}^E + (1 + \phi) \eta_i + \tau_i \]  \hspace{1cm} (16)

- Generalized, log gross output equation \((D_{it} \text{ is entrepreneurship dummy})\):

\[ y_{it} = \beta_t^F + (\beta_t^E - \beta_t^F) D_{it} + \rho [k_{it}^F + (k_{it}^E - k_{it}^F) D_{it}] + \eta_i (1 + \phi D_{it}) + \tau_i \]
Model: Perfect Information

\[ y_{it} = \beta^F_t + (\beta^E_t - \beta^F_t)D_{it} + \rho[k^F_{it} + (k^E_{it} - k^F_{it})D_{it}] + \eta_i(1 + \phi D_{it}) + \tau_i \]

- All market participants know
  - average productivity: \( \beta^F_t \) and \( \beta^E_t \)
  - return to capital: \( \rho \)
  - absolute advantage: \( \tau_i \) (unobserved)
  - covariance of productivity across sectors, \( \phi \), given \( \eta_i \)
  - perfect information about \( \eta_i \) \( \rightarrow \) static selection on comparative advantage
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▶ Back
Model: Perfect Information

\[ y_{it} = \beta_t^F + (\beta_t^E - \beta_t^F)D_{it} + \rho[k_{it}^F + (k_{it}^E - k_{it}^F)D_{it}] + \eta_i(1 + \phi D_{it}) + \tau_i \]

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- perfect information about \( \eta_i \) → static selection on comparative advantage
Model: Imperfect Information

\[ y_{it} = \beta_t^F + (\beta_t^E - \beta_t^F)D_{it} + \rho[k_{it}^E + (k_{it}^E - k_{it}^F)D_{it}] \\
+ (\eta_i + \varepsilon_{it})(1 + \phi D_{it}) + \tau_i \]  

(17)

- Imperfect information about \( \eta_i \)
- Replace \( \eta_i \) with \( \eta_i + \varepsilon_{it} \)
- Random error: \( \varepsilon_{it} \sim N(0, \sigma^2_\varepsilon = 1/h_\varepsilon) \)
Model: Imperfect Information

\[ y_{it} = \beta_t^F + (\beta_t^E - \beta_t^F)D_{it} + \rho[k_{it}^F + (k_{it}^E - k_{it}^F)D_{it}] + (\eta_i + \varepsilon_{it})(1 + \phi D_{it}) + \tau_i \]  

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- Random error: \( \varepsilon_{it} \sim N(0, \sigma^2_{\varepsilon} = 1/h_{\varepsilon}) \)

- Can compute noisy signal of comparative advantage each period, independent of sectoral choice

- Let \( l_i^t = (l_{i1}, ..., l_{it}) \) denote the history of the normalized comparative advantage observations up to period \( t \)

\[
l_{it} = \frac{y_{it} - \beta_t^F - (\beta_t^E - \beta_t^F)D_{it} - \rho [k_{it}^E + (k_{it}^E - k_{it}^F)D_{it}] - \tau_i}{(1 + \phi D_{it})}
\]

\[
= \eta_i + \varepsilon_{it},
\] (18)

- Initial belief $\eta_i \sim N(m_{i0}, \sigma^2 = 1/h)$
- Posterior distribution of $\eta_i$ given history $l_i^t$ is $N(m_t(l_i^t), 1/h_t)$, where

$$m_t(l_i^t) = \frac{hm_{i0} + h_\varepsilon (l_{i1} + \ldots + l_{it})}{h + th_\varepsilon}, \quad \text{and} \quad h_t = h + th_\varepsilon \quad (19)$$

- Bayesian beliefs are a martingale
  - $m_{i,t}$ is shorthand for $m_t(I^t_i)$
  - Law of motion: $m_{i,t} = m_{i,t-1} + \xi_{it}$
  - $\xi_{it}$ is a noise term orthogonal to $m_{i,t-1}$

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Model: Timing

1. Household $i$ chooses $D_{it}$ and $K_{ijt}$ at the beginning of period $t$ using $m_{i,t-1} \equiv m_{t-1}(l^t_i)$

2. Household $i$ produces $y_{it}$ during period $t$ and observes the productivity shock $\varepsilon_{it}$

3. End of period $t$, household $i$ calculates productivity signal and updates expectation of $\eta_i$ according to law of motion
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In each sector $j \in \{E, F\}$, household solves

$$\max_{K_{ijt}} E_t \left[ e^{\theta_j^i t} K_{ijt} \eta_i^j - rK_{ijt} \right]$$

where the expectation is with respect to beliefs at the beginning of period $t$, $E_t[\eta_i] = m_{i,t-1}$

$$K_{iEt}^* = \kappa \left( m_{i,t-1}, \phi; r, \rho \right) \quad (20)$$

$$K_{iFt}^* = \kappa \left( m_{i,t-1}; r, \rho \right) \quad (21)$$
Substitute in for $K_{iEt}$ and $K_{iFt}$

Take logs, as in estimation

Household produces in entrepreneurial sector in period $t$ iff:

$$m_{i,t-1} > \frac{-(\beta^E_t - \beta^F_t) - (1/2)\phi^2\sigma^2_t}{\phi}, \quad \text{if } \phi > 0$$

$$m_{i,t-1} < \frac{-(\beta^E_t - \beta^F_t) - (1/2)\phi^2\sigma^2_t}{\phi}, \quad \text{if } \phi < 0 \quad (22)$$
Model: Sectoral Choice (Learning)

- Sign of $\phi$ determines which direction of evolution in $m_{i,t-1}$ will drive switching
  - $\phi > 0 \rightarrow$ upward evolution predicts entry
  - $\phi < 0 \rightarrow$ downward evolution predicts entry

$$
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\end{align*}
\]
Suppose now household $i$ inputs $(A_{it} + K_{ijt})$ in sector $j$

- $A_{it}$ is household’s beginning-of-period $t$ savings (exogenous)
- $K_{ijt}$ is additional capital that is borrowed (or lent)
- When household borrows, it has option to default
Model: Limited Liability

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Model: Limited Liability

- If household repays, it receives payoff:
  \[ e^{\beta_j t} K_{ijt}^\rho e^{\eta_i} + r(A_{it} - K_{ijt}) \]  
  (23)

- If household defaults, it receives payoff:
  \[ e^{\beta_j t} K_{ijt}^\rho e^{\eta_i} - \pi A_{it} \]  
  (24)

- where \( \pi \) is the fraction of assets \( A_{it} \) put up as collateral
Model: Credit Constraints

- Lenders will only lend up to \( \left(1 + \frac{\pi}{r}\right)A_{it} \) in equilibrium.

- Households constrained if

\[
m_{i,t-1} > \Gamma\left(\pi, r, A_{it}\right) \implies K_{ijt}^* = \left(1 + \frac{\pi}{r}\right)A_{it}
\]

- Otherwise, \( K_{ijt}^* \) as in unconstrained case

\[
K_{iEt}^* = \kappa\left(m_{i,t-1}, \phi; r, \rho; \pi, A_{it}\right) \tag{25}
\]

\[
K_{iFt}^* = \kappa\left(m_{i,t-1}; r, \rho; \pi, A_{it}\right) \tag{26}
\]
Plug capital inputs into sectoral choice cutoff rule, as in unconstrained case

$D_{it}$ will now also be a function of constraint, which is itself a function of $\pi$, $r$, $A_{it}$ and $m_{i,t-1}$

$\pi$, $r$, $A_{it}$ have no effect on output except through $K_{ijt}^*$ and $D_{it}$

Address correlation between $m_{i,t-1}$ and choices, $K_{ijt}^*$ and $D_{it}$, in empirical strategy

Robust to treating $A_{it}$ as a choice variable
Model: Credit Constraints

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- Address correlation between $m_{i,t-1}$ and choices, $K_{ijt}^*$ and $D_{it}$, in empirical strategy
- Robust to treating $A_{it}$ as a choice variable
Then, for $D_{it} = 1$,

$$K_{iEt}^* = E_t \left[ \left( \frac{\rho^E e^{\beta^E_t + (1+\phi)\eta_i + \tau_i}}{r} \right)^{\frac{1}{1-\rho^E}} \right]$$  \hspace{1cm} (27)

For $D_{it} = 0$,

$$K_{iFt}^* = E_t \left[ \left( \frac{\rho^F e^{\beta^F_t + \eta_i + \tau_i}}{r} \right)^{\frac{1}{1-\rho^F}} \right]$$  \hspace{1cm} (28)
Lenders learn at same rate as household and observe sector choice, constrained if $\lambda \equiv \left(1 + \frac{\pi}{r}\right)$

$$m_{i,t-1} > \left(\ln \left[\left(\lambda A_{it}\right)^{1-\rho} \frac{r}{\rho}\right] - \beta_F^E - (\beta_F^E - \beta_F^F)D_{it} - \tau_i\right) \frac{1}{1 + \phi D_{it}}$$

$\Rightarrow K_{ijt}^* = \lambda A_{it}$

Otherwise, $K_{ijt}^*$ as in unconstrained case

$$K_{ijt}^* = \kappa'(E_t[\eta_i], r, A_{it}, \pi)$$
Empirical Strategy: Dynamic CRC

- 2 period, endogenous capital projections:

\[ m_{i0} = \lambda_0 + \lambda_1 D_{i1} + \lambda_2 D_{i2} + \lambda_3 D_{i1} D_{i2} + \lambda_{k1} k_{i1} + \lambda_{k2} k_{i2} \]

\[ \quad + \lambda_{k1-1} k_{i1} D_{i1} + \lambda_{k1-2} k_{i1} D_{i2} + \lambda_{k1-12} k_{i1} D_{i1} D_{i2} \]

\[ \quad + \lambda_{k2-1} k_{i2} D_{i1} + \lambda_{k2-2} k_{i2} D_{i2} + \lambda_{k2-12} k_{i2} D_{i1} D_{i2} + \psi_{i0} \]

\[ m_{i1} = \theta_0 + \theta_2 D_{i2} + \theta_{k2} k_{i2} + \theta_{k2-2} k_{i2} D_{i2} + \psi_{i1} \]
Empirical Strategy: Threats to Identification

- Sequential exogeneity: unpredictable current and future productivity shocks
  - If households predict shocks, current choices still endogenous
- Households know distribution of returns given realization of relative ability, but not own ability
  - If don’t know distribution, becomes dynamic programming problem
- Projections are “complete”
  - If unobserved productive decisions, returns not consistently estimated
Empirical Strategy: Threats to Identification

- Sequential exogeneity: unpredictable current and future productivity shocks
  - If households predict shocks, current choices still endogenous
- Households know distribution of returns given realization of relative ability, but not own ability
  - If don’t know distribution, becomes dynamic programming problem
- Projections are “complete”
  - If unobserved productive decisions, returns not consistently estimated
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[Back]
Data on labor input is unavailable

- Omission of labor does not affect estimation under some assumptions
  - no market for entrepreneurial labor
  - household composition is either fixed or subject only to exogenous shocks
  - leisure is not valued
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- no market for entrepreneurial labor
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- leisure is not valued
## Table IV: Labor Market Percentage of Households with Business Owners, Unpaid Family Workers, and Wage Employees as Members

<table>
<thead>
<tr>
<th></th>
<th>Business Owner</th>
<th>Unpaid Family Worker</th>
<th>Wage Employee</th>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
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<tr>
<td>All Entrepreneurial Industries</td>
<td>0.258</td>
<td>0.438</td>
<td>0.144</td>
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<tr>
<td>Fish or Shrimp Farming</td>
<td>0.033</td>
<td>0.178</td>
<td>0.032</td>
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<tr>
<td>Raising Livestock</td>
<td>0.149</td>
<td>0.356</td>
<td>0.086</td>
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<tr>
<td>Shop / Mechanic</td>
<td>0.076</td>
<td>0.265</td>
<td>0.054</td>
</tr>
<tr>
<td>All Default Industries</td>
<td>0.457</td>
<td>0.498</td>
<td>0.388</td>
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<tr>
<td>Farm</td>
<td>0.456</td>
<td>0.498</td>
<td>0.334</td>
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<tr>
<td>Construction</td>
<td>0.030</td>
<td>0.172</td>
<td>0.029</td>
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<tr>
<td>Low Skilled (Factory, Janitorial, etc.)</td>
<td>0.030</td>
<td>0.170</td>
<td>0.087</td>
</tr>
<tr>
<td>High Skilled (Nurse, Teacher, Accountant, etc.)</td>
<td>0.030</td>
<td>0.170</td>
<td>0.030</td>
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</table>
### Table V: Changes in Labor Endowments

<table>
<thead>
<tr>
<th>Change in Household Demographics</th>
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<tbody>
<tr>
<td>Change in Household Size</td>
<td>0.551</td>
<td>0.498</td>
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<tr>
<td>Change in Number of Males</td>
<td>0.430</td>
<td>0.495</td>
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<tr>
<td>Change in Number of Primary Educated</td>
<td>0.514</td>
<td>0.500</td>
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<tr>
<td>Change in Number of Unemployed, Inactive, In School</td>
<td>0.503</td>
<td>0.500</td>
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Labor Checks: Exogenous Composition Changes

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<tr>
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<th>OLS</th>
<th>FE</th>
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<td>0.0170</td>
<td>0.00672</td>
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<td>(0.0109)</td>
<td>(0.0188)</td>
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<tr>
<td>Number of Males</td>
<td>-0.0145</td>
<td>-0.0180</td>
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<tr>
<td></td>
<td>(0.0149)</td>
<td>(0.0276)</td>
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<tr>
<td>Number of Primary Educated</td>
<td>0.0616***</td>
<td>0.0138</td>
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<td>(0.0112)</td>
<td>(0.0184)</td>
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<tr>
<td>Number of Unemployed, Inactive, In School</td>
<td>-0.0526***</td>
<td>-0.0207</td>
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<td>(0.0120)</td>
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<td>Observations</td>
<td>2,206</td>
<td>2,206</td>
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<td>R-squared</td>
<td>0.0482</td>
<td>0.0324</td>
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Notes: Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1).
No market for entrepreneurial labor

Changes to composition appear exogenous

- number of primary educated and number of active laborers contribute to $\eta_i$
- household size and number of males contribute to $\tau_i$

Cannot check valuation of leisure
Labor

- No market for entrepreneurial labor
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  - number of primary educated and number of active laborers contribute to $\eta_i$
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▶ Back
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No market for entrepreneurial labor

Changes to composition appear exogenous
  
  number of primary educated and number of active laborers contribute to $\eta_i$
  
  household size and number of males contribute to $\tau_i$

Cannot check valuation of leisure
Nested Models: CRC

- Comparative advantage with perfect information

\[ y_{it} = \alpha_t + \beta D_{it} + \eta_i (1 + \phi D_{it}) + \tau_i + \zeta_{it} \]  

- A single projection of \( \eta_i \) on sector choices, capital choices, and interactions
Nested Models: CRC

- 3 restrictions on full model: $\theta$'s = 0
- 14 remaining structural parameters:
  - 11 $\lambda$'s estimate correlations of choices with known comparative advantage
  - $\rho$, $\beta$, and $\phi$ are as in preferred model
Nested Models: CRC

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  - $\rho$, $\beta$, and $\phi$ are as in preferred model
Nested Models: DCRE

- Homogeneous return with imperfect information

\[ y_{it} = \alpha_t + \beta D_{it} + (\eta_i + \varepsilon_{it}) + \tau_i + \zeta_{it} \]  (30)

- \( \eta_i \) is household's unknown part of fixed effect that affects choices

- Histories no longer matter:
  - project \( m_{i0} \) on sector and capital choices, no interactions
  - project \( m_{it-1} \) on choices in period \( t-1 \) onward, no interactions
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(30)

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  - project \( m_{t-1}^i \) on choices in period \( t \) onward, no interactions
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\[ y_{it} = \alpha_t + \beta D_{it} + \phi D_{it} \left( \eta_i + \varepsilon_{it} \right) + \tau_i + \zeta_{it} \] (30)

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  - project \( m_{i}^{t-1} \) on choices in period \( t \) onward, no interactions
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Nested Models: DCRE

- 9 restrictions on full model: 7 of the $\lambda$‘s = 0, 1 of the $\theta$‘s = 0 and $\phi = 0$

- 8 remaining structural parameters:
  - 4 $\lambda$‘s estimate differences in initial belief of entrepreneurs vs. non-entrepreneurs in each period
  - 2 $\theta$‘s estimate updates that drive switching
  - $\rho$ and $\beta$ are as in preferred model
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Back
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Nested Models: CRE

- Homogeneous return with perfect information (HH FE)

\[
y_{it} = \alpha_t + \beta D_{it} + \eta_i + \tau_i + \zeta_{it}
\]

- \(\eta_i\) is known part of fixed effect that affects choices
- Histories still do not matter
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Nested Models: CRE

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\[ y_{it} = \alpha_t + \beta D_{it} + \eta_i + \tau_i + \zeta_{it} \]  

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Nested Models: CRE

- Homogeneous return with perfect information (HH FE)

\[ y_{it} = \alpha_t + \beta D_{it} + \eta_i + \tau_i + \zeta_{it} \] (31)

- \( \eta_i \) is known part of fixed effect that affects choices

- Histories still do not matter

- Single projection of \( \eta_i \) on sector and capital choices, no interactions
Nested Models: CRE

- Homogeneous return with perfect information (HH FE)

\[ y_{it} = \alpha_t + \beta D_{it} + \underbrace{\eta_i}_{\text{no shock } (\varepsilon_{it})} + \tau_i + \zeta_{it} \]  

- \( \eta_i \) is known part of fixed effect that affects choices
- Histories still do not matter
- Single projection of \( \eta_i \) on sector and capital choices, no interactions
Nested Models: CRE

- 11 restrictions on full model, combination of restrictions from CRC and DCRE
  - 3 \( \theta \)'s = 0
  - 7 of the \( \lambda \)'s = 0
  - \( \phi = 0 \)
- 4 remaining structural parameters:
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  - 7 of the $\lambda$'s = 0
  - $\phi = 0$

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  - 4 $\lambda$'s
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## Summary Statistics

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<td>Proportion Completed Primary School</td>
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Notes: Please see data appendix for details on the construction of variables.
### Summary Statistics

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<td><strong>Household Demographics, 2005</strong></td>
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<td>0.18</td>
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Notes: Please see data appendix for details on the construction of variables.

Switch Out

Switch In

364 156

Back
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<td>Household Has Savings,</td>
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<td>0.87</td>
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## OLS

<table>
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<td>0.245***</td>
<td>0.646***</td>
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<td></td>
<td>(0.0452)</td>
<td>(0.0467)</td>
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<td>ln(Input Expenditure)</td>
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<td></td>
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<td>2,206</td>
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<td>R-squared</td>
<td>0.432</td>
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Notes: Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1).
## OLS and FE Estimates of Returns to Entrepreneurship

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<td><strong>Observations</strong></td>
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<td><strong>R-squared</strong></td>
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Notes: Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1).
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<th>CRC</th>
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<td>0.3064***</td>
<td>0.3436</td>
<td>0.3493</td>
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<td></td>
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<td>(0.0624)</td>
<td>(0.2050)</td>
<td>(0.2146)</td>
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<tr>
<td>$\phi$</td>
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<td>-0.1732</td>
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Notes: Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Price controls...
### MD (Endogenous Capital with Prices)

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Notes: Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Price controls.
### MD (Endogenous Capital with Prices)

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Notes: Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Price controls.
Perceived Gains ($\beta + \phi \eta_i$)

Figure IV
Static CRC: Perceived Productivity Gains ($\beta + \phi \eta$)

Projection Coefficients
3 period results
3 Period: Data

- Townsend Thai Project data from 2001, 2005 and 2009
- 4 provinces: 2 from rural Northeast region and 2 from urban Central region
  - 4 sub-regions randomly selected (tambons) from each province
  - 4 villages from each sub-region
  - 15 households from each village
- 2009 latest available wave
3 Period: Data

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- 4 provinces: 2 from rural Northeast region and 2 from urban Central region
  - 4 sub-regions randomly selected (tambons) from each province
    - 4 villages from each sub-region
    - 15 households from each village
- 2009 latest available wave
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3 Period: Data

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- 4 provinces: 2 from rural Northeast region and 2 from urban Central region
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- 2009 latest available wave
3 Period: Data

- Townsend Thai Project data from 2001, 2005 and 2009
- 4 provinces: 2 from rural Northeast region and 2 from urban Central region
  - 4 sub-regions randomly selected (tambons) from each province
  - 4 villages from each sub-region
  - 15 households from each village
- 2009 latest available wave
Balanced panel includes 794 households

- Information on income and expenditure in agriculture, wage labor, and entrepreneurship
- Information on savings, self-reported credit constraints, and expected incomes in good and bad states and on average
- Roughly 45% of households engage in entrepreneurship in each wave
- Roughly 49% switch sectors at least once
3 Period: Data

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- Roughly 49% switch sectors at least once
## 3 Period: Summary Statistics

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### 3 Period: Summary Statistics

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Notes: Please see data appendix for details on the construction of variables.
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<td><strong>Saving</strong></td>
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### Table IIa: OLS and FE Estimates of Returns to Entrepreneurship

#### FE

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Notes: Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1).
### 3 Period: MD (Price and Input Controls)

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3 Period: Perceived Returns (DCRC)

Figure A.1a: Dynamic CRC: Perceived Productivity Gains ($\beta + \phi_{m,t-1}$)

- 2009 only
- 2005 only
- 2005 & 2009
- 2001 & 2009
- All Periods

- 2001
- 2005
- 2009
3 Period: Perceived Returns (DCRC)

Figure A.1b: Dynamic CRC: Perceived Productivity Gains ($\beta + \phi_{mi,t-1}$)
3 Period: Perceived Returns (CRC)

Figure A.2a: Static CRC: Perceived Productivity Gains ($\beta + \phi \eta$)

- 2009 only
- 2005 only
- 2005 & 2009
- 2001 & 2009
- All Periods
3 Period: Perceived Returns (CRC)

Figure A.2b

Static CRC: Perceived Productivity Gains ($\beta + \phi \eta$)

- Never
- 2001 only
- 2001 & 2005