The Effect of Parental Rural-to-Urban Migration on Children's Cognitive Skill Formation

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Background

- Large-scale internal migration is prevalent in developing countries
  - economic growth has lead rural workers to migrate to urban areas
  - 10 million migrant workers in Indonesia
  - 130 million migrant workers in China
- Parental rural-to-urban migration $\Longrightarrow$ **left-behind children**
  - **left-behind children** $\equiv$ rural-origin children w/ at least 1 migrant parent
  - 5 million in Indonesia, 8% of all Indonesian children
  - 30 million in China, 11% of all Chinese children
- Limited parent-child interactions pose developmental challenges
  - Heckman & Mosso (2014)

Motivation

- Early cognitive skills are important in predicting later life outcomes
  - 1 st. dev. increase in math scores at the end of developmental stage translates into 4% higher **employment** rate (Currie & Thomas, 2001)
  - **schooling** (Heckman, Stixrud & Urzua, 2006)
  - **income** (Chetty, Friedman & Rockoff, 2014)
- Left-behind children have received wide attention from policy-makers
  - United Nation Children's Fund (2008)
    "reinforcing and promoting childrens rights, with a focus on the protection and well-being of children left behind."
  - United Nations (2015)
    "Transforming our world: the 2030 Agenda for Sustainable Development."
  - New York Times (2018)
    "Left-behind children are the orphans of China's economic miracle."

Research Question

I. How does parental rural-to-urban migration affect children's cognitive skill formation?

II. What would happen to the cognitive skill development of left-behind children if their parents had not left?

III. What types of migration policies are effective in promoting children's human capital development?

Preview of Findings

- Estimate a dynamic model of children's skill formation w/in household migration using panel survey data from Indonesia
- Children's cognitive skill formation is sensitive to the duration and type of parental migration
  - leaving children behind one year reduces cognitive skill by 0.02 st. dev.
- Cognitive skills of left-behind children would have improved substantially at age 14 if their families had remained together
  - equivalent to 7% $\uparrow$ high school graduation rates (national average 53%)
- Migration policies of encouraging family moving w/ their children promote cognitive skill formation
  - annual subsidy of \$150 $\Longrightarrow$ 3% $\uparrow$ high school graduation rates

Outline

- Literature review
- A dynamic model of skill formation w/in household migration
- Data from the Indonesia Family Life Survey
- Identification and Simulated Maximum Likelihood estimation
- Counterfactual policy experiments

Selected Literature Review

- Children's skill formation
  - Todd & Wolpin (2003, 2007), Bernal (2008), Cunha, Heckman & Schennach (2010), Del Boca, Flinn & Wiswall (2013), Agostinelli (2018)
  - Attanasio, Cattan, Fitzsimons, Meghir & Rubio-Codina (2015), Attanasio, Meghir, & Nix (2015), Attanasio, Meghir, Nix & Salvati (2017)
  - **contribution: understand skills formation in developing countries**

- Labor migration
  - Liu, Mroz & Van der Klaauw (2010), Kennan & Walker (2011), Gemici (2011)
  - Bryan, Chowdhury & Mobarak (2014), Kleemans (2015), Lagakos, Mobarak & Waugh (2018), Bryan & Morten (2019)
  - **contribution: study welfare impacts of migration policies on children**

- Impact of migration on children
  - McKenzie & Rapoport (2011), Antman (2011,2012), Zhang, Behrman, Fan, Wei, & Zhang (2014), Lu (2014), Xu & Xie (2015), Meng & Yamauchi (2017)
  - **contribution: model skill dynamics & include a full sample of rural-origin children**

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Economic Model

- **Setup**
  - a dynamic discrete choice model of rural household migration
  - a married coupled w/ oldest child born in a rural location
  - exogenous but stochastic fertility

- **Decision**
  - sequential annual migration decision j_t from birth till age 14

$$j_t = \begin{cases} 1, & \text{if both parents stay with the child in a rural location} \\ 2, & \text{if at least one parent migrates and child is left behind in a rural location} \\ 3, & \text{if both parents move with the child to an urban location} \end{cases}$$

- **Household Utility**

$$U_t = U(C_t, Q_t, j_t, j_{t-1}, S_t^O, S_t^U, \varepsilon_t; \alpha)$$ functional form

  - parents face a trade-off consumption C_t and child's skill Q_t
  - S_t^O = observed characteristics
  - S_t^U = unobserved household types
  - ε_t = preference shock $\sim$ TIEV distribution

Economic Model

- **Budget Constraint**

$$C_t = \underbrace{\mathbb{1}\{j_t = j\} Y_{jt}}_{\text{income}} - \underbrace{(\Delta_1 \mathbb{1}\{j_t = 2,3\} D + \Delta_2 \mathbb{1}\{j_t = 2\} N_t + \Delta_3 \mathbb{1}\{j_t = 3\} N_t)}_{\text{migraiton cost}}, \quad j \in J_t$$

  - Y_j = income
  - D = distance between home village & provincial capital
  - N_t = number of children

- **Parental Income**

$$\ln Y_{jt} = \beta_{j1}\ educ_f + \beta_{j2}\ educ_m + \sum_{k \in K} \delta_{jk} \mathbb{1}\{\text{type} = k\} + \eta_{jt}$$

  - location-dependent stochastic process
  - k = unobserved type
  - η_{jt} = income shock $\sim$ Normal distribution

Economic Model

- **Cognitive skill production function**

$$Q_t = \delta_1 age + \delta_2 age^2 + \delta_3 gender + \delta_4 educ_f + \delta_5 educ_m + \delta_6 N_t$$
$$+ \delta_7 H_{2t} + \delta_8 H_{3t} + \delta_9 H_{2t}^2 + \delta_{10} H_{3t}^2 + \sum_{k \in K} \delta_k \mathbb{1}\{\text{type} = k\} + \omega_t$$

  - N_t = number of children
  - $H_{jt} \equiv \sum_{\tau=1}^{t-1} \mathbb{1}\{j_\tau = j\}$ = migration experience
  - k = unobserved household type
  - ω_t = stochastic production component $\sim$ Normal distribution

- Features & restrictions
  1. migration experience serve as proxy for parental investments
  2. cumulative migration history matter instead of its timing
  3. stock of children captures resource allocation among children
  4. unobserved heterogeneity has a constant effect over time

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Economic Model

- **Household Problem**

$$\max_{\{j_t \in J\}_{t=0}^{T}} E\left[\sum_{t=0}^{T} \rho^t U_{jt} \mid \Omega_t\right]$$

  - parents choose sequentially optimal migration alternatives to maximize discounted expected lifetime utility
  - ρ = discount factor
  - Ω_t = state space

- Bellman equation

$$V(\Omega_t) = \max_{j \in J}\left\{U_{jt}(\Omega_t) + \rho E[V(S_{t+1}) \mid \Omega_t, j_t]\right\} \quad \text{for } t < T,$$
$$= \max_{j \in J}\left\{U_{jT}(\Omega_T) + \alpha_{jqT} \ln Q_{T+1}\right\} \quad \text{for } t = T$$

  - with period timing: 1st fertility, 2nd shocks, 3rd decision
  - solution: backward recursion due to finite horizon

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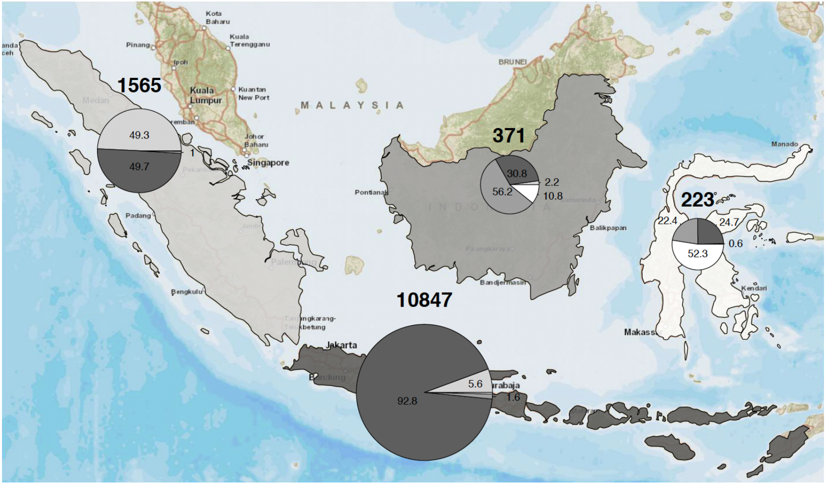
Data: Indonesia Family Life Survey

- Main feature
  - retrospective & longitudinal information on migration & household income
  - established cognitive measures using Raven's Colored Progressive Matrices test & math test (Raven, 2000; Unsworth et al., 2014) test example
  - transform raw score using Item Response Theory score disttribution
- Migration patterns statistics
  - majority (70%) of rural households stay in rural over a long period (11 yrs)
  - migration (64%) is concentrated internally w/in each major island

Data: Internal Migration in Indonesia



Sorce: Kleeman. M. (2015) Migration choice under risk and liquidity constraints. & Indonesia Family Life Survey

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Identification & Estimation

- Identification
  - **problem**: skills are endogenously formed through migration experience
  - **instrument 1**: distance from home village to provincial capital in *budget constraint* (Card, 1995, 2001; Meng & Yamauchi, 2017)
  - **instrument 2**: ratio of number of schools divided by population in one's home village to its counterpart in provincial capital cities in *utility function*
  - instruments validity

- Estimation

$$L_i(\theta) = \sum_{k \in K} \mu_k \prod_{t=1}^{15} \left[\sum_{j \in J} d_{jt} \Pr(d_{jt} = 1, Y_{jt}, Q_t \mid \Omega_t, k; \theta) \right]$$

  - iterative process of solving the dynamic model and maximizing the likelihood
  - simulation deals with missing income
  - stochastic production component is assumed to be a measurement error

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  - iterative process of solving the dynamic model and maximizing the likelihood
  - simulation deals with missing income
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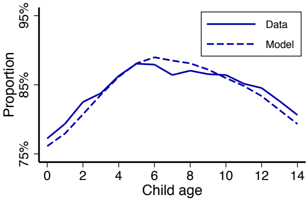
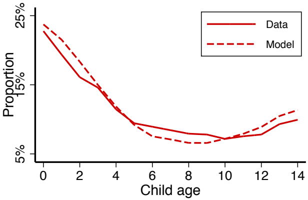
Model Fit

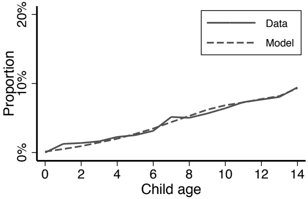
- The estimated dynamic model replicates the data reasonably well



Both parents stay w/ child rural (j =1)



At least one parent moves w/o child (j =2)



Both parents move w/ child urban (j =3)

χ^2 Goodness-of-Fit Test of Choice Distribution

χ^2 Goodness-of-Fit Test of Transition Matrix

model fit to skill & income

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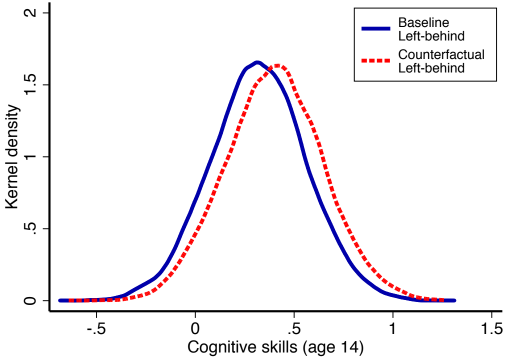
Counterfactual: Are Left-behind Children Worse Off?

Figure: Counterfactual Skill Distribution of **Left-behind Children**



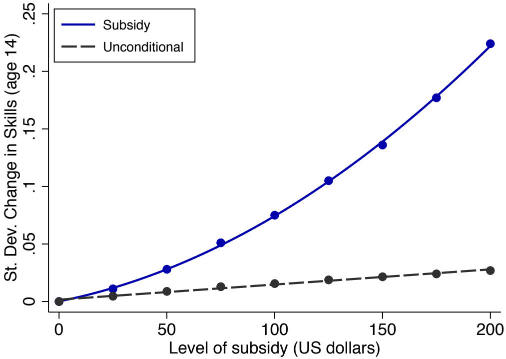
- **0.3 st. dev. ↑ skills if parents of left-behind children had never left them**
- skill improvement ≈ 6.8% ↑ graduation rates (national average 53%)

Counterfactual: Decomposition of Cognitive Skills

- Decomposition by counterfactual migration choices
  - of all parents who leave their children behind in the baseline (factual world)
  - 94% now stay in rural areas $\longrightarrow$ 0.2 st. dev. $\uparrow$ in skills
  - 6% now migrate w/ child to urban locations $\longrightarrow$ 0.6 st. dev. $\uparrow$ in skills
  - **policy suggestion**: encouraging family migration together w/ children

Policy Experiments: Migration Subsidy

- Subsidize families if parents migrate w/ their children to urban locations



Policy Experiments: Migration Subsidy

Table: Effects of Cash Transfer Programs on Migration Rates

	Subsidy		
Subsidy	$j = 1$ nonmigrant	$j = 2$ left-behind	$j = 3$ migrant
\$0	84.02%	11.55%	4.44%
\$25	83.56%	11.49%	4.95%
\$50	82.81%	11.37%	5.82%
\$75	81.89%	11.22%	6.89%
\$100	80.81%	11.08%	8.11%
\$125	79.49%	10.90%	9.61%
\$150	78.11%	10.71%	11.18%
\$175	76.45%	10.43%	13.11%
\$200	74.36%	10.17%	15.47%
\$450	34.15%	4.88%	60.97%

[a] $j = 1$ if both parents stay w/ child rural
$j = 2$ if at least one parent migrates w/o child
$j = 3$ if both parents migrate w/ child to urban

Policy Experiments: Migration Subsidy

Table: Effects of Cash Transfer Programs on Migration Rates

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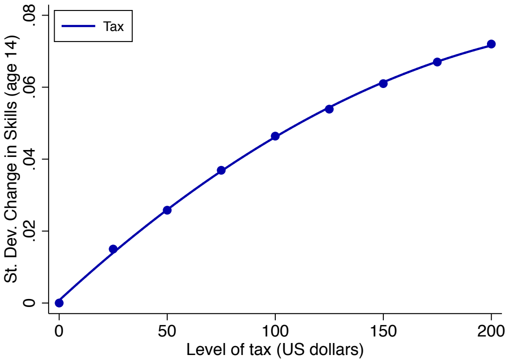
$j = 3$ if both parents migrate w/ child to urban

Policy Experiments: Migration Tax

- Tax parents if they leave their children behind



Policy Experiments: Migration Tax

Table: Effects of Migration Tax on Migration Rates

Subsidy	Tax $j=1$ nonmigrant	$j=2$ left-behind	$j=3$ migrant
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\$50	86.31%	9.31%	4.55%
\$75	86.98%	8.4%	4.62%
\$100	87.68%	7.63%	4.69%
\$125	88.29%	6.99%	4.72%
\$150	88.81%	6.45%	4.74%
\$175	89.24%	5.96%	4.80%
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$j=3$ if both parents migrate w/ child to urban

Policy Experiments: Relaxing Constraints

- Recent debate whether to relax household registration system (National Development and Reform Commission of China, 2019)
- Reduce migration cost by 25% if parents move together w/ their child
  - Estimated cost of family migration with children is $3,255
- Children's cognitive skill $\uparrow$ by 0.28 st. dev., accompanied by 14% inflow of rural families to urban destinations

Conclusion

- Estimate a dynamic household migration model embedding a child's cognitive skill formation
- Left-behind children's cognitive skills would have improved if their families had remained together
- Encouraging rural-to-urban family migration advances children's cognitive development
- Next steps
  - model material inputs (income) in the cognitive production
  - allow differentials impacts of parental investments by age

Thank you!

Any comments and suggestions are appreciated!

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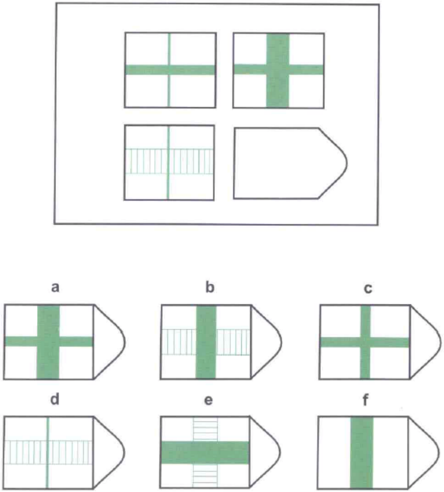
Utility function

$$
\begin{aligned}
U_t = \quad & C_t + \alpha_{2c}\mathbb{1}\{j_t = 2\}C_t + \alpha_{3c}\mathbb{1}\{j_t = 3\}C_t \ \Big\} = \textbf{consumption} \\
& +Q_t + \alpha_{2q}\mathbb{1}\{j_t = 2\}Q_t + \alpha_{3q}\mathbb{1}\{j_t = 3\}Q_t + \alpha_{cq}C_tQ_t \ \Big\} = \text{child's cognitive skill} \\
& \left.\begin{array}{l} +\alpha_{21}\mathbb{1}\{j_t = 2\}\mathbb{1}\{j_{t-1} \neq 2\} \\ +\alpha_{31}\mathbb{1}\{j_t = 3\}\mathbb{1}\{j_{t-1} \neq 3\} \end{array}\right\} = \text{transition cost} \\
& \left.\begin{array}{l} +\mathbb{1}\{j_t = 2\}(\alpha_{22}age + \alpha_{23}age^2 + \alpha_{24}relative + \alpha_{25}school\ \ ratio) \\ +\mathbb{1}\{j_t = 3\}(\alpha_{32}age + \alpha_{33}age^2 + \alpha_{34}relative + \alpha_{35}school\ \ ratio) \end{array}\right\} = \text{characteristics} \\
& \left.\begin{array}{l} +\mathbb{1}\{j_t = 2\}\sum_{k\in K}\alpha_{2k}\mathbb{1}\{\text{type} = k\} \\ +\mathbb{1}\{j_t = 3\}\sum_{k\in K}\alpha_{3k}\mathbb{1}\{\text{type} = k\} \end{array}\right\} = \text{unobserved heterogeneity} \\
& +\mathbb{1}\{j_t = 1\}\varepsilon_{1t} + \mathbb{1}\{j_t = 2\}\varepsilon_{2t} + \mathbb{1}\{j_t = 3\}\varepsilon_{3t} \ \Big\} = \text{preference shocks}
\end{aligned}
$$

Model

Figure: Raven's Colored Progressive Matrices Example



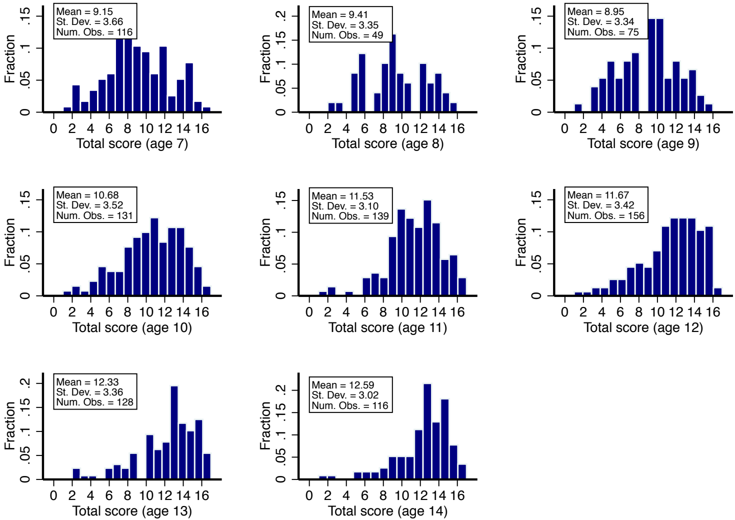
Data

Descriptive Statistics

	Mean	St. Dev.
Household characteristics		
Household income ($)	1069.82	235.29
Distance (miles)	60.35	46.23
Relative	0.44	0.50
Father education	2.62	1.04
Mother education	2.46	0.95
Choice fraction		
Never move	56.60%	-
Leave child behind at least once	35.34%	-
Move at least once w/ child	12.33%	-
Cumulative decision periods (yrs)		
Stay w/ child	12.84	3.52
Leave child behind conditional on moving	4.49	3.69
Move w/ child conditional on moving	4.66	3.56

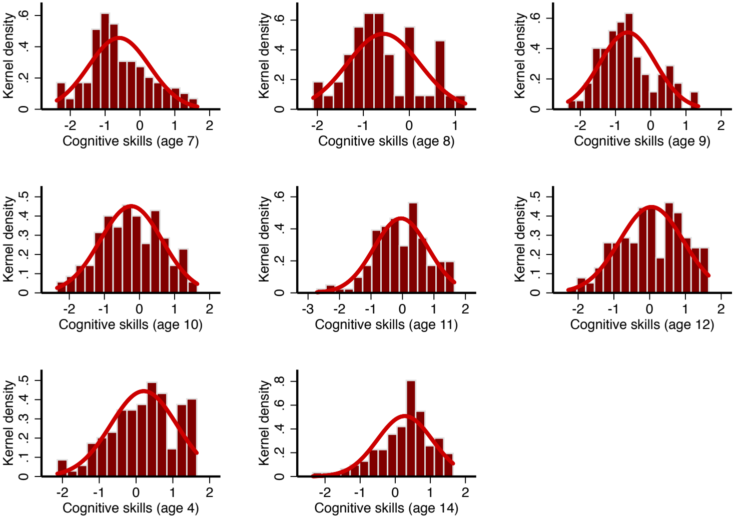
Data

Raw Score Distribution



Data

IRT Transformed Skill Distribution



Data

Item Response Theory

Item Response Theory

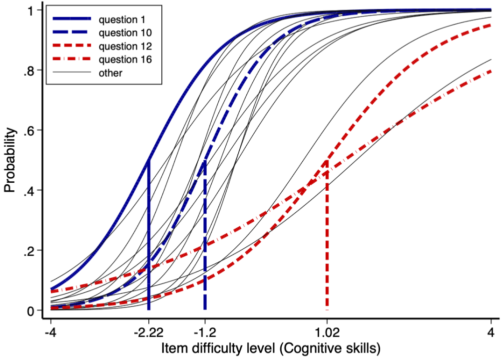
- model the probability of correctly answering a question from a test as a function of test characteristics and a test takers latent skills
- test characteristics include difficulty level λ_i and discrimination level κ_i
- latent skill ζ_j is assumed to follow a standard Normal distribution
- estimate parameters of test characteristics using maximum likelihood ICC

$$\Pr(Y_{ij} = 1 \mid \Gamma, \zeta_j) = \frac{\exp\{\kappa_i(\zeta_j - \lambda_i)\}}{1 + \exp\{\kappa_i(\zeta_j - \lambda_i)\}}$$

- recover latent skill using empirical Bayesian updating TCC

Latent Cognitive Skill Distribution

Figure: Item Characteristics Curve



IRT

Figure: Item Characteristics Curve

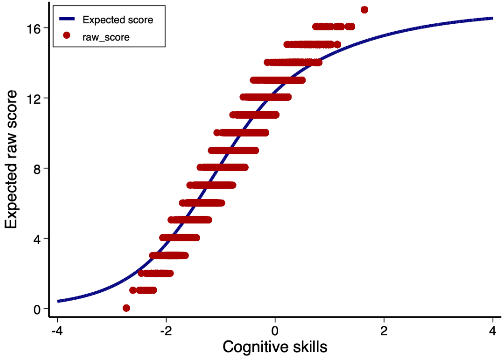
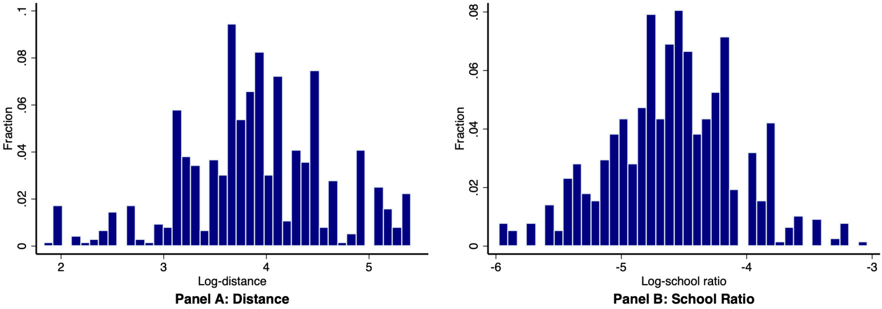


Figure: Variation in Instruments



Identification

Table: Instrumental Variable Test & Evidence

Panel A: Tests for Weak Instruments		
Under Identification Test		
Kleibergen-Paap rank LM statistic (p-value)	31.53 (0.00)	
Weak Instrument Test		
Cragg-Donald Wald F statistic	11.39	
Kleibergen-Paap Wald F statistic	10.57	
Stock-Yogo Critical values		
10% & 15% maximal relative biases	13.43 & 8.18	

Panel B: Suggestive Evidence	Correlation	St. Err.
Distance		
Electricity availability	−0.025	0.016
Agricultural wage	−0.001	0.001
Housing price	−0.248	0.335
Number of School		
Subjective measure of school quality	−0.031	0.023

Identification

Table: χ^2 Goodness-of-Fit Tests of the Within-Sample Choice Distribution

Age	$j = 1$	$j = 2$	$j = 3$	Row
0	0.13	1.11	0.32	1.56
1	0.20	8.72*	1.72	10.64*
2	0.31	1.76	2.17	4.25
3	0.00	0.17	0.08	0.25
4	0.00	0.28	0.11	0.39
5	0.00	0.11	0.05	0.16
6	0.10	0.26	2.04	2.40
7	0.39	1.01	2.01	3.40
8	0.10	0.12	2.15	2.37
9	0.04	0.39	1.79	2.22
10	0.02	0.22	0.00	0.24
11	0.01	0.00	0.13	0.14
12	0.13	0.01	1.06	1.20
13	0.17	0.02	1.04	1.22
14	0.17	0.01	1.38	1.56

Model Fit

Model Fit: Migration Choice Transition Matrix

Table: χ^2 Goodness-of-Fit Tests of the Migration Transition Matrix

	Choice (t)			
Choice ($t-1$)	$j=1$	$j=2$	$j=3$	Row
$j=1$				
Data	95.88%	0.91%	3.21%	-
Model	95.51%	0.99%	4.51%	-
χ^2	0.14	0.66	38.24*	39.04*
$j=2$				
Data	19.51%	79.78%	0.71%	-
Model	28.42%	71.26%	0.32%	-
χ^2	35.22*	12.85*	5.99*	54.06*
$j=3$				
Data	4.60%	1.31%	94.09%	-
Model	6.49%	0.17%	93.34%	-
χ^2	2.51	34.94*	0.03	37.48*

Model Fit

Model Fit: Skill Distribution by Migration Experience

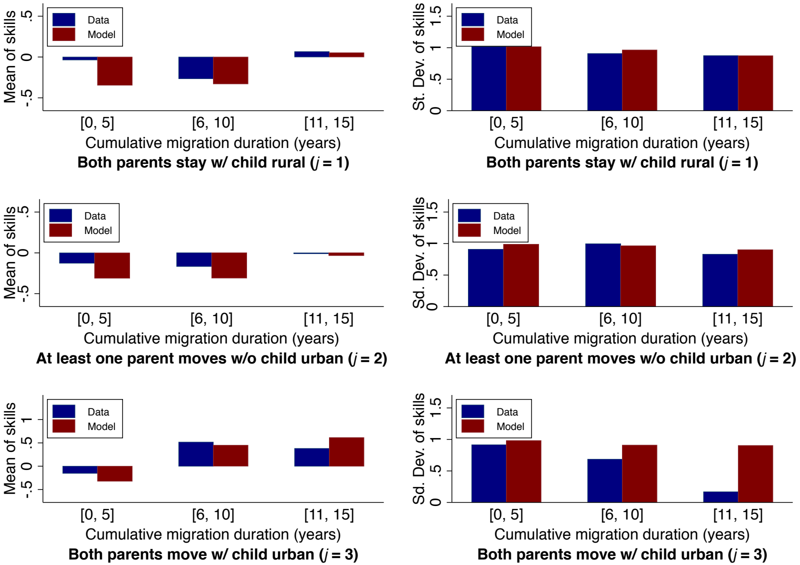
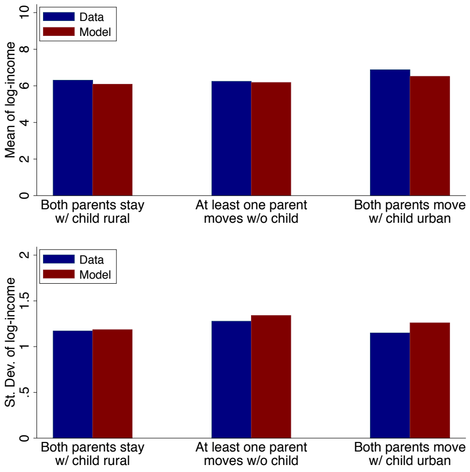


Figure: Model Fit to Income Distribution by Migration Status



Model Fit

Figure: Model Fit to Income Distribution by Parental Education