Incorporating Micro Financial Foundations into Macro Analysis

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CFSP
Consortium on Financial Systems and Poverty

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Fixed Assets and Number of Employees

Fixed assets	Total	
	N	%
Less than 10m BHT	240	37.4
11-50m BHT	157	24.5
51- 100m BHT	44	6.9
101-200m BHT	41	6.4
NA	160	24.9
Base all respondents	642	100.0

Employees	Total	
	N	%
Less than 10 employees	137	21.3
11-50 employees	266	41.4
51- 100 employees	114	17.8
101- 200 employees	125	19.5
Base all respondents	642	100.0

Note: 1) as of June 1999, at cost

Establishments in the Bangkok–Thonburi area (1960)

Table 5.14. *Establishments in the Bangkok–Thonburi area, 1960*

	Numbers of establishments				
Type of business	Total	Thai	Foreign[a]	Number of employees	Employees per establishment
Hardware	1,024	285	739	5,926	5.8
Printing, book binding	530	290	240	5,014	9.5
Sawmilling	317	89	228	4,771	15.1
Weaving with handlooms[b]	382	15	367	4,527	11.9
Rice-milling	149	92	57	2,625	17.6
Candles, joss sticks	111	34	77	2,148	19.4
Machinery repairing	283	122	161	2,096	7.4
Weaving with machines	185	16	169	2,052	11.1
Spinning	62	9	53	1,586	25.6
Pharmaceuticals	228	85	143	1,562	6.9
Flour-milling	196	32	164	1,448	7.4
Matches	4	1	3	1,283	320.8
Garments[c]	29	8	21	1,116	38.5
Aerated water	47	14	33	1,005	21.4
Tobacco	94	23	71	825	8.8
Shellac	24	7	17	558	23.3
Soap[c]	13	2	11	550	42.3
Cement	1	0	1	521	521.0
Ice	43	24	19	510	11.9
Liquor	6	5	1	218	36.3
Total[d]	7,302	2,233	5,069	62,264	8.5

Notes: [a]Mostly the Chinese group.
[b]Establishments with five looms or more.
[c]Establishments with five employees or more.
[d]Includes other businesses.

Source: Suehiro 1989.

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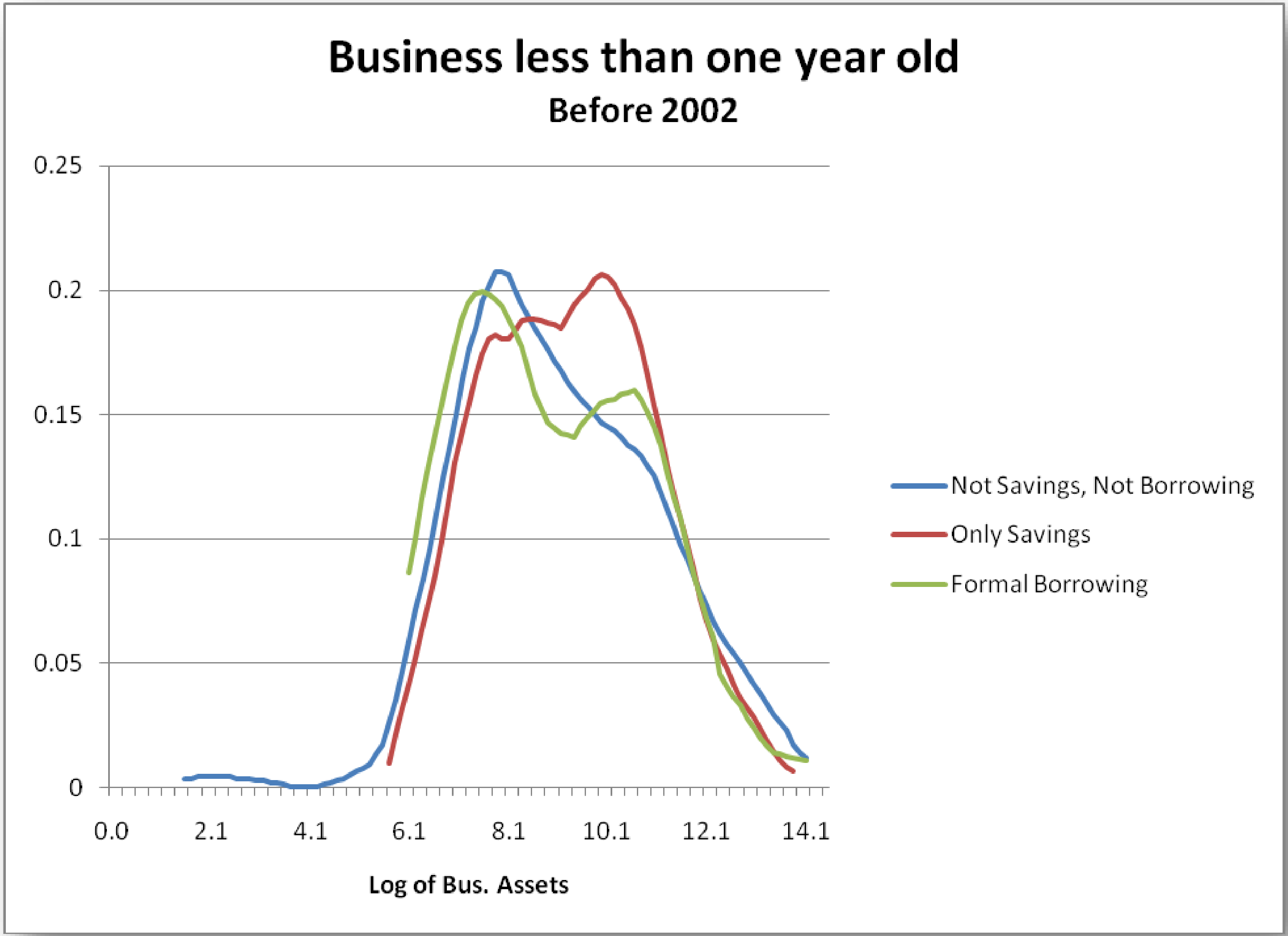
Business less than one year old
Before 2002
0.25
0.2
0.15
0.1
0.05
0
0.0
2.1
4.1
6.1
8.1
10.1
12.1
14.1
Log of Bus. Assets
Not Savings, Not Borrowing
Only Savings
Formal Borrowing

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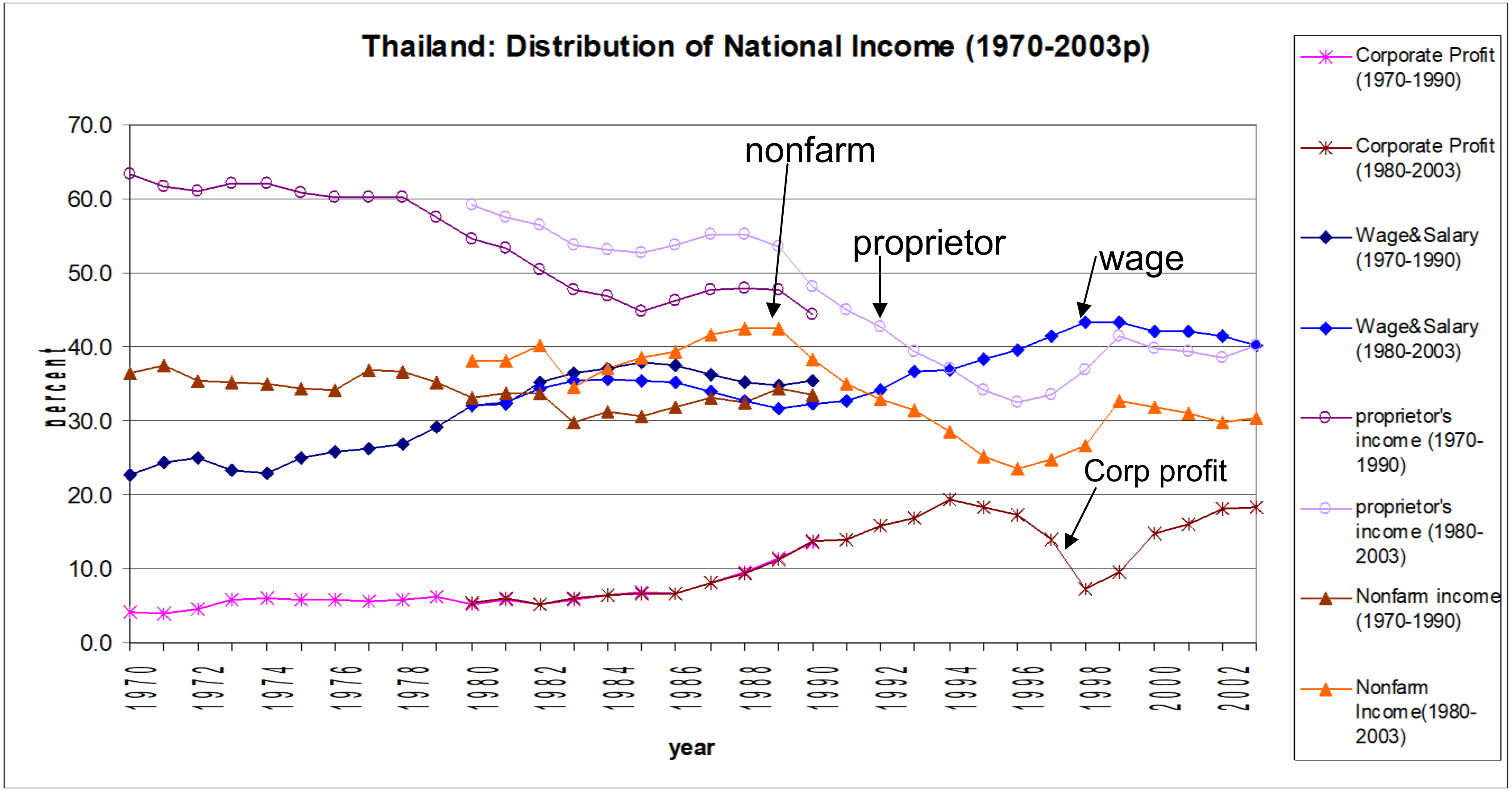
Thailand
Importance of NFPI in NIPA itself



Source: NESDB data series

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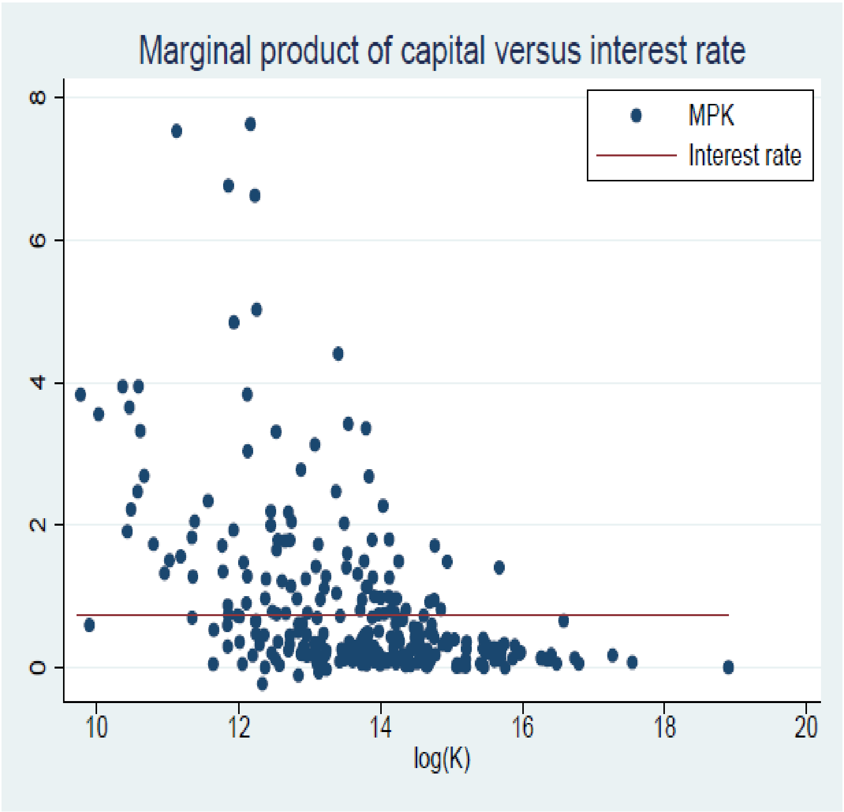
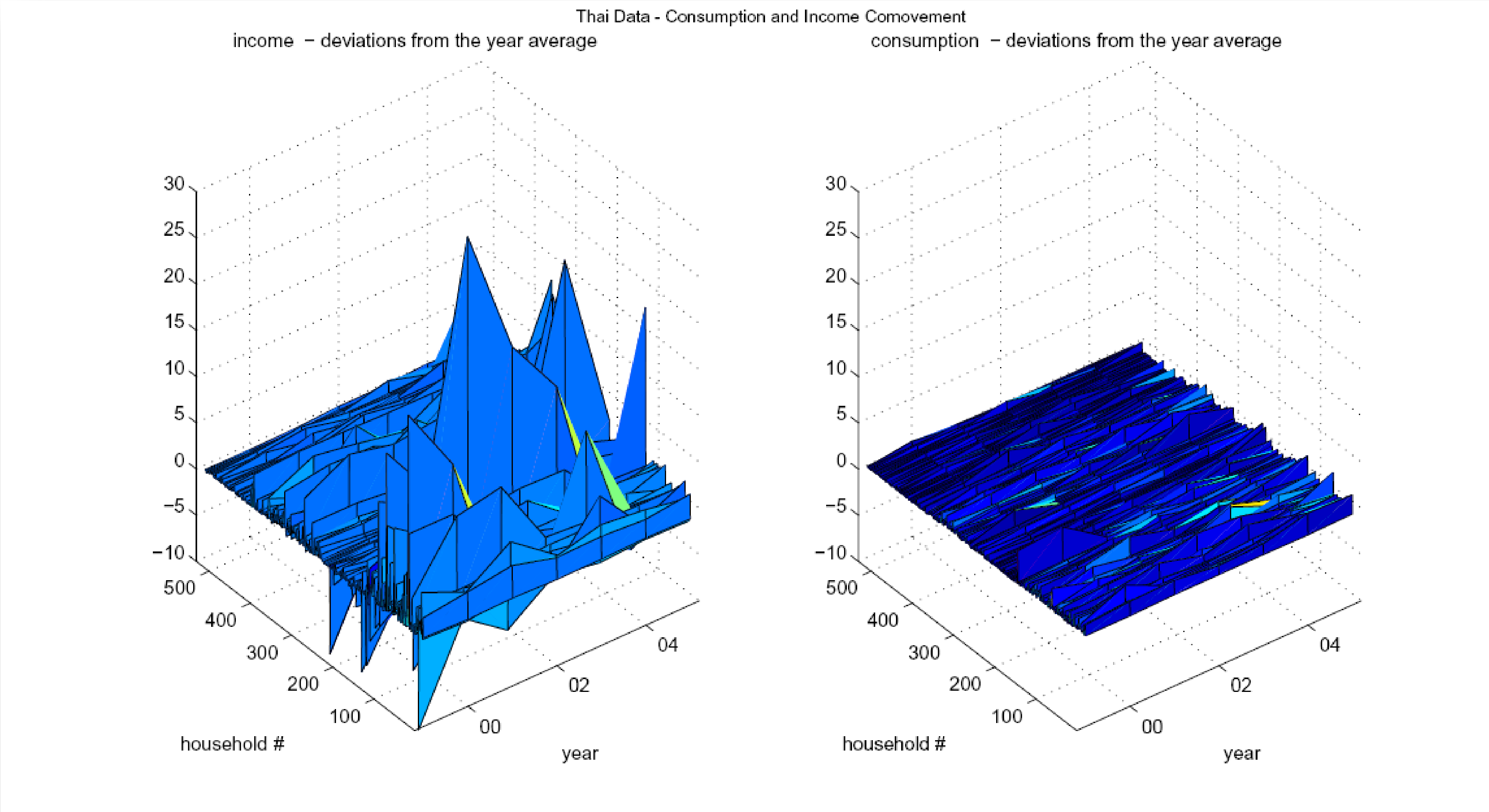
Marginal Product of Capital



[Pawasutipaisit & Townsend, 2010]

- Within-network vs out-of-network, some improve
  - Mean ROA of HH with network are higher, and sd is lower relative to those HHs without network
- Poor investing and saving in own enterprise-long term remedy
- Note in picture:
  - Matching observed interest rates does not help


Thai Data - Consumption and Income Comovement
income − deviations from the year average
consumption − deviations from the year average
30
25
20
15
10
5
0
−5
−10
500
400
300
200
100
household #
00
02
04
year

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Literature on financial constraints: consumers vs. firms dichotomy

- **Consumption smoothing literature** – various models with risk aversion
  - permanent income, buffer stock, full insurance
  - private information (Phelan, 94, Ligon 98) or limited commitment (Thomas and Worrall, 90; Ligon et al., 05; Dubois et al., 08)
- **Investment literature** – firms modeled mostly as risk neutral
  - adjustment costs: Abel and Blanchard, 83; Bond and Meghir, 94
  - IO (including structural): Hopenhayn, 92; Ericson & Pakes, 95, Cooley & Quadrini, 01; Albuquerque & Hopenhayn, 04; Clementi & Hopenhayn, 06; Schmid, 09
  - empirical: e.g., Fazzari et al, 88 – unclear what the nature of financial constraints is (Kaplan and Zingales, 00 critique); Samphantharak and Townsend, 10; Alem and Townsend, 10; Kinnan and Townsend, 11

Literature (cont.)

- **Comparing/testing across models of financial constraints** – Meh and Quadrini 06; Paulson et al. 06; Jappelli and Pistaferri 06; Kocherlakota and Pistaferri 07; Attanasio and Pavoni 08; Kinnan 09; Krueger and Perri 10; Krueger, Lustig and Perri 08 (asset pricing implications)

- **Macro literature with micro foundations**

  – largely assumes exogenously missing markets – Cagetti & De Nardi, 06; Covas, 06; Angeletos and Calvet, 07; Heaton and Lucas, 00; Castro Clementi and Macdonald 09, Greenwood, Sanchez and Weage 10a,b

Dynamic Financial Constraints: Distinguishing Mechanism Design from Exogenously Incomplete Regimes

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Objectives

- how good an approximation are the various models of financial markets access and constraints across the different literatures?

- what would be a reasonable assumption for the financial regime if it is taken to the data as well?

  - many ways in which markets can be incomplete

  - financial constraints affect investment and consumption jointly (no separation with incomplete markets)

  - it matters *what* the exact source and nature of the constraints are

  - can we distinguish and based on what and how much data?

Contributions

- we solve dynamic models of incomplete markets – hard but captures the full implications of financial constraints
- we can handle any number of regimes with different frictions and any preferences and technologies (no problems with non-convexities)
- using MLE we can estimate all structural parameters as opposed to only a subset available using other methods (e.g., Euler equations)
- using MLE we capture in principle more (all) dimensions of the data (joint distribution of consumption, output, investment) as opposed to only particular dimensions (e.g. consumption-output comovement; Euler equations)
- structural approach allows computing counterfactuals, policy and welfare evaluations

What we do

- formulate and solve a wide range of *dynamic* models/regimes of financial markets sharing common preferences and technology
  - **exogenously incomplete** markets regimes – financial constraints assumed / exogenously given (autarky, A; saving only, S; borrowing or lending in a single risk-free asset, B)
  - **mechanism-design** (endogenously incomplete markets) regimes – financial constraints arise endogenously due to asymmetric information (moral hazard, MH; limited commitment, LC; hidden output; unobserved investment)
  - complete markets (full information, FI)

What we do

- develop methods based on mechanism design, dynamic programming, linear programming, and maximum likelihood to
  - **compute** (Prescott and Townsend, 84; Phelan and Townsend, 91; Doepke and Townsend, 06)
  - **estimate** (via maximum likelihood)
  - **statistically test** the alternative models (Vuong, 89)
- apply these methods to simulated data and actual data from Thai villages

Main findings

- we use consumption, income, and productive assets data for small household-run enterprises

- using joint consumption, income and investment data improves ability to distinguish the regimes relative to using consumption/income or investment/income data alone

- the saving and/or borrowing/lending regimes fit the Thai data best overall (but some evidence for moral hazard if using consumption and income data for households in networks)

- the autarky, full information (complete markets) and limited commitment regimes are rejected overall

- our results are robust to many alternative specifications – two-year panels, alternative grids, no measurement error, risk neutrality, adjustment costs.

$ differences in regimes urban vs rural, regional (northeast vs central)

The common theoretical framework

- **preferences:** $u(c, z)$ over consumption, c, and effort, z
- **technology:** $P(q|z, k)$ – probability of obtaining output level q from effort z and capital k
- household can contract with a risk-neutral competitive **financial intermediary** with outside rate of return R
  - dynamic optimal contracting problem $(T = \infty)$
  - the contract specifies probability distribution over consumption, output, investment, debt or transfers allocations
  - two interpretations: (i) single agent and probabilistic allocations or (ii) continuum of agents and fractions over allocations

Timing

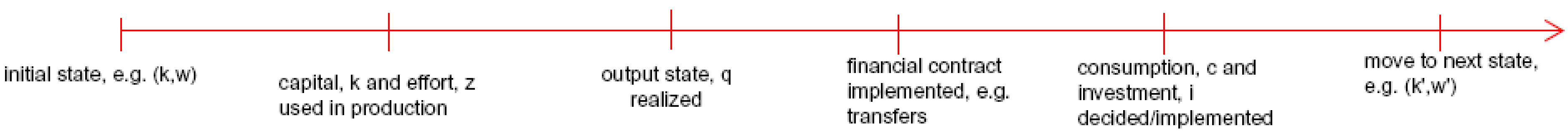
- initial state: k or (k, w) or (k, b) depending on the model regime (w is promised utility, b is debt/savings)

- capital, k and effort, z used in production

- output, q realized, financial contract terms implemented (transfers, τ or new debt/savings, b')

- consumption, c and investment, $i \equiv k' - (1-\delta)k$ decided/implemented,

- go to next period state: k', (k', w') or (k', b') depending on regime



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The linear programming (LP) approach

- we compute all models using linear programming
- write each model as dynamic linear program; all state and policy variables belong to finite grids, Z, K, W, T, Q, B, e.g. $K = [0, .1, .5, 1]$
- the choice variables are *probabilities* over all possible allocations (Prescott and Townsend, 84), e.g. $\pi(q, z, k', w') \in [0, 1]$
- extremely general formulation
  - by construction, no non-convexities for *any* preferences or technology (can be critical for MH, LC models)
  - very suitable for MLE – direct mapping to probabilities
  - contrast with the "first order approach" – need additional restrictive assumptions (Rogerson, 85; Jewitt, 88) or to verify solutions numerically (Abraham and Pavoni, 08)

Example with the autarky problem

- "standard" formulation

$$v(k) = \max_{z,\{k'_i\}_{i=1}^{\#Q}} \sum_{q_i \in Q} P(q_i|k,z)[u(q_i + (1-\delta)k - k'_i,\ z) + \beta v(k'_i)]$$

- linear programming formulation

$$v(k) = \max_{\pi(q,z,k'|k) \geq 0} \sum_{QxZxK'} \pi(q,z,k'|k)[u(q + (1-\delta)k - k',\ z) + \beta v(k')]$$

$$\text{s.t.} \quad \sum_{K'} \pi(q,z,k'|k) = P(\bar{q}|\bar{z},k) \sum_{Q \times K} \pi(q,\bar{z},k'|k) \text{ for all } (\bar{q},\bar{z}) \in Q \times Z$$

$$\sum_{QxZxK'} \pi(q,z,k'|k) = 1$$

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Exogenously incomplete markets models (B, S, A)

- no information asymmetries; no default
- The agent's problem:

$$v(k,b) = \max_{\pi(q,z,k',b'|k,b)} \sum_{QxZxK'xB'} \pi(q,z,k',b'|k,b)[U(q+b'-Rb+(1-\delta)k-k',z)+\beta v(k',b')]$$

subject to Bayes-rule consistency and adding-up:

$$\sum_{K'xB'} \pi(\bar{q},\bar{z},k',b'|k,b) = P(\bar{q}|\bar{z},k) \sum_{Q\times K'xB'} \pi(q,\bar{z},k',b'|k,b) \text{ for all } (\bar{q},\bar{z}) \in Q \times Z$$

$$\sum_{QxZxK'\times B'} \pi(q,z,k',b'|k,b) = 1$$

and s.t. $\pi(q,z,k',b'|k,b) \geq 0, \ \forall (q,z,k',b') \in Q \times Z \times K' \times B'$

- *autarky*: set $B' = \{0\}$; *saving only*: set $b_{\max} = 0$; *debt*: allow $b_{\max} > 0$

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Mechanism design models (FI, MH, LC)

- allow state- and history-contingent transfers, τ
- dynamic optimal contracting problem between a risk-neutral lender and the household

$$V(w,k) = \max_{\{\pi(\tau,q,z,k',w'|k,w)\}} \sum_{T\times Q\times Z\times K'\times W'} \pi(\tau,q,z,k',w'|k,w)[q-\tau+(1/R)V(w',k')]$$

s.t. *promise-keeping:*

$$\sum_{T\times Q\times Z\times K'\times W'} \pi(\tau,q,z,k',w'|k,w)[U(\tau+(1-\delta)k-k',z)+\beta w'] = w,$$

and s.t. Bayes-rule consistency, adding-up, and non-negativity as before.

Moral hazard

- additional constraints – *incentive-compatibility*, $\forall(\bar{z}, \hat{z}) \in Z \times Z$

$$\sum_{T\times Q\times K'\times W'} \pi(\tau, q, \bar{z}, k', w'|k, w)[U(\tau + (1-\delta)k - k', \bar{z}) + \beta w'] \geq$$

$$\geq \sum_{T\times Q\times K'\times W'} \pi(\tau, q, \bar{z}, k', w'|k, w)\frac{P(q|\hat{z}, k)}{P(q|\bar{z}, k)}[U(\tau + (1-\delta)k - k', \hat{z}) + \beta w']$$

- we also compute a moral hazard model with unobserved k and k' (UI) – adds dynamic adverse selection as source of financial constraints

Limited commitment

- additional constraints – *limited commitment*, for all $(\bar{q}, \bar{z}) \in Q \times Z$

$$\sum_{T \times K' \times W'} \pi(\tau, \bar{q}, \bar{z}, k', w' | k, w)[u(\tau + (1-\delta)k - k', \bar{z}) + \beta w'] \geq \Omega(k, \bar{q}, \bar{z})$$

where $\Omega(k, q, z)$ is the present value of the agent going to autarky with his current output at hand q and capital k, which is defined as:

$$\Omega(k, q, z) \equiv \max_{k' \in K'} \{u(q + (1-\delta)k - k', z) + \beta v^{aut}(k')\}$$

where $v^{aut}(k)$ is the autarky-forever value (from the A regime).

Hidden output/income model

As MH or LC above, but instead subject to *truth-telling constraints* (true output is $\bar{q}$ but considering announcing $\hat{q}$), $\forall$ $(\bar{z}, \bar{q}, \hat{q} \neq \bar{q})$:

$$\sum_{T\times K'\times W'} \pi(\tau, \bar{q}, \bar{z}, k', w'|k, w)[U(\bar{q} + \tau + (1-\delta)k - k', \bar{z}) + \beta w'] \geq$$

$$\geq \sum_{T\times K'\times W'} \pi(\tau, \hat{q}, \bar{z}, k', w'|k, w)[U(\bar{q} + \tau + (1-\delta)k - k', \bar{z}) + \beta w']$$

Functional forms and baseline parameters

- **preferences:**

$$u(c, z) = \frac{c^{1-\sigma}}{1-\sigma} - \xi z^{\theta}$$

- **technology:** calibrated from data, the matrix $P(q|z, k)$ for all $q, z, k \in Q \times Z \times K$

- **calibrated parameters** (the rest, σ, θ, ρ are estimated in the MLE):

$$\beta = .95,\ \delta = .05,\ R = 1.053,\ \xi = 1$$

Computation

- compute each model using policy function iteration (Judd 98)

- in general, let the initial state s be distributed $D_0(s)$ over the grid $\mathbf{S}$ (in the estimations we use the k distribution from the data)

  – use the LP solutions, $\pi^*(.|s)$ to create the state transition matrix, $M(s, s')$ with elements $\{m_{ss'}\}_{s,s' \in S}$
  – for example, for MH $s = (w, k)$ and thus

$$m_{ss'} \equiv prob(w', k'|w, k) = \sum_{T \times Q \times Z} \pi^*(\tau, q, z, k', w'|w, k)$$

  the state distribution at time t is thus $D_t(s) = (M')^t D_0(s)$

- use $D(s)$, $M(s, s')$ and $\pi^*(.|s)$ to generate cross-sectional distributions, time series or panels of any model variables

Structural estimation

Given:

- – structural parameters, ϕ^s (to be estimated),
  – discretized over K initial capital (observable state) distribution $H_0(k)$
  – the unobservable state (b or w) distribution – parameterized by ϕ^d and estimated

- generate the probability, $f_0^m(x|H_0(k), \phi^s, \phi^d)$ of any $x = (c, q)$ or $x = (k, i, q)$ or $x = (c, q, i, k)$ implied by the solution $\pi^*(.)$ of model regime, m (m is A through FI), integrating over unobservable state variables.

- construct the simulated log-likelihood of the data $\{\hat{x}_i\}_{i=1}^n$ in model m given ϕ and $H_0(k)$ and allowing for measurement error (stdev γ_{me} estimated) in k, c, q, $\Lambda^m(\phi|H_0(k))$

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Application to Thai data

- Townsend Thai Surveys (16 villages in four provinces, Northeast and Central regions)
- balanced panel of 531 rural households observed 1999-2005 (seven years of data)
- data series used in estimation and testing
  - **consumption expenditure** (c) – household-level, includes owner-produced consumption (fish, rice, etc.)
  - **assets** (k) – used in production; include business and farm equipment, exclude livestock and household durables
  - **income** (q) – measured on accrual basis (Samphantharak and Townsend, 09)
  - **investment** (i) – constructed from assets data, $i \equiv k' - (1-\delta)k$

$ using urban data as well

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Calibrated production function from the data

- use data on labor, output and capital stock $\{q_{it}, z_{it}, k_{it}\}$ for a sub-sample of Thai households $(n = 296)$ to calibrate the production function
- use a histogram function to discretize (normalized) output, capital and labor data onto the model grids K, Q, Z
  - labor data is normalized setting $z_{\max}$ equal to the 80th percentile of the labor data $\{z_{it}\}$
- the result is an 'empirical' version of the production function: $P(q|k,z)$ for any $q \in Q$ and $k, z \in K \times Z$.

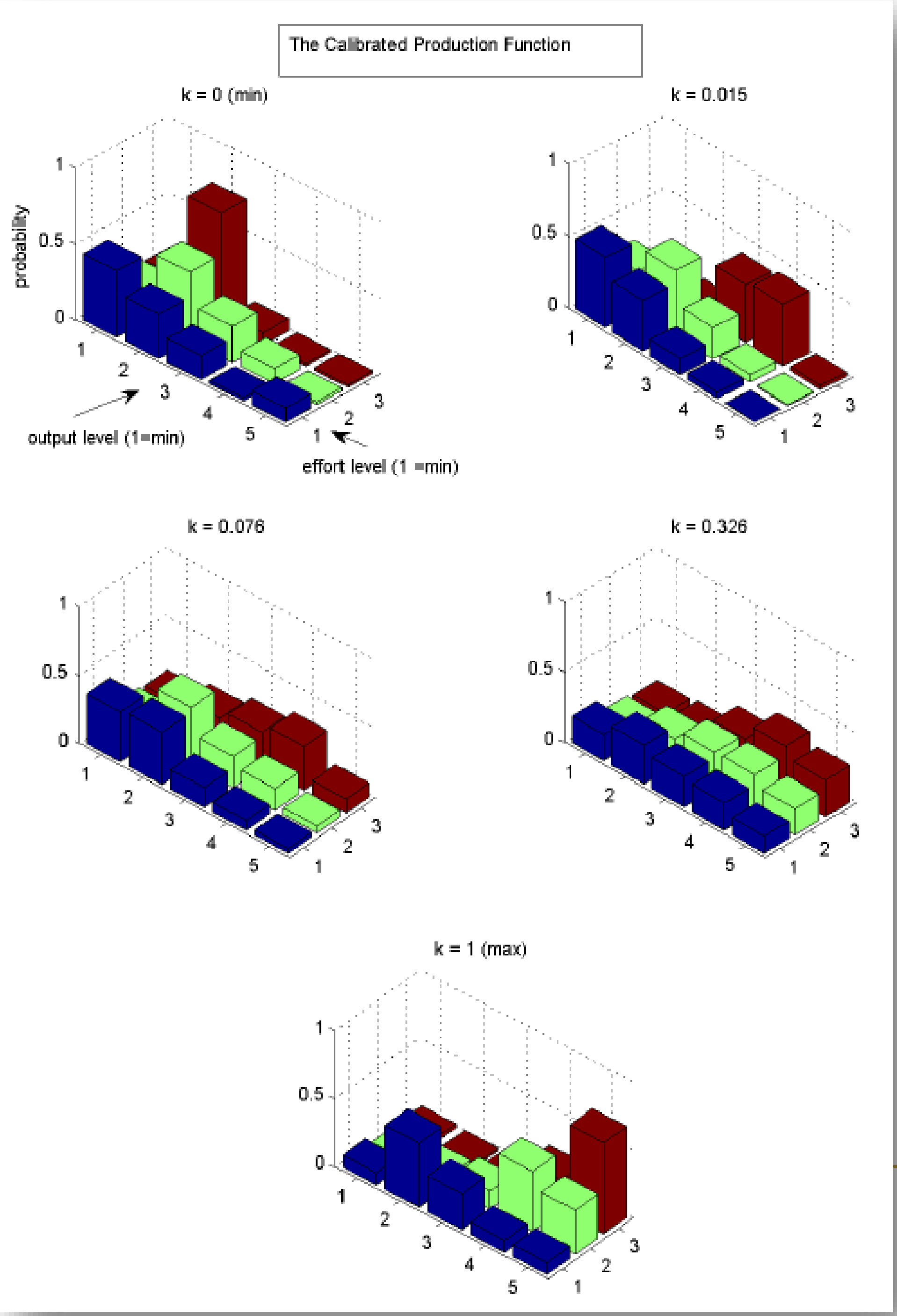
The Calibrated Production Function
k = 0 (min)
k = 0.015
k = 0.076
k = 0.326
k = 1 (max)
probability
output level (1=min)
effort level (1 =min)

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Table 9 - Model regime comparisons[1,2,3] using Thai data - Baseline Vuong test results

Comparison	MH v FI	MH v LC	MH v B	MH v S	MH v A	FI v LC	FI v B	FI v S	FI v A	LC v B	LC v S	LC v A	B v S	B v A	S v A	Best Fit
1. Using (k,i,q) data																
1.1. years: 99-00	tie	tie	B***	S***	A***	tie	B***	S***	A***	B***	S***	A***	S***	B***	S***	S
1.2. years: 04-05	FI***	MH***	B***	S***	A***	FI**	B***	S***	A***	B***	S***	A***	tie	B***	S***	B,S
2. Using (c,q,i,k) data																
2.1. years: 99-00	tie	MH***	B***	S***	A**	FI***	B***	S***	A**	B***	S***	A***	S***	tie	S***	S
2.2. years: 04-05	FI***	MH***	B***	S***	A***	FI***	B***	S***	A**	B***	S***	A***	S***	tie	S**	S
3. Using (c,q) data																
3.1. year: 99	MH***	MH**	MH**	tie	MH***	FI*	tie	tie	FI***	tie	tie	LC**	S***	B***	S***	MH,S
3.2. year: 05	tie	MH***	tie	tie	tie	FI***	tie	S***	tie	B**	S***	tie	S**	tie	S***	S,MH
4. Two-Year Panel																
4.1. (c,q), years: 99 and 00	MH***	MH***	B***	S***	MH**	FI**	B***	S***	tie	B***	S***	tie	tie	B***	S***	S,B
4.2. (c,q), years: 99 and 05	MH***	MH***	tie	tie	MH***	FI***	B***	S***	tie	B***	S***	tie	tie	B***	S***	B,S,MH
5. Dynamics																
5.1. 99 k distribution & 04-05 (c,q,i,k)	FI***	MH***	B***	tie	tie	FI***	B***	tie	FI*	B***	S***	A***	B***	B***	S**	B
5.2. 99 k distribution & 05 (c,q)	tie	MH***	tie	tie	MH***	FI***	tie	tie	FI***	B***	S***	A***	tie	B***	S***	S,B,FI,MH
5.3. 99 k distribution & 04-05 (k,i,q)	FI***	LC***	B***	S**	MH**	tie	B***	S*	FI**	B***	S*	LC**	B***	B***	S***	B

NOTES:

1. *** = 1%, ** = 5%, * = 10% two-sided significance level, the better fitting model regime's abbreviation is displayed
2. Z-statistics cutoffs: 2.575 = 1.96 = 1.645 = "tie"
3. Investment, i is constructed from the firm assets data as $i = k' - (1 - \delta)k$ with $\delta = .05$

Table 10 - Model comparisons[1] using Thai data - Robustness runs

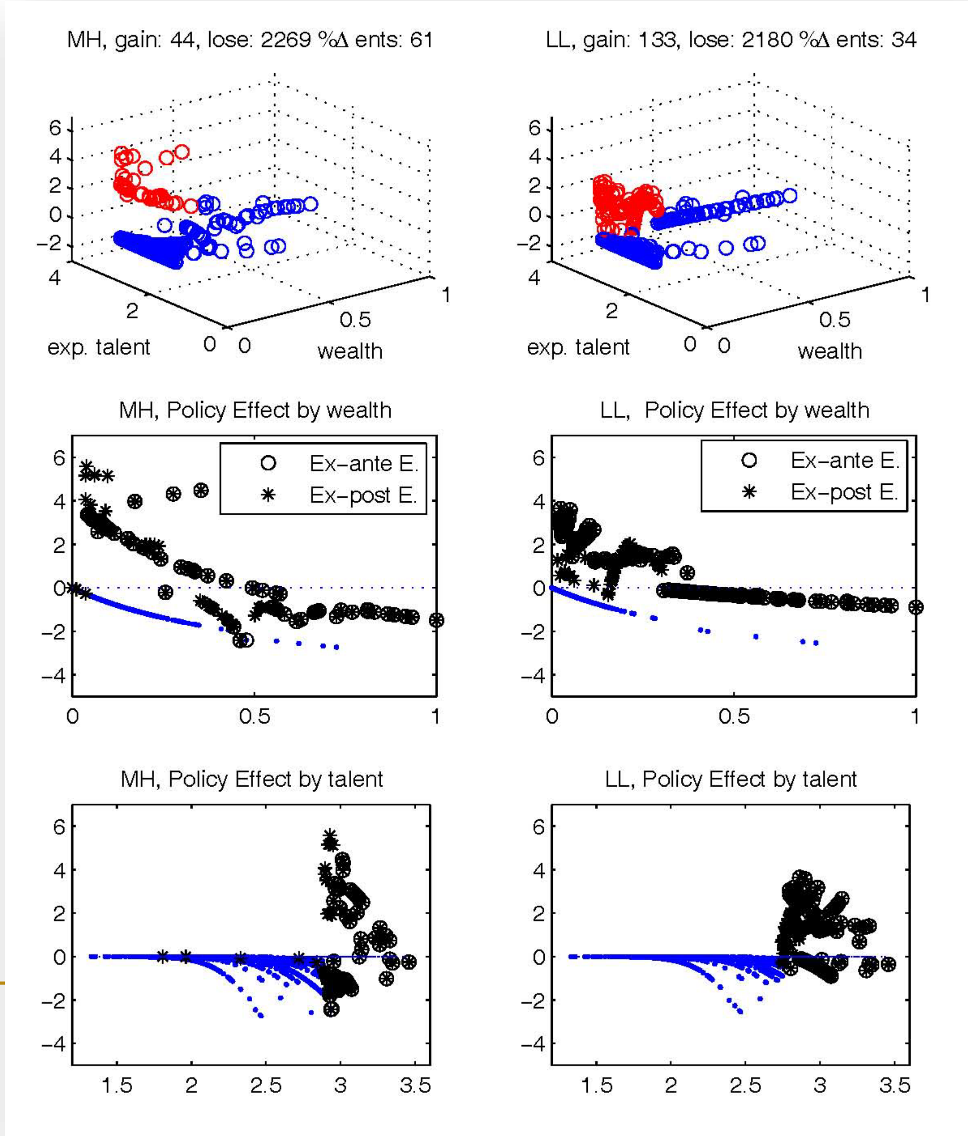
Comparison	MH v FI	MH v LC	MH v B	MH v S	MH v A	FI v LC	FI v B	FI v S	FI v A	LC v B	LC v S	LC v A	B v S	B v A	S v A	Best Fit
1. Risk neutrality[2]																
1.1 (c,q) data	MH***	MH***	MH***	MH***	MH***	LC***	B***	S***	A***	B***	S***	A***	S**	tie	S***	MH
1.2 (k,i,q) data	tie	tie	B***	S***	A***	FI**	B***	S***	A***	B***	S***	A***	B***	B***	tie	B
1.3 (c,q,i,k) data	tie	tie	B***	S***	A***	LC**	B***	S***	A***	B***	S***	A***	tie	B*	S***	S,B
2. Fixed measurement error variance																
2.1 (c,q) data	tie	MH***	MH***	tie	MH***	FI***	FI***	tie	FI***	tie	S***	tie	S***	B***	S***	MH,S,FI
2.2 (k,i,q) data	tie	MH***	B***	S***	A***	FI***	B***	S***	A***	B***	S***	A***	S***	B***	S***	S
2.3 (c,q,i,k) data	FI***	MH***	B***	S***	A***	FI***	B***	S***	A*	B***	S***	A***	S***	tie	S***	S
3. Networks sub-sample (n=391)																
3.1. (c,q) data	MH***	MH***	MH**	MH**	MH***	FI***	tie	tie	FI**	tie	tie	tie	tie	B**	S***	MH
3.2 (k,i,q) data	tie	tie	B***	S***	A***	tie	B***	S***	A***	B***	S***	A***	S**	B*	S***	S
3.2 (c,q,i,k) data	tie	MH***	B***	S***	A***	FI***	B***	S***	A***	B***	S***	A***	S**	tie	S***	S
4. Investment adjustment costs																
4.1. (c,q) data	MH**	MH***	B**	tie	MH***	FI***	B***	S**	tie	B***	S***	tie	B***	B***	S***	B
4.1 (k,i,q) data	tie	tie	B**	S***	A***	tie	B***	S***	A***	B***	S***	A***	S*	A*	tie	S,A
4.2 (c,q,i,k) data	tie	MH***	tie	S**	MH**	FI***	tie	tie	FI***	B***	S***	A***	S**	B***	S***	S,FI
5. Stratified by Region																
5.1 Central, (c,q,i,k) data (n=288)	tie	MH***	B***	S***	tie	FI***	B***	S***	tie	B***	S***	A***	tie	B***	S***	B,S
5.2 Central, (c,q) data (n=288)	MH*	MH***	MH***	tie	MH***	FI**	FI**	tie	FI***	tie	tie	tie	tie	B**	S***	MH,S
5.3 North-East, (c,q,i,k) data (n=243)	FI*	MH***	tie	tie	A***	FI***	FI***	tie	tie	B***	S***	A***	S*	A***	A**	A,FI
5.4 North-East, (c,q) data (n=243)	tie	MH***	MH**	tie	MH***	FI***	FI***	FI*	FI***	B**	S***	tie	tie	B***	S***	FI,MH
6. Other robustness runs (c,q,i,k data unless otherwise indicated)																
6.1 networks v.2; (c,q) data, n=357	MH***	MH***	tie	MH***	MH***	FI***	tie	tie	FI**	B**	tie	tie	tie	B***	S***	MH,B
6.2 networks v.2, n=357	tie	MH***	B***	S***	tie	FI***	B***	S***	tie	B***	S***	A***	S***	B**	S***	S
6.3 removed fixed effects	tie	MH***	MH***	MH***	MH***	FI***	FI***	FI***	FI***	B***	S***	A***	S***	B***	S***	MH,FI
6.4 coarser grids	MH***	MH***	B***	S***	A***	FI***	B***	S***	A***	B***	S***	A***	B**	B***	S***	B
6.5 alternative assets definition	FI**	MH*	B***	S***	A***	FI***	B***	S***	A**	B***	S***	A***	B**	B***	S***	B
6.6. estimated production function	tie	MH***	B***	S***	A***	FI***	B***	S***	A***	B***	S***	A***	tie	B***	S***	S,B
6.7. urban data, n=957; 2005-06	MH***	MH***	B***	S***	A***	FI***	B***	S***	A***	B***	S***	A***	B***	B***	S***	B
6.8. removed aggregate shocks, n=525	MH***	MH***	tie	tie	tie	FI***	tie	S*	tie	B***	S***	A***	tie	B***	S**	MH,S,B,A

7. Runs with hidden output (HO) and unobserved investment (UI) models[3]

	v MH	v FI	v B	v S	v A	v LC	Best Fit
7.1. hidden output, (c,q,i,k)	tie	tie	B***	S***	A***	HO***	B,S
7.2. unobserved investment, (c,q,i,k)	UI***	UI***	B***	S***	tie	UI***	B

1. *** = 1%, ** = 5%, * = 10% Vuong (1989) test two-sided significance level. Listed is the better fitting model or "tie" if the models are tied. Sample size is n=531; data are for 1999-00 unless noted otherwise.
2. The upper bound of the output grid, Q was adjusted to 1.25 for these runs, since our baseline grid produced no solution for the LC regime for σ = 0.
3. For computational reasons the HO model is computed with estimated production function (read with line 6.6); the UI model is with coarser grids (read with line 6.5).

Quantification of the gains and losses to various possible policy interventions



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Finance and Development: Limited Commitment vs. Private Information

Benjamin Moll   Robert M. Townsend   Victor Zhorin

August 21, 2011

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Our Contribution

- Develop a general equilibrium model of entrepreneurship and financial frictions that is general enough to encompass:

(1) financial frictions stemming from limited commitment.

(2) financial frictions stemming from private information (moral hazard).

(3) Mixtures of different regimes in different regions.

- Most existing studies: category (1).
- Notable exceptions in category (2): Castro, Clementi and Macdonald (2009); Greenwood, Sanchez and Wang (2010*a*,*b*)

Preview of Results

- Different frictions have potentially very different implications.
- Limited commitment causes misallocation of capital across different productivity types.
- In contrast, moral hazard lowers TFP at the firm level, providing a theory of endogenously lower firm-level TFP.
- Mixture of regimes not just convex combination, e.g. for occupational choice and factor prices.

Common Theoretical Framework

- Individuals: wealth, a, entrepreneurial ability, z. Markov process $\mu(z'|z)$.
- Preferences over consumption and effort:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t, e_t).$$

- Occupational choice: entrepreneur $(x = 1)$ or worker $(x = 0)$.

Entrepreneurs and Workers

- **Entrepreneurs,** $x = 1$**:** technologies

$$y = f(z, \varepsilon, k, l) = z\varepsilon k^{\alpha} l^{\gamma}, \quad \alpha + \gamma < 1$$

- $\varepsilon \equiv$ idiosyncratic production risk, with distribution $p(\varepsilon|e)$.
- **Workers,** $x = 0$**:** supply ε efficiency units of labor, with distribution $p(\varepsilon|e)$.
- Note: Depending on $x = 0$ or $x = 1$, ε is either firm productivity or worker's efficiency units. Allow for differential responsiveness to e through appropriate scaling.

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Risk-Sharing

- Households contract with risk-neutral intermediaries to form "risk-sharing syndicates": intermediaries bear some of HH risk.
- Assume: can only insure against production risk, ε, but not against talent, z.
- Optimal contract:

(1) assigns occupation, x, effort, e, capital, k, and labor, l. After ε is drawn, assigns consumption and savings $c(\varepsilon)$ and $a'(\varepsilon)$.

(2) leaves zero profits to intermediary $\Leftrightarrow$ maximizes individual's utility.

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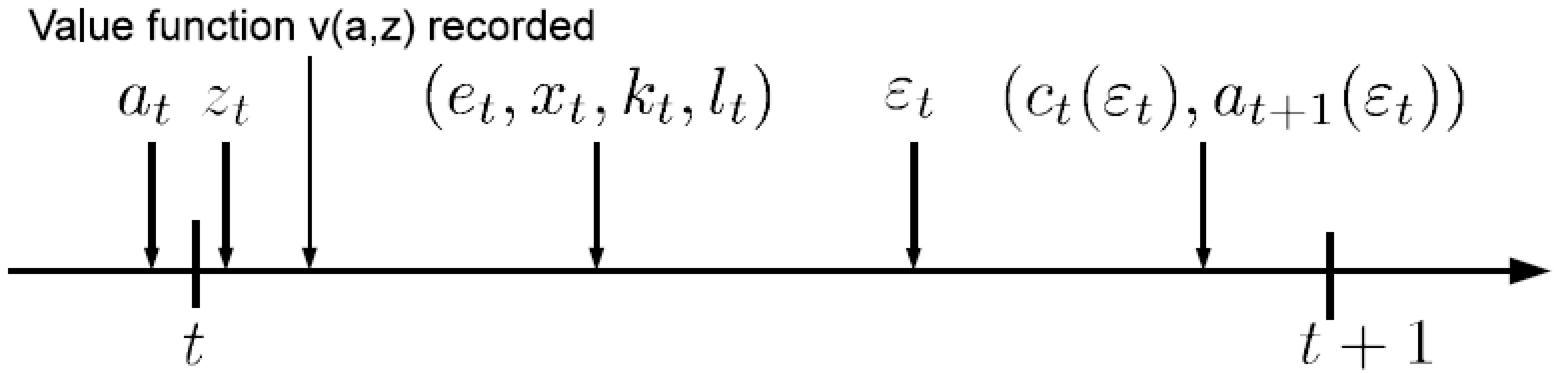
Timing


Value function v(a,z) recorded
a_t
z_t
(e_t, x_t, k_t, l_t)
ε_t
$(c_t(\varepsilon_t), a_{t+1}(\varepsilon_t))$
t
$t+1$

Optimal Contract: Bellman Equation

$$v(a,z) = \max_{e,x,k,l,c(\varepsilon),a'(\varepsilon)} \sum_{\varepsilon} p(\varepsilon|e)\left\{u[c(\varepsilon),e] + \beta \mathbb{E} v[a'(\varepsilon),z']\right\} \quad \text{s.t.}$$

$$\sum_{\varepsilon} p(\varepsilon|e)\left\{c(\varepsilon) + a'(\varepsilon)\right\}$$
$$\leq \sum_{\varepsilon} p(\varepsilon|e)\left\{x[z\varepsilon k^{\alpha} l^{\gamma} - wl - (r+\delta)k] + (1-x)w\varepsilon]\right\} + (1+r)a$$

and s.t. regime-specific constraints

Capital Accumulation

Private Information

- effort, e, unobserved $\Rightarrow$ moral hazard problem.
- Note: moral hazard for **both** entrepreneurs and workers.
- IC constraint:

$$\sum_{\varepsilon} p(\varepsilon|e)\left\{u[c(\varepsilon),e]+\beta\mathbb{E}v[a'(\varepsilon),z']\right\}$$

$$\geq \sum_{\varepsilon} p(\varepsilon|\hat{e})\left\{u[c(\varepsilon),\hat{e}]+\beta\mathbb{E}v[a'(\varepsilon),z']\right\} \quad \forall e,\hat{e},x$$

- ▸ Lotteries ▸ Equivalence with Promised Utility Formulation

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Formulation with Lotteries

Return

- Notation: control variables $d = (c, \varepsilon, e, x)$.
- Lotteries: $\pi(d, a'|a, z) = \pi(c, \varepsilon, e, x, a'|a, z)$

$$v(a, z) = \max_{\pi(d,a'|a,z)} \sum_{D,A} \pi(d, a'|a, z) \{u(c, e) + \beta \mathbb{E} v(a', z')\} \quad \text{s.t.}$$

$$\sum_{D,A} \pi(d, a'|a, z) \{a' + c\}$$

$$= \sum_{D,A} \pi(d, a'|a, z) \{x\Pi(\varepsilon, e, z; w, r) + (1 - x) w\varepsilon\} (1 + r)a.$$

$$\sum_{(D\setminus E),A} \pi(d, a'|a, z) \{u(c, e) + \beta \mathbb{E} v(a', z')\}$$

$$\geq \sum_{(D\setminus E),A} \pi(d, a'|a, z) \frac{p(\varepsilon|\hat{e})}{p(\varepsilon|e)} \{u(c, \hat{e}) + \beta \mathbb{E} v(a', z')\} \ \forall e, \hat{e}, x$$

$$\sum_{C,A} \pi(d, a'|a, z) = p(\varepsilon|e) \sum_{C,\varepsilon,A} \pi(d, a'|a, z), \quad \forall \varepsilon, e, x$$

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Limited Commitment

- effort, e, observed $\Rightarrow$ perfect insurance against production risk, ε.
- But collateral constraint:

$$k \leq \lambda a, \quad \lambda \geq 1.$$

Factor Demands

- Denote optimal occupational choice and factor demands by

$$x(a,z), \quad l(a,z;w,r), \quad k(a,z;w,r)$$

- and individual (average) labor supply:

$$n(a,z;w,r) \equiv [1-x(a,z)] \sum_{\varepsilon} p[\varepsilon | e(a,z)] \varepsilon.$$

Steady State Equilibrium

- Prices r and w, and corresponding quantities such that:

(i) Taking as given r and w, quantities are determined by optimal contract

(ii) Markets clear

$$\int l(a,z;w,r)dG(a,z) = \int n(a,z;w,r)dG(a,z)$$
$$\int k(a,z;w,r)dG(a,z) = \int a dG(a,z).$$

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Parameterization

- GHH utility

$$u(c,e) = \frac{(c - v(e))^{1-\sigma}}{1-\sigma}, \quad v(e) = \chi e^{\theta}$$

- Purpose: no wealth effect, any effect comes from MH.
- Recall production function $\varepsilon z k^{\alpha} l^{\gamma}$.
- Parameters:

$$\alpha = 0.3, \quad \gamma = 0.4, \quad \delta = 0.06$$

$$\beta = 1.05^{-1}, \quad \sigma = 2, \quad \chi = 5, \quad \theta = 1.2$$

- Serious calibration on top of to-do list.

Limited Commitment vs. Moral Hazard

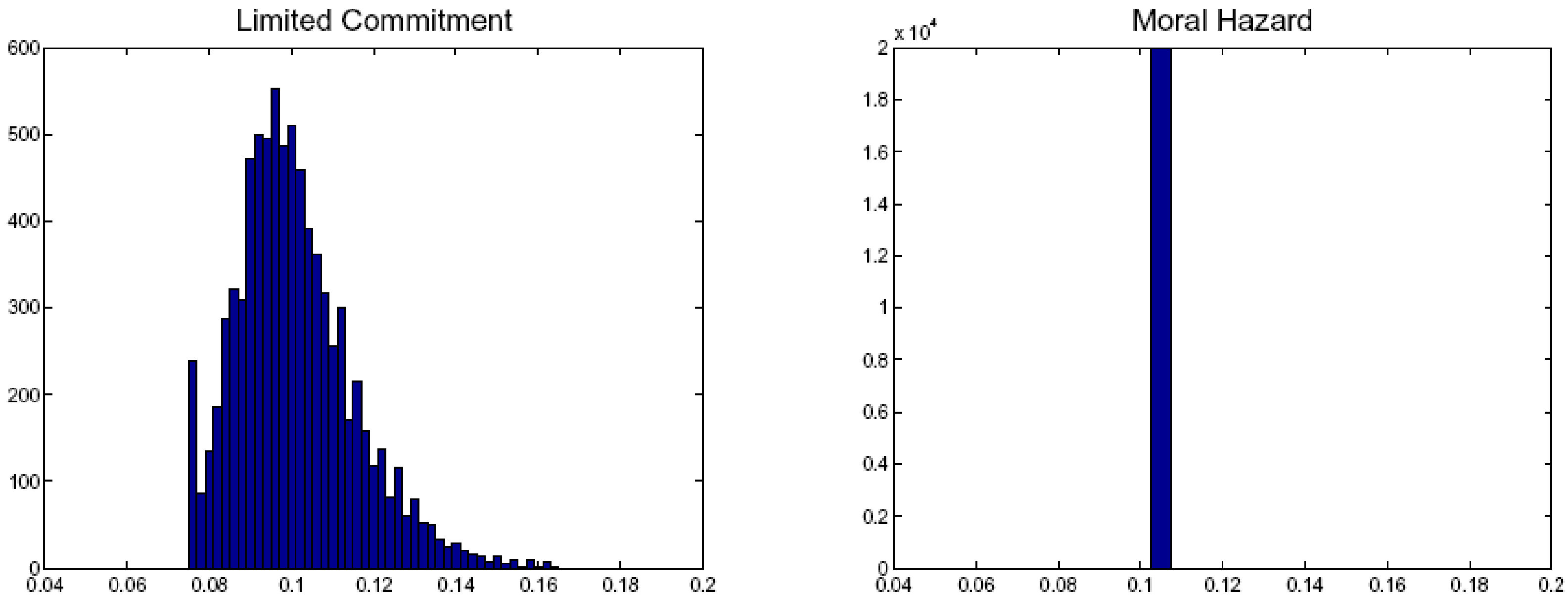

Figure: Distribution of Marginal Products of Capital.

▸ Why are MPKs equalized?

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Limited Commitment vs. Moral Hazard

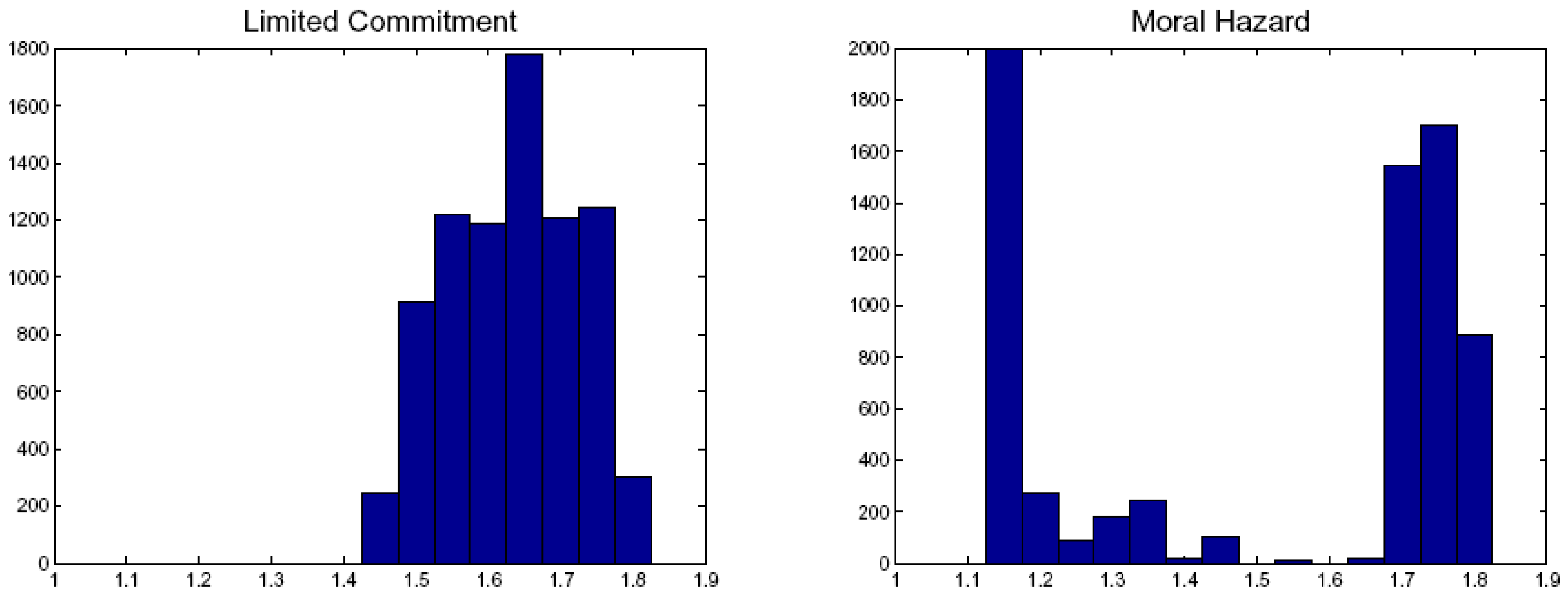


Figure: Distribution of Firm-level TFP.

- Recall $y = z\varepsilon k^{\alpha} l^{\gamma}$.

Limited Commitment vs. Moral Hazard

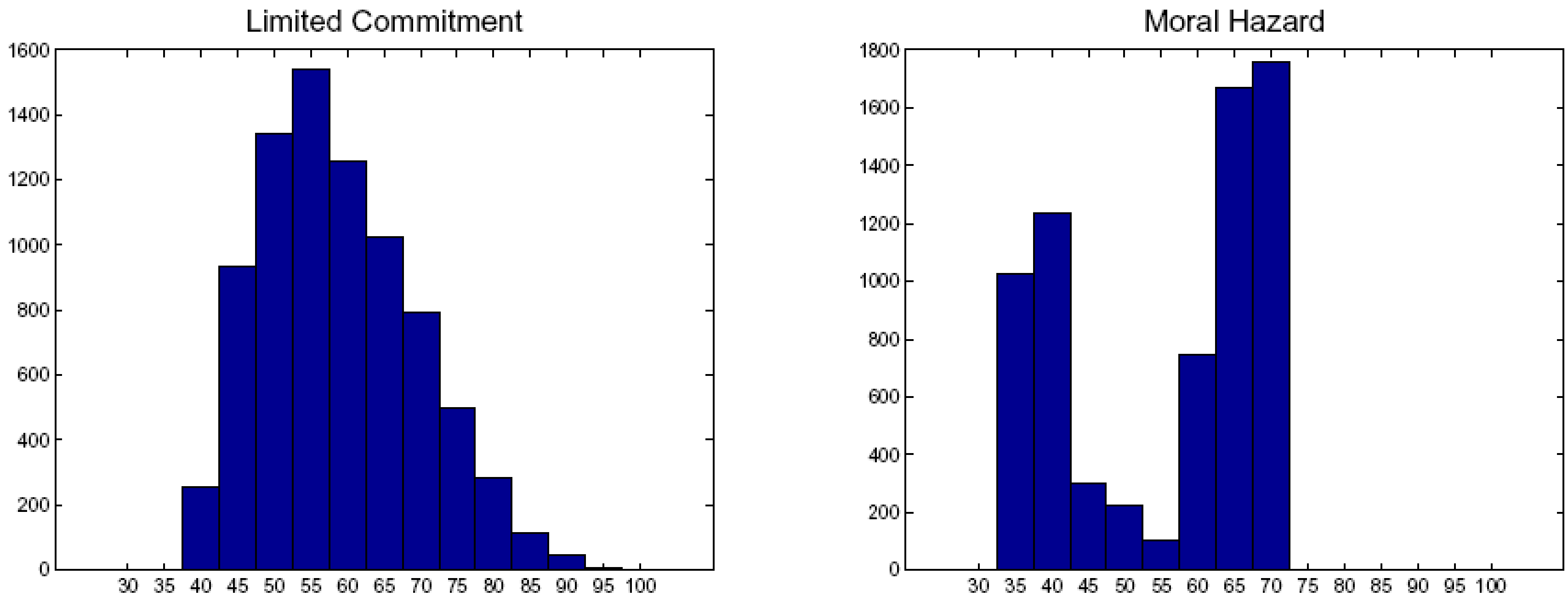


Figure: Firm-Size Distribution (Employees).

Mixtures of Moral Hazard and Limited Commitment

- Combine the two regimes in one economy. 50% of pop. subject to moral hazard, 50% to limited commitment.
- Motivation: no reason why economy as a whole should be subject to only one friction.
- Estimated "on the ground" by Paulson, Townsend and Karaivanov (2006) and Ahlin and Townsend (2007): for Thailand, MH fits better in and around Bangkok and LC better in Northeast (see also Karaivanov and Townsend, 2010)
- Also: factor prices different in two regimes $\Rightarrow$ potentially interesting GE effects.

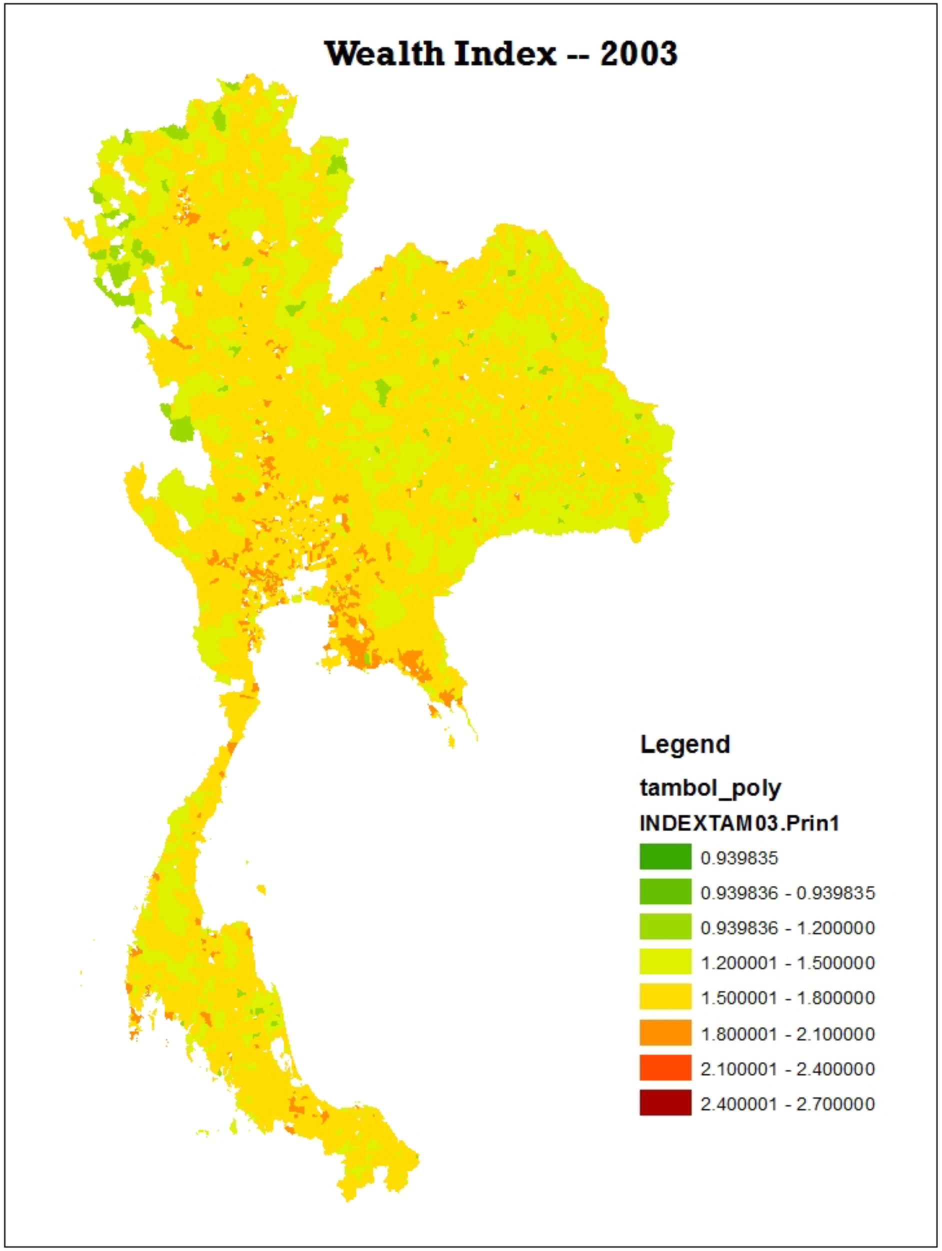
Mixtures of Moral Hazard and Limited Commitment

	LC	MH	Mix -LC	Mix - MH
Interest Rate	0.0154	0.0472	0.05	
Wage	0.2263	0.3625	0.3070	
% Entrepreneurs	40.49	35.33	0	69.84

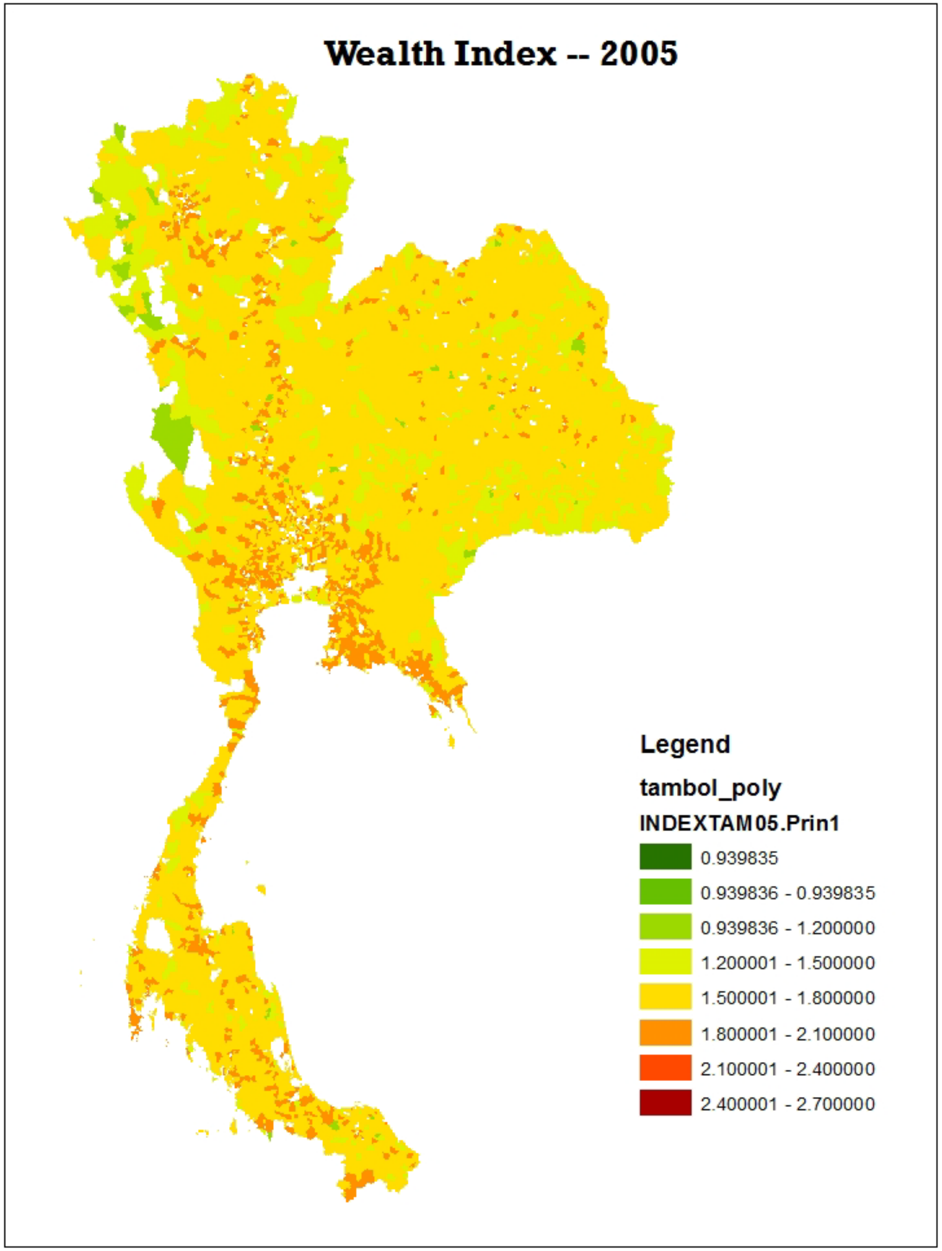
Table: Factor Prices and Occupational Choice

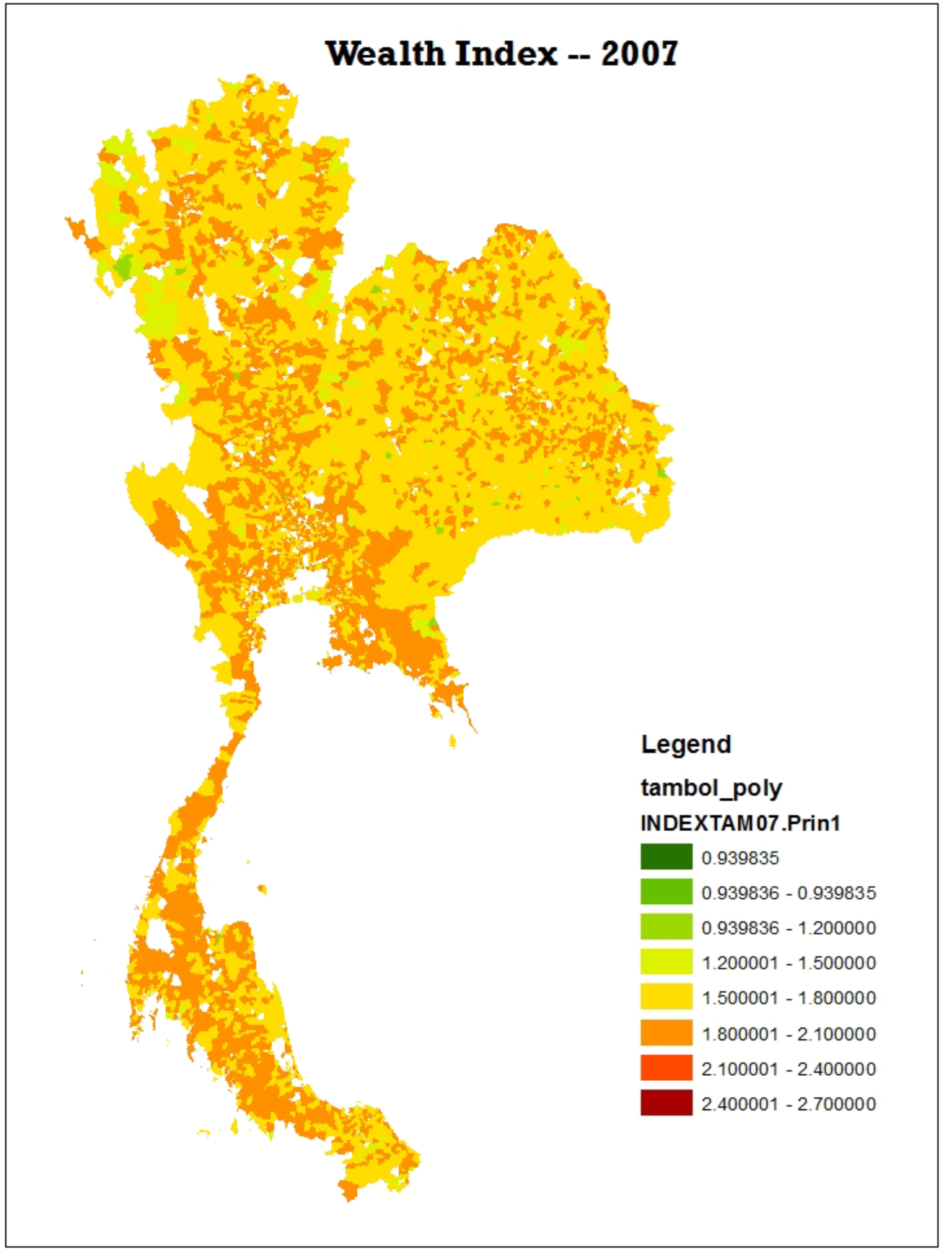
Transition

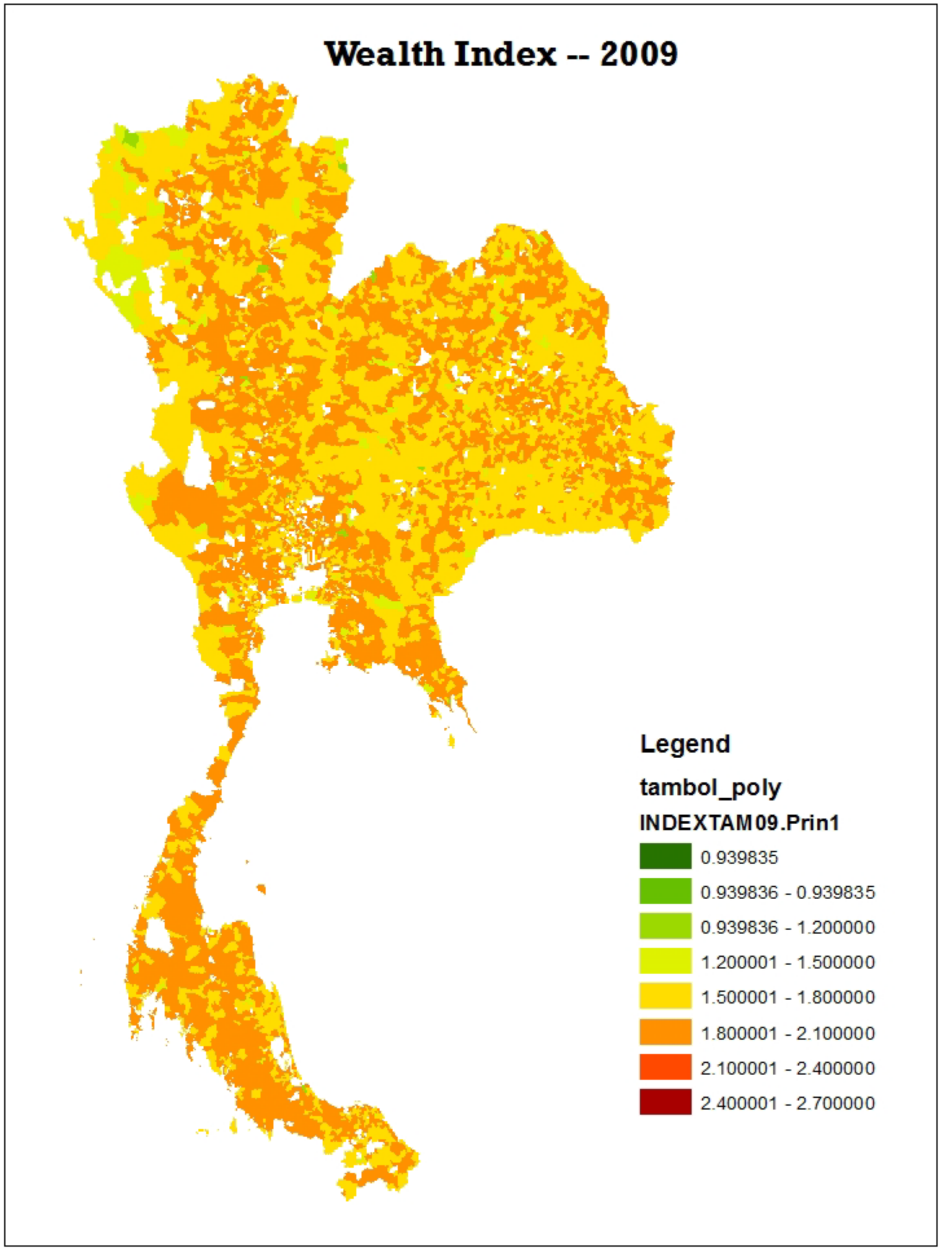
TO BE ADDED



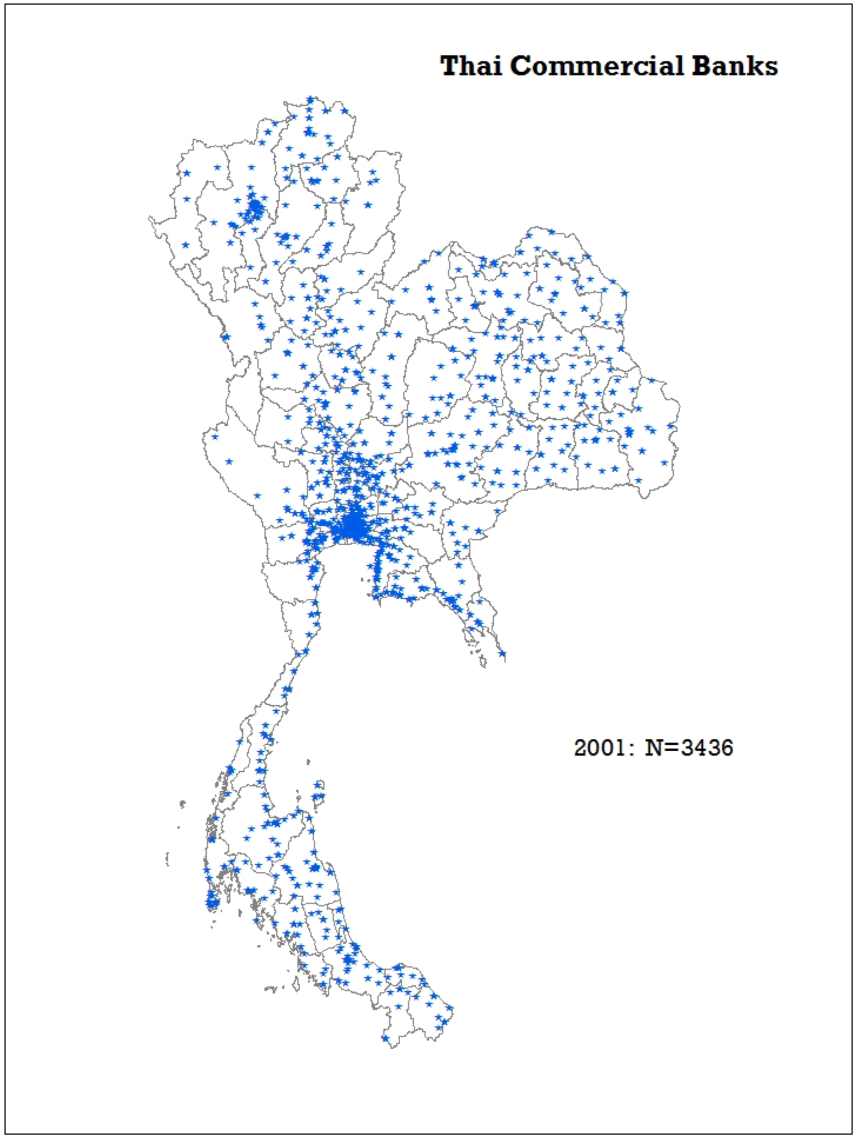
CFSI
Consortiu
Systems a

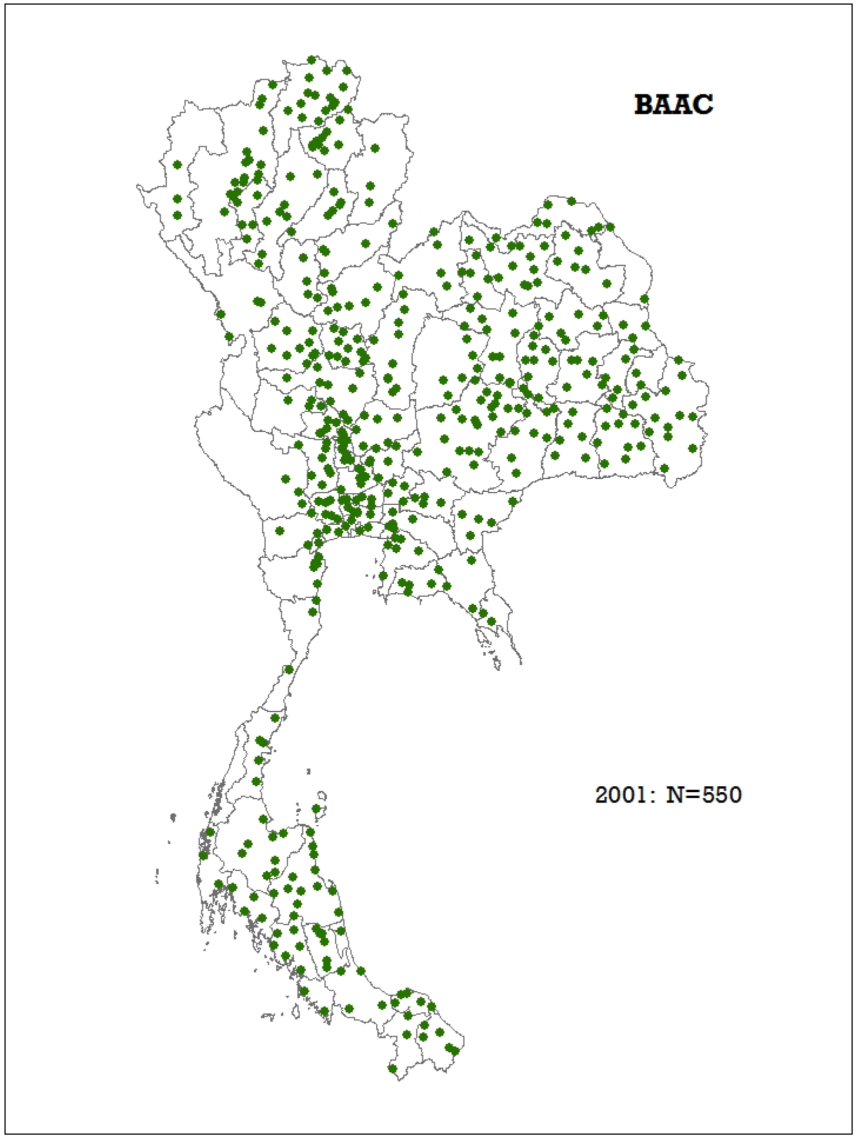

Wealth Index -- 2005
Legend
tambol_poly
INDEXTAM05.Prin1
0.939835
0.939836 - 0.939835
0.939836 - 1.200000
1.200001 - 1.500000
1.500001 - 1.800000
1.800001 - 2.100000
2.100001 - 2.400000
2.400001 - 2.700000


Wealth Index -- 2007
Legend
tambol_poly
INDEXTAM07.Prin1
0.939835
0.939836 - 0.939835
0.939836 - 1.200000
1.200001 - 1.500000
1.500001 - 1.800000
1.800001 - 2.100000
2.100001 - 2.400000
2.400001 - 2.700000

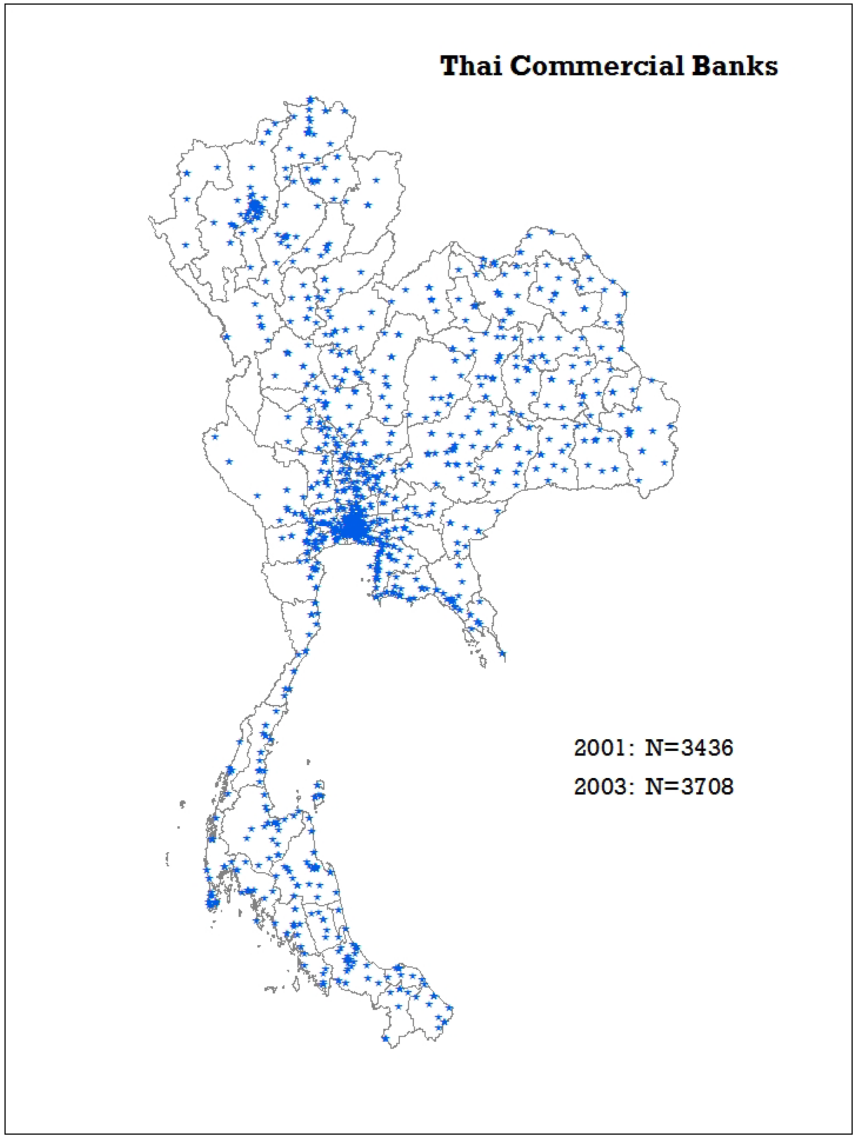

Wealth Index -- 2009
Legend
tambol_poly
INDEXTAM09.Prin1
0.939835
0.939836 - 0.939835
0.939836 - 1.200000
1.200001 - 1.500000
1.500001 - 1.800000
1.800001 - 2.100000
2.100001 - 2.400000
2.400001 - 2.700000

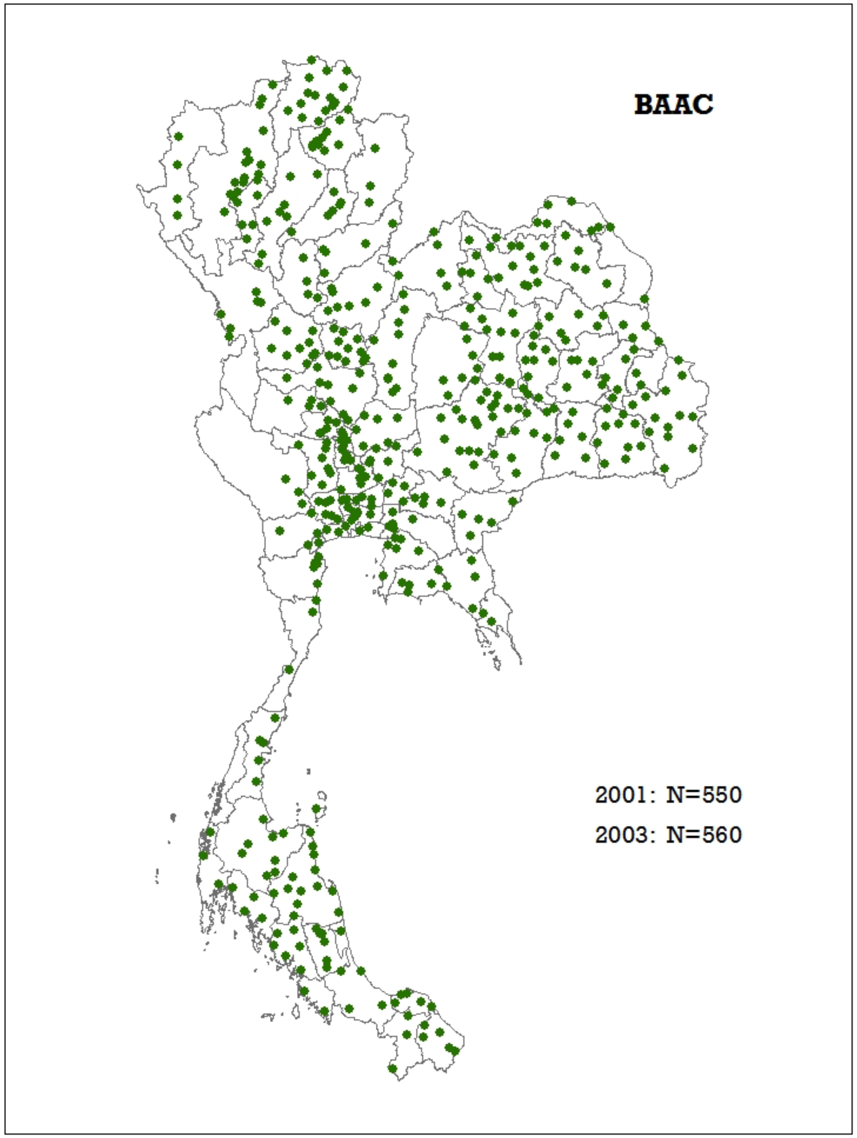
Operating Branches – Commercial Banks vs. BAAC
2001



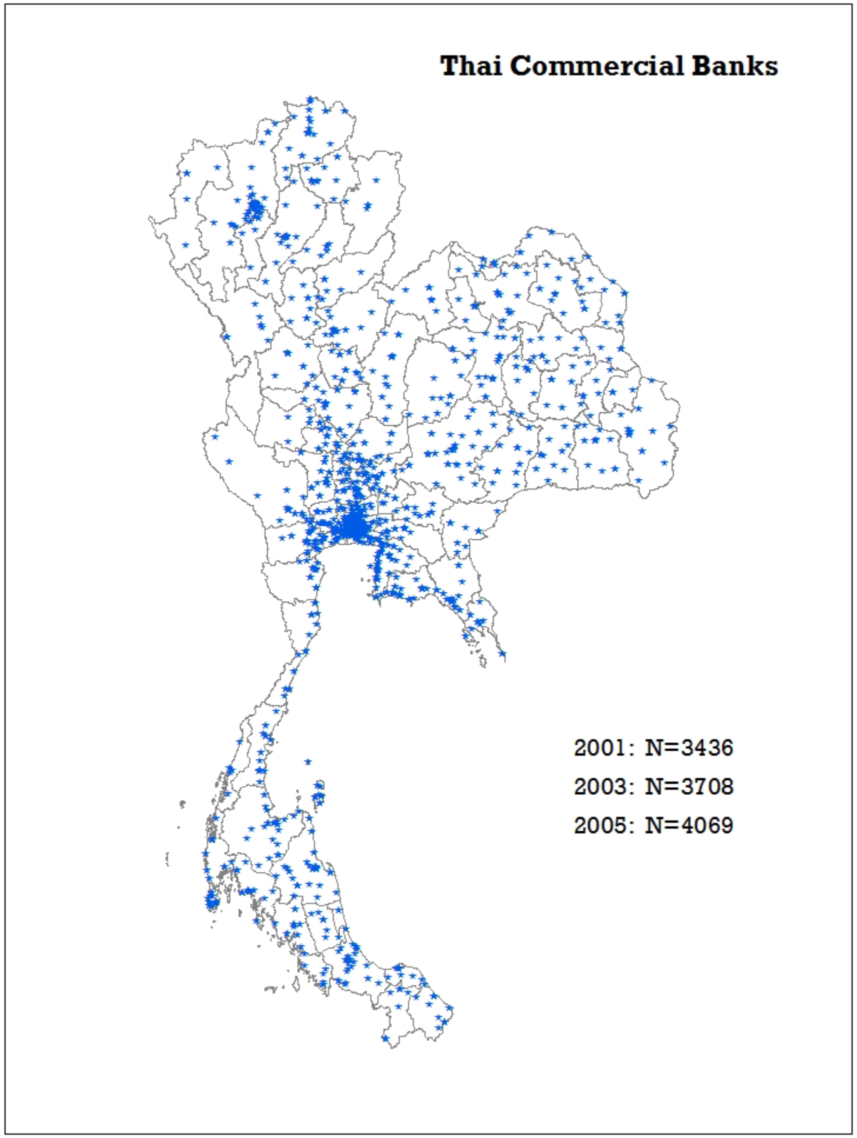


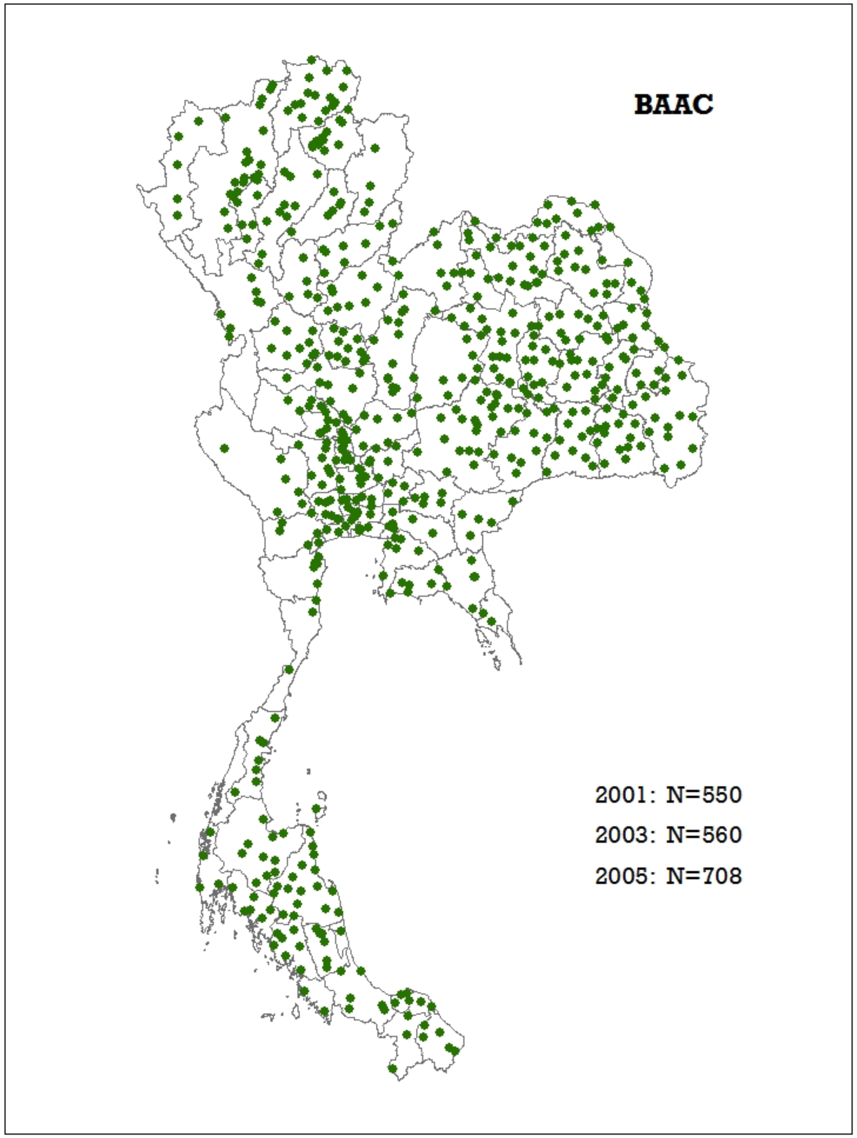
Operating Branches – Commercial Banks vs. BAAC
2003



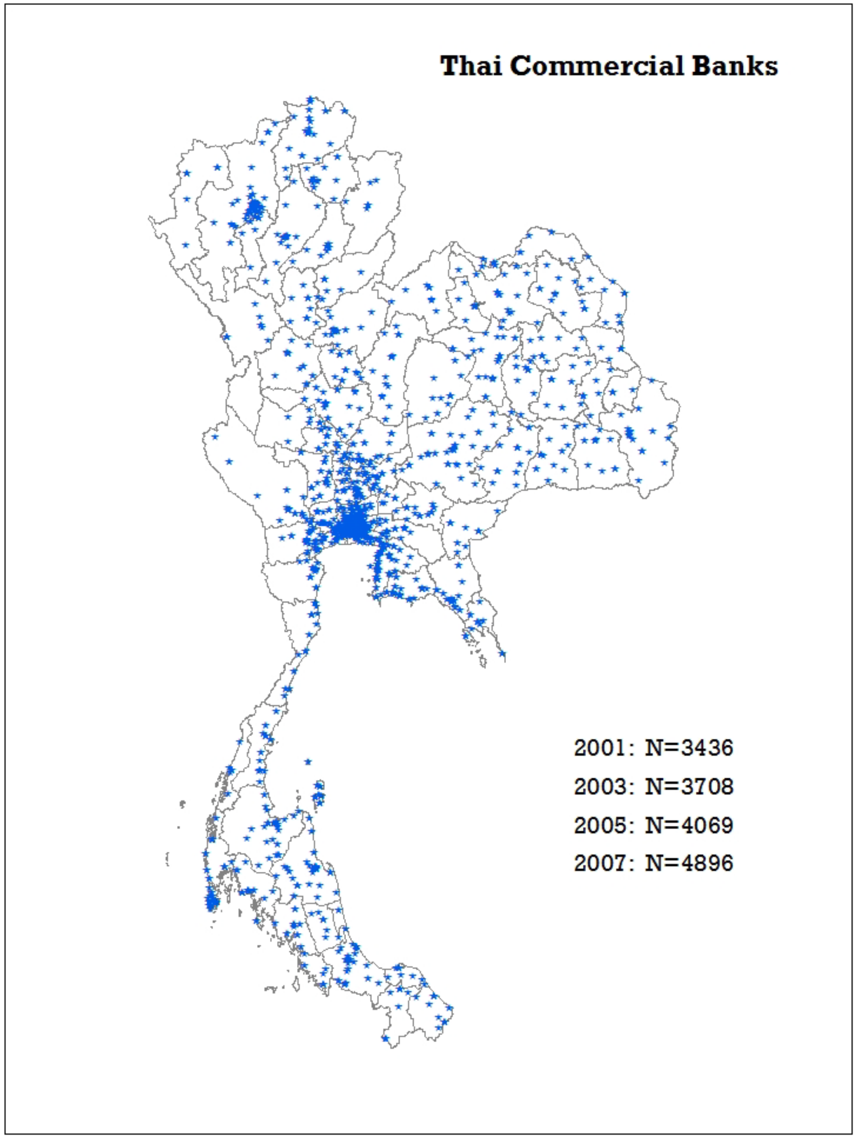


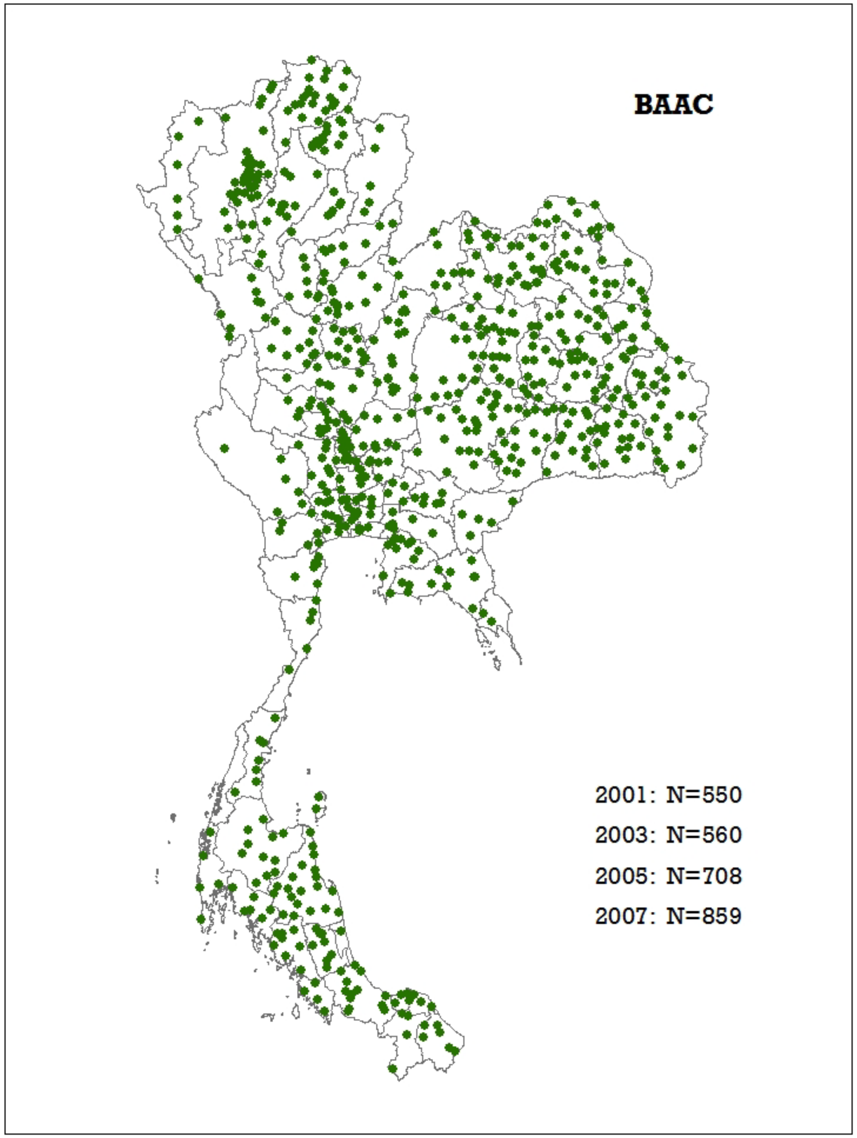
Operating Branches – Commercial Banks vs. BAAC
2005



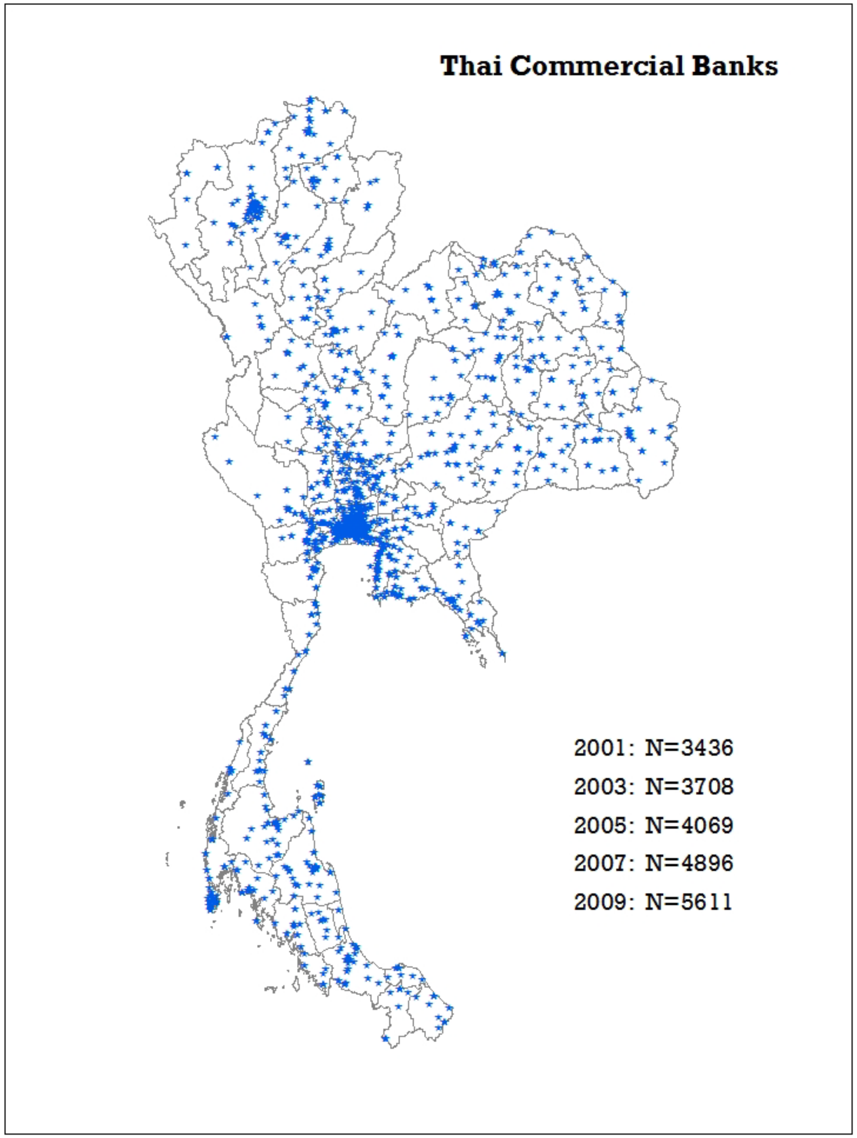


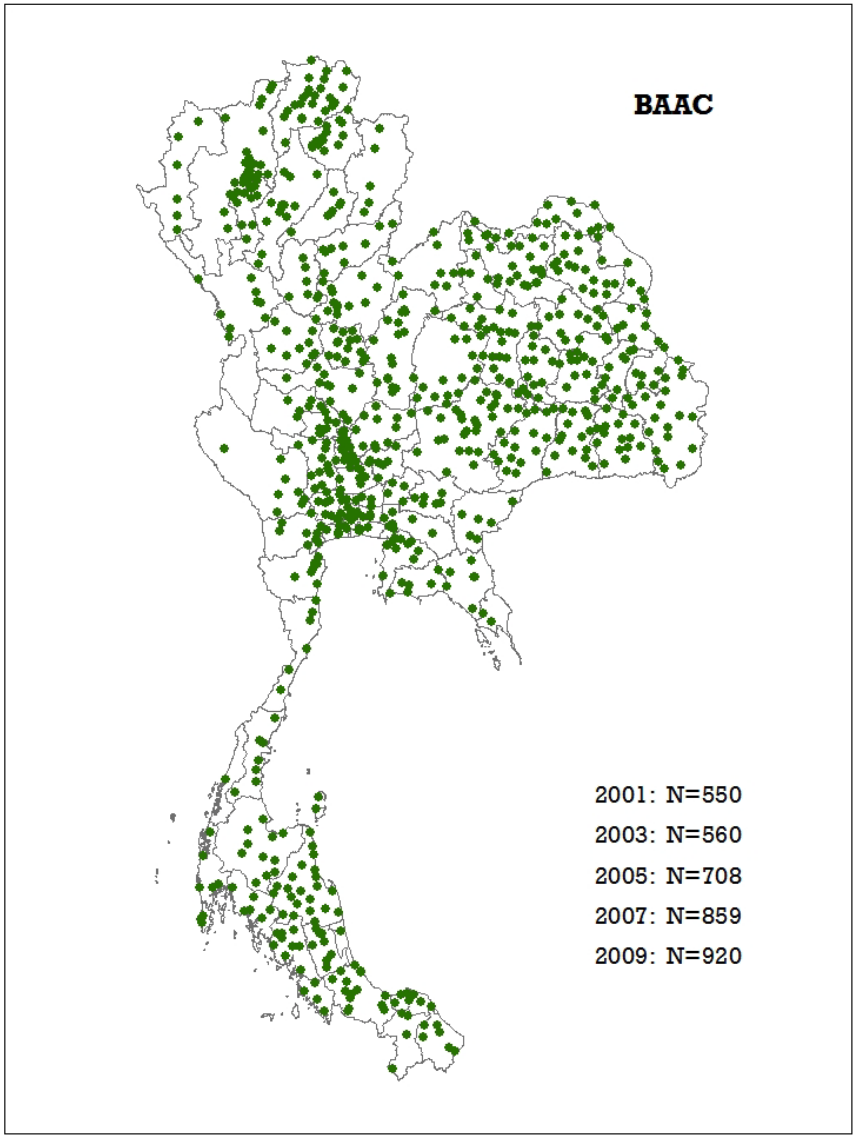
Operating Branches – Commercial Banks vs. BAAC
2007



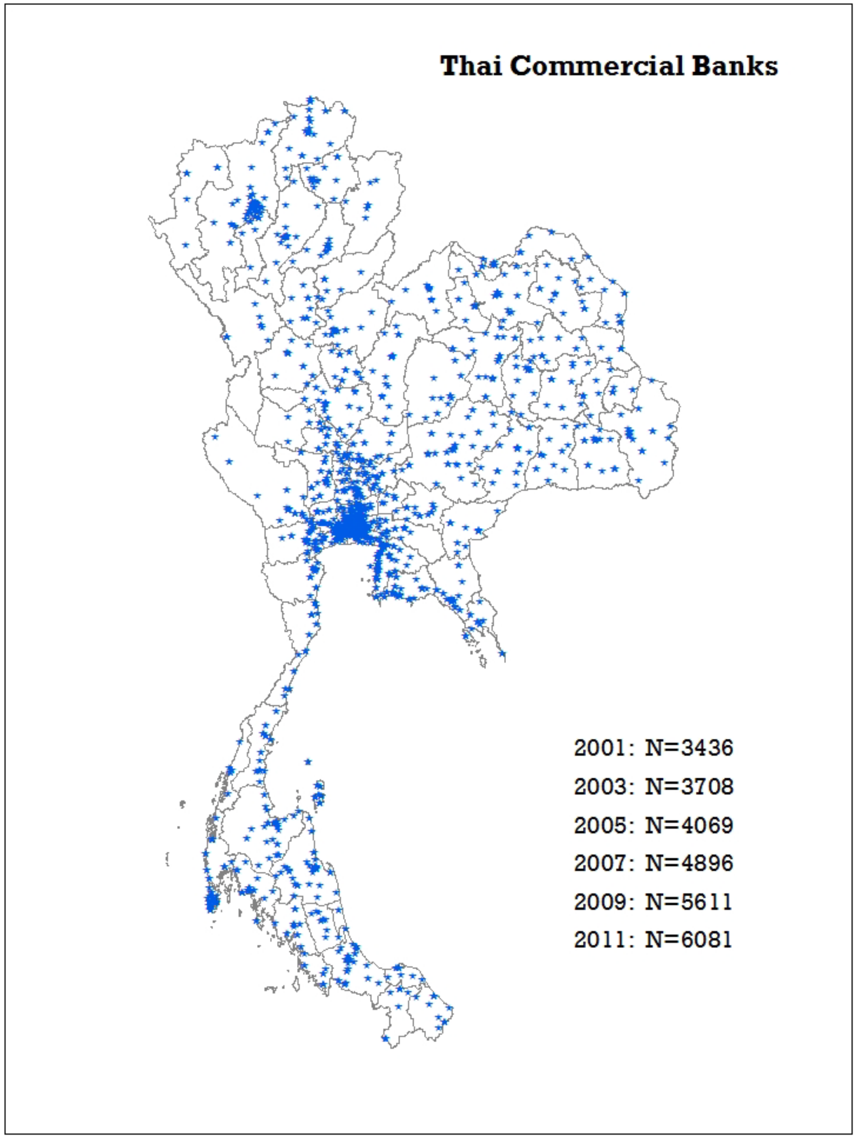


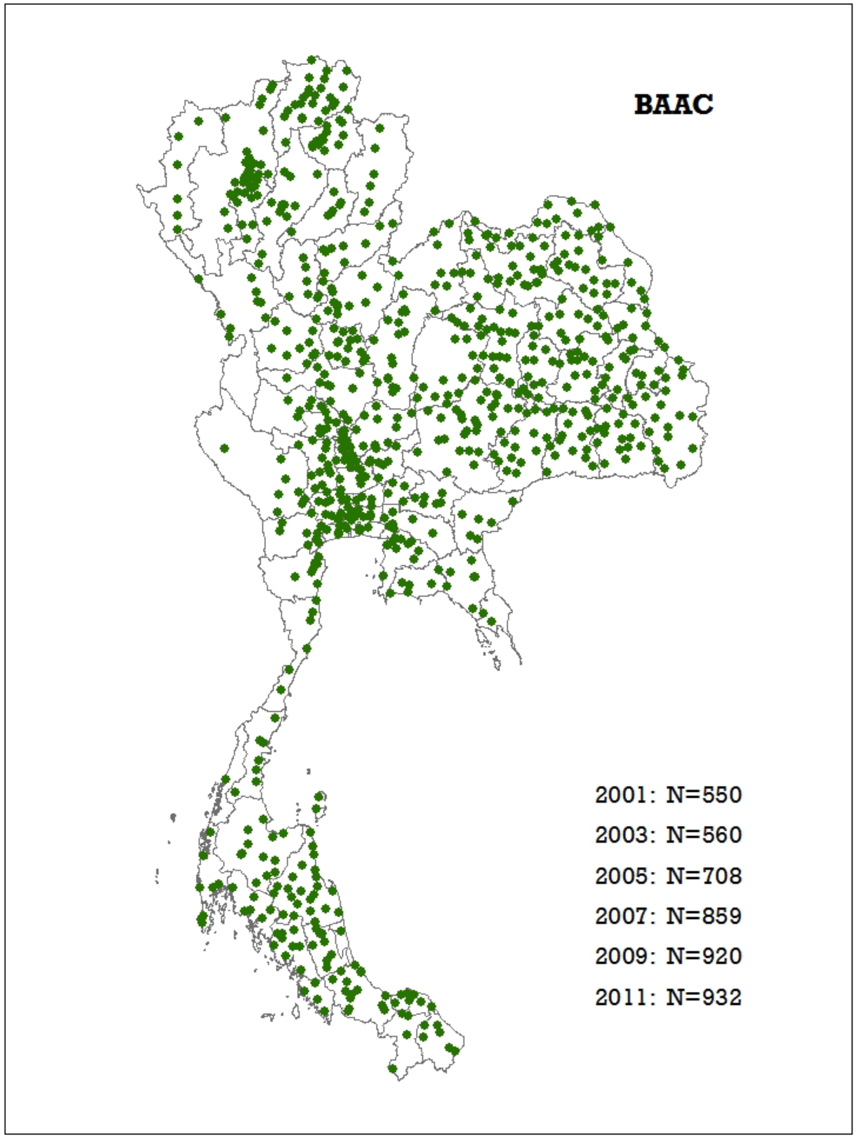
Operating Branches – Commercial Banks vs. BAAC
2009



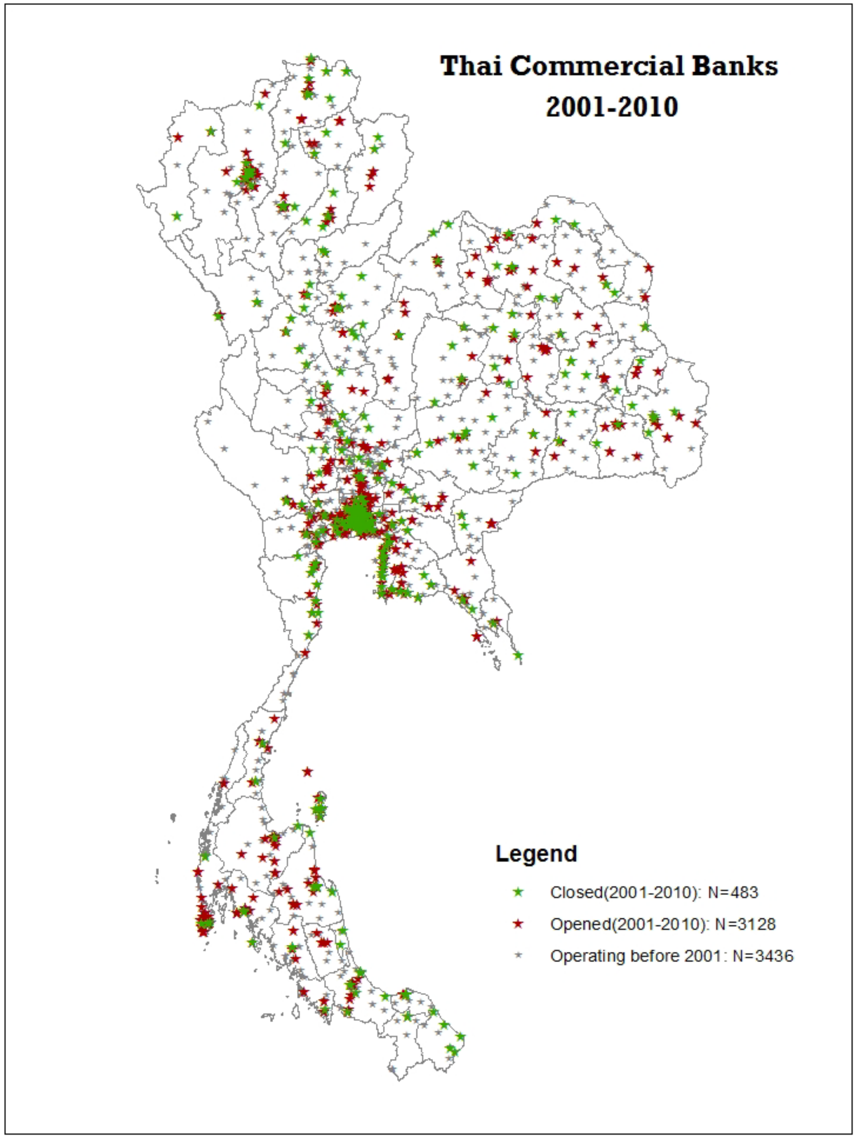


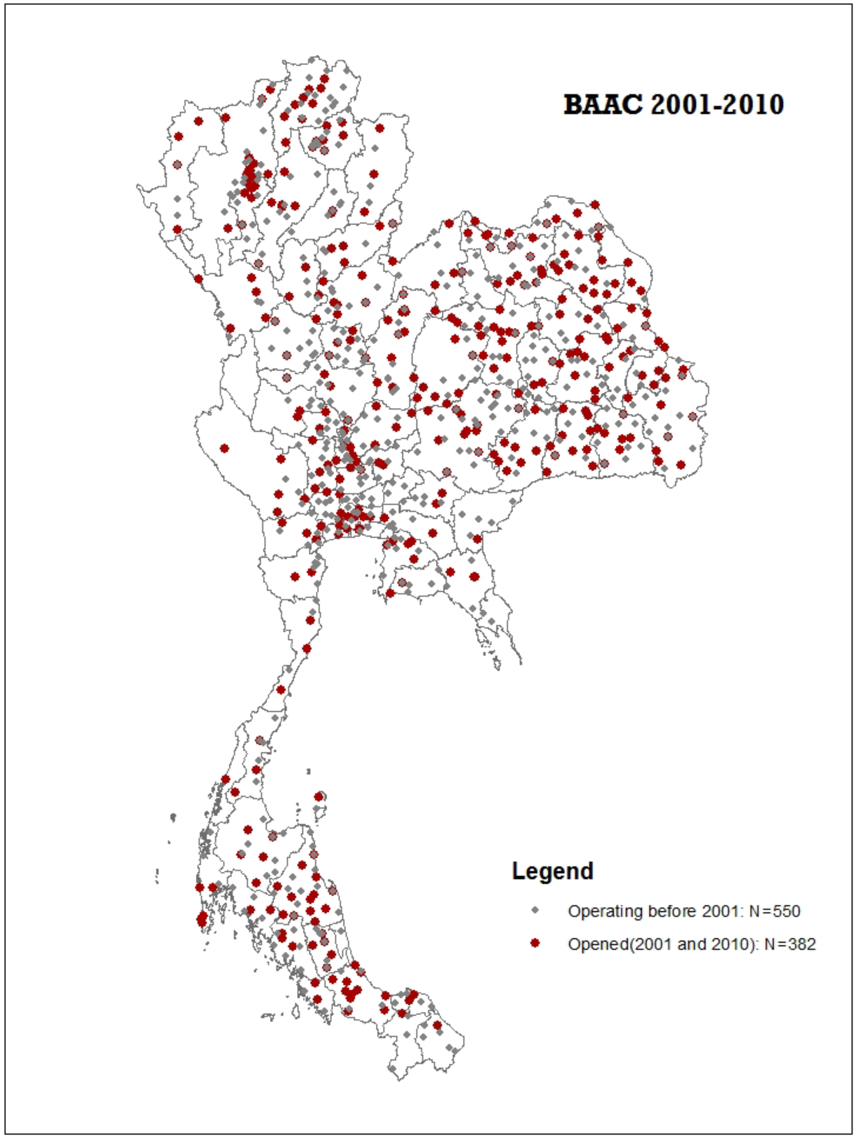
Operating Branches – Commercial Banks vs. BAAC
2011





Opened and Closed Branches
2001-2010





Income decompositions, Inequality next

- Increasing access/use of the formal sector along with high and increasing income differentials
- account for a nontrivial part of growth of per capita income and increasing inequality, albeit with other factors (Jeong thesis)

Characteristics	Overall	Stage 1	Stage 2	Stage 3
Age	0	3	0	0
Gender	2	5	1	4
Community Type	7	17	2	12
Production Sector	18	33	13	21
Occupation	21	39	17	30
Financial Participation	20	23	27	18
Education	25	45	20	24
Joint Three	39	66	38	38
Total Growth	4.96	1.98	8.78	6.94

population shifts

rises again

peak

Big but falling

$$\Delta\mu = \sum_k \overline{p}^k \Delta\mu^k + \sum_k \overline{\mu}^k \Delta p^k$$

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Understanding the evolution

- Key ingredient in Thailand:
  - Expanding financial system

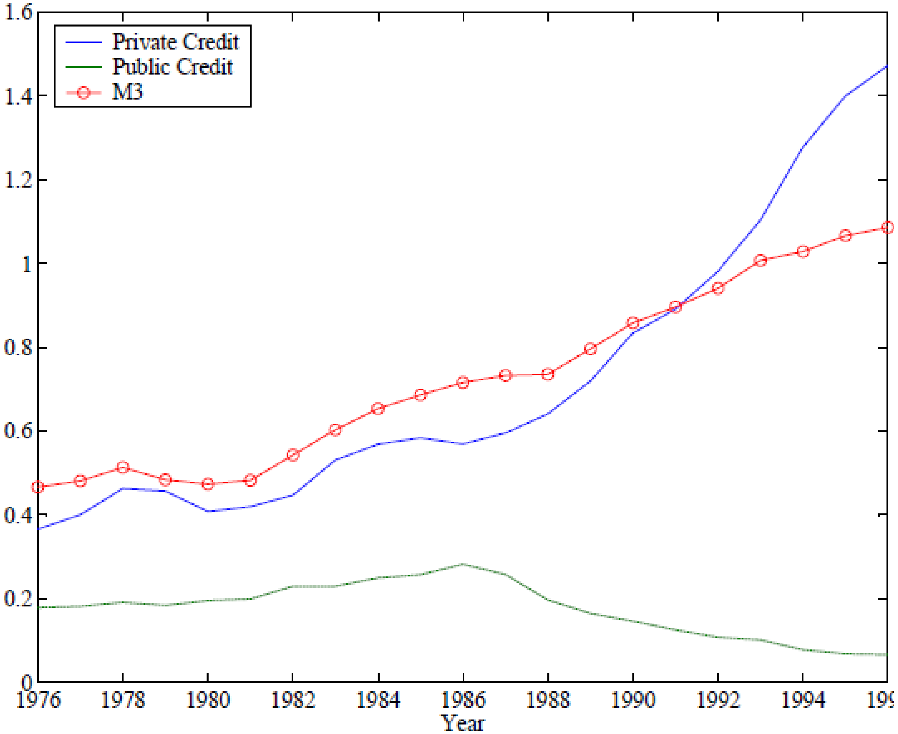

Figure 5. Macro Indicators of Financial Development in Thailand

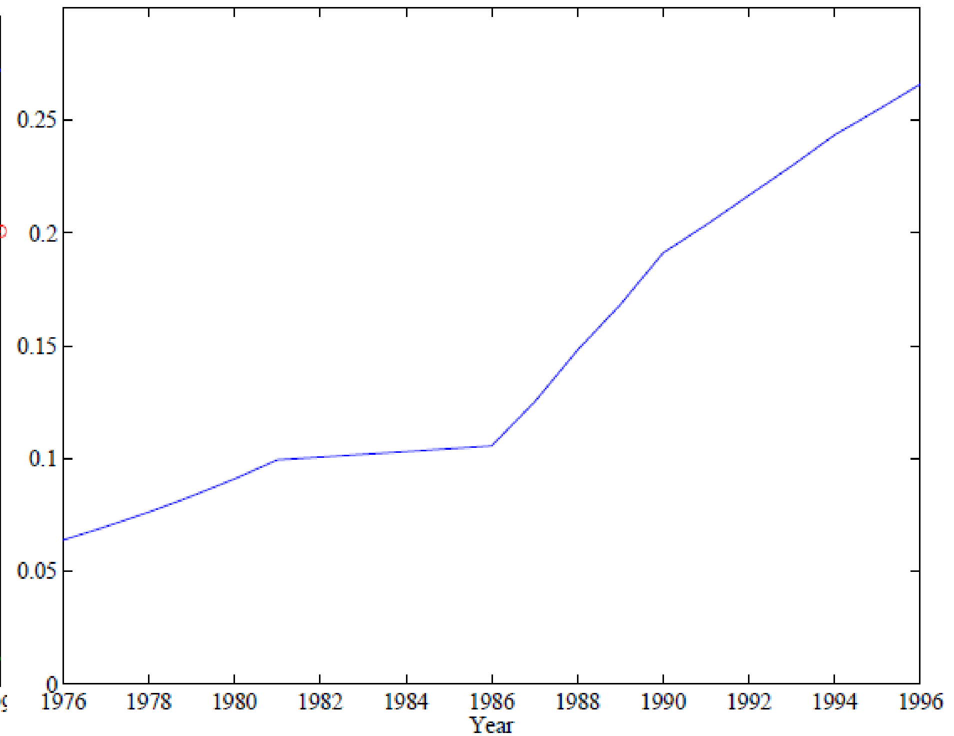

Figure 6. Expansion of Financial Sector in Thailand

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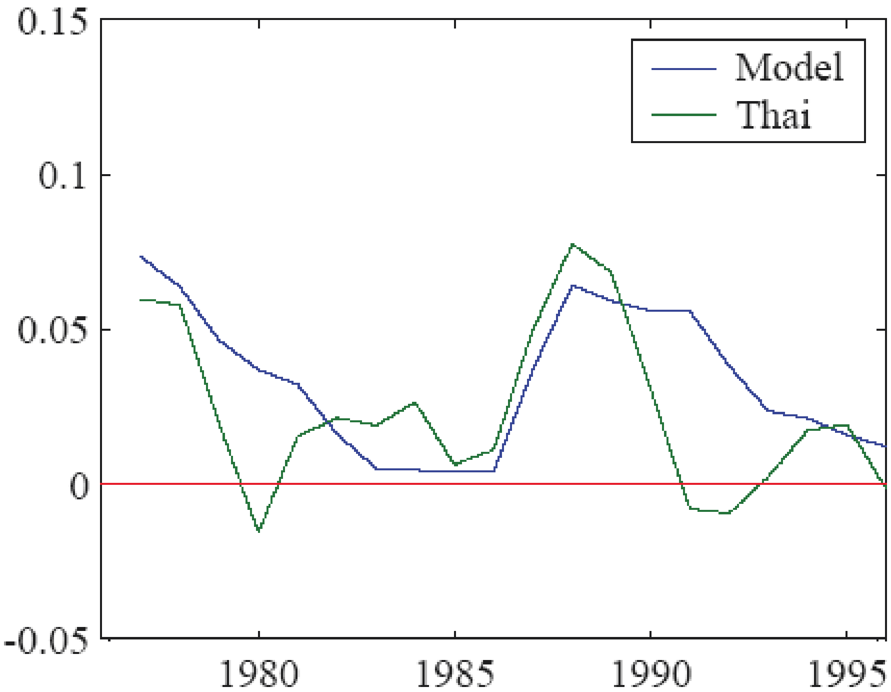
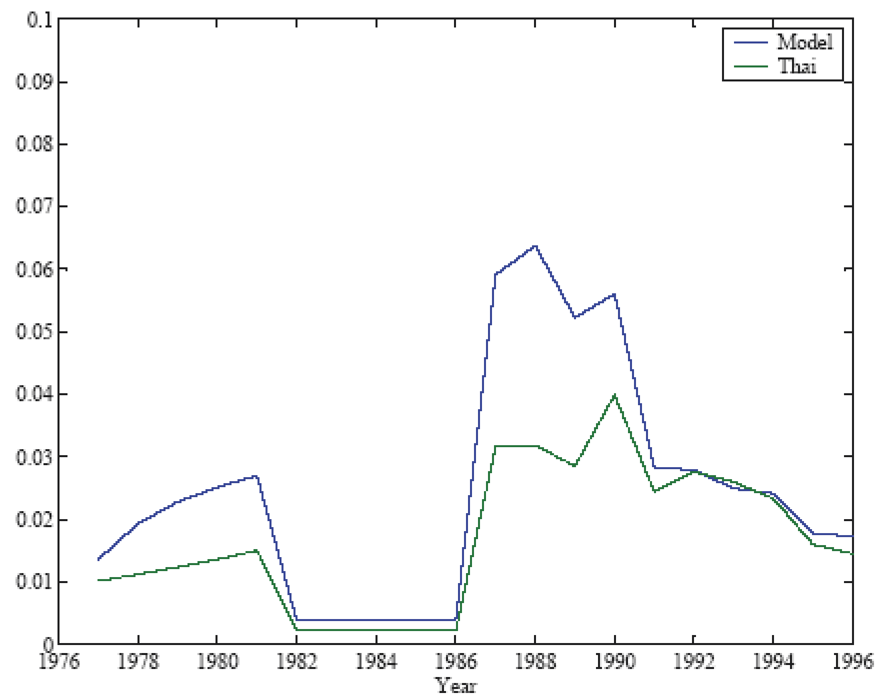
[Jeong and Townsend, 2005]

Thailand– transitional growth and TFP upsurge in financial liberalization

- Macro, total factor productivity is largely explained,
- It is NOT an unmeasured residual aggregate shock
- Access–no access dichotomy is used– (with Hyeok Jeong) through the lens of a model, coming next…





$$TFPG = TFPG\_SSR + TFPG\_ACH + TFPG\_OCCS + TFPG\_FIN$$

$$TFPG\_FIN = \left[s_{Y_2} \frac{\Pi_2}{Y_2} - s_{Y_1} \frac{\Pi_1}{Y_1} \right] pg_p$$

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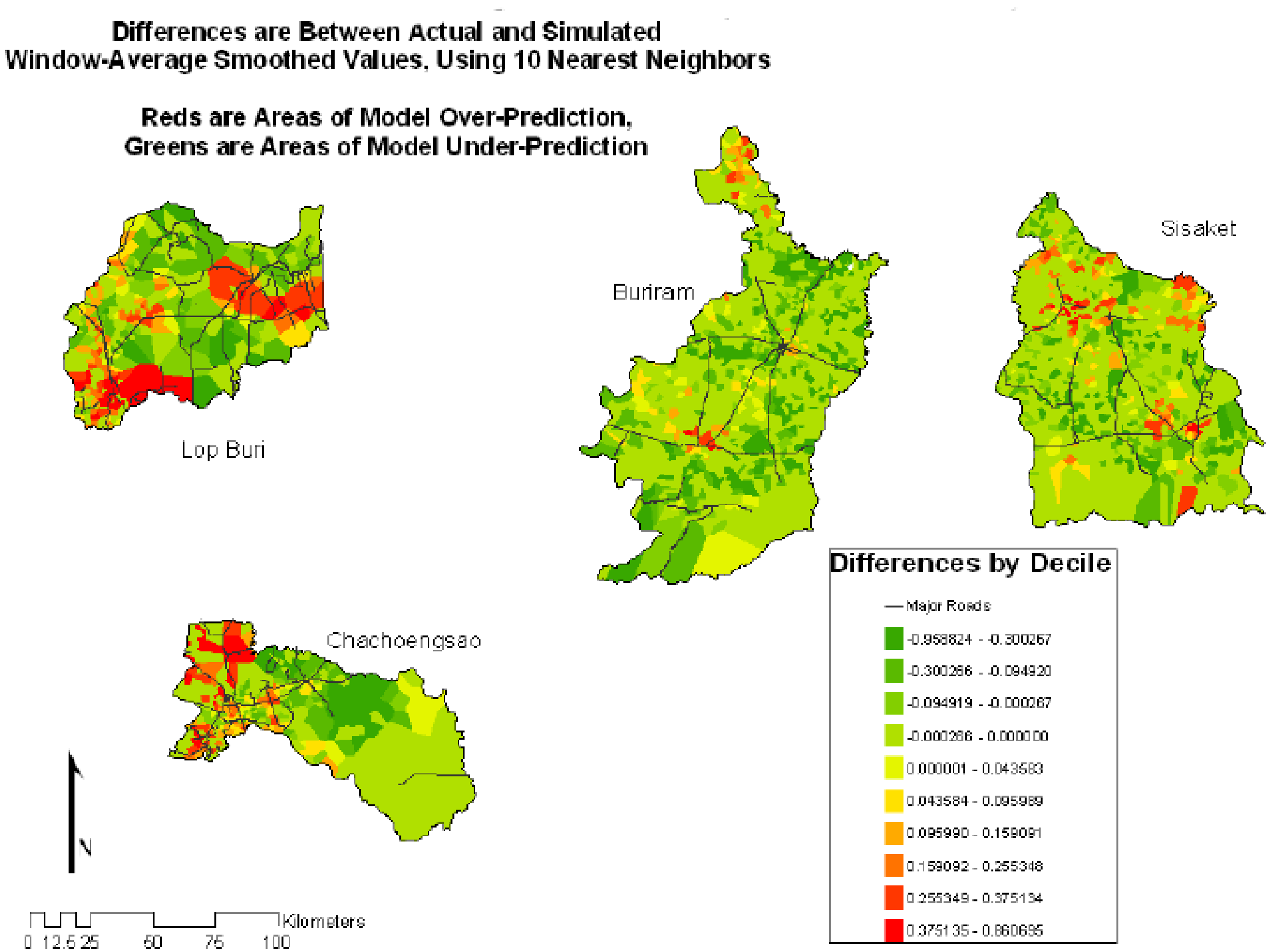
Financial deepening model–Prediction Errors at village level– failure suggest policies distortion



- less intermediation in towns and more in rural areas than model with endogenous access predicts

[1996 GJ Access Index Simulation Differences. Source: Felkner and Townsend (2004)]

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