Chapter 6: Integrated Micro Macro Models with Dual Financial Sectors

This chapter presents the first two micro/macro dual sector models, based on some of the findings of the initial chapters. These first models emphasize occupation/activity choice, with the financial sector either expanding exogenously in one model, imitating the data, or chosen endogenously and growing in a second. Occupation/sector and financial access were key variables as established earlier. Both these models are applied at varying geographic scales: from the macro aggregate economy to regional and village economies and then to households, as anticipated. Success and anomalies are documented.

The first model emphasizes the transitions of households from subsistence agriculture or wage work into the establishment of non-farm enterprise. For the sector without intermediation, this transition is facilitated by pre-determined wealth. Thus, those without wealth will be constrained. The transition into business is also facilitated by talent, which lowers the fixed costs of establishing business. Talent could be related to education. Wealth and talent are the sources of heterogeneity, with measured and unobserved components. Micro, cross-sectional or retrospective data from those not participating in the financial sector allow estimation and identification of the key underlying parameters of the production function and talent distribution. Note the use of micro data to estimate the micro underpinnings. A second sector allows perfect intermediation at an equilibrium interest rate, so that talent, time and factor inputs are used optimally. Unrestricted migration across the two sectors is allowed at an equilibrating wage.

The intermediated sector is given increasing weight over time, exactly as observed in actual participation data. The savings rate and cost of living parameters are calibrated. Then, given an estimate of the initial distribution of wealth, as observed in cross section data, the model is simulated over time, delivering an endogenous interest rate and wage rate, the evolving distribution of wealth, GDP growth, labor share, and the fraction of entrepreneurs. Simulations illustrate the importance of financial liberalization to observed growth spurts and deliver simultaneously the distribution of gains and losses to liberalization in the population. This is the first assessment in the book of the impact of financial policy variation, here through the lens of this structural model. Similar counterfactual model experiments show that foreign capital inflows were not the big driver of growth. Similarly, the informal sector adds little. A decomposition of total factor productivity growth using the explicit micro underpinnings shows that financial deepening explains much of that widely used macro residual.

A second model emphasizes the information and risk-sharing advantages of the formal financial sector, imagined again to be perfect for those with access but quite limited for those without access, not inconsistent with the data. Fixed and marginal transactions costs yield a wealth threshold below which households remain in autarky, smoothing idiosyncratic and aggregate shocks with accumulated wealth, diversifying into safe and risky activities. Wealth again is a key variable determining who is constrained, but the predicted path is Pareto optimal given transactions costs. Rates of returns, the range of shocks, risk aversion, the preference discount rate, and transactions costs are either calibrated or estimated, with the scale of fixed costs determined by the initial distribution of wealth and participation data. Note again the use of micro data to estimate underpinnings. Simulations of growth, inequality, and financial participation establish that the model can explain well the observed trends in the featured macro facts, but not the spurt in the growth rate at the time of financial liberalization. Incorporating financial sector policy as a prior distortion allows an estimate of the distribution of gains to liberalization: these favor the middle class. This is the second assessment of the gains to financial sector liberalization, again though the lens of a structural model. Related, the model tends to over predict financial deepening for the educated and urban population, as if there were policy restrictions with unintended consequences. Note the use of the model with micro data to assess financial sector distortions.

Both these dual sector models are estimated and simulated at the village level, for the four provinces of the original Townsend Thai surveys. These provinces display interesting patterns in the concentration of wealth, enterprise, bank access, and transportation infrastructure as noted earlier. Both models do well with temporal trends. The occupation choice model also does well with spatial and reduced forms patterns if the cost of business entry is inversely proportional to distance from "hot spot" agglomeration centers. New roads have a large impact on regional development. The endogenous financial participation model allows estimation of entry costs which vary across space and by financial provider. But costs are estimated to be lower for those far from main roads and lower for those using the Bank for Agriculture, revealing again an apparent distortion and/or targeting. Wealth redistributions can slow down growth in urban centers.

The occupation choice and financial access choice models are estimated again with the SES income and expenditure cross-sectional survey and taken to the growth and inequality decompositions featured in the introductory chapters. The models, though occasionally off in levels, do well with temporal trends and do well qualitatively with the decompositions. Aspects of the end-of-period simulations match well the observed distributions of income. But the models overemphasize the financial access or occupation dichotomies relative to the data, which have much more within group diversity and less of a difference across sectors. In the data, there is more co-movement across occupation wage/firm groups and across financial access, no-access groups than in the models. The models also overdo the

financial dichotomy: there are more firms in the data in the non-intermediated sector than a dichotomous model would imply, and likewise less risk-sharing in the data in the intermediated sector than the model would imply. The access/no access dichotomy will be further scrutinized below.

6.1 Occupation Choice – Financial Sector Exogenous

6.1.1 Review of the Key Facts

To review, Thailand experienced relatively rapid growth between 1950 and 1997. This is associated with an increase in inequality countered by an eventual rise in the wage and labor share, even for the low skilled. There has been a steady exit from agriculture into non-farm wage employment and non-farm enterprise. Wealth seems to constrain the relatively poor away from non-farm enterprise. Many enterprises operate on a small scale. There is a high if not increasing level of savings. The financial system has expanded, as measured by traditional macro ratios and micro access surveys. Measured TFP growth has contributed, apparently, but TFP growth is often negative in time and sector decompositions.

6.1.2 The Model

The basic building block of the model at the micro, household level is the choice of occupation. A household has income γ in subsistence agriculture, wage w in (unskilled) employment, and profits π in non-farm enterprise. The latter is determined by choice of hired unskilled labor l and utilized capital k

$$\pi(b,x,w) = \max_{k,l} f(k,l) - wl - k$$
$$s.t. \ k \in [0, b-x], \ l \geq 0$$

Specifically, let $f(k,l) = \alpha k - \frac{\beta}{2}k^2 + \xi l - \frac{\rho}{2}l^2 + \sigma lk$. Then $l(b,x,w) = \dfrac{\sigma k(b,x,w) + (\xi - w)}{\rho}$ and

$k(b,x,w) = b - x$ if constrained or $k(b,x,w) = \dfrac{\rho(\alpha - r) + \sigma(\xi - w)}{\beta\rho + \sigma^2}$ otherwise.

Note that there is no access to credit; also capital must be self-financed, that is, $k \leq b - x$ where b is initial, beginning-of-period, predetermined wealth and x is a fixed set up cost for going into business. The latter is imagined to be unobserved to the econometrician/analyst, but known to be distributed in the population according to density $h(x,m)$. Each household has to know its own x before choosing, so x along with wealth b ids the key pair of state variables. Wage w is vital and also exogenous. The cumulative distribution of x in the population is:

Draft: July 2010

$$x \sim H(x,m) = (1-m)x + mx^2$$

When $m = 0$, this distribution is uniform, when m<0 it is tilted to the left, and $m > 0$, tilted to the right.

End-of-period resources consist of earnings from a chosen occupation, plus what is left of initial wealth, so that

$$W(b,x,w) = \begin{cases} \gamma + b & \text{if a subsistence worker,} \\ w - \eta + b & \text{if a wage earner,} \\ \pi(b,x,w) - x - \eta + b & \text{if a firm} \end{cases}$$

is the array of choices. Here η is an additional disutility cost of leaving subsistence agriculture. End of period utility $U(C,B) = C^{1-\omega}B^{\omega}$ is maximized by choice of consumption C and savings B for next period. That way, ω is the saving rate out of end-of-period wealth.
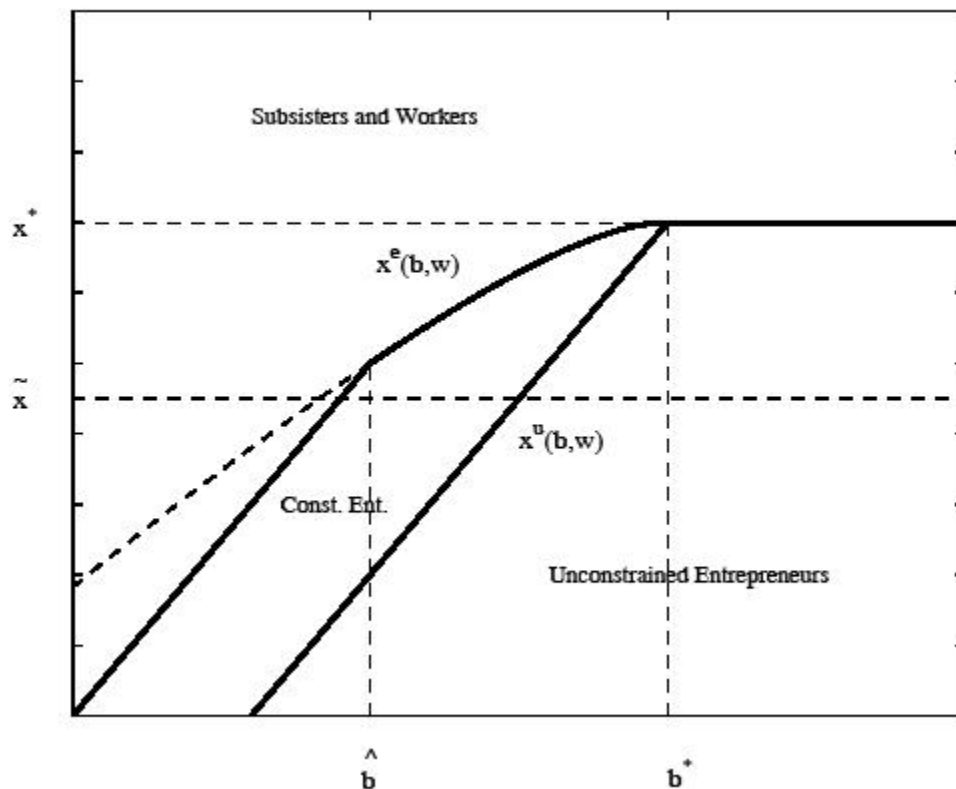
[Figure 6.1.2.1. Occupation Choice Map. Wealth facilitates entry into business, facilitates investment of existing businesses (ROA). Source: Giné and Townsend (2004)]

The original model is taken from Lloyd-Ellis and Bernhardt, but it is representative of occupation choice models in the literature. See Banerjee and Newman (1993), Matsuyama (2001), Aghion and Bolton (1997). It is modified by Giné and Townsend (2004). Again, the key beginning-of-period state variables capturing heterogeneity for the household are initial wealth b and set up cost x. See Figure 6.1.2.1. Intuitively, there is a region of high cost and low wealth households who choose to be subsistence wage earners. Note that in equilibrium, with some population left in subsistence agriculture, $w - \eta = \gamma$, and thus we can collapse the wage and subsistence sectors into one: households will either be indifferent or the entire subsistence agricultural sector will be depleted. On the other extreme, there is a region of low cost, $x < x^*$, high wealth, $b > b^*$, households who will be running firms at the scale l^* and k^* as if they can hire labor and utilize capital at wage w and implicit zero net interest rate, $1 + r = 1$, the rate at which resources at the beginning of the period can be carried over in the back yard to resources at the end of the period. There is also a region of constrained firms with wealth and setup costs such that $k = b - x < k^*$. These firms hire a limited number of workers, if any, and have limited capitalization. They would also appear to have high rates of return as measured by the average yield $\frac{y}{k}$, or ROA. The "curve of indifference" $x^e(b, w)$ marks the combinations of wealth and cost pairs under which a household is indifferent between subsistence/wage work and profits from enterprise, and $x^u(b, w)$ marks the margin at operating at unrestricted scale k^*. It is important to note that most firms will not be indifferent, that is, will have profits π over and above the opportunity cost of foregone earning w.

If there were perfect credit markets, that is, a market clearing interest rate r at which households and firms could borrow and save as much as they wanted, then occupation choice would not depend at all on initial wealth b. This is a typical, neoclassical result. There would be complete separation between the production and consumption activities. Firms operated by households maximize profits, as would any firm. Here, without other sources of heterogeneity in production by type or sector, all firms operate at a common scale $k^*(w, r) = \frac{\rho(\alpha - r) + \sigma(\xi - w)}{\beta\rho - \sigma^2}$, and hire identical labor $l^*(w, r) = \frac{\sigma k^* + (\xi - w)}{\rho}$. All have marginal ROA = r, that is, rates of internal and external returns are equated, at a common market clearing interest rate. There would be a critical level of cost $\tilde{x}(w, r) = \frac{f(k^*, l^*) - wl^* - rk^* - w}{r}$, below which all households would be entrepreneurs. Thus, only talent matters in occupation choice, not initial wealth, and only talented households are running firms. In comparison to the non-intermediated sector, low

wealth households are more likely to be firms, but high wealth low talent households are more likely to be savers, to put their money in the bank rather than operate an inefficient enterprise.

What we see in a cross sectional retrospective Townsend Thai panel is the initial wealth b of households in 1992, and whether they choose to enter business in some specified interval of time, between 1992 and 1997. The occupation diagram with costs x uniformly distributed, that is $m = 0$, tells us in a straightforward way the fraction of households who are predicted to enter business. According to the model, those entering business at initial wealth b are those with costs less than $x^e(b, w)$. This is just the vertical distance from zero up to the $x^e(b, w)$ curve of indifference. Note this probability is increasing in wealth b, for example. Less obvious from the diagram, the curves shift up when the wage w decreases.

More formally, let $y_i = 1, 0$ denote the binary choice of household i for setting up an enterprise, or not. The probability that $y_i = 1$ is $\Pr\{y_i{=}1\}{=}\Pr\{x_i \leq x^e(b_i, w)\}$. The log likelihood for a sample of n households is then written as:

$$\log L = \sum_{i=1}^{n} \{y_i \ln[\Pr\{x_i \leq x^e(b_i, w)\}] + (1 - y_i) \ln([1 - \Pr\{x_i \leq x^e(b_i, w)\}])\}$$
where
$$\Pr\{x_i \leq x^e(b_i, w)\} = (1 - m)x^e(b_i, w) + mx^e(b_i, w)^2$$

MLE results

	SES		Townsend-Thai	
	Coefficient	S.E.	Coefficient	S.E.
Scaling factor				
s^a	1.4236	0.00881	1.4338	0.03978
Subsistence level				
γ	0.02744	0.00119	0.01538	0.00408
Fixed cost distribution				
m	-0.5933	0.05801	0.00559	0.17056
Technology				
α	0.54561	0.06711	0.97545	0.00191
β	0.39064	0.09028	0.0033	0.00013
ρ	0.03384	0.00364	0.00966	0.00692
σ	0.1021	0.02484	0.00432	0.00157
ξ	0.2582	0.03523	0.12905	0.04146
Number of observations	24,433		1272	
log-likelihood	-8233.92		-616.92	

^{a} The parameter value and standard error reported are multiplied by a factor of 10^6.

[Table 6.1.2.2 MLE Results: Estimation from Two Data Sets. Source: Giné and Townsend (2004)]

In cross sectional SES data we imagine we are seeing (estimated) wealth at the beginning of the period and occupation choice at the end of the period, on the assumption that wealth moves slowly with the life cycle, as in the data. That is, the wealth/enterprise profile is meant to have an implicit causality running from initial wealth to subsequent enterprise and not the other way around.

If there is variation in the wage rate over time, or alternatively the Northeast and Central regions of Thailand are not well linked by migration, as if self-contained regional economies, then there are two sets of curves in the occupation choice diagram and all the underlying parameters of technology can be identified from the micro data. We also need to estimate a scale parameter which converts Thai baht into model units.

Parameters such as the cost of living η, savings rate ω, and potentially exogenous growth in subsistence income γ_{gr} are not obtained from micro data but rather are calibrated. The model is simulated as below, getting the best possible fit to five "macro" time-series variables z^{ec} : GDP growth, inequality, the savings rate, the time varying fraction of entrepreneurs, and labor share. The mean square error criterion for best fit is the squared difference between the model estimated z^{sim} and actual economy z^{ec} variables z , normalized by actual means μ_z . That is the calibration metric is

Draft: July 2010

$$C = \sum_{s=1}^{5} \sum_{t=1976}^{1996} w_{st} \left[\frac{z_{st}^{sim} - z_{st}^{ec}}{\mu_z} \right]$$

Table 6.1.2.2 displays the set of estimated parameters from the Townsend Thai and SES data, as well as those obtained when all parameters are calibrated. The standard error bands indicate the potential range of parameter values at a 95% confidence interval, obtained from bootstrap estimation, drawing the sample repeatedly from an urn with replacement.

The LEB (Lloyd-Ellis-Bernhardt) model is simulated using the computer programs of Giné and Townsend (2004). At every date there is a distribution of beginning-of-period wealth, presumed to lie on some a priori grid. Guessing a wage, along with using the estimated parameters of technology, the regions of the occupation partition are pinned down. The distribution of talent then determines the fractions of the population choosing to be workers, subsisters, or entrepreneurs at each level of wealth. Adding up over all wealth levels, these population fractions should sum up to one, and otherwise the labor market does not clear. This procedure is repeated to find an equilibrium wage in a bisection algorithm. The end-of-period wealth is determined.

A fraction ϖ of this wealth is saved, and this determines next period's distribution of beginning-of-period wealth. The distribution of setup cost for entrepreneurs adds additional diversity. The lower endpoint of the wealth distribution is the wealth of the household in the previous period who had least beginning-of-period wealth and the lowest talent (highest setup cost), and the upper endpoint is associated with the household in the previous period who had the highest beginning-of-period wealth and the highest talent (lowest setup cost). The initial condition of the model is the estimated initial distribution of wealth. Here we take the 1976 SES wealth distribution, scaled by the chosen wealth scale for converting Thai baht into model units, s, determined also in the estimation, as the initial wealth distribution for simulation. One period in the simulation corresponds to one year in the data.
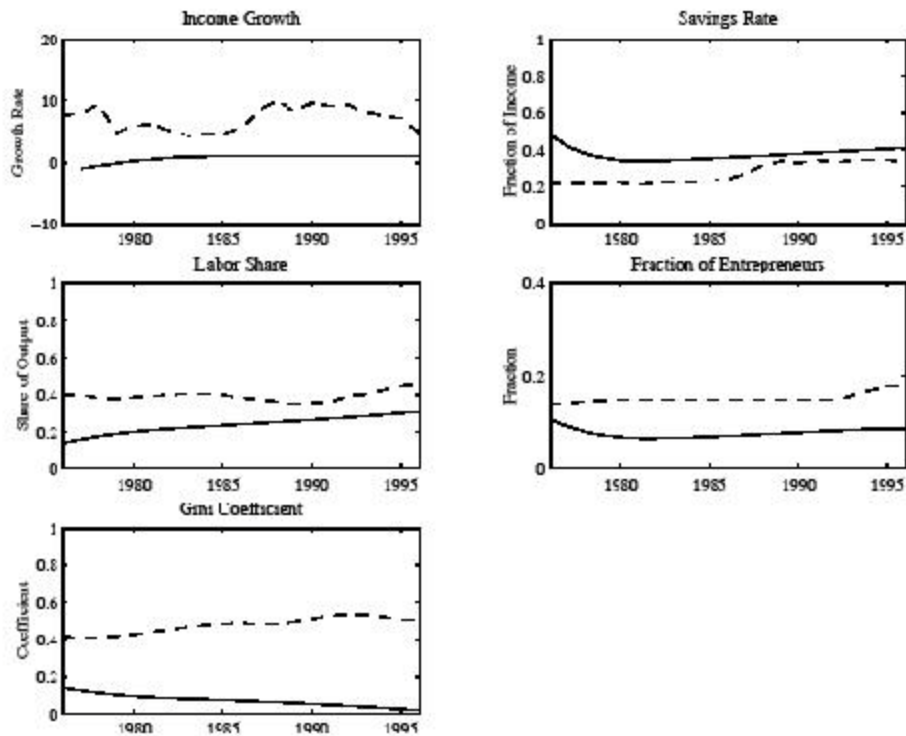
[Figure 6.1.2.3. Benchmark Model Best Overall Fit (SES Data). Legend: --- Thai Economy (dotted), Simulation (solid). Source: Giné and Townsend (2003)]
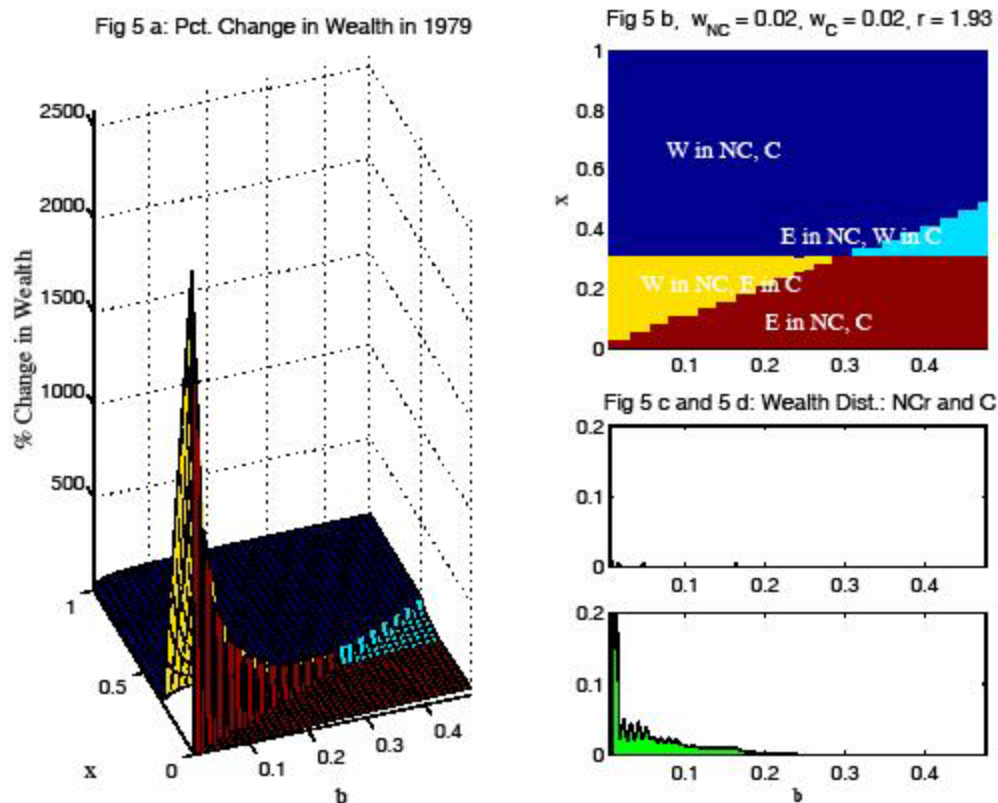
The model without a financial sector fails to explain much of the data even when ω, γ_{gr} and η are calibrated to allow the model to do as well as possible. As illustrated in the figure for the parameters estimated from SES data, the model's growth rate is low, virtually zero. The savings rate matches better, via calibration. Labor share is rising, as it does eventually in the data, but it is too low. The fraction of entrepreneurs and the Gini measure of inequality are both low as well, and the latter decreases in the model simulation, unlike the data. Behind the scenes, the model is converging to one with many people in subsistence agriculture with common earnings.
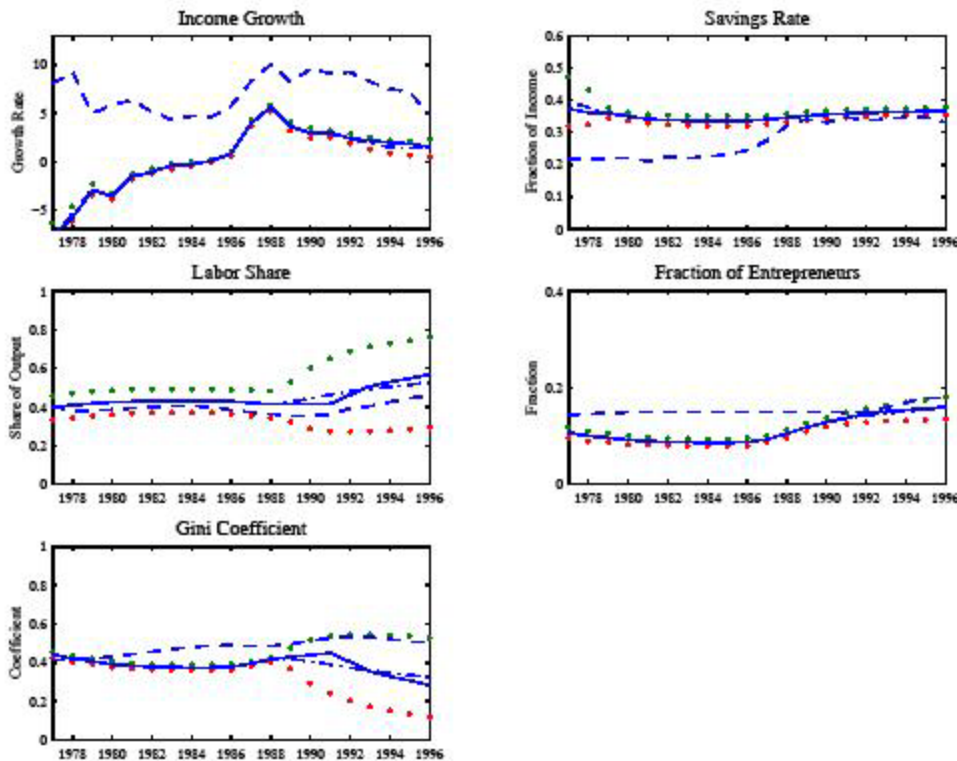
[Figure 6.1.2.4. Intermediated Model (SES Data). Notes: $\eta = .026,\ \omega = .321,\ \gamma_{gr} = 0$. Source: Giné and Townsend (2004) Legend: dashed line=Thai economy, solid line=simulation at estimated parameter, green dotted=mean simulation, red dotted=confidence intervals]

In contrast, suppose we allow the intermediated sector, with perfect credit markets, to expand at exactly the rate we see in the SES participation data. Then the model at both point estimates and standard error bands does well with the observed time varying growth of GDP, particularly the upturn in 1986 when the financial sector expanded dramatically. See Figure 6.1.2.3. The savings rate and labor share are reasonably well matched. Note that the point estimates of labor share first decrease and then increase, as in the data, and the Gini measure of inequality first increases and then decreases, as in the data. The wider confidence intervals have to do with the undesirable knife-edge property of the model: the wage does not increase until the farm sector is depleted, and the timing of that event varies with parameter values. The fraction of predicted entrepreneurs is low but increasing, as in the data.

6.1.3 Distribution of Gains and Losses

Fig 5 a: Pct. Change in Wealth in 1979

Fig 5 b, $w_{NC} = 0.02$, $w_C = 0.02$, r = 1.93

W in NC, C

E in NC, W in C

W in NC, E in C

E in NC, C

Fig 5 c and 5 d: Wealth Dist.: NCr and C

[Figure 6.1.3.1. Welfare Comparison in 1979 (Townsend Thai data) Source: Giné and Townsend (2004)]

The distinct paths of the Thai economy with and without intermediation allow us to estimate at the micro, household level the distribution of gains (and potential losses) from the observed expansion/liberalization of the financial sector. Essentially, one can overlap the occupation choice diagrams of the non-intermediated and intermediated sectors. The figure above shows estimated parameters for the simulated year 1979 with both sectors. Of great interest is the region of those who establish enterprise in the economy with some intermediation and would not do so in the economy without intermediation. As the wage w is the same in both economies in 1979, this is simply a comparison across sectors in 1979 of otherwise identical households with and without access to banks. Of interest also are those who would set up firms in the non-intermediated sector but who save their money in the bank in the intermediated sector. The associated differences in end-of period wealth, that is, the "static" welfare gains, are depicted in Figure 6.1.3.1. These in turn can be weighted by the fractions of the population imagined to be at various $wealth = b$, $cost = x$ combinations, according to the estimated distribution of costs x and various assumptions about what the distribution of wealth b would look like in the non-intermediated and intermediated economies.

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Apparent are the extraordinary gains for talented, poor households. There are other interesting features of the graph, such as the gain for high cost, high wealth households who abandon the inefficient enterprises they would have been running. Related is financial income; wealth increases savings that can be put into the bank. Note, however, that those who would be wage earners in either sector do not experience any welfare gain. Again, in 1979 the wage is the same in the two economies. Likewise, no one can experience a welfare loss. As prices have not moved, the choice of every household is the same or less restricted than what it would have been without intermediation.
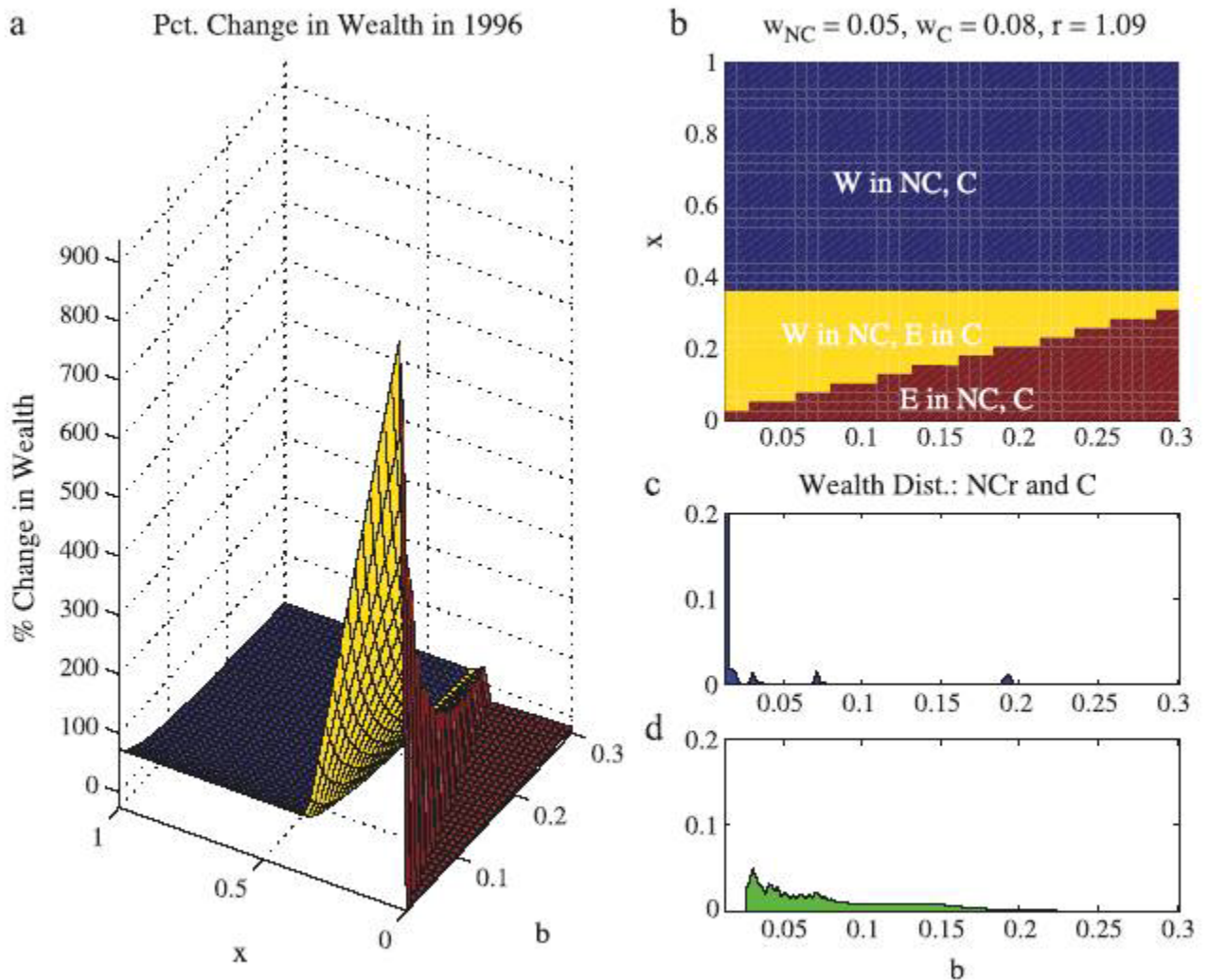
Fig. 6. Welfare Comparison in 1996: SES Data.

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[Figure 6.1.3.2. Welfare Comparison in 1996 (SES Data) Source: Giné and Townsend (2004)]

By 1996, however, the wage in the Thai economy is higher than it would have been without intermediation. That means that a (b, x) household running a firm in the actual, intermediated economy has lower profits (See Figure 6.1.3.2) than they would have had if running a firm in the associated non-intermediated economy at a lower wage. One can no longer compare across intermediated and non-intermediated sectors in the actual Thai economy. Difference in earnings, due to differences in access, do not pick up the general equilibrium wage effect. We can still calculate, however, from the structure of the model, the differences in earnings of those wage earners at (b, x) points who would be wage earners in the non-intermediated economy but set up firms by borrowing from banks in the intermediated economy. These gains are still quite large. But now those who would be wage earners in the economy without intermediation and remain wage earners in the economy with intermediation also experience the gain of an increased wage. As mentioned, those who would be firms in the non-intermediated economy and in the intermediated economy if given access may well experience losses due to the increase in the wage (though excess savings can be put in the bank at interest). For previously constrained firms, in the economy without intermediation, enhanced access allows them to operate at a more efficient scale. Higher wage effects and increased efficiency compete with one another.

|	Intermediated ec.		Wealth Dist	Non-intermediated ec.		Wealth Dist
	1997 Baht	Dollar	Pct. of Inc.	1997 Baht	Dollar	Pct. of Inc.
Townsend-Thai Data, 1979						
Welfare gains						
Mean	82,376	3295	200.93	61,582	2463	150.21
Median	22,839	914	55.71	3676	147	8.97
Mode	7779	311	18.97	6961	278	16.98
Pct. of population		100			100	
SES Data, 1996						
Welfare gains						
Mean	76,840	3074	100.54	83,444	3338	109.18
Median	25,408	1016	33.24	20,645	826	27.01
Mode	25,655	1026	33.57	18,591	744	24.32
Pct. of population		86			95	
Welfare losses						
Mean	117,051	4682	107.59	115,861	4634	106.50
Median	113,705	4548	104.51	112,097	4484	103.04
Mode	117,486	4699	107.99	118,119	4725	108.57
Pct. of population		14			5	

[Table 6.1.3.3. Welfare Gains and Losses. Source: Giné and Townsend (2004)]

Table 6.1.3.3 from Giné and Townsend (2004), summarizes the distribution of gains and losses to expansion of the financial sector. As anticipated average, median, and modal gains can be substantial in the various years, from 17% to 201% of average Thai household income. The skewness of gains is what makes the three measures so different from one another. Welfare losses are also substantial, at approximately 104-109% of average income (the overall average, not the income of entrepreneurs). The fraction of losers varies from 5% to 14 % of the population.

## 6.1.4 Some Structure Policy Experiments
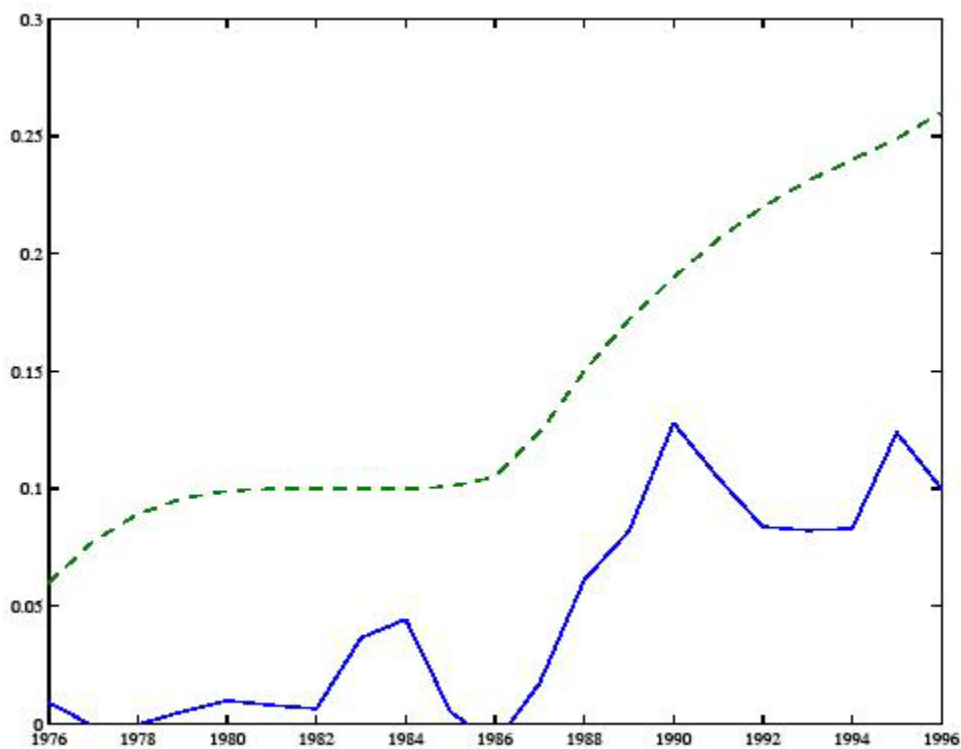
[Figure 6.1.4.1.(a) Foreign capital inflows and financial liberalization. Legend: – Foreign cap. Inflows as a fraction of GDP, – – Fraction of population with access to intermediation. Source: Source: Giné and Townsend (2004)]
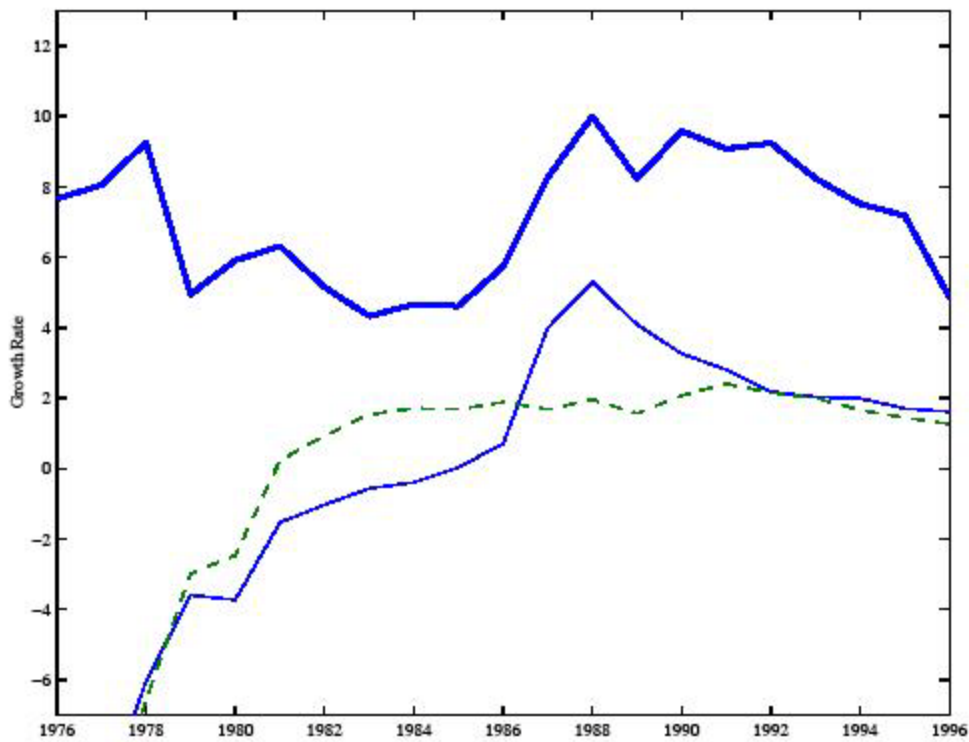
[Figure 6.1.4.1.(b). Access to capital and foreign cap. Inflows: SES. Legend: — (thick) Thai economy , — Closed economy, – – Economy with capital flows and linear participation. Source: Source: Giné and Townsend (2004)]
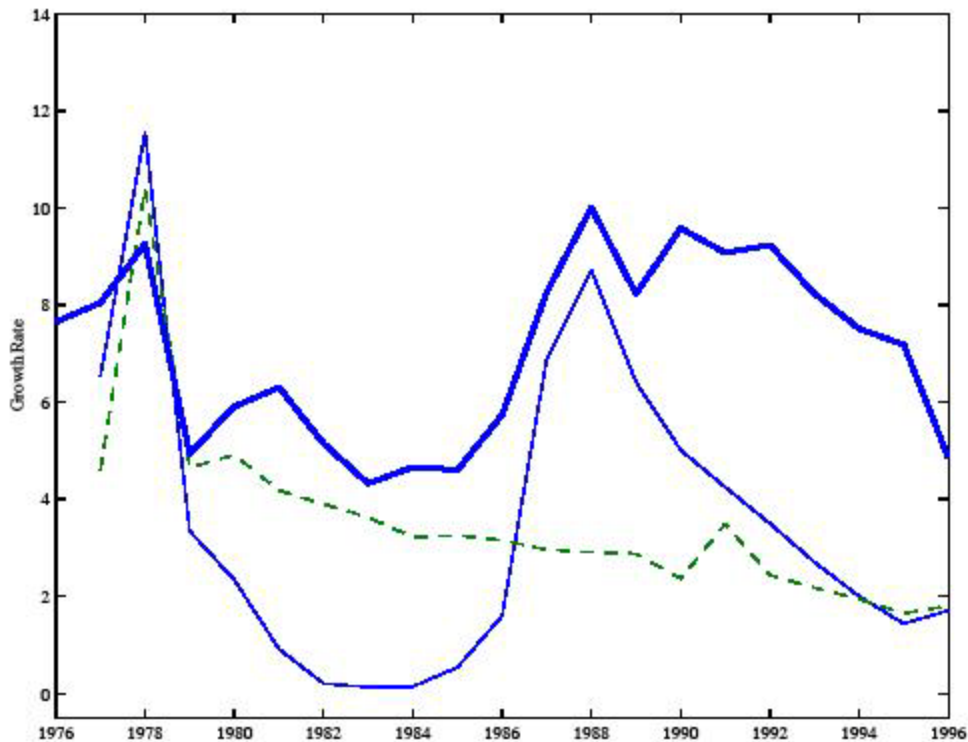
[Figure 6.1.4.1.(b) and (c). Access to capital and foreign cap. Inflows: Townsend-Thai. Legend: — (thick) Thai economy , — Closed economy, – – Economy with capital flows and linear participation. Source: Source: Giné and Townsend (2004)]

The structure of the model at estimated parameter values also allows us to assess the impact of foreign capital inflows. Recall that there is increased domestic use of the banking system at almost the same time as increased foreign inflows. We linearize the observed trend of increasing access to the domestic financial system, eliminating the 'S' upturn that we suspect is behind the accelerated growth. At the same time, we allow augmented savings (investment) from foreign sources and the associated decreased domestic interest rate. The wage is also endogenous. Featured in Figure 6.1.4.1 are three paths: the growth path of the actual Thai economy; the former predicted, simulated path of the closed economy (with its acceleration), and the newly predicted path. The latter at the estimated SES and Townsend Thai parameters is essentially flat. Foreign capital inflows did not cause the accelerated growth, apparently.

We conduct another experiment, allowing some measure of informal credit for those outside the formal sector. Specifically, borrowers who renege on a loan contract are apprehended with probability p and though they can hide their income they receive a punishment with additive disutility d and lose their wealth. This is weighed against repaying loans *L*. Specifically, borrowers will renege if $rb + pd < rL$, so

loan size is bounded; that is, $L \leq b + \Delta$ where $\Delta = pd / r$. Setting r at 1 and calibrating Δ to best fit the observed dynamics gives most scope for the informal sector to have impact. The calibrated Δ turns out to be consistent with informal borrowing to wealth ratios as in the Townsend Thai data. Wages increase earlier than before, but the path of the economy is not much altered from the economy without informal credit. The welfare gains from an expansion of the formal sector are similar to the earlier calculations without informal credit.

6.1.5 Total Factor Productivity Due to Financial Deepening
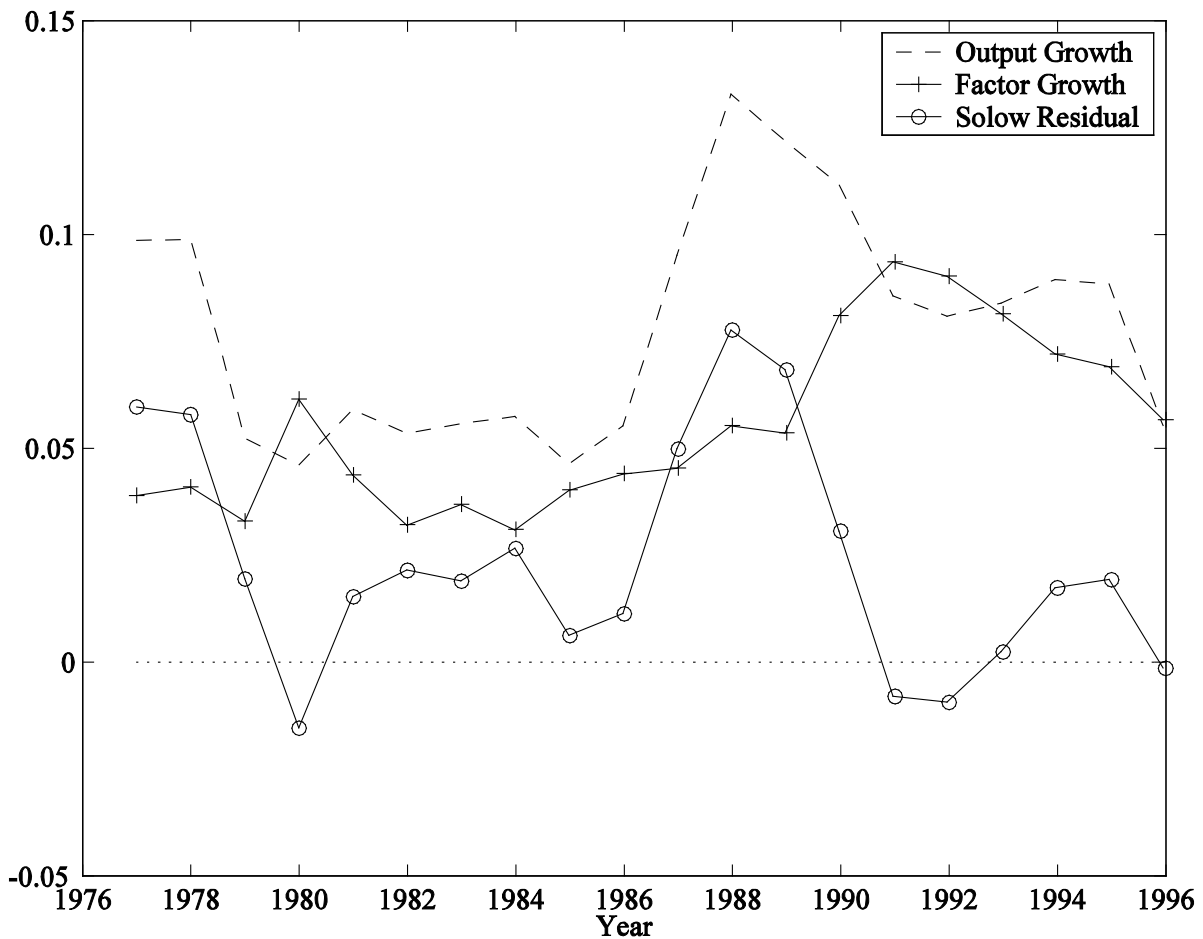
Figure 1. Standard Growth Accounting in Thailand .

[Figure 6.1.5.1. Standard Growth Accounting in Thailand. Source: Jeong and Townsend (2007)]

As we may recall from the earlier figure, Thai TFP growth, as measured by the standard Solow residual, also shoots up during the period when the domestic financial system expanded, 1986-1990.

The structure of the micro-based occupation choice model allows us to disentangle the differences in output across sectors and over time that give rise to measured total factor productivity growth. Specifically, output from firms in the intermediated sector, say sector 2, Y_2^m consists of output under production function $f(k,l)$ with inputs $k^*(w,r)$ and $l^*(w,r)$ at wage w and interest rate r. The integral over the sources of heterogeneity, wealth b and talent x, delivers output of the representative firm (firms are all identical) multiplied times the fraction of entrepreneurs in the population:

$$Y_2^m = H(x(w,r))f[k_2^*(w,r),l_2^*(w,r)] = G_2(w,r) \qquad (6.1.5.1)$$

This is per capita GDP from manufacturing (better put, GDP minus agriculture). The growth of output can vary if changing wages and interest rates change the fraction of firms in the population, even adjusting for changes in the measured inputs, capital and labor. But per capita GDP in manufacturing from firms without access Y_1^m is a complicated weighted average of firms run by constrained households of varying wealth b, distributed according to $\Psi_1(b)$, and talent x distributed according to *H(x)*:

$$Y_1^m = \int_0^\infty \int_0^{x^e(b,w)} f[k_1(b,x,w),l_1(b,x,w)]dH(x)d\Psi_1(b) = G_1(w,\Psi) \qquad (6.1.5.2)$$

We will have to work further to get a decomposition. Persistent algebra breaks aggregate TFP growth into four key components.

$$TFPG = TFPG\_SSR + TFPG\_ACH + TFPG\_OCCS + TFPG\_FIN \qquad (6.1.5.3)$$

The first term,

$$TFPG\_SSR \equiv (1-p)\tilde{s}_{Y_1} SR_1 + p\tilde{s}_{Y_2} SR_2 \qquad (6.1.5.4)$$

is the Solow residual SR_j in each of the two sectors, $j = 1,2$, weighted by the proportion of output in the two sectors the $\tilde{s}_{Y_j}$, $j = 1,2$ and weighted in turn by the fraction p of the population in the intermediated sector and $(1-p)$ in the non-intermediated sectors. Here, output consists not only of that produced but also that coming from subsistence agriculture. There is a second capital adjustment component in the first, non-intermediated sector:

$$TFPG\_ACH \equiv (1-p)\tilde{s}_{Y_1} s_{K_1} g_{K_1} \qquad (6.1.5.5)$$

as standard TFP calculations assume, incorrectly, that all capital is priced at its rental rate *r*. The change in capital g_{K_1} in the non-intermediated sector is weighted by fraction of the population $(1-p)$ in the non-intermediated sector, the share $\tilde{s}_{Y_j}$ of output coming from that sector, and also the share of capital s_{K_1} in

factor payments in that sector. The third component is a pure occupation shift effect from those moving out of subsistence and/or wage labor into enterprise:

$$TFPG\_OCC \equiv (1-p)\overline{s_{Y_1}}(-s_{L_1}g_{L_1}) + p\overline{s_{Y_2}}(-s_{L_2}g_{L_2}) \qquad (6.1.5.6)$$

Here $-g_{L_j}$ is weighted at labor shares s_{L_j}, the fraction of total output, and the population fraction p and (1-p) in the intermediated and non-intermediated sectors, respectively. The negative sign occurs because the fraction still in subsistence is not helping overall productivity; it is the fraction *leaving* which helps. The final, fourth component is the direct financial deepening effect:

$$TFPG\_FIN = \left[\tilde{S}_{Y_2}\frac{\Pi_2}{Y_2} - \tilde{S}_{Y_1}\frac{\Pi_1}{Y_1} \right] pg_p \qquad (6.1.5.7)$$

Much in the spirit of the earlier Theil decompositions, this is the ratio of total profits to total output differenced across the two sectors, presumably higher in the intermediated sector, though weighted by the proportion of total output coming from sector. The impact on productivity comes from the shift in the population pg_P into the intermediated sector.
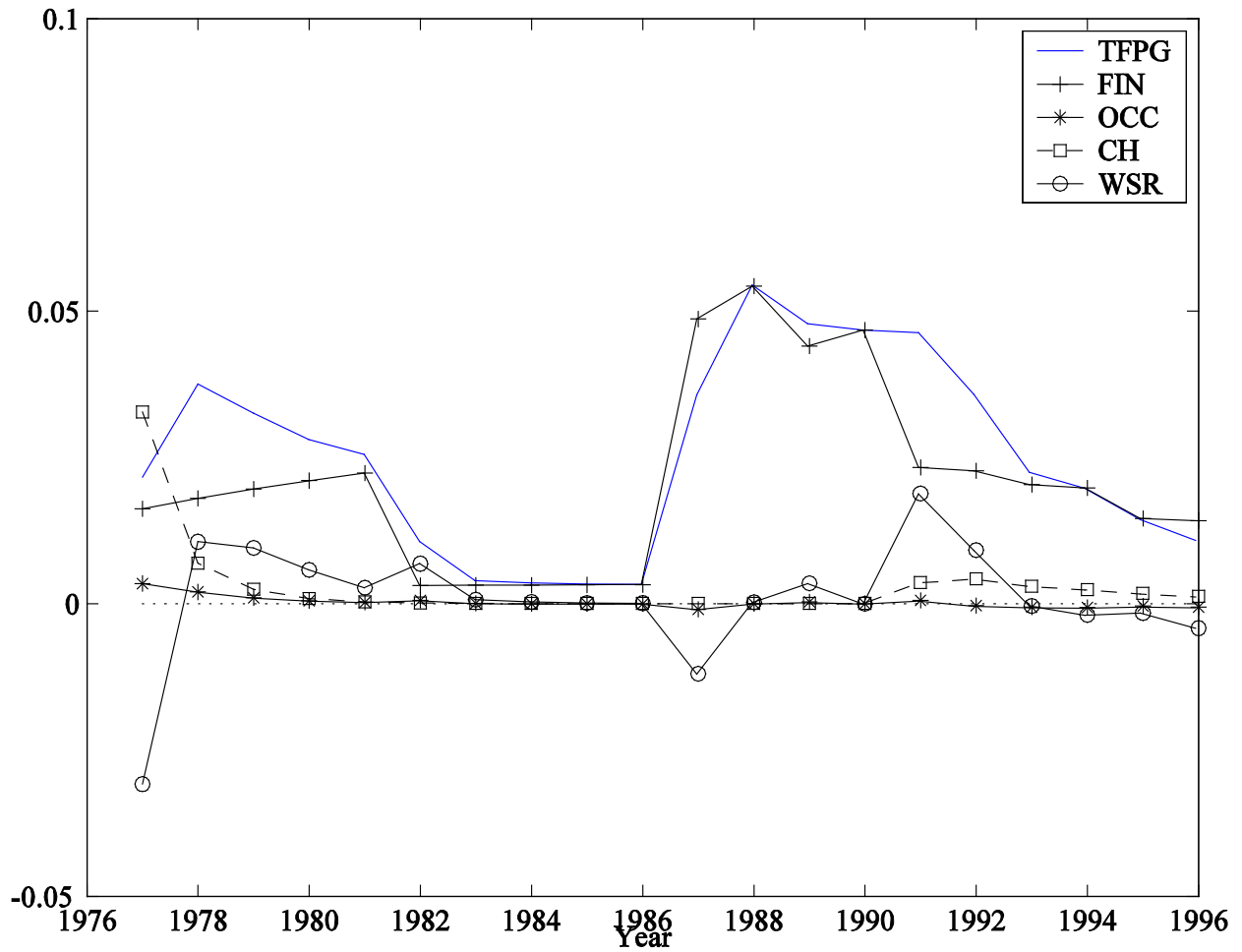
Figure 7. Decomposition of Simulated TFP Growth

Notes: TFPG: TFP Growth in equation (27). FIN: Financial-deepening effect in equation (38). OCC: Occupational-shift effect in equation (39)
CH: Capital-heterogeneity effect in equation (40). WSR: Within-sector Solow residual in equation (41).

[Figure 6.1.5.2.a. Decomposition of Standard TFP Growth. Source: Jeong and Townsend (2005)]

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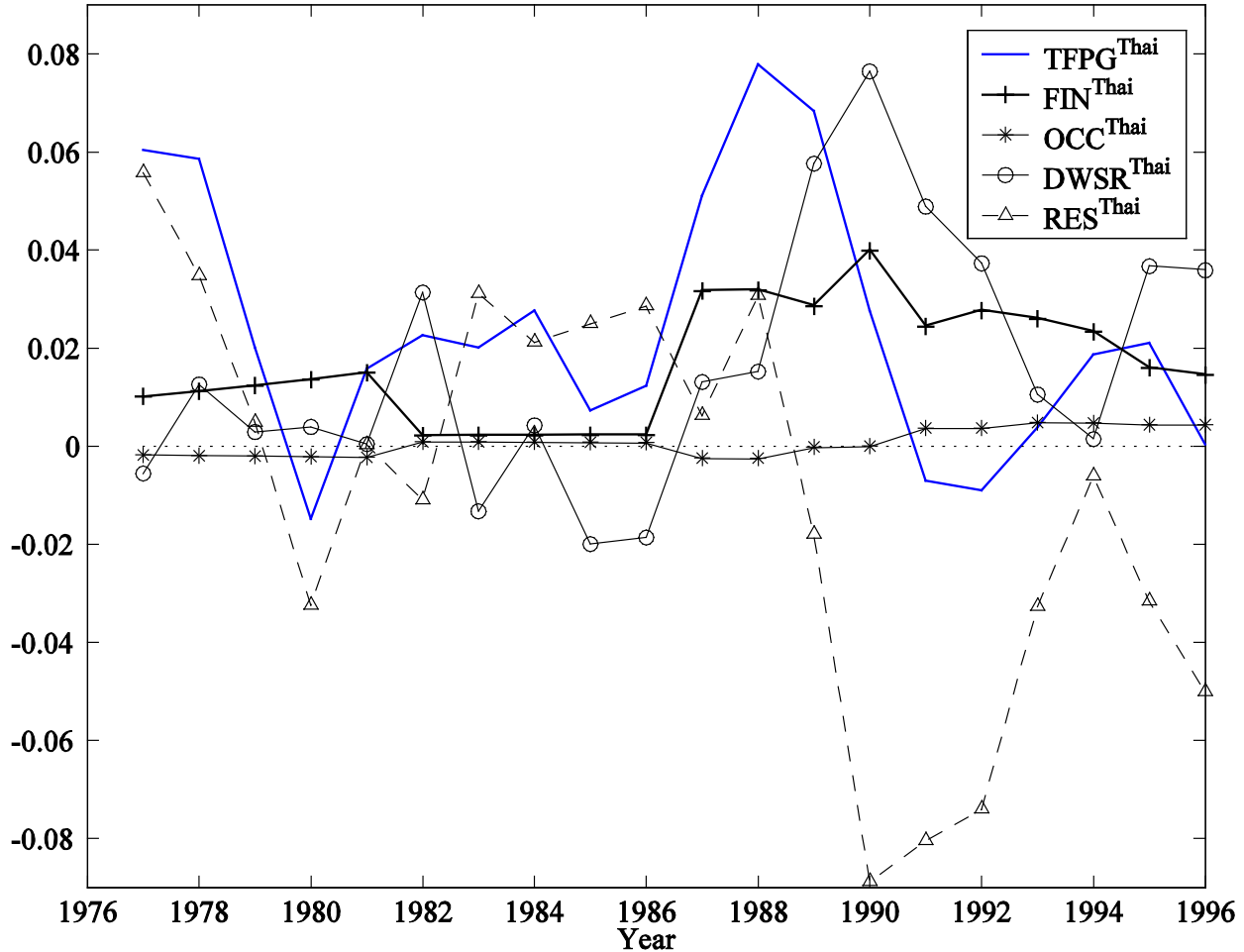
Figure 11. Decomposition of Actual Thai TFP Growth

Notes: TFPG^{Thai}: TFP growth in equation (46). FIN^{Thai}: Financial-deepening effect in equation (38). OCC^{Thai}: Occupational-shift effect in equation (39). DWSR^{Thai}: Dual within-sector Solow residual in equation (47). RES^{Thai}: Residual TFP growth in equation (48).

[Figure 6.1.5.2.b. Decomposition of Actual Thai TFP Growth. Source: Jeong and Townsend (2005)]

The decomposition of TFP growth in the model and in the data reveals a striking success of the modeling effort. Measured Thai TFPG moves with the financial deepening effect not only in the model but also in the data. In both there is a "repression" effect through the early to mid 80's and then a dramatic surge from 1986 to 1990. This continues in the model through the late 90's but drops in the data. A residual in the Thai data that we cannot decompose also goes negative in the 90's. Both may presage the financial crisis. In the model and the data the occupation effect and SR effects are smaller, though the SR effect is much larger in the data than in the model.
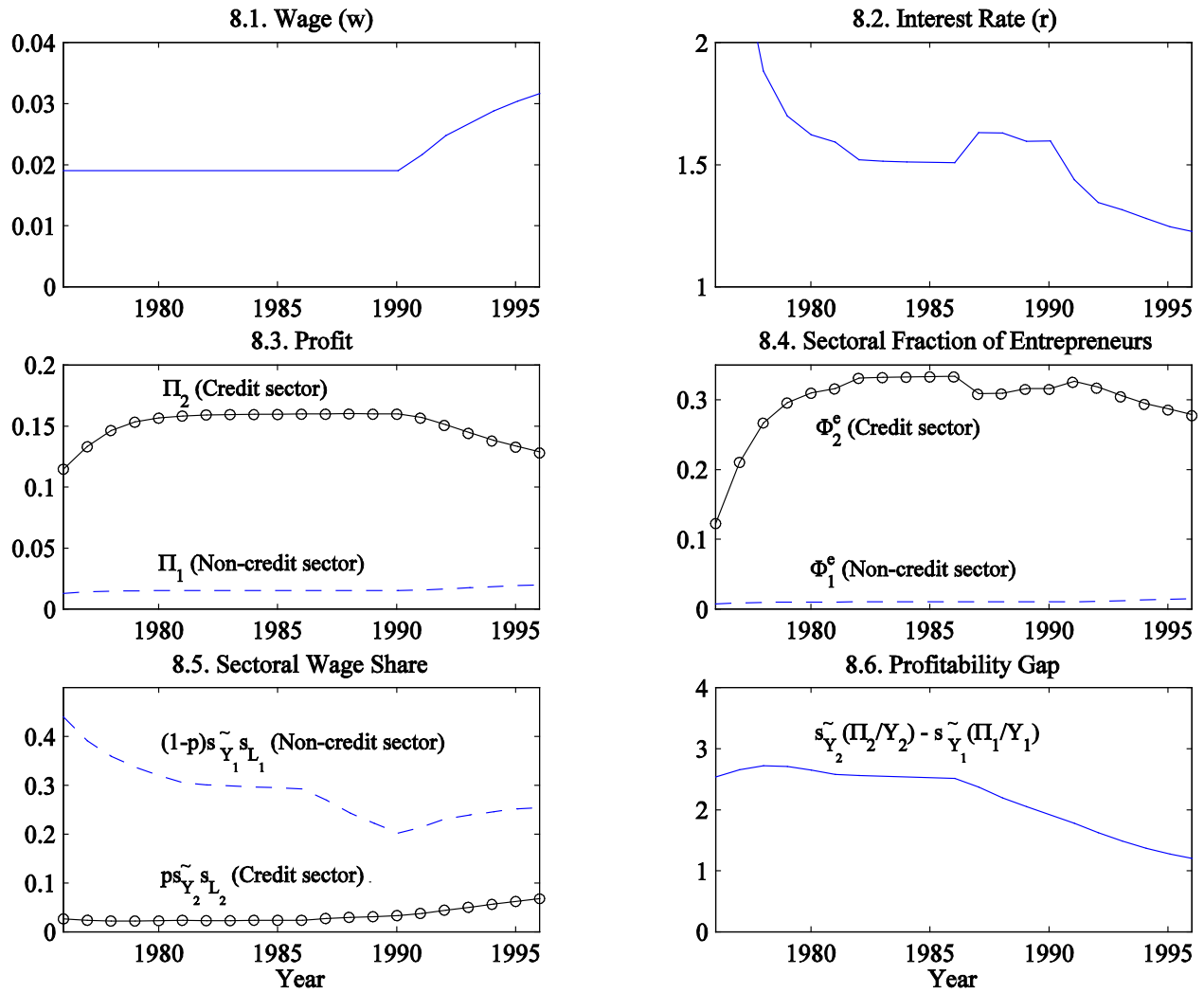
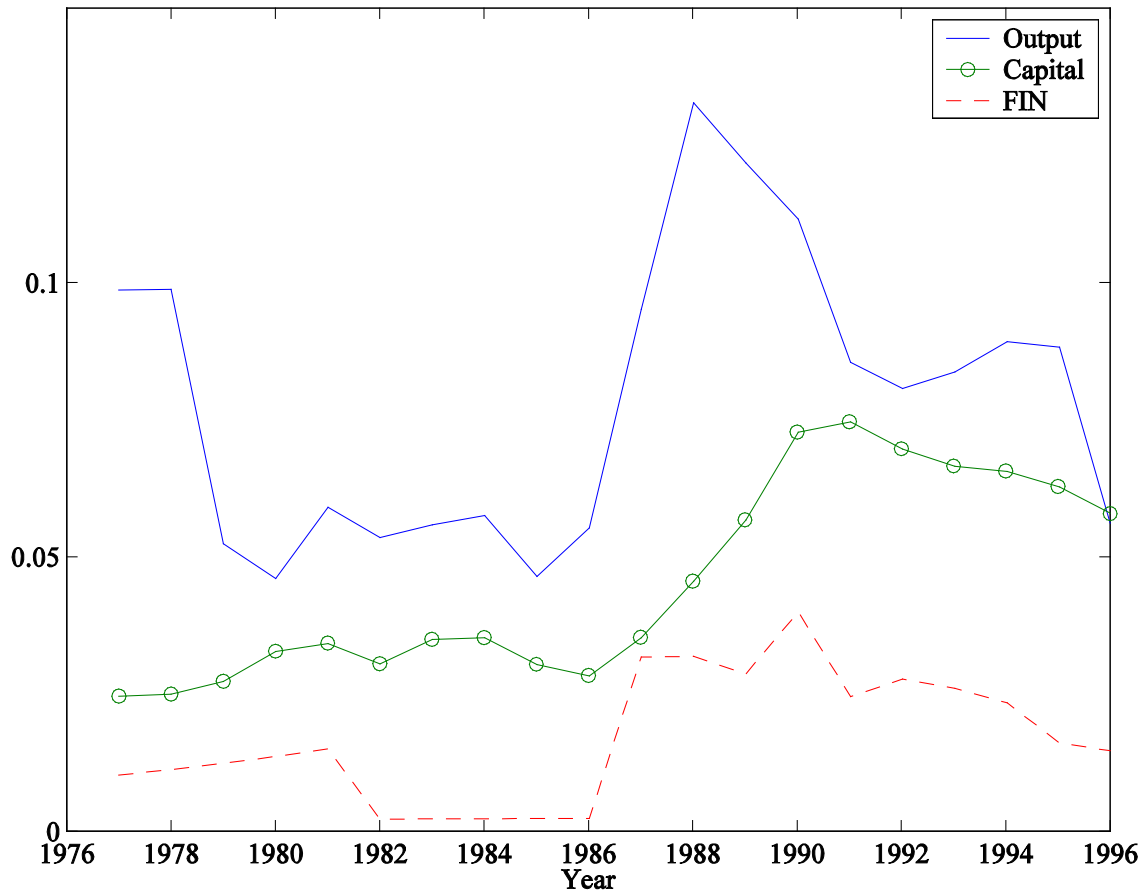**Figure 8. Underlying Variables for Simulated TFP Growth**

[Figure 6.1.5.3. Underlying Variables for Simulated TFP Growth. Source: Jeong and Townsend (2007)]
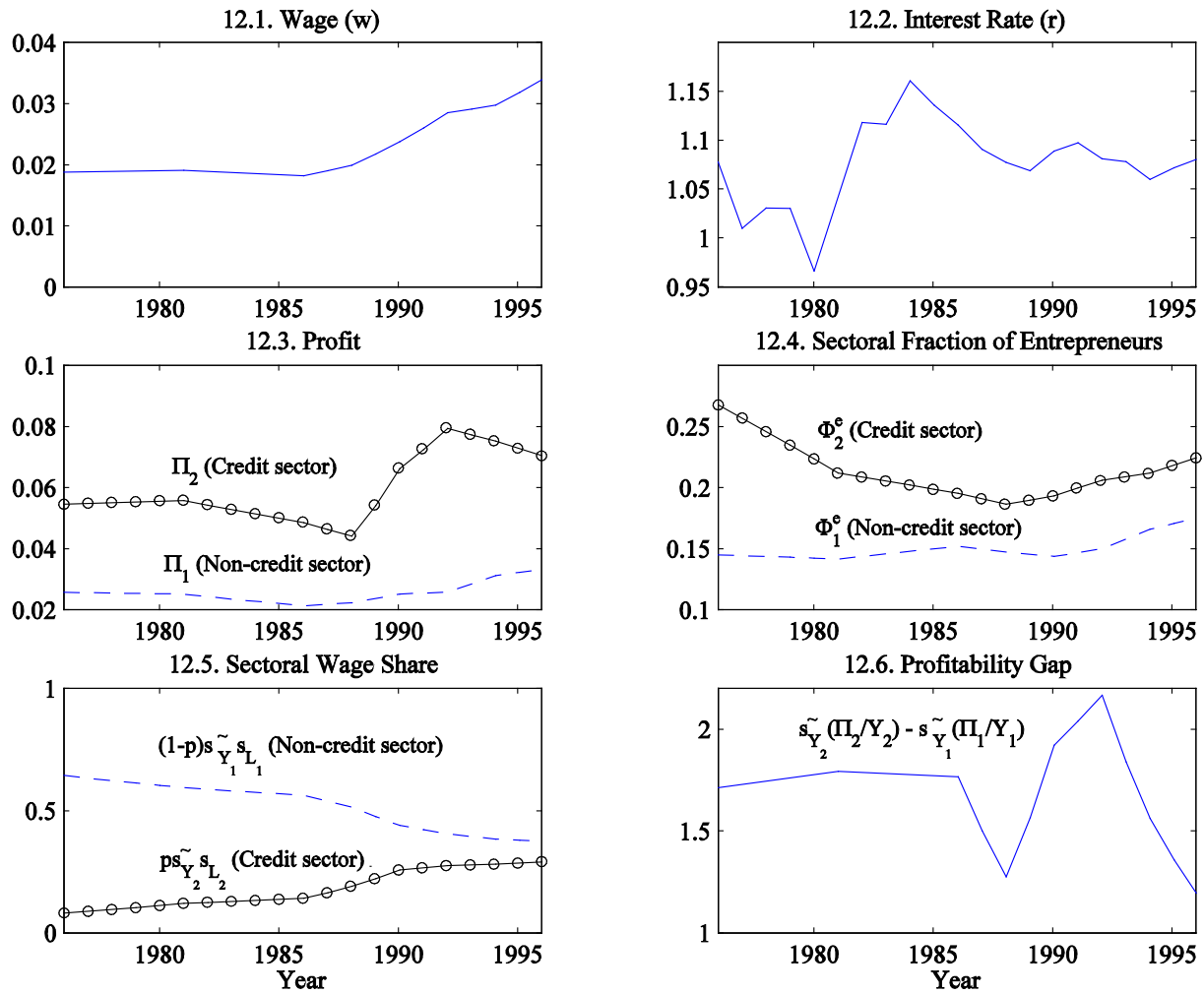
Figure 12. Underlying Variables for Thai TFP Growth

[Figure 6.1.5.4. Underlying Variables for Thai TFP Growth. Source: Jeong and Townsend (2005)]
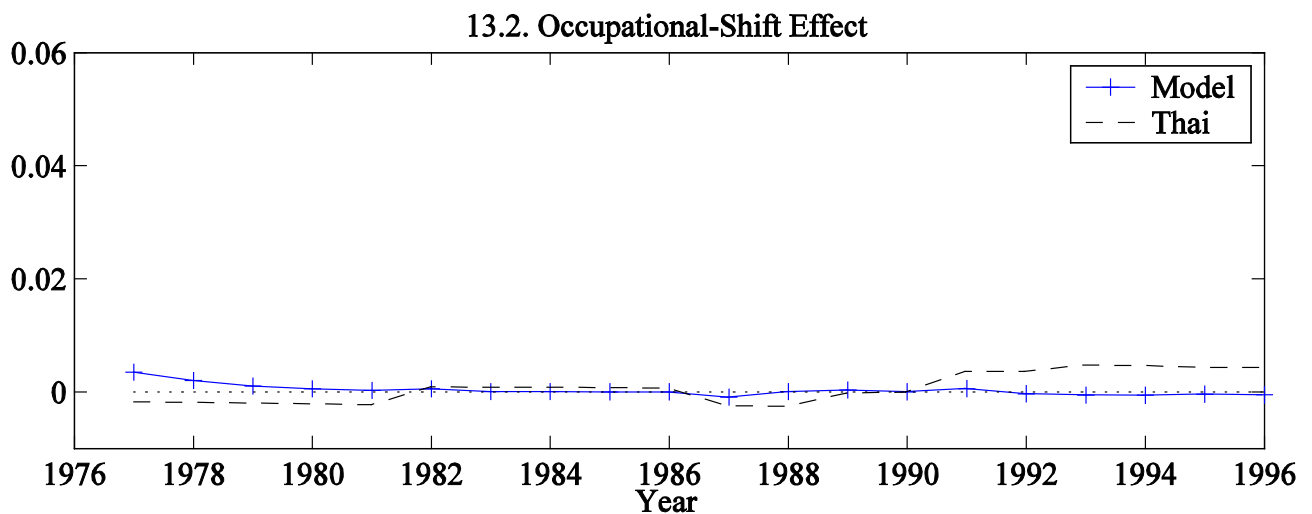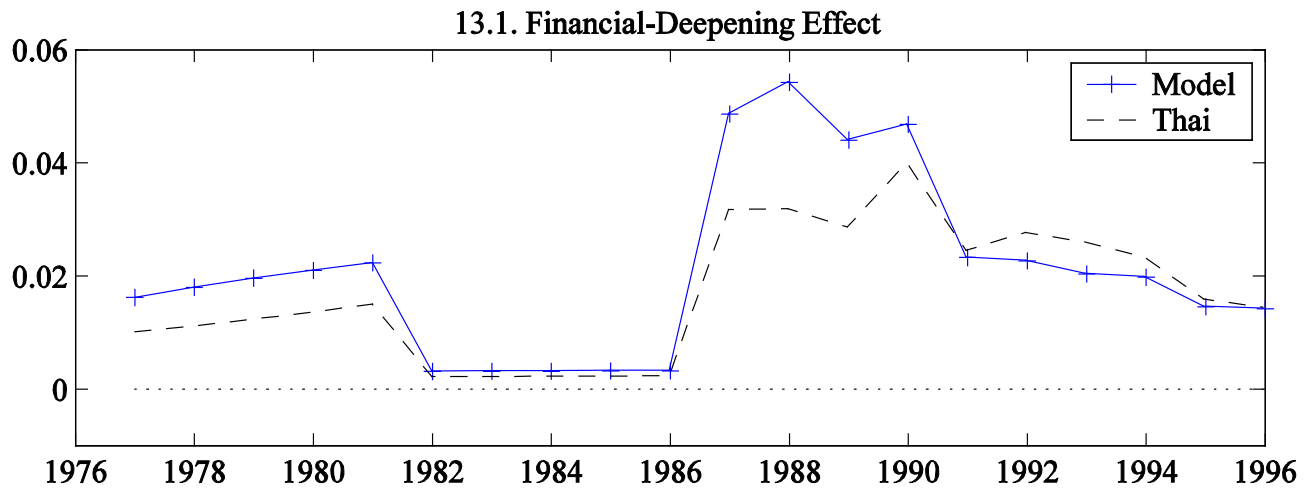
Figure 6.1.5.5. Capital Deepening vs. Financial Deepening

[Figure 6.1.5.5. Capital Deepening vs. Financial Deepening. Source: Jeong and Townsend (2005)]

Some of the key ingredients in the model simulation, at calibrated values, and in the Thai economy, are displayed in these figures. Movements of wages and interest rates are in the top panels. As has been anticipated repeatedly, wage rates are more or less steady until the 90's, both in the model and in the data. The wage is measured as the average earnings of full-time wage households, excluding part-time income. The interest rate naturally declines in the model and may be badly measured in the data, especially initially where all we see is the regulated rate. The occupation effect is determined by Figure 6.1.5.3 panels 4 and 5 for the model, and Figure 6.1.5.4 panels 4 and 5 for the data. These are the fraction of firms and sector wage shares, respectively. In the model, as in the data, the fraction of firms are higher in intermediated sector 2, and the wage share is lower there, but the differences across sectors are too large in the model relative to the data. Likewise, the financial deepening effect is determined by the variables panels 3 and 6 for the data. Again, the rank ordering is correct, but the differences are accentuated in the model relative to the data. (Note the differences in scale in the Figures). Also in the data is an upturn in absolute profits and an upturn in the profitability gap not predicted by the model.

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13.1. Financial-Deepening Effect

13.2. Occupational-Shift Effect

Figure 13. Sources of TFP Growth

Notes: Financial-deepening effect and occupational-shift effect are measured as in equations (38) and (39), respectively.

[Figure 6.1.5.6. Source: Jeong and Townsend (2005)]

Figure 6.1.5.6 summarizes the main conclusions: the actual financial deepening effect in the data is much like the financial deepening effect model. That effect plus the substantial growth in capital are what contributed to the increase in Thai GDP.

6.2   Access Choice- Financial Sector Endogenous

6.2.1 Review

The motivation for the second model comes from our earlier review of the essential facts. Thailand experienced growth with increasing inequality, financial deepening, varying cycles with a difference between the maximum and minimum growth rate of 10%, large idiosyncratic shocks relative to macro aggregate shocks, low levels of inequality in agriculture relative to non-farm entrepreneurs, increasing wealth to access transition profiles, and financial sector providers with operating systems which would allow the amelioration of idiosyncratic shocks (schemata).

6.2.2 The Model

The model follows GJ (Greenwood-Jovanovic) (1990) and the earlier literature, as modified by Townsend and Ueda (2005). The model features risk and the re-allocation risk, though savings rates and activities are also endogenous. Specifically, the typical household is imagined to be risk averse and to maximize discounted expected utility

$$E_1\left[\sum_{t=1}^{\infty} \beta^{t-1} u(c_t)\right] \tag{6.2.2.1}$$

with contemporaneous utility is $u(c) = \dfrac{c^{1-\gamma}}{1-\gamma}$. Households are risk averse, so $\gamma > 0$. When in autarky, not connected to the formal financial sector, the household chooses the amount to save s_t; the fraction ϕ_t of that to put in a risky activity, with a linear return per unit capital of δ; and residual fraction $1-\phi_t$ in a safe activity with a linear return per unit capital $\theta_t + \varepsilon_t$. Here the aggregate shock is θ_t and the idiosyncratic, household/firm specific risk ε_t. The realization of macro and idiosyncratic shocks takes place after investment, between periods t and $t+1$. As a first approximation, ϕ_t can be taken to be household resources devoted to farming and the residual to non-farm business. The law of motion for wealth is simply

$$k_{t+1} = s_t(\phi_t(\theta_t + \varepsilon_t) + (1-\phi_t)\delta) \tag{6.2.2.2}$$

where wealth k_t is entirely fungible (like putty), either consumed in amount c_t, or saved in amount s_t, as stated earlier.

There are advantages to being in the formal financial system, namely, the sharing of idiosyncratic risks. But this comes at a cost. There is competition among potential intermediaries who form mutual funds and charge fees to cover the costs. The earlier model of Townsend (1978), though static with idiosyncratic shocks, is illustrative, so we cover that part here.

Let *I* denote the set of agents. It is assumed here that *I* is countable infinite. Each agent $j \in I$ is endowed with a quantity of the unique factor of production of the model, the capital good k^j. The endowments of this capital good are identical for all agents and perfectly divisible. Each agent is also endowed with a stochastic technology which transforms the capital good into a distribution of the unique

consumption good of the model. Each of these technologies or investment projects displays constant return to scale. Let λ^j denote the output of the consumption good per unit of the capital input y_j in project j. Each λ^j is a random variable and the λ^j, $j \in I$ are assumed to be independent and identically distributed. A state of the economy subsequent to the realization of the shocks is a complete specification of the value of each of the λ^j, $j \in I$. The set of all possible states will be denoted Ω with typical element ω. Let $\mu(\omega)$ denote the probability that state ω will occur. Each agent tries to maximize expected utility, so that each has objective function

$$W^j\left(c^j\right) = \int_{\omega \in \Omega} \mu(\omega) U\left[c^j(\omega)\right] \tag{6.2.2.3}$$

Here of course $c^j(\omega)$ is the consumption of agent j in state ω.

Exchange in the model is assumed to be costly. For each bilateral deal a fixed cost of 2α units of the capital good is incurred, α per agent. This gives rise to intermediaries, to economize on these costs.

A market M is defined to be the smallest set of agents for which every agent of the set deals with other agents of the set and with no agent outside that set. Let $\eta(M)$ denote the number of bilateral exchanges in a market M with $\#M$ participants. Hence,

$$\left(\#M - 1\right) \le \eta(M) \le \left(\#M\right)\left(\#M - 1\right)/2 \tag{6.2.2.4}$$

Then an allocation $\left\{c^j, y^j; j \in M\right\}$ is said to be feasible for market M if the reallocation of the capital good is feasible, net of transactions costs,

$$\sum_{j \in M}\left(k^j - y^j\right) \ge \left(2\alpha\right)\eta(M) \tag{6.2.2.5}$$

and there is enough output to meet consumption demands,

$$\sum_{j \in M} \lambda^j(\omega) y^j \ge \sum_{j \in M} c^j(\omega), \quad \omega \in \Omega \tag{6.2.2.6}$$

An allocation $\left\{c^j, y^j; j \in C\right\}$ is said to be *feasible for a coalition C* if there exists a set of markets, A such that $\cup_{M \in A} M = C$ and the allocation $\left\{c^j, y^j; j \in M\right\}$ is feasible for each market $M \in A$. ☐The *core* for the economy I is the set of allocations which are feasible for the entire economy I and which are not blocked by any coalition. An allocation $\left\{c^j, y^j; j \in I\right\}$ is said to be *blocked* by a coalition B if there exists an allocation $\left\{c_*^j, y_*^j; j \in B\right\}\}$ which is feasible for B such that

$W^j\left(c_*^j\right) > W^j\left(c^j\right)$ for each agent $j \in B$.

In the cooperative version of this economy specified agents are designated as intermediaries. Each intermediary selects a group of agents for projects in his portfolio. These sets are assumed to be disjoint so that in effect intermediaries are forming markets M. Each agent in a market agrees to sell shares in his project to the intermediary for a price of one in terms of the capital good, and the intermediary sells shares in his portfolio for a price of one in terms of the capital good. In effect, shares are exchanged one for one. A share in the output of project j entitles the holder to λ^j units of the consumption good. A share in the portfolio of an intermediary of market M entitles the holder to $\sum_{i \in M} \lambda^i / \#M$ units of the consumption good. All transactions costs are shared equally by all agents in a given market. With $(\#M - 1)$ as the minimum number of bilateral exchanges in M, these transactions costs will be $(\#M - 1)(2\alpha)$. In these circumstances agents in a market will trade shares with the intermediary on a one-to-one basis up to the limits of their initial endowments, less transactions costs. Each intermediary determines the number of agents in his market, and each will act to maximize the utility function of a representative consumer,

$$EU\left\{\left[k^j - \frac{(2\alpha)(\#M - 1)}{\#M}\right]\left[\sum_{i \in M} \lambda^i / \#M\right]\right\} \qquad (6.2.2.7)$$

with respect to *#M*. Core allocations are equivalent to the equilibrium allocations of a non-cooperative game.

In the non-cooperative game the determination of who is to act as an intermediary, and under what terms is endogenous. Each agent is free to announce any intermediation strategy, and it is assumed that each selects a strategy in such a way as to maximize expected utility. This strategy is the market proposed by agent h as intermediary, the yield in terms of the consumption good for one share in the portfolio of agent h; a price in terms of the capital good at which agent h is willing to buy an unlimited number of shares in any project j of its market, a fixed fee in terms of the capital good for the purchase of shares in the portfolio of agent h by agent j, and a price in terms of the capital good at which agent h is willing to sell an unlimited number of shares in his portfolio to agents j. Agents must act on the strategies prior to the realization of the state. Once the state has occurred, agents make the transfers of the consumption good required to honor claims issued. Given that intermediaries have been selected in some way, all other agents regard the strategies as parameters and maximize expected utility. An intermediary who is active for his proposed market will have expected utility that is determined by the residual consumption left over after completing all trades.

An agent *b* may find it is in his *own* interest to announce a blocking strategy. In the process of undercutting an active intermediary of a specified market or in the process of forming a new market, all the agents with whom agent *b* deals are made better off than initially. Roughly speaking agent *b* may be viewed as a firm who is aware of demand curves and seeks to exploit profitable markets. This type of free entry will be crucial in determining the allocation of resources. A non-cooperative equilibrium is described in part as an allocation for which there exist no blocking strategies for any agent.

In an equilibrium (i) any agent who is not an active intermediary maximizes expected utility by choosing an intermediary with whom to trade, the number of shares in his own project to be sold to that intermediary, the number of shares in the portfolio of that intermediary to be purchased, and the amount to invest in his own project, regarding as parameters the announced intermediation strategies of all other agents. (ii) agents partition themselves into markets --for each market there is one active intermediary with a strategy and a maximizing input choice, which support the maximizing choices of inactive agents. (iii) free entry condition is the motivated above with the discussion of blocking.

The equivalence of core allocations and equilibrium allocations can be established. In particular, if there exists an equilibrium, the equilibrium allocation is in the core. All core allocations can be supported as equilibria. These are the analogues of the two fundamental welfare theorems. Finally, note that with free entry, intermediaries have zero profits in the sense that their utility is drawn down to that of non-intermediated customers.

As incorporated in Greenwood and Jovanovic, there is a continuum of agents in the financial sector, a kind of limit in the above model, and all idiosyncratic shocks are shared completely by members/customers of the associated financial institution, so there is no residual idiosyncratic risk for these households. This could be accomplished by having loan repayment vary with idiosyncratic shocks ε_t, as in the BAAC implicit insurance, risk-contingency system. Thus, in principle, all projects are evaluated at their expected returns. A second advantage to the formal financial system here is advanced information on forthcoming aggregate shocks, as if experienced loan officers were advising clients. Thus the mutual fund yield is

$$r(\theta_t) = \gamma \max[\theta_t, \delta] \qquad\qquad (6.2.2.8)$$

where γ is the return left over after proportional transaction costs $1-\gamma$. Here, then, even the choice between risky and safe technologies is without risk. This is a bit overdone.

In sum, in the present model the advantages of the formal financial sector are imagined to go to extremes: full risk sharing and complete advanced information. The advantages of the financial sector must be weighed against two costs. One is the marginal cost $1-\gamma$, a spread between borrowing and lending rates. A second cost is a fixed cost q for entering the financial system. The latter is a stylized version of the earlier model of costly bilateral exchange and captures the cost of financial infrastructure, branch banks, roads, and household learning.

The solution technique for the dynamic model is summarized by a pair of value functions. Let $V(k)$ denote the discounted expected utility value of being in the financial system today with wealth k, and $W(k)$ is the value for those currently not in the financial system at wealth k. Those having decided not to enter today at date t face the choice again next period, so

$$W(k_t) = \max_{s_t, \phi_t} u(k_t - s_t) + \beta \int \max \{W(k_{t+1}), V(k_{t+1} - q)\} dH(\eta_t) \qquad (6.2.2.9)$$

where at the time of entry fixed cost q is subtracted from wealth. Shock $\eta_t \equiv \theta_t + \varepsilon_t$, and the law of motion for capital was given earlier in equation 6.2.2.2. Once households enter they will never exit, and the value function $V(k)$ is

$$V(k_t) = \max_{s_t} u(k_t - s_t) + \beta \int V(k_{t+1}) \} dF(\theta_t) \qquad (6.2.2.10)$$

with law of motion of capital, $k_{t+1} = s_t r(\theta_t)$, and investment return given earlier in equation 6.2.2.8. There is also a counter factual lower bound, the value for those never ever allowed to enter the financial system, $W_o(k_t) = \max_{s_t, \phi_t} u(k_t - s_t) + \beta \int W_o(k_{t+1}) dH(\eta_t)$ subject to 6.2.2.2. The advantage of this formulation is that one can obtain closed form solutions for V and W_o, and hence trap function W between them, that is, $W_o(k_t) \le W(k_t) < V(k_t)$. The savings and portfolio policies s and ϕ under W_o also offer an interesting benchmark.
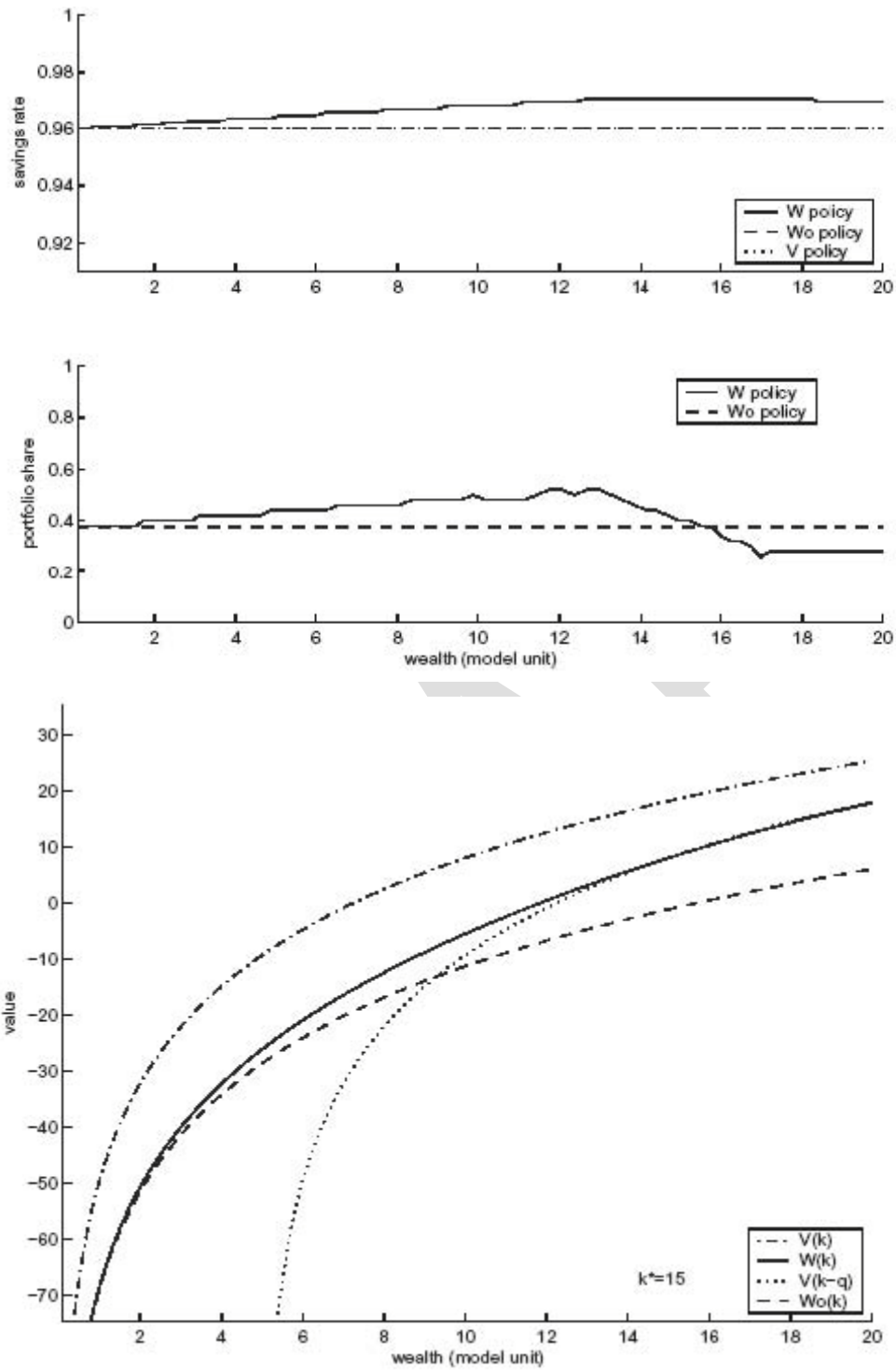
[Figure 6.2.2.1. Policy Functions (top), Value Functions (bottom). Source: Townsend and Ueda (2006)]

Example value functions $V(k), V(k-q), W(k),$ and $W_0(k)$ are all depicted for selected

parameter values, along with the savings and portfolio decisions under W and W_0. The savings rate under

Draft: July 2010

W_0 and V is .96 out of wealth k and the fraction ϕ put in risky activities is .4. Key to the model

dynamics: there is a critical level of wealth, here $k^* = 15$, below which a household will not (yet) enter

the financial system and above which the household will enter and stay. Also, the savings rate rises the

nearer is the household to that critical value of wealth k^*, to finance q at the time of entry. Surprisingly,

the portfolio share into risky activities is also higher than under permanent autarky, W_0, and rises as the

household approaches the same critical value of wealth k^*. This is because the utility frontier is otherwise

not concave.

The savings and portfolio decisions of those in temporary autarky reflect the probability of future

entry. Otherwise, those without access are essentially in a savings only regime and can be expected to

display a kind of buffer stock behavior. Both consumption and investment will move with today's

realized income.

Benchmark Parameter Values Calibrated, as RBC						
σ	q	δ	θ	ε	β	$1-\gamma$
1	5	1.054	[1.047, 1.147]	[-0.6, 0.6]	0.96	0

MLE Estimated GJ Parameters – Micro Data						
σ	q	δ	$\underline{\theta}, \theta$	$\overline{\varepsilon}$	β	$1-\gamma$
0.9946	0.5021	1.0479	[1.0470, 1.1905]	[-0.9954, 0.9954]	0.9627	0
[0.0926]	[0.0482]	[0.0064]	[0.0451, 0.0514]	[0.0355]	[0.0061]	[0.0000]

[Table 6.2.2.2. Calibration/Data Sources. Source: Top - Townsend and Ueda (2006) and Bottom - Jeong
and Townsend (2008)]

Parameters of preferences and technology can be calibrated. Alternatively, they can be estimated

with micro data via an explicit likelihood function. Both methods will be described in more detail

momentarily. As is evident from Table 6.2.2.2, the two methods yield strikingly similar conclusions: risk

aversion, close to the log utility; rate of return on the safe technology at about 5%; the range of macro

shocks from $\pm 10\%$ to 15%; the range of idiosyncratic shocks (ROA holding θ constant, from $\pm 60\%$ to

$\pm 100\%$; preference discount rate β at .96, and zero marginal transaction costs γ. The fixed cost q varies

across specifications, but it will be rescaled relative to the estimated initial empirical distribution of

wealth.

For calibration, we set the technology parameters using Townsend Thai data. We use income to capital ratios to estimate the technology parameters for those not in the financial system. The survey shows that the net return from capital investment in subsistence agriculture, which we regard here as a crude approximation to the safe project δ, at 5.4 percent in 1997. For the idiosyncratic shocks in the risky project, we also use income to capital ratios, but for those in nonagricultural business, and set the support of idiosyncratic shocks ε as $\varepsilon =$[-0.6, +0.6]. This is the range of returns or income to capital ratios in the cross section from the bottom 1 percent to the top 99 percent.

Pinning down the parameters on aggregate shocks turned out to be somewhat difficult. We know that the difference between the minimum and maximum real per capita growth rate from 1976 to 1996 is 8.7 percent. According to the model with projects selected by the financial sector, underlying variation of the aggregate shocks would be yet larger. Thus we assume the *range* for the aggregate shocks θ at 10 percent. We vary the *mean* of θ and pick the support of θ as (1.047, 1.1471) to minimize sum of squared (production) errors of the actual GDP growth rate versus the model prediction. This is the only part of calibration which uses dynamic data. This is our benchmark.

The fixed cost q is a free parameter, and we take it to be $q = 5$ in model units of capital. By comparing the critical capital level k^* in the model units and k^* in the actual data in Thai baht, we find a scalar or "exchange rate" between the model units and the actual Thai baht. The critical capital level in model units is obtained by computing the value function, namely $k^* = 15$ under the benchmark parameter values. The critical capital level in the actual data is estimated using the SES and the observed fraction participating in 1976. That is, we use the actual wealth distribution of 1976 from SES of Thailand as the initial condition (in 1990 baht, following Jeong (2000)). We also use the information about participation in the financial system from the same SES. According to that survey the fraction of the population who had access to the financial system was 6 percent in 1976. The estimated cumulative distribution of wealth in 1976 shows that people who had wealth of more than 220,000 baht were 6 percent of the population in 1976. To generate the observed 6 percent participation in 1976 with the critical level of the model at $k^* = 15$, we set the scalar or "exchange rate" at about 15,000 baht per model unit per model unit capital.

Likelihood methods for estimation require the probability that a household j with initial wealth $k_{j,t-1}$ at period *t-1* would be observed to participate, $d_{jt} = 1$, in the formal financial system at date *t*, and $d_{jt} = 0$ otherwise. That is,

$$d_{jt} = 1, \quad if \ V(k_{jt} - q) \geq W(k_{jt})$$
$$= 0, \quad if \ V(k_{jt} - q) < W(k_{jt})$$

Equivalently,

$$d_{jt} = 1, \quad if \ k_{jt} \geq k^*$$
$$= 0, \quad if \ k_{jt} < k^{*\cdot}$$

We imagine in the SES cross-section for young households we are seeing wealth at the beginning of the period and the participation decision at the end of the period. Critical wealth k^* can be determined numerically, given an initial guessed parameter vector, denoted PM, for utility and technology. We determine the probability that saving (investment) at $k_{j,t-1}$, with fraction ϕ_{t-1} of that savings invested in the risky activity, delivers wealth k_j above (not less than) the threshold k*. Expressions for the critical value of composite shocks $\eta_t \equiv \theta_t + \varepsilon_t$, coming from the law of motion in 6.2.2 are given as

$$d_{jt} = 1, \quad if \ \eta_{jt} \geq \eta^*(k_{j,t-1}, PM)$$
$$= 0, \quad if \ \eta_{jt} < \eta^*(k_{j,t-1}, PM)$$

where

$$\eta^*(k_{j,t-1}, PM) \equiv \frac{1}{\phi(k_{j,t-1}, PM)} \left[\frac{k^*(PM)}{s(k_{j,t-1}, PM)} - (1 - \phi(k_{j,t-1}, PM))\delta \right]$$

Summing over all periods for a specified draw of shocks θ_t over the sample period, then weighting by the probability of those shocks, delivers the overall likelihood for each household j.

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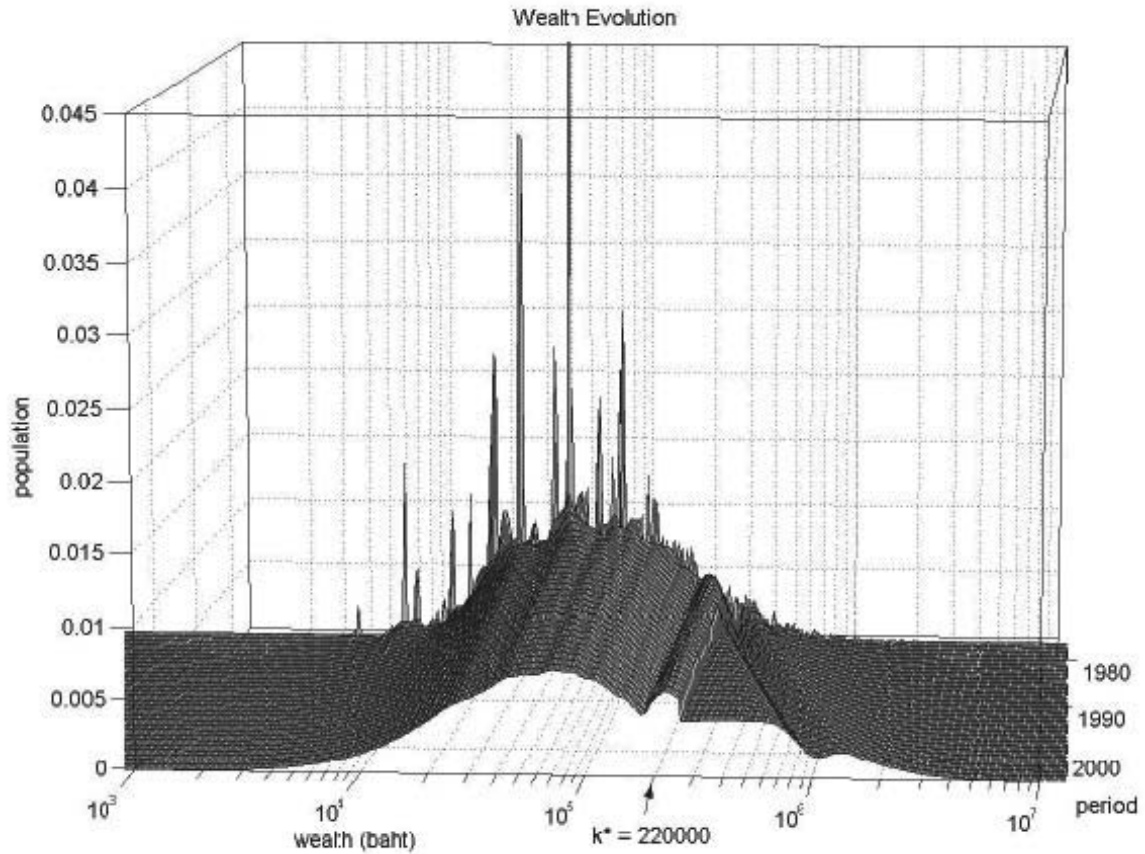
[Figure 6.2.2.3. Wealth Evolution. Source: Townsend and Ueda (2006)]

The driving underlying force in the model is the endogenous and evolving distribution of wealth. Again, the initial condition at 1976 comes from the SES data and Jeong's principal components measure of wealth. Figure 6.2.2.3 makes clear the tendency for those with access, with wealth above k^*, to take off from the rest of the distribution. One of the ridges is created by the assumption of uniform transactions costs q incurred at k^* (to be explored further below).

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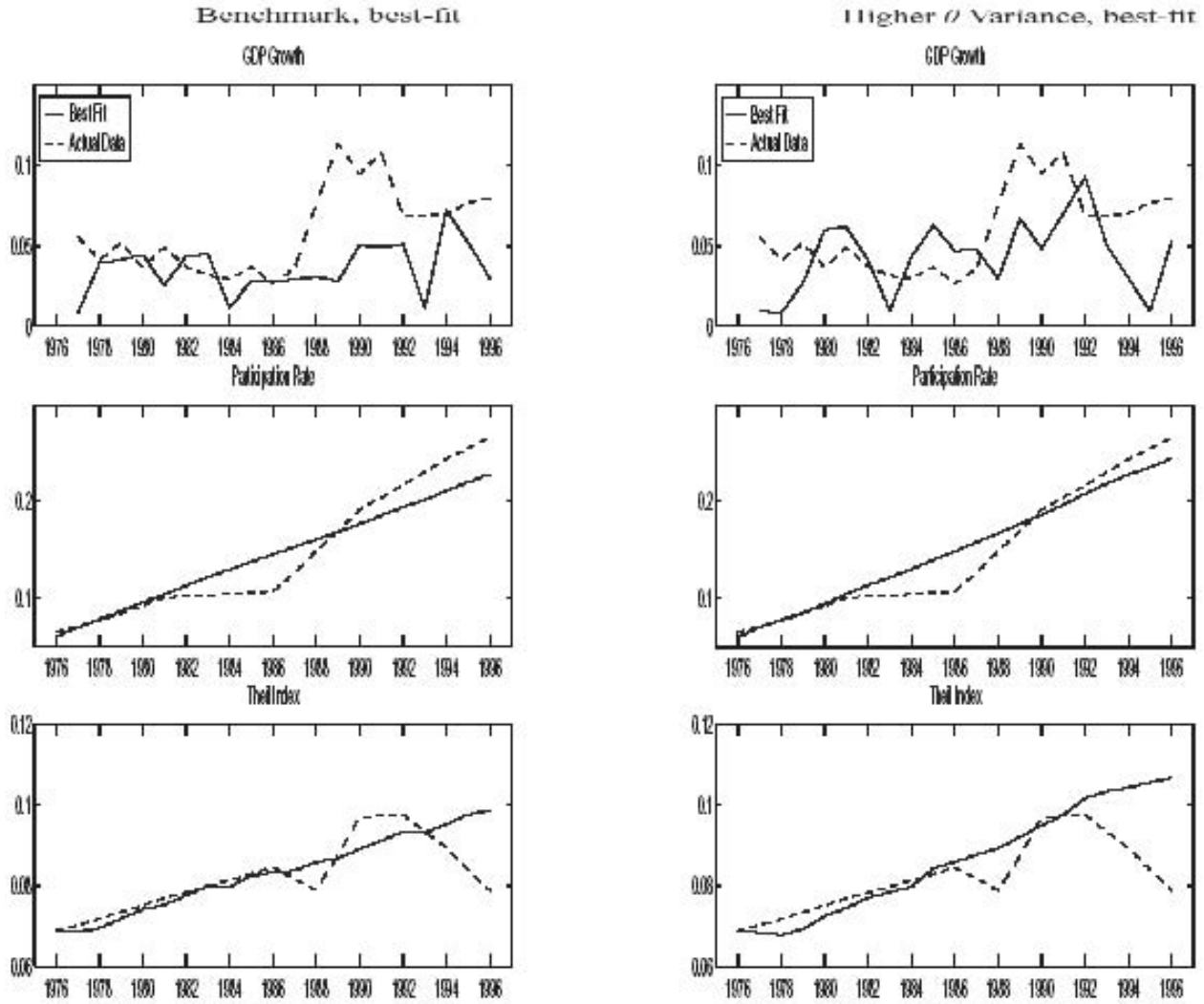
[Figure 6.2.2.4. Benchmark, best-fit (left-hand graphs) and Higher θ Variance, best-fit (right-hand graphs). Source: Townsend and Ueda (2006)]

The trends for growth, financial participation, and inequality delivered by the model, averaging over 1000 random draws for the aggregate shocks, are displayed the Figure 6.2.2.4. A variance co-variance weighted mean squared error criterion minimizing the distance between a given simulation and the actual data delivers a 'best fit' path, also displayed. Specifically, the metric is

$$\psi_s \equiv (x_s - x_0)' b_0^{-1} (x_s - x_0),$$

where x_s is the simulated data, and x_0 is the Thai actual path. Matrix b_0 is estimated by the simulated sample analogue

$$\frac{1}{S} \sum_{s=1}^{S} (x_s - x_0)' (x_s - x_0).$$

Draft: July 2010

Evidently, the model delivers a trend for financial participation that goes right though the middle of the Thai data. The model's Theil inequality measure coincides with the Thai data initially and then, after 1992, stays above the decreasing Thai level. The growth rate of the model is on average low and less volatile than GDP in the actual data. Note in particular the model with its entirely endogenous financial deepening misses the surge in the financial system and upturn in growth around 1986 that we have previous associated with financial liberalization. This gives credence to the view that the deviation above trend was indeed policy induced.

There is empirical literature connecting growth and inequality to financial deepening, arguing for example that more liberal systems and those with low inequality parameters grow faster. We need to try to compare this literature to the model at hand. Specifically, we conduct an experiment: we fix the benchmark economy, populate it with 1002 households respecting the initial 1976 Thai wealth distribution, and then draw idiosyncratic shocks in the population and aggregate temporal shocks for 30 years. We do this experiment 1000 times, with different shocks, generating in effect panel data for 1000 (artificial) countries. We then revisit these countries after 1976 to examine their status in later years.

The advantage of any formal, structural model of growth is that the mechanism or "drivers" are made clear. Here for example, given common initial inequality in the wealth distribution and the parameters of technology and preferences, the drivers are the realized draws of idiosyncratic and aggregate shocks. There are stationary aspects to the model: household savings and portfolio decisions at date t, hence the likelihood of financial participation at date $t+1$, are all determined by current wealth and current participation status. But aggregate growth, inequality, and overall financial deepening are not stationary time series even after taking logs and lags. They are all endogenous and all determined by these underlying shocks and decisions in complex and nonlinear ways. Note that these complex dynamics are not only found in our canonical model, but also in many other theoretical models that depict endogenous financial deepening, inequality, and growth.

King and Levine (1993) report that there is a robust positive relationship between "initial" 1960 financial depth and subsequent growth, averaged over 1960 to 1989. They conclude that financial services stimulated growth. Here we regress 20 year average growth rates on the "initial" 1985, or 1980, level of financial depth, controlling for the initial log level of GDP (as created by 5 or 10 years of early model history). Likewise Forbes (2000) replicates a typical finding in the empirical literature: a robust negative relationship between "initial" inequality in 1965 and average growth from 1965 to 1990. Here we regress 20 year average growth rates on initial 1985, or 1980, levels of inequality.

What shows up in the regression results appear to be determined by initial conditions and the history of shocks, rather than the structure of the model. There is an extreme, if easy, way to make this point. Suppose we had taken 1976 as an "initial" period. Then, all 1000 simulations share the same wealth distribution in 1976, and hence the same levels of inequality and financial depth. In other words, the true initial condition is the same for all 1000 simulated economies, meaning there would not exist any meaningful relationship between initial financial depth or initial inequality and subsequent growth. The fact that this is less true over time does not mitigate the point that a regression of growth onto financial depth and inequality is a questionable way to think about the data and possible structural models.

Forbes (2000) estimated a robust positive relationship between lagged inequality and five year average growth rates over 1965 to 1995, contrary to her long-run regressions. We construct medium-term, five year average variables and conduct panel estimation of the effect of lagged financial deepening and inequality on the GDP growth rate, controlling for country fixed effects, time dummies, and the lagged GDP levels in logarithms. While the sign on inequality is now positive in some instances, consistent with the results of Forbes (2000), the sign is negative in other instances, depending apparently on sampling and data availability, as it were, and inequality is never significant. Indeed, none of the regressors are significant. We conclude that regressions are not an effective way to examine the data from economies in transition. We need to use the structure of the presumed, trial model to assess the impact of inequality and financial reforms.

6.2.3 Distribution of Gains from Liberalization
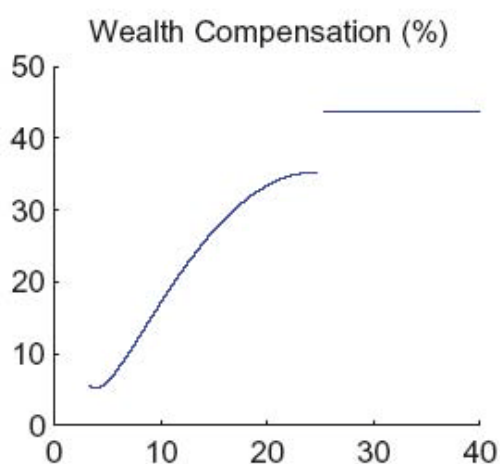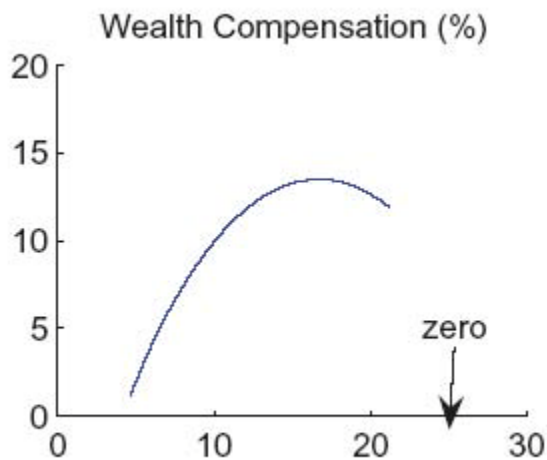
[Figure 6.2.3.1. Welfare gains from reduction of marginal costs (wealth compensation %) (left) and from reduction in entry costs (wealth compensation %) (right). Source: Townsend and Ueda (2008)]

If, as does seem evident from the model simulations, the Thai economy suffered from policy distortions, then we can ask what the welfare gains from liberalization were relative to a continued repression. In model terms, we vary the marginal costs of banking in proportion to an increasing share of government directed lending, as calibrated from actual data, raising this in the financial repression of the early 1980's – then lower in the liberalization period. We do the same in another experiment for the cost of entry q. We then compute the (discounted expected) utility gain and its consumption equivalent for the liberalization. The distribution of gains is evident in figure 6.2.3.1. The average gain is about 8%, and 27% for the reduction in transaction cost, a large number. The average gain for the reduction in entry costs is 2%. This is the group, otherwise near the threshold, which would have been willing to pay transactions costs to enter the financial system and could not when there is an artificial restriction effectively raising that cost. But though the welfare gains are large, the effect on growth is negligible.
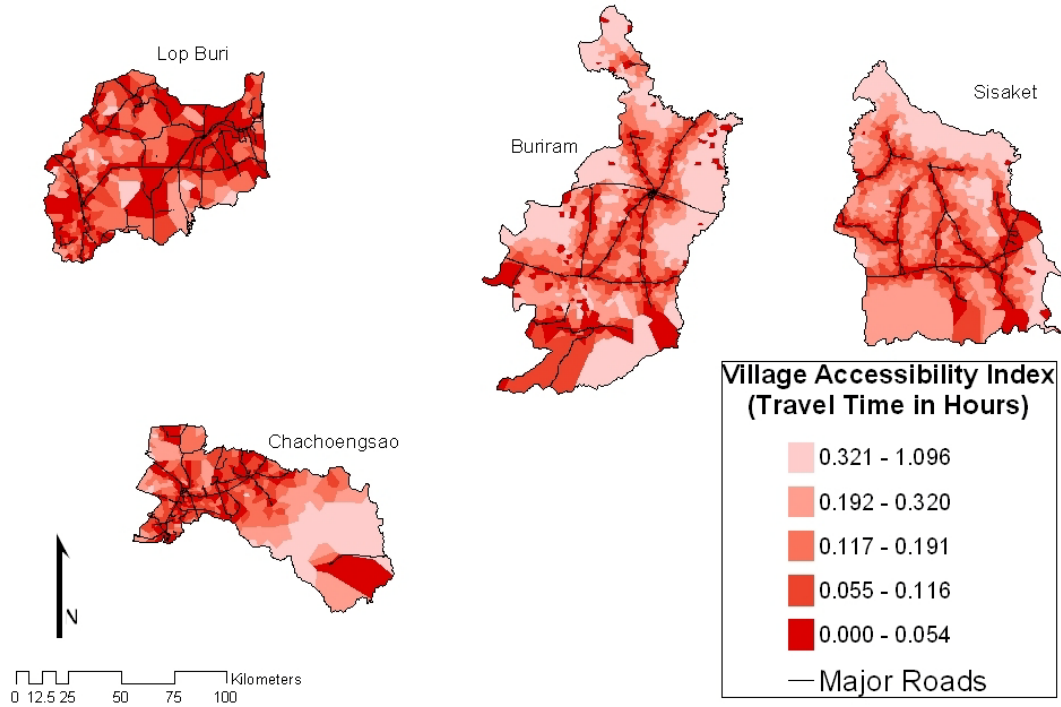
With heterogeneity in mind, we have conducted a preliminary sensitivity analysis, specifically allowing variation in the entry cost q over different education and geographic groups, utilizing additional information in SES. Fortunately, the model with its linear returns (and no endogenous prices) allows us to calibrate and simulate for various key education and geographic groups, one at a time. For example, we can distinguish SES households by the completed level of education of the head (elementary and advanced secondary). We continue to fix technology and preference parameters at their benchmark values, including the model version of q, hence $k*$. But for each group separately we center the initial (SES estimated) wealth distribution so that the initial participation rates of the Thai data match the predictions

Draft: July 2010

of the model (on the false assumption that everyone above the threshold was participating). Those initial participation rates in 1976 were 5 and 20 percent for the two chosen education groups (again, elementary and advanced secondary) and 5 and 16 percent for rural and urban households, respectively. We then simulate the model economy from 1976 to 1996 one group at a time. The model substantially over predicts access for the educated and urban households. The inference is that these households were suffering from implicit policy restrictions.

6.3   Occupation Choice and Financial Access at the Provincial/Village

The occupation choice and financial access choice models can each be taken to a more local, provincial context, as in the work done with Felkner (2006). Specifically, villages within four provinces have been geo-located and vectorized in a Geographic Information System. Thus data such as those from the CDD village census can be displayed on the maps and used in analysis. The four provinces are those of the original Townsend Thai survey, with two provinces in the Central region near Bangkok, Lop Buri and Chachoengsao, and two in the poorer Northeast, Buriram and Srisaket. As anticipated earlier, wealth and commercial bank access vary across provinces in the obvious way. The point here is that these and other variables vary within each province.

Agglomeration Accessibility Variable 1: Distance to Major Roads

Lop Buri

Buriram

Sisaket

Chachoengsao

Village Accessibility Index (Travel Time in Hours)

- 0.321 - 1.096
- 0.192 - 0.320
- 0.117 - 0.191
- 0.055 - 0.116
- 0.000 - 0.054
— Major Roads

N

Kilometers
0 12.5 25   50   75   100

[Figure 6.3.1. CDD Village and Amphoe District Center Locations (top) and Distance-Cost Variable (Travel Time to Major Roads) (bottom). Source: Felkner and Townsend (2007)]

Roads, district center, and all transport systems can also be vectorized and used in analysis. See Figure 6.3.1. Time to a major highway and to the intersections of major highways are computed and can be shown to bear some relationship to wealth, financial access, frequency of enterprise, and other variables.

LEB and GJ Estimated Parameter Values

LEB Estimated Parameters

Parameters:	α	β	ω	η	m	ρ	σ	γ	g_z	ε
			Allowed To Vary							
Initial Values (from Jeong and Townsend (2003) for SES data):	1.0011	0.0940	0.2400	0.0000	-1.0000	0.0033	0.0000	0.0120	0.0020	0.0565
Estimated Values for CDD:	0.9186	0.0910	0.2727	0.0208	-0.0004					

Estimated LEB M Parameter: Distance Modified LEB Simulation	Bin 1	Bin 2	Bin 3		
Sample Divided into Three Bins by Equal Distance	-0.2143	0.3612	0.2659		

Estimated LEB M Parameter: Distance Modified LEB Simulation	Bin 1	Bin 2	Bin 3	Bin 4	Bin 5
Sample Divided into Five Bins by Equal Number of Villages	-1.0000	-1.0000	-0.1587	0.3978	0.4256

GJ Estimated Parameters

Parameters:	σ	q	δ	θ	ε	β	γ
Initial Values (from Townsend and Ueda (2003) for Townsend Thai data):	1.000	5.000	1.054	1.047,1.147	-0.600,0.600	0.960	0.000

[Table 6.3.2. Source: Felkner and Townsend (2004), unpublished]

Draft: July 2010

The earlier models are initialized and then simulated using the within-province village data. The financial access model uses exactly the same parameters that were calibrated for the work of Townsend and Ueda (2005) at the national level, using the Townsend Thai data. The occupation choice model starts with the parameters that were used in the work with Giné and Townsend (2004), and also Jeong and Townsend (2005) using the SES data. Most of these parameters remain fixed throughout the analysis below. See Table 6.3.2. However, the key cost skewness parameter m, was calibrated to best fit to the CDD village data. Specifically the end-of-period, 1996 model simulation of frequency of enterprise, sorting by village was calibrated against the actual frequency allowing parameter m to vary by bins, according to their distance from major intersections. Strikingly, the greater the distance from major intersections, the higher these estimated set up costs.

Occupational Choice Simulated Vs. Actual Means
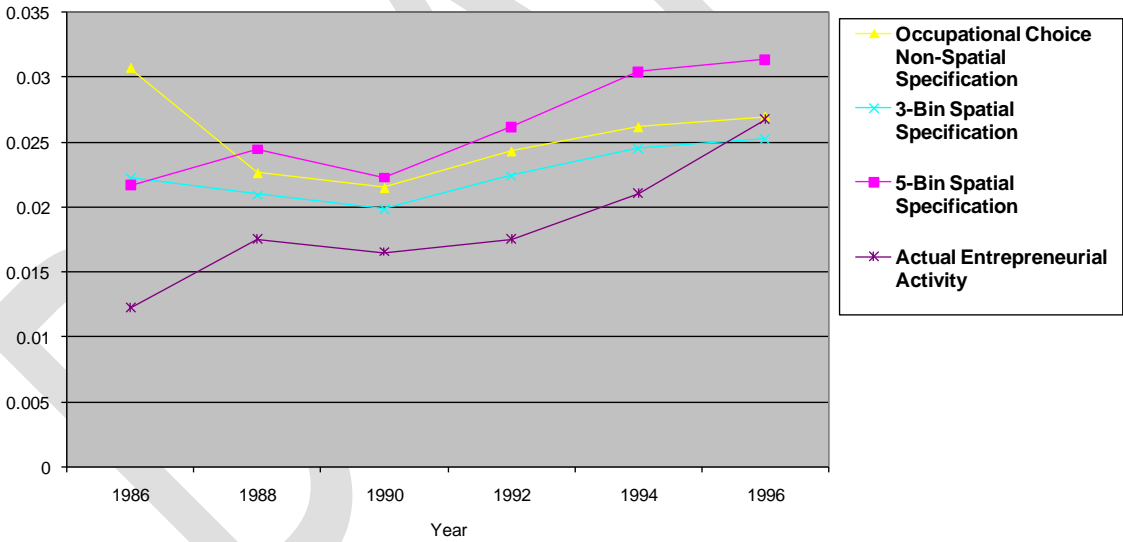
[Figure 6.3.3. Felkner and Townsend (2004), unpublished]

Financial Deepening Simulation - Actual Vs. Simulated Financial Credit Access
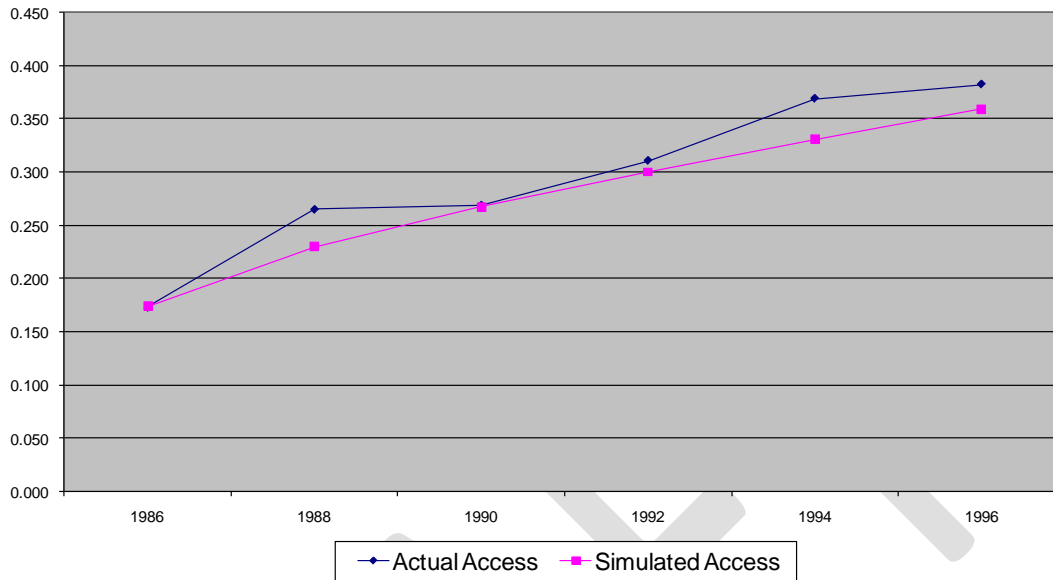
[Figure 6.3.4. Felkner and Townsend (2007)]

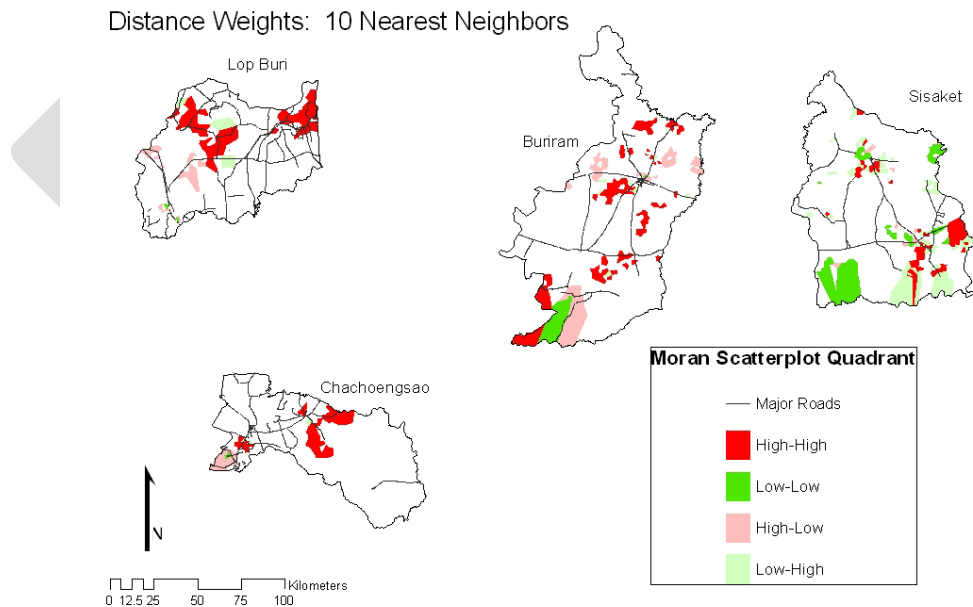# Financial Deepening Simulation - Actual Vs. Simulated Wealth

[Figure 6.3.5. Felkner and Townsend (2007)]

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As earlier, but here with village level data, the time series generated from the two models, occupation choice and financial access choice, are close to the actual data. See Figures 6.3.3. to 6.3.5. For the occupation choice model the model-simulated enterprise variable is above the data, as in actuality the measured enterprise variable in the CDD data is quite low. But the simulated variable has the same trend and moves up and down almost exactly as in the data. The average simulation of the financial access model hits the trend in access very well and only under-predicts slightly, for the 1986-1988 and 1990-1996 periods. The model predicts an increase in village wealth, as in the data. But here, using wealth data, not income data, it is clear that the model under-predicts the observed, dramatic increase in the wealth of villages. (In the SES wealth growth is also much higher than income growth, but income is better measured in the SES. Income is in turn measured poorly in the CDD data).

The occupation choice model also does well spatially. Geographic prediction errors for the end of the sample year, 1996, that is model-predicted minus actual frequency of enterprise, display some clustering initially, in Figure 6.3.9, but these correlated error areas virtually disappear in Figure 6.3.10 when allowing cost parameter m to vary with distance as indicated earlier. Varying costs are important as a determinant of who goes into business.

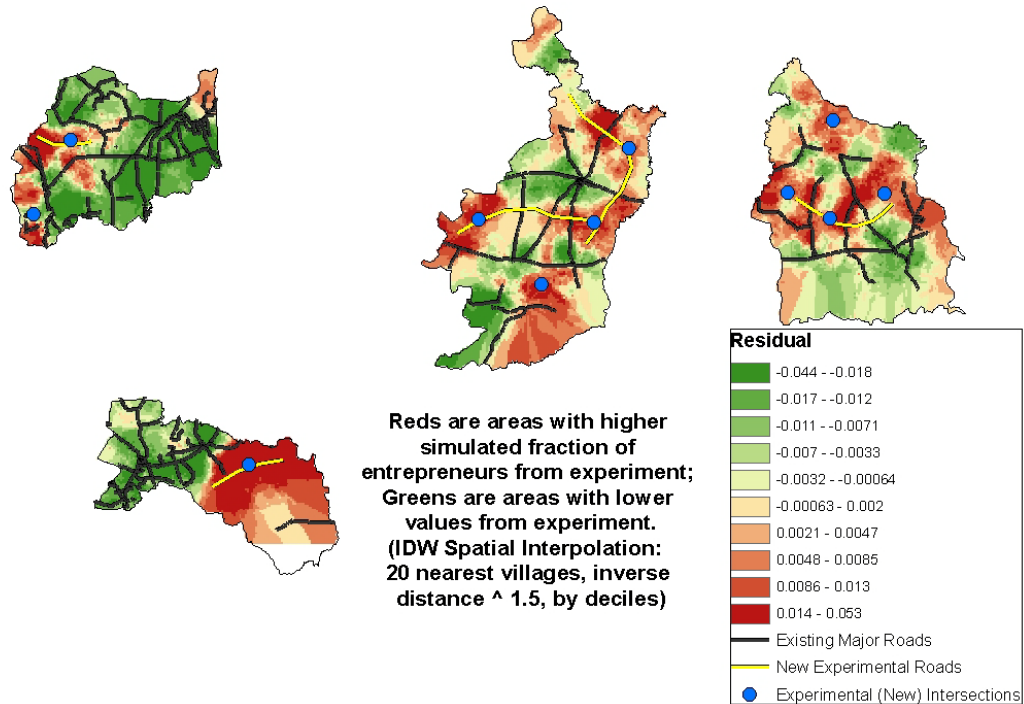[Figure 6.3.6. Lloyd-Ellis-Bernhardt (LEB) Simulation Residuals, Local Moran Map at P=.05 Cut-off Value. Source: Felkner and Townsend (2007)]

Draft: July 2010

Occupational Choice Structural Simulation
Spatial Specification (5 Bin) Simulation Residuals:
M Parameter Varies With Space
(Local Moran Map at P=.05 Cut-Off Value)

Distance Weights: 10 Nearest Neighbors
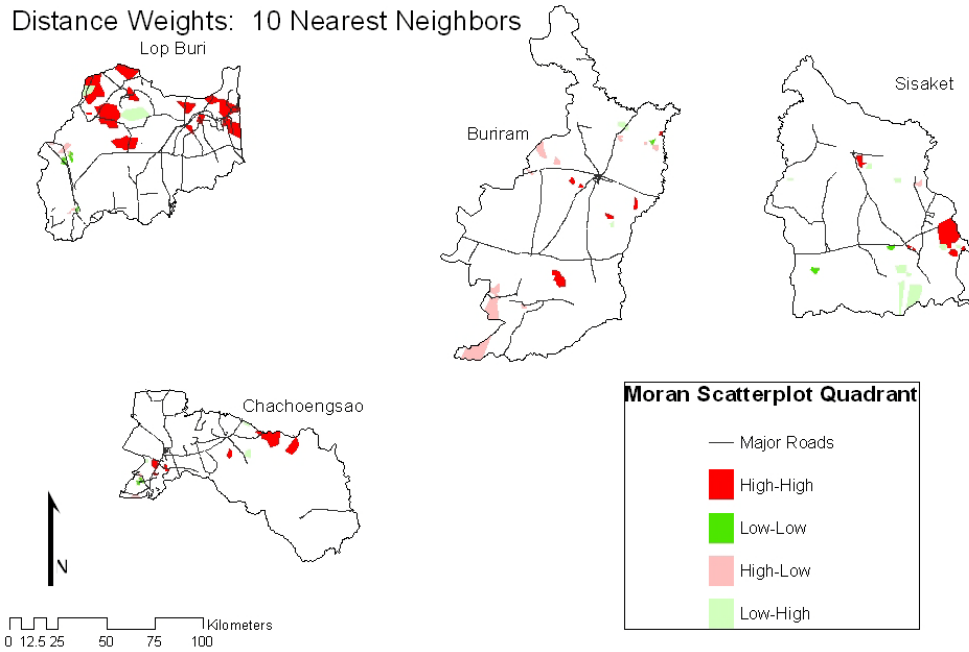
[Figure 6.3.7. Lloyd-Ellis-Bernhardt (LEB) Distance-Modified (5-Bin) Simulation Residuals, Local Moran Map at P=.05 Cut-off Value. Source: Felkner and Townsend (2007)]

**Residuals from Entrepreneurial Choice Experiment:
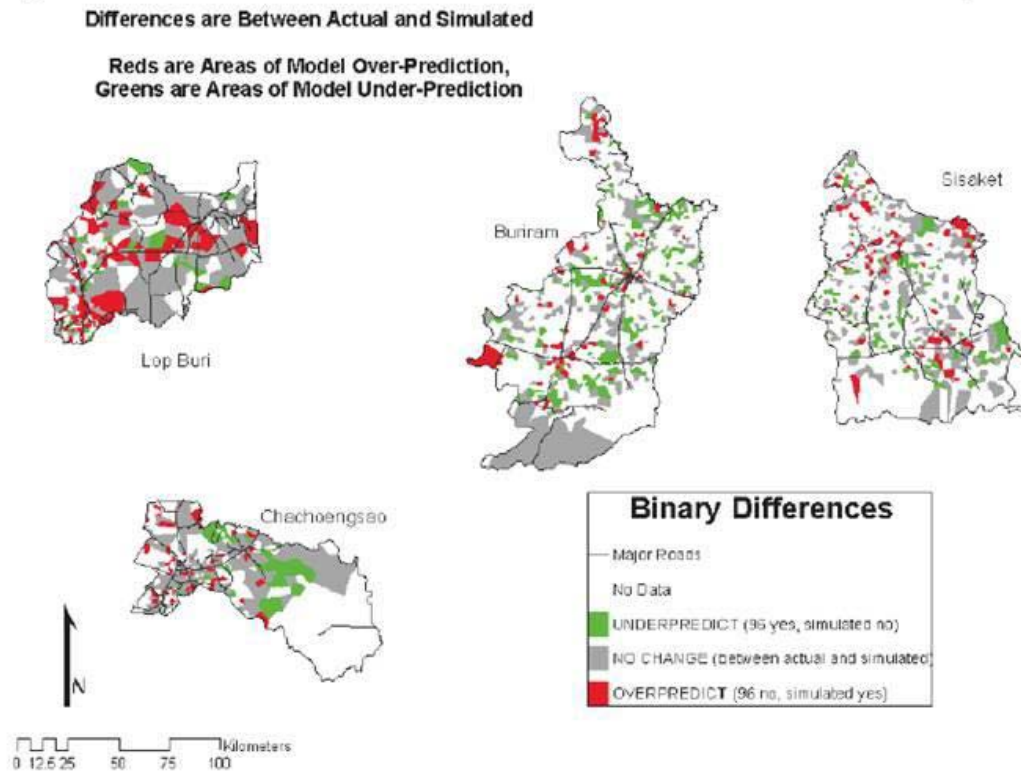Effect of Adding New (Hypothetical) Road Intersections**

Reds are areas with higher
simulated fraction of
entrepreneurs from experiment;
Greens are areas with lower
values from experiment.
(IDW Spatial Interpolation:
20 nearest villages, inverse
distance ^ 1.5, by deciles)

Residual

■	-0.044 - -0.018
■	-0.017 - -0.012
■	-0.011 - -0.0071
■	-0.007 - -0.0033
■	-0.0032 - -0.00064
■	-0.00063 - 0.002
■	0.0021 - 0.0047
■	0.0048 - 0.0085
■	0.0086 - 0.013
■	0.014 - 0.053
—	Existing Major Roads
—	New Experimental Roads
●	Experimental (New) Intersections

[Figure 6.3.8. Source: Felkner and Townsend (2007)]

Indeed, the impact of road construction is evident through the lens of the model. In a simulation we moved the location of roads with their major intersections into agricultural areas. The frequency of business enterprise jumps up dramatically.

Figure 20: 1996 GJ Access Index Simulation Differences: Binary Values

Differences are Between Actual and Simulated

Reds are Areas of Model Over-Prediction,
Greens are Areas of Model Under-Prediction

[Figure 6.3.9. 1996 GJ Access Index Simulation Differences. Note: Differences are between actual and simulated. Reds are areas of model over-prediction, greens are areas of model underprediction. Source: Felkner and Townsend (2007), unpublished]

**Figure 20: GJ Wealth Simulation Residuals
Local Moran Map at P=.05 Cut-Off Value**

Distance Weights: 10 Nearest Neighbors
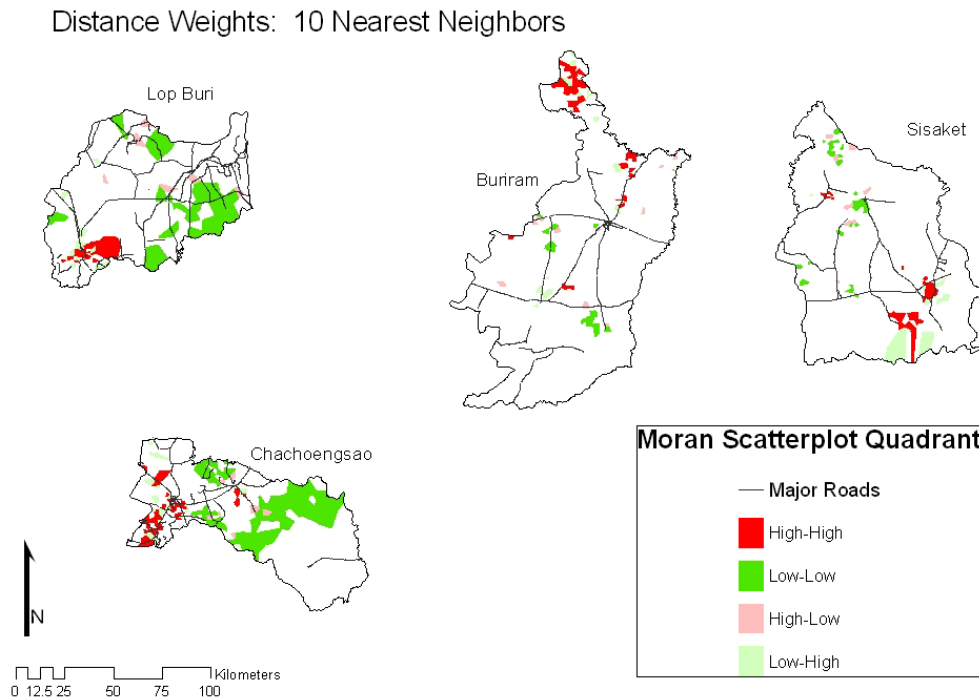
[Figure 6.3.10. 1996 GJ Wealth Simulation Residuals Local Moran Map at P=.05 Cut-off Value. Source: Felkner and Townsend (2007), unpublished]

Spatially, the financial access model does less well, though this could be anticipated from the earlier work with Ueda and the reduced form regressions. Prediction errors for financial access show *significant clustering, with model over prediction* in and around the red hot-spots of initial concentration near the intersections of major roads and district centers and green cool-spots of *model under prediction* in the less developed areas of eastern Chachoengsao and the more rural areas of Srisaket and Buriram. The prediction errors for wealth display a similar, if even more salient, pattern. Wealth grew considerably more than predicted off the main roads and away from towns.

(Coefficient values in bold, probability values in italics)

Independent Variables	Dependent Variable: LEB Simulation 1996 Residuals		
	Distance To Major Roads	Distance To Major Intersections	Distance to District Centers
Distance	**0.0033**	**0.0001**	**0.0285**
	0.8925	*0.0986*	*0.2589*
Intermediation Index	**0.0431**	**0.0427**	**0.0426**
	0.0001	*0.0001*	*0.0001*
Education	**-0.0030**	**-0.0003**	**-0.0026**
	0.9060	*0.9921*	*0.9183*
Wealth	**-0.0002**	**-0.0001**	**-0.0002**
	0.2793	*0.4016*	*0.3703*
R-Squared	**0.0686**	**0.0700**	**0.0703**

Independent Variables	Dependent Variable: LEB Distance-Modified 3-Bin Simulation Residuals		
	Distance To Major Roads	Distance To Major Intersections	Distance to District Centers
Distance	**-0.0044**	**0.0001**	**0.0166**
	0.8621	*0.9947*	*0.5301*
Intermediation Index	**-0.0089**	**-0.0089**	**-0.0091**
	0.2460	*0.2486*	*0.9504*
Education	**0.0013**	**0.0014**	**0.0017**
	0.9611	*0.9582*	*0.9504*
Wealth	**-0.0001**	**-0.0001**	**-0.0001**
	0.6719	*0.6880*	*0.7598*
R-Squared	**0.0331**	**0.0330**	**0.0336**

Independent Variables	Dependent Variable: LEB Distance-Modified 5-Bin Simulation Residuals		
	Distance To Major Roads	Distance To Major Intersections	Distance to District Centers
Distance	**-0.0207**	**0.0001**	**0.0164**
	0.4312	*0.1518*	*0.5441*
Intermediation Index	**-0.0024**	**-0.0016**	**-0.0025**
	0.7578	*0.8403*	*0.7486*
Education	**0.0244**	**0.0206**	**0.0251**
	0.3723	*0.4529*	*0.3594*
Wealth	**-0.0002**	**-0.0002**	**-0.0001**
	0.3810	*0.2615*	*0.4732*
R-Squared	**0.0230**	**0.0250**	**0.0227**

Independent Variables	Dependent Variable: GJ Wealth Simulation 1996 Residuals		
	Distance To Major Roads	Distance To Major Intersections	Distance to District Centers
Distance	**-17.4512**	**-0.0008**	**-31.5170**
	0.0002	*0.0001*	*0.0001*
Intermediation Index	**2.1993**	**2.8967**	**2.1405**
	0.1376	*0.0462*	*0.1448*
Education	**34.6477**	**30.5663**	**33.3364**
	0.0001	*0.0001*	*0.0001*
R-Squared	**0.3051**	**0.3320**	**0.3171**

Independent Variables	Dependent Variable: GJ Credit Intermediation Simulation 1996 Residuals		
	Distance To Major Roads	Distance To Major Intersections	Distance to District Centers
Distance	**-0.7028**	**-0.0001**	**-0.6625**
	0.0000	*0.0000*	*0.0002*
Education	**0.0027**	**0.0024**	**0.0024**
	0.0002	*0.0009*	*0.0006*
Wealth	**1.1009**	**1.0195**	**1.1015**
	0.0000	*0.0000*	*0.0000*
R-Squared	**0.5853**	**0.5863**	**0.5844**

[Table 6.3.11. LEB and GJ 1996 Simulation Differences Regressed Onto Distance Variables. Source: Felkner and Townsend (2004), unpublished]

Sisaket	LEB Dependent Variables			GJ Dependent Variables					
Independent Variables	LEB Residuals	LEB 3-Bin Residuals	LEB 5-Bin Residuals	GJ Access Index	GJ Wealth Residuals	GJ BAAC Residuals	GJ Commercial Banks	GJ Suppliers' Credit	GJ Village Savings
North-South Regimes	**-0.0194**	**-0.0026**	**-0.0050**	**0.3106**	**1.2029**	**0.1092**	**0.3978**	**0.3426**	**0.0925**
	0.0460	*0.7882*	*0.6205*	*0.0000*	*0.5861*	*0.0050*	*0.0000*	*0.0000*	*0.1001*
Two-Clusters Regimes	**0.0082**	**0.0134**	**0.0255**	**0.2683**	**13.0947**	**0.1339**	**0.2929**	**0.3656**	**0.1061**
	0.3998	*0.1677*	*0.0100*	*0.0001*	*0.0000*	*0.0008*	*0.0001*	*0.0000*	*0.0658*
Three-Clusters Regimes	**-0.0105**	**-0.0054**	**0.0093**	**0.3176**	**12.8600**	**0.1450**	**0.3072**	**0.4186**	**0.1405**
	0.2792	*0.5816*	*0.3526*	*0.0000*	*0.0000*	*0.0002*	*0.0000*	*0.0000*	*0.0122*
Distance To Two-Clusters	**-0.0001**	**-0.0001**	**-0.0001**	**-0.0001**	**-0.0003**	**-0.0001**	**-0.0001**	**-0.0001**	**-0.0001**
	0.0419	*0.0157*	*0.0005*	*0.0567*	*0.0001*	*0.0013*	*0.0130*	*0.0001*	*0.8211*
Distance To Three-Clusters	**0.0000**	**-0.0001**	**-0.0001**	**-0.0001**	**-0.0003**	**-0.0001**	**-0.0001**	**-0.0001**	**-0.0001**
	0.9034	*0.8430*	*0.1437*	*0.0005*	*0.0001*	*0.0001*	*0.0006*	*0.0000*	*0.3732*

Buriram	LEB Dependent Variables			GJ Dependent Variables					
Independent Variables	LEB Residuals	LEB 3-Bin Residuals	LEB 5-Bin Residuals	GJ Access Index	GJ Wealth Residuals	GJ BAAC Residuals	GJ Commercial Banks	GJ Suppliers' Credit	GJ Village Savings
Distance To Three-Clusters	**0.0000**	**-0.0001**	**-0.0001**	**-0.0001**	**-0.0004**	**-0.0001**	**-0.0001**	**-0.0001**	**-0.0001**
	0.6099	*0.5685*	*0.8250*	*0.1974*	*0.0000*	*0.0128*	*0.0197*	*0.0003*	*0.0058*
Distance To Four-Clusters	**0.0000**	**0.0000**	**-0.0001**	**-0.0001**	**-0.0004**	**-0.0001**	**-0.0001**	**-0.0001**	**-0.0001**
	0.3582	*0.4936*	*0.5871*	*0.1595*	*0.0000*	*0.0332*	*0.0285*	*0.0005*	*0.0525*

Lop Buri	LEB Dependent Variables			GJ Dependent Variables					
Independent Variables	LEB Residuals	LEB 3-Bin Residuals	LEB 5-Bin Residuals	GJ Access Index	GJ Wealth Residuals	GJ BAAC Residuals	GJ Commercial Banks	GJ Suppliers' Credit	GJ Village Savings
East-West Regimes	**-0.0370**	**-0.0310**	**-0.0209**	**0.1665**	**20.5449**	**-0.0446**	**0.2929**	**0.2857**	**0.1034**
	0.0105	*0.0440*	*0.2057*	*0.1342*	*0.0001*	*0.3278*	*0.0014*	*0.0004*	*0.2128*
Distance To One-Cluster	**0.0000**	**0.0000**	**0.0000**	**-0.0001**	**-0.0004**	**-0.0001**	**-0.0001**	**-0.0001**	**-0.0001**
	0.0059	*0.0792*	*0.4588*	*0.0207*	*0.0000*	*0.7083*	*0.0014*	*0.0000*	*0.2001*
Distance To Two-Clusters	**0.0000**	**0.0000**	**-0.0001**	**-0.0001**	**-0.0010**	**-0.0001**	**-0.0001**	**-0.0001**	**-0.0001**
	0.0730	*0.3756*	*0.8741*	*0.0002*	*0.0000*	*0.5291*	*0.0149*	*0.0000*	*0.0884*

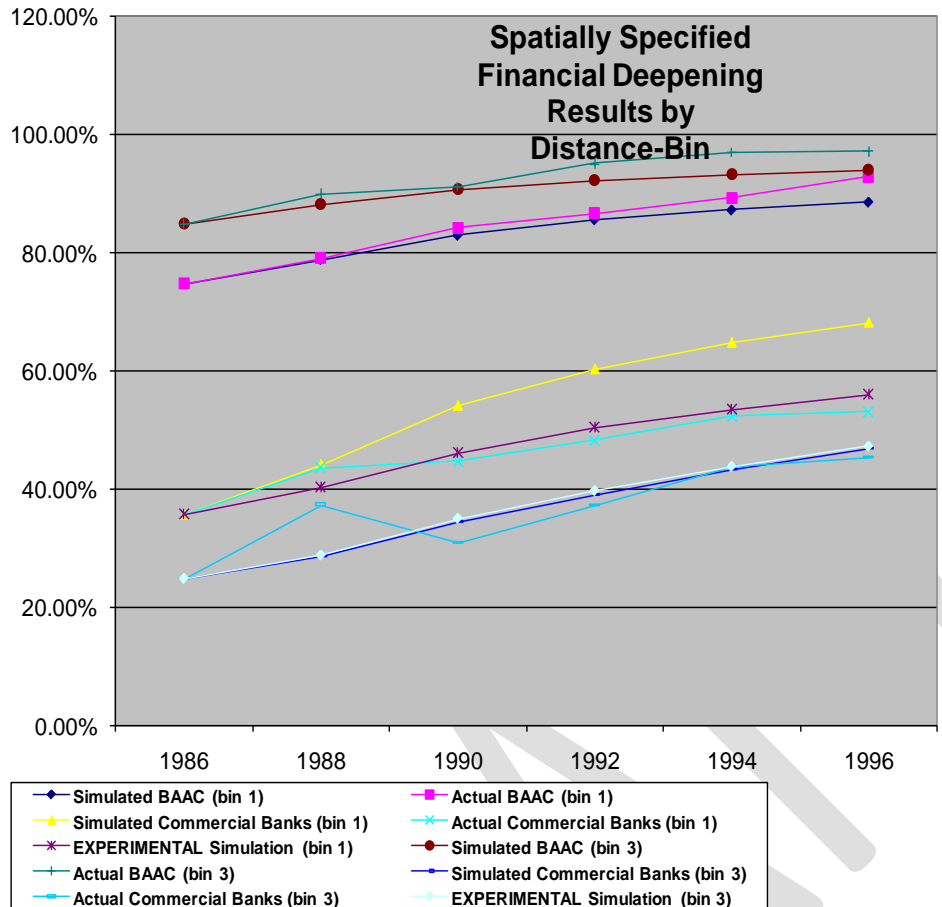| Chachoengsao	LEB Dependent Variables			GJ Dependent Variables					
Independent Variables	LEB Residuals	LEB 3-Bin Residuals	LEB 5-Bin Residuals	GJ Access Index	GJ Wealth Residuals	GJ BAAC Residuals	GJ Commercial Banks	GJ Suppliers' Credit	GJ Village Savings
East-West Regimes	**-0.0219**	**-0.0139**	**0.0067**	**0.2589**	**30.9920**	**0.0500**	**0.1995**	**0.2330**	**0.1616**
	0.4981	*0.6627*	*0.8324*	*0.0005*	*0.0000*	*0.1047*	*0.0026*	*0.0031*	*0.0664*
West Cluster	**-0.0086**	**-0.0005**	**0.0151**	**0.2181**	**29.8703**	**0.0286**	**0.1472**	**0.1738**	**0.1610**
	0.7754	*0.9865*	*0.6055*	*0.0052*	*0.0000*	*0.3779*	*0.0338*	*0.0345*	*0.0784*

[Table 6.3.12. Summary of LEB and GJ Simulation Residuals Onto Spatial Heterogeneity Variables. Source: Felkner and Townsend (2004), unpublished]

Multivariate regressions of the prediction errors confirm these patterns. The spatially-calibrated occupation choice model has prediction errors which are not correlated with distance to major roads, major intersections, or district centers, nor with wealth, education, or financial access. Being in the area of a 1986 agglomeration hot spots, or distance to the center of such hot spots, are rarely significant, or of the wrong sign, as in Lop Buri.

In contrast, the financial choice model over predicts for villages near major roads, the intersections of major roads, or district centers and over prediction with increasing levels of education and wealth. Being in a 1986 agglomeration hot spot is highly correlated with the model's over prediction of financial access, and distance to the center of such spots is a significant negative covariate for the prediction error in access almost all the time. The same pattern emerges with wealth.

These patterns hold for many of the principal financial sector providers, with the telling exception of the BAAC in the central areas provinces. We now turn out attention to this.

Draft: July 2010

Spatially Specified
Financial Deepening
Results by
Distance-Bin

Legend:
- Simulated BAAC (bin 1)
- Actual BAAC (bin 1)
- Simulated Commercial Banks (bin 1)
- Actual Commercial Banks (bin 1)
- EXPERIMENTAL Simulation (bin 1)
- Simulated BAAC (bin 3)
- Actual BAAC (bin 3)
- Simulated Commercial Banks (bin 3)
- Actual Commercial Banks (bin 3)
- EXPERIMENTAL Simulation (bin 3)

[Figure 6.3.13. Source: Felkner and Townsend (2004), unpublished]

The financial access model can be initialized and simulated separately for each financial sector provider, again respecting distance from major intersections. For bin 1, villages close to the intersections of major roads, the model under predicts somewhat the expansion of the BAAC and over-predicts substantially the expansion of commercial banks. This would be consistent with the expansion of the BAAC, targeting outlying provinces like those far away from Bangkok, also consistent with restrictions, or a political economy motive, that might have impeded the expansion of commercial banks in areas they might otherwise be more prone to serve, the educated middle class.

Related, if we take high wealth villages from bin 1, near the main roads, and redistribute them to bin 3, far from main roads, the model predicts that commercial bank expansion in bin 1 would be much as we see it in the data (only slightly higher). The distribution of wealth in the model has an impact on growth and financial deepening. This particular experiment moves villages away from a key threshold in

the high growth urban sector to a more rural sector where they are already over the threshold, hence no subsequent transition effects through the extensive margin.

**Financial Deepening Simulation -
k^defined by actual wealth distribution and participation rate**
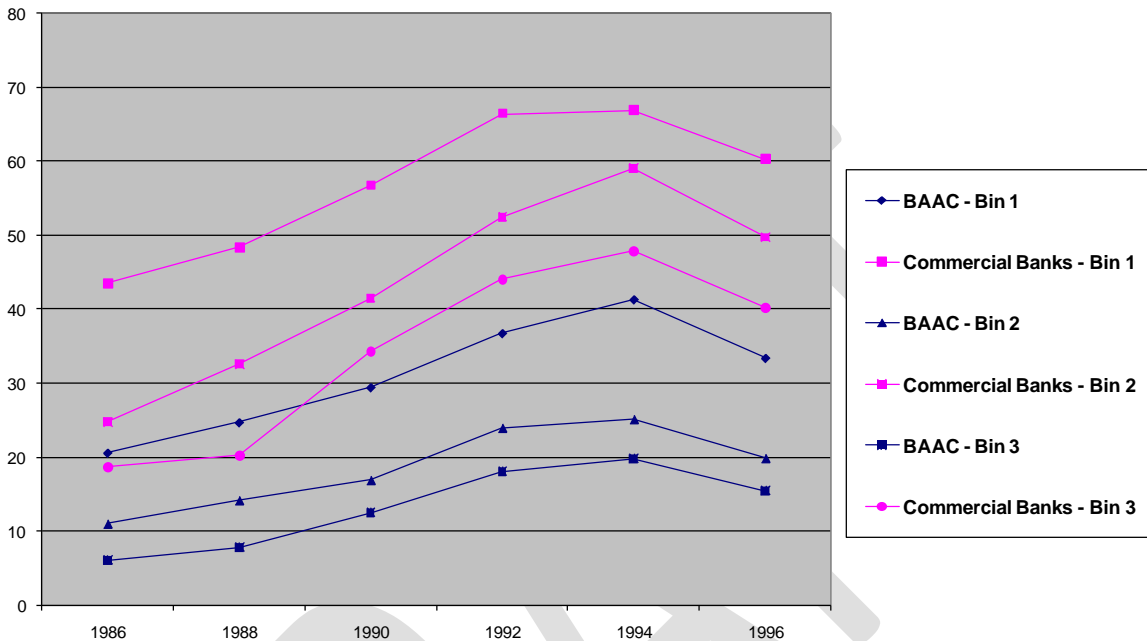
[Figure 6.3.14. Financial Deepening Simulation - k^ Defined by Actual Wealth Distribution and Participation Rate. Source: Felkner and Townsend (2007)]

Indeed, the structure of the model can be used to rationalize the data we see, not by moving wealth but by varying the supposed transaction cost. See Figure 6.3.13. Consistently, costs are lower for the BAAC. But for both the BAAC and commercial banks costs are *higher* for those *closer* to the intersection of major roads.

If, however, wealth were measured inaccurately, and had more mass in the right tail than in measured reality, then these estimates could be off. Likewise, the redistribution of wealth away from high wealth areas in the earlier experiment might only be capturing a measurement error correction.

6.4   Disaggregated to the Household Levels: Successes and Anomalies

The two models can also be taken to household level data, First, as described earlier, both the occupation choice model and financial access choices model are estimated against the SES using the likelihoods of the cross sectional data for young households, aged less than 30. Here, moreover, we disaggregate into sectors.

The goal is to try to understand the patterns in growth and inequality that were described earlier, namely, high composition effects for financial access and high income effects for occupation.

By Occupation			
	Subgroup	Composition	Total
Thailand	0.867	0.032	0.899
LEB	0.115	0.754	0.869
By Financial Participation			
	Subgroup	Composition	Total
Thailand	0.580	0.319	0.899
LEB	0.413	0.456	0.869
By Joint Category			
	Subgroup	Composition	Total
Thailand	0.573	0.326	0.899
LEB	0.141	0.728	0.869

[Table 6.4.1.Growth Decompositions. Source: Jeong and Townsend (2008)]

Specifically, the occupation choice model (LEB) at estimated parameter values delivers repeated cross sections of household data, as in the SES, and so the model's predictions for the growth of income and inequality can be compared to growth and inequality in the SES data. As is obvious from Table 6.4.1, for growth, the composition effects of population shifts into non-farm business are positive in the model, as in the data, but the effect is much larger in the model, which apparently overdoes the occupation dichotomy. Keeping track of financial access as another category, jointly, moves the model closer to the data, but the gap remains substantial.

By Occupation					
	Within-Group		Across-Group		Total
	Subgroup	Composition	Income Gap	Composition	
Thailand	0.524	0.001	-0.051	0.010	0.483
LEB	0.042	0.022	-1.056	1.881	0.338
By Financial Participation					
	Within-Group		Across-Group		Total
	Subgroup	Composition	Income Gap	Composition	
Thailand	0.304	0.032	0.015	0.133	0.483
LEB	-0.177	0.189	-0.066	0.439	0.338
By Joint Category					
	Within-Group		Across-Group		Total
	Subgroup	Composition	Income Gap	Composition	
Thailand	0.340	0.028	-0.003	0.120	0.483
LEB	0.015	0.053	-0.750	1.371	0.338

[Table 6.4.2. Decomposition of Aggregate Inequality Change in LEB. Source: Jeong and Townsend (2008)]
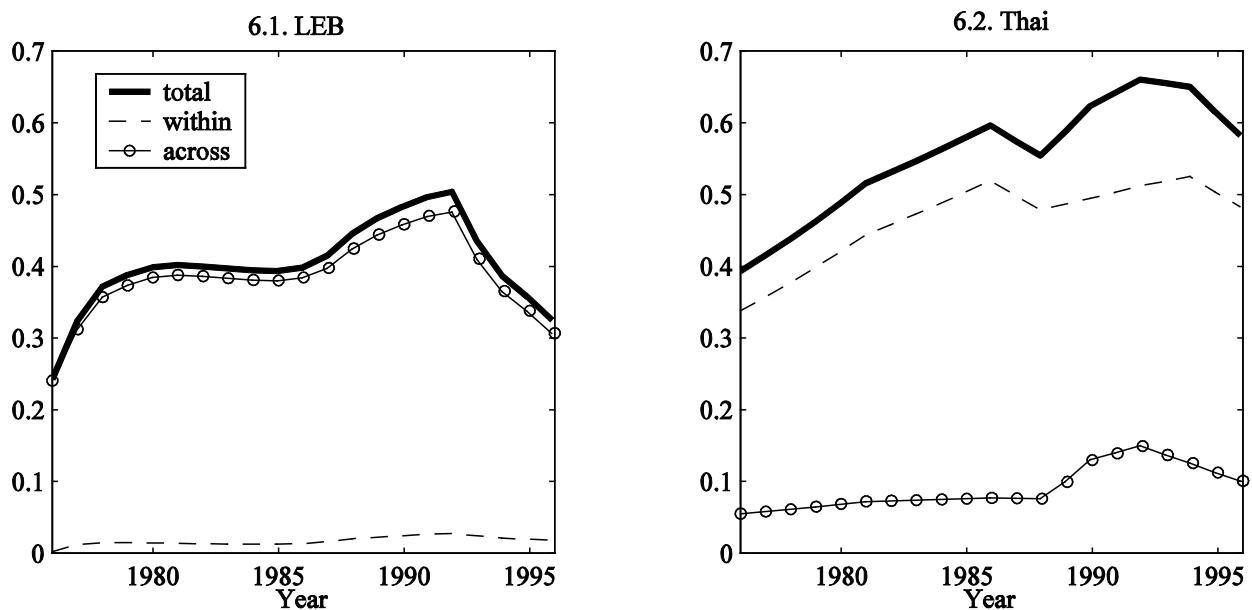
Figure 6. Within vs. Across Inequality Decomposition .

[Figure 6.4.3.Within vs. Across Inequality Decomposition. Source: Jeong and Townsend (2008)]

Similarly, the occupation choice models gets correct the sign of each of the terms in the change in inequality, positive for the two composition effects and negative for the income convergence effect. But these are much smaller in the data, while the "unexplained" within-group effect is much large in the data. See Figure 6.4.3. Financial access and occupation categories jointly again allow the model to do better.
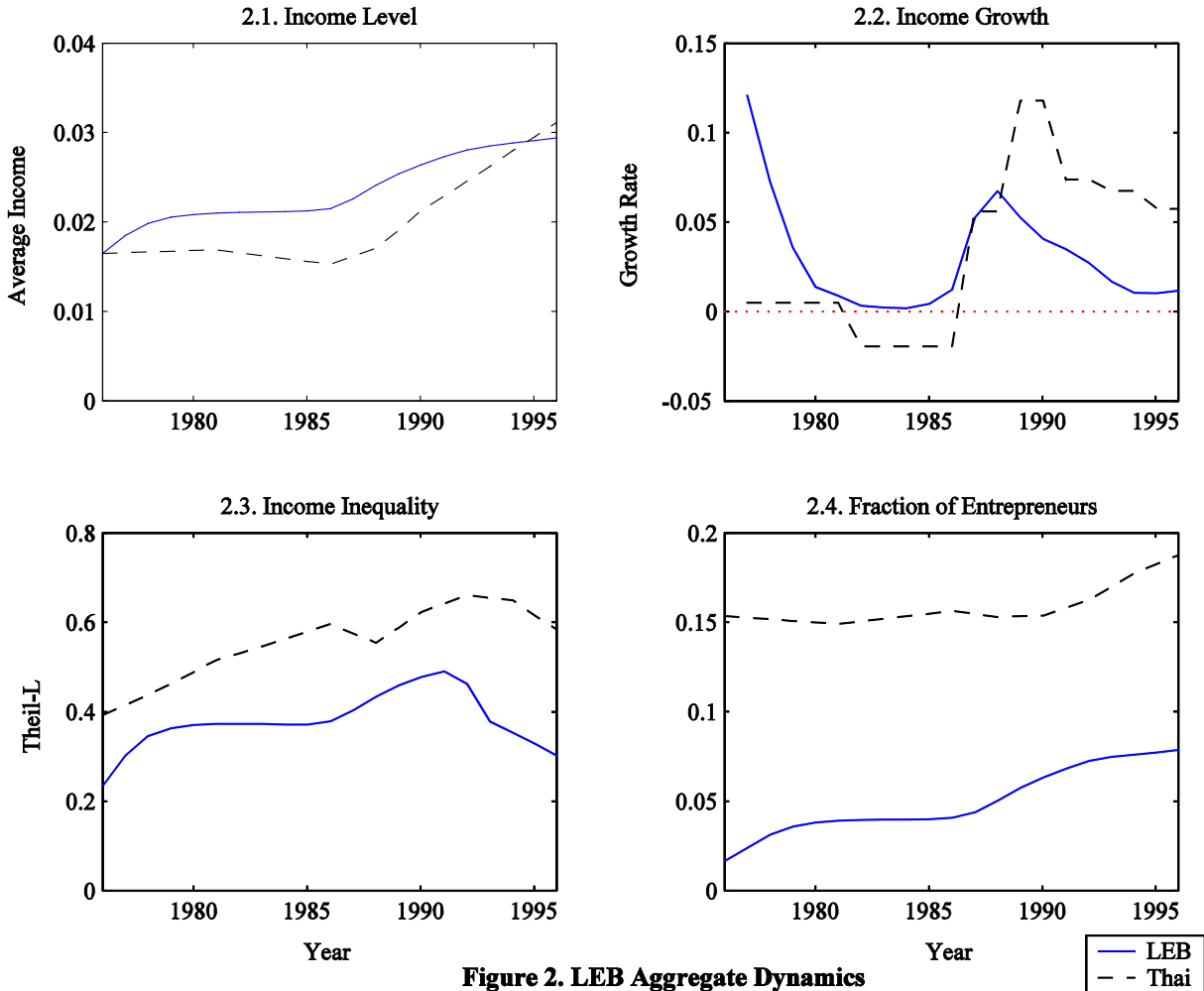
Figure 2. LEB Aggregate Dynamics

[Figure 6.4.4. Source: Jeong and Townsend (2008)]

These success and anomalies are related to the degree of sector aggregation, more or less successful for aggregated data and less satisfactory for the data disaggregated into specific sectors. As anticipated earlier in the work in Giné and Townsend (2004), the occupation choice model does reasonably well with the change in income levels, particularly the upturn associated with liberalization. It also delivers paths for inequality and the fraction of entrepreneurs which are lower than the data but move in tandem with the data.
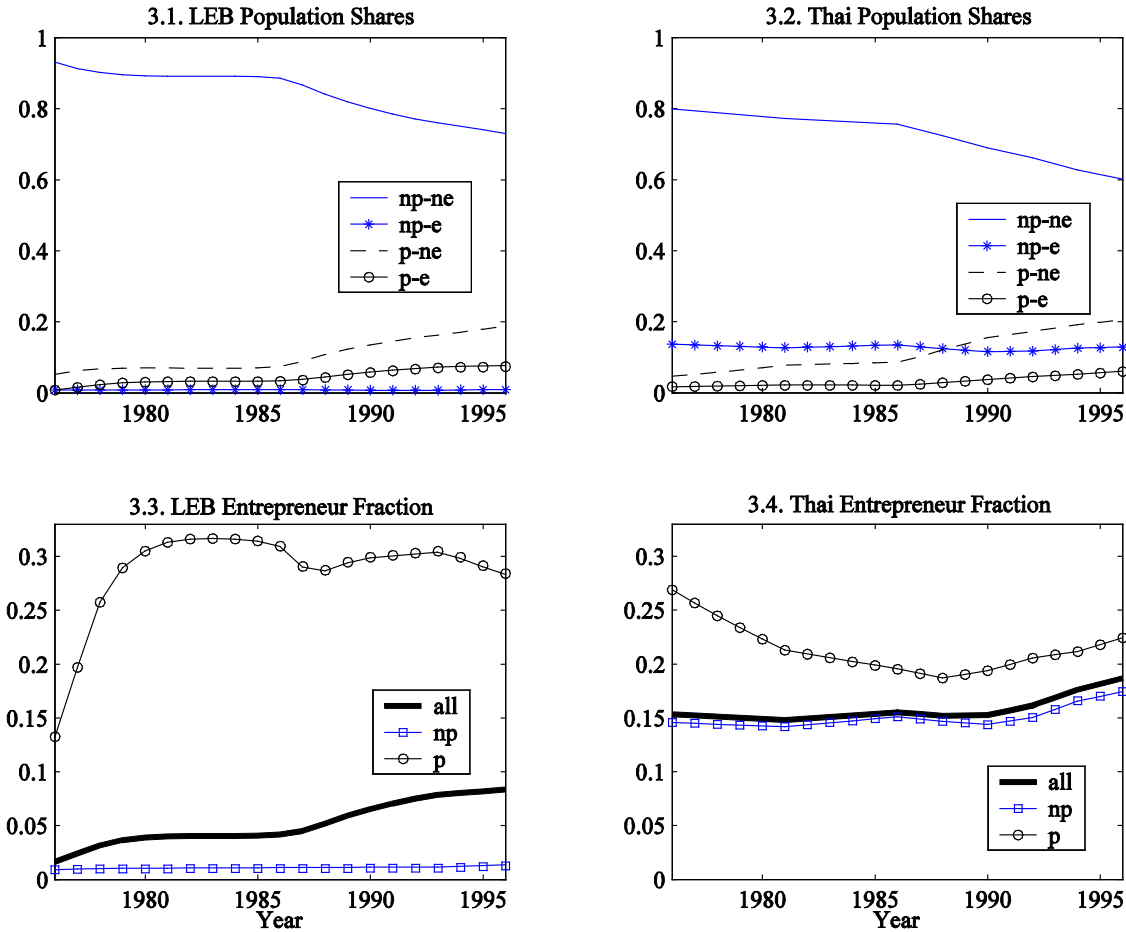
Figure 3. LEB Population Dynamics .

(Legend: p = participant, np = non-participant, e = entrepreneur, ne = non-entrepreneur)

[Figure 6.4.5. Source: Jeong and Townsend (2008)]

The model also gets right the falling trend of non-participant wage earners/farmers and the rising trend of participant entrepreneurs and participant wage earners/farmers. But the model misses the higher level, and falling trend, of non-participant entrepreneurs. In the model, among all entrepreneurs there are too few without transactions in the financial sector and too many with financial transactions relative to the data.
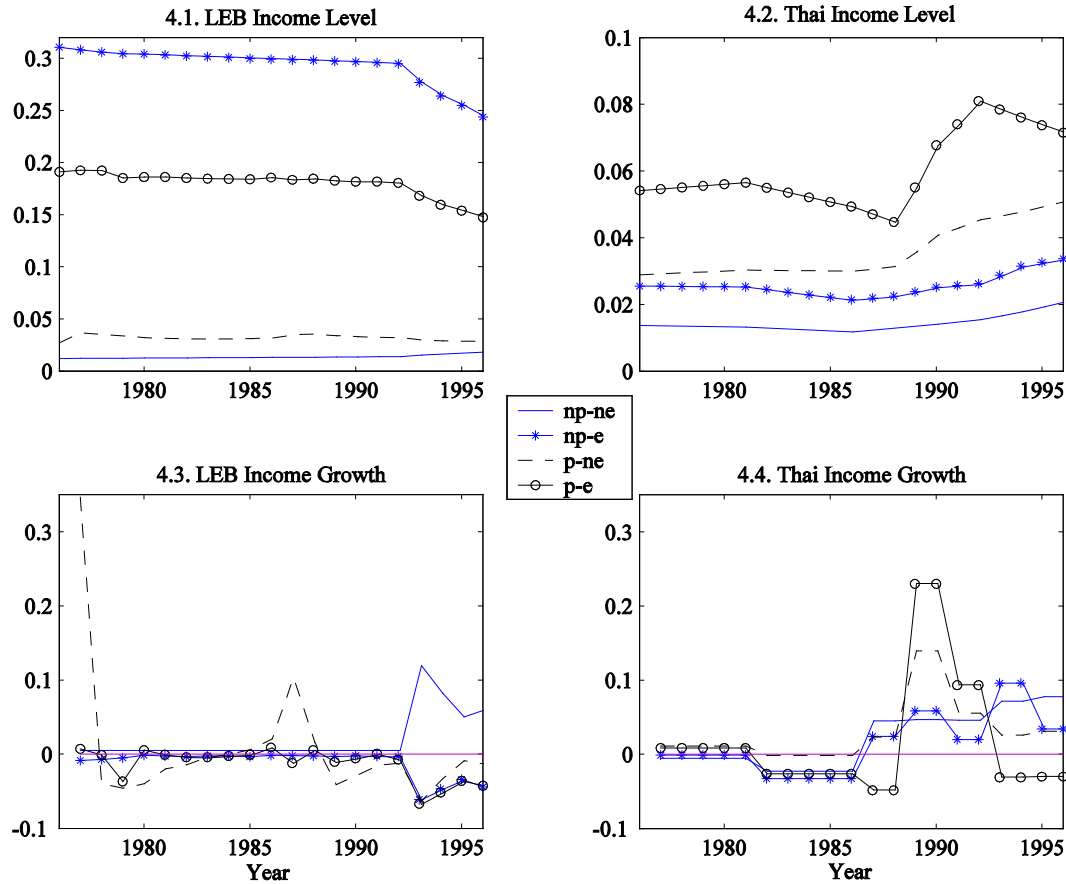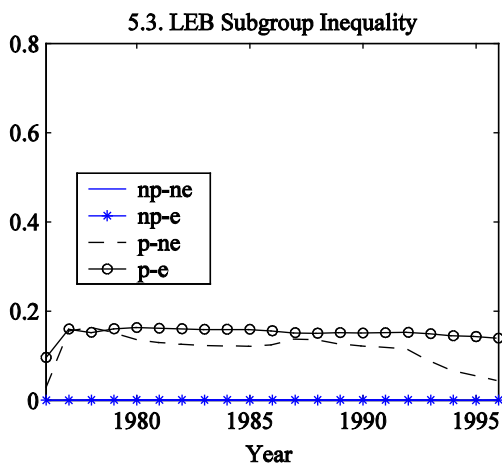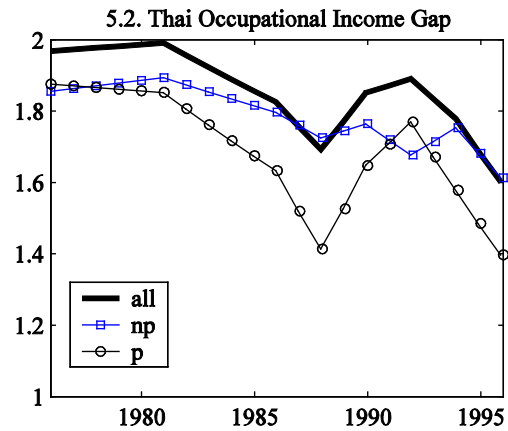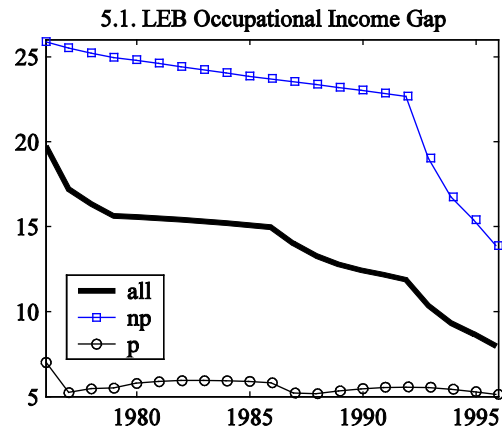
Figure 4. LEB Subgroup Growth Dynamics

(Legend: p = participant, np = non-participant, e = entrepreneur, ne = non-entrepreneur)

[Figure 6.4.6. Source: Jeong and Townsend (2008)]

Likewise, income differences, of entrepreneurs relative to wage earners/farmers, are far too large in the model at the current set of parameter values. In the model, entrepreneurs earn more than farmers/wage earners (regardless of financial participation), and non-participant entrepreneurs earn the most. In the SES data, financial sector participants earn more than non-participants (regardless of occupation), and participant entrepreneurs earn the most. Entrepreneurs in the model tend to have decreasing incomes, due to diminishing returns, but in the data all categories tend to have increasing incomes. More generally, there is much more co-movement in the data across groups/categories, whereas in the model increasing wages causes divergence. Wage earners benefit and entrepreneurs suffer. Revealing perhaps, the income of participant entrepreneurs in the data most closely matches aggregate GDP statistics though their numbers in household surveys are low. The household data may be underestimating their true number.

5.1. LEB Occupational Income Gap

5.2. Thai Occupational Income Gap

5.3. LEB Subgroup Inequality

5.4. Thai Subgroup Inequality
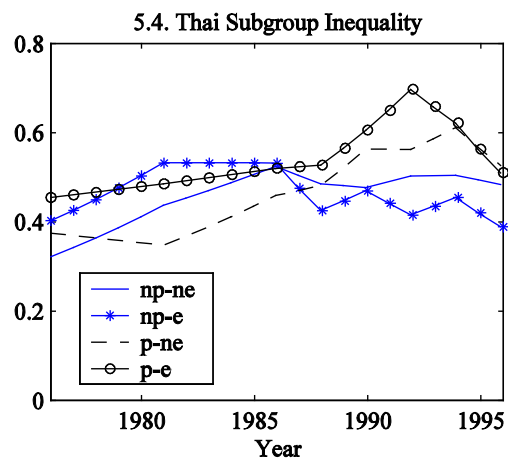
Figure 5. LEB Subgroup Inequality Dynamics .

(Legend: p = participant, np = non-participant, e = entrepreneur, ne = non-entrepreneur)

[Figure 6.4.7. Lloyd-Ellis-Bernhardt (LEB) subgroup inequality dynamics. Source: Jeong and Townsend (2008)]

The overestimation in the occupation choice model of the composition effect in inequality is intimately related to the overestimation of income gaps of entrepreneurs over wage earners/farmers. The model does however get right the decline over time of the income gap and the fact that the gap is smaller for participants, as barriers to entry are reduced. The model thus seems to be overstating the magnitude efficiency of the intermediated sector, but gets right the improvement over time. Related, there is high inequality among participant entrepreneurs in the model, as a participating low cost household can borrow at high interest and have low net earnings after subtracting financing costs. In the data, participant entrepreneurs have the highest inequality only after the liberalization of the mid 1980s.

Draft: July 2010
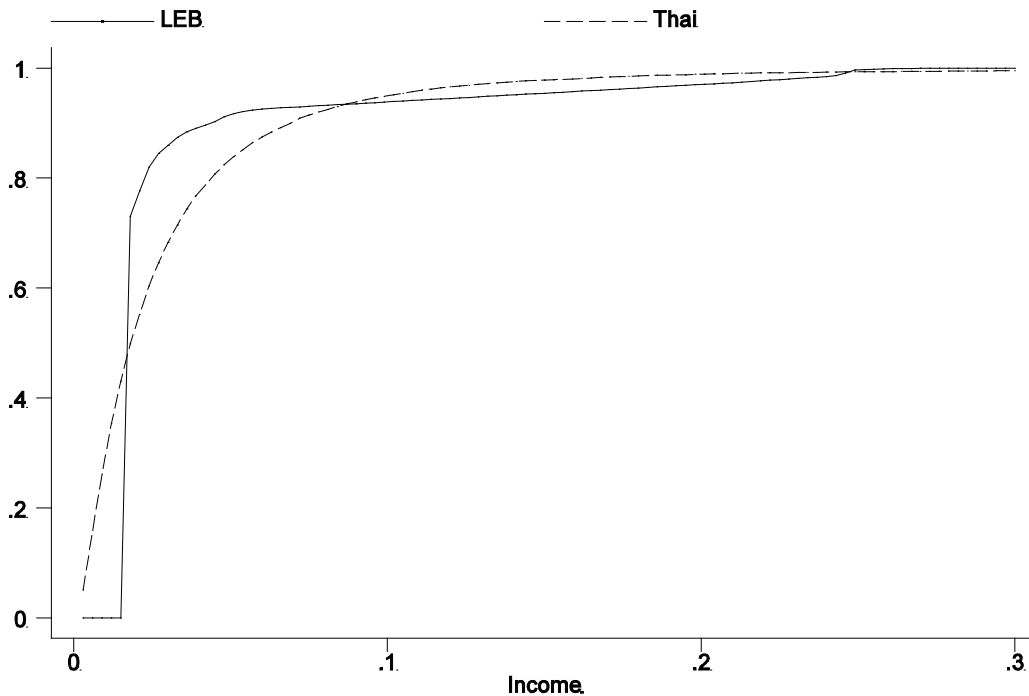
Figure 7. CDF of 1996 Income Distribution.

[Figure 6.4.8. CDF of 1996 Income Distribution. Source: Jeong and Townsend (2008)]

The occupation choice model's prediction for the income distribution misses much variation on the low end and some variation on the high end. The model does not have diversity created by education, for example. Thus the low-skilled labor force of the model earns a common low wage. There is also a small fraction of the population in the data who seem to have very high incomes, more so than in the model.

	Subgroup	Composition	Total
Thailand	0.580	0.319	0.899
GJ	0.184	0.654	0.838

[Table 6.4.9. Decomposition of Aggregate Income Growth in GJ. Source: Jeong and Townsend (2008)]

|	Within-Group		Across-Group		Total
	Subgroup	Composition	Income Gap	Composition	
Thailand	0.304	0.032	0.015	0.133	0.483
GJ	-0.014	-0.085	0.295	0.338	0.575

[Table 6.4.10. Decomposition of Aggregate Inequality Change in GJ. Source: Jeong and Townsend (2008)]

Draft: July 2010

The financial access model, when estimated via maximum likelihood in the SES data for those under 30, does a reasonably job in matching the composition of population shifts across access, no-access categories. This is true in both the change of income and the Kuznets effect in the change in inequality. The model gets correct also the sign in inequality change of the income divergence effect but gets incorrect the residual composition effect in inequality. More telling, there remains much more inequality within the access no-access subgroups in the data than in the model. See Figure 6.4.11.
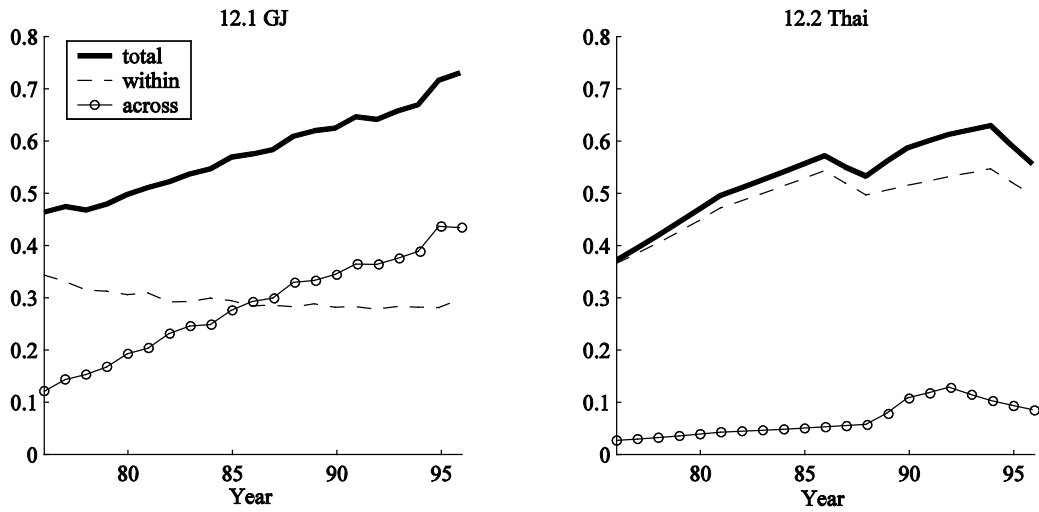


Figure 12. Within vs. Across Inequality Decomposition .

[Figure 6.4.11. Within Versus Across Inequality Decomposition. Source: Jeong and Townsend (2008)]

9.1 Income Level 9.2 Income Growth 9.3. Income Inequality 9.4. Fraction of Participants
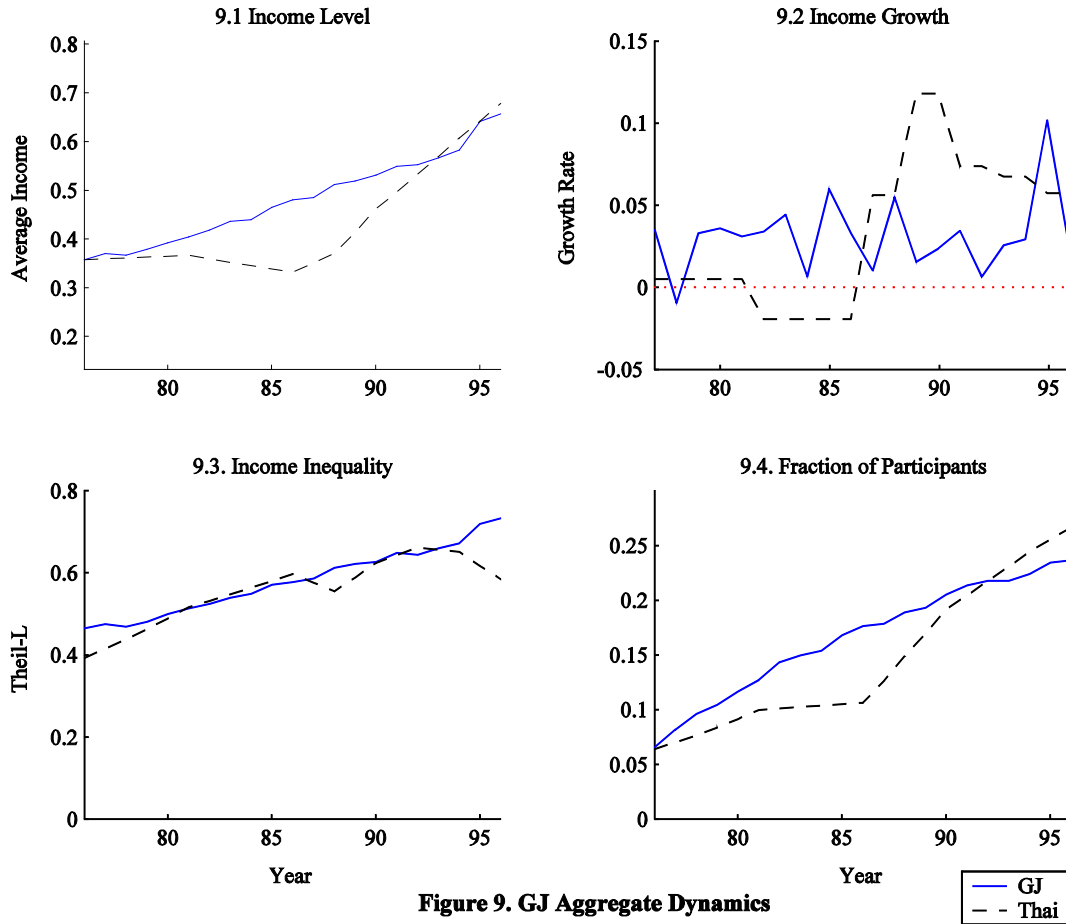
Figure 9. GJ Aggregate Dynamics

GJ
Thai

[Figure 6.4.12. Greenwood-Jovanovic aggregate dynamics. Source: Jeong and Townsend (2008)]

Simulations over time reveal familiar patterns. The model misses the surge in household income from the mid 1980's and the increase in participation at that time. But the match to inequality is quite good, except for the eventual decrease in inequality in the data.
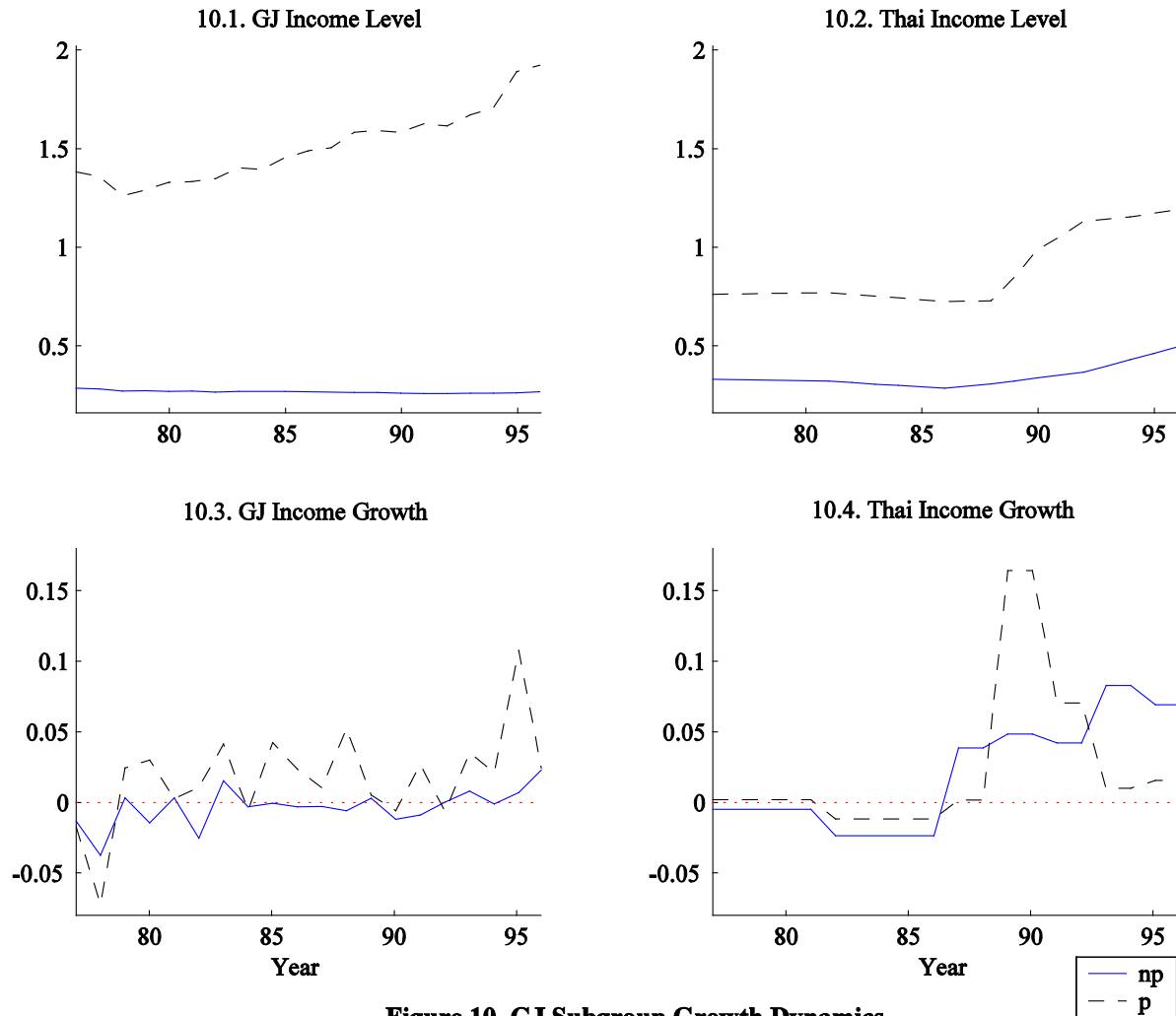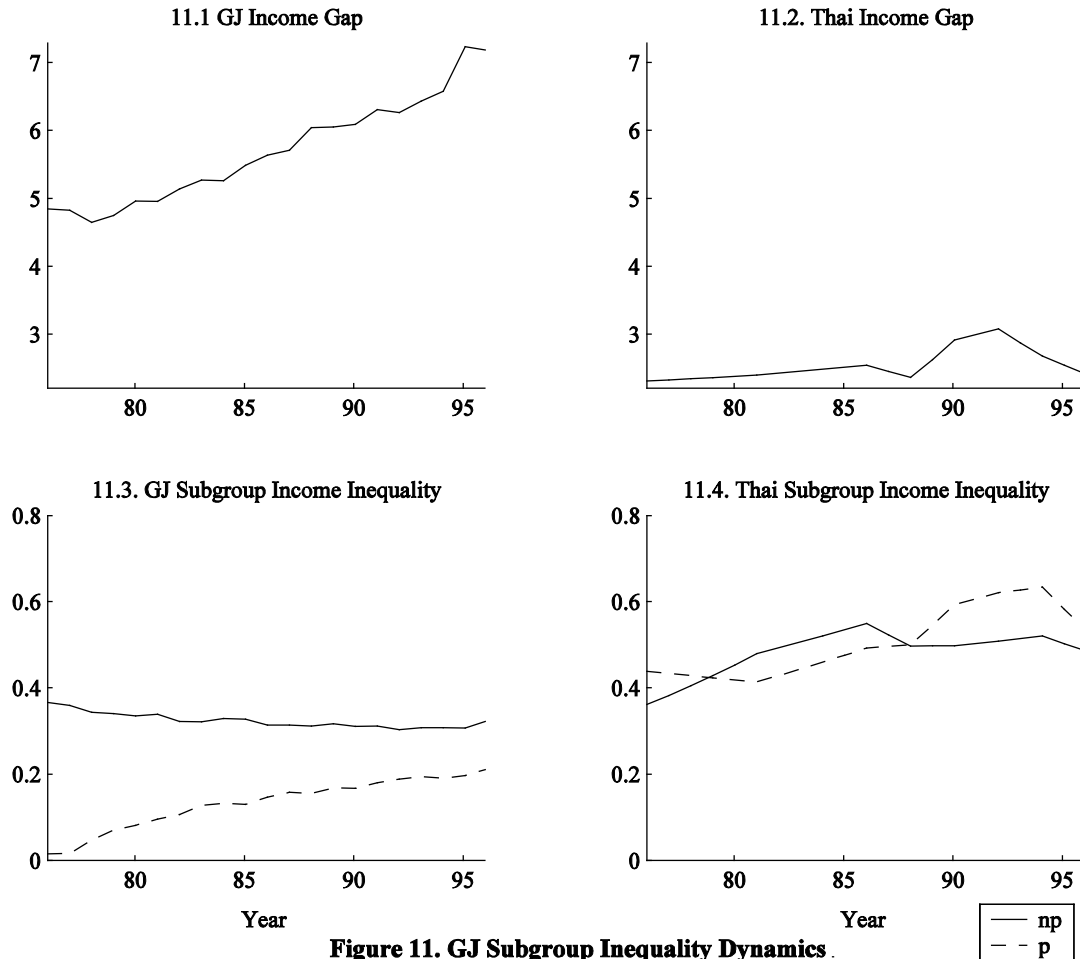
Figure 10. GJ Subgroup Growth Dynamics.

[Figure 6.4.13. Greenwood-Jovanovic subgroup dynamics. Source: Jeong and Townsend (2008)]

One success story for the model is the predicted increase in the income of financial sector participants, and the gap over non-participants, though the model misses the fact that income increases for non-participants also. Likewise, there is co-movement in incomes in the data, whereas in the model participant income is more volatile than the relatively flat non-participant income.

11.1 GJ Income Gap

11.2. Thai Income Gap

11.3. GJ Subgroup Income Inequality

11.4. Thai Subgroup Income Inequality

Year

Year

np
p

Figure 11. GJ Subgroup Inequality Dynamics

[Figure 6.4.14. Source: Jeong and Townsend (2008)]

Again, the model widely over predicts the gaps in income between participants and non-participants. Inequality is increasing for participants in the model, as in the data, but inequality among non-participants is decreasing in the model while increasing overall in the data. The biggest discrepancy perhaps is the low level of income inequality among participants relative to non-participants in the model, relative to the data. This is symptomatic of the assumed perfect risk-sharing among financial sector participants. The actual financial system seems imperfect.
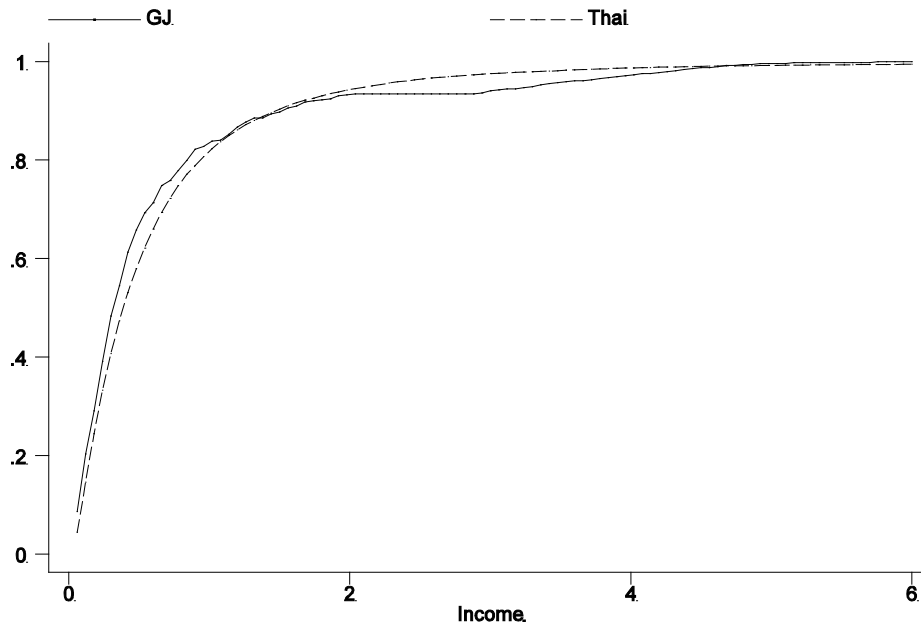
Figure 13. CDF of 1996 Income Distribution.

[Figure 6.4.15. Source: Jeong and Townsend (2008)]

Overall, the financial access model does quite well in predicting the end-of-sample, 1996 distribution of income. It cannot be statistically distinguished from the actual data according to a Kolmorgorov-Smirnov (KS) test. The model is still missing variety among the relatively poor, missing the very rich that exist in the SES data, and missing the single-peaked modal value of the data. This last effect can be attributed, as noted earlier, to the (false) assumption that all household have common access costs.