Chapter 3: Disparities among Regional Economies – Spatial (Dis) Aggregation

From province to village, to household, to individual; followed by some international comparisons.

This chapter spatially disaggregates the national economy into provinces and then disaggregates further from counties (*amphoe*), to villages, to households, and even down to individuals. This is literally the physical representation of the macro economy built up from its micro foundations. Of course no model should try to incorporate all aspects, and the models in the subsequent chapters take different actors as decision makers: sometimes the household, sometimes an entire village, or when aggregation permits, higher macro units. This chapter also reminds us that diversity in physical geography and locations is a source of economic heterogeneity.

Gross Provincial Product (GPP), which is analogous to GDP, displays great differences across provinces in wealth and in the relative importance of manufacturing versus agriculture. Moving across provinces within Thailand is akin to moving across countries. Poverty rates differ greatly across provinces, and the Townsend Thai panel data is well placed to pick up this variation. The process of transition appears to have changed over time, with a greater tendency recently toward lack of convergence in provincial product across Thai provinces. The data also show signs of the kind of macro-micro discrepancy discussed in Section 2.4; for example, variation in the manufacturing share of GPP across provinces is much greater than the variation in non-farm income attested in household surveys Treating provinces as countries, we can use a simple model of endogenous household migration out of agriculture in the provinces to production and manufacturing in Bangkok, with remittances contributing to income back home in the province, to explain much of the apparent difference, just as foreign remittances can account for the distinction between product and income at the national macro level.

An overlap in the villages covered by the SES socioeconomic database and CDD village data establishes via projections of the latter onto the former, with extrapolations, the spatial and temporal patterns of income growth at the county level (*amphoes*). There is initial concentration and then relatively dramatic convergence. Inequality across villages is strikingly high when the level of average income and development is low, drawing attention to across-village heterogeneity. Village level data within provinces reveal unevenness of development, with concentrations in wealth and a variety of geo-spatial patterns. In later chapters we will use a variety of models to interpret these data, to try to explain divergent growth given initial conditions.

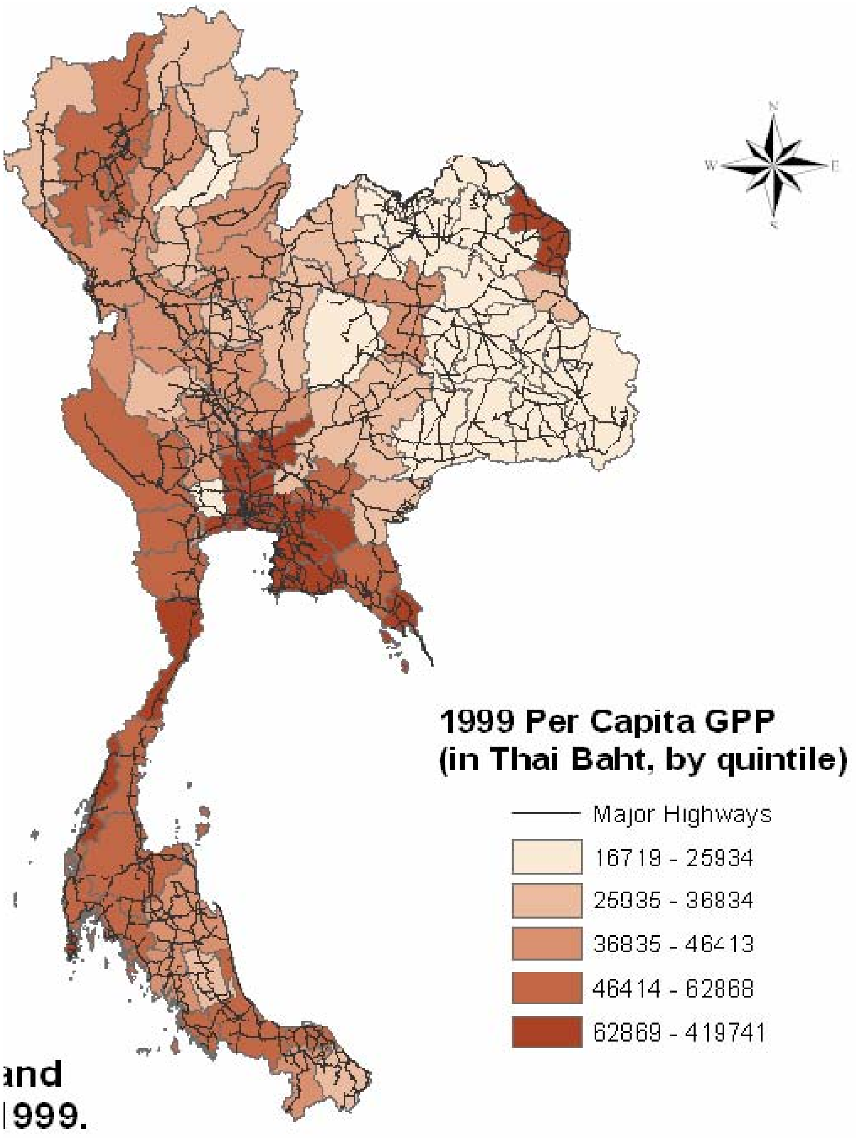
At the household level, income change correlates weakly with macro/temporal shocks, even during the financial crisis. Clearly occupation and geography play an important role in determining resistance to such shocks. Local satellite imagery picks up variation in ground cover, and this too helps to determine the timing of good and bad years. Townsend Thai survey sampled tambons within provinces were selected in a stratified random sample, using that imagery. More generally, households are experiencing a variety of idiosyncratic shocks and common regional shocks, for example, deviations in rainfall and rubber prices from their historical average. There is some specialization in households and variation in diversification strategies, such as migration.

With all these shocks and sources of heterogeneity, it might seem there would be little that is systematic in the regional or national economies. Models will thus need to take into account variables at various spatial and temporal scales in order to provide a coherent, integrated macro-micro picture of the economy. But the heterogeneity we see in the various aggregate levels within Thailand mirror the patterns we see in the regional international economy. But at the international scale, Thailand looks rich. Specifically relative to other nearby countries, the Northeast of Thailand has low poverty, low malnutrition, high deforestation, and much made-man irrigation. It differs dramatically from its Mekong basin, regional counterparts in Cambodia, Laos, and Vietnam. This raises of the question of why these countries, adjacent to one another, differ so much, and motivates our choice of Thailand as a starting point of the studying the determinants of growth, inequality, and poverty.

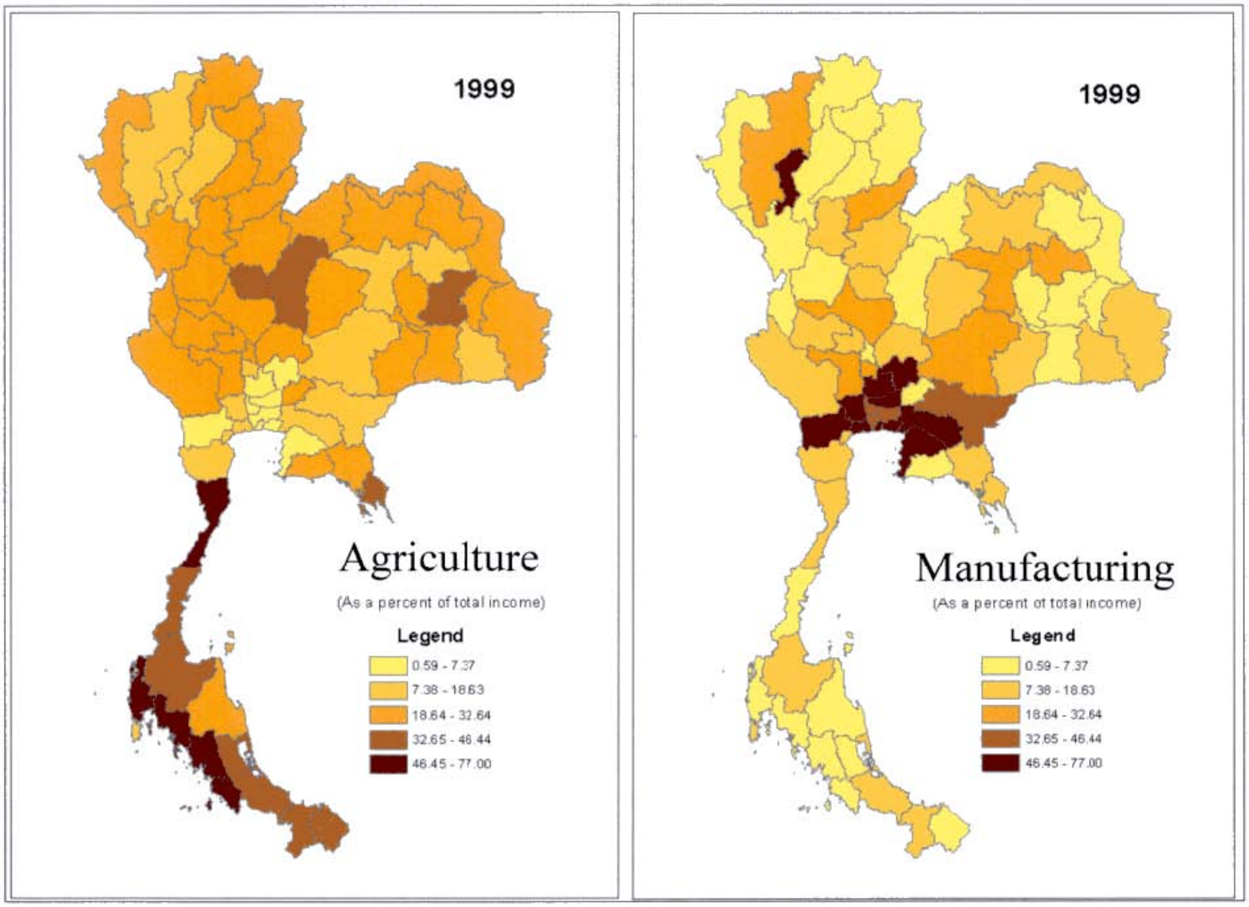
3.1 Provincial Economies

A province can be thought of as a country, and indeed estimates of GPP are available from the NESDB. One can see from Figure 3.1.1 the various regional patterns. Income/product is relatively high in and around Bangkok, the Central plains, and connections going north to Chiengmai. Product is high also in much of the South, but not the provinces bordering Malaysia. Income/product is lowest in the Northeast. The ratio of the highest quintile of product per capita to the lower quintile is 3 to 1. The ratio of the highest province to lowest is 25 to one. For comparison the range of per capita GDP across countries in the Penn World Table is between those two.

Likewise, the fractions of product/income attributable to manufacturing and agriculture vary considerably and are more or less inversely related. The inter-quintile range of these percentages is from 7% to 46%, with extremes at .59% and 77.00%. See Figure 3.1.2.

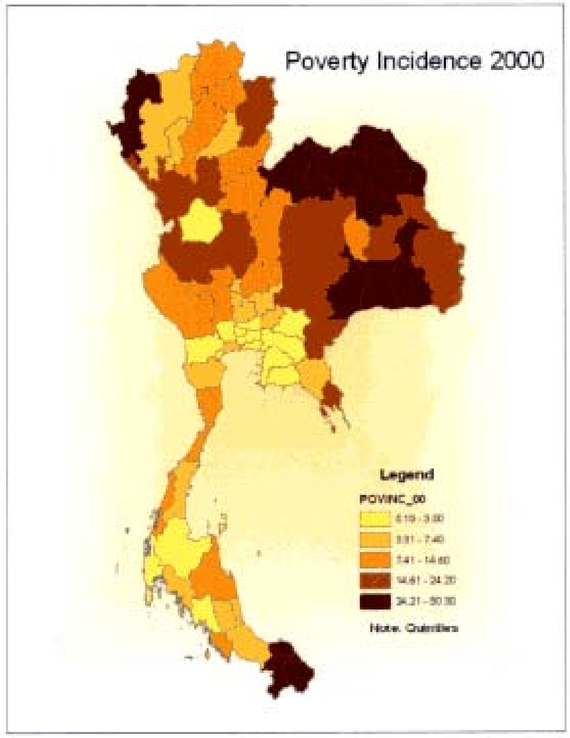


[Figure 3.1.1. 1999 Thailand per Capita Gross Provincial Product (GPP). Source: Adapted from NESDB data]

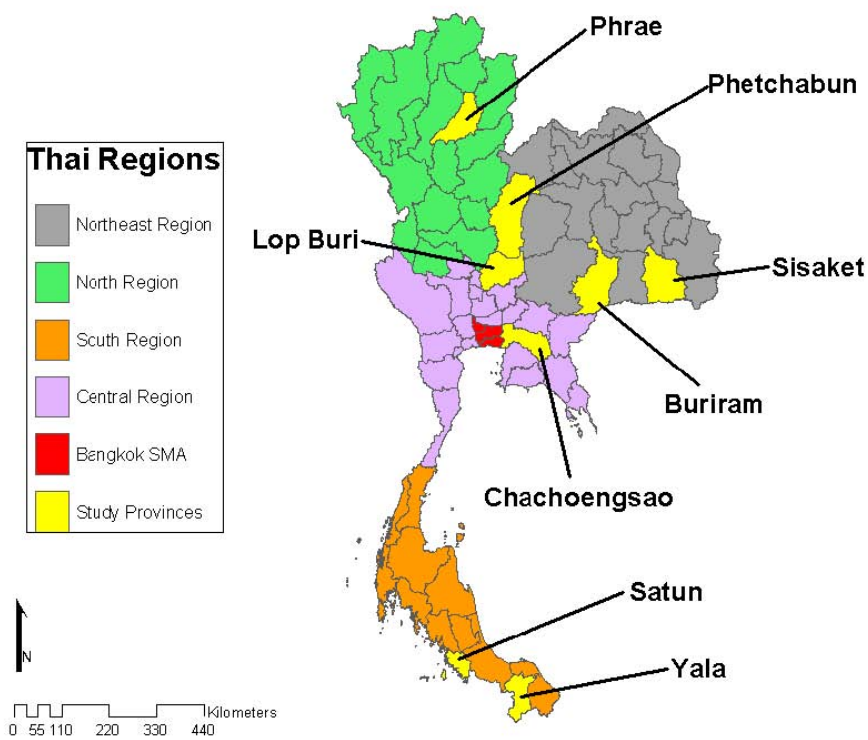


[Figure 3.1.2. Source: UNDP data]

Poverty rates also vary across provinces. These range form 3% or less in the lowest quintile of all provinces up to the 24-50% in the highest quintile. Rates are low in and around Bangkok, modest near Bangkok and much of the South, but high in the Northeast, the Islamic provinces bordering on Malaysia, and some provinces bordering on Myanmar. Thus note that the Townsend Thai project data span provinces with high and low poverty rates. See Figures 3.1.3 and 3.1.4, respectively.



[Figure 3.1.3. Poverty Incidence in Thailand (2000). Source: UNDP data]



[Figure 3.1.4. Thai Geographic Regions and Study Provinces. Source: Adapted from NESDB data]

A common characteristic of the literature on cross-country incomes is the search for evidence of convergence, with the lower income provinces growing faster and catching up with the higher income provinces. The same considerations apply to cross-provincial incomes in Thailand. Liu Yang's (2004) thesis uses the methods of Danny Quah (1993) to establish that there was a greater tendency toward convergence early on, 1978-1986, than in the subsequent high growth period, 1989-1998. That is, in the period of industrialization and financial deepening, a province is more likely to stay in its relative income quintile. Table 3.1.5 at the top counts the frequency of annual transitions. Symptomatic of this, the "steady state" ergodic distribution is relatively uniformly distributed, somewhat skewed left. In contrast, in the earlier period, a province with higher income is more likely to fall back to a lower category and the "steady state" has a more concentrated distribution on the left.

First order, time-stationary (1978-1986)
Grid (0, 0.5, 0.75, 1, 1.25, ∞)

	Upper Endpoint:				
Number	0.5	0.75	1	1.25	∞
174	0.9528	0.0410	0.0062	0	0
210	0.1090	0.8132	0.0778	0	0
105	0	0.3126	0.6256	0.0618	0
62	0	0.0224	0.2182	0.6101	0.1493
97	0	0	0	0.1400	0.8600
Ergodic	0.6156	0.2665	0.077	0.0198	0.0211

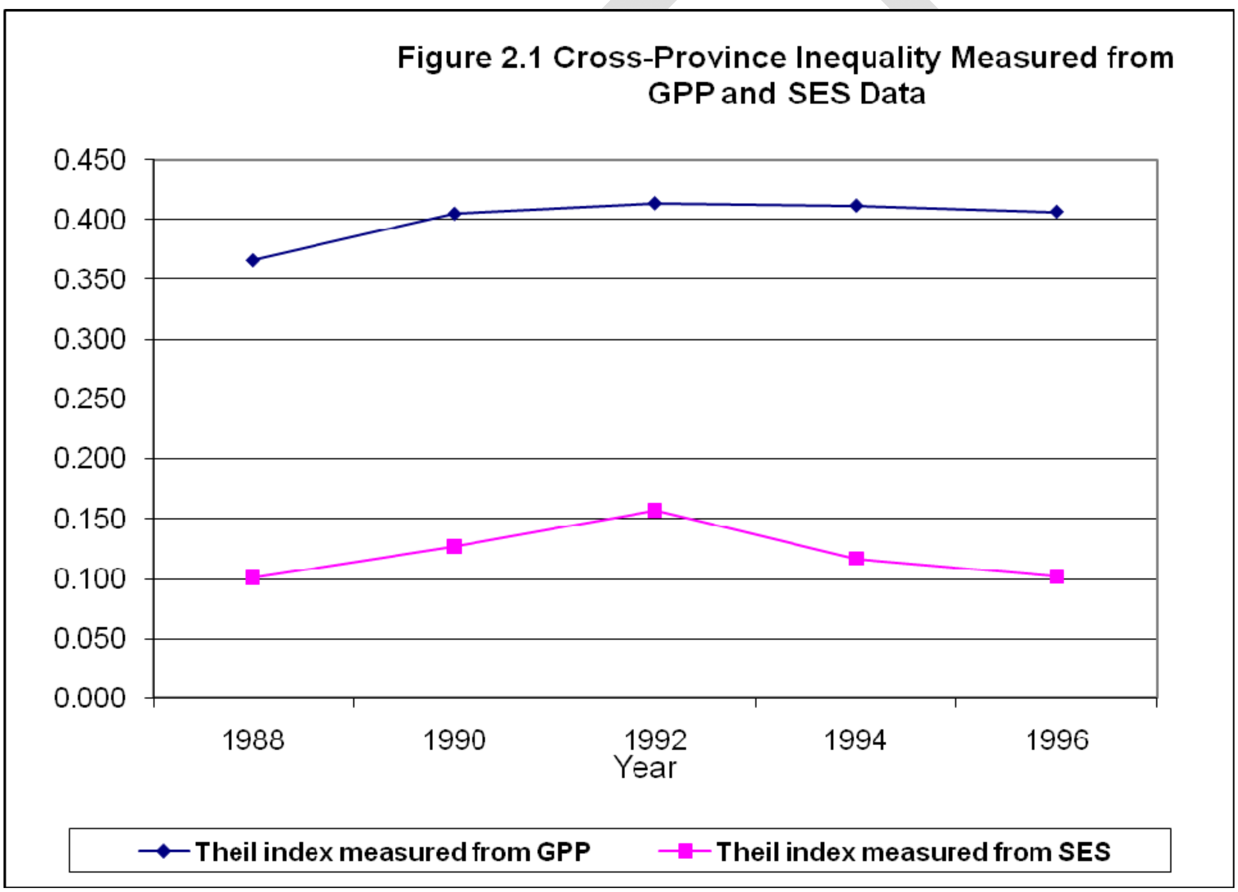
First order, time-stationary (1989-1998)
Grid (0, 0.35, 0.5, 0.75, 1.25, ∞)

	Upper Endpoint:				
Number	0.35	0.5	0.75	1.25	∞
156	0.9498	0.0502	0	0	0
155	0.0868	0.8596	0.0536	0	0
208	0	0.0501	0.9067	0.0432	0
102	0	0	0.0941	0.8645	0.0413
109	0	0	0	0.0439	0.9561
Ergodic	0.3639	0.2106	0.2251	0.1033	0.0971

[Table 3.1.5. Transition of Real Per Capita GDP. Note: 1978-1986 – likely to move forward, 1989-1998 – forward and backward movement equally likely. Source: Yang (2003)]

3.1.1 Discrepancies Between Provincial Product and Income: Migration and Remittances

Related to the measurement issue is the discrepancy between provincial product and provincial income. More specifically, as with growth and poverty, we can measure inequality at the cross-province level. The Theil-L index for provincial product is relatively high, at about 0.4, and displays the rising and falling pattern described earlier in the SES household data, hitting a peak in 1992. However, cross province product inequality levels are high relative to the cross province contribution to inequality in the SES household income data. See Figure 3.1.6. The discrepancy is associated with product from manufacturing only. That is, the cross province contribution to inequality in agrarian product is similar, if not less, than SES inequality in agriculture incomes. See Table 3.1.7.



[Figure 3.1.6. Cross-Province Inequality Measured from GPP and SES Data. Source: Yang (2004)]

Data Source	1988	1990	1992	1994	1996	1998	2000
GPP	0.159	0.125	0.164	0.189	0.187	0.197	0.202
SES individual earnings [a]	0.152	0.248	0.192	0.265	0.248	0.232	0.216
SES household income [b]	0.048	0.084	0.059	0.079	0.064	0.065	0.061

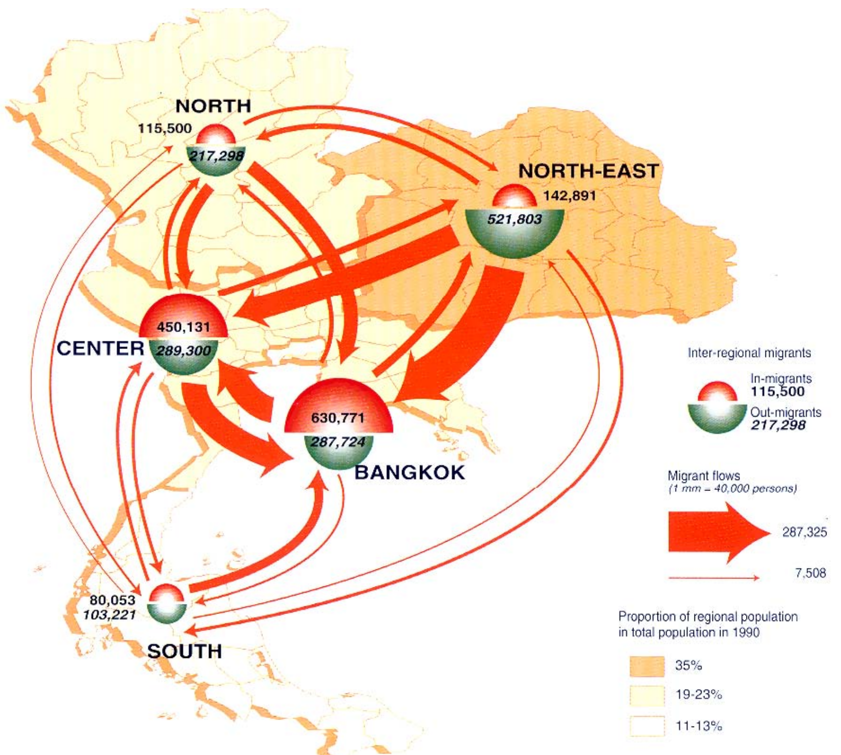
[Table 3.1.7. Cross-Province Inequality (Theil-L Index) in Agriculture. Notes: a. Earnings measured as a sum of wage and farm profit, excluding remittances. b. Income measured as total monthly per capita income, including remittances. Source: Yang (2004)]

	1988	1990	1992	1994	1996	1999
GPP dataset						
Number of provinces in sample	73	73	73	73	73	73
Mean pc gpp in baht						
Whole sample (1988 prices)	28710	34864	39840	46605	52727	47135
Bangkok (1988 prices)	98383	125601	141272	159430	169151	135236
Sample w/o Bangkok (1988 prices)	20183	23532	26871	31528	36833	34687
Population of whole sample (1,000 persons)	54330	55839	57294	57514	58780	60549
Population of Bangkok (1,000 persons)	5924	6199	6495	6780	7061	7496
SES dataset						
Number of households in sample	11045	13177	13458	24583	24433	7580
Mean monthly per capita hh income in baht						
Whole sample (1988 prices)	1064	1239	1512	1677	2030	2119
Bangkok (1988 prices)	2506	2922	4162	4081	4673	4794
Sample w/o Bangkok (1988 prices)	876	1007	1179	1378	1661	1731
Fraction of hh's receiving remittances (%)	23.06	22.30	24.46	28.41	29.72	34.47
Share of remittances in household income (%) among hh's with positive remittances	24.55	23.49	23.83	27.05	27.92	27.55
CDD dataset						
Number of villages in sample	56744	57684	59640	60133	61134	63239
Mean % of households w/ migrants laborers	22.8	25.7	28.1	31.2	32.4	23.6
Mean % of out-migrants in population	8.1	9	10.3	11.6	12.1	9.8
Mean % of out-of-province migrants in pop.	5.4	6	7	7.9	8.2	6.2
Mean % of out migrants to Bangkok in pop.	3.7	4.6	5.7	6.5	6.7	4.7

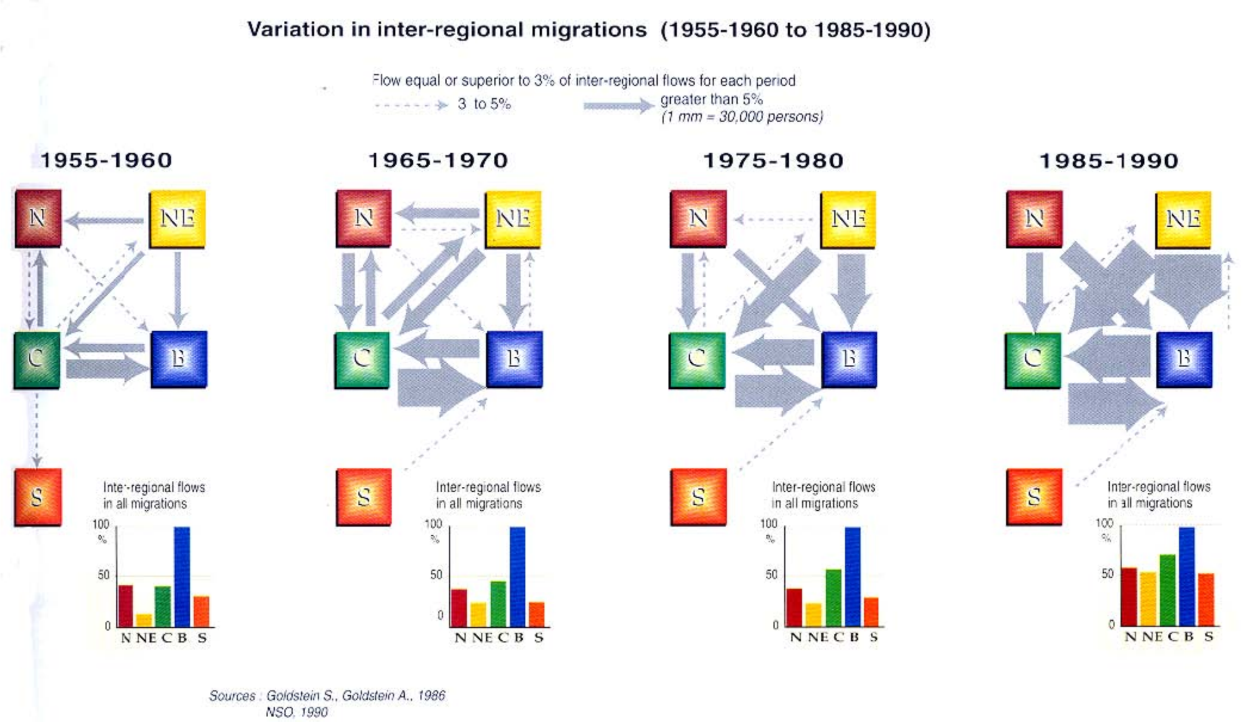
Notes: from 1988 to 1992, population of whole sample in GPP dataset equals whole population of Thailand. From 1994 on, population of whole sample leaves out the part of three new small provinces, Sakaew, Nong Bualamphu and Amnat Charoen. Mean percentage of remittances share (in gross income) is calculated by equally weighting households with different incomes.

[Table 3.1.8. Summary Statistics, 1988-1999. Source: Yang (2004)]

The discrepancy analogous to the discrepancy between national product and income, and is consistent with a relatively simple model of migration out of provinces with “foreign” remittances from migrants; which thus compensates for factors not located within the province. Yang (2004) first notes in the SES data that the fraction of households receiving remittances is large; it is 23% in 1988, increasing to 34.5% in 1999. Similarly, the income share of remittances for those SES households is large, 24.5% in 1988 to 27.5% in 1999. In CDD village level data, the fraction of households with migrant laborers increases from 22.8% in 1986 to 32.4% in 1998, and as a fraction of all individuals from 8% to 12% during these years. Summary statistics are provided in Table 3.1.8.



[Figure 3.1.9.a. Inter-regional Migrations (1985-1990). Source: Kermel-Torres (2004)]



[Figure 3.1.9.b. Variation in Inter-regional Migrations (1885-1990). Source: Kermel-Torres (2004)]

The number of migrants and the fraction of migrants leaving their regions have increased overtime, as shown by Figures 3.1.9a and 3.1.9b. Migration was relatively limited in the early period of 1955-1960, and a substantial amount migration remained internal within the regions. From 1965-1970 intra-regional flows increased, and the largest intra-regional flow was from the Central region to Bangkok. By 1985-1990 the largest intra-regional flows were from the Northeast to the Central region and to Bangkok, and also back and forth from Bangkok and the Central region. There has been little migration up from the South, and with the exception of 1955-1960, even less in the reverse direction.

A mathematical model helps us think about the pattern more systematically. The simple model of Yang for the more recent 1988-1998 period imagines that household j (as the representative consumer of household *j*) as a unit maximizes its total income at date t, $Y_{j,t}$, namely

$$Y_{j,t} = \max_{m_{j,t}} \left\{ \left(1-\theta m_{j,t}\right) W_{j,t-1} + \theta m_{j,t} * W_{bkk,t-1} - C\left(\theta m_{j,t}\right) \right\}, \tag{3.1.1}$$

Here then, $Y_{j,t}$ denotes the expected household income of province j at the beginning of year t. Total labor supply of a household is normalized to one, $m_{j,t}$ denotes the proportion of laborers who migrate to Bangkok, and θ represents the mean work duration of an average migrant in Bangkok. In other words, $\theta m_{j,t}$ is the realized migrant labor supply, while $m_{j,t}$ is the observed incidence of migrants departing in year t. The relevant information on wage differentials is the wage earnings from the previous period.

Variable $W_{bkk,t-1}$ denotes lagged wages earned by an average migrant household in Bangkok. Variable $W_{j,t-1}$ is alternative wages earned in the home province, j.

C is a convex function of migration cost. Assume $C\left(\theta m_{j,t}\right)$ has the functional form of $Ce^{\gamma_2 d_2+\gamma_3 d_3}D_j^{\gamma_1}\left(\theta m_{j,t}\right)^{\sigma}$, where C is a scalar, d_2 is a dummy variable indicating the Northern region and d_3 is a dummy variable indicating the Northeastern region. D_j is the railway distance between Bangkok and home province j, measured in the GIS. As $C\left(\theta m_{j,t}\right)$ is convex, $\sigma > 1$. Differentiation of objective 3.1.1 with respect to $m_{j,t}$ and taking logs,

$$\ln m_{j,t} = -\ln\theta - \frac{1}{\sigma-1}\ln\sigma C + \frac{1}{\sigma-1}\ln\left(W_{bkk,t-1} - W_{j,t-1}\right)$$
$$-\frac{\gamma_1}{\sigma-1}\ln D_j - \frac{\gamma_2}{\sigma-1}d_2 - \frac{\gamma_3}{\sigma-1}d_3 \qquad (3.1.2)$$

In equation 3.1.2, the proportion of migrant laborers $m_{j,t}$ is measured by the percentage of rural – to-Bangkok migrants in the rural population by province. Five rounds of CDD survey data, every other year over the period from 1988 to 1996, are used in the estimation. Wage differentials are measured by the wage earnings in Bangkok (per capita GPP in Bangkok multiplied by the share of labor) minus per capita GPP of other provinces, assumed to be agricultural economies.

The estimated parameter values are: $\sigma = 2.15$, $\gamma_1 = 1.4$, $\gamma_2 = -3.1$, and $\gamma_3 = -3.9$. The values imply that migration cost is convex in the proportion of emigrants and increasing in the distance from Bangkok. But, a household in the Northern, or especially, Northeastern regions has lower migration cost compared with a household in the Southern or Central region, *ceteris paribus*.

Assume output in Bangkok is determined by a Cobb-Douglas production function:

$$Y_{bkk,t} = e^{\delta+\lambda t}K_{bkk,t}^{\alpha}L_{bkk,t}^{1-\alpha} \qquad (3.1.3)$$

where $Y_{bkk,t}$ denotes output, $K_{bkk,t}$ denotes capital stock, $L_{bkk,t}$ denotes total labor input, α is the share of capital compensation in output, δ is a constant, and λ is a technology shifter over time. Labor $L_{bkk,t}$ is $L_{bkk,t} = N_{bkk,t} + \theta\sum_j m_{j,t}N_{j,t}$, the sum of the labor supply, $N_{bkk,t}$, the stock of native labor supply in

Bangkok plus migrant labor supply summing over all other provinces j, namely $\theta\sum_j m_{j,t}N_{j,t}$ where $N_{j,t}$ is population in province j.

Per capita GPP of Bangkok in logs in given by:

$$\ln y_{bkk,t} = \sigma + \alpha\left\{\ln K_{bkk,t} - \ln\left(N_{bkk,t} + \theta\sum_j m_{j,t}N_{j,t}\right)\right\} + \lambda t \qquad (3.1.4)$$

and wage earnings are proportional, i.e.,

$$W_{bkk,t} = (1-\alpha)\, y_{bkk,t} \qquad (3.1.5)$$

The series of capital input, $K_{bkk,t}$, is constructed from Regional Gross Fixed Capital Formation Series released also by NESDB. Labor input series $L_{bkk,t}$ is constructed by combining the number of employed non-migrant laborers and number of employed migrants from the Reports of Labor Force Survey. Twelve years of data over the period 1985 to 1996 are used in the estimation.

The estimated share of capital, α, is 0.40 from the sample. The coefficient on the time trend, λ, is estimated to be .04, interpreted as an estimated annual productivity growth rate of 4 percent. θ is not identified from the estimation because the whole term $\theta\sum_j m_{j,t}N_{j,t}$ is proxied by the number of employed migrants. In the analysis θ is assumed to be 0.5, i.e., an average migrant works half a year in Bangkok.

We can derive the realized net income gain from migration from the entire household:

$$\begin{aligned}&\left(1-\theta m^*_{j,t}\right)W_{j,t} + \theta m^*_{j,t} * W_{bkk,y} - Ce^{\gamma_2 d_2+\gamma_3 d_3}D_j^{\gamma_1}\left(\theta m_{j,t}\right)^{\sigma} - W_{j,t} \\ &= \theta\left(W_{bkk,t} - W_{j,t}\right)m^*_{j,t} - Ce^{\gamma_2 d_2+\gamma_3 d_3}D_j^{\gamma_1}\left(\theta m_{j,t}\right)^{\sigma}\end{aligned}, \qquad (3.1.6)$$

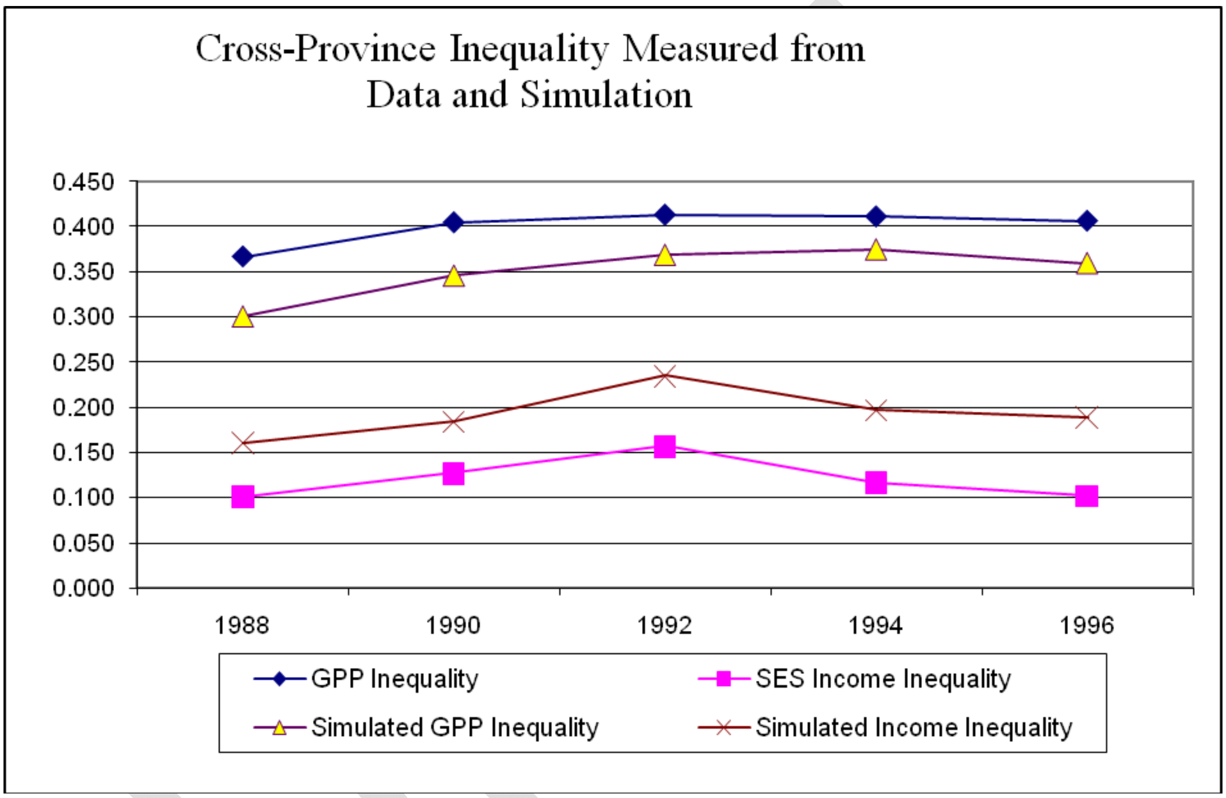
where

$$m_{i,t}^{*\sigma-1} = \frac{\left(W_{bkk,t-1} - W_{j,t-1}\right)}{\theta^{\sigma-1}\sigma Ce^{\gamma_2 d_2+\gamma_3 d_3}D_j^{\gamma_1}}, \qquad (3.1.7)$$

and with other substitutions income and production inequality measures can be derived.

The model does well in tracking the CDD-estimated migrant population and Bangkok wage earnings. See Table 3.1.11. More to the point here, about half of the discrepancy in inequality of gross provincial product versus household income is explained. See Figure 3.1.10. Migration and remittances seem to be a big part of the inter-provincial, national economy. We learn from this as well that the informal financial system in the form of remittances is large and increasing.

Table 3.1.11 presents the aggregate level comparison of simulated migrant population and wage rates in Bangkok with those from the sample data. Overall, simulated results are a good approximation to the sample estimates.



[Figure 3.1.10. Cross-Province Inequality in Production and Income: Data vs. Simulation Results. Source: Yang (2004) Notes: the calibrated parameter values for simulation are: $\mu = 1$, $\theta = 0.5$, $\alpha = 0.4$, $\sigma = 2.15$. To simulate the Bangkok wage downturn during the financial crisis, it is assumed that productivity in Bangkok incurs a negative 20% shock from 1996 to 1998. Inequality is measured by Theil-L index here.]

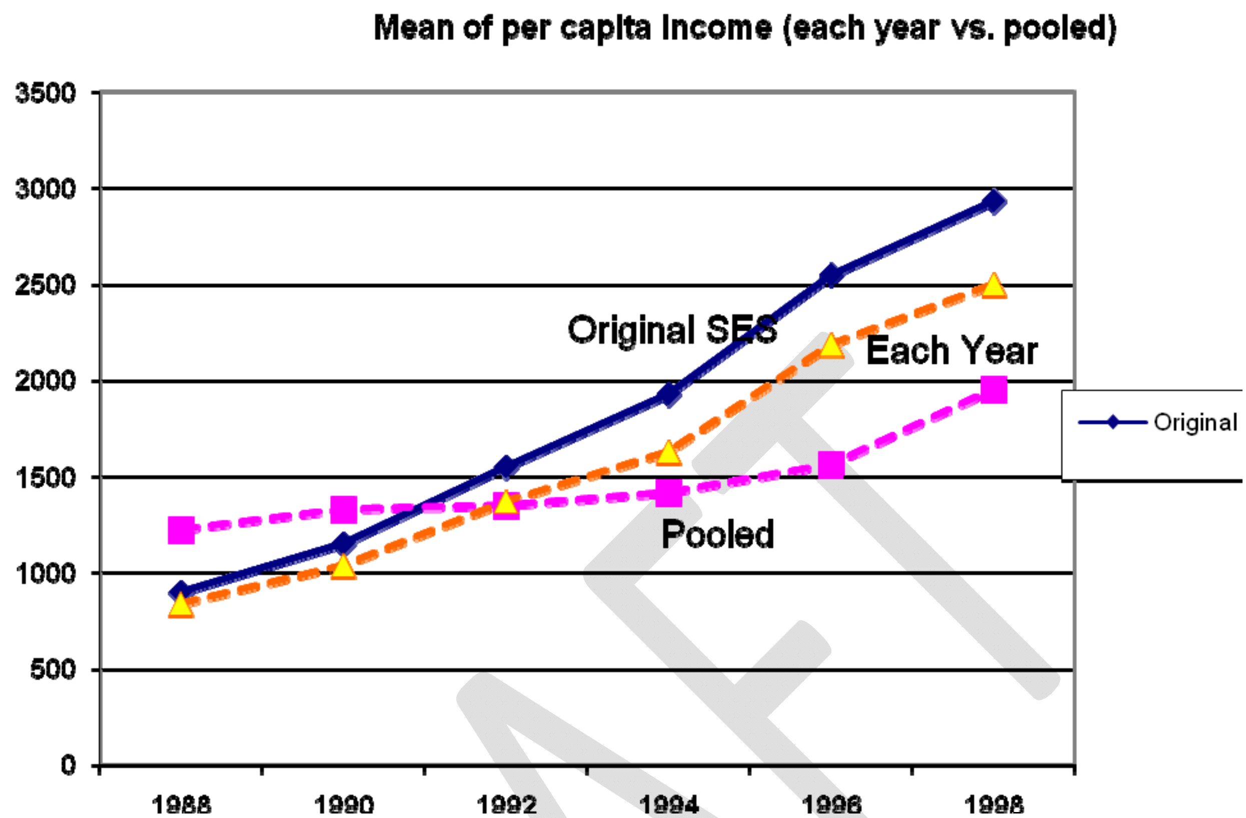
	1988	1990	1992	1994	1996
Simulated migrants population (1,000 persons)	1242.6	1359.7	1748.9	1971.4	2277.0
CDD-estimated migrant population	1287.8	1596.6	1951.5	2191.2	2348.1
LFS-estimated migrant population	400.6	433.5	624.6	509.5	718.4
Simulated Bangkok wage (1,000 baht)	51.90	67.33	77.67	86.90	92.98
Bangkok wage [a]	59.04	75.36	84.78	95.64	101.52
Bangkok pcgpp	98.40	125.60	141.30	159.40	169.20

[Table 3.1.11. Comparison of Simulated Results vs. Sample Data. Notes: Bangkok wage earnings are calculated by multiplying per capita GPP of Bangkok by the share of labor, which is set to be 0.6 for the benchmark case. Source: Yang (2004)]

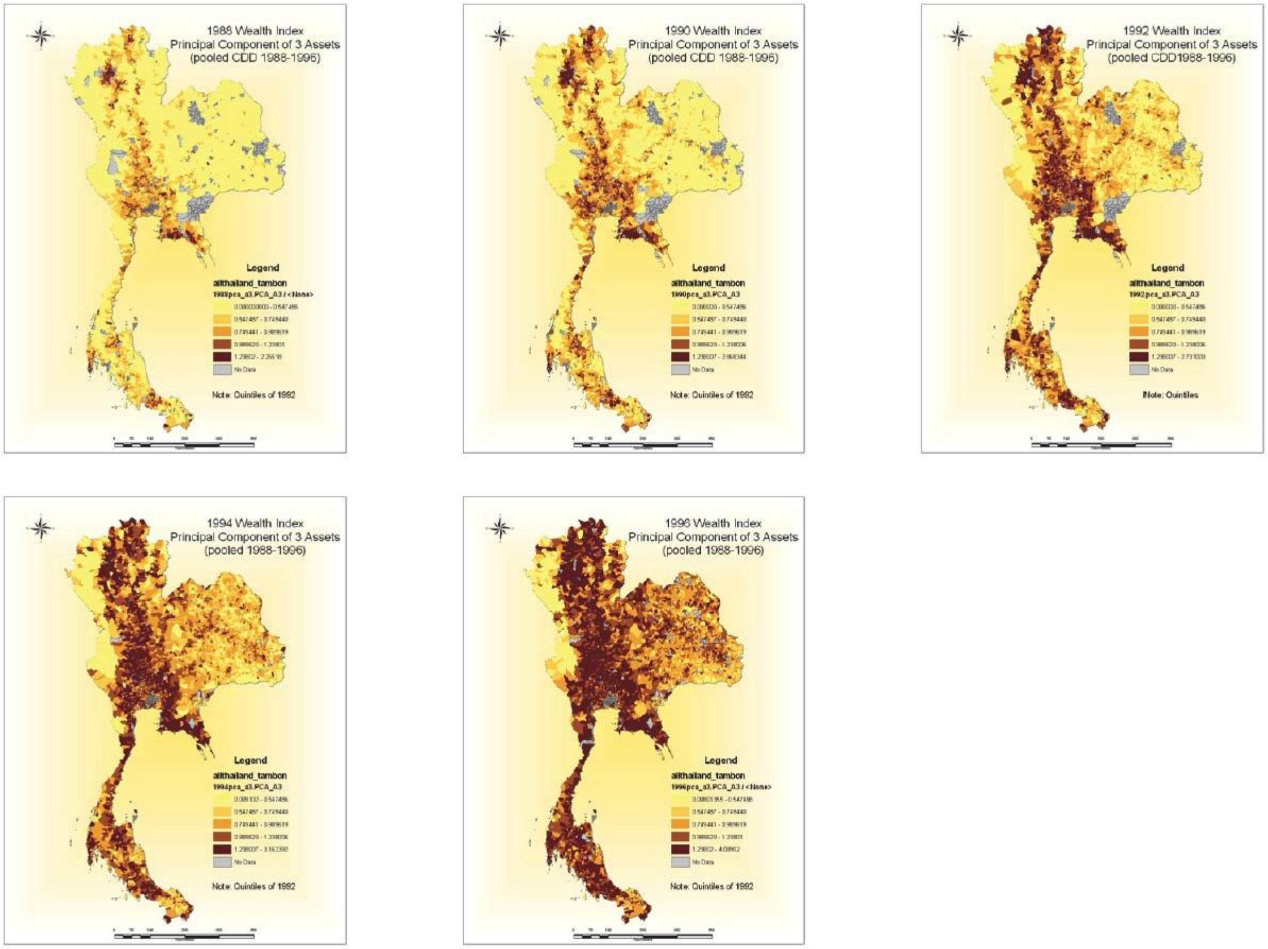
3.2 County/Tambon Economies

Townsend and Koriyama, in "Dynamic Poverty Mapping in Thailand: A Spatial Kuznets Analysis," (2008) take advantage of an overlap between the randomly selected villages of the SES household expenditure and income survey and the virtually universal village level CDD census. Specifically, per capita real income and consumption are regressed onto CDD variables stepwise with a truncation significance level of 5%. Naturally, different variables are significant in different years, and there are some tradeoffs between number of variables used and the percent of the sample remaining. We then project income onto the remainder of the CDD sample. Maps at the tambon level distinguishing quintiles show a dramatic rise in income. See Figure 3.2.2. At first this is largely concentrated in and around Bangkok and the Eastern Seaboard, including the corridor stretching North and in parts of the South. But by 1994, a convergent catch-up effect in household income is evident. Likewise, we can portray the incomes of the wealthiest and poorest tambons. See Figure 3.2.3. As is displayed, relative poverty remains concentrated in the periphery of the country.

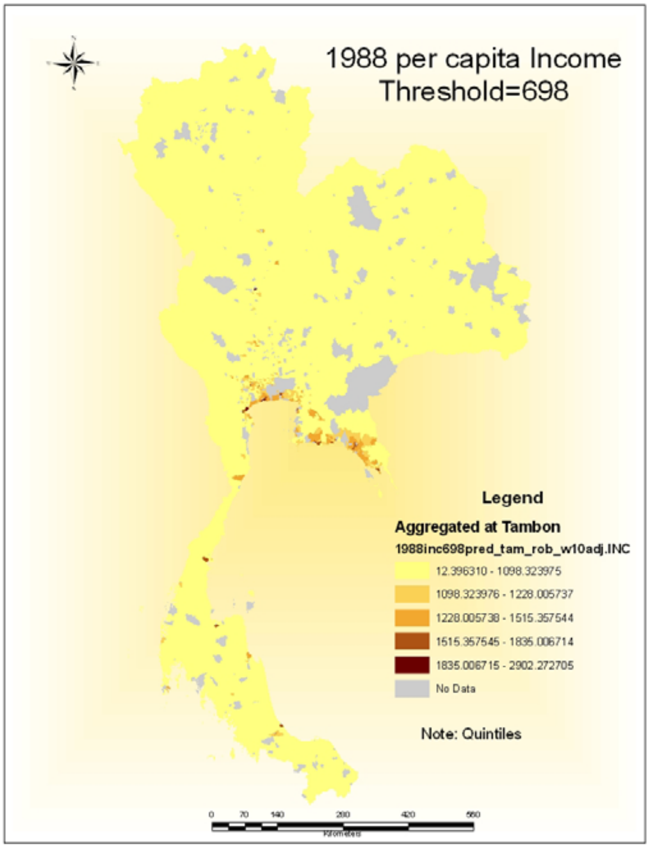
Finally, income across villages in each amphoe gives a measure of income inequality. Again, inequality increases till about 1992, and then decreases. The contribution of across-amphoe income levels to the total inequality starts to diminish even earlier.



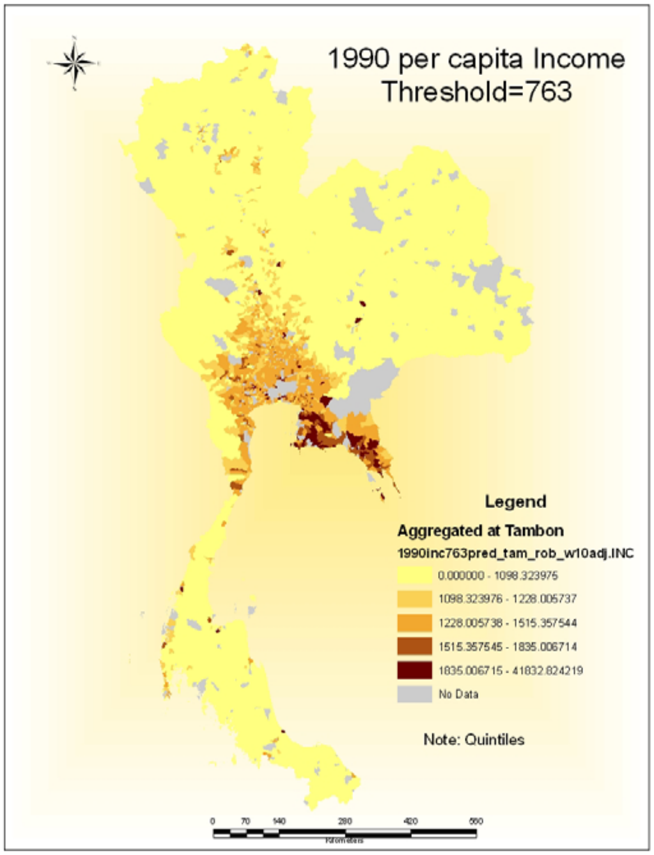
[Figure 3.2.1 Source: Townsend and Koriyama (2008)]



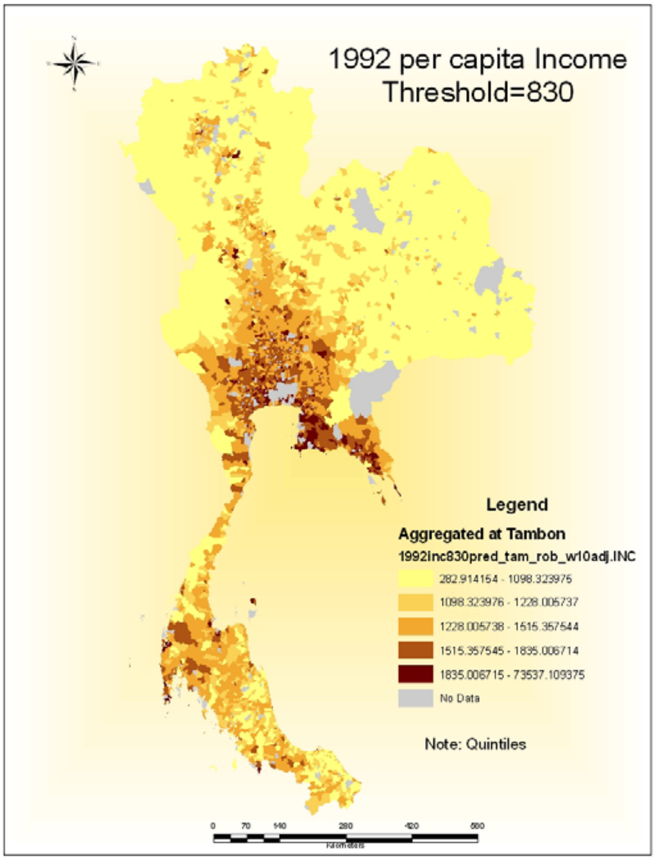
[Figures 3.2.2. Wealth index, 1998-96, principal component of 3 assets. Source: Townsend and Koriyama (2008)]

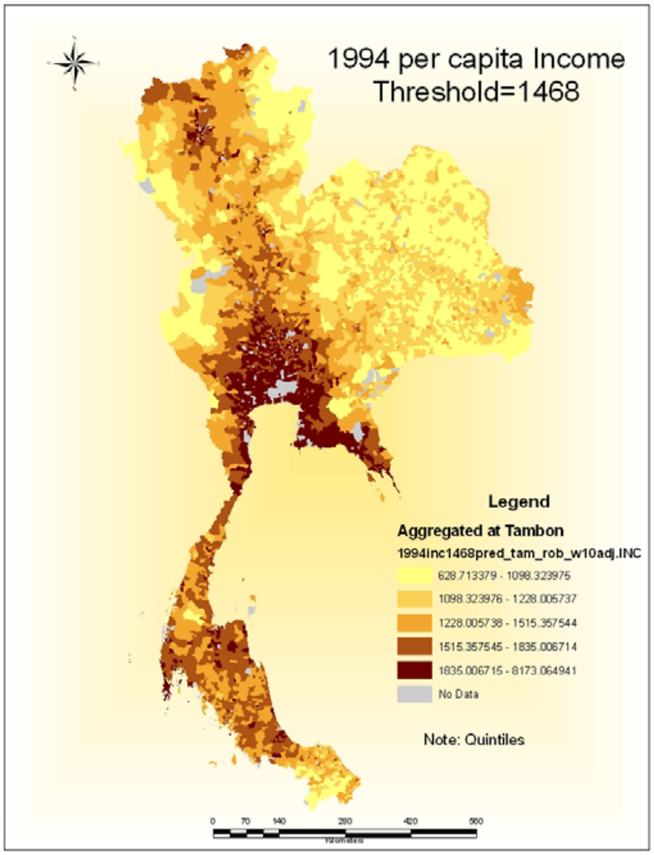


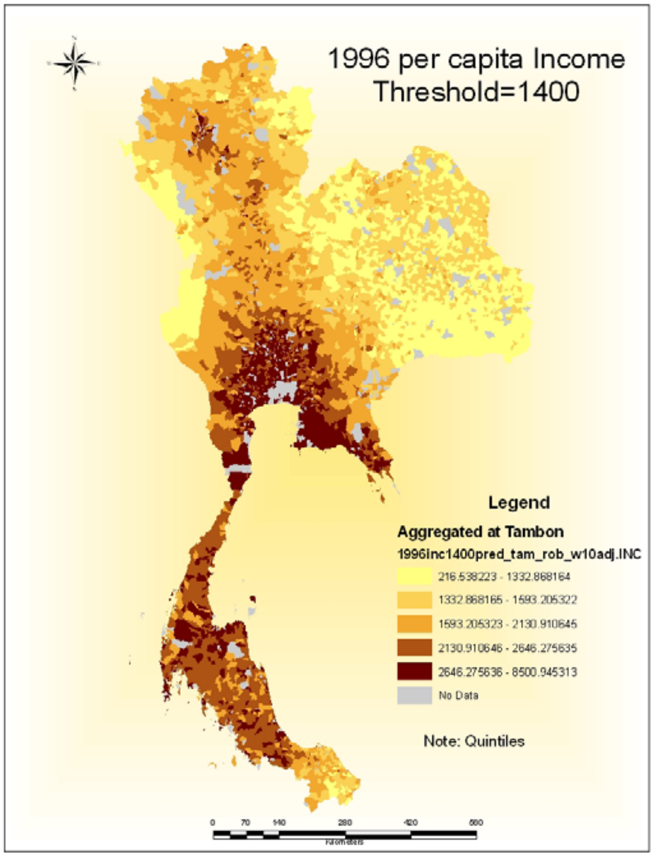
1988 per capita Income
Threshold=698
Legend
Aggregated at Tambon
1988inc698pred_tam_rob_w10adj.INC
12.396310 - 1098.323975
1098.323976 - 1228.005737
1228.005738 - 1515.357544
1515.357545 - 1835.006714
1835.006715 - 2902.272705
No Data
Note: Quintiles
0 70 140 280 420 560



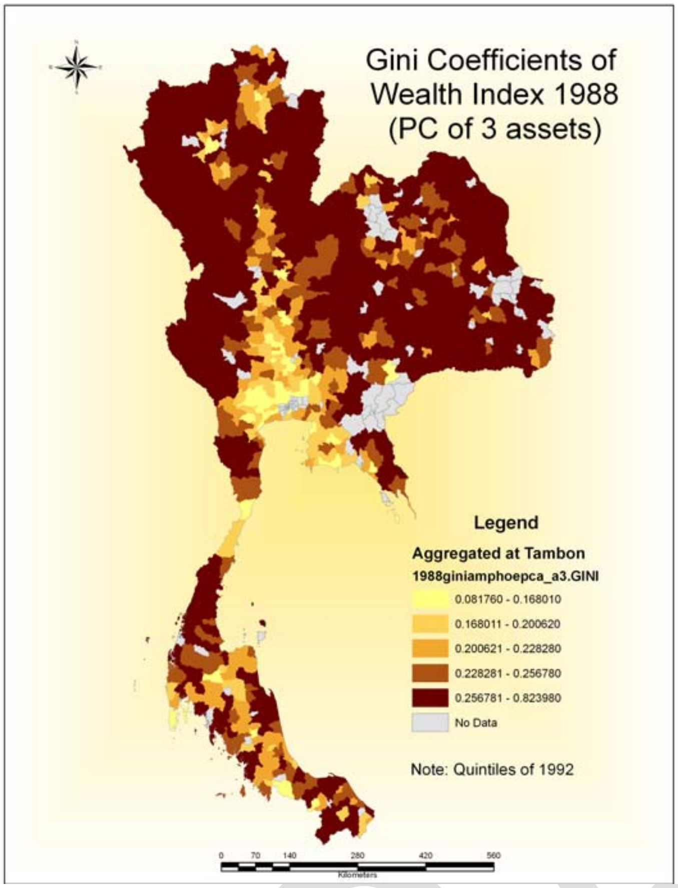
1990 per capita Income
Threshold=763
Legend
Aggregated at Tambon
1990inc763pred_tam_rob_w10adj.INC
0.000000 - 1098.323976
1098.323976 - 1228.005737
1228.005738 - 1515.357544
1515.357545 - 1835.006714
1835.006715 - 41832.824219
No Data
Note: Quintiles
0
70
140
280
420
560

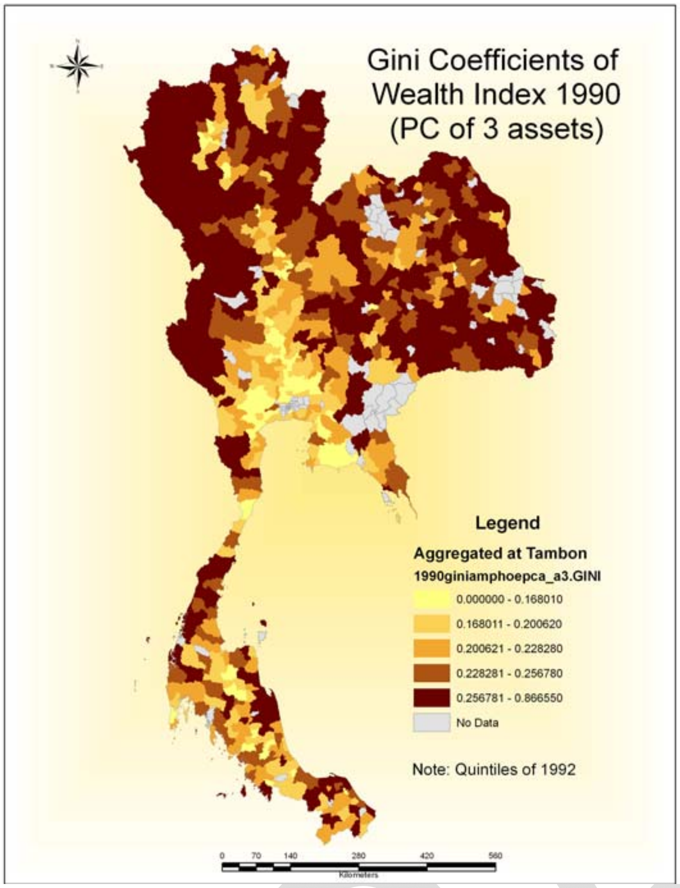

1992 per capita Income
Threshold=830
Legend
Aggregated at Tambon
1992inc830pred_tam_rob_w10adj.INC
282.914164 - 1098.323975
1098.323976 - 1228.005737
1228.005738 - 1515.357544
1515.357545 - 1835.006714
1835.006715 - 73537.109375
No Data
Note: Quintiles
0
70
140
280
420
560

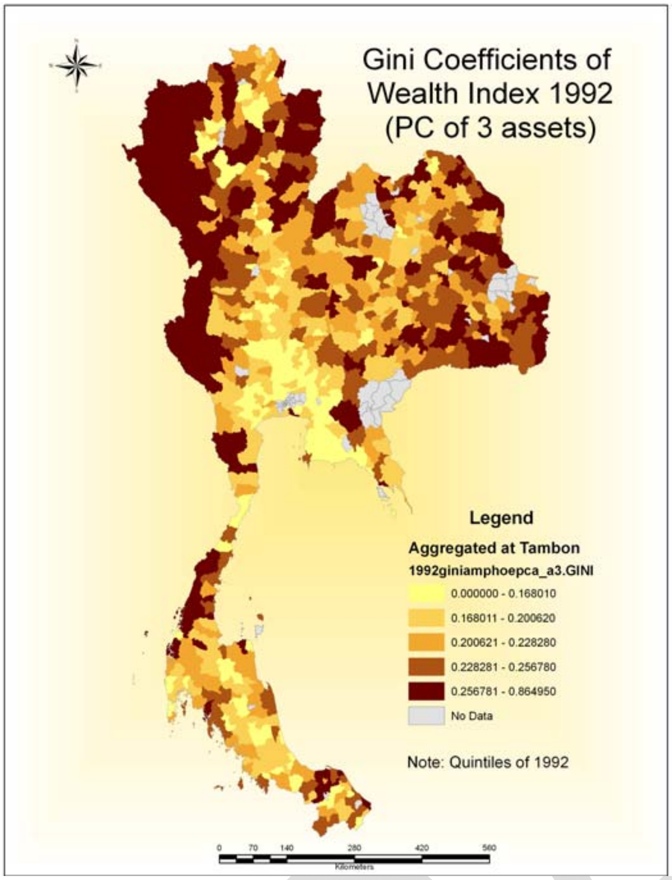

1994 per capita Income
Threshold=1468
Legend
Aggregated at Tambon
1994inc1468pred_tam_rob_w10adj.INC
628.713379 - 1098.323975
1098.323976 - 1228.005737
1228.005738 - 1515.357544
1515.357545 - 1835.006714
1835.006715 - 8173.064941
No Data
Note: Quintiles
0
70
140
280
420
560

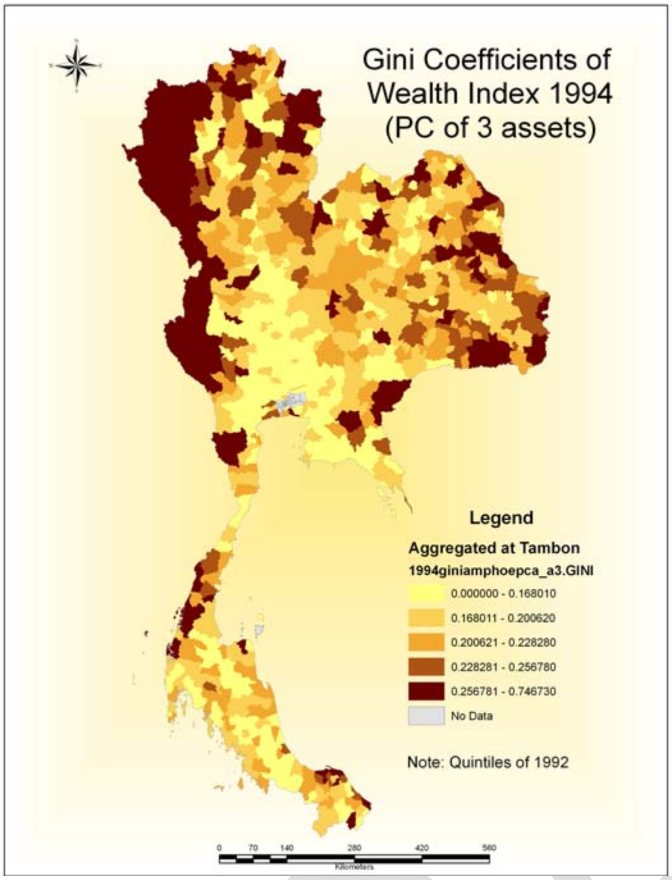


[Figures 3.2.3. Per capita income 1988-96. Source: Townsend and Koriyama (2008), CDD data]


Gini Coefficients of
Wealth Index 1988
(PC of 3 assets)
Legend
Aggregated at Tambon
1988giniamphoepca_a3.GINI
0.081760 - 0.168010
0.168011 - 0.200620
0.200621 - 0.228280
0.228281 - 0.256780
0.256781 - 0.823980
No Data
Note: Quintiles of 1992
0
70
140
280
420
560
Kilometers


Gini Coefficients of
Wealth Index 1990
(PC of 3 assets)
Legend
Aggregated at Tambon
1990giniamphoepca_a3.GINI
0.000000 - 0.168010
0.168011 - 0.200620
0.200621 - 0.228280
0.228281 - 0.256780
0.256781 - 0.866550
No Data
Note: Quintiles of 1992
0
70
140
280
420
560
Kilometers


Gini Coefficients of
Wealth Index 1992
(PC of 3 assets)
Legend
Aggregated at Tambon
1992giniamphoepca_a3.GINI
0.000000 - 0.168010
0.168011 - 0.200620
0.200621 - 0.228280
0.228281 - 0.256780
0.256781 - 0.864950
No Data
Note: Quintiles of 1992
0
70
140
280
420
560
Kilometers


Gini Coefficients of
Wealth Index 1994
(PC of 3 assets)
Legend
Aggregated at Tambon
1994giniamphoepca_a3.GINI
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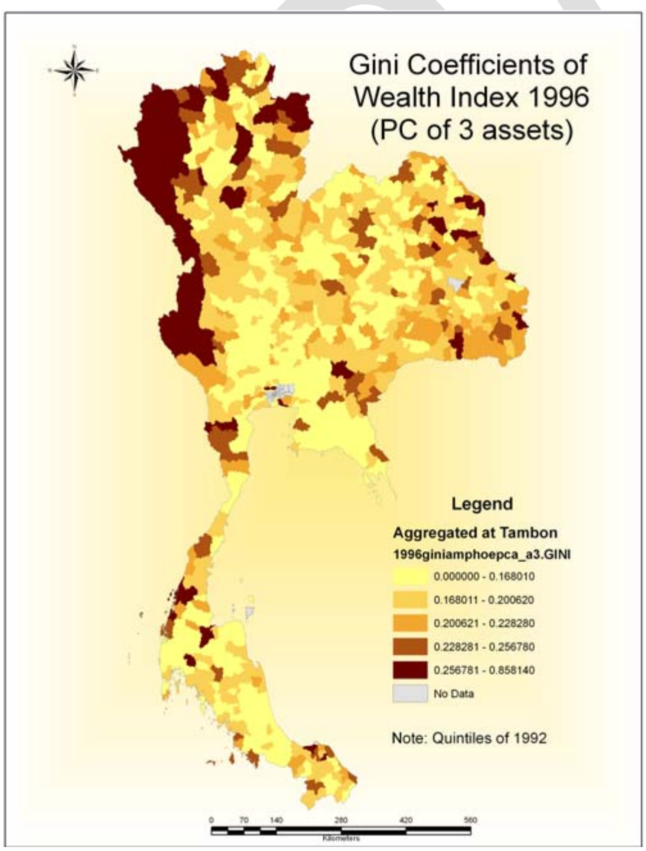
0.168011 - 0.200620
0.200621 - 0.228280
0.228281 - 0.256780
0.256781 - 0.746730
No Data
Note: Quintiles of 1992
0
70
140
280
420
560
Kilometers

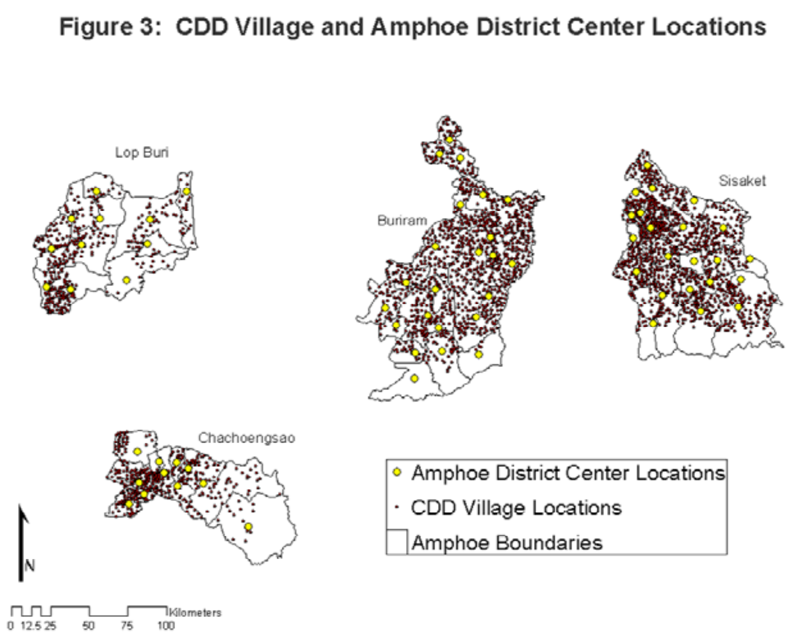

Gini Coefficients of
Wealth Index 1996
(PC of 3 assets)
Legend
Aggregated at Tambon
1996giniamphoepca_a3.GINI
0.000000 - 0.168010
0.168011 - 0.200620
0.200621 - 0.228280
0.228281 - 0.256780
0.256781 - 0.858140
No Data
Note: Quintiles of 1992
0
70
140
280
420
560
Kilometers

[Figures 3.2.4. Gini coefficients of wealth index, 1988-96, principal component of 3 assets. Source: Townsend and Koriyama (2008)]

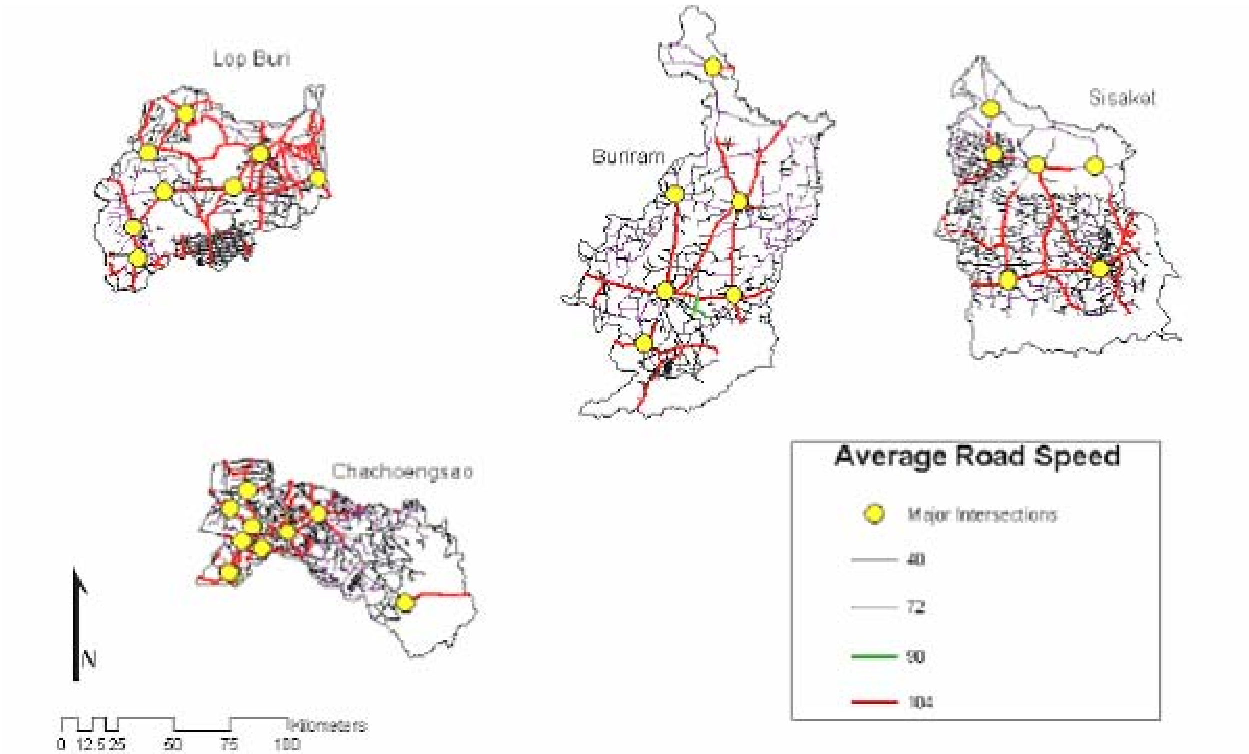
[Figures 3.2.5. Source: Townsend and Koriyama (2008)]

3.3 Village Economies: Within Provinces

The same techniques can be used to create a variety of perspectives on village economies. We used a Geographic Information System (GIS) to vectorize the location of villages, amphoe district centers, and roads by type. See Figures 3.3.1 and 3.3.2. The GIS supports sophisticated geographic analysis; for example, we can compute minimum travel times between any two points, such as from a village to the intersection of two major highways or to a district center. All locations can be linked to existing secondary data, e.g., village points to the CDD village census data.

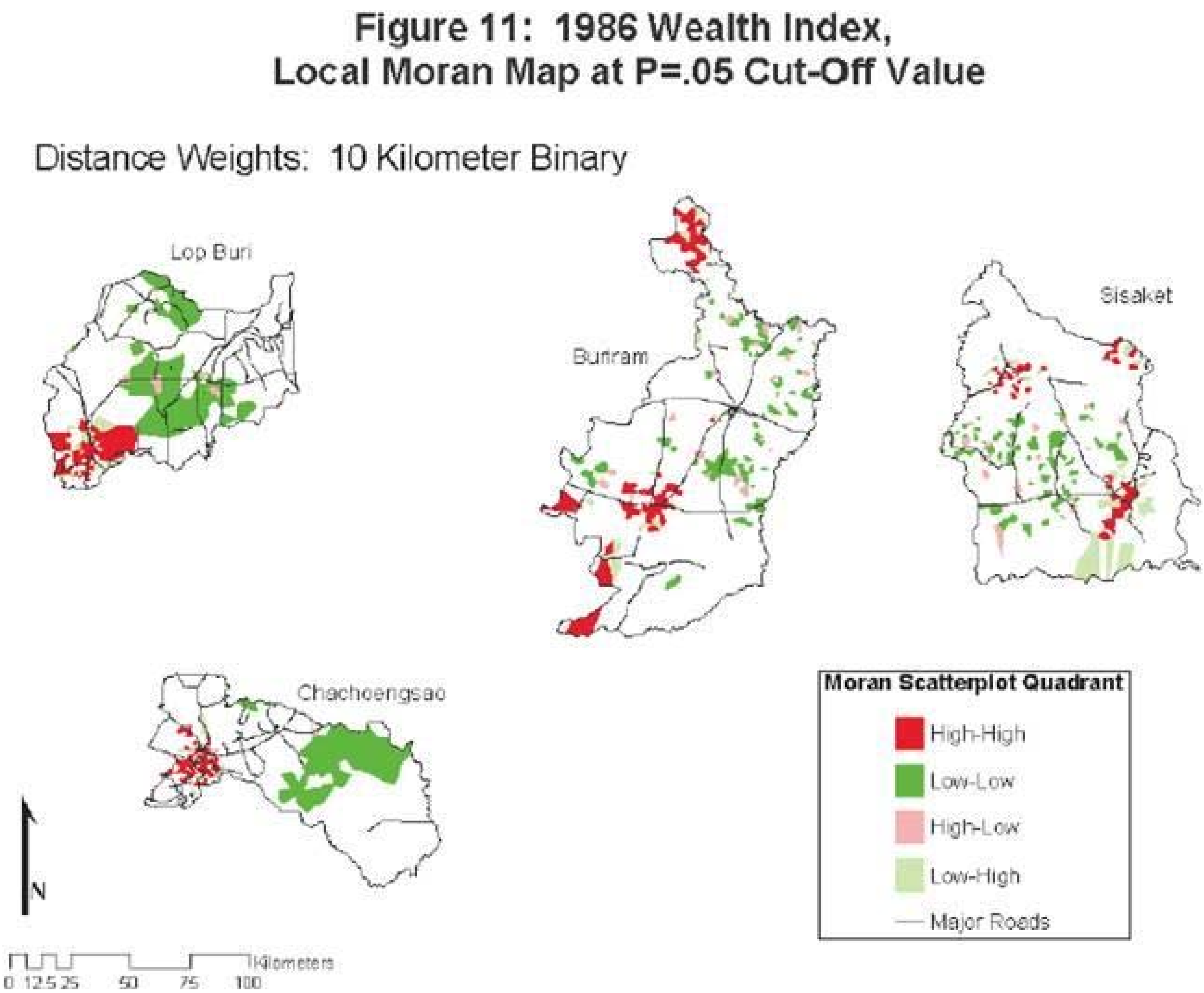


[Figure 3.3.1. CDD Village and Amphoe District Center Locations. Source: Adapted from Townsend Thai Data and SES Data]



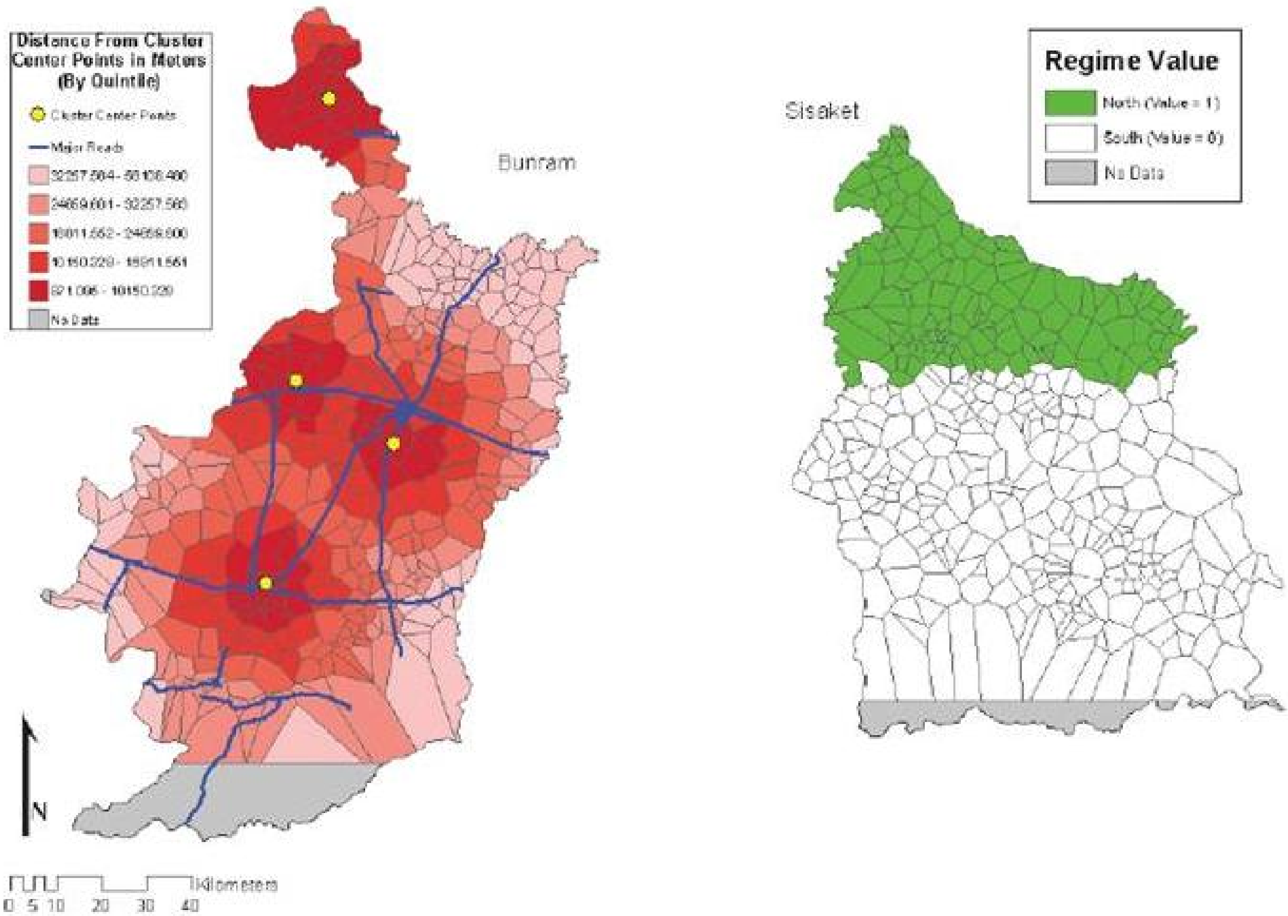
[Figure 3.3.2. Road Networks and Major Intersection Locations, with average road speeds. CDD Village and Amphoe District Center Locations. Source: Adapted from Townsend Thai Data and SES Data]

Within province differences in income are striking. For example, the CDD can be used to create an index of wealth, based on principal components analysis of the holdings of TV's, toilets, pickup trucks, and motorcycles. A Moran index as in Figure 3.3.3 plots the concentration patterns, that is, villages with high wealth surrounded within a 10 km radius by villages of high wealth, low wealth surrounded by low, and the so-called high-low and low-high transition areas. The hot spots are in and around most provincial capitals and just off of highways and rail networks. One can also identify hot-spot spatial regimes, as in Figure 3.3.4, i.e. the north of Sisaket versus the south, or the west of Lop Buri versus the east (not shown). There are also hot spot areas related to agglomeration-concentrations, as in Buriram (Figure 3.3.4). Some hot spots in 1986, such as eastern Lop Buri and Chachoengsao, and northern Sisaket seem related to areas of early settlement. See Figure 3.3.5.

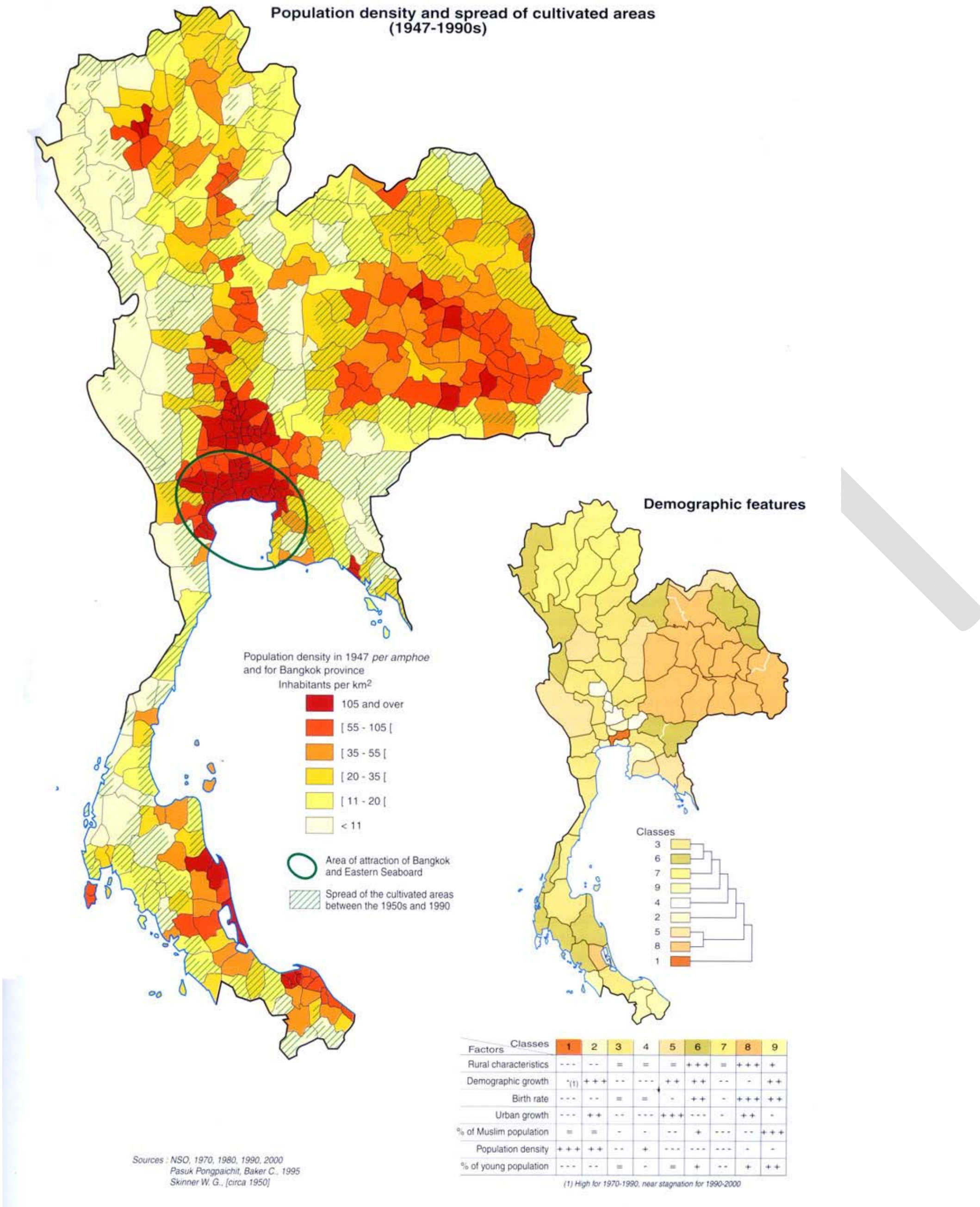


[Figure 3.3.3. 1986 Wealth Index, Local Moran Map: Clusters Statistically. Significant at *P*=.05 Cutoff Value (Distance Weights: 10km binary) Source: Adapted from Townsend Thai Data and SES Data]

Figure 12: Buriram and Sisaket Spatial Heterogeneity Variables



[Figure 3.3.4. Economic Agglomeration Variables: Buriram and Sisaket provinces. Buriram and Sisaket Spatial Heterogeneity Variables. Source: Adapted from Townsend Thai Data and SES Data]



Factors \ Classes	1	2	3	4	5	6	7	8	9
Rural characteristics	- - -	- -	=	=	=	+ + +	=	+ + +	+
Demographic growth	*(1)	+ + +	- -	- - -	+ +	+ +	- -	-	+ +
Birth rate	- - -	- -	=	=	-	+ +	-	+ + +	+ +
Urban growth	- - -	+ +	- -	- - -	+ + +	- - -	-	+ +	-
% of Muslim population	=	=	-	-	- -	+	- - -	- -	+ + +
Population density	+ + +	+ +	- -	+	- - -	- - -	- - -	-	-
% of young population	- - -	- -	=	-	=	+	- -	+	+ +

[Figure 3.3.5. Population Distribution and Demographic Features. Source: Kermel-Torres (2004)]

3.4 Households in the National Economy: Temporal and Geospatial Variations

Regressing Household income change onto time-specific fixed effects

Time	All Sample		Central		Northeast	
Dummies	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
TOWNSEND-THAI Data						
1997-98	-1120.163	0.016	-2516.863	0.002	153.652	0.754
1998-99	395.854	0.392	-881.836	0.269	1596.774	0.001
1999-00	-1800.597	0.000	-2099.467	0.008	-1512.011	0.002
2000-01	603.138	0.191	753.864	0.342	459.218	0.349
R2	0.0054		0.0084		0.0091	
Prob>F	0.0001		0.0009		0.0003	
Obs	3618		1756		1862	

Regressing Household Consumption Change onto time-specific fixed effects

Time	All Sample		Central		Northeast	
Dummies	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
TOWNSEND-THAI Data						
1997-98	-4873.324	0.000	-5332.876	0.000	-4446.596	0.000
1998-99	363.001	0.374	1480.457	0.016	-694.506	0.200
1999-00	-905.69	0.026	-953.273	0.117	-859.524	0.114
2000-01	593.106	0.146	1026.804	0.091	167.893	0.758
R2	0.0382		0.0436		0.0349	
Prob>F	0.0000		0.0000		0.0000	
Obs	3623		1771		1852	

Regressing Household Investment onto time-specific fixed effects

Time	All Sample		Central		Northeast	
Dummies	Coefficient	p-value	Coefficient	P-value	Coefficient	p-value
TOWNSEND-THAI Data						
1997-98	3860.084	0.000	4306.129	0.000	3422.472	0.000
1998-99	-468.128	0.153	-1140.926	0.024	186.333	0.655
1999-00	1580.115	0.000	1628.293	0.001	1533.446	0.000
2000-01	827.785	0.011	780.082	0.122	874.886	0.036
R2	0.0424		0.0443		0.0410	
Prob>F	0.0000		0.0000		0.0000	
Obs	3771		1864		1907	

[Table 3.4.1. Aggregate versus Idiosyncratic Shock: Regressions Onto Time-Specific Fixed Effects. Source: Alem and Townsend (2006)]

It is natural to ask how much of the variation in income at the aggregate, macro level or the regional level is detectable at the micro household level. A simple way to capture common macro shocks is to regress household income change in a panel onto common time effects, $\Delta y_{it} = \theta_t + \varepsilon_{it}$. See Table 3.4.1. The "explained" contribution to overall variance is low, indicating either a large degree of measurement error or little impact on households of what one might have presumed *a priori* to be a large influence from the macro economy. The signs are as expected, e.g. negative in the 1997 crisis and positive in the subsequent recovery, but the orders of magnitude are not. The R^2's for consumption and especially investment are slightly higher, as the theory of risk-sharing below might imply. Stratification by region picks up regional shocks but only slightly higher explained variance.

The construction of cohort is as follows (TTP-equivalent)

- **Education: 7**
  - → **1: no formal education**
  - → **2: elementary (lower)**
  - → **3: elementary (higher)**
  - → **4: secondary (lower)**
  - → **5: secondary (higher)**
  - → **6: vocational education**
  - → **7: college and above**

- **Socio-economic class: 7**
  - → **1: farm operator, mainly owning land**
  - → **2: farm operator, mainly renting land**
  - → **3: entrepreneurs, trade and industry**
  - → **4: professional, technical & managerial**

- **Region: 4 (provinces)**
  - → **1: Lop Buri**
  - → **2: Chachoengsao (Central)**
  - → **3: Sisaket**
  - → **4: Buriram (Northeast)**

*Hence the maximum possible combination will be 196 (7*7*4)*

[Table 3.4.2. Creating a Pseudo-SES Panel. Source: Adapted from SES data]

Similarly, as a check, one can create a synthetic cohort from the cross sectional SES data. We treat households as in a common cohort if they have the same levels of education and the same occupation type. The latter is what the SES refers to as socio-economic class. For each of the four provinces of the Townsend Thai survey, there are 7-x-7 potential cohort groups. See Table 3.4.2. For comparability to the Townsend Thai survey we restrict attention in the SES to those living in villages. In practice it is not possible to create all cells, and the number of cells with sufficient data is even less. For example, in the comparable Central region in 1996 there are 401 SES rural households, 50 cohorts, with an average cell size of 8 households. The pseudo panel of 1996 and 1998 has 42 common cohort groups.

ALL	1996	1998	1999	2000
Households (number)	1246	1172	367	1075
Avg. Size of Cell	11	9	5	9
Cohort included (number)	63	63	63	63
CENTRAL				
Households (number)	401	359	121	368
Cell/Year (number)	50	58	35	59
Avg. Size of Cell	8	6	3	6
Cohort included (number)	25	25	25	25
NORTHEAST				
Households (number)	845	813	246	707
Cell/Year (number)	63	67	43	66
Avg. Size of Cell	13	12	6	11
Cohort included (number)	38	38	38	38

*Implies number of cohort in consecutive years

SES DATA	ALL		CENTRAL		NORTHEAST	
1996-98	160.5989	0.472	-173.8037	0.350	186.5974	0.454
1998-99	-615.5994	0.007	-245.3791	0.189	-471.166	0.061
1999-2000	329.4181	0.142	428.1347	0.024	229.234	0.358
R2	0.0505		0.0859		0.0264	
Prob > F	0.0186		0.0559		0.1795	
Obs	138		54		75	

[Table 3.4.3. Importance of Idiosyncratic Shocks. SES Data, Rural Regions. Source: Alem and Townsend, unpublished]

Limited as it is, regressions on this panel imply that aggregate, common time effects have slightly higher explanatory value, though obviously individual household variation is suppressed. There is some hint that geography matters: explained variance goes up to .086 when attention is restricted to Central region alone.

	Chachoengsao	Lop Buri	Buriram	Sisaket
1997-98	Fish* _Remittances _Govt transfers _Wages* _Financial _Agriculture* _Business* _Rentals*	Fish* Govt transfers Remittances _Wages* _Agriculture* _Financial* _Business* _Rentals	Rentals Financial _Remittances _Wages* _Govt transfers _Agriculture* _Business* _ Fish	Govt transfers* Rentals* Remittances _Agriculture* _Wages* _Business* _Financial* _Fish*
Adjusted R^2	.45	.52	.43	.37
	Financial Remittances _Rentals	Govt transfers* Remittances Financial	Govt transfers Fish Remittances	Fish* Rentals* Financial

1998-99	_Fish _Wages* _Agriculture* _Business* _Govt transfers	_Wages* _Agriculture* _Rentals _Business* _Fish	Financial _Wages* _Rentals _Agriculture* _Business*	_Wages _Remittances _Agriculture* _Business* _Govt transfers
Adjusted R^2	.32	.25	.24	.22
1999-2000	Rentals Remittances _Wages* _Business* _Financial _Agriculture* _Fish* _Govt transfers	Remittances Govt transfers _Wages _Agriculture* _ Financial _ Rentals _Business* _Fish	Rentals* _Wages _Financial _Agriculture* _Remittances* _Govt transfers _Business* _Fish	Fish Remittances _Wages _Govt transfers _Rentals _Agriculture* _Business* _Financial*
Adjusted R^2	.27	.29	.25	.27
2000-01	Rentals Fish Business Financial _Wages* _Agriculture* _Govt transfers _Remittances	Business* Agriculture Financial _Wages _Remittances _Rentals _Fish _Govt transfers	Rentals* Govt transfers _Remittances _Wages* _Agriculture* _Business* _Financial* _Fish	Fish Rentals Remittances* Business* Govt transfers _Wages _Agriculture* _Financial*
Adjusted R^2	.14	.08	.16	.13

Notes: _ indicates Negative coefficients, * significant at 10%, Coefficients are ranked in descending order. Agriculture: Rice, Corn, Vegetable or Orchard Farming and Other Crops, Raising Chicken/Ducks or pig/cow/buffalo and Other Livestock; Fish: Raising Fish or Shrimp; Wages: Wages and Salaries; Business: Rice Mill, Store, Mechanic/Repair Shop, Hair Salon/Barber, Restaurant/Noodle Shop, Trading and Other Business; Rentals: Payments from Land or Other Rentals, Roomers/Boarders; Financial: Interest on Savings, Income-Loan Repayment, Proceeds from ROSCA and Dividends; Government Transfers: Government Assistance, Scholarships or Grants and Retirement Compensation, Remittances: Remittances from Relatives or Friends and Gifts. Tambon fixed effects are included.

[Table 3.4.4.a. Level Change Household Income regressed on Base Period Income by Source. Source: Alem and Townsend (2006)]

	Chachoengsao	Lop Buri	Buriram	Sisaket
97-98	**Agriculture** Wages Business Financial Rental	**Rental** Financial * (-) Business *** Wages *** Agriculture	**Wages** Financial (-) Business *** Agriculture ** Business	**Financial** Wages (-) Business *** Agriculture Rental
Adj. R2	**0.68**	**0.92**	**0.57**	**0.7**
	Agriculture **Financial ****	**Wages** **Business**	**Rental** **Financial ***	**Rental** **Agriculture**

98-99	**Wages** ** **Business** Rental ** (-)	Rental (-) Agriculture	Wages (-) Business *** Agriculture	Wages Business (-) Financial
Adj. R2	**0.34**	**-0.08**	**0.56**	**-0.04**
99-00	**Rental** ** Financial (-) Business Wages ** Agriculture	**Agriculture** **Rental** **Wages** **Business**	**Wages** **Agriculture** **Business** *** Financial * (-) Rental	Financial Wages (-) Business Agriculture Rental
Adj. R2	**0.14**	**-0.72**	**0.27**	**-0.49**

(-) : negative coefficients
* : significant at 10
coefficients are ranked in descending order

[Table 3.4.4b. Changes (levels) of Real Income of Households Regressed on Fraction of Income by Source, by changwat, including tambon Fixed Effects. Source: SES data]

There are other observable sources of heterogeneity that determine income change, for example, occupation helps to predict income, more so than common temporal effects, *per se*, as in equation,

$$\Delta Y^{j}_{t,t+1} = \beta D_{t,t+1} + \sum_{i} \xi_i Y^{j}_{0,i,t} + \varepsilon^{j}_{t,t+1} \qquad (3.3.1)$$

That is, one can regress household j specific income change $\Delta Y^{j}_{t,t+1}$ onto the amount of income Y^{j}_{t} of j from various occupations i in the base year t, along with common tambon fixed effects $D_{t,t+1}$. Explained variation in Table 3.8 now reaches higher levels e.g., from .08 to .52. We can see by the rank ordering of coefficients from high to low that households with wage earnings and those with remittances in the base year suffered lower income change than might have been anticipated in the crisis, while those in business suffered sharp declines. To an extent the situation is reversed by the end of the panel, in the recovery. Reassuringly, the SES cohort analysis, Table 3.4.4.b, yields conclusions similar to the Townsend Thai panel data.

Evidently, both geography and occupation play a role in income shocks. Using the SES, Townsend (1995) regressed the difference between amphoe (*a*) income growth and the regional (*r*) average income growth onto time difference and community *c* (urban, rural, sanitary district) fixed effects, as in the equation,

$$\frac{\overline{\ln y_t^a} - \overline{\ln y_\tau^a}}{t-\tau} - \frac{\overline{\overline{\ln y_t^a} - \overline{\ln y_\tau^a}}}{t-\tau} = \chi \delta_{t,\tau}^{r,c} + \varepsilon_{t,\tau}^{a,r,c} \tag{3.3.2}$$

where $\frac{\overline{\ln y_t^a} - \overline{\ln y_\tau^a}}{t-\tau}$ denotes the amphoe average, $\frac{\overline{\overline{\ln y_t^a} - \overline{\ln y_\tau^a}}}{t-\tau}$ denotes the regional average, and $\delta_{t,\tau}^{r,c}$ denotes the community/time fixed effect. Similarly for consumption,

$$\frac{\overline{\ln c_t^a} - \overline{\ln c_\tau^a}}{t-\tau} - \frac{\overline{\overline{\ln c_t^a} - \overline{\ln c_\tau^a}}}{t-\tau} = \theta \delta_{t,\tau}^{r,c} + \varepsilon_{t,\tau}^{a,r,c} \tag{3.3.3}$$

This was also done also for each primary occupation group one at a time. There are many statistically significant fixed effects, especially for farmers; less so for rice farmers, and few for entrepreneurs. See Table 3.4.5 for an example of the results.

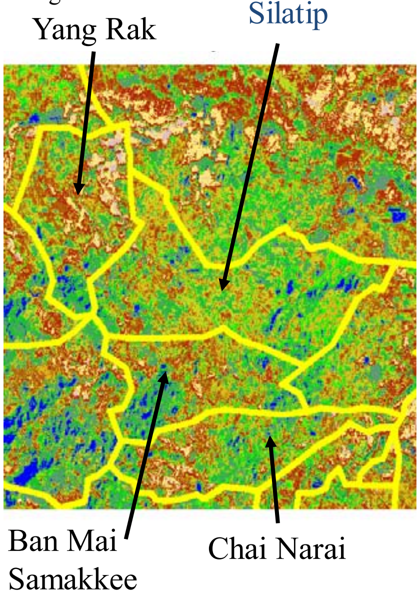
		Different Occupation Groups								Different Measures of Income and Consumption			
	F test for	All Households		All Farmers		Rice Farmers		Entrepreneurs		All Income	No In Kind	Wages	Food
		Y	C	Y	C	Y	C	Y	C	Y	Y	Y	C
1	N: 75-81												
2	N: 81-86			••									
3	N:86-88	••		••	••	••	••			••	•		
4	N	••		••	••	••	••			•			
5	NE: 75-81											••	
6	NE: 81-86												
7	NE: 86-88	••	•	••	••	•		•	••	••	••	••	••
8	NE	••		••					••	••	••	••	
9	C: 75-81												
10	C: 81-86												
11	C: 86-88	••	•	••	••	••	••			••	••		••
12	C	••		••	••	••	••			••	••		
13	S: 75-81												
14	S: 81-86			••									
15	S: 86-88			••		•		••	•				
16	S			••									
17	B: 75-81			••									
18	B: 81-86												
19	B: 86-88			••									

20	B		• •									
21	U: 75-81											
22	U: 81-86		• •									
23	U: 86-88		• •	• •	•	•						• •
24	U		• •	• •	•	•						
25	SD: 75-81											
26	SD: 81-86											
27	SD: 86-88	• •	•	•	•		• •	• •	• •	• •	•	•

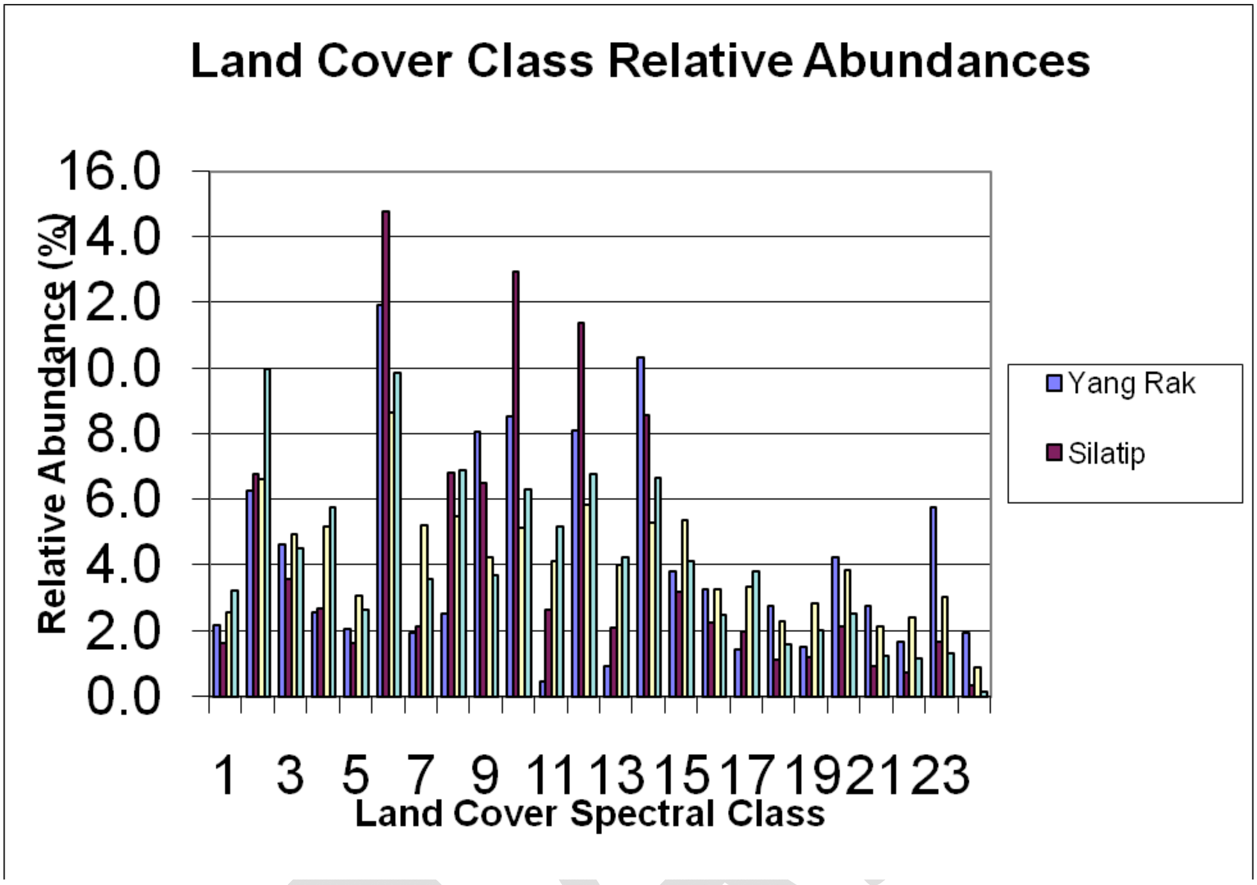
N = North, C = Central, S = South, B = Bangkok, U = Urban, SD = Sanitary District, Y= year, C= community
• • = significant at 5% level, • = significant at 10% level
** = measured in C (community types) and Y (years)
(Table 3.4.5)

[Table 3.4.5. Region, Year, and Community Type Patterns in Income and Consumption Growth Rates. Note that many fixed effects in income disappear in consumption. Note: N = North, C = Central, S = South, B = Bangkok, U = Urban, SD = Sanitary District, C=community. (** = significant at 5% level, * = significant at 10%). Source: Townsend (1998)]

Fig. 2

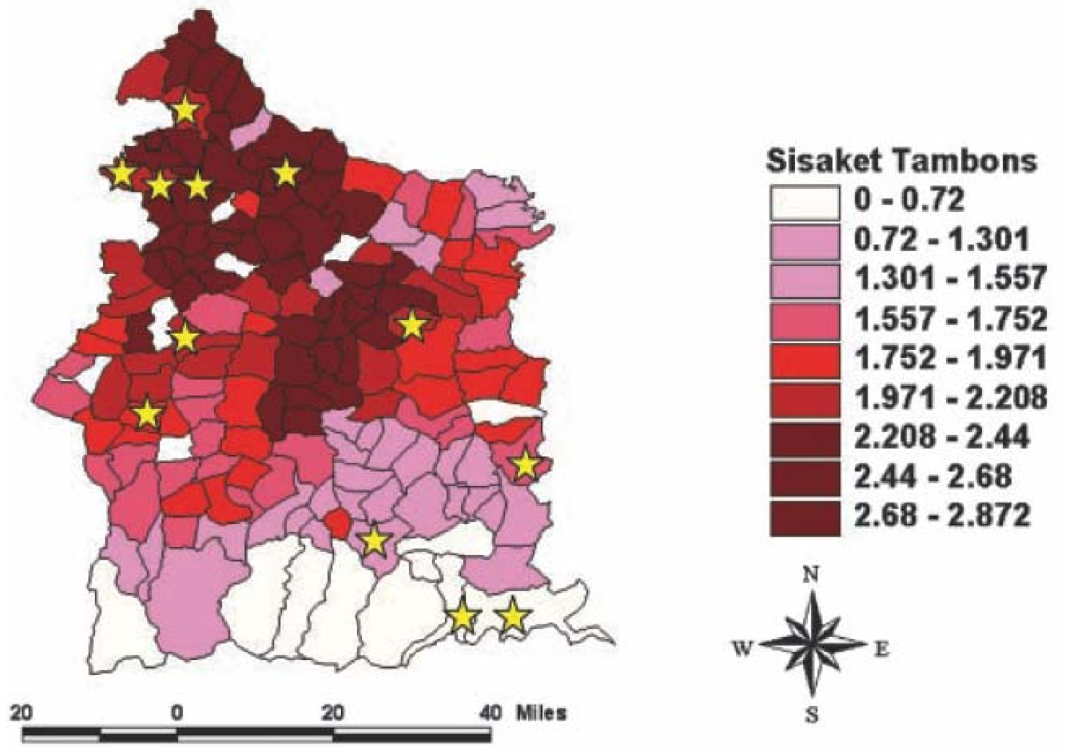


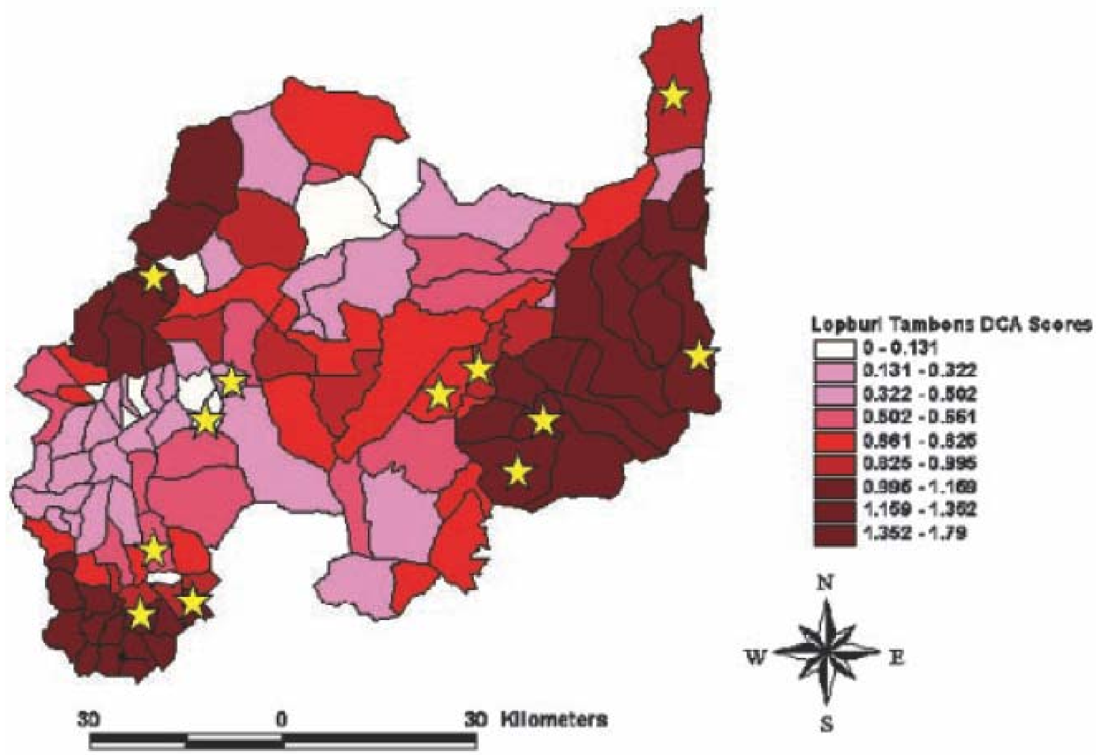
[Variation in land cover in Lop Buri]



[Figure 3.4.6. Histogram of land-cover class-relative abundances for 4 tambons in Lop Buri. Source: Binford, Lee, and Townsend (2004)]

Even within amphoes, and smaller areas, there is important variation. For example, land cover varies across tambons. Satellites provide 7-dimensional readings of light reflectance. Each pixel, 30-meters square, can then be grouped into classes, such as the 23 classes depicted in Figure 3.4.6, for part of Lop Buri. By construction, there is low variation across pixels within a class, and high variation across pixels across classes. The histogram of abundance of the 23 spectral classes and the associated ground cover imagery for four tambons in Lop Buri are displayed again in Figure 3.4.6. A principal components analysis then delivers low-dimensional factors or indices which account for the distribution of land classes within tambons. Two factors explain 70-76% percent of the variation.





[Figure 3.4.7. Sisaket Tambon DCA Scores (top) and Lop Buri Tambon DCA Scores (bottom). Note: Stars indicate geographic location of sampled Townsend Thai survey tambons. Source: Binford, Lee, and Townsend (2004)]

Maps (Figure 3.4.7) reveal the distribution of (the first) factor score, varying from low to high as one moves in Sisaket from south to north. The Townsend Thai data were stratified so that random selection would pick up this salient variation. Subsequent analysis with the annual panel indicates that the likelihood of the timing of good and bad years varies with the factor scores. That is, in a given year, one is likely to have some tambons with high factor scores having high incomes and others with low factor scores having low income, and much to the point, the reverse in other years. This is ideal for testing of theory of the optimal allocation of risk.

	Chachoengsao	**Lop Buri**	**Buriram**	**Sisaket**
11 Flood	17 (10.63%)	0	18 (10.71%)	56 (28.72%)
13 Drought	83 (51.88%)	17 (10.76%)	27 (16.07%)	107 (54.87%)
15 Pests	9 (5.63%)	44 (27.85%)	3 (1.79%)	11 (5.64%)
17 Other reason low crop yield	40 (25%)	49 (31.01%)	27 (16.07%)	100 (51.28%)
19 Fire	0	0	0	10 (5.13%)
21 Low price of output	52 (32.5%)	58 (36.71%)	85 (50.6%)	29 (14.87%)
23 High input price	49 (30.63%)	19 (12.03%)	12 (7.14%)	20 (10.26%)
25 Education expenses higher	8 (5%)	3 (1.9%)	2 (1.19%)	6 (3.08%)
27 Need extra money for ceremony	5 (3.13%)	0	0	10 (5.13%)
29 Lower income due to retirement	0	0	0	0
31 High investment costs	12 (7.5%)	12 (7.59%)	5 (2.98%)	13 (6.67%)
33 Expenses due to illness	4 (2.5%)	4 (2.53%)	4 (2.38%)	6 (3.08%)
35 Building expenses higher	0	0	0	4 (2.05%)
37 Death in family	0	0	0	0
39 Worked fewer days	23 (14.38%)	29 (18.35%)	7 (4.17%)	13 (6.67%)
41 Bad year for hh business	48 (30%)	10 (6.33%)	10 (5.95%)	14 (7.18%)
43 Lost money from gambling	0	0	0	0
45 Unable to repay debts	4 (2.5%)	3 (1.9%)	10 (5.95%)	8 (4.10%)
Other	8 (5%)	18 (11.39%)	3 (1.79%)	9 (4.62%)

[Table 3.4.8. Idiosyncratic Shocks. Source: Alem and Townsend (2006)]

Comparison between 1998 and 1999 (from 1999 survey)							
	All	**Central**	**Chachoengsao**	**Lop Buri**	**Northeast**	**Buriam**	**Sisaket**
Worse than 1998	46	11	10	1	35	27	8

	(35.38	(22.00	(31.25	(5.56	(43.75	(47.37	(34.78
Better than 1998	12	5	5	0	7	7	0
	(9.23	(10.00	(15.63	(0.00	(8.75	(12.28	(0.00
Unchanged income	72	34	17	17	38	23	15
	(55.38	(68.00	(53.13	(94.44	(47.50	(40.35	(65.22
# of HH	130	50	32	18	80	57	23

( ) : ratio of HH, %

Reason for Bad Income - Number and % of HH, 1998-1999

	Chachoengsao	**Lop Buri**	**Burinam**	**Sisaket**
Job Loss	2 (6.25)	0	5 (8.77)	0
Reduced Wages	0	0	8 (14.04)	2 (8.70)
Price/cost of agri-prod increased/decreased	0	0	3 (5.26)	1 (4.35)
Drought/flood	0	0	1 (1.75)	0
Income from business decreased	5 (15.63)	0	14 (24.56)	3 (13.04)
Declined remittance/assistance from gov't	0	0	4 (7.02)	0
Declined remittance/assistance from person outside HH	2 (6.25)	0	2 (3.51)	4 (17.39)
Decreased property income	0	1 (5.56)	1 (1.75)	0
Other	2 (6.25)	1 (5.56)	2 (3.51)	1 (4.35)

[Table 3.4.9. Source: Adapted from Townsend Thai Annual Panel, 1999 special SES survey]

Households respond both in the SES and in the Townsend Thai surveys to questions about whether the past 12 months constituted a good or bad year, and if bad, the cause. One can see not only the macro, regional and occupational shocks but also idiosyncratic shocks such as expenses due to illness. The questions differ on the two survey instruments, and so the response rates and the apparent importance of distinct shocks are not identical. But the overall picture is consistent: not all households have a bad year at the same time and the cause of bad years varies across the households. See Tables 3.4.8 and 3.4.9.

One can summarize the temporal, occupational, geographic, and household specific shocks by equations capturing income processes. The well known permanent income hypothesis postulates that income $y_{i,a,t}$ of household i at age a and date t is as follows,

$$\begin{aligned} y_{i,a,t} &= Z'_{i,a,t} + P_{i,a,t} + \upsilon_{i,a,t} \\ P_{i,a,t} &= P_{i,a,t-1} + \varepsilon_t \end{aligned}, \text{ where } \upsilon_{i,a,t} \text{ is MA.} \qquad (3.3.4)$$

Thus, $y_{i,a,t}$ is the sum of household characteristics $Z'_{i,a,t}$, occupation or location for example: a permanent auto-regressive or random walk process $P_{i,a,t}$, with independent shocks $\varepsilon_{t,i}$, and a transitory shocks $\upsilon_{i,a,t}$ following a moving average process. In some specifications in the literature, such as Paxson (1994),

$$y_{i,t} = \underbrace{y^P_{i,t}}_{\alpha_0 + \alpha X_{i,t}} + \underbrace{y^T_{i,t}}_{\alpha_2 E_{i,t} R_t} + \varepsilon_{i,t} \qquad (3.3.5)$$

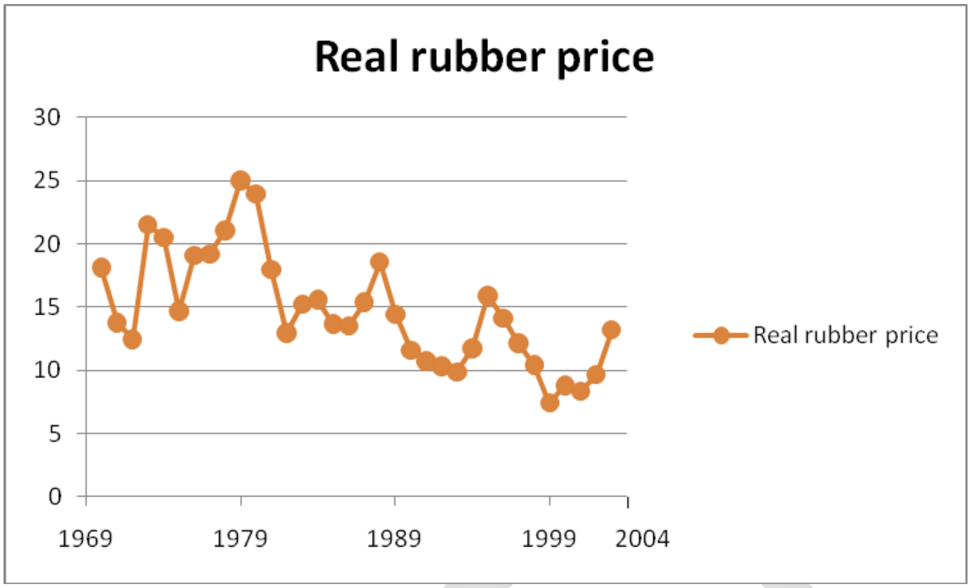
Here, transitory shocks $y^T_{i,t}$ consist of the product of a measure of exposure $E_{i,t}$, e.g., land devoted to rice, and some regional/local shock, such as rainfall R_t. Another potential shock could be prices.

International rubber prices follow a slow moving process. The half-life of a shock, deviation of the price from its long-term average, is 43 months. See Table 3.4.10. That is, only 18% of the shock is dissipated after one year. In effect a rubber price has a transitory and highly persistent component.

	% shock dissipated after 1 year	half-life of shock (months)
Rubber	18	43
Copper	10	80
Timber	43	15
Coffee	10	80
Rainfall	*≈ 100*	*≈ <3*

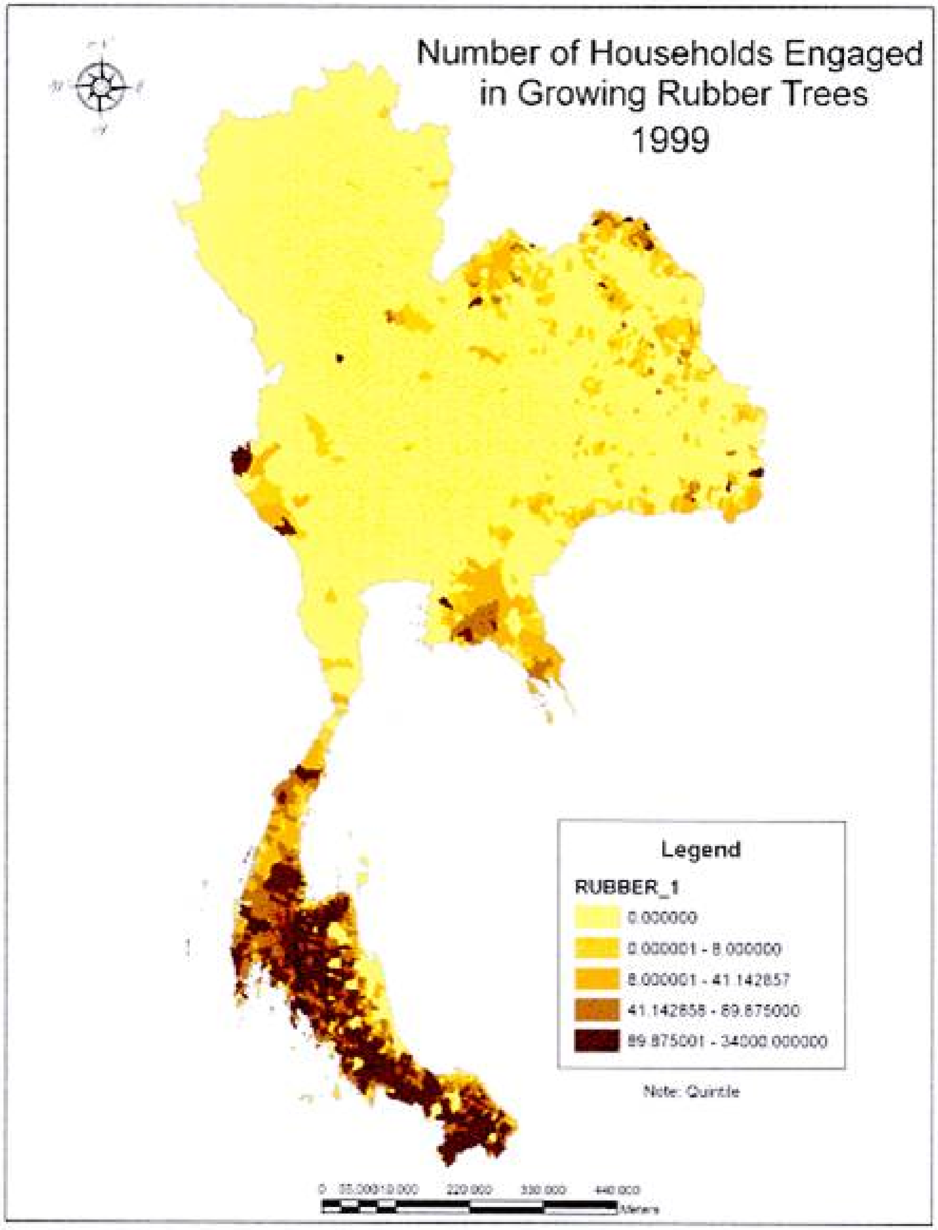
[Table 3.4.10. Source: Townsend and Vickery (2004)]

Evident from Figure 3.4.11, real prices have drifted downward on average over the sample period, driven in substantial part by increasing competition from synthetic rubber substitutes.

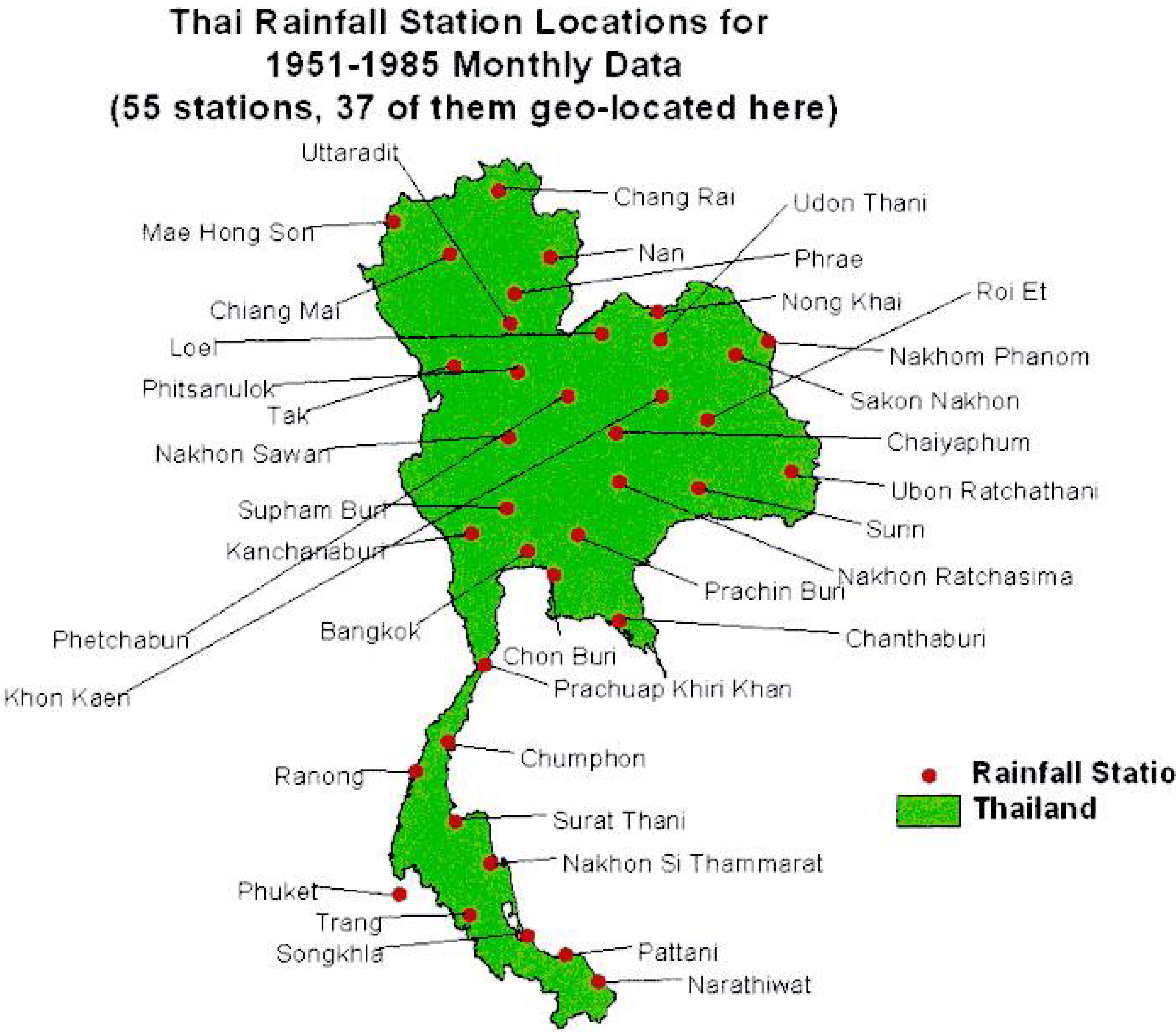


[Figure 3.4.11. Real Rubber Price in 1996 Thai baht/kg *1/100. Source: Townsend and Vickery (2004)]

Exposure to rubber price shocks is captured in the Geographic Information System with the CDD village data measuring the percent of households in a village growing rubber. Figure 3.4.12. displays substantial spatial variation, with rubber concentrated mainly in the lower two-thirds of the South, the Eastern Seaboard, and now parts of the Northeast.

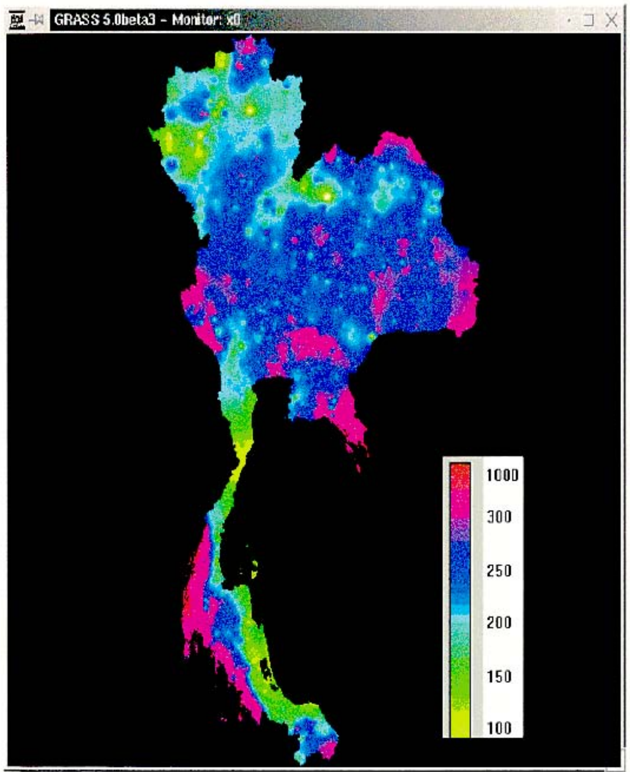


[Figure 3.4.12. Source: Townsend and Vickery (2004)]

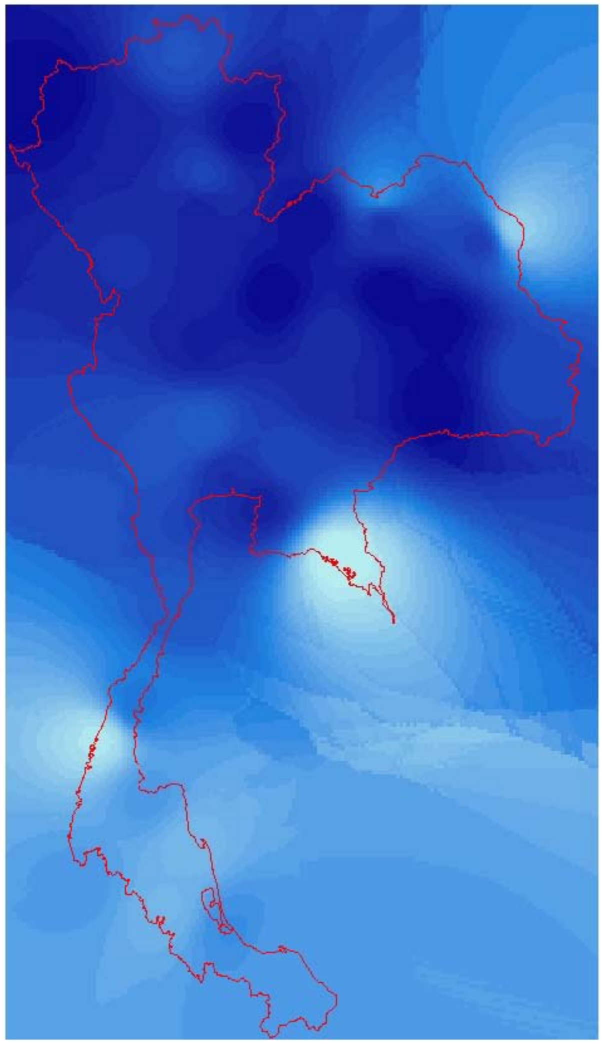


[Figure 3.4.13. Source: Adapted from NECTEC/TEI]

Rainfall is measured by Thai stations, with data going back 50 years. See Figure 3.4.13. One can easily compute average rainfall for each gauge, and interpolate over the map, as in Figure 3.4.14. Likewise, one can compute a measure of variability. Figure 3.4.15 displays rainfall shocks and deviation from the historical average. (IDW Interpolation done by NECTEC in Thailand (from same station set as TEI daily stations))



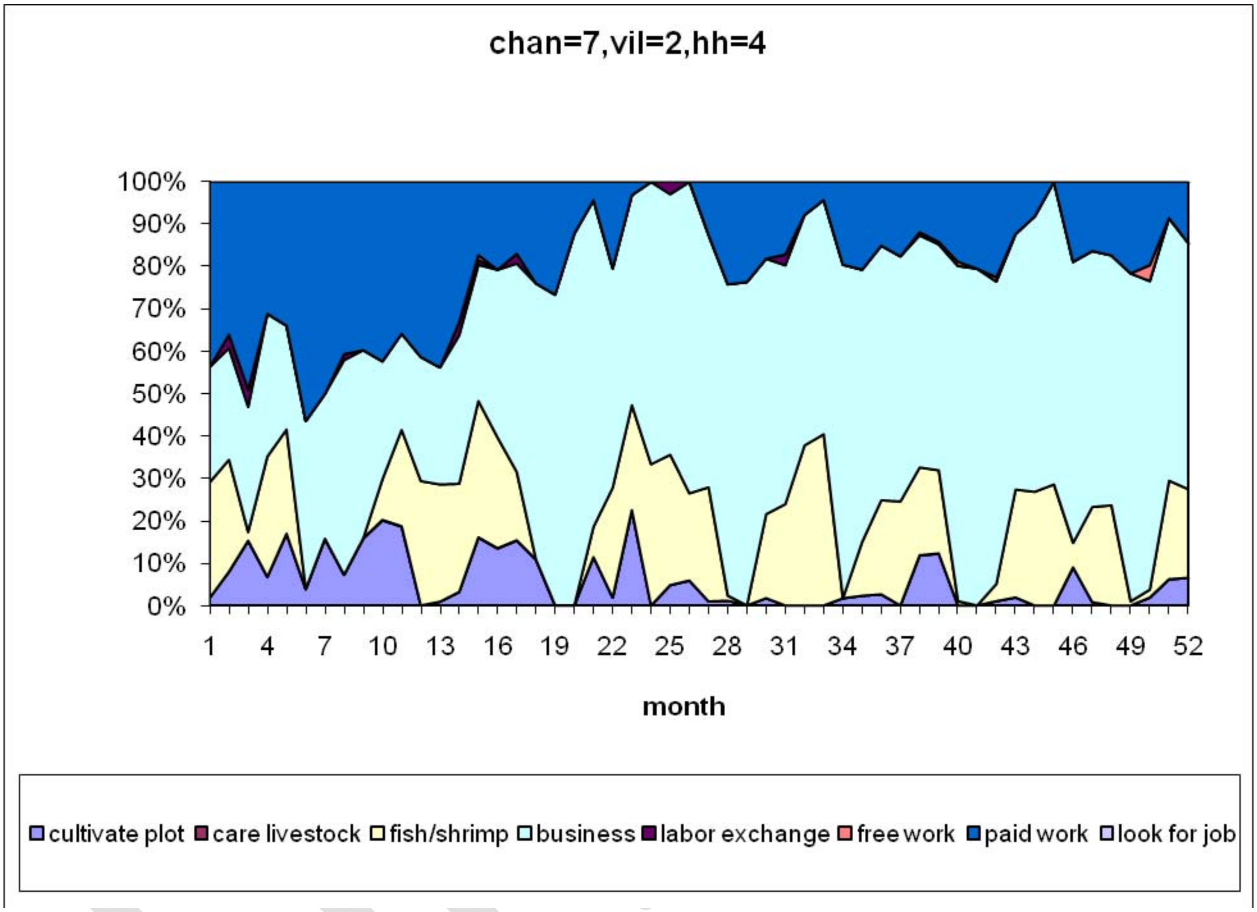
[Figure 3.4.14. Average Rainfall in Thailand. Source: Data from Thai Meteorological Department]



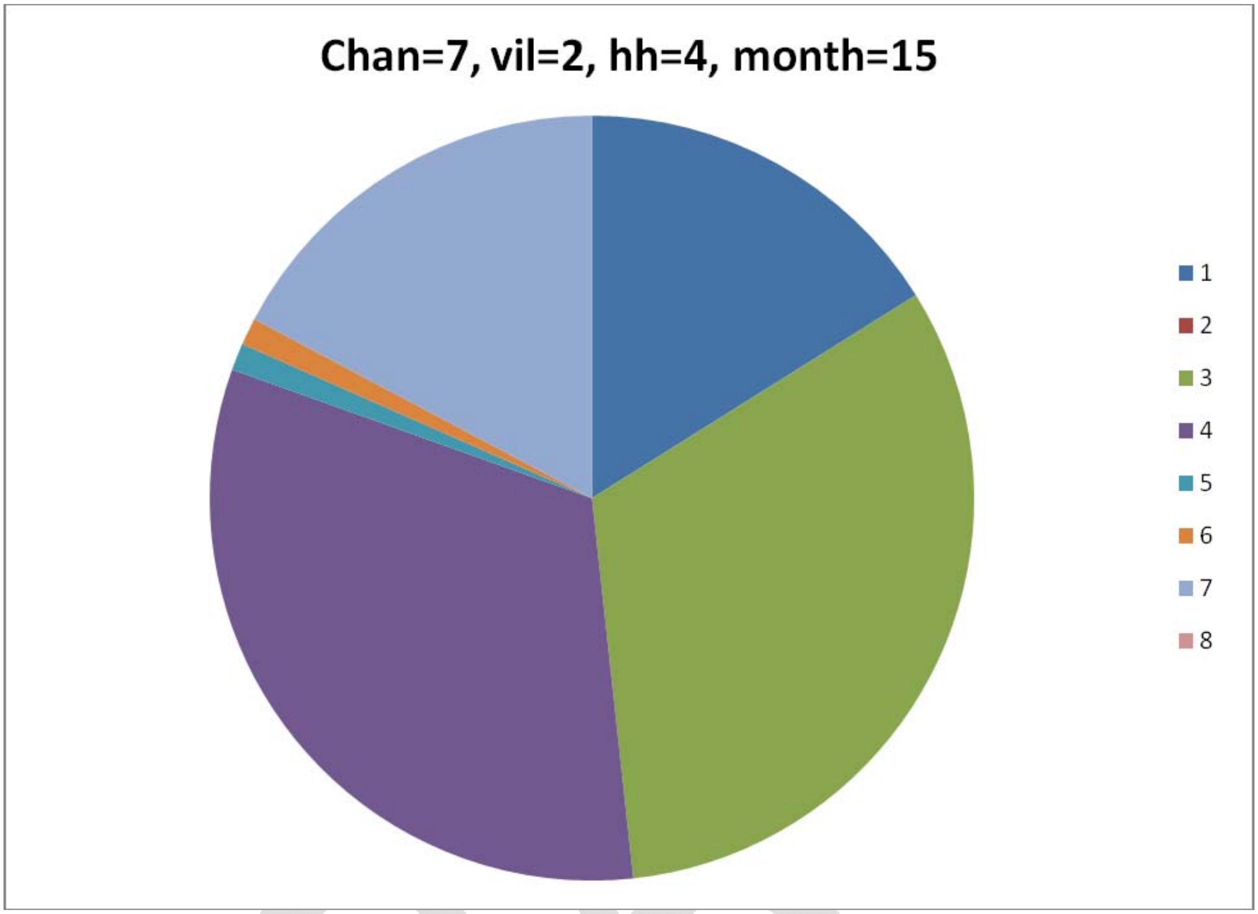
[Figure 3.4.15. Rainfall Variability, 1951-1985. 10th to 90th decile spread (dark blue is higher variation, light blue is lower variation. Source: Data from Thai Meteorological Department]

3.5 Individuals in the Household

There is diversity even within households. That is, individuals within a household often work at distinct occupations. From the monthly micro time allocation data, we create a measure of the extent of household diversification or its inverse. Though atypical, the household depicted in the time series and the pie chart below, Figures 3.5.1 and 3.5.2 respectively, allocates the time of its members to labor supply, fish and shrimp, business, and agriculture, among other things. The average value of a diversification index is non trivial. Thus in a sense we should treat households as multi division firms, presumably balancing risk, productivity, and utility of its members. Likewise, a typical household has an individual or individuals that have migrated out of the village, 40% of all individuals have left the village at some time. Migration is a topic we have considered earlier. This is a key aspect of within household heterogeneity which shows up in national level statistics.

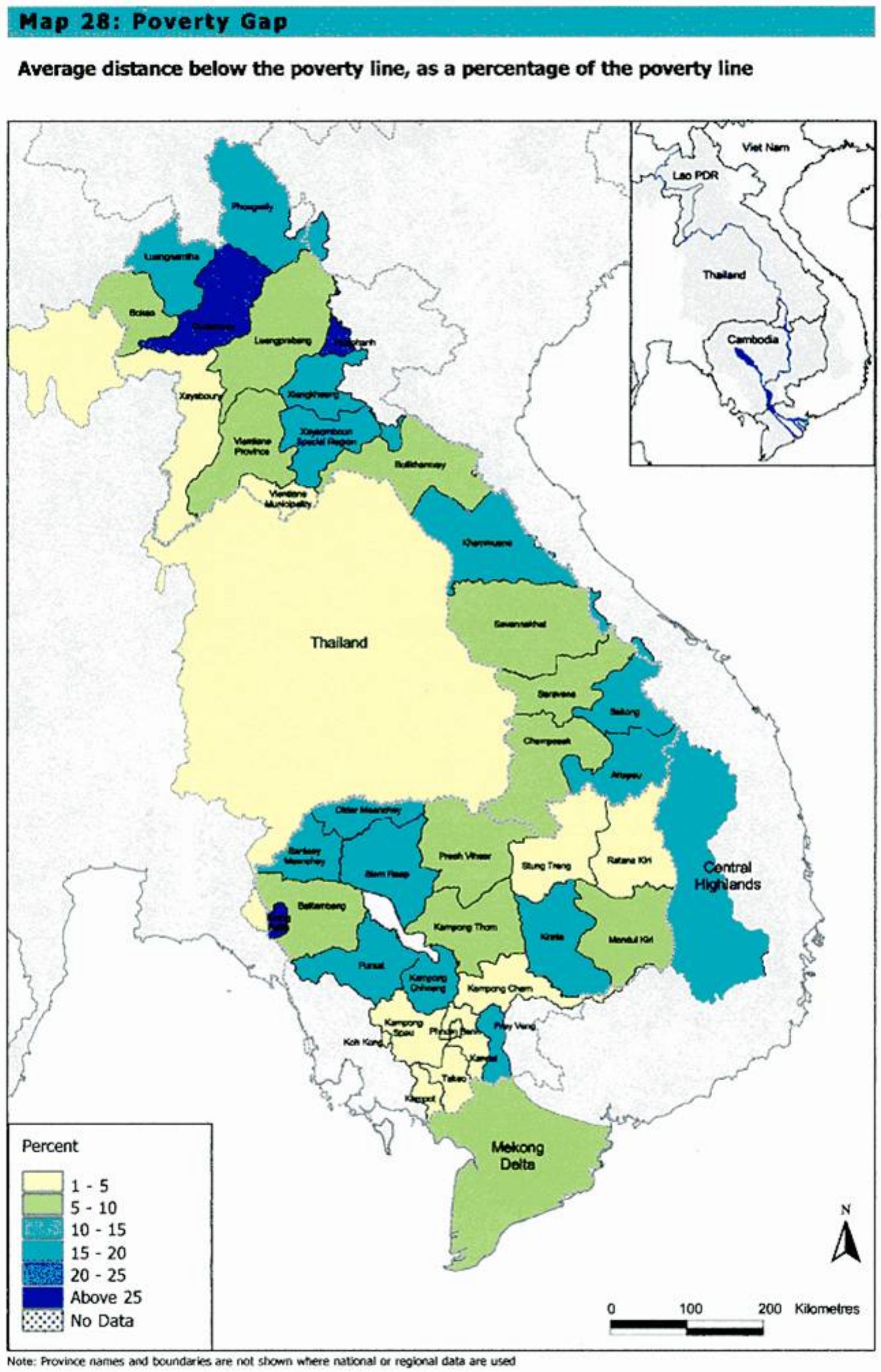


[Figure 3.5.1. Within household diversification. Source: Adapted from Townsend Thai data]



[Figure 3.5.2. Within household diversification. Source: Townsend Thai data]

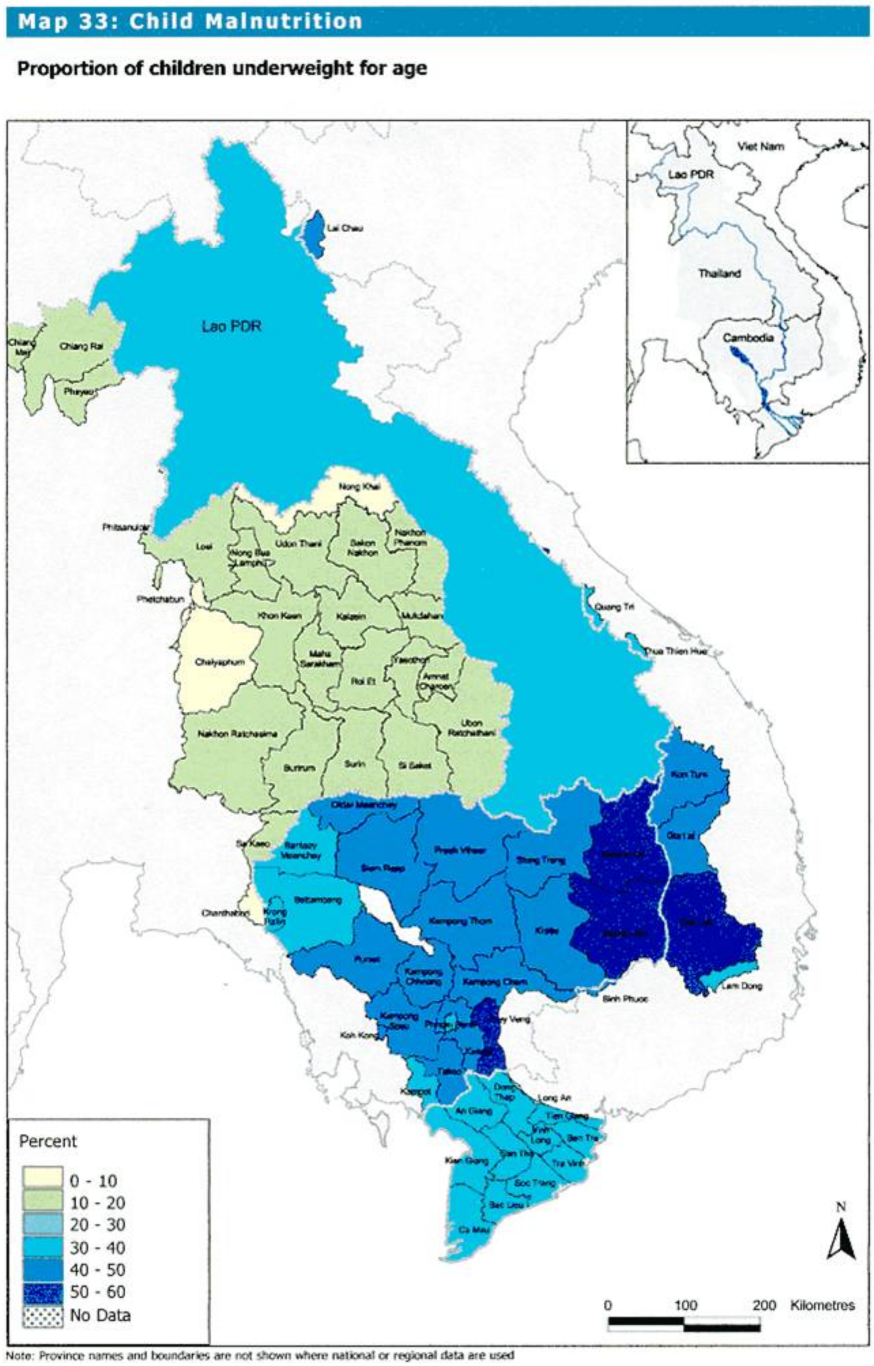
3.6 Mekong Economies: International Comparisons



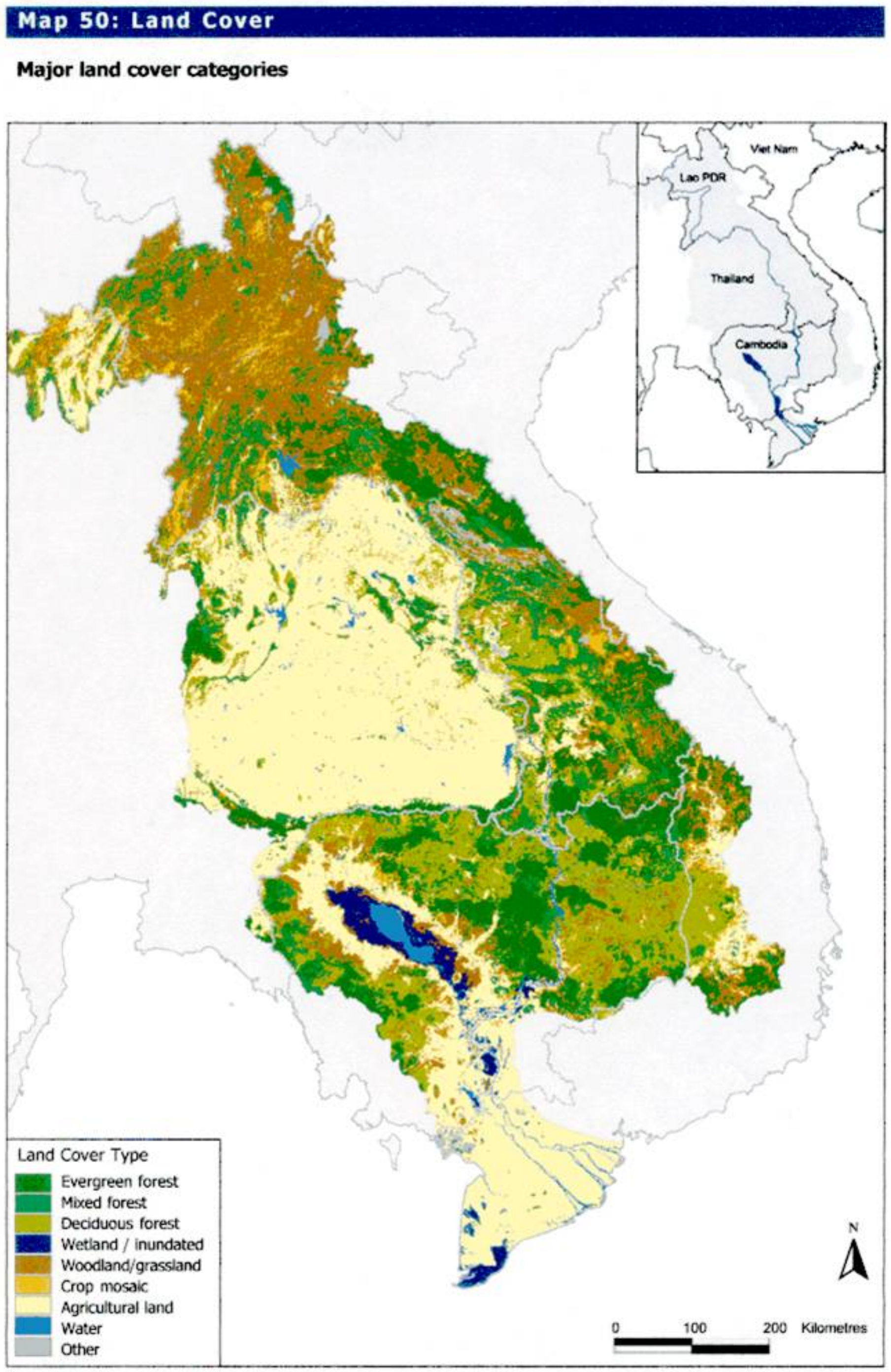
[Figure 3.6.1. Source: Hook, Novak and Johnston (2003)]

The plethora of shocks at the individual (or local) level in a given year, and the earlier analysis, suggest there is little relation in a given year between a household's income, or regional income, and macro GDP. But over the long haul, the impact of sustained and high GDP growth can be dramatic. In an ongoing project, the Northeast of Thailand - its relatively poor area - is compared to neighboring countries in the Mekong basin, specifically Laos, Cambodia, and parts of Vietnam.

One can plot the average distance to the poverty line by province, comparing across provinces and countries. See Figure 3.6.1. The entire Northeast of Thailand is no more than 5 percent below the poverty line while rates in Laos and Cambodia are significantly higher, reaching 15-20% in various areas, and occasionally above 25%. Rates of children underweight by age are similarly striking (see Figure 3.6.2), at 10-20% of the population in the Northeast of Thailand, but 34-40% in Laos and 40-60% in much of Cambodia.

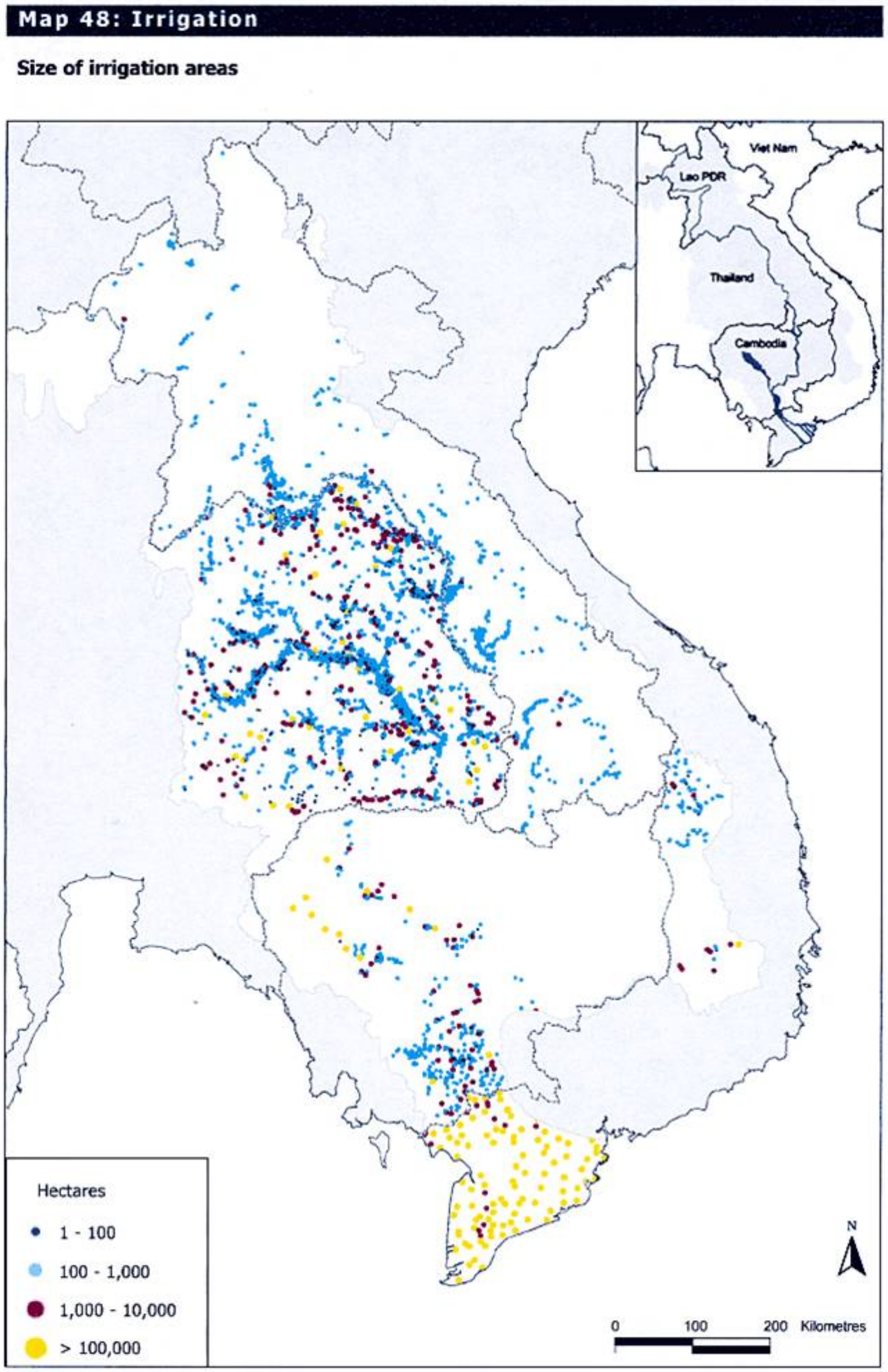


[Figure 3.6.2. Note: province names and boundaries are not shown where national or regional data are used. Source: Source: Hook, Novak and Johnston (2003)]



[Figure 3.6.3. Source: Source: Hook, Novak and Johnston (2003)]

Deforested areas follow closely geo-political boundaries. See Figure 3.6.3. Virtually the entire Northeast is converted to agricultural use, in contrast to standing evergreen and deciduous forests or woodland/grass land in much of Cambodia and Laos. There are some exceptions: cleared agricultural land in Laos near Vientiane, in Cambodia around Lake Ton Lae Sap, and the Mekong drainage basin.



[Figure 3.6.4. Source: Hook, Novak and Johnston (2003)]

Related, of course, is the size of irrigation areas, with vast amounts of water control in the drainage basins of the Northeast. See Figure 3.6.4. In this case, however, Laos has significant irrigated areas as does Cambodia around the Lake. The Mekong drainage basin in Vietnam is even more dramatic.

By and large, economic, health, and environmental variables have all been transformed in the process of 50 years of economic growth. It is important to understand what lies beneath this growth and transformation process.