

Appreciation Rates of Land Values In Rural Economies of Thailand

Narapong Srivisal
The University of Chicago

January 25, 2010

This paper examines changes in land values in the four rural provinces of Thailand, including Buriram, Chachoengsao, Lopburi, and Sisaket. We employ parts of the survey data collected monthly for the Townsend Thai Project. We follow the idea of the Hedonic Pricing Model by Hall (1971) and extend it to allow for various rates of changes for different types of land and to allow for non-linear changes in land values. We find that the constant geometric appreciation rate of 7.78 per cent per annum can describe the data we have across all the four provinces, once land characteristics are controlled for. Besides, we find that provincial locations can explain differentials in price levels in the data set. In addition, we find that a plot of land with a border connected to a paved way has higher land values, ceteris paribus. On the contrary, a plot suffering from drought within the previous five years has lower land values, given all other things equal.

I would like to thank Professor Robert M Townsend and Krislert Samphantharak for all the helpful comments. All the mistakes remain mine.

Part I: Introduction

To understand financial development in a micro-level economy, it is interesting to look at wealth and financial behaviors of households within the economy. Samphantharak and Townsend (2009) present a solid construction of balance sheets, income statements, and statements of cash flow for households from survey data. To construct these financial accounts for households, however, one needs to assess values of assets held by the households which usually vary over time due to depreciation or changes in economic environments. A difficulty occurs when an asset is illiquid, and there is no centralized market to quote an instantaneous price of the asset. In this case, it is essential to estimate the changes in asset values from data within the economy.

Land is an important asset because it can account for a large portion of wealth for low- or middle-income households. Furthermore, land is an imperative input to agricultural products which is one of the main sources of income for many households in a developing economy like Thailand, especially in rural provinces. Therefore, an error in land valuation can have a significant effect on the overall financial accounts of households. This paper studies appreciation rates of land values possessed by the households in the sample villages in four rural provinces of Thailand, using the monthly survey data collected for the Townsend Thai Project. The four provinces are Lopburi, Chachoengsao, Buriram, and Sisaket. The main objective of this paper is to find an appropriate estimate of the appreciation rates of land held by the households in the survey data. We expect to later apply the estimates derived in this study to improve the Townsend Thai Monthly Survey Household Financial Accounts that are constructed according to Pawasutipaisit et.al (2009).

We organize the rest of the paper into several parts as follows. Part II explains the data used in the study. Part III discusses theoretical background and estimation methods employed in this paper. We then present and discuss the results in the following part. In Part V, we discuss how to apply the estimator studied here to improve the monthly financial accounts for the households in the survey data. The final part provides concluding remarks.

Part II: Data Description

The data employed in this paper are parts of the monthly survey data collected for the Townsend Thai Project. The survey was first conducted in August 1998, and we have the data of each of the following months until August 2008. The subjects in the survey are households living in the randomly assigned sixteen rural villages in Thailand, comprising four villages in Chachoengsao, four villages in Lopburi, four villages in Burirum, and four villages in Sisaket.¹

In the data set, there are variables that record transactions and some characteristics of land that the households acquired or relinquished. When the transactions are not buying or selling, there are no records of prices but values estimated by the households. These estimates are subjective and, thus, could suffer some deviations from the true market prices because of some unobservable non-random factors. These unobservable factors are likely to be correlated with some characteristics of land or even time that

¹ For more detailed description and information regarding the data set, please refer to the Townsend Thai Project web site at http://cier.uchicago.edu/townsend_thai/monthly/month.htm

we include in the set of regressors. For instance, a household receiving a piece of isolated land as a gift may not have cared to examine the true value and productivity of the land if the household did not plan to use or liquidate the land. As a result of lacking precise information about the land, the household was prone to assess its value incorrectly. Therefore, we herein employ only the data with available market prices from actual transactions reported by the households.

In addition, we cannot use the selling data despite availability of the selling prices. The problem is that the prices recorded in the data set are in fact the combination of prices of land and values of the assets attached to the land. The survey did not ask the households to report these asset values but costs of acquiring these assets. Hence, we cannot separate the values of land and assets attached to it without knowing how the asset values changes from the point of acquisition to the sale. As a consequence, we limit the data usage in this study to the land purchasing data.

For land purchasing data, we first subtract the value of assets attached to the land from the purchasing price to derive the price of each land plot net of other asset values. Then, we calculate the acquisition price per unit of land by dividing the net land price by its size which was recorded in rai.² For most of the observations, we have the data for buying years and months. However, there are some observations that households did not report the buying months. In these cases, we set the buying month equal to June, or month 6, in order to minimize square errors. We drop the observations if the buying year is missing. Then, we normalize the earliest purchasing month, which is June 1953, to be the baseline month zero. The latest available purchasing data we extract from the data set is month 661 or July 2008.

The characteristics of the purchased land available in the data set includes

1. The province in which the land is located
2. Distance from the household's home to each plot of land
3. Whether a border of land is connected to a paved road
4. Whether land was applied any manures within the previous three years
5. Whether land was applied any chemical fertilizers within the previous three years
6. Whether land suffered from flood in the previous five years
7. Whether land suffered from drought in the previous five years
8. Whether land lost significant amount of soil within the previous five years

Here we do not include village locations in the list of the characteristic variables because of two primary reasons. First, we do not have sufficient data to account for variations by villages. Although we have observations from all the 16 villages in the data set, there are only one or two observations for some villages, and it is impossible to make any statistical inference from one observation. Secondly, we do not have precise knowledge about land location. In the monthly data set we have, there are the variables storing the distance from the households' residents to each plot of land and recording how the households referred to that land plot. Therefore, for the cases that the households reported the distance larger than, for example, ten kilometers, we cannot conclude whether those pieces of land are located within the same village as the households' residents. Moreover, if they are not located in the same village as the households' residents, they are unlikely to be in our sampled 16 villages, and we face more severe problem of limited variations by village as explained above.

² "rai" is a common unit used in Thailand to measure sizes of land. One rai is equivalent to 1,600 square meters.

For the provincial locations, we also have to look at the distance and the description of how the households referred to the land. However, it is possible to determine whether each land is within the same province as that the household lives in. For the cases that the locations of land are quite far from home, the households usually referred to them by the names of the land locations, such as by villages, sub-districts, or districts. We could then check whether the villages, sub-districts, or districts are within the same province as the households' residents. We delete the cases in which land locations are not within the same provinces as the households' residents, because we are interested only in the rate of changes of land values in the four provinces in this data set. Nevertheless, there is one exception which is the case that the household lived in Burirum but purchased land in Chachoengsao; we set the land location as Chachoengsao for this case.

If the data for the characteristic numbers 3 to 8 are missing, we set the answers to no because that the households lacked of knowledge about these fact implies that they did not care much about these characteristics. Thus, we should not expect these characteristics to have a significant impact on prices paid by the households.

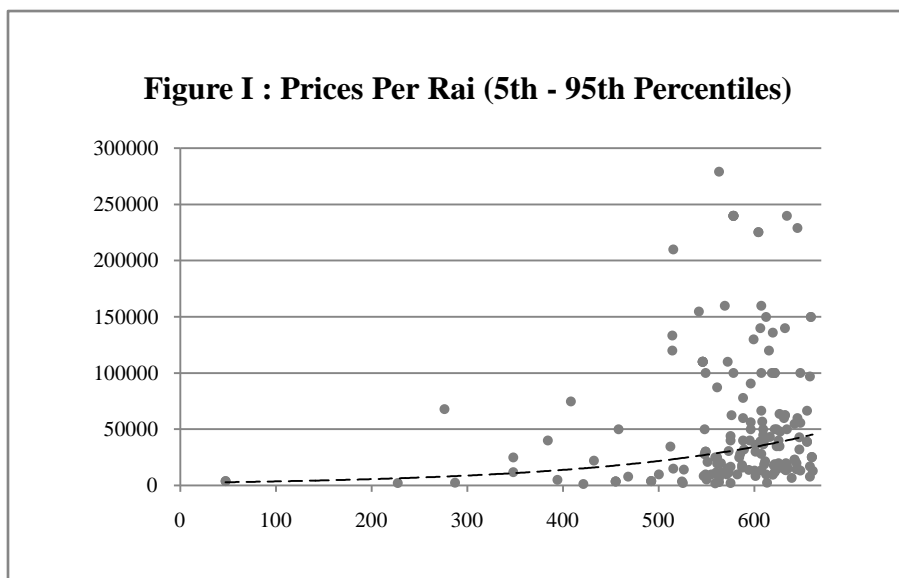
The total number of observations we have after cleaning the data is 191. The following table, Table I, summarizes basic statistics of the data. Prices denote per-rai purchasing prices of land, and distance from home is in unit of kilometers.

Table I: Summary of Purchasing Prices of Land in the Data Set

Variables	Mean	Standard Deviation	Minimum	Maximum
Prices	94,854.91	313,095.50	100.00	4,000,000.00
Months from the Baseline (t)	550.78	128.07	0.00	661.00
Distance from Home	7.41	28.80	0.00	350.00
Prices in Burirum	61,321.46	143,346.50	200.00	1,250,000.00
t Burirum	558.57	107.43	0.00	661.00
Prices in Chachoengsao	298,856.00	698,038.30	3,714.29	4,000,000.00
t Chachoengsao	563.59	92.91	276.00	660.00
Prices in Lopburi	45,501.32	49,858.73	100.00	279,069.80
t Lopburi	538.16	151.57	44.00	655.00
Prices in Sisaket	44,962.07	62,283.41	1,237.50	229,000.00
t Sisaket	531.61	184.43	47.00	658.00

We can see roughly that prices of land in Chachoengsao are higher on average than those of the other provinces. Nevertheless, we see from the table above that the observations in Chachoengsao are clustered in later dates of the sample, starting from month 276 after the baseline month, whereas the observations of the other three provinces spread over wider horizons and include the early months. This fact may contribute to the high average prices of land in Chachoengsao relative to the other three, as we can see from Figure I below that there seems to be a positive correlation between time and land prices. We will

investigate in the later part of this paper whether prices of land in Chachoengsao are actually higher than those in the other three provinces after we control for dates and other characteristics.



From the figure above, the horizontal axis displays the number of months from the baseline month that the land was purchased, and the vertical axis shows per-rai prices of land. We limit the data in the figure here to those corresponding to prices between the fifth and ninety-fifth percentiles, simply because of illustrative purpose. There are a few observations with very high prices compared with the rest of the observations. For instance, we can see from Table I that the maximum land price is 4,000,000 baht per rai. Thus, it is difficult to see the trend line when these extreme values are included. In any case, we see the same pattern that prices of land tend to increase with time. We will discuss this point later in Part IV.

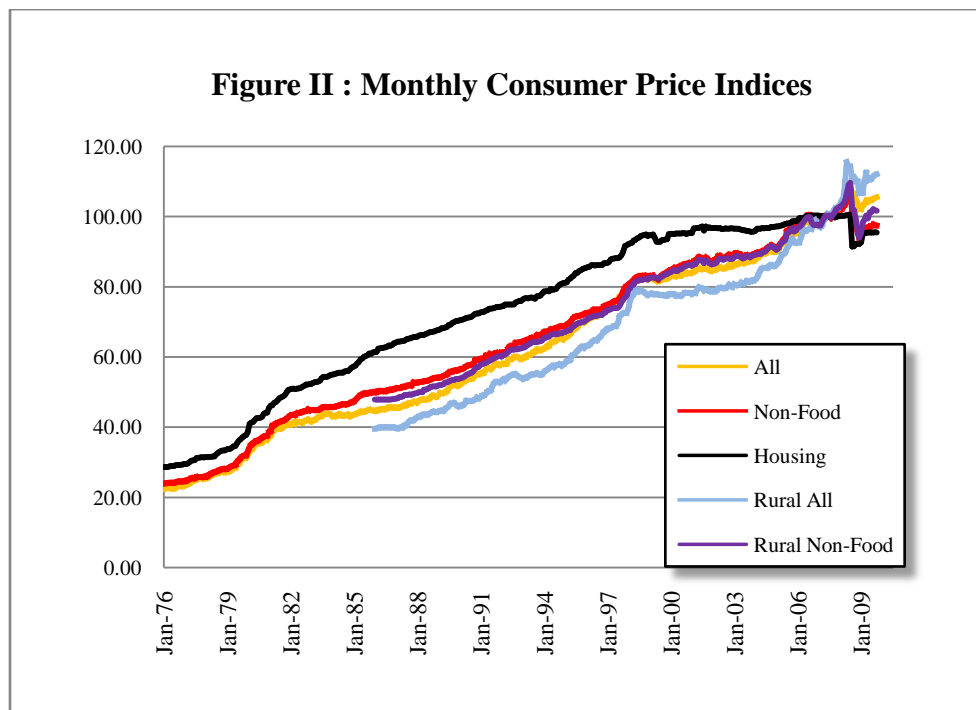
Table II: Summary of the Characteristic Dummy Variables

Characteristic Dummies	Number of Observations
Buriram	84
Chachoengsao	32
Lopburi	57
Sisaket	18
Paved way	39
Manure Applied	14
Chemical Applied	25
Flood	18
Drought	67
Soil Lost	23

Table II above summarizes the dummy variables regarding the characteristics of the land we have in the data set. The first four rows are the variables indicating the provincial locations of land. The rest of the variables in Table II respectively correspond to the characteristics number three to eight described in the earlier part of this section.

In addition to the characteristic data from the Townsend Thai Project, we retrieved several relevant monthly consumer price indices from the Bureau of Trade and Economic Indices, the Ministry of Commerce of Thailand. The overall price index, non-food price index, and housing-and-furniture price index for the whole Thailand economy are available from January 1976 to October 2009. The indices for the rural area of Thailand are available from January 1986 to October 2009.

In the figure below, the based year for the consumer price indices is year 2007. These indices are good references for inflation rates which should be correlated to the changes in values of land. However, how these indices are constructed is complex and beyond the study of this paper. Moreover, they are not built to apply to study changes in land values. How land values in Thailand change has been examining separately every four years, previously by the Department of Land, the Ministry of Interior of Thailand, and currently by the Treasury Department, the Ministry of Finance of Thailand. Unfortunately, the data sets by these governmental departments are very large and not ready for our study at this point. In addition, the data sets contain assessment of land values in very small-scaled locations rather than overall rates of changes of land values in a larger scale like villages, districts, or provinces. Therefore, we will only use the consumer price indices to compare to our estimates in the later part, instead of analyzing in depth the relationship between the land price process and the indices.



From the data we retrieve as displayed in Figure II, the average annual inflation rates over the available period described above are approximately 4.627 per cent for all goods, 4.202 per cent for all non-food and beverage products, 3.600 per cent for housing and furniture, 4.429 per cent for all goods in rural area, and 3.204 per cent for non-food and beverage in rural area.

Part III: Theoretical Background and Empirical Methods

Jorgenson (1996) presents a good review of literatures regarding empirical studies of rates of changes in capital asset values from purchasing prices. In the paper, given quality of assets, there are two main sources of changes in asset prices. The first one is depreciation rate, δ , which is defined as the unit cost of capital corresponding to aging of the assets. The other is the rate of changes in prices of new assets over time which Jorgenson calls it the rate of inflation price, denoted by γ . With the assumption of constant geometric depreciation and price inflation rates, he derives the model

$$\ln p_{t,v} = \ln p_0 + \ln(1 - \delta) \cdot v + \ln(1 + \gamma) \cdot t + \varepsilon_{t,v}$$

where $p_{t,v}$ is the acquisition price, defined per unit, of the asset of age v at time t ; p_0 is the acquisition price of the new asset at time zero; and $\varepsilon_{t,v}$ is an unobserved random disturbance.

For land, however, there is no decline in values due to aging. It is more sensible to think of land as an endowment rather than an asset occurred from production. Thus, we cannot have a point of time at which land is new. On the contrary, we should expect to see value of land appreciates over time due to more scarcity when economy expands, in addition to inflation. Figure I discussed in the previous section illustrates a rough appreciation trend. Moreover, what we are interested in is the overall rate of changes of land values that affect households' wealth. Therefore, we combine all the components of changes in land values to a single rate and call it an appreciation rate of land values.

Now, we derive a model similar to that presented in Jorgenson (1996) mentioned earlier but in continuous time. Let p_T be value of land per rai at time T , where the unit of T is years from the initial period 0. Suppose that the values of land change at a constant geometric rate of $\tilde{\alpha}$ per annum, and the changes in the values are compounded n times a year. Then, for time $T > 0$, the value of land is

$$p_T = \left(1 + \frac{\tilde{\alpha}}{n}\right)^{nT} p_0$$

For continuously compounded land values, we have

$$p_T = \lim_{n \rightarrow \infty} \left(1 + \frac{\tilde{\alpha}}{n}\right)^{nT} p_0 = p_0 \exp\{\tilde{\alpha}T\}$$

Let t be time in monthly unit. Then, $t = 12T$. Substituting this into the previous equation and taking natural logarithm of the equation, we derive a similar model to that presented in Jorgenson (1996) after adding an unobserved random disturbance, ε_t :

$$\ln p_t = \ln p_0 + \alpha \cdot t + \varepsilon_t \quad \text{----- (1)}$$

where $12\alpha = \tilde{\alpha}$. Note that this regression is based on the assumption that all pieces of land share the same characteristics or that the differences in characteristics have no impact on land values.

In reality, it is more likely that some characteristics contribute to a variation in land prices. Location and land productivity can be good examples of such characteristics. For example, land that is conveniently accessible should be priced at a higher level than that in an isolated area. A rationale for this is simply that an easy access helps reduce transportation costs to the market, yielding higher net profit to the land owner. Thus, demand for land with a convenient access should be higher *ceteris paribus*. To account for the effect of characteristics on values of land, we follow the idea of the Hedonic Pricing Model by Hall (1971) and express logarithm of the initial value as a function of characteristics. The equation (1) becomes

$$\ln p_t = \beta_0 + \beta' x_t + \alpha \cdot t + \varepsilon_t \quad \text{----- (2)}$$

where x_t is the vector of land characteristics, and β is a vector of the same size.

Next, we allow for the possibility of non-geometric rate of changes by approximating the non-linear function of time with a polynomial of higher degrees.

$$\ln p_t = \beta_0 + \beta' x_t + \alpha \cdot t + \alpha_1 \cdot t^2 + \dots + \alpha_m \cdot t^{m+1} + \varepsilon_t \quad \text{----- (3)}$$

If a polynomial of degree m is a good estimate of the underlying non-linear function, and we increase the degree, the coefficient α_m will become lower because the higher degree term merely captures errors of the estimation by the m -degree polynomial. Therefore, we can stop when the coefficient of the highest degree becomes sufficiently small, depending on how precise we need.

In addition to non-constant, non-geometric rate of changes, it is possible that plots of land with different dummy characteristics appreciate at different rates. To allow for this possibility, we add the interaction terms between characteristic dummies and time to the regression.

$$\ln p_t = \beta_0 + \beta' x_t + \alpha \cdot t + \lambda'(t \cdot x_t) + \varepsilon_t \quad \text{----- (4)}$$

It should be noted that the sample size we have in this study is small. Therefore, it is sensible that we have insufficient variations in the data set to account for disparity in appreciation rates of all kinds of characteristics. What we are particularly interested in is whether different plots of land in different provinces appreciate at different rates because economic environments of different provinces do not necessarily move in the same direction. Apart from the province-specific trends, we will only examine the interaction terms of time with the characteristics that have significant explanatory power on prices instead of all the possible interactions.

To estimate the coefficients, we employ the standard ordinary least-squared regressions with robust standard errors. We allow for possibility of heteroskedasticity and serial correlation because we have a limited set of land characteristics, and it is possible that some unobserved characteristics can cause non-constant variances in the disturbance terms. For example, we may expect land closer to a business district or a center of a village to depend more on economic environments which can fluctuate over time; thus, prices of this kind of land should have a higher variance. So, we may expect land with a higher price to have a higher variance.

Part IV: Results of the Estimation

We first look at the results of the pooled regressions of all provinces without characteristics, according to equation (1). As the following table shows, there is a trivial appreciation trend of land prices over time. Both the regression using all the 191 observations and the regression using only the unit prices between the fifth and ninety-fifth percentiles yield similar results of the estimated appreciation rates about 0.75 per cent a month, or nine per cent annually. The number in each parenthesis represents the t -statistic under the null hypothesis that the coefficient is equal to zero. We can see from the table that all the estimated coefficients of pooled regressions are very significant, although the adjusted R -squared numbers are not very high. This low adjusted R -squared may be a result of exclusion of characteristic variables.

Table III: The Estimated Results of the Regression without Characteristics

(The numbers in each parenthesis represents the t -statistics for the null-hypothesis that the coefficient is zero.)

	All Observations			5 th -95 th Percentiles		
	Pooled	Province Fixed Effect	Various Trends	Pooled	Province Fixed Effect	Various Trends
Number of Observations	191	191	191	176	176	176
Constant	6.068215 (11.45)	7.294128 (12.55)	8.859409 (4.52)	5.960385 (11.08)	6.775854 (11.28)	8.630687 (4.77)
Burirum	-	-1.296517 (-4.00)	-2.791501 (-1.37)	-	-0.865723 (-2.77)	-2.771984 (-1.47)
Lopburi	-	-1.344851 (-4.00)	-4.031780 (-1.85)	-	-0.855876 (-2.61)	-3.803058 (-1.86)
Sisaket	-	-1.503235 (-3.26)	2.050642 (-0.68)	-	-1.013904 (-2.22)	-1.168472 (-0.61)
t	0.007528 (8.45)	0.007324 (8.30)	0.004546 (1.34)	0.007497 (8.36)	0.007378 (8.23)	0.004089 (1.35)
t .Burirum	-	-	0.002652 (0.75)	-	-	0.003381 (1.07)
t .Lopburi	-	-	0.004862 (1.30)	-	-	0.005319 (1.55)
t .Sisaket	-	-	-0.000367 (-0.10)	-	-	0.000091 (0.03)
Adj R -squared	0.3126	0.3895	0.4044	0.3700	0.3981	0.4193
RMSE	1.4216	1.3397	1.3233	1.2824	1.2535	1.2313

With the province dummies added to the regression, we call it the *province fixed effect* regression in order to emphasize the differences in land values in different provinces. This term fixed effect should not be interpreted as a fixed-effect panel-data regression. The Province Fixed Effect columns in Table III above

show that unit prices of land in Burirum, Lopburi, and Sisaket are significantly lower than those in Chachoengsao even when we control for time. Therefore, the high average price of land in Chachoengsao shown in Table I is not solely owing to the lack of early-purchasing observations in this province. Both of the data sets we use suggest that land prices in Chachoengsao are the highest, and land prices in Sisaket are the lowest among the four provinces in our sample. However, there is no statistical evidence to support the differences in prices of land in Burirum, Sisaket, and Lopburi. With this specification of regression, the annual appreciation rates of land using all the observations and the 5th-to-95th-percentile observations are 8.79 and 8.85 respectively. We also see some improvement in the adjusted R -squared.

Next, we allow for disparity of trends among the four provinces. When we include the interaction terms in the regressions, none of the coefficients, except the constant term, is significantly different from zero. This is not a surprising result given our limited data. The small sample-size data set does not show sufficient variations in the trends. So, the estimators are very imprecise and have large variances which imply small values of t -statistics for the estimated coefficients. As a result, we will assume a common appreciation trend for all of the four provinces in the rest of the paper.

Moreover, we see from Table III that the qualitative results remain the same when we drop the observations associated with prices below the fifth and above the ninety-fifth percentiles. Even though the adjusted R -squared increases after we drop the observations, it should not be surprising because we should expect to see a better fit with fewer extreme values. In fact, the adjusted R -squared value does not change much once we control for the province fixed effects. This confirms the fact that the extreme values do not alter the pattern of the data. We then stay with the data set with all the observations and ignore the other smaller set of observations from this point on.

Consider now the regressions with non-provincial characteristics as additional regressors. Table IV reports the results of the regressions along with the previous regression without non-provincial characteristics. Again, the numbers displayed in the parentheses are the t -statistics. An outstanding result from the table is that the adjusted R -squared improves dramatically from less than 0.4 to almost 0.53 when we include land characteristics in the regression.

Similar to the previous regressions without the land characteristics, the province fixed effects are still significant and actually more pronounced here with larger sizes of the t -statistics, implying stronger statistical evidence for the distinctions. Land prices in Chachoengsao are still significantly higher than the others three provinces with this specification, and there is no statistical difference in prices among the other three provinces. In term of magnitudes, the estimates in Table IV shows that land prices in Burirum, Sisaket, and Lopburi are only 14.73%, 16.14%, and 21.65% of land prices in Chachoengsao respectively, given that they share the same characteristics.³ This means that approximately land price in Chachoengsao is at least five times as high as that in the other three provinces. One possible explanation for the price differential could be the superior location of Chachoengsao compared with the other three. Chachoengsao is in the industrialized Eastern Seaboard area of Thailand and in proximity to Laem Chabang Port, the country's largest port, and to Suvarnabhumi International Airport. Moreover,

³ To derive these numbers, let p_c be price of land in Chachoengsao and p_B be price of land in province B . Suppose α_B be the coefficient of the dummy variable for province B . Then, given the same characteristics, $\ln p_B - \ln p_c = \ln \frac{p_B}{p_c} = \alpha_B$. Thus, we have $\frac{p_B}{p_c} = 100 \cdot \exp(\alpha_B)$ percent. We cannot use the estimator of α_B directly in this case because the dummy variables are discrete rather than continuous.

Chachoengsao is closer to Bangkok, the capital city and main business district of the country, and to Pattaya, which is another big city and tourist main destination. This fact that Chachoengsao is closer and more accessible to markets implies lower transportation costs from Chachoengsao to markets and, thus, more productivity of land as a factor of production. Our result is consistent with the investment-zone policy by Thailand Board of Investment (BOI) to decentralize industrial base of the country. The policy divides the country into three zones with tax privileges increase from zone one, which is the most industrialized region, to zone three, which is the least industrialized area. According to this policy, Chachoengsao is in zone two, whereas the other three provinces are in zone three. Thus, Chachoengsao possesses a location premium over Lopburi, Burirum, and Sisaket on the basis of the BOI's policy. However, more research beyond this paper may be needed in order to conclude whether this location premium can fully explain the sizable land price differential.

Table IV: The Estimated Results of the Regressions with Characteristics

(The numbers in each parenthesis represents the t -statistics for the null-hypothesis that the coefficient is zero.)

	Characteristics		
	Province Fixed Effect	Pooled	Province Fixed Effect
Number of Observations	191	191	191
Constant	7.294128 (12.55)	6.610757 (14.11)	8.337938 (15.96)
Burirum	-1.296517 (-4.00)	-	-1.915177 (-5.99)
Lopburi	-1.344851 (-4.00)	-	-1.530017 (-4.30)
Sisaket	-1.503235 (-3.26)	-	-1.823984 (-4.29)
t	0.007324 (8.30)	0.006891 (8.79)	0.006483 (8.81)
Distance	-	-0.009181 (-1.88)	-0.015217 (-2.40)
Paved Way	-	0.719709 (3.40)	0.886382 (3.98)
Manures	-	0.016455 (0.04)	0.014707 (0.04)
Chemicals	-	0.149935 (0.41)	-0.225244 (-0.67)
Flood	-	0.088564 (0.23)	-0.195740 (-0.51)
Drought	-	-0.748334 (-3.51)	-0.730846 (-3.28)
Soil Lost	-	-0.311069 (-0.92)	0.098244 (0.32)
Adj R-squared	0.3895	0.3923	0.5288
RMSE	1.3397	1.3366	1.1845

In addition to the provincial locations, the characteristics with explanatory power on prices are Distance, Pave Way and Drought; the other variables are not statistically significant at even at 10% significant level. The estimates imply that if a plot of land has a border on a paved way, the initial purchasing price is expected to be 142.63 per cent higher than a plot without a border on a paved way *ceteris paribus*. Similarly, if a plot suffered from drought within the previous five years, the price is expected to be about 51.85 per cent lower than a normal plot with the other identical characteristics. The signs of these estimates are as we expect, but the values of the estimates seem too large quantitatively. Again, that the available data are limited can be a reason. In reality, there is a wider range to classify borders of land than whether one of them is on a paved way. For example, we may expect prices of land to increase if we change the accessibility of land from a walk way to an unpaved way to a small paved road to a two-lane paved road to a four-lane paved road to a highway. Prices of land with unpaved way and those with a small paved road as the best accessible mean may not differ much. However, price differentials between a plot of land next to a highway and an isolated land inaccessible by a paved way could be very large. Therefore, it is possible to have an estimate of price differential larger than a hundred per cent if the sample size is small and mostly contains the extreme ends of scales. A similar explanation can be applied to the estimated coefficient of drought variable because we do not have the variable recording how severe or frequent a drought was for each observation.

The *t*-statistics of the coefficient of Distance under the pooled and province fixed-effect models corresponds to the *p*-values equal to 0.062 and 0.018 respectively. Thus, the variable Distance becomes statistically significant at five percent significant level when we control for locations, although it is not significant at one percent level. The fact that they are barely significant can be explained by the strong explanatory power of the variable Pave Way. First of all, the market for land should be competitive instead of monopsony in which a buyer's characteristic such as his residential location can affect prices. Hence, the distance between land plot and the buyer's home should not directly affect price of the land plot. Nevertheless, we include this variable in the regression because it may be a proxy for how far each plot is from a community or market, since households are more likely to live within proximity of a community or market than in an isolated place. We can actually see that the sign of the estimates are as we expect. The further the land is from the households' residents, the lower the price is. Yet, this may not be a good proxy. In particular, the variable Paved Way has already explained whether each plot is easily accessible, leaving little room for the variable Distance to explain price differentials.

From these results, we see that the characteristics with significant effect on land prices seem to be the permanent characteristics like locations, distance from home, and paved ways. The temporary characteristics such as applying manures or chemical substances to land and losing significant amount of soil have no impact on land prices, although we should expect that these factors affect productivity of land. For drought and flood, one may view them as temporary factors; however, whether each plot of land facing drought or flood usually depends on its landscape and climate which can hardly change. If a plot suffers from drought or flood in one year, then it is likely to suffer almost every year. For droughts, we discussed earlier that it had large impact on prices. Therefore, it is likely that droughts that the observations in our data set experienced were severe or frequent. Then, it is sensible by this argument to regard drought as a permanent characteristic. For floods, the fact that they play no role in explaining land prices in our data set may be because floods observed in our data set were infrequent, or because they have no significant impact on land productivity. If floods are not severe, it is possible to observe no impact on land productivity. Furthermore, some agricultural farms such as rice can be conducted in

paddy fields in which flood is needed. Therefore, if some land plots in our samples can benefit from floods, while the others are negatively affected by floods, it is possible to observe no impact on average.

Table IV implies that the estimated appreciation rate of land values drops by about one percentage point to 7.78 per cent a year after we control for the characteristics. This finding is sensible given that the estimated coefficient of the variable Paved Way is positive, inasmuch as there is an increase in the number of paved ways over time when the economy expands. From now on, we will refer to this regression with the province fixed effects and characteristics the benchmark model.

We now turn to analyze the effect of paved ways and droughts on the appreciation rates. As mentioned above that these two characteristics have explanatory power on purchasing price differentials. Thus, it is interesting to investigate whether they have an impact on how price changes over time as well. To answer this question, we add the interaction terms between time and the two variables to the benchmark regression in order to allow the appreciation rates associated with different characteristics to vary. The result is displayed in Table V. There is no statistical evidence to conclude that the appreciation rates of land values are different if the land has a border connected to a paved way or if it suffers from drought in the most recent five years.

Finally, we generalize the model to non-constant rate of changes as described by equation (3) in Part III. Theoretically, the higher degree is, the better the polynomial can approximate the true underlying function. As mentioned before, high-degree terms usually capture the errors that the lower-degree terms leave unexplained. Thus, the estimated coefficients of high-degree terms become economically small when we increase degrees of the polynomial. Besides, we lose one degree of freedom every time we add one more degree to the polynomial. Therefore, we terminate the polynomial approximation at degree five when the estimated coefficient of the highest degree term becomes as infinitesimally small as 1.08E-12. The results of these regressions with the approximating polynomials of time up to the fifth degree are illustrated in Table VI below.

According to the results presented in Table VI, the coefficients of higher-degree terms are very small and mostly not statistically significant as we expected. The t -statistics of 2.14 and -2.20 for the monomial degree two and three under the column 3 yield the p -values equal to 0.034 and 0.029 respectively, and the t -statistic of -2.15 for the monomial degree two under the column 5 corresponds to the p -value of 0.033. The other coefficients are not statistically significant at five percent significant level. For these significant coefficients, the sizes of the estimates are too small to be economically significant. More importantly, we do not see any dramatic improvement in the adjusted R -squared values when including higher degree to the regression. This finding implies that the constant geometric rate, or the benchmark model, is sufficiently good for describing the changes in land values in these sampled economies. In addition, adding higher degrees of t to the benchmark regression does not have a large impact on the qualitative results of the estimated coefficients of the characteristic variables as well as the t -statistics. As a result, we stay with the benchmark model.

Table V: The Estimated Results of the Regressions with Characteristic-varied Trends(The numbers in each parenthesis represents the t -statistics for the null-hypothesis that the coefficient is zero.)

	Benchmark	Characteristic-varied Trends
Constant	8.337938 (15.96)	8.837356 (13.57)
Burirum	-1.915177 (-5.99)	-1.925336 (-6.20)
Lopburi	-1.530017 (-4.30)	-1.571068 (-4.59)
Sisaket	-1.823984 (-4.29)	-1.881449 (-4.57)
t	0.006483 (8.81)	0.005633 (5.48)
t .(Paved Way)	-	0.002293 (0.72)
t .Drought	-	0.001577 (1.06)
Distance	-0.015217 (-2.40)	-0.014955 (-2.38)
Paved Way	0.886382 (3.98)	-0.445297 (-0.24)
Manures	0.014707 (0.04)	-0.051738 (-0.15)
Chemicals	-0.225244 (-0.67)	-0.203207 (-0.59)
Flood	-0.195740 (-0.51)	-0.272647 (-0.68)
Drought	-0.730846 (-3.28)	-1.582104 (-1.78)
Soil Lost	0.098244 (0.32)	0.138606 (0.44)
Adj R-squared	0.5228	0.5221
RMSE	1.1845	1.1853

**Table VI: The Estimated Results of the Regressions with Non-linear Appreciation Rates
Approximated by Polynomials of Higher Degrees**

(The numbers in each parenthesis represents the t -statistics for the null-hypothesis that the coefficient is zero.)

	Degree of the Polynomials				
	1 (Benchmark)	2	3	4	5
Constant	8.337938 (15.96)	8.479228 (13.59)	9.627977 (9.85)	8.492591 (8.75)	7.679295 (12.22)
Burirum	-1.915177 (-5.99)	-1.913567 (-5.94)	-1.949630 (-6.44)	-1.992817 (-6.89)	-1.934267 (-6.51)
Lopburi	-1.530017 (-4.30)	-1.540571 (-4.26)	-1.593721 (-4.59)	-1.721499 (-5.18)	-1.653696 (-4.85)
Sisaket	-1.823984 (-4.29)	-1.838976 (-4.29)	-1.904213 (-4.54)	-1.979248 (-4.89)	-1.961554 (-4.86)
t	0.006483 (8.81)	0.005452 (1.79)	-0.017324 (-1.45)	0.021320 (0.94)	0.056160 (2.38)
t^2	-	1.33E-06 (0.33)	0.000076 (2.14)	-0.000150 (-1.20)	-0.000487 (-2.15)
t^3	-	-	-6.61E-08 (-2.20)	3.93E-07 (1.56)	1.63E-06 (1.89)
t^4	-	-	-	-3.05E-10 (-1.82)	-2.24E-09 (-1.60)
t^5	-	-	-	-	1.08E-12 (1.34)
Distance	-0.015217 (-2.40)	-0.015149 (-2.43)	-0.013185 (-2.39)	-0.012271 (-2.34)	-0.012487 (-2.42)
Paved Way	0.886382 (3.98)	0.892810 (3.98)	0.865611 (3.82)	0.879821 (3.81)	0.883544 (3.86)
Manures	0.014707 (0.04)	0.009542 (0.03)	0.022750 (0.07)	-0.016848 (-0.05)	0.062422 (0.19)
Chemicals	-0.225244 (-0.67)	-0.219822 (-0.66)	-0.322022 (-1.00)	-0.263103 (-0.83)	-0.361221 (-1.12)
Flood	-0.195740 (-0.51)	-0.186239 (-0.48)	-0.201670 (-0.53)	-0.196351 (-0.51)	-0.157315 (-0.41)
Drought	-0.730846 (-3.28)	-0.722970 (-3.30)	-0.587471 (-2.70)	-0.538683 (-2.49)	-0.523202 (-2.38)
Soil Lost	0.098244 (0.32)	0.091256 (0.30)	0.031252 (0.11)	0.053815 (0.18)	-0.011866 (-0.04)
Adj R-squared	0.5228	0.5204	0.5392	0.5463	0.5487
RMSE	1.1845	1.1874	1.1639	1.1549	1.1519

Recall that the benchmark model yields the estimated appreciation rate equal to 7.78 per cent annually. This rate seems very high compared with the inflation rates we derive from the consumer price indices described in the second part of the paper. The differences between our estimated appreciation rate of land values and the inflation range from 3.15 per cent, when the all-good index is used, to 4.58, when the rural non-food-and-beverage index is used. In other words, this model implies that the households in this sample enjoy real rate of returns on holding a plot of land between 3.15 and 4.58 per cent per annum. These estimates are in fact over look the return on land productivity if land is also used as an input to production. Given that land values do not depreciate over time, this is a stunning result because the average rates of returns on riskless assets in Thailand are not that high. The data we retrieve from the Bank of Thailand show that even relatively illiquid risk-free financial assets such as 14-year government bonds have average nominal rates of returns less than 6 per cent annually. Perhaps, land is less liquid than the government bonds because of the existence of secondary markets for the government bonds.

Part V: Application to Household Financial Accounts

The previous parts show that land values do appreciate over time with a rate even higher than inflation rates and risk-free interest rates in Thailand. This fact should provide a strong incentive for some households to exploit land as an asset to store their wealth or simply to generate high returns in the long run. Therefore, it is important to take into account the changes in households' financial accounts due to the appreciation of land values. Failing to do so will result in underestimation of the households' wealth.

In the household financial account manual by Pawasutipaisit et.al. (2009), the financial accounts are updated if the households reported an exogenous change in land value. An increase in land value is credited to the asset side of the balance sheet under BS13, Land and Other Fixed Assets, and credited to the liability and net worth side under BS20, Cumulative Savings. The income statement is affected through IS23, Capital Gains. Without these reports, the values of land owned by the households remain unchanged in the financial accounts even if many years have passed. In addition, for the case that households reported land selling, there are usually big jumps in wealth and contributed capital because land prices at the point of sale are usually higher than the values when the households acquired the land due to the appreciation. For each of these cases, the difference between the selling price and the recorded land value enters BS19, Contributed Capital, in the net worth side. On the asset side, BS13 decreases by the land value of the sold plot, and BS1, Cash in Hand, increases by the selling price.

Thus, we could improve the accounts by updating the appreciated values of land in every month using the estimators studied in this paper to correct for changes in wealth and to reduce the jumps in contributed capital. The update can be done in a parallel way as the update of an exogenous change in land value suggested by the manual. Since changes in land values should be continuously compounded, the amount to credit to BS13 and BS20 in month t is

$$[\exp(\alpha) - 1] \cdot p_{t-1}$$

where α is the estimated appreciation rate of land values from the benchmark model, and p_{t-1} is the value of land in period $t-1$ which should be equal to one-period lag of BS13. In the income statements, IS23 for

month t rises by the same amount as BS13 and BS20. The inclusion of land appreciation as suggested herein will result in higher cumulative saving and, thus, wealth of the household in every month as long as the households keep the land. In addition, the rate of changes of wealth will be affected because the increase in value propagates over time. The asset values will also increase by the same magnitude to balance out the balance sheet. For the income statement, an increase in capital gains recorded in IS23 will cause the total net income and savings, stored by IS28 and IS32 respectively, to rise by the same amount. The items CF1 and CF6_2 in the cash flow statements will automatically adjust according to the changes in the income statements.

Part VI: Conclusion

This paper employs parts of the data collected monthly for the Townsend Thai Project to study rates of changes of land values in the four rural provinces of Thailand, including Chachoengsao, Lopburi, Buriram, and Sisaket. The main idea of the empirical method used in the paper follows the Hedonic Pricing Model by Hall (1971), in which assets' characteristics can be controlled for. We also augment the model with interaction terms to allow each type of land to change at a rate independent of the other types of land. Last, we allow the changes of land values to be non-linear by using polynomial approximations.

What we find herein is that there is insufficient evidence to support variety of trends for different characteristics in our sampled economies. Still, some characteristics are important to explain variations of land prices at each given date. First, land prices in Chachoengsao are higher than prices in Lopburi, Buriram, and Sisaket. Secondly, land prices diminish when the distance from the land to the resident of its owner increases. Thirdly, prices of land with a border connecting to a paved way are higher. Finally, the value of land declines if it suffered from a drought in the previous five years.

More importantly, we find that the constant-geometric rate of changes is good enough to approximate the appreciation trend, once the land characteristics are controlled for. We estimate the appreciation rate to be 0.6483 per cent a month, or 7.78 per cent per annum across all the four provinces. This rate could be usefully employed to adjust the household financial accounts of the households in these provincial economies.

Finally, it is important to note that the work done in this paper is quite limited to the small sample size, and we have to rely on only the purchasing data. It is possible to extend the study to include data when land is sold. One will need to first separate out the value of assets attached to land by investigating the rate of changes of those assets or examining how to evaluate the value of those assets at the point of sale of land. Furthermore, it is interesting to compare the estimates by other organization such as the Treasury Department of the Ministry of Finance of Thailand. However, more resources are required to acquire the data that are applicable for the study.

References:

- “Consumer Price Index by Group” *The Bureau of Trade and Economic Indices, The Ministry of Commerce of Thailand*. Retrieved November 24, 2009, from web site:
http://www.indexpr.moc.go.th/price_present/tableIndexCpi_bot.asp
- Hall, R.E. (1971) “The Measurement of Quality Changes from Vintage Price Data,” in *Price Indexes and Quality Change*, edited by Z. Grilliches, Harvard University Press, 1971, 240-271.
- “Interest Rates in Financial Market” *Bank of Thailand*, Retrieved December 9, 2009, from web site:
<http://www.bot.or.th/English/Statistics/FinancialMarkets/InterestRate/Pages/StatInterestRate.aspx>
- Jorgenson, D.W. (1996) “Empirical Studies of Depreciation,” *Economic Inquiry*, vol.34, 24-42.
- Pawasutipaisit, A et.al. (2009, September 25) “User’s Manual Townsend Thai Monthly Survey Household Financial Accounting,”
- Samphantharak, K and R. M. Townsend.(2009) “Households as Corporate Firms: An Analysis of Household Finance Using Integrated Household Surveys and Corporate Financial Accounting,” Cambridge University Press.
- “Townsend Project Overview: Monthly Survey Overview” Web site:
http://cier.uchicago.edu/townsend_thai/monthly/month.htm