An Evaluation of Financial Institutions: Impact on Consumption and Investment using Panel Data and the Theory of Risk-Bearing*

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June 7, 2010

Abstract

The theory of the optimal allocation of risk and some unusual panel data on financial transactions are used to assess the impact of the major formal and informal financial institutions of an emerging market economy. We link financial institution assessment to the actual impact on clients, rather than ratios and non-performing loans. We derive both consumption and investment equations from a common core theory with both risk and productive activities. The empirical specification follows closely from this theory and allows both OLS and IV estimation. We thus quantify the consumption and investment smoothing impact of financial institutions on households including those running farms and small businesses. A government development bank (BAAC) and commercial banks are shown to be particularly helpful in smoothing consumption and investment, consistent with the operating system of at least the former. Surprisingly, the informal sector seems most helpful in investment, not consumption. Other institutions seem ineffective by these metrics.

1. Introduction

There has been little theory-based assessment of formal and informal financial institutions which uses not only financial statements and institutional detail but also household panel data on actual customers. Here we explicitly incorporate the diversity of shocks across households in an environment with productive opportunities in a choice model of financial participation. We use the theory of an optimal allocation of risk-bearing to derive both consumption and investment equations for customers of financial institutions. We also do the same for those in financial autarky. Finally, we make

* Research support from the National Institutes of Health, the National Science Foundation, the John Templeton Foundation, the Consortium on Financial Systems and Poverty at the University of Chicago, and the Ford Foundation are gratefully acknowledged. We thank the National Statistic Office of Thailand for permission to use their data. We gratefully acknowledge Ananth Ramanarayanan, Carlos Perez-Verdia, Kaveh Hemmat and John Felkner for able research assistance. Helpful comments from participants of the MIT development lunch group, the Chicago econometrics workshop, and the IMF conference on structural reforms and poverty, and especially from Joshua Angrist, Abhijit Banerjee, Esther Duflo, Michael Greenstone, and Joe Kaboski are all greatly acknowledged.
participation endogenous and evaluate the formal and informal financial institutions that offer savings, credit and insurance.

We make use of a relatively unusual database, the Townsend Thai data, a panel of approximately 960 households, including about 200 running their own businesses. The data start in May 1997, just prior to the onset of the July 1997 financial crisis, through 2001, that is, through the recovery. Thus there is macro, aggregate risk. The data are gathered from households and small businesses specialized in different mixes of occupations and subject to different shocks. Thus, there is ample idiosyncratic risk. The data contain the measurements of consumption, investment, and income necessary to carry out the standard risk-bearing or equivalent-with-complete-market tests. Further, the data record the actual use of formal and informal financial institutions and mechanisms by type of financial product, both borrowing and saving. From this we can see which devices are used and gauge the plausibility of econometric instruments for subsequent actual participation. The instruments are derived from a baseline key informant interview and from a baseline 1996 village-level census from the Community Development Department (CDD). One of the instruments makes use of a Geographic Information System (GIS).

The principal findings offer a score card or rating system for the major financial institutions of the country. A government development bank (the BAAC) and commercial banks as a group are shown to be particularly helpful in smoothing consumption and investment. Surprisingly, the informal sector seems most helpful in investment, not consumption smoothing. Production Credit Groups, a type of village-level fund, and Agricultural Cooperatives do not seem to have significant impact.

The paper is outlined as follows. Section 2 describes the data used in the analysis. In Section 3, we present the basic choice model of financial regimes featuring the assumed environment. In Section 4, we derive from the theory of the optimal allocation of risk the explicit consumption and investment equations used in the empirical work. In Section 5, we do the same for those in financia utarky. In section 6, we derive the econometric specification, including how we use the data and our instruments. The assessed impact of each major financial institution is summarized in Section 7. Finally, Section 8 presents the estimates of impact equations and some concluding remarks.

2. Data and Institutions

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1 In the working paper version (Alem and Townsend 2004), we show that consumption drops across both surveyed regions in the first three years. Surprisingly however, the few statistically significant common time effects in income over households explain little of the income variation. Droughts, floods and price changes are events that drive much income change according to the surveyed households, but these are not uniform within and across regions.

2 In the working paper version (Alem and Townsend 2004), we show that wage earners and those in agriculture suffered lower declines in income than anticipated in the Thai government’s policy response, and business owners suffered large declines in income on average. Within each of the occupation groups there is enormous heterogeneity income change.
The panel data used in this paper come from a project funded by the National Institutes of Health, the National Science Foundation, and the Ford Foundation (see Townsend et al, 1997). An initial cross-sectional survey, with retrospective data, was fielded in May, 1997, before the crisis that began with the devaluation of the Thai baht in July, 1997. Two regions were chosen deliberately, namely, the more developed Central region and the relatively poor, semi-arid Northeast. Within each region two provinces were chosen deliberately as each had at least one county (amphoe) that had been randomly selected in all previous rounds of the larger Socio-Economic Survey (SES). In the Central region the province of Chachoengsao is adjacent to Bangkok and contains an industrial corridor that makes its way to the eastern seaboard. The province of Lopburi is in the fertile central valley north of Bangkok. In the Northeast, the province of Sisaket is the poorest in Thailand according to provincial product data, and Buriram, also in the Northeast, represents a transition province as one moves west back toward Bangkok.

Within each province twelve tambons or sub-counties were chosen at random (see Binford, Lee, and Townsend, 2004). Within each tambon, four villages were chosen at random from an enumeration of villages available from the Community Development Department (CDD), and within each village fifteen households were chosen at random from a listing held by the headman. In addition to the household questionnaire, survey instruments were designed for the headman of each village, soliciting in particular a retrospective village history of the use of formal and quasi-formal financial institutions.

With the advent of the crisis, funding from the Ford Foundation allowed a resurvey one year later, in May, 1998, of one-third of the original sample, and this was continued with NICHD funding into subsequent years, and the data we use in this paper is through 2001. For this Townsend Thai resurvey panel, four tambons were chosen at random from the original twelve of each province. Otherwise, the same villages and the same households were selected for re-interviews. The target number of households was 960, or 240 in each province. The actual response rate for this 1997-1998 pairing is relatively high, for example, 98.2% of the target 1997 households respond again to the survey. Likewise, there were successful re-interviews of 96.2%, 97.1% and 96.5%, for the other pairs of years. Tables A.1 and A.2 in the appendix contain a summary of key variables used in the data analysis.

**Measurement of income, consumption and investment.** We note that income is measured as the difference between gross income and gross expenses, solicited from the household for each occupation category separately: business, agriculture, fish/shrimp, farming and livestock. Labor income is gross revenue from wages. Likewise, all physical assets held at each interview date are solicited along with purchase date and value at that time. Discrepancies in ownership across interviews are checked and reconciled with the households directly. Depreciation rates, e.g., 10%, can be applied to create retrospective panel data on wealth. There are, in addition, direct questions on land sales and acquisitions, the major asset in many cases (this is not depreciated). Consumption is

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3 With the exception that one tambon was set aside for a separate intensive monthly survey.
measured by a solicitation of 13 items\textsuperscript{4} that best predict aggregated non-durable consumption expenditure in the larger more comprehensive Socio-Economic Survey. In practice, 50-80\% of the variation can be explained by these 13 items. A price index at province level was obtained using average prices of purchases of consumption in order to deflate and express income, consumption and investment in real terms.\textsuperscript{5} Specifically, the Townsend Thai annual data records both the overall value and quantity of the first 9 consumption items purchased by each surveyed household (see list in footnote 3). There is a considerable range for these deduced prices for a given year and province, and so in order to reduce measurement error and provide a reliable overall central tendency, the top and bottom 25\% of the histogram for each item are removed, then a simple average is taken. The overall price index is constructed by weighting each price item by its quantity in the base year (Laspeyres).

**Measurement of financial participation.** Membership or customer of the various financial institutions was solicited in the 1997 interview, along with a retrospective history. Hence, we know in principle if a household was using a commercial bank in, for example, the 1996 baseline year, the year prior to the survey. We also have measurements of all subsequent financial transactions (borrowing, lending, saving) with the formal sector (type of institution, e.g., Bank for Agriculture and Agricultural Cooperatives [BAAC], village funds such as Production Credit Groups [PCG], commercial bank) and with the informal sector (output purchaser, money lender, friends, relatives, store owner). There are also data on remittances and the use of rice in storage.

**Financial institutions overview.** We emphasize here that we have the typical array of financial institutions of emerging market economies: government banks, local savings and loans, a private (but regulated) commercial banking sector and, again, a substantial informal sector.

BAAC is the Thai government’s Bank for Agriculture and Agricultural Cooperatives. It makes modestly sized loans, about half with joint liability and hence no physical collateral. Its interest rate is slightly subsidized, and the BAAC could break even by raising its on-lending rate only a modest amount (Yaron, 1994). The BAAC does compete actively for savings deposits (as commercial banks are no longer required to deposit funds). Though nominally lending to agriculture (fertilizer, seed), business households in the Townsend Thai survey sometimes report that they get initial funding from the BAAC. Most loans are short term but long term investment is also possible. The BAAC has focused on getting credit to a certain segment of farmers, and in the data it appears they are more willing to lend off the main road, away from towns. The BAAC had 34\% of all loans outstanding in the larger 1997 baseline survey and focus on the middle wealth segment of the market in each village. Townsend and Yaron (2001) have

\textsuperscript{4} Grain, milk and milk products, meat, alcohol consumed at home, alcohol consumed away, tobacco, gasoline, ceremonies, house repairs, vehicle repairs, educational expenses, clothing and meals away from home.

\textsuperscript{5} As a robustness check, a national deflator price index was obtained from the National Statistics Office and results though statistically weaker, did not vary in sign and order of magnitude.
featured the “risk-contingency” nature of lending, in which delayed repayment and possibly reduced interest and/or principal is part of the BAAC operating system. This presumably is a mechanism which would allow mitigation of idiosyncratic shocks, though that has not been tested previously.

Commercial banks make relatively few loans in the Townsend Thai peri-urban data, 3% of all loans in the 1997 data, but loan size is relatively large, larger than all other lenders. So, by value, commercial banks have 16% of all loans. Bank lending is clustered in the sense that if a commercial bank is active in a village, it is likely to be active nearby, and there remains plenty of gaps. Virtually all commercial bank loans require collateral. On the other hand, commercial banks’ savings account for 56% of all savings, especially for higher wealth households and those in more developed regions.

Agricultural Cooperatives are now part of the Bank for Agriculture and Agricultural Cooperatives, but many retain their former quasi-independent status, run by local boards and so on. The BAAC on-lends to Cooperatives and historically suffers a lower repayment rate than with direct loans to customers.

Village level financial institutions appear frequently. One of the more common types is a Production Credit Group, essentially a local savings and loan run by a village committee. There are also women’s groups, rice banks, buffalo banks, poverty eradication funds, and others, though sample size in the annual panel did not allow us to do much with these. See Kaboski and Townsend (2010) for a more detailed description and analysis using the 1997 data. The well known and larger One Million Baht Village Funds, analyzed in Kaboski and Townsend (2009) were not introduced until 2002, and we do not use that data here.

The informal sector comprises approximately half of all loans, not only from money lenders but also store keepers, traders, friends, relatives, and so on. There is great variety in collateral, interest rates, repayment, and so on. We also think of rice storage as an activity of the informal sector, distinct from savings in commercial banks or the BAAC. Rice accounts for 14% of all savings (excluding the value of cash, gold, and jewelry which are not measured in the annual data).

**Instruments for financial participation.** We also employ the CDD data, a comprehensive village-level census and the key informant questionnaire to obtain instruments for membership of formal and informal institutions: (i) Key informant responses regarding the availability of productive credit in the village from various specific financial institutions; (ii) Travel times to district centers as measured in CDD data; and (iii) GIS-calculated probabilities based on CDD neighborhood averages that a village will have each of the various financial institutions.

As in the Greenwood and Jovanovic (1990) model, we test for the impact of financial sector participation versus non-participation. We do this for each institution one
at a time. Other strategies could be followed, though enumerating all possible combinations would be tedious, and it is not clear if our instruments are appropriate.6

3. A choice model of financial participation

To assess the impact of financial institutions on households, we follow a modified version of the financial choice model of Greenwood and Jovanovic (1990). In the model, households choose whether to become a member of a financial institution by weighing the costs and benefits of participation. On the one hand, as in Townsend (1978, 1983), we assume that financial institutions are costly to establish or to learn to use. Specifically, household \( i \) has to pay a once-and-for-all lump-sum cost \( Z_i \) to become member of a financial institution, incurred at the time of joining. This captures initial household specific learning costs and more generally the cost of bank infrastructure itself. On the other hand, financial participation entails important potential benefits. Financial institutions collect and process information on project returns, and this allows participating households to achieve higher expected returns, essentially by coordinating production activities. Financial institutions also allow households to diversify away idiosyncratic risk, essentially by pooling returns. More generally, we interpret financial institutions as providing households access to better information and as-if-complete-markets, and we then compare the consumption and investment implications of members/customers of financial institutions to those in financial autarky.

To simplify, we imagine the decision of whether or not to join the financial system is taken at the initial date, \( t = 0 \). Thus, in empirical terms, all decisions before and during 1996 are encapsulated in the \( t = 0 \) decision. In the model, no one who has incurred the cost of entry and joined will give up the advantages of the financial system and exit, and this is largely true in the data, from 1997 on.7

Environment. The underlying environment has a very large number of households. In Townsend (1983), this was a countable infinity and in Greenwood and Jovanovic (1990, hereafter referred to as GJ) a continuum of measure one. Here, for simplicity of exposition, we imagine the number of households is large but finite, so large that in effect the population-weighted sum over households in the financial system of any given idiosyncratic shock is zero. One can assume, as in GJ, that all idiosyncratic shocks are drawn from a uniform distribution, so one can drop the population weights though here

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6 Ongoing work explores whether combinations of service providers might be a key to effectiveness. Kinnan and Townsend (2010) looks at village kinship networks, and chains of gifts and loans which link households if only indirectly to primary formal sector providers. Sripakdeepong and Townsend (2010) study the role of informal sector bridge loans to mitigate adverse impacts of repaying when formal sector loans are due. But in this paper, our instruments for the informal sector are already not working well. Note also that time to the district center in Table 2 below is positively correlated with BAAC use and negatively correlated with commercial bank use.

7 Puentes (2009) has summarized the annual Townsend Thai data on participation. The biggest innovation is the coming of village-level, Million Baht Funds in 2002, but this is after the 1997-2001 panel used here. There is a modest increase in the informal sector in the two years after the 1997 financial crisis, but this then goes back down to its previous level, and, in the longer panel not used here, follows a downward trend.
we try to be a bit more general. However, we do not want to stray too far from the original work of GJ, as this model was used in the work on growth, inequality, and financial repression in Jeong and Townsend (2008) and Townsend and Ueda (forthcoming; 2006), and part of our goal here is to provide some unity by testing the assumed micro underpinnings of all those models.

Preferences. Each household $i$ has a contemporary utility function $u_i(c_{it}, \xi_{it})$, where $c_{it}$ is consumption of household $i$ at date $t$ and $\xi_{it}$ is a preference shock determining marginal utility. This shock is orthogonal to all other random variables other than its own past. Each household $i$ seeks to maximize the discounted time separable flow of contemporary utilities at discount rate $\beta$. The preference shock $\xi_{it}$ has an autoregressive structure: $\xi_{it+1} = \rho \xi_{it} + \nu_{it}$ where $\nu_{it}$ is i.i.d. over individuals and time and $\rho$ is potentially zero. When $\rho$ is greater than zero, some information on future preference shocks, that is, future urgency of consumption, is known, hence known in particular at the time of the participation decision, $t = 0$. As preferences are never observed by us as econometricians, this creates a potential endogeneity problem: The error term in the impact equations over the sample period can be correlated with the participation decision (and we will need instruments to correct for this). On the other hand, if $\rho = 0$, and the model is true, no such problem exists (and OLS will not be biased). 8

Technology. To focus on the financial participation, we abstract from occupation choice and imagine that each household $i$ is tagged with an initial occupation which does not change. For those in agriculture and business, we collapse them into one sector and give them a production technology $q_{it} = f_i(k_{it}, \theta_{t+} + \epsilon_{it})$, where $k_{it}$ is the capital stock of household $i$ at date $t$, $\theta_{t+}$ is a composite technology shock, and output is measured in common units of consumption. Here $\theta_{t}$ represents a common, aggregate disturbance which is i.i.d over time and the idiosyncratic shock $\epsilon_{t}$ is i.i.d both over time and over households. 9

Investment. There is also a cost of adjustment function $g_i(I_{it}, k_{it}, w_{it})$ where $I_{it}$ is investment of household $i$ at $t$ and $w_{it}$ is an i.i.d. household-specific shock to the cost of capital stock adjustment. The law of motion for capital with depreciation rate $\delta$ is standard: $k_{i,t+1} = (1 - \delta)k_{it} + I_{it}$. Note that under the assumed costly adjustment function, investment can be negative, but it is costly to convert capital to the consumption good. Again, the population-weighted sum of these idiosyncratic shocks $w_{it}$ is zero so that ex post, for households in the financial sector, full insurance sets that sum to zero in consumption. But each shock enters into its own real production technology, making one

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8 The model here abstracts away from elastic labor supply. As is well known, if a utility function were non-separable in consumption and leisure, then even in an optimal allocation of risk bearing, consumption could move with an income term. In this paper, we focus on the differential response to income of those with financial access and those without, and as that is determined by (plausible exogenous) instruments, there should be no differential due to this effect. We also test the null that those which are fully insured have zero coefficients on income, and are sometimes unable to reject this. Nevertheless endogeneity of labor supply remains a concern.

9 Townsend and Ueda (forthcoming; 2006) show that the endogenously evolving wealth distribution can generate an autoregressive process on income, despite the i.i.d. specification on $\theta_{t}$ in the technology.
technology different from another, so the $\omega_t$ matter for investment decisions even including those households in the financial sector.

Wage earners. There is a group of wage earning households who are not engaged in farming or running businesses of any kind. These households have an exogenous income process $y_{it}$ which is not influenced by decisions such as capital investment. To simplify the notation, especially in the equivalent-with-complete-markets setting with financial participation, we give these households what would appear to be the same production technology as above, namely, $q_i = f_i(k_{it}, \theta_i + \epsilon_{it})$ but with a fixed $k_{it}$, and so it must be understood that $k_{it}$ is simply a constant, not business capital. Thus, for wage earners only the aggregate and idiosyncratic shocks appear in income $y_{it}$, but obviously, both of the latter are allowed. When a wage earning household $i$ is in financial autarky, then we make explicit that household $i$ has initial beginning-of-period stock of savings $s_{it}$ and can save an increment $S_{it}$, the difference between income and consumption, carrying all savings over into the next period. Note that lowercase and uppercase letters distinguish stocks and flows in both savings and capital. To be yet more comparable to the earlier investment technology, this savings can depreciate at rate $\delta$ and suffers a cost-of-adjustment $g(S_{it}, s_{it}, \omega_{it})$. Wage earning households participating in the financial sector would never use this technology for saving, as it is assumed to be strictly dominated in return by the real capital investment technologies. Wage earning households who do not participate in the financial sector do use the saving technology, since by assumption, as wage earners, they do not have the higher yield production technology available to them. This savings thus represents something like rice in storage, which depreciates. But again, to economize on notation below, we often replace $s_{it}$ by $k_{it}$ for these households.

Timeline and decision-making. To fix the timeline for initial decisions at $t = 0$, household $i$ occupation, all initial preference shocks $\xi_{i0}$, technology shocks $\theta_0 + \epsilon_{i0}$, adjustment cost shocks $\omega_{i0}$ and initial asset conditions $k_{i0}$ (or savings $s_{i0}$) are determined. Initially, the household can only see the sum, $\theta_0 + \epsilon_{i0}$. Then, a financial participation decision is made, and, if positive, a cost $Z_i$ is subtracted from capital $k_{i0}$ (or savings). Toward the end of the period, consumption and investment (or savings) decisions are made, in coordination with the bank or in autarky, depending on the participation decision, respectively.

Consider the decision-making of a household (of any occupation, replacing $k$ by $s$ as necessary) in period $t = 0$. Let $V_t(k_{i0} - Z_i, \xi_{i0}, \theta_0 + \epsilon_{i0}, \omega_{i0})$ denote the discounted expected utility value of participating in the financial system. Note that $Z_i$ subtracts from wealth $k_{i0}$ (or saving). By the end of the period, participating households benefit from full insurance, from next year on. Likewise, let $W_t(k_{i0}, \xi_{i0}, \theta_0 + \epsilon_{i0}, \omega_{i0})$ denote the discounted expected utility of those households who choose financial autarky. These households retain their capital $k_{i0}$ (or savings) and see only $\theta_t + \epsilon_{it}$ in all future time periods, as by assumption they cannot distinguish between them. Now let a binary variable $P_{i0}$ denote

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10 The cost of this is that $k_{it}$ has a time date below, and it may appear as well that it is part of each and every household’s state variable. But this should be suppressed when referring to wage earning households. We come back to this in our treatment of the data, later.
financial participation. With this notation, household \(i\) chooses whether to participate as a member of a formal financial sector using the following decision rule:

\[
P_{i0} = 1 \text{ if } V_i(k_{i0} - Z_i, \xi_{i0}, \theta_0 + \varepsilon_{i0}, \omega_{i0}) \geq W_i(k_{i0}, \xi_{i0}, \theta_0, \omega_{i0})
\]

\[
P_{i0} = 0 \text{ otherwise.}
\]

To anticipate what follows, after having made the participation decision, the solution of the appropriate dynamic programming problems, derived in detail below, will give us policy functions for consumption \(c\) and investment \(I\) (or saving).

Table 1: Policy Functions for the Different Financial Regimes

<table>
<thead>
<tr>
<th>(P_{i0} = 1) (participation)</th>
<th>Consumption</th>
<th>Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>for all (t &gt; 0) (c_{it} = c_i(\lambda_i, \xi_{it}, \tau_i))</td>
<td>(I_{it} = I_i(k_{it}, \omega_{it}, \tau_i))</td>
<td></td>
</tr>
<tr>
<td>(P_{i0} = 0) (autarky)</td>
<td>for all (t &gt; 0) (c_{it} = c_i(k_{it}, \xi_{it}, \theta_t + \varepsilon_{it}, \omega_{it}))</td>
<td>(I_{it} = I_i(k_{it}, \xi_{it}, \theta_t, \varepsilon_{it}, \omega_{it}))</td>
</tr>
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</table>

Here \(\lambda_i\) is the Pareto-weight of household \(i\), determined upon entry into the financial sector at \(t = 0\) by initial wealth \(k_{i0} - Z_i\) and shocks \(\theta_0, \varepsilon_{i0},\) and \(\omega_{i0}\). What we see in the data will be \(P\)-weighted versions of these policy functions. That is, all households have consumption functions, but which one we see depends on the participation decision \(P\). As some part of the policy functions has unobserved idiosyncratic shocks \(\xi_{it}\), the error term is also a function of \(P\). With serial correlation, this creates the potential endogeneity problem which requires the use of instruments to net out selection effects and truly gauge the impact of the financial participation.\(^{11}\)

4. The optimal allocation of risk-bearing and investment for financial sector participants

For those participating in the financial sector the set of Pareto optimal consumption and investment allocations are determined as if from a programming problem. In addition, we employ a decentralized complete markets version of the programming problem to better interpret the solution. This will give us the value function \(V_i(k_{i0} - Z_i, \xi_{i0}, \theta_0 + \varepsilon_{i0}, \omega_{i0})\), the contemporary initial policies for household \(i\) in 1996, which are before we have the sampled data, and the policy functions \(c_{it}\) and \(I_{it}\) for all \(t > 0\), just enumerated above in Table 1.

Suppose there are a large but finite number of households, \(i = 1, 2, \ldots N\), who are participating in the financial system, where again \(N\) is large enough so that the sum of i.i.d. population-weighted idiosyncratic shocks is essentially zero. Denote \(h_t^\prime\) as the whole history of shocks through date \(t\) and \(h_t\) as the contemporary date \(t\) realization only. In

\[^{11}\text{Selection effects can make OLS regressions quite distinct from those of IV or other corrections. See Townsend and Urzua (2009) for various examples using data generated from models themselves. Though we deal with selection, we restrict ourselves here to the case where IV and weighted averages of local treatment effects coincide. See Heckman and Vytlacil (2002) for more general treatments.}\]
principle, this aggregate state $h_t$ includes the contemporary realization of idiosyncratic shocks for household $i$, $h_{it} = \{ \xi_{it}, \omega_{it}, e_{it}, \theta_{it} \}$ so the aggregate state is a long vector over all households $j$. With a large number of households in the financial sector, the fraction of households at various configurations of idiosyncratic shocks is all that matters for the aggregate, and as this configuration is virtually constant over all dates and states, it can be suppressed when we talk about aggregate shocks. Still, what matters for household $i$ is its own position; that is, its shock $h_{it}$ inclusive of household $i$ idiosyncratic shocks $\xi_{it}$, $e_{it}$, $\omega_{it}$ as embedded in the aggregate shock $h_t$. So when we refer to a decentralized decision of household $i$, $h_{it}$ is embedded in $h_t$, as if it were written out explicitly. Finally, to be consistent with the notation, there is an initial aggregate state $h_0$ and the initial preference shock is in $h_0$, so with serial correlation, the future aggregate shock and idiosyncratic shock probabilities are conditioned on these. We thus write $\text{prob}(h_t | h_a)$. Occasionally we drop $h_0$ when it does not cause any confusion.

The programming problem under complete insurance and credit markets is to maximize the Pareto-weighted sum of households expected utilities:

1. $$\max_{c_{it}, I_{it}} \sum_{i=1}^{N} \lambda_{i} \left[ u(c_{i0}, \xi_{i0}) + \sum_{i=1}^{\infty} \beta^{t} \sum_{h'} \text{prob}(h' | h_0) \mu[c_{it}, \xi_{it}] \right]$$ subject to

2. $$\sum_{i=1}^{N} c_{it}(h_t) \leq C_{i}(h_t) \text{ for all } t$$

3. $$C_{i}(h_t) = \sum_{i=1}^{N} f(k_{i0} - Z_{i}, \theta_{i} + e_{i0}) - \sum_{i=1}^{N} I_{it}(h_t') + \sum_{i=1}^{N} g[I_{it}(h_{it}' - 1), \omega_{it}] \text{ for } t > 0$$

4. $$C_{0} = \sum_{i=1}^{N} f(k_{i0} - Z_{i}, \theta_{i} + e_{i0}) - \sum_{i=1}^{N} I_{i0} - \sum_{i=1}^{N} g[I_{i0}, k_{i0} - Z_{i}, \omega_{i0}] \text{ at } t = 0$$

5. $$k_{i1}(h_{it}') = (1 - \delta)k_{i0}(h_{it}' - 1) + I_{i0} \text{ (for } h_{it}' > 0)$$

6. $$k_{i1} = (1 - \delta)(k_{i0} - Z_{i}) + I_{i0} \text{ at } t = 0.$$  

The first-order condition for consumption

7. $$\lambda_{i} \beta^{t} \text{prob}(h_t' | h_0) \mu'(c_{it}, \xi_{it}) = \mu(h_t') t > 0$$

where $\mu(h_t')$ is the Lagrange multiplier for (2), which is equivalent to the multiplier in (3). This first equation equates weighted marginal utilities of consumption over all households.

We now derive the first-order condition for investment (Euler equation) where the contemporary marginal cost of investment is equated to the future marginal revenue from production, summing over future states, as expressed in the next equation:
We can exploit the equivalence between Pareto optimal allocations and competitive equilibria to decentralize the problem, and hence further characterize the investment equation by tying it into existing literature. Specifically, let the price of consumption at date \( t \) under state \( h_t \) be equal to the Lagrange multiplier, that is, 
\[
p(h_t) = \mu(h_t).
\]
We can arbitrarily choose the numéraire to be the price of consumption at date 0. Again we note that the pricing function depends on aggregate states, those things determine the marginal utility of (aggregate) consumption, and that prices do not depend on idiosyncratic shocks. However, a household can purchase insurance against idiosyncratic shocks, and since there is no aggregate risk involved, that insurance will be priced at its actuarial value. More specifically, a household can buy insurance that gives an indemnity for low idiosyncratic income shocks and sell insurance that effectively pays out when the issuer household has high income. The price of each is simply the associated probability. Thus the net purchase price of the indemnity/premia bundle is zero as its actuarial value is simply the probability weighted sum of idiosyncratic shocks, and the latter is zero by construction (see the initial assumption in the environment of the model). Then the problem for household \( i \) under complete markets is

\[
V_i(k_{i0} - Z_i, \xi_{i0} + \epsilon_{i0}, \omega_{i0}) = \max \left\{ u(c_{i0}, \xi_{i0}) + \sum_{t=1}^{\infty} \beta^t \sum_{h} \text{prob}(h' | h_0) u\left[ c_{it}(h'), \xi_{it} \right] \right\}
\]

\[
e_{it} + \sum_{t=1}^{\infty} \sum_{h} p(h') e_{it}(h') = \int [k_{i0} - Z_i, \theta_0 + \epsilon_{i0}] - I_{i0} - g\left[ I_{i0}, k_{i0} - Z_i, \omega_{i0} \right] + \\
+ \sum_{t=1}^{\infty} \sum_{h} p(h') \left\{ \int [k_{it}(h^{t-1}), \theta_i + \epsilon_{it}] - I_{it}(h') - g\left[ I_{it}(h'), k_{it}(h^{t-1}), \omega_{it} \right] \right\}
\]

\[
k_{it+1}(h') = (1 - \delta) k_{it}(h^{t-1}) + I_{it} \text{ for } t > 0
\]

\[
k_{i1} = (1 - \delta)(k_{i0} - Z_i) + I_{i0}.
\]

The wealth of household \( i \) at \( t = 0 \) upon entering the financial system is determined by initial capital \( k_{i0} \) minus entry cost \( Z_i \) and the initial shocks, including \( \epsilon_{i0} \) and \( \omega_{i0} \). The solution to this maximization problem is again 
\[
V_i(k_{i0} - Z_i, \xi_{i0} + \epsilon_{i0}, \omega_{i0})
\]

The first-order condition for investment is the following equation:

\[
1 + \frac{\partial g[I_{it}(h^{t-1}), k_{it}(h^{t-1}), \omega_{it}]}{\partial I_{it}} \mu(h_t) = \\
\sum_{h_{t+1}} \mu(h', h_{t+1}) \left[ \frac{\partial f[k_{it+1}(h'), (\theta_{t+1} + \epsilon_{t+1})]}{\partial k_{it+1}} - \frac{\partial g[I_{it+1}(h^{t+1}), k_{it+1}(h'), \omega_{it+1}]}{\partial k_{it+1}} \right].
\]
\[
\left\{ 1 + \frac{\partial g\left[ I_{\alpha}(h'), k_{\alpha}(h'^{-1}), \omega_{\alpha} \right]}{\partial i_{\alpha}} \right\} p(h') = \\
= \sum_{h_{i,t+1}} p(h'^{i+1}) \left[ \frac{\partial f\left[ k_{i,t+1}(h'), \theta_{i,t+1} + \epsilon_{i,t+1} \right]}{\partial k_{i,t+1}} - \frac{\partial g\left[ I_{i,t+1}(h'^{i+1}), k_{i,t+1}(h'), \omega_{i,t+1} \right]}{\partial k_{i,t+1}} \right].
\]

It is explicit in this market context that the marginal cost of investment inclusive of adjustment costs on the left-hand side is equal to the net marginal revenue product on the right-hand side, revenue less costs of adjustment. This is the same investment rule as was previously derived under the programming problem. More to the point, the usual separation theorem applies, and we can determine investment independent of household utility or wealth. Though firm size matters as it enters into the cost of adjustment, the “firm” in this competitive complete markets setting will simply maximize profits at date \( t = 0 \) choosing current investment and future plans:

\[
\max f[k_{i_0} - Z_i, \theta_{i_0} + \epsilon_{i_0}] - I_{i_0} - g[I_{i_0}, k_{i_0} - Z_i, \omega_{i_0}] + \\
\sum_{t=1}^{\infty} \sum_{h'} p(h') \left[ f[k_{i,t}(h'^{-1}), \theta_{i,t} + \epsilon_{i,t}] - I_{i,t}(h') - g[I_{i,t}(h'), k_{i,t}(h'^{-1}), \omega_{i,t}] \right]
\]

by choice of investment \( I_{i0} \) and state-and-date-contingent investments \( I_{it}(h') \). This delivers exactly the same investment behavior. Furthermore, multiplying and dividing by probabilities at each date and state, this is also equivalent with maximizing the discounted expected stream of dividends (namely, consumption) where the discount rate appears stochastic but is actually just a renormalization of prices divided by probabilities. This then looks like the risk neutral firm of the investment literature.

5. Autarky

We now turn to the problem of households who do not participate in the financial sector and so are entirely on their own. It is best to distinguish here those who can invest in farm and other business with income \( y_{it} = q_{it} \) gross of costs of adjustment (costs which we do not observe) and those wage earners with income \( y_{it} \) as a function of \( \theta_{it} \) and \( \epsilon_{it} \) who do not invest in productive technologies, though the notation is similar in the end. For both we ignore demographics. For the former group with investment, the problem is:

\[
W_i(k_{i_0}, \xi_{i_0}, \theta_{i_0} + \epsilon_{i_0}, \omega_{i_0}) = \max_{c_{i_0}, \xi_{i_0}} u(c_{i_0}, \xi_{i_0}) + \sum_{i=1}^{\infty} \beta^i \sum_{h'} \text{prob}(h' \mid h_{i_0}) u\left[ c_{i}(h'), \xi_{i} \right] \\
c_{i}(h') = q_{i}(h') - I_{i}(h') - g\left[ I_{i}(h'), k_{i}(h'^{-1}), \omega_{i} \right] \\
k_{i,t+1}(h') = (1-\delta)k_{i}(h'^{-1}) + I_{i}(h')
\]
The Euler equation is familiar:

\[
\left\{1 + \frac{\partial g[I_t(h_t^i), k_t(h_t^{i-1}), \omega_t]}{\partial k_t}\right\} u'(c_{it}, \xi_{it}) = \\
\sum_{k_{it}} \left[ \frac{\partial f[k_{it}, \theta_t + \epsilon_t]}{\partial k_{it}} - \frac{\partial g[I_{it+1}(h_{it+1}), k_{it+1}(h_t^i), \omega_{it+1}]}{\partial k_{it+1}} \right] u'(c_{it+1}, \xi_{it+1})
\]

For wage earners, just replace flows \(I\) with \(S\) and stock \(k\) with \(s\) and function \(f\) as described earlier. That is, replace \(f(k_{it}, \theta_t + \epsilon_t)\) with a separate term of income \(y_t (\theta_t + \epsilon_t)\) gross of savings adjustment costs, which we do not observe, and of course add to the resource constraint initial stock \(s_0\). Stock of savings \(s_{it}\) accumulates as in the law of motion for capital above at depreciation rate \(\delta\). We do not treat the stocks of savings at the beginning of the period \(t\) as a real capital asset but rather something retained and unobserved in the backyard (unproductive) storage technology.

6. Empirical Strategy

The empirical implementation of the general problem will make use of additional assumptions on the functional forms for preferences and technology, convenient for obtaining closed-form solutions or linear approximations to the consumption and investment policy functions. We follow the empirical strategies in the existing literature on consumption smoothing (Townsend 1994, among others) and on investment financing (Gilchrist and Himmelberg 1999, among others), but again we use the common derivation from the given model for both.

Consumption policy equation with financial participation. To be yet more specific about within-household members’ allocations, suppose the utility function of member \(k\) of household \(j\) is of the form \(u^k(c_{it}^k, \xi_{it}) = -\frac{1}{\sigma} \exp\left[-\sigma\left(\frac{c_{it}^k}{A_{it}^k} + \xi_{it}\right)\right]\) where \(A_{it}^k\) is a gender-age weight of member \(k\) determined by metabolic requirements. Then, adjusting for these metabolic requirements by age and gender of the \(N_{it}\) members \(k\) of household \(i\), assuming common risk aversion, \(\sigma\), common preference shocks, and equal within-household Pareto weights, we obtain from (7) the following equation:

\[
\sum_{k=1}^{N_i} \frac{c_{it}^k}{A_{it}^k} = \frac{1}{\sigma} \left( \log(\lambda) - \frac{1}{N} \sum_{j=1}^{N} \log(\lambda j) \right) - \frac{1}{\sigma} \left[ \sum_{t=1}^{N} A_t^i \log(A_t^i) - \frac{1}{N} \sum_{j=1}^{N} \sum_{t=1}^{N} A_t^i \log(A_t^i) \right] + \frac{1}{N} \sum_{j=1}^{N} \sum_{t=1}^{N} c_{jt}^i + \xi_0
\]
Here the dependent variable is the per-capita (weighted) consumption of household \(i\), \(c_{it}\). The first term on the right-hand side is the household-specific fixed effect (say \(f_i\)) essentially household \(i\)’s relative \(\lambda\)-weight. Note that the average weight in the population is virtually constant, as it is assumed in equilibrium a large number of households have entered and the impact of household \(i\) on the sum is negligible. The second term on the right-hand side is a demographic term reflecting the age-adjusted number of members \(N_{jt}\) of household \(j\) relative to the aggregate risk-sharing group, the set of financial participants. In principle, as in Townsend (1994), this may move over time, but here we suppose it to be constant, and we have verified this makes little difference in the empirical specification below. The final term is the average consumption of financial participants. In practice that latter term is replaced by a common, time-specific fixed effect, \(d_t\), to avoid biases and to have power against alternative hypotheses (see Chauduri and Ravaillon 1997). Term \(d_t\) is determined by the Lagrange multiplier \(\mu(h')\). In sum, we can express each term of equation (15) for household \(i\) with the following notation:

\[
(16) \quad c_{it} = f_i + dem_i + d_t + \xi_{it} .
\]

The main point here is that consumption depends on income only through the common fixed-effect \(d_t\).

**Investment policy equation with financial participation.** The production function is imagined to be linear in capital and multiplicative in the shocks: \(q_u = f_i(k_u, \theta_i + \varepsilon_u) = (\theta_i + \varepsilon_u) k_u\). This makes the average and marginal product of capital easy to compute (if the data came from the model). The adjustment cost function takes the form \(g_i(l_u, k_u, \omega_u) = \frac{1}{2} \left( \frac{l_u}{k_u} \right)^2 k_u + l_u (\omega_u + b_i)\) where \(b_i\) is a household-\(i\) specific fixed effect. This gives a partially closed form decision rule for investment with fixed effect \(b_i\) and an additive unobserved error \(\omega_t\) as the marginal cost of adjustment. Further, under as-if-complete markets, this gives the empirical specification of the investment equation used in the literature. In summary, both investment and consumption equations of the literature are derived in the next section from a common foundation based on the optimal allocation of risk. Note that subscript \(i\) can now be deleted from functions \(u_i(\cdot), f_i(\cdot),\) and \(g_i(\cdot)\).

Under the functional forms for \(f\) and \(g\), we get from the Euler equation (13):

\[
(17) \quad \left(1 + \frac{l_u}{k_{it}} + b_i + \omega_u\right) p(h') = \sum_{k_{i+1}} \left[ (\theta_{i+1} + \varepsilon_{i+1}) + \frac{1}{2} \left( \frac{l_{i+1}}{k_{i+1}} \right)^2 \right] p(h_{i+1})
\]

As in Gilchrist and Himmelberg (1999), one can make repeated substitutions for the investment to capital ratios and derive an expression on the right-hand side which is a

---

\(^{12}\) ICRISAT weights are calculated following Townsend (1994).
nonlinear function of $\theta_t$ over all future $t$ and the contingent prices over all future $t$. The price of an idiosyncratic shock such as $\varepsilon_{i,t+1}$ is simply its probability as that shock does not influence the aggregate state. Thus, as anticipated, adding up the probability-weighted sum, with some terms negative and some positive, delivers the mean, namely zero. Otherwise, both current and future prices and aggregate shocks are common to all the households in the financial sector and thus are captured by a single common time dummy, say $d_t$. The main point is that household investment depends on the aggregate fixed effect $d_t$ and not on household income. The normalization with respect to $k_{it}$ gets rid of household specific technology effects except for the marginal cost shifter $\omega_{it}$. Then, linearizing, again as in Gilchrist and Himmelberg (1999), and switching signs:

$$\frac{I_{it}}{k_{it}} = \text{const} + \theta_{it} + b_i + \omega_{it}$$

Consumption and investment equations under financial autarky. In the autarky problem, consumption is determined at the same time as investment for households running businesses, or at the same time as savings for wage earners, and so consumption will be captured by similar equations to investment. The relevant state variables are $\{k_{it}, \xi_{it}, \theta_{it}, \varepsilon_{it}, \omega_{it}\}$ and we write the policy functions as follows: $I_{it} = I_t(k_{it}, \xi_{it}, \theta_{it} + \varepsilon_{it}, \omega_{it})$ and $c_{it} = c_t(k_{it}, \xi_{it}, \theta_{it} + \varepsilon_{it}, \omega_{it})$. For wage earners, again replace $k$ with $s$ and $I$ with $S$. But again, we do not track savings the way we do for investment by businesses, and so there are no investment equations to be estimated for wage earners. The key point is that the current state for a household at the time of making the joint consumption and investment (or savings) decision includes current income plus other idiosyncratic shocks to preferences and adjustment costs. That is, for farms and business, the state includes both the contemporaneous shocks $\theta_{it} + \varepsilon_{it}$ and also $k_{it}$. Current income is $q_{it} = k_{it}(\theta_{it} + \varepsilon_{it})$ and as we have already included the contemporaneous shocks, the capital piece $k_{it}$ is the only thing otherwise left out of $q_{it}$. With the linear approximation we include each term separately.

In sum, the linear approximation of the policy functions for those in financial autarky, replacing $\theta_{it} + \varepsilon_{it}$ by $q_{it}/k_{it}$ are, for consumption

$$\varepsilon_{it} = \eta_1 k_{it} + \eta_2 \left(\frac{q_{it}}{k_{it}}\right) + \chi_{it}$$

Where $\chi_{it}$ captures both $\xi_{it}$ and $\omega_{it}$, and, for investment

$$I_{it} = \phi_1 k_{it} + \phi_2 \left(\frac{q_{it}}{k_{it}}\right) + \delta_{it}$$

---

13 This is related to $d_t$ in the consumption equation though not identical with it. We do not test the two equations jointly, so the distinction does not matter.
where \( \omega_{it} \) captures again both \( \xi_{it} \) and \( \omega_{it} \). Now, as in equation (17) above for those in as-if-complete markets, we normalize investment by the scale of the capital stock:

\[
\frac{I_{it}}{k_{it}} = \phi_0 + \phi_1 \left( \frac{q_{it}}{k_{it}} \right) + \nu_{it}
\]

In this specification, with the error term now normalized by \( k \), it is natural to check for heteroskedasticity.

**Impact equations of financial participation.** Observed consumption and investment at time \( t > 0 \) for those households \( i \) participating in the financial sector \( P_{i0} = 1 \) and in financial autarky \( P_{i0} = 0 \) can be written by using equations (16), (18), (19) and (21):

\[
c_{it} = P_{i0} \left[ f_i + dem_i + d_i + \xi_{it} \right] + (1 - P_{i0}) \left[ \eta_i k_i + \eta_i \left( \frac{q_{it}}{k_{it}} \right) + \chi_i \right]
\]

\[
\frac{I_{it}}{k_{it}} = P_{i0} \left[ \text{const}_i + d_i + b_i + \omega_{it} \right] + (1 - P_{i0}) \left[ \phi_0 + \phi_1 \left( \frac{q_{it}}{k_{it}} \right) + \nu_{it} \right]
\]

By rearranging terms and taking first differences, and letting \( \tilde{d}_i = d_i - d_{i-1} \), we rid ourselves of household-specific effects and get the following impact equations for changes in consumption and investment-per-unit capital:

\[
\Delta c_{it} = P_{i0} \tilde{d}_i + (1 - P_{i0}) \eta_i \Delta k_{it} + (1 - P_{i0}) \eta_i \Delta \left( \frac{q_{it}}{k_{it}} \right) + [(1 - P_{i0}) \Delta \chi_i + P_{i0} \Delta \xi_{it}]
\]

\[
\Delta \frac{I_{it}}{k_{it}} = P_{i0} \tilde{d}_i + (1 - P_{i0}) \phi_1 \Delta \left( \frac{q_{it}}{k_{it}} \right) + [(1 - P_{i0}) \Delta \nu_{it} + P_{i0} \Delta \omega_{it}]
\]

If the idiosyncratic shock \( \xi_{it} \) is i.i.d., then the error terms in equations (24) and (25) are i.i.d., and the participation decision \( P_{i0} \) taken at \( t = 0 \) would be independent of error terms in the impact equations, which implies in turn that the OLS estimates of financial participation impact are unbiased. However, allowing serial correlation in the idiosyncratic shock \( \xi_{it} \) will make OLS estimates biased and would require Instrumental Variable (IV) estimation. Note that cost \( Z_i \) does not affect potential levels of consumption or investment other than in the initial date before our sample periods, but cost \( Z_i \) does affect the initial choice of financial participation. In this sense, \( Z_i \) in the theory is a valid instrument for the participation decision. The question is then what instrument we employ in the data. IV estimation requires finding variables in the data that are correlated with the cost of participation but uncorrelated with initial shocks \( \xi_{i0}, \omega_{i0}, \theta_{i0} \) and \( \epsilon_{i0} \).
Note that \( \frac{q}{k} \) appears in the consumption and investment equations for those autarky households running firms and businesses, but not for wage earners who have no \( k \), only wage income. For empirical purposes we now put \( \frac{q}{k} \) in units of income for both groups. That is, we run a simple linear regression of income onto \( \frac{q}{k} \) each year one at a time for farms/business, and then use the rescaled predicted value. Note that this income term is just a linear function of \( \frac{q}{k} \). For wage earners we need not run a regression and we just use reported income. This in first differences is “income change”, one of the variables on the right-hand side of the consumption equation. The other term in the consumption equation is capital change. We ran this specification and conducted robustness checks with its exclusion. Results are not sensitive, so capital change is dropped from results reported in Table 4. This also has the advantage of making the autarky consumption equation more comparable to the empirical literature. The investment equation is run only for farms and business and is already scaled by \( k \) so there is no need to include \( k \) on the right-hand side. Finally, in earlier work (Alem and Townsend 2004) we included demographic effects in levels and all interaction terms, though this specification does not come from the theory. Results are largely similar.\(^{14}\)

**Instruments.** We employ several candidates as instruments for \( Z_i \) and test them as over-identifying restrictions (OIR) as we describe below. Each instrument has its strength and limitations, and they all consist of alternative measures of the cost of financial participation \( Z_i \) based on geographic variation, as in Card (1995).\(^{15}\)

**Headman Response (HEAD):** The key informant of a particular village in the Townsend Thai survey answers retrospective questions delivering the history of institution use, in particular the presence of a named institution in the base year, 1996. That is, were there any households who were clients or used the services of a named financial institution? This seems likely correlated with whether an individual is a member

\(^{14}\) Specifically, control \( X_{j96} \) is an expanded vector of household \( j \) characteristics including age, wealth, gender, and also other demographic terms (number of adult males, adult females and children). Control \( Z_{ji96} \) is a vector of characteristics for village \( i \) of household \( j \). From the Townsend Thai data we include average wealth of the village and average education. We also include measured CDD village characteristics such as fraction of households with piped water and state supplied electricity, number of households with migrants outside the village, whether there is a village assembly hall, fraction of households in agriculture, in cottage industries, in paddy production, and fraction receiving government assistance, and with multiple occupations. The \( X_j \) and \( Z_{ji} \) are all dated 1996 and all entered in both levels and interacted with income change. The goal is to have as many controls as possible for consumption and investment change to extract out the incremental smoothing effect of membership in an institution.

\(^{15}\) This strategy is vulnerable to the possibility that financial institutions choose where to operate based on the risk sharing capabilities of their borrowers. Though not implausible, there are indications of other motives in the data: Commercial banks cluster around towns as if a more aggressive strategy of lending to farmers or putting branches or mobile vans in rural areas were inconsistent with Bank of Thailand regulation. The BAAC tends over time to try to establish a branch in every county. Here we treat the placement as random, though clearly this at best an approximation, and focus on the choice of potential customers given branch location. It is clear from CDD data that households can travel non-trivial distances to get to somewhat distant branches. It is the cost of doing this that rationalizes several of the instruments we use. Ongoing work with Assuncao, Mityakov and Townsend (2010) is exploring these issues in detail but not enough is known at present to incorporate here.
or a customer, particularly so for institutions that operate at the village level only or institutions that target or expand at the village level (less so for Commercial Banks, for example). This instrument is not available for informal borrowing or savings.

Time to District Center (TIME): CDD data estimates travel times from the village to District Centers. These are used as instruments for all formal institutions, though it is questionable a priori if there is relevance in this for village institutions. Commercial Banks might be supposed to operate near district centers, and the BAAC may target poor farmers far off the main road.

Geographic Information System (GIS): We also created from CDD data another instrument for financial participation that indicates institutional presence in 1996. Again, Headmen of all villages in Thailand are asked in the CDD survey whether anyone in the village has access to credit from each one of several named institutions such as village funds, commercial bank, agricultural cooperatives, and trader or supplier of inputs (as a proxy for the informal sector). As all villages in each of the survey provinces have been vectorized in a GIS, we can use the responses from nearby villages in 1996 to create a weighted membership variable for each of the villages of the Townsend Thai survey. The GIS variable has several advantages. First, the response of any given headman may be inaccurate, so with presumed spatial correlation, the averaging is removing some measurement error. Second, we can impute values to villages that otherwise are missing headmen responses. Third, there may be supply-side variation: For example, village funds (PCG’s) are promoted by energetic local officials responsible for tambons or amphoe.

The instruments we have chosen are by and large correlated with active participation in the base year and subsequent use of the financial institutions, as shown in Table 2. In many other applications with limited data, being a customer or member cannot be checked directly with actual subsequent use, so here again a panel which asks about savings and borrowing transactions by provider has its huge advantages.

<table>
<thead>
<tr>
<th></th>
<th>HEAD P-value</th>
<th>TIME P-value</th>
<th>GIS P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAAC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Borrowing</td>
<td>.0869 (.0050)</td>
<td>.0675 (.0307)</td>
<td>.2115 (.0000)</td>
</tr>
<tr>
<td>- Savings</td>
<td>.0667 (.0313)</td>
<td>.0602 (.0540)</td>
<td>.2140 (.0000)</td>
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<tr>
<td>Commercial Banks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Borrowing</td>
<td>-.0209 (.4995)</td>
<td>-.0795 (.0108)</td>
<td>.0977 (.0016)</td>
</tr>
<tr>
<td>- Savings</td>
<td>.0558 (.0714)</td>
<td>-.0988 (.0015)</td>
<td>.0889 (.0041)</td>
</tr>
<tr>
<td>Agric. Cooperatives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Borrowing</td>
<td>.1062 (.0006)</td>
<td>.0045 (.8847)</td>
<td>.1818 (.0000)</td>
</tr>
</tbody>
</table>

16 Specifically every pixel is assigned a number by weighting the nearest 12 villages to the center of the pixel, the weight falling inversely with distance. Thus every village, including those of the Townsend Thai data, can be assigned an indicator. The weights and number of villages used were chosen to produce non-trivial variation, between zero and one, so that on average there is neither too little nor too much damping. Robustness checks with alternative specifications were performed.
Method. We use Instrumental Variables (IV) as the benchmark case but employ Generalized Method of Moments (GMM) when the presence of heteroskedasticity in the error term makes IV estimates of standard errors inconsistent. Assuming conditional homoskedasticity, we calculate an IV estimator in two stages, test for the validity of sets of instruments as over-identifying restrictions (OIR), and report the Sargan statistic. We test for heteroskedasticity as in Pagan and Hall (1983), and when indicated, we use GMM and report Hansen J-statistics for the validity of instruments. We first test for the validity of the three instruments, and if this is rejected we test for the various combinations of instruments pair-wise. The advantage of GMM in overcoming heteroskedasticity comes with a cost, as Hayashi (2000) points out, that estimates of the optimal weighting matrix require a very large sample size. We come back to this issue when we report results.

Table 3 reports statistics on the relevance and validity of instruments employed on each financial institution for both consumption and investment impact equations. The first column presents the Shea (1997) partial $R^2$ measure for (time) dummies interacted with measured participation $P_0$, and the second column the income coefficient interacted with measured participation $P_0$. Results indicate that the instruments are largely correlated with these endogenous variables, which is what we expected. There are exceptions. Note in particular that the partial correlation of instruments in the income column for Agricultural Cooperatives and PCG in the consumption specification are low, to anticipate future results. This is also true for Agriculture Cooperatives in the investment specification. The third column reports the p-value of the Pagan-Hall (1983) test for the presence of heteroskedasticity in the error term. It was found that the null hypothesis of conditional homoskedasticity is not rejected for the consumption specification, but it is uniformly rejected at 1% in the case of the investment equation. The investment equation is thus estimated using the GMM instead of IV, and again we anticipate weaker results. The last two columns report the p-value of the over-identifying restrictions test, and we present in the last column the combination of instruments for which the Sargan/Hansen statistic did not reject the null hypothesis of validity of instruments.

Table 3: Properties of the Instruments

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PCG SA</td>
<td>.1527 (.0000)</td>
<td>-.0013 (.9678)</td>
<td>.1897 (.0000)</td>
<td></td>
</tr>
<tr>
<td>PCG B</td>
<td>.2186 (.0000)</td>
<td>-.0961 (.0020)</td>
<td>.1312 (.0000)</td>
<td></td>
</tr>
<tr>
<td>PCG S</td>
<td>.1943 (.0000)</td>
<td>-.0930 (.0028)</td>
<td>.1668 (.0000)</td>
<td></td>
</tr>
<tr>
<td>Informal sector</td>
<td>- Borrowing NA - .0174 (.5770) .0098 (.7522)</td>
<td>- .1228 (.0001)</td>
<td>.0696 (.0244)</td>
<td></td>
</tr>
<tr>
<td>Informal sector</td>
<td>- Savings (Rice) NA - .1228 (.0001) .0696 (.0244)</td>
<td>- .1228 (.0001)</td>
<td>.0696 (.0244)</td>
<td></td>
</tr>
</tbody>
</table>

Notes: GIS is the Geographical Information System instrument, TIME is the response of the Headman to questions about institutional presence. Frequent use is a dummy variable indicating whether the household had a transaction with named institution in 3 out of the 4 years in the panel. Note that informal sector borrowing is not highly correlated with the two available instruments.
7. The impact of financial institutions

Tables 4 and 5 present the estimates of consumption and investment impact equations (24) and (25), respectively. The first column reports the point estimates (and p-values) of the time-varying constant that measures consumption/investment co-movements for members of the particular institution under analysis (BAAC, Commercial Banks, Agricultural Cooperatives, PCG and the Informal Sector). The second column reports the sensitivity of consumption/investment to income changes for non-participants of the financial institution, and the third column measures the effect of financial participation on the income coefficient sensitivity (that is, income change sensitivity for members is the sum of the second and third columns). Finally, the last, fourth column, tests the complete-markets-full-insurance hypothesis for financial participants.

Table 4: Impact of Financial Institutions on Consumption Smoothing (Eq. 24)

<table>
<thead>
<tr>
<th></th>
<th>$P_0$ dt</th>
<th>$P_0 q/k$</th>
<th>p-value</th>
<th>p-value</th>
<th>F-test $\eta_1 = 0$</th>
<th>F-test $\eta_1 + P_0 \eta_1 = 0$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(p-value)</td>
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<td>(p-value)</td>
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<td><strong>Consumption</strong></td>
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<tr>
<td>BAAC</td>
<td>.994</td>
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<td>.675</td>
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<tr>
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<td>.424</td>
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<td>.668</td>
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<td>Agric. Coop.</td>
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<td>.911</td>
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<td>.6710</td>
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<tr>
<td>BAAC</td>
<td>.9922</td>
<td>.2300</td>
<td>.004</td>
<td>.8176</td>
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<tr>
<td>Comm. Banks</td>
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<td>.000</td>
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<tr>
<td>Agric. Coop.</td>
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<td>PCG</td>
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<td>.2123</td>
<td>.000</td>
<td>.7414</td>
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<tr>
<td>Informal sector</td>
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<td>.3615</td>
<td>.000</td>
<td>.4915</td>
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</table>
Summary of results. The BAAC is the most helpful institution in the sense that it helps both in consumption and investment. The sensitivity of consumption to income changes is highest for those non-members of BAAC under IV estimation, but it is fully undone for members in the IV specification, that is, members of the BAAC seem to enjoy full insurance against income shocks (see the results in the last column). For investment, both OLS and IV indicate that the BAAC has a favorable impact, except that the impact of the financial institution on the income coefficient ($P_0 \eta_1$) subtracts too much and consequently the complete markets hypothesis of the last column is rejected (at p-value 0.000). The instruments employed are correlated with subsequent use of both savings and credit (Table 2), though TIME has a somewhat weaker correlation with subsequent use and is not a valid instrument in consumption regression. Note that TIME has a positive correlation as more distant customers are better served, consistent with the premise that BAAC customers are usually located off road, so to speak.

Table 5: Impact of Financial Institutions on Investment Sensitivity to Shocks (Eq. 25)

<table>
<thead>
<tr>
<th></th>
<th>F-test $P_0 \varphi_1 = 0$</th>
<th>$\varphi_1$</th>
<th>$P_0 \varphi_1$</th>
<th>F-test $\varphi_1 + P_0 \varphi_1 = 0$</th>
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<tr>
<td></td>
<td>(p-value)</td>
<td>(p-value)</td>
<td>(p-value)</td>
<td>(p-value)</td>
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<td><strong>BAAC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS</td>
<td>.76 (.5151)</td>
<td>.031*** (.000)</td>
<td>-.192*** (.000)</td>
<td>77.19 (.000)</td>
</tr>
<tr>
<td>IV</td>
<td>3.54 (.3150)</td>
<td>.162*** (.000)</td>
<td>-1.372*** (.000)</td>
<td>270.36 (.000)</td>
</tr>
<tr>
<td><strong>Commercial Banks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS</td>
<td>.06 (.983)</td>
<td>.010*** (.002)</td>
<td>-.058* (.066)</td>
<td>2.26 (.133)</td>
</tr>
<tr>
<td>IV</td>
<td>6.54 (.088)</td>
<td>-.003 (.807)</td>
<td>.026 (.739)</td>
<td>.07 (.787)</td>
</tr>
<tr>
<td><strong>Agric. Cooperatives</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS</td>
<td>.00 (.999)</td>
<td>.010*** (.002)</td>
<td>.381*** (.003)</td>
<td>9.32 (.002)</td>
</tr>
<tr>
<td>IV</td>
<td>2.98 (.395)</td>
<td>-.011 (.403)</td>
<td>.436 (.844)</td>
<td>.04 (.848)</td>
</tr>
</tbody>
</table>
Commercial banks are also helpful. In consumption smoothing, similar to the BAAC, the impact of income changes on consumption is mitigated by financial participation, again significant in the IV. For investment, the OLS specification is good: That is, participation in commercial banks seems to reduce (albeit too much) investment sensitivity to income shocks, but that is not the case for the IV specification. It is interesting that for commercial banks all three instruments (GIS, HEAD, TIME) are valid, always. For commercial banks the correlation in Table 2 of the instrument Time to District Center with subsequent use is negative, as one might anticipate, that is, nearby customers are better served, so to speak. The negative sign on the instrument HEAD is a puzzle.

For Agricultural Cooperatives and PCG/Village Funds it appears that customers are as vulnerable as non-customers to shocks with respect to consumption. The sign is negative for most specifications, but it is not statistically significant. With respect to investment, the sign is perverse and significant in one case. These two institutions do not appear helpful. Related perhaps, in Table 2, the correlation of the instruments with subsequent use displays weak results for Agricultural Cooperatives.

The Informal Sector presents neutral if not perverse results with respect to the smoothing of consumption from income shocks. Surprisingly, the favorable impact, though overdone, is in investment (the F-test for complete markets is rejected). Also, it seems it is the savings part (rice storage), and not the informal borrowing part, which is picked up by the instruments (TIME and GIS). Note the instrument TIME has a positive coefficient, as again more distance from the district center means more use of rice storage.

8. Concluding Remarks

This paper presents a theory-based assessment of the impact of financial institutions at the micro level, beyond financial statements and stand-alone financial indicators. Access to financial institutions, as predicted from the theory, entails substantial beneficial effects at the household level, particularly in eliminating the damaging effect of income shocks.

17 Consistent with this, Kinnan and Townsend (2010) find that the smoothing in investment seems to work through kinship penalties for default rather than sharing, per se.
variability on consumption and investment. In particular, and consistent with previous analysis (Townsend and Yaron 2001), government development banks, usually considered culprits, seem to have a particularly beneficial effect. The more general point is that theory and data can be combined to provide a rating of how well financial service providers are doing as regards their actual customers and clients in the provision of insurance. This link between the ratings of financial institutions and their impact is rare. Certainly, the panel data required to do this is not typically available, but on the other hand, the knowledge gained can be critical for regulators and policymakers as they try to assess how well a given financial system is functioning and whether or not there can be improvements. 19

References


18 We have also stratified by wealth and hence checked for differences in impact. See the earlier working paper (Alem and Townsend 2004) for details. There is strong evidence that low wealth households are on average less well insured. Other inferences are a bit less decisive statistically, as most of the instruments are not significant in the membership equations. Commercial banks seem helpful in consumption for the middle wealth group and in investment for the middle and upper groups. Likewise, we find that the BAAC is not helping the upper group in consumption and not helping the middle and upper groups in investment. (No instruments are significant for the poor, so we cannot infer anything positive for them. But we know from BAAC policy that it is targeted toward middle if not lower income groups.)

19 As regards occupation and source of income, business owners are able to smooth consumption well overall and in both regions, reducing exposure to idiosyncratic risk to a low number. Business owners, however, are not able to smooth investment, especially so after the crisis. Fluctuations in wage earnings appear to have a high association with fluctuations in consumption for wage earners in the Central region during the crisis. In sum, business income drops on average, but idiosyncratic income movements are covered in consumption. Conversely, wage income does not fall much on average, but idiosyncratic movements are not covered. This makes the point that average income movements by group are a bad metric for making judgments about vulnerability.


Appendix

Table A.1: Summary Statistics, 1997

<table>
<thead>
<tr>
<th>Variable Description</th>
<th># of obs.</th>
<th>Mean</th>
<th>St.Dev.</th>
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<tr>
<td><strong>Households variables (total 960)</strong></td>
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<td>Household Consumption (Baht)</td>
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<td>Household Investment (Baht)</td>
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<td>96630</td>
</tr>
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<td>Household Income (Baht)</td>
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<td>76119</td>
<td>232359</td>
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<td>Age of Head</td>
<td>912</td>
<td>.51</td>
<td>.14</td>
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<tr>
<td>Gender of Head (1 if Male)</td>
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<td>Household Wealth (in Baht)</td>
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<tr>
<td>Household Size (members)</td>
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<td>4.6</td>
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</tr>
<tr>
<td><strong>Financial institution participation (total 960)</strong></td>
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<td></td>
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<td>Dummy BAAC (1 if member)</td>
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<td>Dummy Comm. Banks (1 if member)</td>
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<td>Dummy PCG-Village Fund (1 if member)</td>
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<td>GIS _ BAAC (village level, total 192)</td>
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<td>GIS _ Comm. Banks (village level, total 192)</td>
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<tr>
<td>GIS _ Cooperatives (village level, total 192)</td>
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<td>.35</td>
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<td>GIS _ Village Funds (village level, total 192)</td>
<td>192</td>
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<td>GIS _ Supplier Credit (village level, total 192)</td>
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<td>HEAD _ BAAC (village level, total 192)</td>
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<td>HEAD _ Village Funds (village level, total 192)</td>
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<td>TIME to District Center (village level, total 192)</td>
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Table A.2: Summary Statistics, panel data, 1998-2001

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