Thailand's agricultural household debt: Assessment of recent trends

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Abstract

The sustainability of agricultural household debt has a large welfare implication for Thailand where nearly a half of the country's labor force works in the agricultural sector. This paper reviews selected developments of Thailand's agricultural household debt situation from 1994 Q1 to 2006 Q2 and presents an error correction model of agricultural households' loans in arrears. The paper finds that the increase in the stock of debt per agricultural household in recent years has not caused problems for either agricultural households or their major lender, the Bank for Agriculture and Agricultural Cooperatives. Nevertheless, agricultural households are more indebted than an average household and a major downturn in farm price will have a severe impact on the sector.

Keywords: agricultural sector, household debt, error correction model

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1. Introduction

In recent years, household debt has become a focus of attention of policymakers, not only in Thailand, but also in many other countries. Almost globally, a combination of subdued inflation and low interest rate periods has helped households to take on more debt with ease. On the supply side, modern credit risk management techniques have enabled financial institutions to better manage their retail loan portfolio exposures, making lending to household an attractive business proposition, especially for those awash with liquidity. In some countries, government policies to promote debt-financed domestic spending, for example, the Village Fund in Thailand and the mortgage loan guarantee scheme in Finland, have given household debt an additional boost. All of these factors have resulted in a ballooning level of household debt relative to GDP and/or disposable income in developed and developing countries alike.

The high level of household debt worries many policymakers because its fallout will have a far-reaching repercussion on the economy, from the welfare of its citizens to macroeconomic and financial stability. As the global interest rate cycle tightens and the surge in oil price threatens to slow down many economies, the probability that some of these households will have trouble servicing their debt becomes increasingly paramount. As a result, many central banks now monitor the household debt situation in their countries very closely. Among growing examples of recent work on household debt by central banks are Debelle (2003), Rinaldi and Sanchis-Arellano (2006), and Ariyapruchya (2006),

This paper looks at the debt behaviour of a particular segment of households in Thailand, namely agricultural households. Although agriculture generates a mere 8.7% of GDP in real terms (2005 figure), the sector employs nearly a half of the country's labour force. From a welfare perspective, sustainability of agricultural household debt is thus not a trivial issue.

One reason for looking specifically at agricultural households is that these households are potentially more vulnerable to an economic downturn than other households. Statistically, they are not only among the poorest, but also have a higher debt burden than an average household. Furthermore, their well-beings are typically tied to agricultural price cycles. Should the present rising trend in farm price reverse its course, which could happen if the world is to slow down markedly as the IMF has recently

warned of such possibility (IMF, 2006), these households' debt service ability may be seriously undermined.

In essence, this paper reviews recent developments of agricultural household debt situation and presents an empirical model of loans in arrears of Thai agricultural households. Aggregate loan data from the Bank for Agriculture and Agricultural Cooperatives (BAAC)[1] are used as representatives of total agricultural household debt. The ultimate goal is to have an estimated factor model that links agricultural household arrears to relevant macroeconomic variables that is also usable by policymakers for scenario analysis and high-level stress testing of agricultural loan portfolios.

The rest of the paper is organized as follows. Section two describes an overview of agricultural household debt situation along with contemporaneous developments in the agricultural sector. Section three presents and discusses the results of the estimated model, as well as its applications and possible extensions. Section four concludes.

2. Some facts about agricultural household debt in Thailand

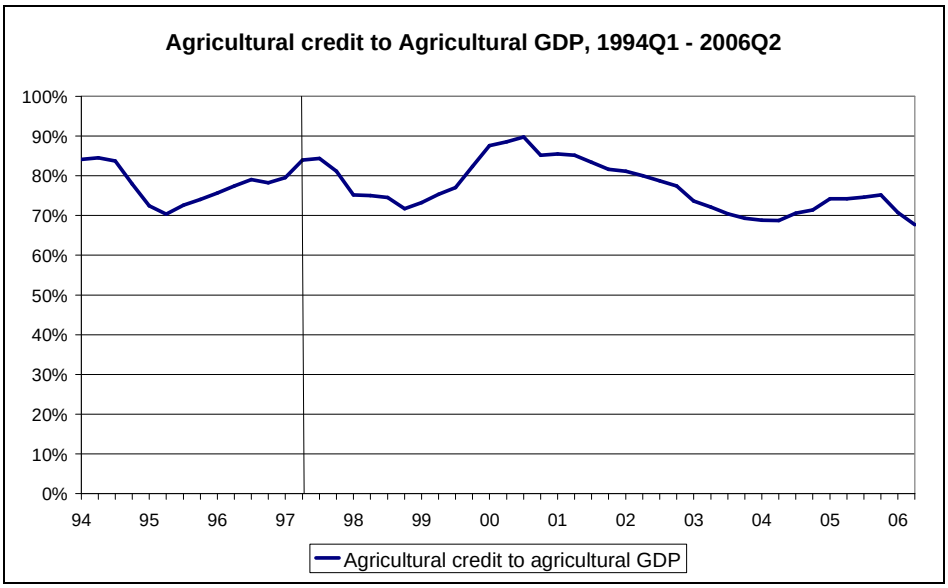
We begin this section with a big picture of agricultural credit (i.e., from the perspective of the lenders). By agricultural credit, we mean loans extended by BAAC, commercial banks, and finance companies for purposes of agriculture, hunting, forestry, and fishing[2]. In total, agricultural credit extended by these institutions amounted to Bt525b at the end of June 2006. It is important to note that loans for activities such as rice mills and sugar factories are not counted as loans for agriculture, but as loans for production. Also, we do not include in our figure loans from the Government Savings Bank (GSB), the other important player in the household finance market. The main reason is that we do not have enough information to distinguish GSB's loans to agricultural households from loans to GSB's non-agricultural households. Nevertheless, our prior is that the amount of GSB agricultural credit is small relative to the amount of credit extended by BAAC and commercial banks.[3]

[1] Founded in 1966, BAAC's outreach and sustainability rank it among the the world's leading agricultural development banks (Klein et al., 1999, p. 36)

[2] Since 2003, commercial bank and finance company loans for fishing purpose are reported as a separate category from loans for agriculture, hunting, and forestry purposes. We include them back here so as to be consistent with the definition of agricultural GDP.

[3] Publicly available GSB sectoral loan data are classified into (1) housing, (2) personal, (3) corporate, (4) SMEs, (5) society and community, and (6) government and state enterprises loans. Loans to agricultural households most likely fall in the second and fifth categories which account for about 20% and 30%, respectively, of GSB total loans (Bt377b as of December 2005).

Figure 1 Ratio of agricultural credit to agricultural GDP, 1994 Q1-2006 Q2



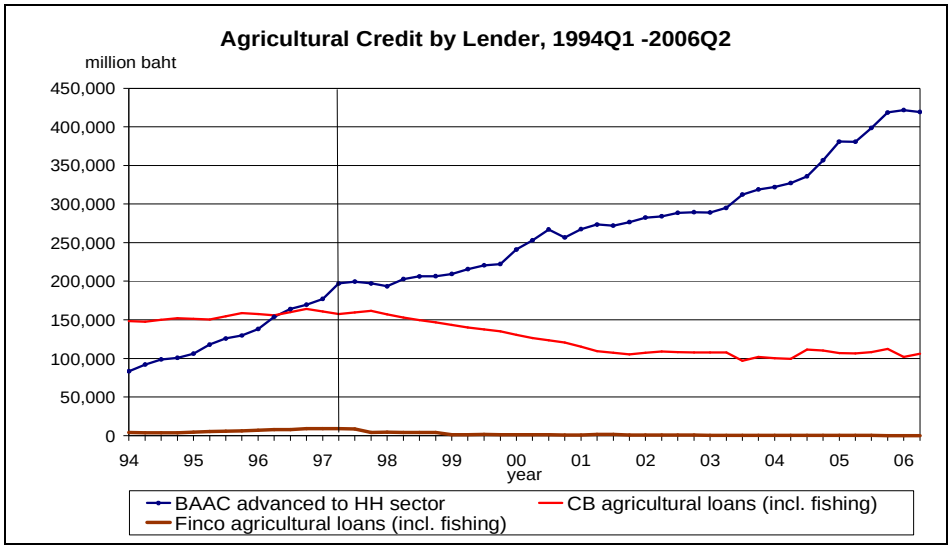
Source: NESDB, BOT and authors' calculation

Figure 1 shows the evolution of the ratio of agricultural credit to GDP from 1994 Q1 to 2006 Q2. We calculate this ratio by dividing the outstanding amount of agricultural credit at the end of each quarter by the sum of nominal GDP in the same and the three preceding quarters. Over the past twelve years, this ratio fluctuated roughly between 70% and 90%. Since reaching a historic high in the middle of 2000, the ratio has been trending down, with the lowest value of 67.7% recorded in 2006 Q2. While the downtrend in agricultural credit is a welcome development, the latest value is about twice as high as the ratio of total household debt to GDP (Ariyapruchaya, 2006). That agricultural households have a higher debt burden than an average household is further supported by the National Statistical Office (NSO) survey data. According to the statistics calculated from the 2004 NSO Household Survey, the ratio of total debt (which also includes loans from relative, friends, money lenders, and other sources of informal borrowing) to annualized income for an average household is 56%, while the corresponding figure for farm owners/farm renters is 73%.

To gain further insight, we look at agricultural loans extended by BAAC and those by commercial banks and finance companies separately. The recipients of these loans are quite different. BAAC mainly lends to small- and medium-scale farmers and agricultural cooperatives (which on-lend BAAC funds to farmer members) while commercial banks and finance companies tend to go for large farms and plantations. For most small- and medium-scale farmers, loans from BAAC are essentially their lifeblood. Since we are

interested in credit extended to agricultural households, the latter may be of less relevance for our purpose.

Figure 2 Agricultural credit by lender, 1994 Q1-2006 Q2



Source: BOT

Figure 2 shows the divergent paths of agricultural credit extended by BAAC and those by commercial banks and finance companies. In 1994, agricultural credit extended by BAAC accounted for 39% of total agricultural credit. In 2006 Q2, the share of BAAC credit stood at 80% or more than doubled its level twelve years ago. During this period, credit extended by BAAC rose almost continuously. In contrast, agricultural credit extended by finance companies and commercial banks showed a declining trend as early as in the first half of 1997. After a steady decline for nearly five years, agricultural credit extended by commercial banks seemed to have stabilized since 2002. But the flat level means that commercial banks' agricultural credit failed to pick up along with the recovery of the overall loan portfolio. In fact, the share of agricultural credit in commercial bank loan portfolio has now shrunk to below 2% compared to 5.5% at the beginning of 1994, indicating the reduced importance of agricultural loans from the perspective of commercial banks. As for agricultural credit extended by finance companies, there was virtually none left by 2006[4].

The increase in BAAC credit was due partly to BAAC's expanded coverage. Between March 1994 and March 2006, the number of BAAC's provincial

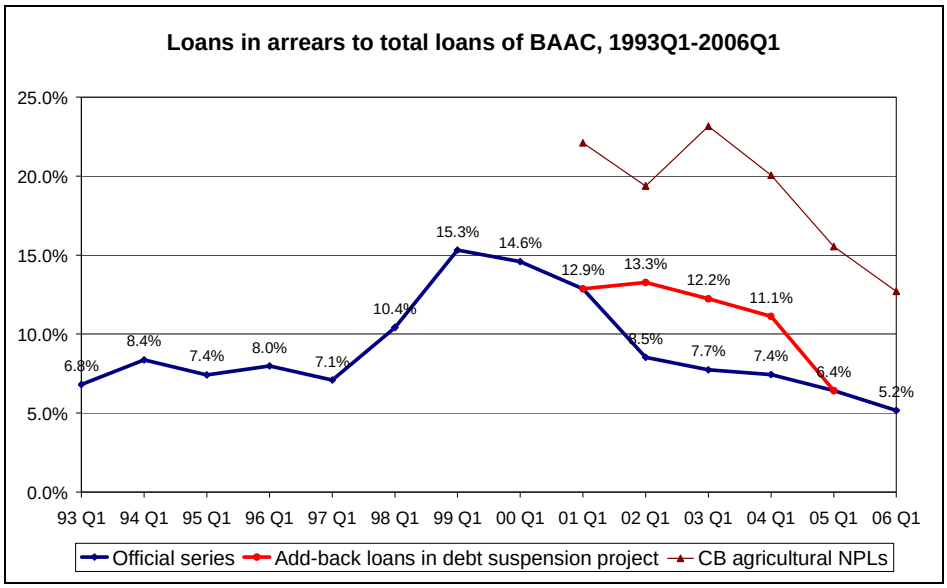
[4] The disappearance of agricultural credit extended by finance companies is due largely to two reasons. One is the closure of finance companies as a result of the 1997 crisis. The other is the phasing-out of finance companies stipulated by the Financial Sector Master Plan which came into effect in January 2004. In the latter case, some agricultural credit would show up as commercial bank credit.

offices/branches grew from 304 to 848. During this period, the number of farm households served by BAAC rose from 4.4 million to 5.5 million. In fact, as Gine and Townsend (2003) have noted, BAAC's extensive provincial network was instrumental in improving financial access in the country's rural area.

In addition to the expanded coverage, BAAC has also lent more per household. As of March 1994, BAAC credit per household stood at twenty-one thousand baht. As of March 2006, the corresponding amount was seventy-six thousand baht. After taking inflation into account, the increase in BAAC's credit per household is still about two-and-a-half fold.

The increase in the stock of debt by itself is not necessary a cause for concern, however. For lending institutions, what matters is that both expected and unexpected losses are cushioned by loan loss provisions and capital. On this ground, BAAC appears well-cushioned. As of March 2006, BAAC's loan loss allowance[5] amounted to Bt81,295m, about four times its loans in arrears of Bt21,787m. On the capital side, the bank's capital adequacy ratio (CAR) is around 10.8, higher than the current regulatory level of 8.5% required for commercial banks (BAAC 2005 annual report).[6]

Figure 3 Ratios of loans in arrears to total loans of BAAC, 1993 Q1 – 2006 Q1



Source: Various issues of BAAC annual reports; authors' calculation

[5] Include interests of restructured accounts. Unlike commercial banks, BAAC's provisions are calculated without the decuction of the values of collateral. The BAAC also has a peculiar practice of booking government compensation for lost interests and cost of funds as reserves.

[6] As a specialized financial institution (SFI), BAAC is not subject to maintain regulatory capital adequacy ratio, however.

Figure 3 plots loans in arrears as percent of total loans of BAAC (annual rate) from the end of BAAC fiscal year 1992 (March 1993) to the end of BAAC fiscal year 2005 (March 2006). BAAC sometimes refers to this figure as the bank's NPL ratio. It is important however to recognize that BAAC's loans in arrears differ significantly from commercial banks' NPLs. While commercial banks' NPLs are generally loans that have been overdue for at least three months, BAAC's loans in arrears are overdue loans aged one year and up. This is due to the fact that interest and principal payments for BAAC loans are made on an annual basis. The annual repayment schedule in effect introduces delayed recognition of BAAC's impaired assets relative to those of commercial banks.

The other major and most important difference is that BAAC only counts the portion of an overdue loan contract that misses the payment schedule as loan in arrears. For example, suppose that the loan contract is for one million baht principal and payable in five equal annual instalments. If the default happens with the first payment, then only 200,000 baht is counted by BAAC as being overdue. This means that BAAC's loans in arrears figure understates the true amount of the bank's defaulted loans. Accordingly, BAAC's seemingly "excessive" provisions may not be excessive at all.

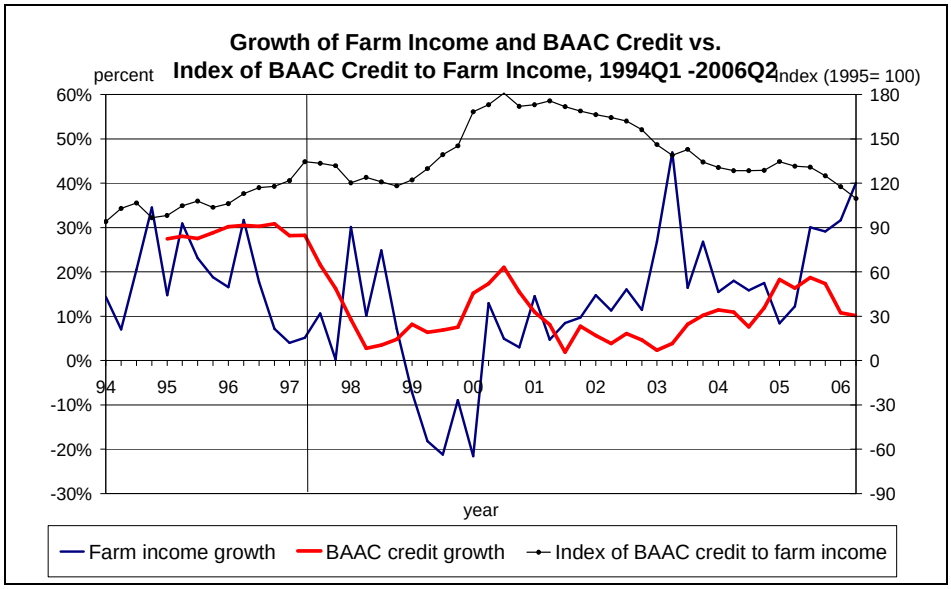
From 1993 Q1 to 1997 Q1, BAAC's loans in arrears ratio were relatively stable with a mean of 7.5%. The 1997 crisis hit BAAC badly as its loans in arrears more than doubled in two years. From 1 April 2001 to 31 March 2004, BAAC administered a Debt Suspension and Debt Burden Reduction Project to help small-scale farmers with debt service problems (interest waived and principal reduction during the period were compensated by the government). The light-colored line in Figure 3 corresponds to the case where the suspended loans are added back to the reported figures of loans in arrears.

The three-year debt suspension and debt burden reduction project benefited more than two million small-scale farmers nationwide and partly helped to bring down BAAC's loans in arrears. By March 2006, the ratio of loans in arrears to total loans of BAAC was down to 5.2%, even lower than its pre-crisis average. For the most part, however, the sharp decline in BAAC's loans in arrears was due mostly to the restructuring of delinquent accounts rather than full repayments. BAAC's troubled debt restructure (TDR) loans, jointly approved by BAAC's board of directors and the Bank of Thailand, amounted to Bt62,520m as of March 2006 (BAAC 2005 annual report). If one were to add these TDR loans (which are normal loans) on top of loans in arrears, BAAC's bad loan ratio would be an astounding 20%. But doing so would be unfair to BAAC. The downtrend in agricultural NPL ratio of commercial banks (represented by the thin

line in Figure 3) suggests that the recent improvement in agricultural loan quality is probably real.

Yet BAAC can still get into trouble if its client farmers find themselves overwhelmed by the increased stock of debt. As we have mentioned earlier, BAAC credit per households increased by about 2.5 times in real terms from 1994 to 2006. Again, it should be stressed that more debt is not a problem if the increase is well cushioned. For households, the cushion comprises their assets and income.

Figure 4 Growth of farm income and BAAC credit versus the index of BAAC credit to farm income, 1994 Q1 – 2006 Q2



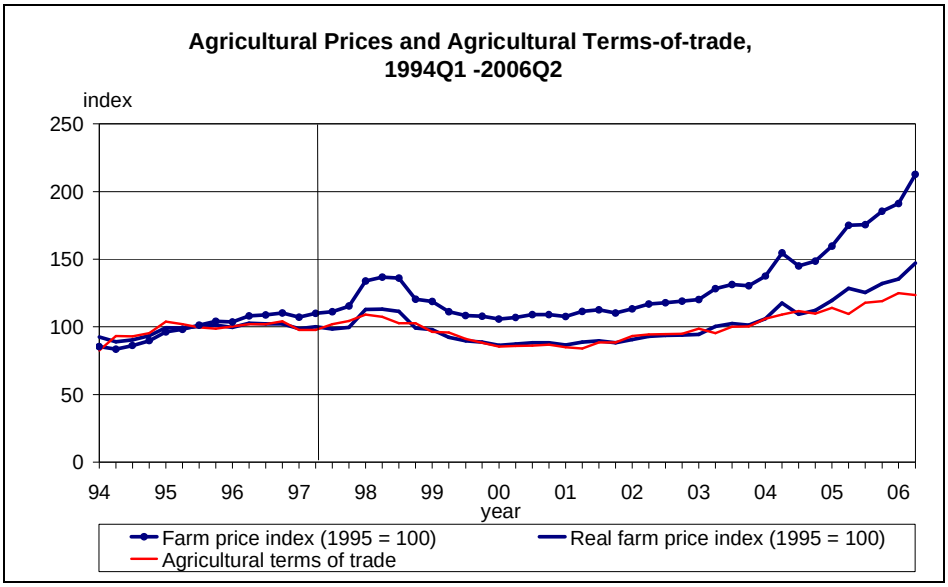
Source: BOT; authors' calculation

Since no reliable time series data is available on assets of agricultural households, we focus on their income. The best available proxy for agricultural household income is probably the farm income index released monthly by the Bank of Thailand.[7] Figure 4 shows that while BAAC credit accelerated two years after the 1997 crisis, farm income has grown faster than BAAC credit in almost every quarter since 2001. As a result, the index of BAAC credit to farm income (1995 = 100), which reached a peak of 181 in mid 2000, has declined almost continuously during the past six years. As of June 2006, the index of BAAC credit to farm income stood at 110, about the same level as its pre-crisis average.

[7] Time series for the farm income from major crops index, or in short the farm income index, can be computed by multiplying the index of crops production with the crop price index, both of which can be downloaded from the Bank of Thailand website, and dividing their products by one hundred.

The surge in farm income since 2000 has been largely driven by the surge in farm prices. Figure 5 plots both nominal and CPI-deflated farm price indexes[8] along with agricultural terms of trade (defined as the ratio of agricultural GDP deflator to non-agricultural GDP deflator). Despite recent increases in oil and other non-agricultural prices, farmers' real purchasing power has maintained its momentum and remained well above its pre-crisis level.

Figure 5 Agricultural price indexes and agricultural terms of trade, 1994 Q1-2006 Q2



Source: BOT; NESDB; authors' calculation

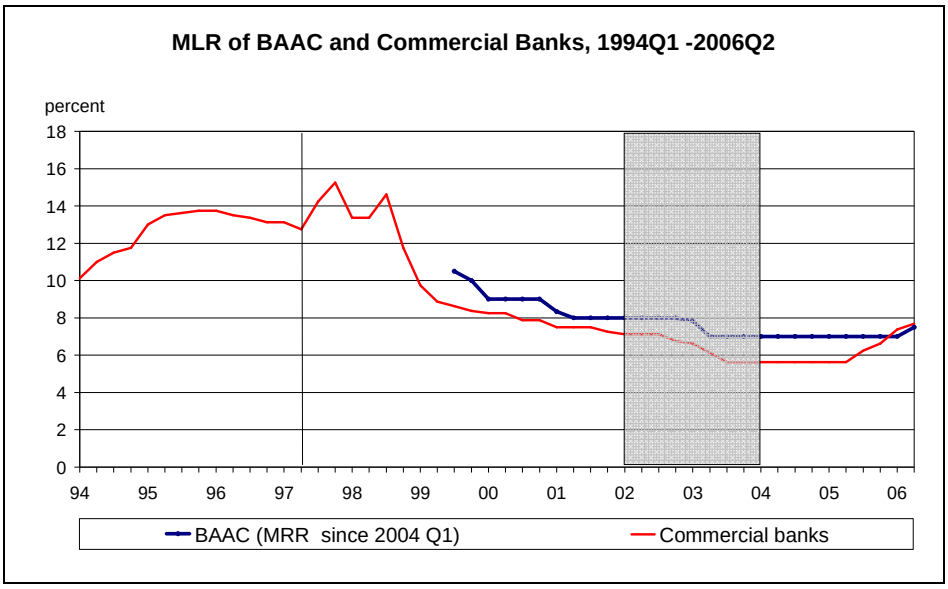
In addition to higher income and real purchasing power, the other factor that plays an important role in determining the evolution of agricultural household loans is interest rate. Figure 6 plots (quarterly average) reference interest rates of BAAC and commercial banks from 1994 to 2006.[9] By historical standards, the levels of these reference rates, both in nominal and in real terms, during the past few years have been relatively low. On a negative side, low interest rates mean more demand for new loans, which may be bad for future debt sustainability if the borrowers do not realize that interest rates will eventually go up and borrow beyond capacity. On a positive side, however, low interest

[8] A composite index of crops, livestock, fishery and forestry prices.

[9] BAAC started using Minimum Lending Rate (MLR) as a reference rate for its client farmers and agricultural cooperatives in August 1999 and switched to Minimum Retail Rate (MRR) for client farmers in April 2004 (MLR remains the reference rate for agricultural cooperatives). A major criterion for customer rating is the loan repayment record. New borrowers are assigned the lowest rating and have to pay MRR+3%. Prior to the adoption of MLR, BAAC did not rate its borrowers. Loans to farmers were charged according to amount, maturity, and purpose.

rates have helped households with debt service problems to remain afloat which in turn also aided the restructuring of BAAC's loan book.

Figure 6 Reference lending rates of BAAC and commercial banks



Source: BOT; BAAC
Note: The shaded area denotes the debt suspension period.

To summarize, the evidence in this section indicates that the surge in BAAC credit has not caused a problem for either the BAAC or its borrowers. At least on the surface, BAAC appears financially healthy (thanks partly to committed government supports[10]). And while it is true that agricultural households now carry much more debt than at any time in the past, they seem to also have higher abilities to service the increased stock of debt.

3. An empirical model of agricultural household loans in arrears

This section presents an estimated model of loans in arrears of Thai agricultural households. The section draws from the recent work by Rinaldi and Sanchis-Arellano (2006) who study household debt sustainability in a sample of euro area countries. The theoretical set-up of their model which we also adopt here is a life-cycle model[11] with a default option developed by Lawrence (1995). In this class of model, the probability of

[10] In addition to government compensation from the incurred losses from the debt suspension project, about 10 percent of BAAC's total loans are in the form of loans to government-secured loan projects. In 2004, the Ministry of Finance also recapitalized BAAC Yankee bonds worth Bt7.2b and placed Bt500m additional shares to lower BAAC's cost of funds.
[11] Ariyapruchya, Chucherd, and Thaicharoen (2003) find that the life cycle hypothesis captures well Thailand's household debt profiles found in the NSO Survey.

default, which we associate in this paper with the chance of falling into arrears, can be derived as a function of the amount of the loan borrowed, income net of other expenses, wealth, the borrowing rate, and the state of the economy. The probability of a borrower falling into arrears increases with the stock of debt, the borrowing rate, and the bad state of the economy, but decreases with net income, wealth, and the good state of the economy.

3.1 The data

Our data set runs from 1994 Q1 to 2006 Q1, consisting of 49 quarterly observations. The choice of the starting date is dictated by the availability of quarterly BAAC loan data which we take as representative of total agricultural household debt.

The data set contains eight variables: (1) the ratio of agricultural household arrears to total agricultural household loans, (2) the real stock of agricultural household debt, (3) the index of agricultural household debt to farm income, (4) real farm income, (5) real farm price, (6) agricultural terms of trade, (7) real reference borrowing rates of agricultural household loans, and (8) real GDP. Appendix A provides the description of each variable

These variables are based on the implications of theoretical model.[12] The ratio of loans in arrears is intended to be a proxy of the probability of default. Real farm income, real farm price and the agricultural terms of trade, three slightly different measures of agricultural households' real purchasing power, are intended to capture income net of other expenses. The state of the economy is proxied by real GDP. The interpretation of the rest of the variables is straightforward.

Notably missing from the list is a wealth variable. Conventional wealth proxies -- the stock market capitalization, bond holdings, the aggregate money stock, and the house price index, bear little connection to Thai agricultural households who live and work predominantly in the rural area.

The construction of the ratio of loans in arrears and the reference borrowing rate series rests on interpolation and extrapolation, respectively. Historical figures of BAAC's loans in arrears are at the end of BAAC fiscal year only. Only from 2005 Q1 did BAAC make available (upon request) quarterly figures of the bank's loans in arrears. To fill in values of intra-fiscal-year ratios of BAAC's loans in arrears to total loans, we make a

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strong assumption that past ratios of loans in arrears follow the same pattern of movements as those from 2005 Q1 to 2006 Q1, which we obtained from BAAC's internal database. Nevertheless, given the annual nature of BAAC loan repayment, such interpolation should roughly approximate the actual intra-fiscal-year ratios except perhaps during 1997 and 1998 when the 1997 crisis led to a slow down in BAAC's credit growth and sharp increases in the amount of loans in arrears.

The other series that we do not have a full time series is the reference borrowing rate. As mentioned in previous section, BAAC only started using a reference rate in 1998. To extend the series backward, we assume a constant markup on top of commercial banks' MLRs. The time path of BAAC's quoted interest rates prior to the adoption of MLR as a reference rate (not shown) suggests that this assumption is not too unreasonable, for those rates appeared to move in lockstep with commercial bank MLRs. To get real reference lending rates, we deflate the nominal interest rate series by four-quarter-ahead annual CPI inflation.

Table 1 Contemporaneous and lead correlations of potential explanatory variables with the ratio of loans in arrears

Variable	Correlation with	
	Loans in arrears$_t$	Loans in arrears$_{t+1}$
Loans in arrears	100%	95%
Real debt stock	18%	18%
Debt-to-farm-income ratio	67%	63%
Agricultural terms of trade	-62%	-57%
Real farm income	-29%	-30%
Real farm price	-58%	-56%
Real interest rate	26%	36%
Headline inflation rate	-65%	-53%
Real GDP	-25%	-34%

Table 1 shows how each variable in the data set correlates with the ratios of agricultural household loans in arrears in the same and the following quarters. A priori, all of these variables are our potential explanatory variables for the movements of the ratio of agricultural household loans in arrears. Note that lagged ratio of loans in arrears is also one of the potential explanatory variables although it does not show up in the theoretical model. There are strong reasons to believe that current ratios of loans in

arrears are influenced by past ratios. First, the current stock of arrears is the accumulated amount of arrears originated in previous periods that have not been taken out of the bank's balance sheet. Second, the current ratio of loans in arrears generally affects financial institutions' lending policy which in turn affects the behavior of the ratio of loans in arrears in the future.

The signs of all correlation coefficients conform to our prior. The ratio of loans in arrears is positively related to the ratio of loans in arrears in the previous period, the present and lagged values of real debt, debt-to-farm-income ratio, and the real interest rate, but is negatively related to the present and lagged values of the agricultural terms of trade, real farm income, real farm price, and real GDP.

3.2 Econometric results

The high value of the correlation coefficient between the current and the past ratios of loans in arrears suggests that the variable may be nonstationary and that ordinary least-squares estimation may result in spurious regression (Phillips, 1986). To attest this possibility, we run an Augmented Dickey-Fuller (ADF) test on the ratio of BAAC's loans in arrears. The ADF test statistic indeed fails to reject the null hypothesis that the ratio of loans in arrears is a unit root.

There are several econometric estimation procedures designed to deal with the unit root problem. In this paper, we follow Rinaldi and Sanchis-Arellano (2006) in using an error correction model (ECM) specification. The use of ECM is also in line with other other work on debt in arrears, see for examples, Davis (1995) and Whitney et al. (2004).

One advantage of the ECM specification is that it allows the estimation of both short-term and loan-run effects of explanatory time series variables. In the approach pioneered by Engle and Granger (1987), a long-run equilibrium relationship (cointegrating regression) is first fit to the levels of the variables. In the second step of the two-step procedure, the calculated residuals from the cointegrating regression are used as an additional explanatory variable in the short-run equation, hence the name error correction model. In both steps, ordinary least squares (OLS) estimation is employed.

The assumption that is necessary to yield meaningful estimates of the ECM is the existence of cointegrating relationship in the long-run regression. In other words, not only do we need each variable in the long-run equation to be nonstationary, we also need the resulting residuals to be I(0). To ensure the applicability of our econometric model,

we perform both the Phillips-Perron and the ADF test on each variable and the residuals of the long-run regression equation[13].

It turns out that we cannot reject the null hypothesis of unit root for any of our variables. Of the three measures of agricultural households' real purchasing power, real farm price best helps explain the behavior of the ratio of agricultural household loans in arrears. The other two measures, real farm income and the agricultural terms of trade, either fail to form cointegrating relationship with the ratio of loans in arrears and the rest of the variables in the long-run regression or lead to serially correlated errors in the short-run dynamic equation.

Estimated error correction model of the ratio of agricultural household loans in arrears

$$\Delta \ln(\text{loans in arrears ratio}_t) = \underset{(1.97)*}{0.439}*\Delta \ln(\text{debt to income}_{t-1}) + \underset{(3.63)***}{1.040}*\Delta\Sigma_{i=0-3}(\text{real reference rate}_{t-i})$$

$$\underset{(-4.10)***}{-0.007}*\Delta(\text{real farm price}_{t-1}) - \underset{(-3.27)***}{0.262}*\text{ecm}_{t-3}$$

Adjusted $R^2 = 0.50$ S.E. of regression = 0.067 Breusch-Godfrey LM(2) : 1.3 (0.29)

$$\text{ecm}_t = \ln(\text{loans in arrears ratio}_t) - (\underset{(9.78)}{0.802}*\ln(\text{real debt}_t) + \underset{(5.69)}{0.981}*\Sigma_{i=0-3}(\text{real reference rate}_{t-i})$$

$$- \underset{(-10.81)}{0.528}*\ln(\text{real GDP}) - \underset{(-8.83)}{0.013}*\text{real farm price}_t)$$

Adjusted $R^2 = 0.81$

Note: Number of observation = 46 after adjustments (1994Q4 – 2006Q1)
t-statistics are in parenteses.
***, **, * denote significance at 1%, 5%, and 10%, respectively.

Let's first look at the long-run estimation results (the second equation in the panel). In line with earlier work on household arrears, we also report the values of t-statistics of the estimated coefficients of the long-run regression. The readers should be aware however that although the OLS estimates of the long-run equation are consistent[14], they are in general not normally distributed. Inferences based on t-statistics can be misleading whether or not these statistics are computed using heteroskedastic and autocorrelation consistent standard errors (Stock and Watson, 2003). In fact, it is a common practice that for a long-run regression to be valid, we only need coefficients of

[13] The ADF test on residuals from the estimated long-run equation is known as the Engle-Granger ADF test (EG-ADF). The critical values of the EG-ADF test are larger than a normal ADF test and vary positively with the number of cointegrating variables. See MacKinnon (1991).
[14] To be more precise, OLS estmates in this case are superconsistent.

explanatory variables to be of an expected sign and the associated residuals to be stationary.

The interpretation of the long-run equation is as follows. Both the level of real debt and the sum of the real reference rates have a positive effect on the ratio of loans in arrears. A one-percent increase in the stock of real debt leads to about a 0.8- percent increase in the ratio of BAAC's loans in arrears in the long run (e.g., if the current level of BAAC's loans in arrears ratio is 5%, a one-percent increase in the stock of real debt will result in a long-run loans in arrears ratio of 5 + 5*0.008 = 5.04%)

Notice that real reference rate enters as a yearly sum instead of a single rate. Separately, their explanatory power is very low. This is due to the fact that BAAC's loans are repaid annually with the required interest payment accumulating according to four preceding quarterly rates. In the long run, a one-hundred basis point increase in the sum of the real reference borrowing rate raises the ratio of BAAC's loans in arrears by about one percentage (e.g., from 5% to 5 + 5*0.01 =5.05%).

The other two variables in the long-run equation are log of real GDP and real farm price, both of which enter with a negative coefficient. In the long run, a one-percent increase in real GDP lowers the ratio of BAAC's loans in arrears by 0.528 percent (e.g., from 5% to 5 -5*0.00528 = 4.97%) while a one-point increase in the real farm price index lowers the ratio of BAAC's loans in arrears by 1.3 percent (e.g., from 5% to 5 -5*0.013 = 4.94%).

The variables in the short-run dynamic equation (the first equation in the panel) are first differences of the log of the index of agricultural debt to farm income, the sum of the real reference borrowing rates, and real farm price and the ecm term. Quarterly growth in the ratio of agricultural loans in arrears varies positively with quarterly growth of the debt-to-farm-income ratio and the sum of quarterly changes in real borrowing rates, but varies negatively with quarterly changes in real farm price. The time subscript of the ECM term reflects the annual schedule of BAAC loan repayment.

The presence of the ratio of debt to farm income captures partially the effect of unpredictable climate changes and natural disasters such as storms, floods, drought, and epidemics, which are a staple of the agricultural sector. Negative supply shocks that

lower farm income increase the debt-to-farm-income ratio, raising the probability of agricultural households falling into arrears.[15]

Overall, the estimated model fits reasonably well given the shortcomings of data. We can use the model to explain both the increase in the ratio of loans in arrears after the crisis and its recent decline. The main culprits for the former are the rise in the real interest rates and the collapse in real GDP (which proxy domestic demand) while the main culprits for the latter have been rising real farm price and real GDP and low interest rates.

One way to improve the fit of the model is to focus on loans to farmers only. The BAAC loan figures that we employ in our analysis include as well loans to agricultural cooperatives, farmer associations, government-secured loan projects, Village Fund accounts, discounted bills, and other miscellaneous items, all of which are likely to respond differently to the explanatory variables.

Working with loans to farmers instead of total loans also has another advantage. From the point of view of BAAC management, ratios of farmer loans in arrears are the most relevant to the risk profile of the bank. These are the bulk of BAAC loans (a little above 80%). The second largest component (about 10% of BAAC's total loans), loans to government-secured loan projects, are virtually risk-free.

3.3 Applications

The econometric results confirm our conjecture in Section 2 that recent developments in the agricultural sector have been a boon to agricultural household debt sustainability. With farm income rising faster than the stock of debt and real borrowing rates falling, agricultural households' debt service capacity has increased, lowering their probability of falling into arrears. Meanwhile, rising real purchasing power of agricultural households means these households have more to spend as their disposal. All of these developments have more than offset the effect of the increased stock of debt and lowered agricultural households' probability of falling into arrears and made lenders like BAAC less vulnerable to future shocks.

The short-term outlook going forward likely remains supportive to agricultural household debt situation. Recent data indicate that BAAC credit growth has begun to

[15] We would like to note that BAAC typically institutes policies such as grace period for loan repayment with lost interest compensated by the government to help farmers who experience output losses due to the occurrence of natural disasters. Such policy in effect dampens the impact of natural disasters on agricultural household loans in arrears.

stall, which given positive inflation rates means that the stock of real debt is poised to fall. Furthermore, with both farm price and farm income expected to continue rising, albeit at slower rates, the ratio of agricultural debt to farm income will likely fall further. The only negative factor in the immediate horizon is the rise in the real borrowing rate. Nevertheless, because interests on BAAC's loans are paid annually, the impact of rising real interest rates on BAAC's loans in arrears will not be fully felt until the middle of next year. In fact, our model predicts that BAAC's ratios of loans in arrears at the end of fiscal year 2006 (March 2007) will be below 5% (see also Figure 8 near the end of this subsection).

Yet the rosy short-term outlook is not time for complacency. Several observers have cautioned that the upward trend in real farm price will sooner or later reverse its course. Mean reversion, agricultural price cycle, and a slowdown of the world economy are among the cited reasons behind future fall in real farm price. If such prediction turns out to be true, the tide will turn against agricultural households' capacity to service their debt.

One way to assess the impact of a fall in farm price on agricultural household debt sustainability is to conduct a stress testing exercise. Originally developed as a risk management tool for financial institutions, stress testing is a generic term describing various techniques used by these institutions to measure potential losses of their portfolios or business units as a result of a shift in risk factors (exchange rates, interest rates, equity prices, or in our case, property prices, etc.). Broadly speaking, stress testing can be divided into two types on the basis of the number of risk factors involved (BIS, 2001). A sensitivity stress test involves a move in a single risk factor while a scenario stress test concerns simultaneous moves in a number of risk factors. Stress testing differs from conventional sensitivity and scenario analyses in that it only deals with exceptional but plausible (tail-end) events.

Stress testing the vulnerability of financial institutions has now become a key element of macroprudential analysis. A number of central banks and financial regulators around the world routinely use stress tests to monitor and anticipate potential vulnerabilities in their financial system. The IMF's Financial Sector Assessment Program (FSAP) requires, with varying degrees of complexity, stress testing of financial institutions's resilience to macroeconomic shocks. Examples of stress tests used by regulators include Frayland and Larsen (Norges Bank, 2002), Hoggarth and Whitley

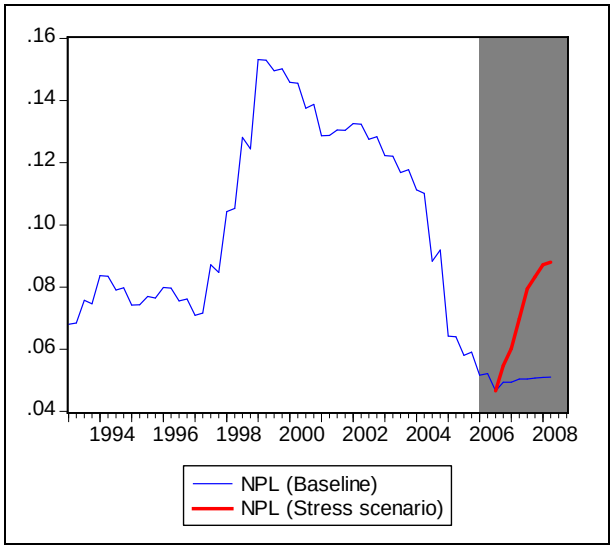
(Bank of England, 2003), Esho (APRA, 2003), and Kanchanasai, Nakornthab , and Piamchol (Bank Of Thailand, 2004).

A realistic stress testing exercise requires a sound factor model that links elements of expected loss (the probability of default and the loss given default) to relevant risk factors. In the absence of detailed loss data, factor models of nonperforming loans/loans in arrears are still nonetheless useful. We believe that the model we have developed in this paper can serve such a purpose.

Looking at the historical behavior of real farm price, an exceptional but plausible scenario would be a one-year 20% fall in real farm price similar to the one that happened between 1998 and 1999 (see figure 5).

Figure 8 trace out the dynamic forecasts of the ratio of BAAC's loans in arrears from 2006 Q2 to 2008 Q2 under two different scenarios. In both scenarios, the real stock of debt and the real reference rate is assumed to remain at the actual 2006 Q2 levels and real GDP from 2006 Q3 onward is assumed to grow at an annual rate of 5%. The difference between the two scenarios lies on the assumption of future farm price. In the baseline scenario, both real farm price and the debt-to-farm-income ratio are assumed to stay at their 2006 Q2 levels. In the "stress" scenario, real farm price is assumed to drop linearly by a total 20% between 2006 Q3 and 2007 Q3 and remain unchanged thereafter. Because the decline in real farm price indirectly raises the debt-to-farm-income ratio, we assume the latter to rise by 25% from 2006 Q3 to 2007 Q2 before stabilizing. Feeding these assumptions into our model results in the ratio of BAAC's loans in arrears of nearly 9% in 2008 Q2.

Figure 8 Dynamic forecasts of BAAC's loans in arrears ratios, 2006 Q2- 2008 Q2



How detrimental would such an increase in loans in arrears be to agricultural households and BAAC requires knowledge of agricultural households' financial statements and those of BAAC, respectively. Conducting a full stress test is beyond the scope of this paper however. Thus we simply outline how to proceed from here.

If one wants to know the impact of a fall in farm price on agricultural households, one would need to construct pro forma balance sheet and income statement of a representative agricultural household. Information on agricultural households' balance sheets will be available in the 2006 NSO survey data due for release in 2007. The hypothetical income statement of agricultural households on the other hand can be constructed with a knowledge of farm and non-farm income and expenses of these households.

To see whether BAAC can withstand the rise in the ratio of loans in arrears following the shock in real farm price is perhaps easier. BAAC's financial statements are already available in its annual report so one does not have to make many assumptions regarding certain information. One can then proceed along the line of Karnchanasai, Nakornthab, and Piamchol (2004) who assessed the impact of a hypothetical fall in house price on capital positions of Thai commercial banks.

4. Conclusions

The rise in household debt in recent years has raised eyebrows of many observers. This paper finds that, despite substantial increases in the stock of debt per agricultural household, Thailand's agricultural household debt situation as of 2006 Q2 was at its best in the past twelve years. The ratio of agricultural credit to agricultural GDP, the index of BAAC credit to farm income, and the ratio of BAAC's loans in arrears were at their lowest levels since the start of our study period in 1994 Q1, thanks to buoyant farm prices and the low interest rate environment.

Yet we do not think that policymakers should be complacent, for there are several caveats in order. First, BAAC's definition of loans in arrears understates the risk profile of the bank. Second, with respect to agricultural households, agricultural credit from BAAC and commercial banks is only a part, though an overwhelming major one, of total agricultural household debt. Third, despite recent improvements, agricultural households still bear a higher debt burden than an average household. Fourth, as we have seen from the empirical model, agricultural household loans in arrears are highly dependent on farm

price. A dramatic fall in farm price will again put the agricultural debt situation under a severe pressure.

The good news is that, according to the BOT internal forecast and the IMF's world commodity price projections, the chance of a dramatic fall in farm price in an immediate horizon is remote. Thus, the next couple years represent an opportunity to strengthen Thailand's agricultural household debt sustainability. For BAAC, the priority should be to make the definition of loans in arrears reflective of actual risks. In addition, an effective risk management platform will be crucial to BAAC's long-run financial viability. In this respect, we commend BAAC's recent strengthening up of the bank's risk management capabilities and urge the bank to keep on its progress on this front. As for a broader set of policies, agricultural household debt situation, particularly agricultural households' debt service capacity, should be closely monitored. To smooth fluctuations in farm income, the government should concentrate on measures like water resource management and crop diversification and may also want to consider crop insurance and/or index-based weather insurance schemes rather than direct market intervention. Finally, the results in this paper suggest promotion of off-farm work to reduce agricultural households' dependence on farm price. All of these measures will not eliminate the risk of agricultural households falling into arrears, but their adoption will go a long way towards reducing it.

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Appendix A Data description and sources

Variable	Description
Agricultural household loans in arrears ratio	BAAC's total loans in arrears divided by BAAC's total loans
Real agricultural debt	BAAC's total loans deflated by headline CPI
The index of agricultural debt to farm income	BAAC's total loans divided by four-quarter moving average of the farm income index in the same quarter, rebased to 1995=100
Real farm income	The farm income index deflated by headline CPI
Real farm price	The (combined) farm price index deflated by headline CPI
Agricultural terms of trade	Agricultural GDP deflator divided by nonagricultural GDP deflator multiplied by 100
Real borrowing rates	Nominal reference rates deflated by four-quarter ahead headline inflation
Real GDP	Official real GDP figures

All data except for BAAC's loans in arrears and reference rates (BAAC annual reports) and national income account data (NESDB) are taken from the Bank of Thailand's website.