FARM INVESTMENT AND OFF-FARM INCOME

A STUDY OF FARMS IN ALABAMA

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THESIS ABSTRACT

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This thesis examines the effect of availability of internal finance, net farm income, and net off-farm household income on farm investment. It presents a detailed review of previous studies, develops and estimates an empirical model of farm investment using annual data from the Alabama Farm Analysis Database. The results show that the effect of internal finance on farm investment is positive and statistically significant for the whole sample. Net farm income also has a positive and significant effect on farm investment. Moreover, the results indicate that the more income farm households earned from off-farm business, the more likely they were to invest it in the farm business. Finally, farm investment of financially constrained farms was more

sensitive to the availability of internal finance than that of financially unconstrained farms. Internal finance has a significantly stronger effect on investment among smaller farms than among larger farms.

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CHAPTER I: INTRODUCTION

The future of an industry is determined by the level of investment of individual firms. In particular, fixed investment is important and has attracted much attention. A common methodology in the research on fixed investment is to analyze firm investment behavior focusing on the availability of investment capital and by incorporating financial constraints considerations (e.g. Fazzari *et al.,* 1988). Some empirical studies on fixed investment focus on the impact of capital market imperfections and document heterogeneity in the investment behavior between firms that financial constrained and firms that are financially less constrained (e.g. Fazzari *et al.*, 1988; Whited, 1992). The others emphasize the impact of uncertainty on investment and analyze different channels through which uncertainty may affect investment (e.g. Leahy and Whited, 1996; Guiso and Parigi, 1999). The main conclusion is that investment is sensitive to availability of internal finance, and that it is affected by imperfections in the capital market.

Many studies have discussed macro and microeconomic views of investment in different countries and firms but there is a lack of analysis focused on farms. Using annual data from 1997 to 2004 of about 150 farms in Alabama, this paper aims to examine the effect of internal finance availability, net farm income, and net non farm income of a farm household on farm investment.

The rest of the paper is organized as follows. The next section of the paper briefly surveys the empirical issues raised in the investment literature, the main factors affecting farm investment, and the linkages between internal finance and investment. Chapter III presents the empirical specification of the investment equations and discusses methodological issues. Chapter IV describes the data used. Chapter V is the core of the paper, where empirical results are presented both for the full sample and for groups of farms partitioned according to farm size. The conclusions of the paper with remarks on possible future research are summarized in the final chapter VI. Some additional empirical tests are presented in data appendix.

CHAPTER II: MOTIVATION AND RELATED LITERATURE

Since farms are very different from firms, reviewing the factors that affect farm investment is a key step towards understanding and explaining the model of farm investment specified and estimated in this thesis. This section reviews the research on issues that may affect farm investment and, thus, were used in the development of the empirical model.

A. FARM HOUSEHOLD INCOME

According to the report of the U.S. Department of Agriculture (USDA), most farms in the United States (98 percent in 2003) are family farms. They are organized as proprietorships, partnerships, or family corporations. Early in the 20th century, farmers and their families did little off-farm work because the cost of such participation was prohibitive (Mishra *et al.*, 2002). Most farm families relied on farming as their primary and usually sole source of income.

Agriculture in the United States changed dramatically during the 20th century. Today, it is rare for any household to receive all of its income from a single source, hold all its wealth in the form of a single asset, or use all its assets in just one activity. Multiple motives prompt households and individuals to diversify assets, incomes and activities. It is necessary to understand the components of income and distinguish between alternative income sources in order to appreciate farm household differences, monitor the sensitivity of farm household income to economic events and evaluate the effectiveness of farm policy in supporting farm investment.

1. Sources of Farm Household Income

Farm household income originates from both farm and off-farm sources and includes farm and off-farm income. Net farm income includes farm rental income, net income from cash sales (livestock, crops, machinery, building, and equipment), inventory change, home consumption (livestock, crops), government payment, and returns from farm machinery custom work. Off-farm income includes income from off-farm businesses (such as a machinery repair shop, seed agency, or insurance agency), labor earnings from farm custom work, wages and salaries (farm operator, spouse, and other family member), pensions, social security, non-farm business income, royalties, interest (income from interest includes the interest income from savings and investment accounts, bonds, treasury bills), dividends (dividends earned by the household are from investment in equities, such as stocks or mutual funds), and rental income from non-farm properties.

Off-farm income and non-farm business opportunities have become increasingly important in many agricultural areas in recent years. In fact, non-farm income sources have dominated net farm income in the USA for many years (income from farming in the USA, measured by net farm cash income, was $ 55.7 billion in 1999, as compared to 124 billion (USDA, 2001). Mishra *et al.* (2000) find that when all farms are considered, 92% of total household income came from non-farm sources. However, these figures depend on the definition of a farm. For example, in large and very large commercial farms, the share of farm income in total household income ranges from 50 to 75%. In their survey, these authors find that more than half of all U.S. farm operators work off-farm, with 80 percent of these working full-time jobs. Nearly half of all spouses were also employed off the farm. Off-farm work is no longer viewed as a transitional position between the agricultural and the industrial economy, but as a lifestyle choice, with farming as a second job or investment. Their results also show that farm household income is relatively stable. Fluctuation in farm output, commodity prices, and business cycles, along with macroeconomic policies all contribute to the variability in farm income. Since these factors are beyond any farmer's control, many farm households have relied successfully on off-farm income to stabilize their total household income.

In another study, Mishra *et al*. (2002) confirmed their previous findings that the farm business as a source of income is playing an increasingly smaller role in determining the well-being of farm households with nearly 90 percent of total farm household income in the U.S in 1999 originated from off-farm sources. This study finds that the contribution of earned income (off-farm) alone amounted to 53 percent of total farm household income. The study also concluded that even for farms located in rural areas, off-farm income is still the dominant source of household earnings. Income and wealth of farm households based on the location of the farm follow a similar pattern: those households in or near a metro area tend to be significantly better off than non-metro households. Farm households in metro areas depend heavily on off-farm income (95 percent of total income). Through their off-farm work, these households can invest in both farm and non-farm assets. These facts are evidence of how important off-farm income has become to the majority of farm households in this country.

Studies carried out in many other countries also confirm that a fairly large share of household income was earned off-farm (Bryceson and Jamal, 1997), recognize the importance of off-farm income to the welfare of rural households (Rosenzweig 1988), and find a strong positive relation between non-farm income share and total household income and, therefore, an even more pronounced relationship between the level of non-farm income and total income (Reardon, 1997). A study by Castagnini, Menon, and Perali (2004) suggests that the economic situation and standard of living of farm households cannot be adequately described by on-farm income alone. Ahearn and Lee (1991) suggest that to reduce income risks and raise total income, farm families have turned to off-farm work to supplement farm household income. Hazell *et al.* (1991), find that off-farm income was somehow positively correlated with farm income. Field surveys across many developing countries performed by Jacoby (1993), Newman and Gertler (1994) show that between one third and one half of farm households derive income from off-farm sources.

It has become widely accepted in both academic and policy researches that rural off-farm activities make up a significant component of rural livelihoods. The hypothesis explored here is that rural off-farm income is important for agricultural development as it may help households to overcome cash constraints when making farm investments. This view, if accurate, would be very important for the future of the agricultural sector and especially for small producers.

Farm and off-farm employment and their contribution to farm household income have also attracted attention. Many farm households are dual-career, holding off-farm jobs as well as farming (Hoppe, 2001). This is most obvious on residential/lifestyle farms, but is also true to a lesser extent on large and very large farms. According to the USDA, about 44 percent of all farm households were dual-career in 2003, with a spouse working off the farm and the principal operator engaged in farming (with or without off-farm work). Mishra and Goodwin (1997) find a positive correlation between off-farm employment and farm income variability, as farm income variability increases, farm families seek off-farm employment (as a source of income) to reduce the variance in their household income. El-Osta *et al.* (1995) find that the distribution of income among farm households with no off-farm employment to be more concentrated than the distribution of income among farm households with off-farm employment. Schultz (1999) notes that off-farm employment was an important means by which farm households can manage risk through diversification of income sources. Mishra and Goodwin (2002) confirm the important role of off-farm employment as an avenue for managing the financial risks faced by farmers.

A number of studies have also considered various demographic factors relevant to participation in off-farm labor markets, including age, household size, experience, and the presence of small children in the household.

2. Uses of Farm Household Income

Mishra *et al.* (2002) find that even though the living standards of farm families have become comparable to those of non-farm families, farm households appear to manage expenditures differently from non-farm households in several ways. Farm households spend the majority of their income on food and household supplies, followed by household rent/mortgage and other household expenditures such as clothing, education, recreation, hobbies, and charitable contributions. The study also concluded that consumption expenditures of farm households are lower than for all U.S. households. Farm household expenditures appear to be lower than non-farm household expenditures, even when the analysis controlled for differences in income, age, location, and size of farm. According to the USDA, mean (or average) farm-operator household income in 2003 was $68,500 or 16 percent greater than the mean for all U.S. households. Considering that the mean income may not be the best choice for comparison because a few very-high-income households can raise the mean well above the income earned by most households, authors also used the medians rather than means, and reported that median farm-operator household income in 2003 was $47,620 or 10 percent greater than the median for all U.S. households. Since almost half of farm households have both higher incomes and greater wealth than U.S. households as a whole but spend less on household consumption, it is reasonable to suppose that perhaps part of the income goes to support the farming business.

Only two types of households, those operating limited-resource or retirement farms, received median household income below the U.S. median. Associated with the considerable rise in total farm household income in recent years have been a rise in expenditures (on goods and services) and a rise in savings and/or investments. Income not used for consumption is available for savings and other investment opportunities both on and off the farm. Savings can be used to finance unexpected future needs in agriculture, retirement income, or unexpected health expenditures. Mishra and Morehart (1998) investigate factors affecting farm household savings, especially the important role of farm income uncertainty. They find that the marginal propensity to save (MPS) for farm households was 0.81, while average propensity to save (APS) for their sample of U.S. farm households was 0.45. An MPS higher than an APS ensures a high degree of responsiveness of savings to disposable income changes.

B. FARM INVESTMENT

Farm investment is financed with profits, household savings as well as reinvestment of capital gains and dividend from capital market investments. According to Mishra *et al.* (2002), investment by individual farmers/farm households will have important implications for their financial well-being, the availability of venture capital for economic development of rural areas, and the competitiveness of financial institutions in rural areas. The authors suggest farmers/managers need to carefully consider their investment (both farm and off-farm) portfolios because many of their financial decisions have ramifications for liquidity, retirement, solvency, taxation, and profitability management. There has been limited research focusing on factors affecting investment in farm assets or type of farm investments. LaDue, Miller, and Kwiatkowski (1991), in a survey of New York producers, find that gross income and age had a positive and negative significant effect, respectively, on farm reinvestments. Mishra and Morehart (2000) compare the savings and off-farm investment behavior of farm households with the behavior of non-farm households; the result is that farm households have a higher savings rate. They maintain a diverse off-farm investment portfolio, and contribute to various retirement and tax-deferred plans.

Non-farm assets and investment also affect the farm business. Crisostomo and Featherstone (1990) suggest that adding high-risk financial assets with expected higher returns can reduce the overall risk associated with farm investment. Schnitkey and Lee (1996) contend that stocks and bonds reduce the variability in farmland returns more effectively than lower return Treasury bills, and that a risk-efficient portfolio should not have more than 50 percent of its value invested in farmland. In another study, Gustafson and Chama identified the types of financial assets held by North Dakota farmers. They found that most respondents invested in liquid, low-risk financial assets such as savings and checking accounts and certificates of deposit. In addition, approximately 31% of producers held investments in mutual funds, common stocks and bonds. Lanjouw (2001) argue that rural off-farm income may have the potential to assist in raising households' farm investment. This suggestion will be further explored in the thesis.

C. INVESTMENT AND FINANCIAL CONSTRAINTS

The pioneering work of Fazzari, Hubbard, and Petersen (1988) examines the importance of financing constraints. The authors separate a sample of US firms into sub-samples based on the dividend payout behavior. Dividends are assumed to relate to financial constraints. The hypothesis is that lower dividends indicate higher financing constraints. The results show larger impact of cash flow on investment for firms with low dividends, which confirms the hypothesis. Other studies have replicated and extended this approach. However, the success of this approach depends critically on the interpretation of cash flow coefficients, which have been the main focus of many studies. One of the most well known problems is that cash flow may imply investment opportunity, so the estimated effects may arise from expectation factors, rather than reflecting liquidity effects. To mitigate the problem it is necessary to use forward-looking variables in the closed form investment equations, but since variables (for example the expected value of future cash flows) are not available in practice, they have been approximated by changes in sales, stock prices, and Tobin's Q (for capital investment).

Devereux and Schiantarelli (1990) examine a set of UK firms to see whether different cash flow investment sensitivities are found in sub-samples based on proxies for agency costs of external capital. The proxies are firm size (capital stock and employees), the number of years since initial quotation, and the industry (growing or declining). The investments of large firms, newly listed firms and firms in growth sectors exhibit higher cash flow sensitivities.

Oliner and Rudebusch (1992) interact the cash flow coefficient in an investment regression model with proxies for information asymmetry (firm age, listing at exchange, and stock trades by insiders), agency costs (insider shareholdings and ownership concentration) and transaction costs (firm size). They also include the dividend yield for comparison with Fazzari, Hubbard and Petersen (1988). Although the individual interaction terms are insignificant for the set of US firms, a compound measure of information asymmetry is significant and yields the predicted positive effect. The authors conclude that information problems worsen financial constraints. Chirinko and Schaller (1995) examine Canadian firms, and define sub-samples based on age (years of inclusion in a financial database), concentration of ownership, industry (manufacturing and others), and group or independent. The results show that the cash flow constraints are most relevant for young firms, firms with dispersed ownership, independent firms and manufacturers.

Kadapakkam, Kumar and Riddick (1998) study six OECD (Organization for Economic Cooperation and Development, an organization of industrial countries that encourages trade and economic growth) countries including France, Germany, US, UK, Canada and Japan. They define sub-samples based on firm size. The results show that the cash flow investment sensitivity is highest in the sample of large firms. This difference is most obvious and strongly expressed in the US and UK. For France, Germany and Canada, the results also show significant differences between the sub-samples in most analyses. For Japan, the difference is insignificant in several analyses. However, in their study, firm size is only one criterion that may be important in explaining cash flow investment sensitivity. Gugler (1998) analyzes Austrian investment spending and corporate governance. He empirically investigates whether the validity of the asymmetric information problem and managerial discretion problem depends on the ownership structure of the firms. His findings suggest that investment of bank-controlled firms is not positively related to cash flow. Asymmetric information problems prevail in family-owned firms, while overinvestment is more prominent in state-controlled firms and pyramidal groups. Haid and Weigand (1998) focus on investment spending and corporate governance in Germany. Using sample splits, they report that liquidity positively affects investments in owner-controlled firms, while management controlled firms show no cash flow investment dependency.

Van Ees and Garretsen (1994) study a sample of Dutch firms over the period 1984-1990. The authors define sub-samples based on the dividend payout ratio, the year of the initial public listing, size (fixed assets) and interlocking directorates with banks. They find that the cash flow investment sensitivity is significantly positive in Dutch firms. Interlocks with banks are found to reduce the cash flow constraints. Firms with ties to banks have a significantly lower impact of cash flow on investment. Van Ees and Garretsen (1994) conclude that bank relations reduce the asymmetric information problem in Dutch firms.

Carpenter, Fazzari and Peterson (1995) estimate within-firm regressions for a standard inventory stock adjustment model augmented with financial variables on quarterly firm-level panel data. They find strong support for the existence of financing constraints due to adverse selection and moral hazard problems in debt and equity markets generated as a result of asymmetric information between firms and potential suppliers of external finance. They predict that investment depends primarily of internal funds because of limited availability of debt.

D. CAPITAL MARKET IMPERFECTION

In the absence of capital market imperfections, finance and investment decisions can be separated completely. This implies among other things that external and internal funds are interchangeable for all purposes or that any particular type of investment can be financed by every financial source. Since Fazzari, Hubbard and Petersen (1988), there has been a substantial empirical literature showing a significantly positive influence of cash-flow on firms' investment spending. This so called "investment cash flow sensitivity" has been explained by financial constraints. Firms simply cannot invest whenever profitable opportunity arise. When markets are imperfect some firms do not have access to external funds. Types and levels of investment spending can only be realized by internally generated cash flows. Hence there is a wedge between the price of internal and external finance. The literature has explained these financial constraints by pointing to capital market imperfections. In capital markets without imperfections, no systematic relationship is predicted between cash flow availability and investment expenditures. Investments should take place whenever they are expected to realize a positive net present value and should not necessarily be linked to cash flow.

Financing constraints due to asymmetric information problems in the issuance of equity cause the cash flow investment dependence. Stiglitz and Weiss (1981), and Greenwald, Stiglitz and Weiss (1984) obtain similar results for debt. Myers and Majluf (1984) argue that asymmetric information can cause firms being rationed in the issuance of equity. A number of empirical studies test for asymmetric information problems. Building on Fazzari, Hubbard and Petersen (1988), these studies apply a sample split based on a priori criterion of asymmetric information. The results show that the impact of cash flow on investment is larger for firms with higher information asymmetries (Oliner and Rudebusch (1992), Schaller (1993), Gilchrist and Himmelberg (1995) and Kadapakkam, Kumar and Riddick (1998)). Asymmetric information in debt financing may increase the cost of new debt or restrict firms from borrowing due to credit rationing (Stiglitz and Weiss, 1984). The reason is that lenders do not know how the money they lend is being invested. For instance, increasing the interest rate may induce firms with valuable projects to drop out (adverse selection). Thus, asymmetric information may hinder firms with growth opportunities. Firms then only invest when internally generated funds are available stemming from equilibrium credit rationing by providers of external funds. This results in a positive dependence between cash flow and investment. There is a large theoretical literature on capital market imperfections which argues that external funds (debt and new equity finance) are a more costly substitute for internally generated funds (cash flow), and hence firms face a “hierarchy” of finance (Myers (1984)).

CHAPTER III: EMPERICAL MODEL AND THE FINAL SPECIFICATION

1. Conceptual model:

The general statement of the reduced-form investment equations that have been applied in previous studies is:

$$(I/K)_{i,t} = f(X/K)_{i,t} + g(CF/K)_{i,t} + u_{i,t}$$

where *I* is the investment in fixed assets for firm *i* at time *t* ; *X* represents a vector of variables that have been identified as determinant of investment from a variety of theoretical perspectives; *u* is the error term and *u* is assumed to be normally distributed. The function *g*(.) depends on the firm's internal funds or cash flow; it represents the "sensitivity" of investment to available internal finance, after investment opportunities are controlled for through the variables in *X*. All variables are divided by the beginning-of-period capital stock *K*.

Cash flow is defined in the literature as current revenues minus expenses and taxes, and is used as the proxy of changes in net worth. The most appropriate measure for investment opportunity (IO) is the expectation of the present value of future profits from additional capital investment. In the neoclassical theory of the choice of capital stock, this expectation is measured by marginal *q*, the shadow value to the firm of an additional unit of physical capital (Hubbard, 1998).

The farm investment conceptual model follows the existing literature is:

Farm Investment= F (Change in Sales, Net farm income, Net non-farm income, Z_1*)* **(1)**

where change in sales proxies for investment opportunity. Z_1 is the vector of variables that may influence farm investment. Unlike in previous studies, farm income is divided into net farm income and net non farm income to account for the fact that family farms receive income form sources other than the farms. This model allows testing the main hypothesis that farms may use off-farm sources to fund their farm investment. Given the literature suggest that farming families spend less on consumption but are richer than the average household, it is important to find out if the off-farm income is being used for farm investment.

2. Empirical model:

The empirical model is constructed as follows: Total farm investment in period t ($I_{i,t}$) is modeled as a function of the change in sales ($\Delta Sales_{i,t}$), current net farm income ($NFI_{i,t}$), lagged net farm income ($NFI_{i,t-1}$), current net non-farm income ($NNFI_{i,t}$), lagged net non-farm income ($NNFI_{i,t-1}$), return on farm assets (AVGROA, STDROA), farm size (TA, TA2), solvency measure (SOLVENCY), dummy year (D97-D04), dummy industry (D30-D100) and $\varepsilon_{i,t}$ is random error term, $\varepsilon_{i,t}$ is normally distribution with zero mean and a constant variance.

For farm *i* at time *t* (measured in years): (2)

$$I_{i,t} = \beta_i + \beta_1 \Delta Sales_{i,t} + \beta_2 NFI_{i,t} + \beta_3 NFI_{i,t-1} + \beta_4 NNFI_{i,t} + \beta_5 NNFI_{i,t-1} + \beta_6 AVGROA_{i,t} + \beta_7 STDROA_{i,t} + \beta_8 TA_{i,t} + \beta_9 (TA_{i,t})^2 + \beta_{10} SOLVENCY_{i,t} + \beta_{11-18} DYEAR + \beta_{19-27} DINDUSTRY + \varepsilon_{i,t} \quad \textbf{(2)}$$

where *i* indicates farm *i* and *t* indicates time.

Because sales and internal finance (net farm income, net non-farm income) may be highly collinear, the variable change in sales ($\Delta Sales_{i,t}$) is used as the proxy of investment opportunity. The net farm income and net non-farm income terms in equation (2) are the main focus of this study. The first variable ($\Delta Sales_{i,t}$) and the rest of the variables are selected based on what the literature suggest may also influence farm investment. Equation (2) allows testing the importance of internal finance after controlling for the accelerator (sales) and other possibly important controls. Given that this equation is specified in levels and there are large differences between the farms in terms of size, all the main variables used are scaled by the farm total assets to control for heteroskedasticity.

The aim of estimating this model is to see whether the internal finance of a farm has an effect on farm investment in general and the particular interest is the role of off-farm income as a source of funds used for on-farm investment. Another goal of this analysis is to see whether there is difference in the investment of small and large farms. In particular, it is important to find out if only small farms (with less than $250,000 in sales as defined by USDA) use their off-farm income to invest in farming or if this is also true for large commercial farms. For that purpose, equation (2) is estimated for two sub-samples – small farms (farms with sales less than $250,000) and large farms with annual sales more than $250,000.

Detailed description of the data and definitions of the variables used in the analysis are presented in the following section, while the section on empirical results describes estimation procedures and the tests performed to identify the best empirical model.

CHAPTER IV: DATA

Data come from Alabama Farm Analysis Database. The database contains 8 consecutive years of data. The observations which have missing values on the key variables used in the regressions were deleted. The panel is unbalanced, consists of 1060 observations and covers the period 1997-2004. The CPI (consumer price index) is used to convert the data into constant 2004 dollars. Since farms in the sample of Alabama Farm Analysis Database are likely to be different than the average farm in Alabama, this section begins with a comparison of the characteristics of the sample with the characteristics of the average farm in Alabama and proceeds to describe the variables used in the empirical model.

A. A COMPARISON OF FARMS FROM THE ALABAMA FARM ANALYSIS DATABASE AND THE AVERGAE ALABAMA FARM

Table 1: Summary statistics of some financial indicators for farms in the sample and Alabama's farms:

Year	Number of farms in sample	Number of farms in Alabama	Net farm income (sample)	Net farm income (Alabama)	Sales (sample)	Sales (Alabama)
1997	118	49,000	64,022	22,052	309,117	65,671
1998	113	49,000	26,501	24,064	303,772	67,229
1999	121	48,000	63,689	29,449	262,418	70,875
2000	127	47,000	33,952	24,740	245,038	67,752
2001	135	46,000	39,399	36,061	234,461	75,175
2002	148	45,000	-5,081	26,086	215,861	64,892
2003	148	45,000	84,093	35,748	230,250	78,766
2004	158	44,000	36,127	46,794	237,686	92,591
Year	**Total assets (sample)**	**Total assets (Alabama)**	**Debt/Assets (sample) percent**	**Debt/assets (Alabama) percent**	**ROA (sample) percent**	**ROA (Alabama) percent**
1997	1,241,859	294,200	31	11.5	8.77	7.31
1998	1,253,471	303,224	28.1	12.1	7.53	9.40
1999	1,034,383	328,613	29.8	12.1	8.82	12.02
2000	1,197,407	351,516	29.3	12.4	7.92	7.40
2001	1,145,739	373,926	31.6	12.6	9.77	7.91
2002	991,610	398,206	37.9	12.8	7.18	5.42
2003	1,129,495	420,388	32.3	12.5	9.49	8.95
2004	1,245,321	N/A	35.1	N/A	10.34	N/A

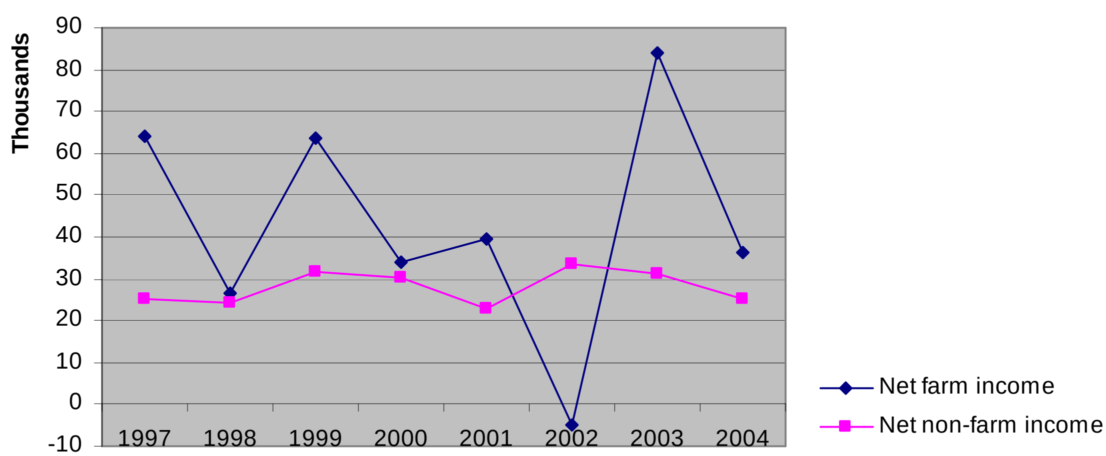
Source: National Agricultural Statistics Service (NASS); Economic Research Service/USDA; Alabama Farm Analysis Database.

The number of farms in the sample is small compared to the large number of farms in the state of Alabama. With about 130 observations for each year during the period 1997-2004, the farms analysis account for only 0.3% of the total number of farms in state of Alabama. Compared to the average total assets of about $300-400,000 for the average farm in Alabama, the average farm in the sample is larger, with average total assets of $1.1 million. The sales volume of farms in the sample is about 4-5 times bigger than the average volume of sales of farms in Alabama, suggesting that the farms in the sample depend more on agricultural activity than do farms not included in the analysis. Net farm income for Alabama's farms has increased gradually during the period without big fluctuation compared to a lot of fluctuations in this variable in the Alabama Farm

Analysis Database. Farms in the sample are also much more leveraged than the average farm in the state - the ratio of farm's total debt to total assets from farm analysis is much higher than Alabama's farms as a whole. The proportions of total farm liabilities to total farm assets of farms from the sample is more than 30% compared to 12% for Alabama's farms. This means farms in the sample use greater external finance source to invest in farms and for those farms which do not have access to external funds, then their investment may be dependent on internally available cash flows. The rate of return on asset is almost the same for farm analysis and for Alabama's farms as a whole.

B. OVERVIEW OF THE FARMS IN THE SAMPLE:

Figure 1: Graph of average net farm income and net non-farm income of the sample during the examined period:

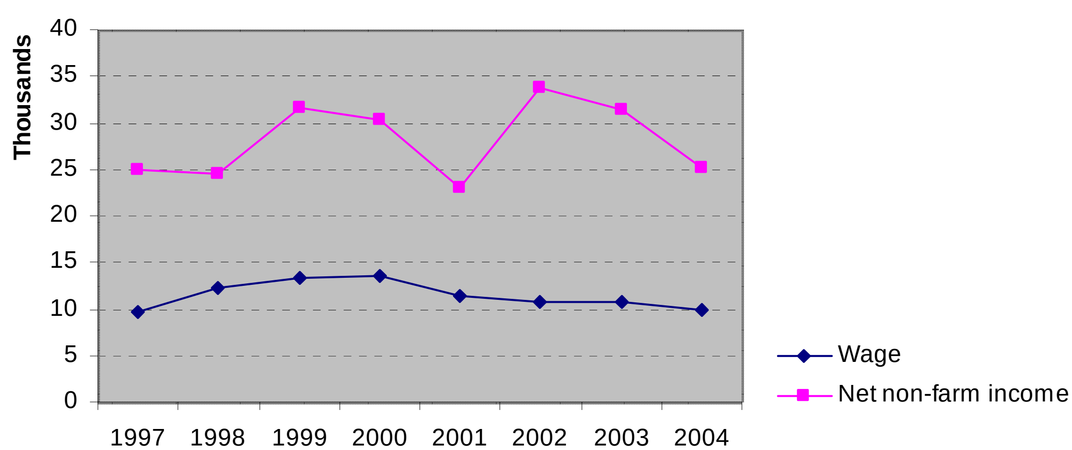


Source: Alabama Farm Analysis Database

The average net farm income of a farm household shows significant fluctuation during the study period from 1997 to 2004. The average net farm income was at a very high level in 1997 with the value of $64,022. In 1998, it fell to the average value of $26,501. In 2002, the average net farm income even has negative value of $ 5,081. The average net farm income of a farm in the sample peaked at $84,093 in 2003.

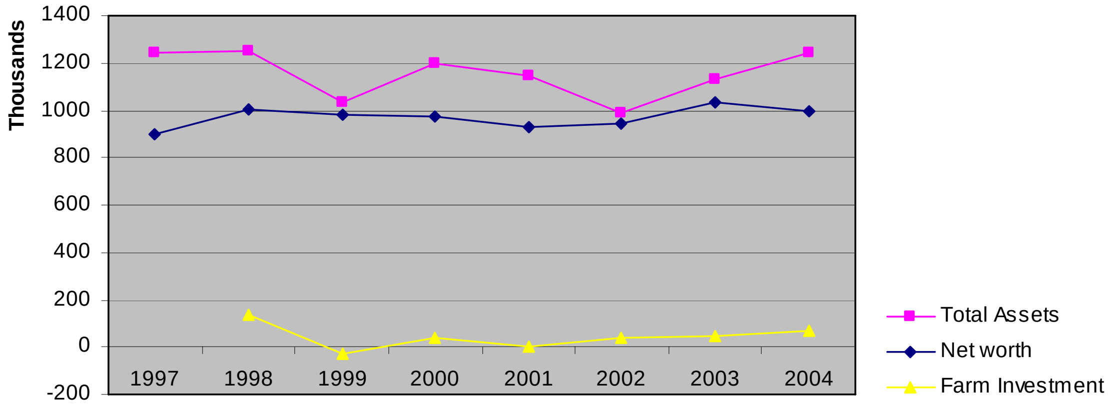
Off-farm income plays an important role in the total income of farm households in the sample. It accounts for a large percentage in total household income. During this time, the average off-farm income of a farm household has fluctuated around $29,000. In 2002, average off-farm income in the sample has increased to the peak of $ 33,735. In the components of off-farm income of farm in the analysis, wages account for the largest percentage and the average wage has fluctuated around $12,000. Other non-farm income also accounts for a significant portion of total off-farm income; it has increased over time from 1997 to 2004 and has reached the highest point of $15,236.

Figure 2: Graph of average net non- farm income and wage of the sample during the examined period:



Source: Alabama Farm Analysis Database.

Figure 3: Graph of average farm household's total assets, net worth and farm investment of the sample during the examined period:



Source: Alabama Farm Analysis Database.

For farms in the sample, liquid assets of the average farm households consist primarily of checking accounts and savings deposits. Data show that total assets of an average farm household in the sample have fluctuated around $ 1.1 million in the period of 1997- 2004. The average level of investment is rather small compared to the level of farm's total assets.

C. SUMMARY STATISTICS AND DEFINITION OF THE VARAIBALE USED IN THE REGRESSION ANALYSIS

Table 2: Key Statistics of Variables used in Regressions Analysis

Variable	Mean	Standard Deviation	Minimum	Maximum
Total Assets	1,164,783	1,170,645	1,204.5	8,638,882
Sales	251,263.5	385,208.9	0	4,201,605
Net farm income	42,791.37	132,823.8	-893,662	894,094.4
Net non-farm income	28,127.91	56,544.73	-470,249	470,000
Investment	42,698.9	398,383.1	-4,370,748	4,151,636
Investment(t)/ Total Assets(t-1)	.067	.415	-.976	6.347
Δ Sales(t)/ Total Assets(t-1)	-.018	1.402	-14.037	11.336
Net Farm Income(t)/ Total Assets(t-1)	.167	1.504	-1.037	19.781
Net non-farm Income(t)/ Total Assets(t-1)	.058	.642	-.477	18.272
solvency	.321	.365	-.0006	7.022

Definition of variables used in the regressions:

Dependent Variable:

Investment (I): investment on farm's fixed asset and intermediate asset, including investment on farm real estate- bare land and building, machinery and equipment, and breeding livestock. It is defined as the change in farm's investment capital in fixed assets and intermediate assets: $I_t = K_t - K_{t-1}$; with K is investment capital on farm's fixed asset and intermediate asset. The change is calculated by subtracting last period capital from capital in the current period.

Independent Variables:

Change in Sales ($\Delta Sales$): Total sales is defined as the sum of total crop sales, market livestock sales, breeding livestock sales and the value of consumed livestock products, i.e., milk and eggs. The change is calculated by subtracting last period sales from sales in the current period.

Net Farm Income (*NFI*): comes directly off of the accrual income statement and is calculated by matching farm revenues with the expenses incurred to create those revenues, plus the gain or loss on the sale of farm capital assets.

Lagged Net Farm Income ($NFI_{i,t-1}$): Net farm income of the previous year.

Net Non-farm income ($NNFI_{i,t}$): comes directly off of the income statement and is defined as sum of net sources of income from all non-farm businesses.

Lagged Net Non-farm income ($NNFI_{i,t-1}$): net non-farm income of the previous year.

Solvency measures variable: measures the amount of borrowed capital used by the farm relative the amount of farm's equity capital invested in farming business. Solvency used in this paper to see whether farm's ability to withstand risks will affect investment in farm. Solvency is concerned with long-term as well as short-term assets and liabilities. It is defined by the ratio of farm's total debt to total assets. This ratio expresses total farm liabilities as a proportion of total farm assets, the higher the ratio, the greater the risk exposure of the farm.

Rate of return on farm assets (*ROA*): A measure of farm profitability. The ROA measures the return to all farm assets and is used as a proxy of farm profitability, the higher the value of ROA, the more profitable the farm business.

Dummy Industry (*DINDUSTRY)*: Data used the SPR (Soil Productivity Rating) to separate farms. Dummy variables for farm sectors are set up based on the code used in the data.

Variables	Definition of Variables
D30	Whether farm produces Cotton, 1 yes, 0 no
D35	Whether farm produces Cotton and Peanuts, 1 yes, 0 no
D40	Whether farm produces Peanuts, 1 yes, 0 no
D50	Whether farm is Contract Broilers, 1 yes, 0 no
D60	Whether farm produces Cow-Calf, 1 yes, 0 no
D70	Whether farm produces Catfish, 1 yes, 0 no
D90	Whether farm produces Dairy, 1 yes, 0 no
D99	Whether farm produces Feeding Livestock, 1 yes, 0 no
D100	Whether farm produces Corn and Soybeans, 1 yes, 0 no

Dummy Year (*DYEAR*): Dummy variables for year are set up for every year; cover the examined period 1997-2004.

Variables	Definition of Variables
D97	Whether year is 1997, 1 yes, 0 no
D98	Whether year is 1998, 1 yes, 0 no
D99	Whether year is 1999, 1 yes, 0 no
D00	Whether year is 2000, 1 yes, 0 no
D01	Whether year is 2001, 1 yes, 0 no
D02	Whether year is 2002, 1 yes, 0 no
D03	Whether year is 2003, 1 yes, 0 no
D04	Whether year is 2004, 1 yes, 0 no

Farm size variables: (based on farm's total assets)

TA (Total Assets): farm's total assets.

TA2 (Total Assets squared): quadratic farm's total assets.

The definition of “small farm” developed by the National Commission on Small Farms is used to separate farms (based on farm’s gross sales). The gross sales of $250,000 is the cutoff between small and large farms. Farms with less than $250,000 of gross sales (in 2004 dollars) are placed into the small farm size class.

Correlations matrix of explanatory variables: (see Appendix)

Correlation is a measure of the relation between two or more variables. It is one of the most common and most useful statistics. The correlation matrix of explanatory variables shows that there are some positive relationships between the main variables used in the model but these relationships are not very strong. For net farm income and net non-farm income variables, the correlation is 0.50; for lagged net farm income and lagged net non-farm income variables, the correlation is 0.51.

CHAPTER V: RESULTS

The results are set out in Tables 3 and 4. Table 3 reports the results of estimating several specifications for farm investment using the whole sample. F-test was performed to test several joint exclusion restrictions and identify the best model among these specifications. All the specifications were tested for heteroskedasticity and multicollinearity. Firstly, the Breusch-Pagan/Cook-Weisberg test was used to test for heteroskedsticity. The null hypothesis states that the regression analysis is homoskedasticity and the alternative is that there is heteroskedasticity. All the specifications show very high Chi-square. The probabilities of all the functions being greater than the Chi-square are nearly zero. This implies that the models suffer from heteroskedasticity. Therefore, the null hypothesis is rejected. Heteroskedasticty is corrected for and all specifications are re-estimated with robust (Huber-White) standard errors.

These heteroskedasticity-robust results are set out in Table 3.

Table 3: OLS Regression analysis of fixed investment, using alternative specifications:

	(1)	(2)	(3)	(4)	(5)	(6)
ΔSales	0.571	0.554	0.551	0.548	0.548	0.542
	(2.07)**	(1.99)**	(1.98)**	(1.96)*	(1.97)**	(2.14)**
NFI	0.381	0.356	0.359	0.341	0.350	0.178
	(2.08)**	(1.99)**	(1.99)**	(1.88)*	(1.92)*	(0.94)
Lagged NFI	-0.046	0.012	0.013	-0.012	0.004	
	(0.26)	(0.07)	(0.08)	(0.07)	(0.03)	
NNFI	0.618	0.671	0.635	0.459	0.662	0.782
	(2.58)**	(2.78)***	(2.56)**	(1.93)*	(2.65)***	(1.32)
Lagged NNFI	0.005	-0.067	-0.067	-0.035	-0.057	
	(0.02)	(0.34)	(0.34)	(0.18)	(0.29)	
AVGROA	0.006	-0.002	-0.001	-0.001		
	(1.16)	(1.16)	(0.88)	(0.52)		
STDROA	-0.001	0.000	-0.000	-0.000		
	(1.49)	(0.17)	(0.05)	(0.06)		
TA	8.02e-08	7.12e-08	6.68e-08		6.56e-08	6.29e-08
	(2.37)**	(2.31)**	(2.16)**		(2.16)**	(1.98)**
TA2	-7.49e-15	-5.89e-15	-5.46e-15		-5.57e-15	-3.06e-15
	(1.41)	(1.23)	(1.15)		(1.19)	(0.61)
solvency	0.040	0.054				
	(0.61)	(0.84)				
D1997	0.000					
	(.)					
D1998	0.000					
	(.)					
D1999	0.031					
	(0.30)					
D2000	0.061					
	(0.55)					
D2001	0.035					
	(0.33)					
D2002	0.092					
	(0.82)					
D2003	0.017					
	(0.17)					
D30(Cotton)	0.000					
	(.)					
D35(C&P)	-0.211					
	(1.51)					
D40(Peanut)	-0.158					
	(1.34)					
D50(CBroi)	-0.181					
	(1.56)					
D60(Cow)	-0.113					
	(1.43)					
D70(Catfish	-0.304					
	(2.59)***					
D90(Dairy)	0.000					
	(.)					
D99(F-Live)	-0.151					
	(1.42)					

	(1)	(2)	(3)	(4)	(5)	(6)
D2004	0.137					
	(1.22)					
D100(C&S)	-0.155					
	(1.57)					
Constant		-0.081	-0.060	0.023	-0.070	-0.057
		(2.10)**	(1.69)*	(1.51)	(1.94)*	(1.18)
Observations	623	623	623	623	623	793
R-squared	0.36	0.32	0.32	0.30	0.32	0.23
F- statistic	F= 14.50	F= 28.82	F= 31.83	F= 37.86	F= 40.67	F= 47.57

Robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

The investment model in the first specification contains the industry dummy and year dummy variables to see the effect of individual farm's sector and individual year on investment. The first column reports the regression analysis with all dummies included but without intercept. This specification can also be estimated with a regression analysis in which the dummies for year 2004 (D2004) and for corn and soybeans sector (D100) serve as a base and to be excluded. In the second specification, all industry dummy and year dummy variables were dropped. The results in column (2) report the regression analysis without the dummies. An F-test was performed to determine whether or not it is important to include the industry and year dummy variables. The null hypothesis states that the sector characteristics and year characteristics are jointly equal to zero and the alternative states that individual industry dummy and year dummy variables are not jointly equal to zero. The results show that individual industry and year are jointly equal to zero and thus should not be included in the farm investment equation. [1]

[1] The F-test statistic is calculated as follows:
F-test = [R^2 (full model) - R^2 (reduced model)]/ (1-R^2) * (n-k-1)/q , where n is the number of observations, n-k-1 is the degrees of freedom, q is the number of restrictions, the f-calculation then is:
F-test = (0.1156 – 0.1024)/ (1-0.1156) * (623-22-1)/17 or F-test = 0.0149 * 35.294 = 0.53.
The critical F (17, 600) is 1.60. Since F < critical F, we fail to reject the null hypothesis.

The difference between the second and the third specification is that the later one does not contain the solvency variable. F-test is performed to study whether the solvency variable should be included. F-value is 0.71, compared to the critical F value of 6.63, thus the solvency variable should not be included in the specification.

F-test is also performed to determine whether or not it is important to include the size and the size of the farm squared. The results of the two specifications are set out in column (3) and (4). The null hypothesis states that farm size and quadratic farm size variables are jointly equal to zero and the alternative states that farm size and quadratic farm size variables are not jointly equal to zero. The unrestricted model is estimated and test command is used to do the F-test. The calculated F-value is 4.66, while the critical F-value is 4.61. Since the estimated F-value is larger than the critical F, the null hypothesis is rejected. These two variables should be included in the model, they are important factors in the farm investment equation.

The difference between the two specifications in column (3) and (5) is that the later one does not contain the average mean of return on farm assets for sector and average standard deviation return on farm assets for sector variables. F-test is performed to determine whether the average mean of return on farm assets for sector and average standard deviation return on farm assets for sector variables have a jointly significant effect on farm investment. The null hypothesis states that these two variables are jointly equal to zero and the alternative states that they are not jointly equal to zero. Results indicate that the null hypothesis cannot be rejected.[2] This implies that the return on farms

[2] The calculated F-value is 0.91 and the critical F value is 4.61. Thus F-value < critical F.

assets for farm sector variables are jointly equal to zero, and that these two indicators of return on farm assets for sector should not be included in the model.

The difference between the fifth and the sixth specification is that the later one does not contain the lagged net farm income and lagged net non farm income variables. That means the later model assume that internal finance of the previous year does not affect farm investment of the current year. An F-test is performed to determine whether or not it is important to include the lagged internal finance variables. The null hypothesis states that the lagged net farm income and lagged net non farm income are jointly equal to zero and the alternative states that these two variables are not jointly equal to zero. Results permit rejecting the null in favor of including the lagged values of net incomes. [3]

The best model identified after testing is:

$$I_{i,t} = \beta_i + \beta_1 \Delta Sales_{i,t} + \beta_2 NFI_{i,t} + \beta_3 NFI_{i,t-1} + \beta_4 NNFI_{i,t} + \beta_5 NNFI_{i,t-1} + \beta_6 TA_{i,t} + \beta_7 (TA_{i,t})^2 + \varepsilon_{i,t}$$

where fixed farm investment in period t is modeled as a function of the current change in sales, current net farm income, lagged net farm income, current net non-farm income, lagged net non-farm income, farm size and quadratic size variables. The fifth column of Table 3 reports the results of this model. The results indicate that the estimated coefficient for the current sales growth is highly positively significant, indicating an accelerator effect. The effect of change in sales on farm investment is 0.548 points for one point increase in the change of sales variable.

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[3] The F-value is calculated to be 16.96 and the Critical F (2, 615) is 4.61. F-value > critical F, therefore the null hypothesis is rejected.

Internal finance is found to be important in the investment equation. Current net farm income has a positive and significant effect on farm investment. Internal finance and fixed investment are annual data and are scaled by farm's total asset, on average, a single annual increase of one unit in the ratio of net farm income to farm's total assets will lead to an increase of 0.35 units in the ratio of fixed investment to total farm's assets. The effect of lagged net farm income on farm investment is 0.004 points, but this effect is not significant. The estimated coefficient for the net non-farm income is also positive and significant. The effect of current net non-farm income on farm investment is very strong, with the value of 0.662 points. On average, an annual increase of one unit in the ratio of net non-farm income to farm's total assets will lead to an increase of 0.662 unit in the ratio of fixed investment to total farm's assets. The result shows the important role of off-farm income in farm business. Farm households in the sample use a large percentage of their income from off-farm business to invest on farms; it seems the more they earn from off-farm business the more likely they are to invest in the farm business. The finding is inconsistent with the idea that farm households reduce their investment on farm when they earn more from the off-farm business. Lagged net non-farm income is not statistically significant in the on farm investment equation.

Farm size (farm's total assets) has a positive sign and TA2 (quadratic size) has a negative sign in the estimated equation. This variable seems to have concave functional form - after a point it has a diminishing impact effect on farm investment. This implies that farm households will decide to stop investing in the farm at some specified level. The estimated R-squared is 0.32, this suggest that 32% of the variation in the sample is explained by the model.

The sample is small compared to the more than 45,000 farms in state of Alabama. Nevertheless, the findings help explain how so many small farms in Alabama continue to exist although the average operating profit margins and average rates of return on assets and equity are negative. Small-farm households and even large-farm households receive substantial off-farm income and do not rely primarily on farm income for their livelihood or as the only source of investment in the farm.

The result is consistent with the report of the U.S. Department of Agriculture that over the past fifty years, the non-farm rural economy has grown in importance as more and more farmers have become increasingly dependent on off-farm income. For the majority of U.S. farm households, the availability of off-farm income is a more significant factor for the financial well-being of the farm. Usually, the increases in off-farm income were more than sufficient to compensate for declines in farm income. Off-farm income from the spouse and/or the farm operator supports the farm. With the existence of financial constraints, market imperfection, limited availability of debt, farm operator uses off-farm income to invest on farm instead of looking for external finance from banks.

In many empirical studies, firm size has been used as an indicator of whether or not a firm is more likely to be financially constrained. For example, Carpenter *et al.* use firm size in their work using US firm data, and Devereux and Schiantarelli (1990) use it in their work on financial effects and fixed investment using data on UK firms. The basic idea is that, in general, larger firms have access to a wider range of suppliers of finance than smaller firms, and as a consequence larger firms are less likely to be financially constrained than smaller firms.

To see whether it is only the investment of financially constrained farms which is affected by the availability of internal finance and off-farm income, the final specification is applied to two types of farms. USDA classifies farm size based on the volume of sales—more than $250,000 and less than $250,000. This classification is used to separate the farms. The results are set out in Table 4. The results in the first column relate to the sub-sample which is defined as large farm (farms with more than $250,000 of gross sales, in 2004 dollars).

Table 4: Results of regression analysis of the two sub-samples:

	Large Farms	**Small Farms**
ΔSales	0.080	0.601
	(1.73)*	(16.84)***
Net farm income	0.134	0.205
	(1.84)*	(1.70)*
Lagged net farm income	0.211	0.631
	(4.00)***	(5.37)***
Net non-farm income	0.384	0.741
	(2.77)***	(4.33)***
Lagged net non-farm income	0.214	0.109
	(2.96)***	(5.76)***
Total assets	5.79e-08	1.13e-07
	(2.42)**	(4.36)***
Total assets squared	-3.91e-15	-1.63e-14
	(1.12)	(3.57)***
Constant	-0.079	-0.182
	(1.79)*	(4.28)***
Observations	354	269
R-squared	0.15	0.31
F-value	F (7, 346)= 7.40	F(7, 261)= 25.07

Absolute value of t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Tests for Models:

To see whether the investment equation for these two groups should be estimated jointly or together a Chow test is performed. The null hypothesis is that the two groups (small farms and large farms) follow the same regression function and there are no differences at all between the groups. The alternative states that there is one or more of the slopes differ across the groups. Results indicate that there is a difference between the groups.[4] The model should be applied separately for the small farms and large farms.

There are indeed big differences between the estimates of two sub-samples. The effect of change in sales is much stronger for the farms classified as small farms, 0.601 percent points compares to 0.08 points effect for large farms. This implies that the accelerator effect is very important for investment of small farms. The main differences between the analyses for two groups, which are also the main focus of this paper, are the coefficients on net farm income and on net non-farm income. Among the farms defined as unconstrained, the coefficient on current net farm income variable is positive and significant, and the magnitude of net farm income on farm investment for large farms is 0.134 points, compared to a significantly larger magnitude of for small farms of 0.205 points. The effect of lagged net farm income on investment of small farms is also stronger with the level of 0.631 points compares to the level of 0.211 points for large farms. The coefficients on lagged net farm income variable are significant and positive

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[4] The F-test statistic is calculated as follows:
F-test= [SSR (full model) - (SSR1+SSR2)]/ (SSR1+SSR2) * [n-2(k+1)]/ (k+1);
SSR1: the sum of squared residuals obtained from estimating for the large farms; this involves 354 observations. SSR2: the sum of squared residuals obtained from estimating the model using the small farms (269 observations); n= number of observations.
Then F-test = [49.84 – (14.26+18.27)/ (14.26+18.27) * [623- 2(7+1)]/ (7+1)= 39.68
and the critical F (7, 623) = 2.64; F-value > critical F, therefore the null hypothesis is rejected.

for the two sub-samples. Net non-farm income also has strong effect on investment of both large farms and small farms. The effect of current net non-farm income on farm investment of the large farms accounts for only 0.384 points, smaller than that of small farms which accounts for 0.741 points. The effect of lagged net non-farm income is 0.214 points for large farms and 0.109 points for small farms.

These findings are consistent with many empirical works on firms' financial constraint. They found that although the effect of internal finance on fixed investment was concentrated among firms defined as financially constrained by their financial policy, internal finance still had a positive effect on the fixed investment of unconstrained firms. The results suggest that the investment of financially constrained farms is more sensitive to the availability of internal finance than that of financially unconstrained farms. Net farm income and net non-farm income both have significantly larger effect on farm investment among smaller farms than among larger farms. This is consistent with what Carpenter *et al.* and Gertler and Gilchrist (1994) report for the United States. They both found that the investment in smaller firms was more sensitive to current cash flow than investment in larger firms. The conclusion is that large farms have easier access to external finance than small farms.

The F statistic for the model with large farms is 7.40, with small farms is 25.07, which are higher than the critical values, suggesting all the variables are jointly different from zero in both cases.

These models were tested for the presence of potential problems such as multicollinearity, heteroskedasticity, and specification or omitted variables error. The Breusch-Pagan/Cook-Weisberg test was used to test for heteroskedsticity in the analysis of small farms and large farms. The null hypothesis states that the variance of the residuals is homogenous and the alternative is that it has problem of heteroskedasticity. The Chi-squared statistic for the Breusch-Pagan test for the model is 0.17 for large farms group, which is well below the critical value. Therefore, it can be concluded that heteroskedasticity is not a problem in this model. For small farms the The Chi-square is equal to 0.62 and the p-value of 0.4306. Therefore, the null hypothesis cannot be rejected and the regression analysis for small farms does not have a problem of heteroskedasticity.

Multicollinearity was assessed in the specifications using the variance inflation factor (VIF). The mean VIFs confirms that multicollinearity is not a problem of all the regressions. (see Appendix). Lastly, specification error and omitted variables bias was tested for using the Ramsey RESET test in both sub-samples. The null hypothesis states that the model does not have specification error and the alternative is that the model does have specification error. The F-test for the Ramsey RESET in group of large farms was calculated to be 3.27, p-value is 0.0214, and thus, the null hypothesis cannot be rejected. Therefore, it can be concluded that for the large farms, the model does not have specification error. In group of small farms, F-value is rather high, to be 7.43, p-value is 0.0005, which may be acceptable. For the RESET test, the lower the F-statistic is, the more certain it can be concluded that specification error or omitted variables test is not a problem. For the group of small farms, it is not highly certain that these problems cannot be proven to exist in the model. Maybe there are still some other factors which have effect on investment of the small farms in this sample. Since the quality of demographic variables available in the dataset is very poor, these factors cannot be included in the analysis. The limitations of this paper come from poor data quality since this is a small sample, unbalanced panel data, a lot of missing values in the sample, thus further improvement cannot be performed. Future work can refine the model with better data.

CHAPTER VI: CONCLUSIONS

This paper tries to give a general view of finance and investment of the sample of about 150 farms in Alabama during the period of 1997-2004. Using annual farm data, the paper has examined the relationship between farm investment and internal finance, the effect of net farm income and net non-farm income on farm investment, and in particular whether the effect of cash flow on farm investment is concentrated among farms that are more likely to be financially constrained.

Firstly, the finding shows that the effect of internal finance on farm investment is positive and significant for the whole sample; net farm income has a positive and significant effect on farm investment. Secondly, in contrast to studies of other businesses, farm households used a large percentage of their income from off-farm business to invest in the farming business. The finding shows that the more income a farm household earns from off-farm business the more likely it is to invest in the farm business. Thirdly, the results suggest that farm investment of financially constrained farms is more sensitive to the availability of internal finance than that of financially unconstrained farms. Internal finance has a significantly stronger effect on investment among smaller farms than among larger farms. This is consistent with what Carpenter *et al.* and Gertler and Gilchrist (1994) report for the United States. They both found that the investment of smaller firms was more sensitive to current cash flow than the investment of larger firms.

However, the results obtained need to be viewed with the limitation of non-availability of more frequently data for farms, the small sample compared to the large number of 45,000 farms in state of Alabama and the unbalanced nature of the panel data.

REFERENCES

Ahearn, M., and J. E. Lee. “Multiple Job-Holding Among Farm Operator Households in the U.S.” Multiple JobHolding Among Farm Families (pp. 3-30). Ames, IA: Iowa State University Press. (1991).

Bryceson, D.F. and Jamal, V., “Farewell to Farms: De-Agrarianisation and Employment in Africa”, African Studies Centre Leiden, Research Series 1997/10.

Carpenter, Robert E., Fazzari, Steven M., Peterson Bruce C., “Three Financing Constraints Hypothesis and Inventory Investment: New Tests with Time and Sectoral Heterogeneity” Economics Working Papers archive, University of Washington, 1995.

Carpenter, Robert E.; Petersen, Bruce C., “Is the Growth of Small Firms Constrained by Internal Finance?”, Review of Economics and Statistics, v. 84, iss. 2, pp. 298-309, May 2002.

Castagnini Raffaella , Menon Martina and Perali Federico, “Extended and Full Incomes at the Household and Individual Level: An Application to Farm Households”, American Journal of Agricultural Economics, American Agricultural Economics Association, vol. 86(3), pages 730-736, 08, 2004.

Chirinko, R.S., and H. Schaller, “Why Does Liquidity Matter in Investment Equations?”, Journal of Money, Credit and Banking, 27 (2): 527-548,1995.

Crisostomo, M.F., and A.M. Featherstone, “A Portfolio Analysis of Returns to Farm Equity and Assets”, North Central Journal of Agricultural Economics 12, 1990.

Devereux, M. and F. Schiantarelli, “Investment, financial factors, and cash flow: Evidence from UK panel data” University of Chicago Press, pp. 279-306, 1990.

El-Osta, H.S., G. Bernat, and M.C. Ahearn, “Regional Differences in the Contribution of Off-Farm Work to Income Inequality”, Agricultural and Resource Economics Review, Vol. 24, 1995.

Fazzari, S, Hubbard, R and Petersen, B., “Financial constraints and corporate investment”, Brookings Papers on Economic Activity, No 1, pages 141-95, 1988.

Gilchrist, S. and C. Himmelberg, “Evidence on the Role of Cash Flow for Investment”, Journal of Monetary Economics 36, 1995.

Goodwin, Barry K.; Mishra, Ashok K., “An Analysis of Risk Premia in U.S. Farm-Level Interest Rates”, Agricultural Finance Review, v. 60, iss. 0, 2000.

Greenwald, B. C., Stiglitz, J. E. and Weiss, A., “Informational Imperfections in the Capital Market and Macroeconomic Fluctuations”, American Economic Review 74, 1984.

Greenwald, B. C. and Stiglitz, J. E., “Financial Market Imperfections and Business Cycles”, Quarterly Journal of Economics 108, 1993.

Gugler, K., “Investment spending in Austria: asymmetric information versus managerial discretion”, working paper University of Vienna, 1998

Guiso, L. and Parigi, G., “Investment and Demand Uncertainty”, Quarterly Journal of Economics, vol. 456, pp. 185–227, 1999.

Gustafson, C. R., and S. L. Chama, “Financial Assets Held by North Dakota Farmers”, J. Amer. Society Farm Mgrs.and Rural Appraisers 58,1994.

Haid, A. and J. Weigand, “R&D liquidity constraints, and corporate governance”, Working paper, Indiana University, 1998.

Hazell P., Haggblade, S., and J. Hammer, “Modelling Agricultural Growth Multipliers”, American Journal of Agricultural Economics, May, pp361-378, 1991.

Hoppe R.A. “Structural and Financial Characteristics of U.S. Farms:2001 Family Farm Report”, U.S Department of Agriculture, Economic Research Service, 2001.

Hubbard, R. Glenn, “Capital market imperfections and investment”, Journal of Economic Literature 36, p.193-227, 1998.

Jacoby, Hanan G., “Shadow Wages and Peasant Family Labour Supply: Application to the Peruvian Sierra”, Review of Economic Studies 60(4), October 1993, p. 903-21.

Kadapakkam, P., P. Kumar and L. Riddick, “The Impact of Cash Flows and Firm Size on Investment: The International Evidence”, Journal of Banking and Finance, 22, pp. 293-320,1998.

LaDue Eddy L., Miller Lynn H., Kwiatkowski Joseph H., “Investment Behavior and Farm Business Expansion”, Review of Agricultural Economics, Vol. 13, No. 1 ,Jan., 1991.

Lanjouw, Jean O.; Lanjouw, Peter , “The Rural Non-farm Sector: Issues and Evidence from Developing Countries”, Agricultural Economics, v. 26, iss. 1, October 2001.

Leahy, J.V. and Whited, T.M., “The Effect of Uncertainty on Investment: Some Stylized Facts”, Journal of Money, Credit, and Banking, vol. 28, pp. 64–83, 1996.

Oliner, S. D. and G. D. Rudebusch, “Sources of the Financing Hierarchy for Business Investment”, Review of Economics and Statistics 74(2), 1992.

Mishra, A.K., and M.J. Morehart, “Off-Farm Investment of Farm Households: A Logit Analysis”, Agricultural Finance Review, Vol. 61, No. 1, 2001.

Mishra, A.K., and M.J. Morehart, “Tax-Deferred Savings and Off-Farm Investment of Farm Households”, Proceedings of Regional Committee NC-221, Minneapolis, MN. Oct. 2-3, 2000.

Mishra, Ashok K., Holthausen, Duncan M., “Effect of Farm Income and Off-Farm Wage Variability on Off-Farm Labor Supply”, Agricultural and Resource Economics Review, v. 31, iss. 2, October 2002.

Mishra, A.K., and B.K. Goodwin, “Farm Income Variability and the Supply of Off-farm Labor”, American Journal of Agricultural Economics, Vol. 79, Aug. 1997.

Mishra, A.K., and C.L. Sandretto, “Stability of Farm Income and the Role of Nonfarm Income in U.S. Agriculture,” Review of Agricultural Economics. Vol. 24, No. 1, 2002.

Myers, S.C. and N. Majluf, “Corporate financing and investment decisions when firms have information that investors do not have”, Journal of Financial Economics 13, 187-221, 1984.

Newman, John L., and Paul J. Gertler, “Family Productivity, Labor Supply, and Welfare in a Low Income Country”, Journal of Human Resources 29(4), Fall 1994, P. 989-1026.

Reardon, Thomas, “Using Evidence of Household Income Diversification to Inform Study of the Rural Nonfarm Labor Market in Africa”, World Development 25(5), May 1997, p. 735-47.

Rosenzweig Mark R., “Risk, Implicit Contracts and the family in Rural Areas of Low-Income Countries”, Economic Journal, Dec 1988, v. 393, pp.1148-70.

Schaller, Huntley, “Asymmetric information, liquidity constraints, and Canadian Investment”, Canadian Journal of Economics 26: 552-574, 1993.

Schnitkey, G., and W. Lee., “Farmers Should Own More Financial Assets—Even if it Means Owning Less Land”, Regulatory, Efficiency, and Management Issues Affecting Rural Financial Markets, Proceedings of Regional Committee NC-207, Staff Paper SP-

0196, Dept. of Agricultural Economics and Rural Sociology, University of Arkansas, Fayetteville, AK, 1996.

Schultz, T. P., "Women's Role in the Agricultural Household: Bargaining and Human Capital", Center Discussion Paper No. 803, Economic Growth Center. New Haven: Yale University, 1999.

Stiglitz, J and Weiss, A., "Credit rationing in markets with imperfect information", American Economic Review, Vol 71, pages 393-410, 1981.

Van Ees, H. and H. Garretsen, "Liquidity and business investment: evidence from Dutch panel data", Journal of Macroeconomics 16, 613-627, 1994.

Whited, T.M., "Debt, Liquidity Constraints, and Corporate Investment: Evidence from Panel Data", Journal of Finance, vol. 47, pp. 1425–1460, 1992.

APPENDIX

Correlations matrix of explanatory variables:

	ChangeSales	NFI	laggedNFI	NNFI	laggedNNFI	AVGROA	STDROA
changeSales	1.0000						
NFI	-0.0007	1.0000					
P-value	0.9851						
laggedNFI	-0.0827	0.1302	1.0000				
P-value	0.0364	0.0010					
NNFI	0.2829	0.5064	0.0761	1.0000			
P-value	0.0000	0.0000	0.0543				
laggedNNFI	0.0307	0.0322	0.5112	0.2766	1.0000		
P-value	0.4379	0.4157	0.0000	0.0000			
AVGROA	0.0163	0.0942	0.0959	0.0378	0.0508	1.0000	
P-value	0.6385	0.0067	0.0149	0.2774	0.1974		
STDROA	0.0526	0.0373	0.0438	0.0614	0.0751	0.8115	1.0000
P-value	0.1299	0.2831	0.2663	0.0774	0.0564	0.0000	
TA	0.0137	-0.1015	-0.1085	-0.0598	-0.0525	0.0712	0.0752
P-value	0.6947	0.0035	0.0058	0.0852	0.1824	0.0206	0.0145
TA2	0.0052	-0.0477	-0.0523	-0.0300	-0.0217	0.0780	0.0594
P-value	0.8811	0.1701	0.1846	0.3879	0.5820	0.0112	0.0535
solvency	0.0754	0.0484	0.0158	0.0739	0.0631	0.2082	0.1226
P-value	0.0300	0.1641	0.6883	0.0335	0.1093	0.0000	0.0001
D1997	.	.	.	.	.	-0.0006	0.0123
P-value	1.0000	1.0000	1.0000	1.0000	1.0000	0.9850	0.6904
D1998	0.0072	-0.0396	.	-0.0148	.	-0.0359	0.0124
P-value	0.8349	0.2547	1.0000	0.6715	1.0000	0.2431	0.6861
D1999	-0.0850	0.0004	-0.0453	-0.0144	-0.0170	0.0008	0.0055
P-value	0.0143	0.9902	0.2503	0.6785	0.6663	0.9788	0.8594
D2000	0.0092	-0.0346	-0.0030	-0.0122	-0.0184	-0.0265	-0.0272
P-value	0.7915	0.3199	0.9391	0.7254	0.6411	0.3893	0.3778
D2001	-0.0125	0.0003	-0.0445	-0.0179	-0.0157	0.0307	0.0235
P-value	0.7199	0.9928	0.2588	0.6058	0.6908	0.3193	0.4459
D2002	-0.0066	0.0232	-0.0046	0.0889	-0.0221	-0.0519	-0.0053
P-value	0.8505	0.5042	0.9069	0.0105	0.5748	0.0918	0.8632

D2003	0.0725	0.0746	0.0175	-0.0168	0.0900	0.0231	-0.0042
P-value	0.0369	0.0317	0.6569	0.6298	0.0222	0.4535	0.8927
D2004	0.0062	-0.0296	0.0712	-0.0149	-0.0211	0.0535	-0.0145
P-value	0.8575	0.3955	0.0707	0.6682	0.5922	0.0821	0.6382
D30	0.0596	0.0162	0.0249	0.0694	0.0829	0.7710	0.9739
P-value	0.0863	0.6423	0.5286	0.0456	0.0351	0.0000	0.0000
D35	-0.0573	0.1298	0.1169	-0.0367	-0.0337	0.4099	-0.0280
P-value	0.0990	0.0002	0.0029	0.2919	0.3927	0.0000	0.3631
D40	-0.0035	-0.0190	-0.0157	-0.0132	-0.0110	-0.0617	-0.1229
P-value	0.9207	0.5856	0.6909	0.7051	0.7809	0.0448	0.0001
D50	0.0069	-0.0354	-0.0405	-0.0034	-0.0046	-0.1260	-0.2413
P-value	0.8428	0.3093	0.3048	0.9229	0.9068	0.0000	0.0000
D60	0.0029	-0.0408	-0.0469	0.0085	0.0062	-0.3758	-0.2411
P-value	0.9337	0.2406	0.2344	0.8072	0.8746	0.0000	0.0000
D70	0.0031	-0.0133	-0.0150	-0.0118	-0.0121	-0.0393	-0.1019
P-value	0.9293	0.7024	0.7029	0.7337	0.7580	0.2020	0.0009
D90	0.0098	-0.0344	-0.0357	-0.0181	-0.0221	-0.4197	-0.0215
P-value	0.7786	0.3235	0.3651	0.6035	0.5752	0.0000	0.4847
D99	0.0061	-0.0388	-0.0427	-0.0156	-0.0193	-0.2300	-0.2830
P-value	0.8612	0.2644	0.2790	0.6537	0.6247	0.0000	0.0000
D100	0.0041	-0.0159	-0.0186	0.0142	-0.0040	-0.1058	-0.0967
P-value	0.9052	0.6469	0.6374	0.6824	0.9200	0.0006	0.0016

	TA	TA2	solvency	D1997	D1998	D1999	D2000
TA	1.0000						
P-value							
TA2	0.9168	1.0000					
P-value	0.0000						
solvency	-0.1066	-0.0627	1.0000				
P-value	0.0005	0.0415					
D1997	-0.0259	-0.0341	-0.0110	1.0000			
P-value	0.4002	0.2678	0.7203				
D1998	0.0088	-0.0055	-0.0347	-0.1226	1.0000		
P-value	0.7759	0.8580	0.2598	0.0001			
D1999	0.0019	-0.0115	-0.0231	-0.1275	-0.1244	1.0000	
P-value	0.9517	0.7086	0.4529	0.0000	0.0001		
D2000	-0.0040	-0.0161	-0.0286	-0.1310	-0.1279	-0.1329	1.0000
P-value	0.8978	0.6010	0.3523	0.0000	0.0000	0.0000	

D2001	-0.0261	-0.0216	-0.0053	-0.1345	-0.1313	-0.1364	-0.1402
P-value	0.3968	0.4835	0.8628	0.0000	0.0000	0.0000	0.0000
D2002	-0.0057	0.0005	0.0587	-0.1385	-0.1352	-0.1405	-0.1444
P-value	0.8539	0.9872	0.0564	0.0000	0.0000	0.0000	0.0000
D2003	0.0239	0.0421	0.0014	-0.1425	-0.1391	-0.1445	-0.1485
P-value	0.4375	0.1717	0.9634	0.0000	0.0000	0.0000	0.0000
D2004	0.0237	0.0386	0.0343	-0.1486	-0.1450	-0.1507	-0.1549
P-value	0.4418	0.2094	0.2650	0.0000	0.0000	0.0000	0.0000
D30	0.0503	0.0398	0.1059	0.0542	0.0215	-0.0057	-0.0289
P-value	0.1020	0.1958	0.0006	0.0783	0.4843	0.8537	0.3472
D35	0.0620	0.0799	0.1518	-0.1530	-0.1073	0.0245	-0.0076
P-value	0.0438	0.0094	0.0000	0.0000	0.0005	0.4266	0.8061
D40	-0.0679	-0.0561	-0.0543	0.0387	0.1533	-0.0040	-0.0080
P-value	0.0273	0.0681	0.0775	0.2089	0.0000	0.8976	0.7958
D50	-0.0309	-0.0473	0.0627	-0.0237	-0.0475	-0.0079	-0.0141
P-value	0.3160	0.1245	0.0416	0.4421	0.1230	0.7964	0.6480
D60	-0.1269	-0.0872	-0.1627	-0.0200	-0.0560	-0.0482	-0.0066
P-value	0.0000	0.0045	0.0000	0.5153	0.0687	0.1173	0.8299
D70	0.1846	0.1320	-0.0001	-0.0024	0.0001	-0.0038	0.0296
P-value	0.0000	0.0000	0.9983	0.9391	0.9967	0.9018	0.3357
D90	0.0950	0.0343	-0.0758	-0.1114	0.0519	0.0532	0.0161
P-value	0.0020	0.2650	0.0137	0.0003	0.0920	0.0836	0.6004
D99	-0.0681	-0.0475	-0.0491	0.2328	0.0634	-0.0033	0.0782
P-value	0.0268	0.1231	0.1105	0.0000	0.0393	0.9136	0.0109
D100	-0.0297	-0.0348	-0.0303	-0.0540	-0.0527	-0.0548	-0.0563
P-value	0.3348	0.2578	0.3253	0.0791	0.0866	0.0749	0.0672

	D2001	D2002	D2003	D2004	D30	D35	D40
D2001	1.0000						
P-value							
D2002	-0.1482	1.0000					
P-value	0.0000						
D2003	-0.1525	-0.1570	1.0000				
P-value	0.0000	0.0000					
D2004	-0.1591	-0.1638	-0.1685	1.0000			
P-value	0.0000	0.0000	0.0000				
D30	0.0168	0.0150	-0.0230	-0.0427	1.0000		
P-value	0.5842	0.6259	0.4546	0.1658			

D35	0.0322	-0.0843	0.0970	0.1691	-0.1962	1.0000	
P-value	0.2950	0.0061	0.0016	0.0000	0.0000		
D40	-0.0247	-0.0287	-0.0572	-0.0504	-0.1065	-0.1011	1.0000
P-value	0.4231	0.3511	0.0629	0.1013	0.0005	0.0010	
D50	-0.0020	0.0348	0.0187	0.0326	-0.1634	-0.1552	-0.0842
P-value	0.9478	0.2579	0.5447	0.2895	0.0000	0.0000	0.0061
D60	0.0333	0.0319	0.0230	0.0317	-0.1955	-0.1856	-0.1008
P-value	0.2792	0.3005	0.4551	0.3032	0.0000	0.0000	0.0010
D70	0.0085	-0.0123	-0.0152	-0.0031	-0.0750	-0.0712	-0.0386
P-value	0.7833	0.6892	0.6211	0.9207	0.0148	0.0206	0.2093
D90	-0.0095	0.0138	0.0075	-0.0204	-0.1428	-0.1356	-0.0736
P-value	0.7574	0.6533	0.8067	0.5073	0.0000	0.0000	0.0167
D99	-0.0195	-0.1146	-0.0862	-0.1181	-0.2169	-0.2059	-0.1118
P-value	0.5257	0.0002	0.0050	0.0001	0.0000	0.0000	0.0003
D100	-0.0578	0.1091	0.1039	0.0430	-0.0693	-0.0658	-0.0357
P-value	0.0602	0.0004	0.0007	0.1627	0.0243	0.0325	0.2460

	D50	D60	D70	D90	D99	D100
D50	1.0000					
D60	-0.1546	1.0000				
P-value	0.0000					
D70	-0.0593	-0.0709	1.0000			
P-value	0.0539	0.0211				
D90	-0.1130	-0.1352	-0.0518	1.0000		
P-value	0.0002	0.0000	0.0921			
D99	-0.1715	-0.2052	-0.0787	-0.1499	1.0000	
P-value	0.0000	0.0000	0.0105	0.0000		
D100	-0.0548	-0.0656	-0.0251	-0.0479	-0.0727	1.0000
P-value	0.0749	0.0331	0.4141	0.1196	0.0180	

APPENDIX 2:

Results of the VIFs (variance inflation factor) for the test of multicollinearity:

As a rule of thumb, the variables whose VIF values are greater than 10 may merit futher investigation. Some variables in the specifications show rather high VIF but the means VIFs are less than 10 for all the specifications,indicating that multicollinearity is not a problem of the models.

. vif (specification 1)

Variable	VIF	1/VIF
STDROA	44.26	0.022596
AVGROA	30.22	0.033087
laggedNFI	20.17	0.049575
NNFI	19.67	0.050834
D35	18.62	0.053694
D50	8.86	0.112859
TA	8.67	0.115345
TA2	7.92	0.126296
D99	7.70	0.129813
D60	4.88	0.205095
D70	3.30	0.303309
D40	3.04	0.329478
D100	2.45	0.407495
D2004	2.07	0.483149
D2003	2.02	0.493882
D2002	1.95	0.513341
D2001	1.83	0.547384
D2000	1.76	0.568613
NNFITA1	1.37	0.730445
NFITA1	1.33	0.749259
solvency	1.23	0.810281
changeSales	1.11	0.904819
Mean VIF	8.84	

. vif (specification 2)

Variable	VIF	1/VIF
laggedNFI	18.30	0.054643

NNFI	17.90	0.055857
TA	7.69	0.130045
TA2	7.39	0.135365
AVGROA	3.13	0.319163
STDROA	2.84	0.352129
NNFI	1.30	0.769329
NFI	1.27	0.788124
solvency	1.17	0.852858
changeSales	1.06	0.939935
Mean VIF	6.21	

. vif (specification 3)

Variable	VIF	1/VIF
laggedNFI	18.30	0.054643
NNFI	17.90	0.055857
TA	7.69	0.130045
TA2	7.39	0.135365
AVGROA	3.13	0.319163
STDROA	2.84	0.352129
NNFI	1.30	0.769329
NFI	1.27	0.788124
solvency	1.17	0.852858
changeSales	1.06	0.939935
Mean VIF	6.21	

. vif (specification 4)

Variable	VIF	1/VIF
laggedNFI	18.30	0.054657
NNFI	17.90	0.055860
TA	7.54	0.132712
TA2	7.33	0.136409
AVGROA	2.88	0.347036
STDROA	2.75	0.363348
NNFI	1.27	0.787387
NFI	1.27	0.788619
changeSales	1.06	0.944608
Mean VIF	6.70	

```
. vif (specification 5)

    Variable |       VIF       1/VIF
-------------+----------------------
   laggedNFI |     18.02    0.055479
        NNFI |     17.63    0.056729
      AVGROA |      2.83    0.352834
      STDROA |      2.74    0.365026
         NFI |      1.26    0.792472
        NNFI |      1.19    0.836931
 changeSales |      1.06    0.945110
-------------+----------------------
    Mean VIF |      6.39

. vif (specification 6)

    Variable |       VIF       1/VIF
-------------+----------------------
   laggedNFI |     17.81    0.056143
        NNFI |     17.45    0.057314
         NFI |      1.24    0.806631
        NNFI |      1.17    0.852491
 changeSales |      1.05    0.949334
-------------+----------------------
    Mean VIF |      7.75
```