Occupation Choices and Education Investments: Unintended Effects of Microcredit

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Abstract

This paper demonstrates the existence of negative effects from microcredit on education outcomes. Among households that start a business as a result of the introduction of a microcredit lender, school enrollment for adolescents declines significantly. To understand the mechanisms driving this result, I develop and estimate a structural model of joint occupation and education choice with heterogeneous households that face frictions in the credit and labor market. Using data on the Thai Million Baht Village Fund program, I find that this quasi-experimental program induces increased self employment and decreased school enrollment among high productivity poor households, which has long-run implications for children's future wage earnings. Their decreased enrollment is offset at the aggregate level by increased enrollment by less productive households. I show in counterfactual simulations that the former can be mitigated by making loans conditional on continued school enrollment. However, such policies must be carefully designed to allow borrowing by ultra-poor households whose children are already out of school.

1 Introduction

Can microcredit do harm? Over the last 30 years, over US$78 billion of microcredit has been extended to households in the developing world[1]. Most of the loans are offered at below-market rates to the very poor who have few alternative credit sources, subsidized by governments, private organizations, or the philanthropic public. Alleviating or ameliorating a credit constraint should never decrease welfare if the original choice set remains available. However, microcredit may change the credit and labor markets sufficiently that options are removed, leaving some segments of the population worse off than before. My paper studies the effects of microcredit on education and occupation choices. I provide reduced form evidence of decreased enrollment among new entrepreneurs. I reproduce this disenrollment effect using a structural model and demonstrate the role of heterogeneity in causing and disguising it.

The key principles of microcredit - offering small loans to borrowers without collateral at reasonable interest rates - are derived as an answer to the well-documented problem of extremely high interest rates on small loans facing borrowers[2]. These interest rates make credit unaffordable or extremely expensive, limiting poor households' access to credit and contributing to the development of debt traps.[3] If microcredit relieves credit constraints facing some households then basic choice theory says they must be weakly better off than

[1] Banerjee, Karlan and Zinman (2015a)

[2] Banerjee et al. (2015a)

[3] Interest rates are particularly high on small loans to poorer borrowers; this has been variously attributed to the fixed costs associated with making a loan, risk of default on un-collateralized debt, and the lack of credit options. In traditional microcredit models, group loans and group liability, and the social pressure to repay that accompanied them, helped to mitigate the first two issues. Many of the first providers were non-profit organizations whose incentives differed from commercial banks or village lenders, which also contributed to lower interest rates. Microcredit lenders have since branched out from the original approach and begun offering individual loans and variations on repayment mechanisms. As a result, some groups' interest rates have crept up, and recently for-profit microcredit providers have entered the market. This has contributed to the shifting popular image of microcredit, from champions of the poor to a new incarnation of usurious money lenders(Banerjee et al. 2015a).

before. They can make choices that are closer to their unconstrained optima, and lose no options. However, the environment facing households may change sufficiently to remove previous options. Spillover or general equilibrium effects may cause some households to be worse off. Decisions by one generation of household decision-makers may harm the prospects of the next, resulting in within-household welfare transfers.

To demonstrate that microcredit affects education via occupation choice, I use the quasi-experimental nature of the Million Baht Village Fund (MBVF) program in Thailand. This program introduced an identical credit infusion to every village in Thailand regardless of village size. The credit increase per household therefore varies across villages. The program thus provides a plausibly exogenous shock to credit access.[4] I use it to show that households that start businesses due to the MBVF experience a decrease in the enrollment probability of teenagers. I propose a model of adult and teenage occupational choice and education decisions with credit and labor market frictions. I estimate this model structurally on pre-program data and validate it using post-program data. Through this dual approach, I establish the existence of effects on education via occupation choice and then quantify the roles of different mechanisms in causing it, as well as their relationship to household heterogeneity.

I develop and estimate a model of joint occupation and education choice by heterogeneous households. In this model, keeping a child in school is a labor supply decision as well as an investment decision. Households differ in their productivity, which affects wage earnings and business profits, as well as in their expected cost of schooling, wealth, and demographic composition. They allocate their adult and teenage members to occupations - wage work,

[4]The exact instrument is inverse village size post-2001, as the MBVF was announced in 2001 and implemented in 2001/2002. Village size prior to 2001 should have no impact on the effects of the program; indeed, this provides a useful test of the exclusion restriction, and is supported by results in Kaboski and Townsend (2012).

self employment, or school - and allocate savings to risk-free assets or business investment. A child in school earns nothing but may graduate as a skilled worker and be more productive in either occupation. A household's ability to optimize is limited by the presence of two frictions, in the credit and labor markets. The labor market friction increases the cost of hired, non-family workers relative to family workers, and hence lowers wages. This creates a preference for self employment over wage employment, and a preference for family labor relative to non-family workers[5]. When microcredit is introduced to this environment, it has several connected effects. First, the net cost of capital decreases, weakly increasing business ownership, and business size conditional on ownership. If labor and capital are complements in the household business's production function, this increases the labor demand of the household business and increases the opportunity cost of education. This may cause decreased schooling. Second, schooling may increase as a form of long-run business investment if skilled labor is more valuable than unskilled labor. Third, general equilibrium effects may cause changes in the wage function, which could increase the opportunity cost of schooling as well as increase the expected return to schooling. The net effect depends on the size of these three mechanisms, all of which are incorporated in my model.

I estimate the model using indirect inference, as proposed by Gourieroux, Monfort and Renault (1993). I estimate the model using only data from before the MBVF implementation to obtain structural parameters. I treat the MBVF as a structural break in the credit environment that changes the credit constraint. I then use the estimated parameters of my model to predict household behavior in this changed credit environment. I compare these predictions to observed data from after the MBVF implementation to validate my model. My model's ability to match observed household choices in the post-program environment

[5]The preference for family over hired labor is well-established in developing countries, and has been attributed to a number of factors, including limited observability of effort, weak contract enforcement laws, and misaligned incentives (Bardhan and Udry 1999).

acts as an out-of-sample validation test and gives the model increased plausibility. I obtain parameter estimates that allow me to quantify the size of each of the three effects discussed above, and thus identify through what channels the observed effects operate. Household heterogeneity allows for different mechanisms to dominate for different types of households. I additionally estimate the type shares in the population, and their differing productivities and education costs.

My model replicates observed household choices well, reproducing the increased borrowing and self-employment responses to the MBVF, as well as the insignificant changes in aggregate educational enrollment. Responses by household sub-group differ significantly. The increase in self-employment is driven by high productivity households starting enterprises: an additional 18 percent of these households own businesses after the change. They also experience a decrease in school enrollment, instead using their adolescent members as labor in the household firm. Enrollment in high productivity households declines by between 5.86 and 5.33 percentage points. These are large percentage changes: 23.16% in households that also have high educational ability, and 47.45% in households with low educational ability. This is balanced out in the aggregate by increases in schooling by households with high educational ability but low productivity, which experience an increase in enrollment of 14.09 percentage points (71.78%).[6] Within the model, skilled workers have wage earnings 8.45% higher than unskilled workers. Thus, withdrawing a child from school potentially decreases their earnings each period substantially. In practice, selection on potential earnings will influence which households do not invest in education, but this figure highlights the possible cost of early withdrawal.

I use the model to simulate household responses to policies designed to limit school withdrawal by adding enrollment conditions to loans. I find that similar rates of borrowing

[6] All these effects occur only for poorer households.

can be achieved without the negative enrollment effects requiring borrowing households to keep currently enrolled children in school. This contrasts with large decreases in borrowing if households must have all children enrolled in school. This reflects the prevalence of borrowing among particularly poor households, which are less likely to have adolescents in school even prior to microcredit. Among these poor households, the loans may act as valuable consumption smoothing tools. Overall income may not increase but consumption variability may decrease, so discouraging borrowing by such households may have large welfare costs.

Related Literature

The literature on the effects of microcredit is still relatively new. The effects of the program I study - the Thai Million Baht Village Fund (MBVF) - have been documented in several papers using a variety of methods.[7] Kaboski and Townsend (2012) use the quasi-experimental nature of the program to show that it significantly increased wages in both the short- and long-run, in addition to short-run increases in consumption and income growth. The paper finds increases in neither the rate of business start-ups nor business investment. I find increased start-ups among households which did not previously own a business, though not on aggregate. This links to the point made in Kaboski and Townsend (2011) - that borrowing behavior differs by household type - and expands it to occupation and education behavior in response to the program. These two papers are methodologically similar to mine, as I employ the same instrumental variable strategy used in Kaboski and

[7] The focus of this literature has been the nature of the financial system and insurance networks. However, there have been several papers related to entrepreneurship: Felkner and Townsend (2011); Jeong and Townsend (2007); Karaivanov (2012); Paulson and Townsend (2004); Paulson, Townsend and Karaivanov (2006); Samphantharak and Townsend (2012). These have all examined aspects of occupational choice unrelated to education. Buera, Kaboski and Shin (2014) looks at the wider implications of microcredit, including its distributional effects across households. I look at inter-generational redistribution effects within households.

Townsend (2012) and similar structural estimation techniques to Kaboski and Townsend (2011), but my paper focuses on households' joint occupation and education decisions, instead of their financial choices, and defines household heterogeneity over unobservable talents rather than wealth.

More similar to my paper is Lakdawala (2011), which examines the effects of the MBVF on child labor and household entrepreneurship. This paper shows reduced form evidence for increased use of child labor within household businesses and infers negative effects on education. I expand on these findings by demonstrating significant decreased school enrollment among newly entrepreneurial households and elucidate the causes by estimating my structural model. The negative socio-economic consequences of child labor typically arise from decreased schooling, not work itself, so it is important to find explicit evidence for schooling effects.[8] The key theoretical difference between our analyses is that Lakdawala (2011) assumes that all households that can afford to do so will engage in self-employment, while I allow for different optimal strategies across household types, as well as participation in both wage and self-employment. This better fits the data and incorporates the results of the literature on heterogeneous firm types.

Experimental evidence on the effects of microcredit is provided by the six papers in the American Economic Journal: Applied, Volume 7(1).[9] These papers use randomized con-

[8] Beegle, Dehejia and Gatti (2005), Beegle et al. (2008), Heady (2003)

[9] Angelucci, Karlan and Zinman (2015) in Mexico; Attanasio *et al* (2015) in Mongolia; Augsburg, De Haas, Harmgart and Meghir (2015) on marginal microcredit clients in Bosnia; Banerjee, Duflo, Glennerster and Kinnan (2015) on Spandana's expansion in Hyderabad; Crepon *et al* (2015) in Morocco; and Tarozzi, Desai and Johnson (2015) on women-targeted loans in Ethiopia

trol trials to study more traditional microcredit programs.[10] Three studies[11] found increased self-employment among borrowers and one found evidence for increases in business size. Banerjee, Duflo, Glennerster and Kinnan (2015b) found no aggregate effects for self-employment, but significant improvements in size and profitability for the upper tail of businesses. Only one study - Augsburg et al. (2015) - finds an impact on schooling. This paper finds that school attendance by adolescent children of post-microcredit entrepreneurs declines, while work hours increase. It seems that these households perceive the current labor supply of their teenagers to be more valuable than potential future wage losses.

En masse, the studies have quite varied findings. Overall they do not find significant increases in consumption or living standards, but neither do they find significant declines. One potential explanation for the lack of significant findings is heterogeneous responses, both with and across contexts, which my paper explores in detail. Households borrow for many different reasons, which opens up a complex and contradictory set of potential saving, consumption and income effects. I find that there are at least four different types of households, whose borrowing behavior, consumption, education and occupation choices, and income outcomes differ. This results in small and marginally significant results at the aggregate level, despite significant results when each group is examined separately. These heterogeneous responses should be considered when designing microcredit interventions. An advantage of my paper is that my structurally estimated model can be used to assess

[10] Six programs in six countries were followed over periods ranging from 14 months to three years, and their effects on borrowing and a wide range of development outcomes were evaluated. These are the first studies of strictly randomized experiments, rather than the quasi-random MBVF. As such, the measured effects are clearly identified. However, low rates of compliance - borrowing among the treated - and high rates of defiance - borrowing from other microcredit sources among the control - result in weak instruments in some studies. The exact format of the programs differed; some included traditional microfinance characteristics such as group lending or female borrower preference, while others offered more routine credit provision. Sample choice also varied, and in one instance - Ethiopia - the microcredit program was accompanied by a family planning intervention (Tarozzi, Desai and Johnson 2015).

[11] (Augsburg, De Haas, Harmgart and Meghir 2015),(Attanasio, Augsburg, De Haas, Fitzsimons and Harmgart 2015) and (Crepon, Devoto, Duflo and Pariente 2015)

the effects of alternative policies prior to implementation.

My paper is also related to the literature on heterogeneous firm types. Several papers have demonstrated that there is substantial heterogeneity in firm responses to environmental or experimental changes.[12] My paper demonstrates that, even controlling for owner characteristics, additional heterogeneity in owner type can provide more analytical power. It also fits well into the literature on entrepreneurship in developed economies, which separates "subsistence" entrepreneurs from "transformational" entrepreneurs (Schoar, 2010). While few firms in my dataset are likely to be truly transformational, my model provides a useful lens through which to view the effects of microcredit differentiated by household productivity. Finally, this paper highlights another channel through which parental self-employment might affect children's educational attainment and occupational choices. Blanchflower and Oswald (1990) and Dunn and Holtz-Eakin (1996) find that parental self-employment increases the probability that an adult enters self-employment, using United States data. My paper suggests that this might be due to decreased return to wage work, through decreased educational attainment, rather than purely to increased return to self-employment.

Paper Structure

The paper proceeds as follows: in Section 2, I outline the key features of the Thai Million Baht Village Fund, describe its effects on the credit market and entrepreneurial behavior, and present instrumental variable results for its effects on education. Section 3 describes the various mechanisms through which the MBVF may affect education decisions. The model is presented in Section 4. I discuss my estimation strategy, results, and counterfactual simulations in Section 5, and Section 6 concludes.

[12] Bruhn (2012), De Mel, McKenzie and Woodruff (2012), De Mel, McKenzie and Woodruff (2008)

2 The Thai Million Baht Village Fund

2.1 Program Details

I make use of the Townsend Thai data to estimate my model. These data span the implementation of the Million Baht Village Fund (MBVF) program. The MBVF is not randomized nor was it an explicit microcredit intervention. However, its implementation strategy created quasi-experimental variation in access to credit. The program was announced in 2001 by the incoming government following a snap election in 2000. It involved the transfer of one million baht to each village in Thailand, earmarked for the purpose of setting up village banks. Villages are an administrative unit and the word implies nothing about the number of households involved. The same grant was made available to every village, regardless of size, wealth or ruralism. Villages elected committees to draw up regulations for the operation of the banks; once these proposals were submitted to and approved by the central government, transfers could be made. One universal requirement was that borrowers had to be residents of the village to borrow from the local bank. Beyond that, the banks did not receive targeting instructions from central government and loan applications were evaluated at the local level on a competitive basis. Most loans were uncollateralized but might require guarantors. Repayment rates were high, and funds disbursed remained constant or increased over time.

The MBVF has two characteristics that make characterizing it as "quasi-experimental" accurate. First, it was announced and implemented within a year. Kaboski and Townsend (2011) note that the program was nonexistent in any survey village in the Townsend Thai data in May 2001 but was operating in all survey villages by May 2002, the next re-survey date. Thus, households did not have time to anticipate the program and adjust their behavior, so observations prior to May 2002 provide genuine baseline information. Second,

there is wide variation in village characteristics but all villages received the same transfer. Specifically, villages vary greatly in size. The number of other households in a given village affects the probability of receiving a loan and the loan size, so the effective size of the credit infusion varies across villages. Kaboski and Townsend (2012) show that village size is not correlated with other economic trends. Thus, the MBVF is equivalent to a credit program that is randomized at the village level.

Further, the MBVF is equivalent to a microcredit intervention. While the program was set up with grants from the central government, it operated in villages as a source of credit, not as transfers. Households were required to repay funds, and for the most part did so (Kaboski and Townsend (2011) find repayment rates of 97%). The money was not targeted to particular sub-groups, was not accompanied by any conditions on behavior or use, nor with any sort of business or skill training. Observed interest rates are well below those available from commercial lenders.[13]

For many years the MBVF was the closest thing to a randomized control trial of microcredit available. However, in the past five years several experimental evaluations of microcredit have been performed, all of whose data are publicly available. However, the Townsend Thai dataset has three advantages over these datasets. First, its time span is unrivaled: it has five years of pre-program data and ten years of post-program data. It covers 960 households in 64 villages. The longer time span allows for village and household fixed effects to be estimated, and the effects of the program to be more precisely estimated. Given that power is a common problem in the papers in American Economic Journal: Applied, 7(1), this is a major advantage. The credit drop was substantial, increasing the probability of finding significant effects: one million baht in 2002 was only $23,000, but adjusted for purchasing power it was $403,000. The long time span also allows long-run

[13] See Figure 3 for median interest rates for different lender types.

effects of the program on children's educational attainment to be studied. In practice, the effects are seen only for one cohort, but these are visible for the full time span for which this cohort's labor market outcomes are observed. Second, the data contain extremely detailed information on household financial decisions and debt portfolios; this information is used for estimating the parameters of the structural model. Third, the program offers better insight into the effects of widespread credit constraint alleviation, as it applied, potentially, to every household in Thailand. This makes calculating general equilibrium effects more plausible.

2.2 Program Effects

As a first step in my argument, I document that the MBVF affected key measures of interest - occupation choice and education investment - and changed the financial environment that households faced. These provide motivation for characteristics of the model I develop, as well as demonstrating that occupation changes due to microcredit affect education investment. The model will then serve to explore the mechanisms through which this effect operates.

First, the MBVF had significant and permanent (at least until the present day) effects on the loan options of households. Figure 1 shows that a large share - over 60% - of households post-2001 have a loan from their village fund. This figure is extremely high, and reflects the fact that most households are participating in the credit market, with loans from informal sources and commercial banks, as well as from the most common lender, the agricultural banks [14] Loans from agricultural banks are available only for agriculture-related activities,

[14]The BAAC, or Bank for Agriculture and Agricultural Collectives, was established in 1966 to provide low-cost credit to farmers. Its focus has broadened to include agriculture and agriculture-related activities, sustainable consumption of natural resources and environmental supervision(Fitchett, 1999). Due to the ubiquity of agricultural production (over 85% of households participate in agriculture), almost all households

whereas applications for MBVF loans can cite any reason. The MBVF had little impact on the predominance of agricultural loans, but loans from commercial and informal lenders decreased markedly in the years following its introduction. This suggests that it was used as an alternative to these sources rather than a replacement to BAAC loans. Figure 2 shows that the value of loans from the village funds has remained relatively constant since 2003, while agricultural loans have grown in value, reflecting a government focus on investing in agriculture in this period [15].

Loans from the MBVF and BAAC are cheaper than commercial and informal options, and the average cost of credit has decreased over the observation period. For non-agricultural endeavors, only the MBVF, commercial and informal lenders are relevant. However, it is not clear from these data what the marginal cost of credit for a particular borrower is. Do borrowers exhaust their access to the MBVF before switching to alternative lenders as top-up credit sources, or are different lenders used for different types of loans? Money is fungible, so access to BAAC may additionally affect a household's borrowing behavior for non-agricultural purposes. Based on Figure 4, households did not decrease their borrowing from other sources, and Figure 3 shows that average (mean or median) interest rates do not seem to have responded to the village fund.[16] There are several possible explanations for this[17]; what is clear is that the creation of the MBVFs gave the rural households in this survey access to another source of credit that differed from those available previously.

In the years following, changes in occupation choices are also visible in the data. This

in the sample are eligible for loans from the BAAC.

[15](Fitchett 1999)

[16]The median interest rate for informal loans is close to zero, while commercial loans are the most expensive. Loans from money lenders are treated as commercial loans in the data, while informal loans are borrowing from friends, neighbors and family members.

[17]This could be explained by price-elastic demand for credit, in which consumption of credit increases when the supply expands, with no change in price of credit. Alternatively, the MBVF might be an infra-marginal source of credit - households exhaust their access to this cheaper source before using more expensive sources of credit, which are price inelastic.

provides the second piece of descriptive evidence - that there is reason to believe that the MBVF changed households' occupation decisions. Household enterprise is common in the data, with over 80% of households engaged in some sort of agricultural activity. Rates of agricultural activity do not change much after 2001. However, the share of households engaged in non-agricultural self-employment increases from 43% in 2001 to a peak of 53% in 2004 (see Figure 5. It falls sharply again in 2005, to 47%, but remains above its 2001 level until 2010. While many other changes took place in this period, the sharp peak in non-agricultural self-employment is consistent with the increased availability of cheap credit for non-agricultural activity between 2001 and 2002. The net increase in households in this occupation is caused by changes in both exit and entry rates, as shown in Figure 6. Fewer households ceased operation of a business in 2002 than in 2001 or 2003, and more households started businesses from 2002 onwards. The latter change is the more persistent one and contributes to the long-lasting increase visible in Figure 5.

2.3 Reduced Form Effects of Program on Occupation and Education

The descriptive trends discussed above demonstrate some of the macro changes following the debut of the MBVF, but they do not show a causal relationship between the occupation changes and the change in the credit environment. This section presents instrumental variable results linking the two. The need for an instrument arises from the fact that many unobservable characteristics of individuals and households will affect their education and occupation choices jointly. For instance, in the language of my model, a more productive household may have higher returns in self-employment and higher returns to skill (education) in both self-employment and wage employment than a less productive household. Thus, if we observe that households that are self-employed are more likely to keep their children enrolled in school, we cannot attribute this to self-employment without heroic

assumptions about unobservable characteristics.

As discussed in Section 2.1, one of the characteristics of the MBVF was that all villages received identical fund capital, despite wide variation in village size and characteristics. However, village size affects any particular household's probability of receiving a loan from their local fund, and the size of any loan they receive. This creates variation in the new credit environment facing households, and thus variation in the net cost of capital, that is uncorrelated with each household's characteristics. Kaboski and Townsend (2012) demonstrate that village size is not strongly correlated with many factors that could be expected to influence local labor markets and business environments and attribute changes in wages post-2001 to the MBVF credit drop. Based on these results, village size provides an instrument for the profitability of self-employment relative to wage employment.

Table 1 shows results from instrumental variable regressions of the effect of occupation choice on education outcomes. In all specifications, median village wage is used as a control to capture the effects of the labor market on education. Column 1, 'Enrollment', displays effects for adolescent enrollment, and uses the group of households with adolescents in 2002 to 2005, Column 2, 'Attainment', shows effects for school level completed by age 20 for people who were adolescents in 2002-2005. Column 3, 'First Stage', shows the first stage results of self-employment on the inverse of village size post-2001. The four rows show results from four different samples: all households; all households who are ever self-employed in this period; households that owned businesses prior to 2001; and households who owned businesses only after 2001. The final group represents households who found it profitable to start a business only once the MBVF was in place - these are the households whose best occupational choice switched due to the program. While the first stage is strong for all regressions - the MBVF increased the probability of self-employment in all samples - the second stage is significant only for the last row. Households that started a

business after 2002, and that contain adolescents in this period, are significantly less likely to have their adolescent members enrolled in school, than households that did not start a business. The coefficient for attainment is negative but not significant, and positive but not significant for the other groups. These results suggest that the decision to withdraw adolescents from school is relevant only for households that were new entrepreneurs, as a result of the MBVF. This matches the idea that decreased education investment occurs only among the group whose best occupation choice switched as a result of the MBVF. Households that already owned a business did not decrease education investment. This reduced form result is interesting but does not pin down the exact reason for the lower likelihood of enrollment. As mentioned in Section 1, there are several mechanisms that could cause this result. These are discussed in the next section.

3 Model Mechanisms

One of the shortcomings of the instrumental variable results is that they cannot be used to identify the precise cause of the change because there are multiple mechanisms that can result in the same observed outcomes, and through which the MBVF could affect education investment directly. In general, education is a trade off between current costs - direct and indirect - and future pay-offs, if skilled workers earn more than unskilled workers. Even if the relative wage gain is small or will accrue only to the children, parents may be willing to pay for education from altruistic motives. In this sense education may be a consumption good for households as well as an investment good. These trade-offs can be divided into four broad groups of mechanisms: increased liquidity; income effects; opportunity costs; and relative returns to skill.

First, the MBVF is an additional source of credit that is cheaper than two other sources.

Additionally, loans from the MBVF are not typically collateralized. For particularly poor households or households with highly variable incomes, the MBVF may provide additional liquidity and make the upfront costs (school fees, uniforms, books and supplies) of schooling affordable. The difficulty of saving for poor households in the developing world is well-established.[18] Even when a household can technically 'afford' upfront costs - they have sufficient liquidity to cover them - paying them all at once may require substantial cuts in other expenditure, which would cause large increases in the marginal utility of consumption and induce households to choose higher consumption expenditure at the expense of lump sum education investment. An alternative to saving or enduring a large one-time cut in other expenditures is borrowing. Households can borrow for the lump-sum payment and repay in small installments, smoothing the decreased consumption over several periods. This may be enough to make increased education investment optimal, and should lead to increased education investment. Within the time period studied, education investment did indeed increase, though this may be due to a long increasing trend.

Second, the program may have an income effect on education. Kaboski and Townsend (2012) document higher income growth for the first few years following the program. If education is a normal good, higher incomes will cause households to demand more of it. This should lead to increased education investment for all households that experience an income gain, regardless of the source of the income gain or whether they personally took a loan from the MBVF. However, education is neither purely a consumption or investment good. It is implicitly also a labor supply choice.

This leads to the third mechanism through which the MBVF may affect education: changes in the opportunity cost of education. Unlike the first two mechanisms, this predicts that education investment may fall. Keeping a child in school not only has direct costs but

[18] Beaman, Karlan and Thuysbaert, 2014

results in losses due to the foregone earnings of the child. Kaboski and Townsend (2012) also find that wage income increased for households in villages with stronger MBVF effects. This increase in wage income is an increase in the opportunity cost of schooling and may cause decreased enrollment. However, there are two major requirements for this implication to follow: that higher wages apply to adolescents as well as adult workers; and that adolescents can find work. Unfortunately, the data cannot speak to the truth of the former as wages per worker are not explicitly surveyed, so we cannot differentiate wage growth between adults and adolescents. Working for non-family employers is seldom observed in the data, but this may reflect endogenous household choices, not the availability of work for adolescents.

The opportunity cost argument applies also to adolescents who would not have a wage job. Some households started businesses in the wake of the MBVF and adolescent labor in such a business may be valuable. It might be relatively cheaper than using an adult family member and foregoing their wage earnings, and cheaper than hiring an outside worker if there are imperfections in the labor market. For households that already had a business, the MBVF may affect the scale of the business through its effect on the cost of capital and other inputs. If labor and physical inputs are complements in production, this increases the marginal product of labor. The household will then want to increase its labor inputs as well, and, for the same reasons as above, household child labor may be preferable to adult or hired labor.

Finally, the return to skilled labor relative to unskilled labor matters in both occupations. If the wage available to a skilled worker is substantially higher than that of an unskilled worker, then the net present value of education may be positive and households will choose to endure the opportunity cost and direct costs in expectation of high future earnings. Similarly, if skilled labor is valuable in a household business, a household may treat enrollment as an investment in future production and keep their adolescents enrolled. If either

of these conditions hold, then they will mitigate the opportunity cost argument.

The contrasting results of these four mechanisms emphasize the difficulty of unraveling the effects of the MBVF on education using reduced form methods. Different mechanisms will dominate for different households. Some of these can be partially observed by selecting on household characteristics, as in Section 2.3. However, this requires selecting on endogenous outcomes - occupation choice, in that instance - and does not properly identify the mechanism. Even for the group selected for in the Section 2.3 results, it is clear whether the decreased enrollment is due to the increased opportunity cost of foregoing wage labor or to increased returns to labor in the household business. For these reasons, the structural model is used.

4 Model

Households are modeled as unitary and risk averse infinitely-lived dynasty, making decisions on occupation, education, consumption and investment in each period. The household's demographic composition is stationary in expectation, and it takes as exogenous its size and age composition. Each member is an adult or a child; children progress to adulthood ("come of age"), adults die, and new children are born with constant probability. Only children can be enrolled in education. These assumptions give rise to the first important model characteristic: if the household desires more family workers, it can obtain them only by withdrawing children (in the data, adolescents) from school; it cannot breed more.

The household has a constant bi-dimensional talent endowment over productivity and educational ability. This determines its type, and thus its expected return to education and its wages and profits. This allows for household responses to differ based on unobservable characteristics, to match heterogeneous household responses in the data. Specifically,

household responses can vary while household composition and wealth are constant due to systematic differences between households, not only due to random preference shocks. This allows the model to reproduce the result of small aggregate responses obscuring interesting and significant correlations among sub-groups. These groups are not exogenously imposed, however - their composition is estimated within the model.

The household faces two frictions, in the credit and labor market. Both of these frictions distort choices from the unconstrained optimum. The MBVF is modeled as a relaxation of the credit constraint. The labor market friction is modeled as increasing the cost of non-family labor while decreasing wage earnings. This is not altered by the introduction of microcredit.

The household makes its allocation decisions prior to observing its shocks for the period, which creates uncertainty about the return to education (positive or negative) and income risk. Households weight the utility of all members equally - parents do not favor children, but nor do they over-discount children's future consumption. Each period, it draws demographic and talent shocks. Demographic shocks determine the the birth, death and coming of age of household members, while talent shocks determine the household's return on investments and in occupations. The relevant state variable is cash-on-hand, ω_{jt}, which is comprised of assets A_{jt} and income y_{jt}. This can be allocated to investment in the household business or consumption, with the residual re-invested in the liquid asset. Worker allocations determine the household's income from profits and wage earnings. The

budget and transition equations are

$$\begin{aligned}
\omega_{jt} &= A_{jt} + y_{jt} && (1)\\
&= A_{jt} + \sum_{i=1}^{N} \left(I_{ijt}^{WE} w_{ijt}\right) + \pi_{jt} && (2)\\
\omega_{jt+1} &= (1+r)\left(\omega_{jt} - c_{jt} - b_{jt+1} - cost_t \sum_i I_{ijt+1}^{E}\right) + y_{jt+1} && (3)
\end{aligned}$$

4.1 Types

Households can be one of four types: good at production and education, or (1,1) households; good at production but poor at education, or (1,0) households; bad at production but good at education, or (0,1) households; and bad at both - (0,0) households. A household's type determines the probability of receiving good talent shocks. A good education shock - above some threshold - means that a child in school graduates and becomes a skilled adult. The lower the threshold, the lower the expected cost of education, as the household expects to pay it for fewer periods, and the higher the expected return, as the child will become a productive member sooner. A good productivity shock means that all wage workers in the household receive a bonus that period, and that the household's business is successful. Thus, a (1,1) household has higher expected earnings in both occupations and higher expected net return to education. Households know their type. The talent endowment of a household is (z_j^B, z_j^E), with z_j^B the probability of a good production shock and z_j^E the probability of a good education shock. Shocks are drawn from two uncorrelated normal distributions. Types differ in the threshold defined for a good shock, which creates the different probabilities.

4.2 Frictions

4.2.1 Credit

Credit is available to households but is constrained by wealth. The microcredit intervention relaxes this constraint but does not eliminate it. Households borrow money to fund total expenditure prior to shocks being observed. Borrowed money can be spent on consumption, business investment or schooling. If the household decides to invest in a business, it "loans" money to its business at interest rate r. This algebraic trick allows the borrowing decision to be handled separately from the investment decision when the model is estimated. Once shocks are observed and total income for that period is realized, the household repays its loans. The household will not borrow more than it can repay in the presence of a negative productivity shock to avoid negative cash-on-hand and negative consumption.

The formal borrowing constraint is a function of cash-on-hand, and the precautionary motive is a function of interest on assets and non-risky income, Y_{jt}^{sure}. Borrowing, B_{jt}, will be less than the lower of the two:

$$B_{jt} \quad \leq \quad min\left[(1+\phi)\omega_{jt}, Y_{jt}^{sure} + A_{t+1}\right] \tag{4}$$

When micro-credit is introduced, it increases the first term but does not change the second directly. To reflect the fact that the majority of MBVF loans are uncollateralized, increase is not a function of assets. Some households will remain constrained, either because their optimal borrowing still exceeds the formal borrowing constraint or because their non-risky

income is low. The new constraint is

$$B_{jt}^{MC} \leq min \ (1+\phi)\omega_{jt} + D, Y_{jt}^{sure} + A_{t+1} \ , \tag{5}$$

$$\text{with} \quad B_{jt}^{MC} \geq B_{jt} \tag{6}$$

Because the borrowing limit is a function of cash-on-hand even after microcredit enters the market, saving and borrowing can be complementary if investments are lumpy.

4.2.2 Labor market

The cause of the labor market friction is not specified with the model, but is simply assumed to exist. There is a large body of evidence in support of imperfect labor markets in developing countries, so this is not a strong assumption.[19]. The labor market friction affects both the returns to wage labor and the cost of outside labor. It decreases wage earnings per household wage worker proportionately, so the loss per skilled worker is larger in absolute but not relative terms, which creates a preference against wage labor. It increases the cost of hiring outside workers in the household business, which creates a preference for family labor over hired labor. This friction is not affected directly by the introduction of microcredit, so even after the change the household is still operating in a second-best world.

The underlying assumption to this view of the labor market is that it clears perfectly. Someone in search of wage work can always find a job, and households can always find wage workers to hire should they wish to do so. An alternative approach to modeling the friction would be to abandon this assumption and posit a search friction such that

[19](Bardhan and Udry 1999)

households cannot always find workers to hire or jobs in which to supply wage labor. This may be more intuitively appealing as a description of the labor market but considerably complicates the model. It generates the same key results - that wage earnings in expectation are depressed and that there is an additional cost to hiring outside laborers[20]. However, it also generates a preference to maintain existing relationships, and thus necessitates tracking whether or not a household member changes jobs or the hired worker is new. The data do not allow for this level of detail, so I choose the simpler model that still gives the main result that I require, that the higher risk of self-employment income is offset by the decreased expected income in wage employment.

4.3 Income

The household has three sources of income: interest on the risk-free asset; wages; and profits from the household business (if applicable). Members pool their earnings and there is no private retention or hiding of income. The risk associated with earnings in each occupation is different, which will affect the household's allocation of members to each occupation, and through this its borrowing behavior.

4.3.1 Wages

In wage employment, a household member is guaranteed some amount of income α_0^W. A skilled household member earns more - $\alpha_0^W + \alpha_1^W$. Both skilled and unskilled workers can potentially earn a bonus of α_2^W in response to a good productivity shock that period. The

[20] Either due to job posting costs or delayed start if search is unsuccessful

household's expected wage earning for each member is thus:

$$\begin{aligned} E_t ln(w_{ijt+1}) &= z_j^B \;\; \alpha_0^W + \alpha_1^W ln(1 + skill_{ijt+1}) + \alpha_2^W & (7) \\ &+ (1 - z_j^B) \;\; \alpha_0^W + \alpha_1^W ln(1 + skill_{ijt+1}) & (8) \\ &= \alpha_0^W + \alpha_1^W ln(1 + I_{ijt+1}^{skill}) + z_j^B \;\; \alpha_2^W & (9) \end{aligned}$$

The shock affects all household members identically, so the household's expected total wage earnings are just the sum of all wage workers' expected earnings. The household's non-risky income, referenced above, is then:

$$Y_{jt}^{sure} = A_{t+1} + \sum_i I_{ijt}^{WE} \left(\alpha_0^W + \alpha_1^W ln(1 + I_{ijt+1}^{skill}) \right) \quad (10)$$

4.3.2 Profits

The household has no guarantee of positive self-employment earnings. The productivity shock determines whether or not the business produces anything in that period. Input costs - for non-household workers, l_{jt+1}^D, and capital - are paid before production occurs. Capital depreciates fully each period. It is thus possible for a household to have negative self-employment income, which creates the variation in risk between the occupations and which causes a risk-averse household not to choose income-maximizing allocations. Worker costs are wages, inflated by the presence of the labor market friction, paid to non-family workers. Family workers are not paid. To simplify the algebra, business expenditure b_{jt+1} is treated as a loan from the household to the business, repaid at rate r. Expected profit

is thus:

$$E_t\pi_{jt+1} = z_j^B A k_{jt+1}^{*\alpha} l_{jt+1}^{*\nu} + (1 - z_j^B)0 - (1 + SC)\, w_{t+1} l_{jt+1}^D - k_{jt+1} \quad r \tag{11}$$

$$= z_j^B A k_{jt+1}^{*\alpha} l_{jt+1}^{*\nu} - (1 + SC)\, w_{t+1} l_{jt+1}^D - k_{jt+1}^* \quad r \tag{12}$$

4.4 Utility

Each member of the household contributes equally to household utility and derives utility from consumption and occupation. Utility is linear and separable in these inputs. Chaow might prefer to be a wage worker than self-employed, but he does not enjoy his meals and clothing more if he is a wage worker. However, Chaow's utility from being self-employed is allowed to differ by his skill level. The preference between occupations is assumed to be the same for adults and for adolescents. This gives rise to the instantaneous utility functions below:

$$u_{ijt}^E = \mu^E + a_0^E ut(\frac{c_{jt}}{N}) + \varepsilon_{jt}^E \tag{13}$$

$$u_{ijt}^{WE} = \mu^{WE} + a_0^{WE} ut(\frac{c_{jt}}{N}) + a_1^{WE} x_{1,ijt} + \varepsilon_{jt}^{WE} \tag{14}$$

$$u_{ijt}^{SE} = \mu^{SE} + a_0^{SE} ut(\frac{c_{jt}}{N}) + a_1^{SE} x_{1,ijt} + \varepsilon_{jt}^{SE} \tag{15}$$

μ_{occ} is the preference for a particular activity, wage work, self-employment, or school. $ut(\frac{c_{jt}}{N})$ is the utility derived from consumption for any household member. ut has a constant relative risk aversion specification, so $ut(\frac{c_{jt}}{N}) = \frac{\frac{c_{jt}}{N}^{1-\gamma}}{1-\gamma}$. a_0^{occ} would represent the interaction between occupation and consumption, and is one by assumption. a_{occ}^1 shows the extent to which a person's preference for an occupation depends on their characteristics.

The household's total utility per period is the sum of its members' instantaneous util-

ity:

$$U_{jt} = \sum_{i=1}^{N} u_{ijt}^{E} I_{ijt}^{E} + u_{ijt}^{WE} I_{ijt}^{WE} + u_{ijt}^{SE} I_{ijt}^{SE} \tag{16}$$

This gives rise to the household's value function,

$$\begin{aligned} V_{jt}\left(\Psi_{jt}, \omega_{jt}, z_{jt}\right) &= \max_{occ_{ijt+1}, b_{jt+1}, c_{jt}} U_{jt}\left(occ_{ijt+1}, c_{jt}\right) & (17) \\ &+ \beta E\left(V_{jt+1}\left(\Psi_{jt+1}, \omega_{jt+1}, z_{jt+1} | \Psi_{jt}, \omega_{jt}, z_{jt}\right)\right) & (18) \end{aligned}$$

ω_{jt} is the household's cash-on-hand and z_{jt} is its talent endowment. Ψjt is the demographic composition of the household - how many adult and child members it has, and how many of the adults are skilled.

4.5 Model Implications

The model produces four key implications. As noted above, due to the form of the credit market constraint, borrowing and saving can be complementary, so we might expect to see saving increase for a subset of households once microcredit enters. Second, the optimal choice of occupation will differ based on the household's relative abilities in production and education, as well as observable characteristics such as wealth, skill level and household size. Third, risk aversion on the part of the household means that utility maximization is not equivalent to profit maximization - the household may under-invest in its enterprise due to the higher risk of this income source. Microcredit may alleviate this, as it provides an alternative form of consumption insurance to the risk-free income sources and savings. Thus, we might expect saving to decrease for another subset of households. Fourth, the presence of the labor market friction creates a preference for family labor in the household

business and against wage employment, both of which will act to increase the allocation of family members to self-employment.

The model also provides a systematic way to think about the four mechanisms discussed in Section 3. The liquidity effect will operate through λ and D. The income effect will operate through cash-on-hand changes once D comes into play. For estimation purposes, I have to shut down the effect of microcredit on the relative wage return to skill (discussed below). In practice, the role of this omitted mechanism may be inferred from the extent to which my model fails to fit the data. If the fit is good without it, then we may infer that this is not a significant omission. Finally, the effect of microcredit on the profitability of each occupation is measured through changes in total wage and business earnings, which will come through changes in household's occupation choices.

5 Estimation

For a risk averse household, the model does not have an algebraic solution, so I solve the model numerically using indirect inference applied to the Townsend Thai data. To make the estimation tractable, I use a two-step procedure based on Gourinchas and Parker (2002) and De Nardi, French and Jones (2010). Model parameters are split into two categories: those identifiable directly from the data or well-established in the literature; and those which are novel to the model or not directly identified. The first category is treated as external to the model during the solution process, with values drawn from the literature or pre-estimated from the data. The second set is estimated using indirect inference (Gourieroux, Monfort and Renault (1993)). I estimate the model using data from the pre-program period (1997 to 2001), and then test the model's ability to reproduce household's behavior in the post-period (2002 to 2011). This provides out-of-sample validation that is not commonly

available to estimators of structural models. As such, this is the primary measure on which I assess my model's performance.

5.1 Mapping the Model to the Data

Households within the model are infinitely lived and have constant household composition in expectation. In practice, this allows the household problem to be treated as stationary. The household's best guess about its demographic composition in the next period is simply its current values. Its skill composition and expected income are dependent on its current actions, but not having to track demographics over several periods considerably simplifies the problem. The problem is further simplified by collapsing a potential continuum of types to four discrete categories, for each of which the problem is solved separately. This reduces the state space to four variables: household size; number of children (adolescents); number of skilled household members; and cash on hand. The first three variables are represented as Ψ_{jt} for household j at time t, and these have clear analogues in the data. Any individual who has completed upper secondary education, or vocational training, is considered to be skilled.[21] Only children between 16 and 18 (inclusive) are converted to children in the model; younger children are omitted from consideration. Based on this definition, **X**% of the sample have children, and the median number per household is one.

The household makes two sets of decisions - allocations of money and allocations of individuals. Cash-on-hand, the household's continuous state variable ω_{jt}, is the sum of its asset portfolio and its currently realized liquid income. ω_{jt} can be assigned to consumption, measured as total expenditure net business and education expenses, business investment, which is surveyed directly for all household businesses in the data, and saving in the liquid

[21] In the model, all skilled individuals are automatically treated as adults - graduation to skilled incorporates coming of age.

asset, measured as the sum of household assets[22]. It can be supplemented by borrowing B_{jt}, which is constrained as specified in Section 4.2.1. The household can borrow for any purpose, which allows for full fungibility between own cash and borrowed credit. Borrowing is recorded by source, with information on the length and repayment terms of the loan. Most households borrow - 71.06% in the pre-2001 data, and 77.95% in the post-2001 data. Business expenditure is split by category, into expenditure on wages, food for workers, transport, capital purchases, maintenance and rental, inventory and fuel. The number of paid workers, family workers, and workers in total is also recorded. The median household firm has two workers, one of whom is the manager, and no hired workers. The detailed breakdown of expenditure and labor inputs is used to estimate the production function directly.

Adults can be allocated to wage work or self employment, and children can additionally be allocated to school. A major simplification between model and data is that individuals can perform only one task per period, while in the data many individuals report two occupations. I do not match on occupation by individuals for this reason, but on occupation (and enrollment) by households. A household is tagged as self-employed if any member identifies as self-employed in their primary or secondary occupation[23]. Based on this measure, 70.21% of households are self-employed in the pre-2001 data, and 76.37% in the post-2001 data.

One period is one year, as that is the period of the survey and a sensible treatment of school enrollment. Additionally, most of the financial variables are measured over the span of the last year. One disadvantage of the data is that school attendance, as opposed to enrollment and attainment, is not measured. I consider a household to be engaged in

[22]Median values for all these variables are shown in Table 5.

[23]This produces very similar results to tagging based on reported expenditure on a household business.

training if any adolescent is enrolled in school, and by this measure 13.53% of the early sample is training, and 12.38% of the later sample. Enrollment is almost universal for younger children, exceeding 95% for all ages until 13%, and a substantial drop occurs only after age 15, when lower secondary education is complete for a student whose progression through school has been smooth.

The credit market friction in the model is handled differently to other parameters. Its initial determinant, λ, is estimated by indirect inference. When microcredit is introduced, a level change in the borrowing limit occurs - the parameter D. D is calibrated from the data to reproduce observed changes in borrowing levels by community; each household is assigned its village-level D estimate and takes this into the simulation as another household starting value.

5.2 External Parameters

There are relatively few parameters of the model that can be identified outside the model, but where possible this approach has been taken. The coefficient of risk aversion of the household's instantaneous utility function ($ut(c)$) is set to 2.0, while the discount factor is 0.9. The interest rate for borrowing is the median rate across all lenders, 0.04. The cost of education is the median log education expenditure per enrolled child in the data, 7.904.

The production function parameters can be estimated directly from the data using the method proposed by Ackerberg, Caves and Frazer, 2006. I estimate two separate production functions for households with a skilled member and those without. Inputs are log capital expenditure, log labor quantity, and log fuel expenditure, which is used as the identifying instrument. The resultant values are given in the bottom panel of Table

2.

5.3 Internal Parameters

The remaining parameters are estimated by indirect inference, and are shown in Table 3. They fall into four sets: the state utility parameters μ and a_1; the talent or type shares and thresholds, $z_1^B, z_0^B, z_1^E, z_0^E$; and the wage function parameters, α_0^W, α_1^W and α_2^W; and λ, the limited liability parameter. In sum, these will be referred to as Θ and total 13. Indirect inference functions similarly to simulated method of moments but with additional flexibility in moments used. Specifically, regression coefficients can be matched even if the regression is mis-specified. Matching in this way will reproduce the same pattern of associations in the simulated data as are observed in the real data, with slightly improved transparency of identification. The optimal choice of parameters is the one that minimizes the distance between the observed and simulated moments, denoted respectively by $\mathbf{p}^D$ and $\mathbf{p}^S(\Theta)$. The objective function is thus

$$L_n(\Theta) = -\frac{n}{2}\left(g_n(\Theta)\right)' W_n(\Theta)\left(g_n(\Theta)\right) \tag{19}$$

$$\text{where} \quad g_n(\Theta) = \mathbf{p}^D - \mathbf{p}^S(\Theta) \tag{20}$$

I used equally weighted minimum distance, so the weighting matrix $W_n = I$ (Altonji and Segal, 1996). I match on 25 regression coefficients of occupation and education choice on household observables, earnings equations and graduation probability, as well as the proportion of households in self-employment, training, and both, and on the proportion of households borrowing. Table 4 shows regression coefficients from the observed and simulated datasets. I additionally match on the quartiles of business investment, consumption and spending, borrowing, liquid investment and earnings from self and wage employment,

in total providing me with 50 moments. Table 5 shows the observed and estimated values of these moments. The resultant parameter estimates are shown in Table 3.

5.4 Model Fit

The key moments on which the model must perform well are the proportions of households borrowing, self-employed, training and both, as these are the outcomes for which my model has strong and interesting predictions. The model does a reasonably good job of estimating these proportions, both in the data used to fit the model and in the later period. To obtain the latter, I simulate household behaviour assuming all parameters other than λ remain constant. The change in λ is calibrated to reproduce the borrowing behavior seen post-2001. In both the pre- and post-program periods, the model fits borrowing and education behavior very well (see Figures 7 and 8. It fits self-employment less well, underestimating it by 12.7 percentage points (18%) in the estimation sample, prior to the MBVF program, and 18 percentage points (22%) in the post-program period. Based on direct manipulation of the parameter estimates, I attribute this to the requirement that simulated households fully repay their debts within one period. This increases the utility cost of investing in the risky income source, self-employment, and discourages households from entering self-employment at all. This also explains the lower predicted values for investing in training. However, the model correctly predicts that more households will enter self-employment after the program is implemented and that the education enrollment will respond little. It also fits well the observed increase in borrowing once the credit regime alters.

5.5 Results

In the first panel of Table 3, the state utility estimates are shown. The preference for self-employment is large relative to the additional differentiation based on skill level, indicating that households do not care (in terms of utility) whether the members allocated to each occupation are skilled or not. While μ is large relative to a_1, it is small relative to the per-period utility of the household. This indicates that the driving force behind the contribution of occupation decisions to utility is through consumption, not a taste for self or wage employment.

In the bottom panels, the wage function parameters and estimated credit constraint are shown. λ is close to values used by other papers using this data (which range from 0.08 to 0.10), which gives additional confidence in my estimates. The wage function parameters indicate that the return to skill in wage employment is somewhat smaller than the productivity 'bonus', but that both are an order of magnitude smaller than the basic wage.

5.6 Type Results

In the simulated data, households are assigned to types that influence their expected income and return to education investment. Both the population shares of these types, and their associated good shock probabilities, are estimated within the model. Based on this, I can comment on the size of each group and the extent to which they differ, as well as differentiating their responses to the MBVF program.

In the middle panel of Table 3, we see that the majority of the population lies on the diagonal of the bi-dimensional talent distribution - type (0,0) households comprise almost half the population and another 24% is type (1,1) households. Households that are good

only at education are somewhat more rare, at 10%, than households that are only good at production, at almost 17%. The threshold values for a good production shock are very different are shown below the shares. In brackets is the resulting probability of a household receiving a good shock. The probability of a good shock is large for both high and low productivity types, with a gap of 12.85 percentage points. The gap in the probability of a good shock is similar, at 13.31 percentage points. Based on these substantially differing probabilities, I conclude that there are at least four distinct types of households within the data. Had the respective z^B or z^E figures been close, this would suggest that fewer than four types might adequately describe the population.

The four types respond quite differently to the MBVF. In Table 6, the proportions of each household type engaged in each of the activities is shown, before and after the program, are shown. Households that are generally untalented respond to the program relatively little. Households that are good at education - (0,1) types - increase their training, while their self-employment levels remain high due to the labor market friction. This reflects the fact that education is relatively cheaper for such households, and when borrowing is easier, poorer households will now choose to invest in their most valuable asset - their skill potential.

Households that are productive but not educationally talented are considerably more likely to be self-employed in the later period. They are less likely to be enrolled, however. This is also true for households that are good at both, though the decline is proportionately smaller. Because the (0,1) types constitute a smaller share of the population than the (1,1) types, their large increase in education investment offsets the (1,1)'s decrease at the aggregate level.

5.7 Counterfactual Simulations

I run two simple counterfactual simulations to consider alternative policy regimes. A policy-maker might want to design a loan program that still allows for increased entrepreneurial activity while preventing a downstream effect on school enrollment of adolescents. The most obvious approach to take is to make loan receipt from the MBVF conditional on all adolescents within the household being enrolled in school, in a similar vein to conditional cash transfer programs such as Mexico's Progresa. The results from such a program are shown in the first panel of Table 7. Enrollment is increased relative to the MBVF results, while self-employment rates are decreased. Particularly notable is that the share of households engaged in both activities - self-employment and training - has increased for all groups for whom the program had a substantial impact. However, the share of households receiving microcredit loans has decreased. Townsend and Kaboski (2011) show that some households use the MBVF primarily as a means to smooth consumption during periods of low income. This is potentially a substantially welfare-enhancing result of the MBVF, and imposing the above condition may block some households' access to this tool.

I then consider a slightly tweaked policy, that makes loan access conditional on *continued* school enrollment - children in school in the period in which the household takes the loan must be kept in school the next period. Children who have already left school do not have to be re-enrolled. Given that re-enrollment rates in the data are extremely low, the possibility that re-enrollment yields particularly low probabilities of graduation is real. Under this scenario, shown in panel B of of Table 7, households borrow more while still having higher enrollment rates than under the MBVF policy (in the left panel of Table 6). This brief analysis highlights the importance of assessing the program holistically when attempting to fix specific issues. It is possible that the increased welfare gain from the smoothing function

of the program outweighs the consequences of the lost enrollment under the actual policy, and efforts to limit school withdrawal need to take this into account.

6 Conclusion

This paper argues for the possibility of negative effects from microcredit on education outcomes. I present suggestive instrumental variable evidence that microcredit can induce some households to withdraw their adolescent children from school and use them as labor in a household enterprise. To explore how this result might be explained, I develop and estimate a structural model of joint occupation and education choice with heterogeneous households that face frictions in the credit and labor market using data on the Thai Million Baht Village Fund program.

Using quasi-experimental variation in business returns (via the cost of capital) created by the design of the village banks set under the MBVF policy, I show that there is a decrease in school enrollment of adolescents among households that start a business. This decrease is not observed among households that already had a business prior to the program or households that do not own a business.

This result is rationalized in the model through changes in the return to labor in household businesses relative to the wage labor market. For some households, the change in the opportunity cost of borrowing makes profitable starting a household enterprise. Capital purchases or rentals are complemented by labor inputs, so this generates demand for labor in this enterprise. Due to the presence of the labor market friction, household labor is preferred to hired labor. Education choice by the household is a labor supply choice as well as an investment, and these households choose to allocate their adolescent members to the household business rather than education or the wage market. Within the data simulated

by the model, I find that the above result is due to changes among poor but productive households. Imposing some school enrollment conditions on access to microcredit can offset the educational decline while still allowing increased self-employment.

This finding contributes to the literatures on the effects of microcredit, heteregeneity of firms, and intergenerational occupation links. The developing literature on microcredit has thus far found few significant effects, and my paper is one of the first to find a significant negative effect on an important socio-economic outcome. This effect applies to a particular sub-group of the population and may be outweighed by diffuse but more widely felt benefits. However, it has the potential to cause substantial transfers from children to parents if the lifetime returns to skill outweigh the gains to income from an immediate occupation switch.

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7 Tables and Figures

Table 1: Instrumenting for having a business

	Enrolled	Attainment	First Stage
All	0.236	1.212	0.023
	(0.198)	(1.000)	(0.007)**
Self-employed	0.099	2.041	0.026
	(0.214)	(2.145)	(0.008)**
Pre-2001 SE	0.383	2.195	0.018
	(0.333)	(2.816)	(0.008)*
Post-2001 SE	-0.316	-0.938	0.057
	(0.157)*	(1.310)	(0.013)**

* $p < 0.05$; ** $p < 0.01$

Instrumental variable linear probability models for the effect of having a business on education outcomes of household adolescents. Household and individual demographic information and household location characteristics are included as controls, as is median village wage. Sample for 'Enrollment' column is households containing adolescents (16-18) in the four years after the MBVF was started (2002-2005). Sample for 'Attainment' column is individuals who were adolescents (16-18) in 2002-2005, measuring attainment at age 20.

Table 2: External parameters

Parameter		Value
Coefficient of risk aversion		-2
Discount rate		0.9
Interest rate on liquid asset		0.04
Cost of education		7.89
Production function parameters		
Skilled HH	Return to capital k_{jt}	0.5103
	Return to labor l_{jt}	0.0341
	Residual lnA	5.8355
Unskilled HH	Return to capital k_{jt}	0.3980
	Return to labor l_{jt}	0.0405
	Residual lnA	6.9055

External to the estimation parameters. Where estimated from the data, the full period is used. The first block contains parameters taken from the literature, the second parameters measured in the data, and the third the production function parameters.

Table 3: Internal parameters

Parameter	Value	Identification
State utilities		
μ	0.497	Distribution of occupations across households
a_1	-0.003	Allocation of skilled members to WE and SE
Type parameters		
Share (0,0)	0.490	
Share (1,0)	0.167	Observed occupation and education choices,
Share (0,1)	0.102	distributions of income sources and investments
Share (1,1)	0.241	
z_1^B	-1.57 (94.18%)	Probability of positive income in self employment
z_0^B	-0.89 (81.33%)	
z_1^E	-0.84 (79.95%)	Probability of graduation given enrollment
z_0^E	-0.43 (66.64%)	
Wage function		
α_0^W	7.46	Observed distribution of wage earnings
α_1^W	0.63	given wage workers and skill level
α_2^W	0.91	
Borrowing constraint	0.11	Probability of borrowing, size of loan

Table 4: Matched regression coefficients in observed and simulated data

		Observed	Simulated
Occ choice	N. enrolled	0.1498	0.2484
	HH size	0.0821	0.0375
	N. adolescent	-0.1065	-0.1044
	N. skilled	-0.0214	-0.0104
	COH	0.0429	0.0219
Ed choice	In SE	0.0268	0.0591
	HH size	-0.0081	-0.0049
	N. adolescent	0.6482	0.4461
	N. skilled	0.0252	0.0126
	COH	0.0021	-0.0020
Wage earnings	Cons	4.8791	4.9210
	N. skilled in WE	0.7384	-0.5363
	N. in WE	0.7119	2.2107
SE income	N. skilled in SE	-0.0903	0.3388
	N. in SE	0.2436	0.2504
	N. hired	-0.2843	-0.1737
	Bus investment	0.4136	0.3849
	COH	0.0476	0.0046
SE income (LPM)	N. skilled in SE	-0.0140	-0.0230
	N. in SE	0.0213	-0.0034
	N. hired	-0.0302	-0.0113
	Bus investment	0.0373	0.0126
	COH	0.0035	0.0264
Graduation (LPM)	HH skilled	-0.1237	-0.0453
	N. skilled	-0.0268	-0.0415
	N. enrolled	0.1852	0.1975
	COH	0.0192	0.0041

Table 5: Matched moments in observed and simulated data

		Observed	Simulated
Proportions	Self-employed	0.7021	0.5753
	Training	0.1353	0.1036
	Both	0.1122	0.0856
	Borrowing	0.7106	0.7611
Bus investment	Mean	2.2057	2.7461
	25th percentile	0.0000	0.0000
	50th percentile	0.0000	0.7079
	75th percentile	0.0000	3.0815
Borrowing	Mean	7.4218	8.9351
	25th percentile	0.0000	0.3589
	50th percentile	9.8953	6.8710
	75th percentile	11.0613	14.7584
Spending	Mean	10.3048	11.7839
	25th percentile	9.8119	2.7267
	50th percentile	10.3253	10.8174
	75th percentile	10.8173	18.7166
Consumption	Mean	10.1790	11.6338
	25th percentile	9.7119	2.6562
	50th percentile	10.1985	10.6803
	75th percentile	10.6729	18.4496
Liquid investment	Mean	6.7197	8.0046
	25th percentile	4.5181	0.2236
	50th percentile	8.2940	7.0388
	75th percentile	9.5399	13.1617
Employment income	Mean	6.6201	7.9058
	25th percentile	0.0000	0.0000
	50th percentile	8.6046	6.1026
	75th percentile	10.3309	13.1451
Self-employment income	Mean	1.7476	2.1912
	25th percentile	0.0000	0.0000
	50th percentile	0.0000	0.4803
	75th percentile	0.0000	2.0920

Table 6: Responses by type

	Pre-program (1997-2001)				Post-program (2002-2006)			
	(0,0)	(0,1)	(1,0)	(1,1)	(0,0)	(0,1)	(1,0)	(1,1)
Self-employed	0.2291	0.2881	0.7143	0.7143	0.2180	0.2930	0.8970	0.9013
	0.0123	0.0133	0.0132	0.0132	0.0121	0.0138	0.0132	0.0134
Training	0.0559	0.1963	0.1235	0.2302	0.0493	0.3372	0.0649	0.1769
	0.0067	0.0086	0.0071	0.0109	0.0061	0.0092	0.0076	0.0103
Both	0.0335	0.0395	0.0551	0.1574	0.0702	0.0983	0.0551	0.1558
	0.0053	0.0057	0.0067	0.0107	0.0061	0.0062	0.0076	0.0099
Borrowing	0.6704	0.7627	0.7995	0.7627	0.6992	0.7596	0.7928	0.7981
	0.0138	0.0125	0.0117	0.0125	0.0134	0.0125	0.0118	0.0117

Proportions of each type engaged in the noted activity, with sample standard error figures below.

Table 7: Responses by type, counterfactuals

	Condition A				Condition B			
	(0,0)	(0,1)	(1,0)	(1,1)	(0,0)	(0,1)	(1,0)	(1,1)
Self-employed	0.2202	0.2906	0.7654	0.8159	0.2202	0.2906	0.8239	0.8567
	0.0121	0.0136	0.0152	0.0146	0.0121	0.0136	0.0132	0.0153
Training	0.0564	0.3090	0.1260	0.2417	0.0559	0.3372	0.0954	0.2093
	0.0068	0.0092	0.0071	0.0115	0.0067	0.0092	0.0074	0.0109
Both	0.0337	0.1327	0.0562	0.1714	0.0335	0.1180	0.0450	0.1680
	0.0052	0.0062	0.0068	0.0106	0.0053	0.0074	0.0065	0.0104
Borrowing	0.6771	0.7520	0.7531	0.7882	0.6992	0.7596	0.7896	0.8000
	0.0139	0.0125	0.0118	0.0122	0.0134	0.0124	0.0119	0.0113

Proportions of each type engaged in the noted activity, with sample standard error figures below. Condition A: complete school enrollment. Condition B: continued school enrollment.

Figure 1: Share of households with loans from each source

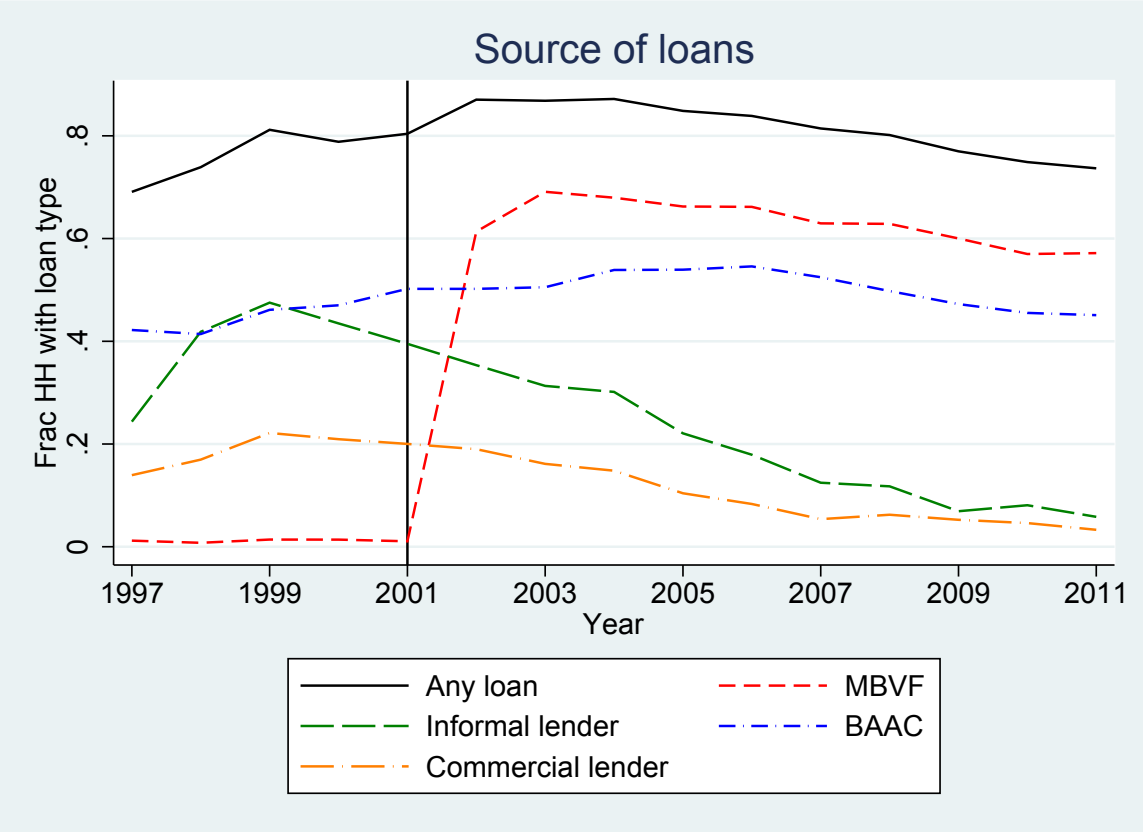
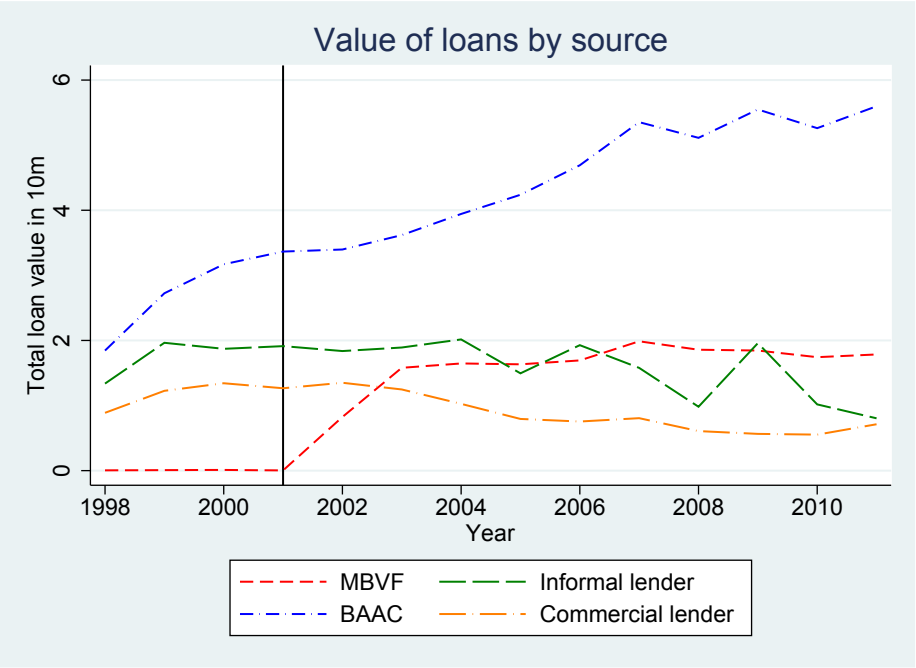
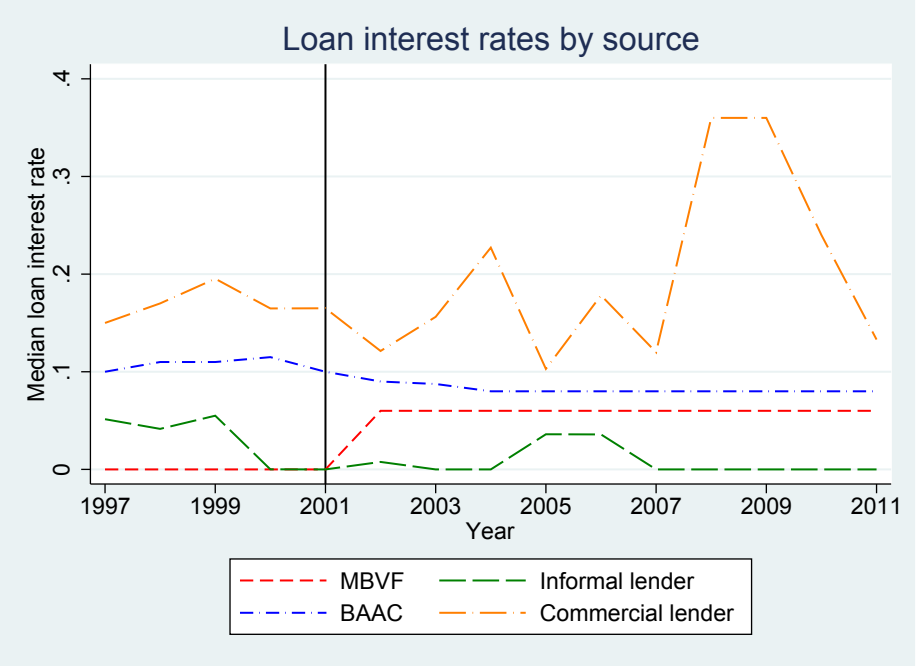


Figure 2: Total value of loans by lender



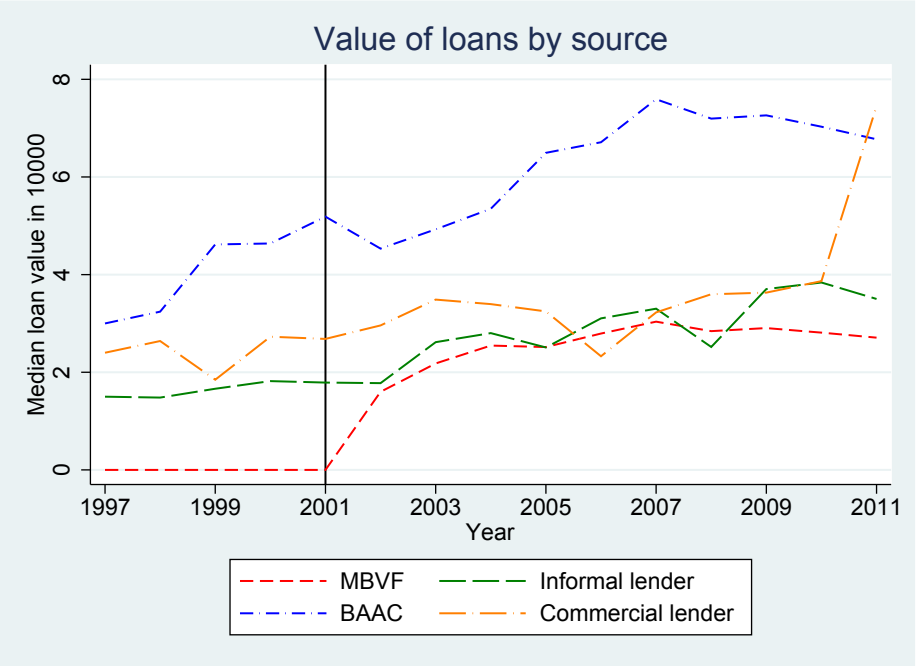
Note: Values are in units of 10 million baht, deflated to constant 2002 baht.

Figure 3: Median interest rates by lender



Note: Median interest rate by year calculated for households with a loan from that lender type in each year. Where interest rates were not reported in the survey, implicit interest rates are calculated by the original value of loan, the total amount that will be repaid, and the term of the loan.

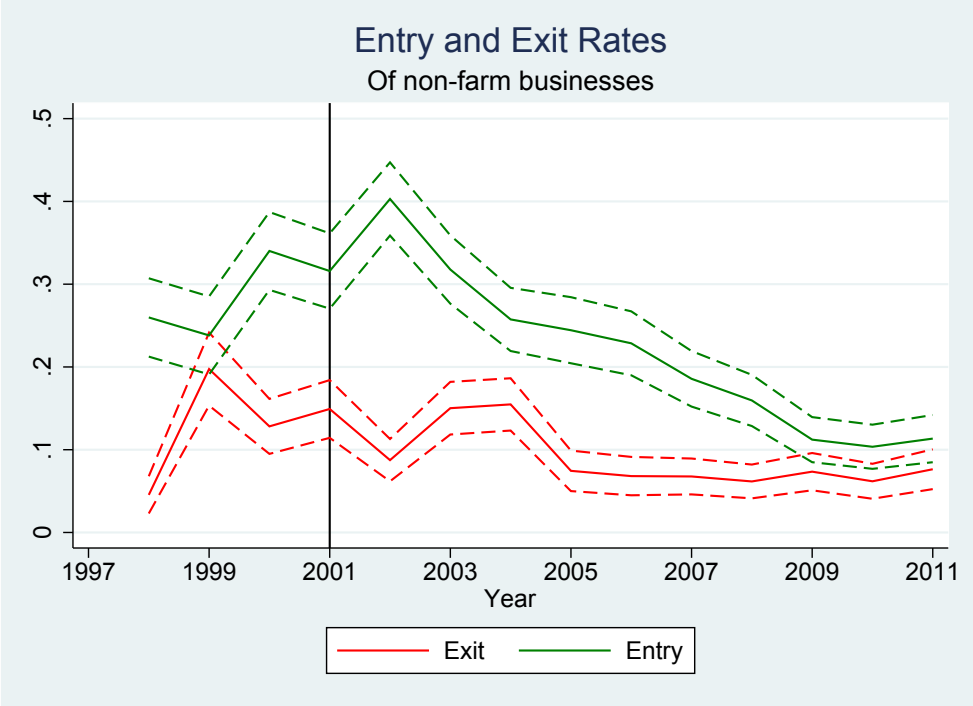
Figure 4: Median loan value



Note: Median loan value by household (in 10,000 baht) by source of loan, in 2002 baht.

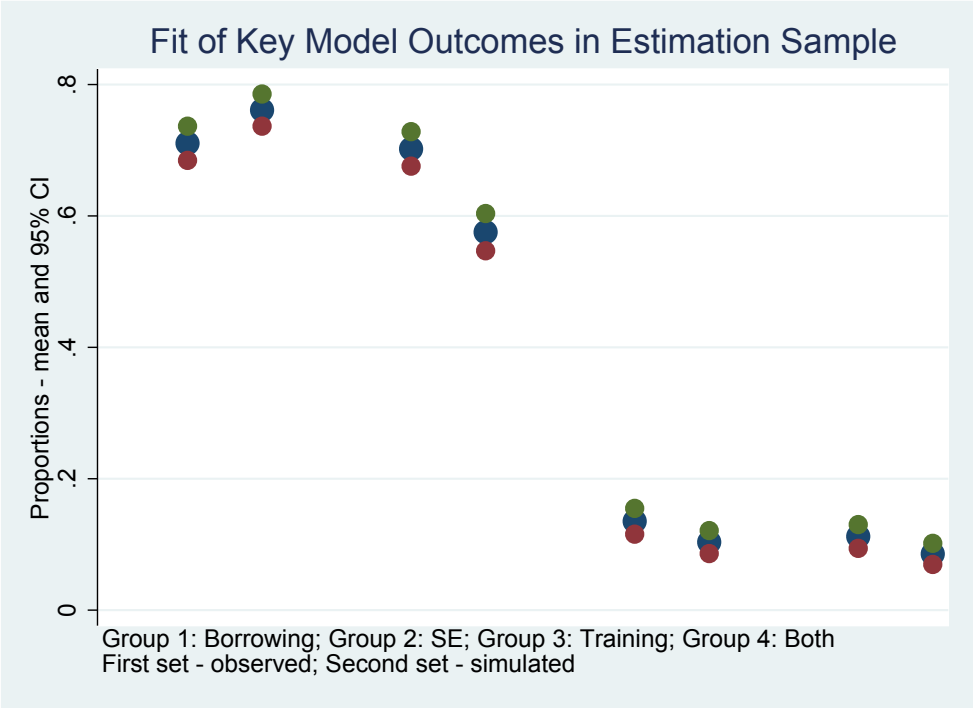
Figure 5: Share of households in self-employment

Figure 6: Household business dynamics



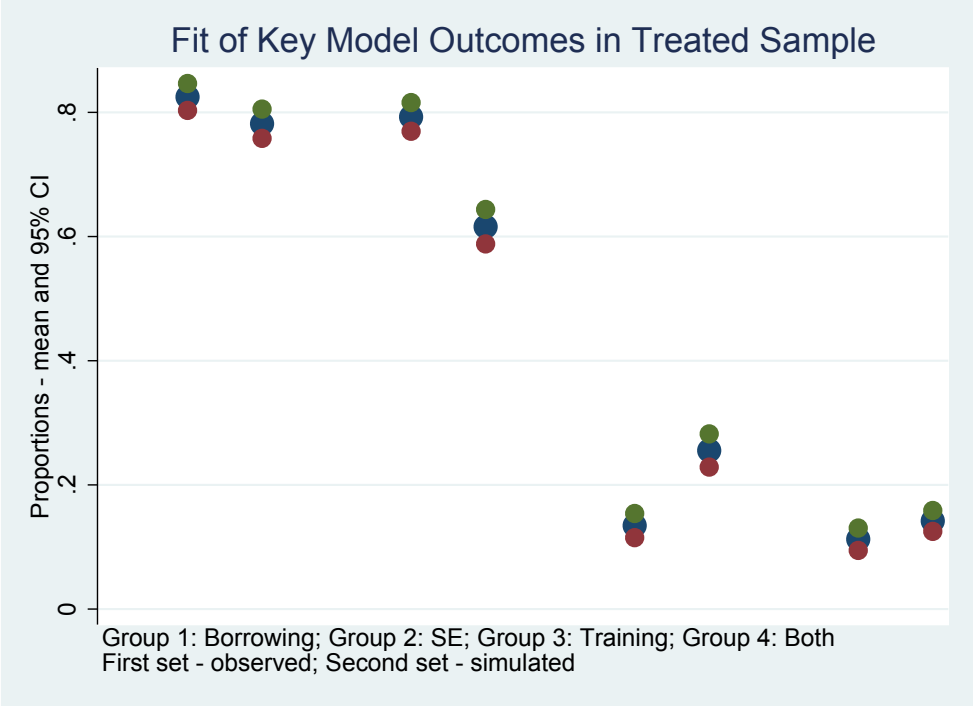
Note: Share of new businesses, and share of businesses that close, each year.

Figure 7: Simulated and observed choices for key proportion moments in the estimation sample



Means and 95% confidence intervals for choices made by households. As the choices are binary, the means represent the proportion of the sample choosing to engage in the named activity - borrow, be self-employed, be enrolled, and be both self-employed and enrolled. For each outcome, the left-hand group of points represents the values calculated from the observed sample, and the right-hand group of points represents choices among the simulated sample. The data sample is drawn from households between 1997 and 2001, representing the pre-program world.

Figure 8: Simulated and observed choices for key proportion moments



Means and 95% confidence intervals for choices made by households. As the choices are binary, the means represent the proportion of the sample choosing to engage in the named activity - borrow, be self-employed, be enrolled, and be both self-employed and enrolled. For each outcome, the left-hand group of points represents the values calculated from the observed sample, and the right-hand group of points represents choices among the simulated sample. The data sample is drawn from households between 2002 and 2006, representing the post-program world.