Human Capital Acquisition and Occupational Choice: Implications for Economic Development*

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Abstract

Using household-level data from Mexico we document patterns among schooling, entrepreneurial decisions and household characteristics such as assets, talent of household members and age of the household head. Motivated by our findings, we develop a heterogeneous-agent, incomplete-markets, overlapping-generations dynasty model. Households jointly decide over their life cycle on *(i)* kids' human capital investments (schooling) and *(ii)* parents' entry, exit and investment into alternative entrepreneurial modes (subsistence and modern). With financial constraints all of these are co-determined. A calibrated version of our model can account for the broad correlation patterns uncovered in the data within and across generations, e.g., a non-monotonic relationship between educational choices and assets across occupations, growth in profits and employment for modern firms only, and dynastic persistence across generations in education and wealth. Endogenous human capital acquisition is a key driver of inequality and intergenerational persistence. Eliminating this channel would decrease the top 10% income share by 47%. Eliminating within-period borrowing constraints would increase average household expenditure by 7.1% and benefit the middle class, reducing top and bottom expenditure shares. It would also reduce by 28% the correlation between household assets and kids' schooling levels.

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1 Introduction

This paper examines the role of credit market imperfections in the joint determination of human capital and entrepreneurial investments. Our motivation for studying simultaneously human capital and entrepreneurial investments comes from the observation that they affect each other when households make investment decisions (taking prices as given) and in general equilibrium. We use household-level data from Mexico to document patterns among schooling, entrepreneurial decisions and household characteristics. These patterns appear to be consistent with credit market imperfections that impact these two investment margins. Motivated by these findings, we develop and quantify a heterogeneous-agent model to investigate the importance of credit market imperfections in the joint determination of human capital and entrepreneurial investments.

To illustrate the mechanisms we study, consider an environment in which a household faces financial constraints. In this case, given equilibrium prices, a household's investments in human capital and entrepreneurial activities are jointly determined by the household's level of wealth. This is in contrast to an economy with perfect markets in which investments in human capital and entrepreneurial activities would be independent from household wealth and solely determined by the rates of return and market prices.

In addition, these two investment margins also interact with each other in general equilibrium. For example, returns to education depend on equilibrium wages. If entrepreneurs suffer from financial frictions, the number of operating firms and their size can be distorted downward relative to an environment with perfect credit markets. These distortions affect firms' labor demand and put downward pressure on equilibrium wages. In turn, this lowers the incentives to acquire education. On the other investment margin, borrowing constraints to investments in human capital also may reduce the effective, productive supply of labor in an economy, distorting upward equilibrium wages relative to the first best. This, in turn, can translate into reductions in the number of firms and their size.

But human capital investments not only increase the effective labor supply of workers, they also improve the productivity of entrepreneurs managing firms. Thus, distortions in educational investments affect the productivity of both workers and entrepreneurs.[1] In fact, the productivity of entrepreneurs has been found to exhibit substantial heterogeneity (across and within countries) and to be highly persistent over the life cycle of an entrepreneur.[2] This suggests that some time-invariant characteristic is likely to be an important driver of entrepreneurs' productivity.

This paper explores the role of innate talent supplemented with human capital in the form of

[1]The causal effect of education on earnings is a well documented fact. See Card (1999) and the references therein. For the case of Mexico, which we use as benchmark in our quantitative exercise, see also Attanasio et al. (2012).

[2]See, among others, Bloom et al. (2012), Buera et al. (2015), Midrigan and Xu (2014) and Pawasutipaisit and Townsend (2011).

schooling investments as a mechanism to rationalize this substantial and persistent heterogeneity.[3] In our model, financial frictions interact with innate talent and households' wealth to generate differences in human capital and entrepreneurial investments across individuals, over time and across generations. As schooling investments are mostly done at the initial periods of the life cycle and they are an input to entrepreneurial productivity, heterogeneity in schooling investments can endogenously generate heterogeneity in entrepreneurs' productivity that persists over the life cycle of a given entrepreneur. In addition, an end-of-life financial constraint also means that households cannot pass debt to future generations even if it were to finance the next generation's education investments. Thus, households use investments in education of their current offspring generation as a way to help their offspring.

We start by investigating how household investments in human capital in the form of schooling and entrepreneurial decisions correlate with household characteristics in the data. We study the Mexican Family Life Survey (MxFLS), which is a representative household survey of the Mexican economy that contains information on household occupational choices and schooling investments. This survey has a number of features that make it suited for our purposes. First, it is a panel survey that spans the period 2002 to 2009-2012.[4] This allows us to study how household characteristics in 2002 correlate with household outcomes in 2009-2012. Second, the MxFLS contains many of the key variables that economic theory suggests play a role in determining household choices. Among others, it contains measures of innate talent for parents and kids as measured by Raven tests, household assets and debt, age of household members and education of the parents.

Section 2 reports our empirical results. We find that a third of the surveyed households with kids age fifteen and above that no longer attend school in 2012 report that the main reason for permanently stopping kids' schooling was that they were not able to afford schooling expenses. We show that there are systematic correlations between innate talent, educational investments and occupational choices. Kids with parents that are more educated or have higher innate talent tend to obtain more years of education.[5] We find that kids' years of education have a high correlation with parental years of education (0.51) and lagged household assets (0.34).[6] We also show that household assets in 2002 are a strong predictor of years of schooling in 2012 for kids in poor households (after controlling for a rich set of covariates that include children's and parents' innate talents). In contrast, for relatively rich households, lagged assets are uncorrelated with educational outcomes (after controlling for the same set of covariates).[7]

[3]Buera et al. (2015) have suggested human capital as a potential channel to rationalize these facts. See also the related literature for contemporaneous work assessing the role of human capital.

[4]The end date is the period 2009-2012 because the last round of the household interviews were done over the 2009-2012 period.

[5]We find a correlation in Raven test scores between parents and kids of 0.47.

[6]For comparison, Mulligan (1999) finds correlations in years of education between parents and kids between 0.15 and 0.45 in a meta-study that only comprises rich countries (except for Malaysia).

[7]We define poor households as those with assets below the median level. Rich households are those with assets above

As in many developing economies, entrepreneurship plays an important role in the Mexican economy.[8] We find that around a third of the households operate businesses. However, there is substantial heterogeneity in the types of businesses operated by households. We distinguish in the data between two entrepreneurship modes, which we label subsistence and modern. Subsistence entrepreneurship consists essentially of self-employment. It is characterized by smaller scale businesses and lower profits than modern entrepreneurship on average. Around 27% of households operate within this subsistence regime. We find that modern entrepreneurs tend to be more educated, have higher innate talent and are more prevalent among wealthier households. We compute the returns to education across occupations in the Mexican Family Life Survey. We find that returns to education are similar for workers and modern entrepreneurs (around 8% Mincerian returns). However, we find significantly lower returns to education (around 5%) for subsistence entrepreneurs.[9]

We also document a non-monotonic relationship between kids' education and parents occupational choices. Richer households operating modern firms tend to educate their kids more. However, we show that poor households operating modern firms educate their kids significantly less than observationally equivalent households not operating modern firms. Also, we find that the rate of entrepreneurship is increasing over the life cycle of a household. For example, the rate of entrepreneurship is 25% higher for households whose household head is more than 45 years old. Also, as has been documented elsewhere, we find that average firm size measured by employment and profits increases over the life cycle.[10] But we find a stark difference between subsistence and modern firms: on average, subsistence firms do not grow at all over the life cycle. Firm growth is entirely driven by modern firms.

Motivated by our empirical analysis of the MxFLS, we develop in Section 3 a model to address these facts, in particular the heterogeneity in outcomes that we have documented. The goal of the model is to guide our analysis in parsing out the role of financial constraints from heterogeneity that would arise in an unconstrained neoclassical life-cycle environment. Our model consists of overlapping generations of forward-looking households that form dynasties and suffer from potential financing constraints (in the form of borrowing constraints and a lower bound on debt position across periods). Each household is composed of a parent and a kid. The household cares about the utility of both at every date, according to fixed Pareto weights. It also cares about the discounted utility of subsequent generations,

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the median level.

[8]This is typical of many other developing countries. In contrast, the rate of entrepreneurship is smaller in richer countries. For example, in the U.S., it is less than 10%.

[9]We estimate a Mincer specification and a log-log specification, which corresponds to the structural equation implied by the human capital production function that we use in our model. We use ordinary least squares to estimate the returns across occupations and, thus, omitted variable bias is an important concern. Using the random allocation of conditional cash transfers (Progresa program) as instrument, we find that the average returns to education of the ordinary least-squares (OLS) and the instrumented version (IV) are similar. See Angelucci and Giorgi (2009) and Behrman et al. (2011) for details on the IV. The fact that OLS and IV estimates of returns to schooling are similar has been documented in a number of surveys, see Card (1999). Unfortunately, we lack instruments to estimate separately returns to education across occupations.

[10]See, for example, Hsieh and Klenow (2014) and Tybout (2000).

out through the infinite future.

Each individual agent is endowed with a draw of innate talent upon being born. We allow for innate talent being a persistent process within the current family, so that a kid's innate talent is correlated with the innate talent of the parent. At each point of the life cycle, a household jointly decides whether to educate the kid or have her participate in the labor market and earn a wage. Education complements innate talent and augments effective human capital. The household also decides whether the parent becomes a worker or an entrepreneur. A novelty of our set-up relative to the benchmark entrepreneurship models (e.g., Buera et al., 2015) is that its overlapping-generations structure allows us to analyze the model's implications for intergenerational mobility and household choices over the life cycle (e.g., entrepreneurship).

Motivated by the findings in Section 2, we allow entrepreneurs to operate two types of technology, which we label modern and subsistence. We allow for the productivity of the modern technology to be more sensitive to the human capital of the entrepreneur than the subsistence technology, as suggested by our estimates of returns to schooling across occupations. However, the modern technology requires a set-up cost to be operated, while the subsistence sector does not.[11] Education is an explicit sector in the model. That is, human capital is produced in schools using final output, labor itself in effective human capital units, and time of students (which entails an opportunity cost in terms of foregone wages).

We focus our analysis on the stationary equilibrium, where factor prices and overall distributions have settled down. The equilibrium heterogeneity in outcomes across households and over time in our model is generated by heterogeneity in innate talent, schooling levels, household wealth (within and across generations) and the presence of financial frictions (affecting schooling and firm investment). The overall joint distribution of wealth and skills is an endogenous equilibrium outcome. There is some intergenerational churning within the steady-state distribution, as different generations within the same dynasty experience talent shocks that make their innate talent levels different from those of their parents. As described above, in equilibrium, some households with low levels of assets are constrained in making their financial and entrepreneurial decisions. This distorts the overall supply of factors and equilibrium factor prices (which in turn affects all agents in the economy). Thus, the presence of borrowing constraints generates heterogeneity in schooling and entrepreneurial investments for households with the same levels of innate talent.

Section 4 presents a quantification of the model. We parametrize our baseline model to match key moments of the cross-section in the MxFLS corresponding to financial markets, occupational choice and educational investment. We then use the quantitative version of our model to inform us in two

[11] Banerjee and Duflo (2005) stress the important of these non-convexities to give rise to realistic investment dynamics and dispersion in the returns to capital.

important dimensions. First, to the extent that our calibrated model can account for the targeted cross-sectional moments, we can use our calibrated model to quantify the effect of financial frictions on entrepreneurship and schooling investments via counterfactual analysis. That is, we can relax financial frictions keeping the rest of parameters at their calibrated values and compare the resulting equilibrium to the calibrated equilibrium. Second, we make the observation that we do not use any information on the household life cycle in the calibration. Despite this, our quantitative model generates magnitudes of entry into entrepreneurship and firm growth over the household life cycle that are well in line with the MxFLS data.

In our calibration of the model, we use some of the results from our analysis of the household survey data in Section 2 to pin down ex-ante some parameters of the model. Some other parameters do not have such a close counterpart in the household data. We follow a calibration strategy to jointly determine these parameters by minimizing the distance between some moments generated by our model and their counterparts in the data.[12]

We find that the quantitative version of our model is capable of reproducing the salient features of the Mexican Family Life Survey documented in Section 2. For example, households with more assets, more talented kids or more educated parents tend to educate their kids more. The intergenerational correlation of education is partly generated by our model through the following neoclassical mechanism. Richer households tend to have higher innate talent. This implies that their kids are also more likely to be talented (because innate talent is persistent) and parents have a higher incentive to invest in schooling (because it is complementary with innate talent). Note that this neoclassical mechanism also tends to make more talented kids relatively more educated irrespective of the education of the parent (since the return from investing in education is increasing in the talent of the kid). Borrowing constraints also play a key role in generating these correlation patterns for education. For example, the fact that, ceteris paribus, wealthier households educate their offspring relatively more is generated in our model through the existence of borrowing constraints that prevent poor households from investing optimally.

The model is also able to match some "untargeted" moments. For example, it generates the non-linear educational policy function for households operating modern technologies described in Section 2. For very low levels of assets, education is increasing in assets. However, when a certain asset threshold is reached, households switch and invest into the modern technology and reduce the investment in education. Eventually, this effect subsides and investments both in education and the modern firm are increasing in assets. Also, the predicted values of private debt to GDP and top 10% income share are

[12]The moments that we use are: yearly interest rate, average of debt to asset ratio, top 10% expenditure share, median household expenditure in education (conditional on positive expenditures in education), average years of schooling, percent in the population of modern and subsistence entrepreneurs, fraction of loans requiring a guarantee and ratio of average household debt to average household assets.

well in line with the ones observed in the data: 16.1% versus 18% and 36% versus 39%, respectively.

Our calibration does not use any moments that target life-cycle aspects. Despite this, our model generates time paths over the life cycle for firm dynamics and entrepreneurship that are similar to those observed in the data. First, the model successfully predicts that entry into entrepreneurship is increasing over the life cycle, with age of the household head. This result is mostly driven by poor households that are constrained in their investments. At the initial stages of the household life cycle, wealth is saved and/or invested in kid's education while subsequently it is used by the parent to operate a subsistence firm. Second, the model also generates firm size and profits that are stagnant for subsistence firms and increasing for modern firms. The stagnation of subsistence firms is partly due to borrowing constraints preventing firm growth. However, it is also driven by substantial entry of new and small subsistence firms started by older households and by the exit of some of the largest subsistence firms that eventually switch to operate the modern technology. Quantitatively, we find rates of growth for the modern sector that match quite closely the ones we observe in the data. The model predicts that the firm size of "old" firms is 33% higher than "young", while we find it to be 30% in the data.

In terms of life-cycle behavior, we find that, in our quantitative version of the model, households always bequeath positive assets to the next generation (even the poorest). This is done to ensure that the next generation of kids can obtain some human capital. Thus, it represents a form of intergenerational self-financing. Because of the irreversibility and front-loaded nature of human capital investments, we see that the previous generation (especially for the poor) tend to "save up" to ensure enough resources are available at the beginning of the life cycle of new individuals.

We can also study intergenerational mobility questions in our model. For example, we show that a kid born with the highest innate talent in a family in the bottom decile of the wealth and parental human capital distribution would only obtain 5 years of education, while that child would obtain 20 years if she were born in a top decile family. Conversely, a kid with the lowest ability level would obtain 4 years of education if born in a bottom decile family, while it would obtain 20 years if born in a top decile. This latter result illustrates how investing in kids' human capital is also a form of transferring resources intertemporally, as higher human capital today translates into higher earnings in the future. We show that the magnitude of the differences in educational outcomes predicted by our calibrated model are similar in magnitude to the predicted differences by our empirical analysis of Section 2, despite being an untargeted moment.

To investigate the role of different mechanisms of our model, we conduct counterfactual experiments in Section 5. First, we show that endogenous human capital investments are crucial in generating inequality in the quantitative model. Conducting the experiment of shutting down human capital formation holding all other parameters constant would reduce inequality enormously. Top 10% expenditure share would be reduced by 47%. Part of this result is due to the existence of borrowing constraints, as we discuss below. Another important part comes from the fact that the calibrated differences in innate talent that we feed into the model are much smaller than standard calibrations that do not account for endogenous human capital. In our calibration the most talented agent is "only" 2.3 more productive than the least talented agent. In contrast, the endogenous education margin alone can generate 9.4-fold differences in productivity between someone with only primary education and someone with a masters' degree. Experience generates three-fold differences. Thus, heterogeneity in agents' productivity and, ultimately, inequality are mostly driven by endogenous human capital investments in our calibrated model.

We study the behavior of our economy as borrowing constraints are loosened, or, equivalently, we make a comparison across economies which differ in this dimension. Holding all other parameters constant, we find that eliminating within-period borrowing constraints would increase average income per capita by 7.1%.[13] Loosening borrowing constraints would generate significant changes in inequality and intergenerational mobility. The consumption expenditure share accruing to the top 10% households would be reduced by 10.5%, and the expenditure share of households at the bottom 10% would also decrease by 3.1%. Thus, households in the middle of the distribution would benefit relative to those in the extremes. We can also use our model to quantify by how much the correlation between household assets and schooling outcomes or the correlation between parent and kids schooling outcomes would change in the absence of borrowing constraints. In our baseline calibration, these correlations are 0.76 and 0.55, respectively.[14] Eliminating borrowing constraints would reduce by 28% the capital-schooling correlation, but only 6% the intergenerational correlation in schooling. This suggest that households reduce substantially the amount of assets bequeathed to the next generation to facilitate human capital investments.

Section 6 concludes the paper by proposing possible applications to policy analysis and directions for future research, such as analyzing non-stationary environments and modeling credit market frictions in yet more detail.

There are different strands of the literature to which this work relates. First, it relates to the estimation of human capital accumulation in dynamic general equilibrium models, such as Heckman et al. (1998). We share with this work an interest in an analysis of the evolution of labor earnings and skill formation. A key aspect of our theory is the existence of borrowing constraints in education. Caucutt et al. (2015), Caucutt and Lochner (2012), Lochner and Monge-Naranjo (2011) among others have provided evidence on the importance of credit constraints in education in the United States. Our formulation of credit constraints is in the form of constraints proportional to net worth plus a non-

[13]We note that we are only eliminating the borrowing constraint, but not the non-negativity constraint on assets next period.

[14]As we discussed, their counterparts in the data are 0.34 and 0.51.

conditional credit line (thus, independent of net worth). Even though Lochner and Monge-Naranjo (2012, 2014) have proposed more elaborate formulations of credit constraints for education, we view our exercise as a first step towards building a more comprehensive general equilibrium theory that encompasses occupational choice and human capital acquisition.

Second, the model builds on the work on occupational choice and wealth distribution in heterogeneous agent models as developed in Banerjee and Newman (1993). DeNardi (2004) and Cagetti and DeNardi (2006) developed quantiative versions of these models for the United States. These models of entrepreneurship have been also applied to qualitative and quantitative analysis in development economics, as in Giné and Townsend (2004), Jeong and Townsend (2007), Shin et al. (2011a), Buera et al. (2011), Shin et al. (2011b), Buera and Shin (2013) and Midrigan and Xu (2014) among others. Relative to this literature, our contribution is to add an endogenous human capital accumulation margin and quantify its role in the process of development.[15]

Third, the work relates to the diverse and rich literature that inquires how human capital accumulation contributes to inequality across and within generations and the process of development, such as Becker et al. (1990), Becker and Tomes (1994) and Galor and Zeira (1993). Erosa et al. (2010) and Cubas et al. (2015) pursue a similar endeavor to ours, but their focus is on explaining cross-country income per capita differences.[16,17] Lee and Seshadri (2015) and Lee et al. (2015) have recently developed heterogeneous-agent models to quantitatively assess the role of innate talent and human capital investments on earnings inequality and intergenerational mobility in the United States. Relative to their work, we introduce entrepreneurship in our model and analyze its interaction with human capital investments. Also, instead of studying the United States, our focus is on economic development. Seshadri and Roys (2014) and Ventura et al. (2015) study models with entrepreneurial choice and human capital accumulation. Relative to this work we introduce credit constraints, which makes the household problem of investing in human capital and entrepreneurial activities non-separable.

This paper is also related to recent work by Samaniego and Sun (2016) and Castro and Sevcik (2016) who also explore the interaction between human capital and occupational choice in a heterogeneous-agent model with financial frictions. Samaniego and Sun focus on college investments in the United States, while Castro and Sevcik focus on understanding how investment distortions on these two mar-

[15]See also Doepke and Zilibotti (2014) for an application of models of entrepreneurship with overlapping-generations to economic growth with an endogenous investment margin in risk tolerance and patience.

[16]Seshadri and Manuelli (2005) argue that adding human capital to the standard one sector growth model does a good job explaining economic miracles. Galor and Moav (2004) model how human capital has played different roles in the last two centuries for economic growth. Munshi (2010) analyzes the transition into a new occupation/sector, but he emphasizes the role of community-based networks for families to bootstrap their way out of poverty rather than investment in human capital and wealth accumulation, as we do.

[17]In terms of techniques, Caucutt and Kumar (2003) use a heterogeneous agent model with borrowing constraints and human capital acquisition to analyze U.S. higher education policies. Huggett et al. (2011) analyze sources of lifetime inequality in the U.S. also using a heterogeneous-agent model and conclude that initial differences at age 23 account for most of the variation in lifetime inequality.

gins translate into aggregate TFP distortions. In contrast, our focus is on studying heterogeneity in household outcomes across and within generations in an economic development context. We note also that our formulation of financial frictions is less stringent, as relative to these models households can roll over debt from period to period and can have access to credit even with no assets.

From an empirical standpoint, we are not the first to point out that financial frictions can have an effect on both occupational choice of parents and schooling investments of children. Garlick (2016) and Lakdawala (2011) follow Kaboski and Townsend (2011) and use the national credit initiative in Thailand, the Million Baht Village Fund, to estimate the effect of an increase in household access to credit. They document an increase in entrepreneurship among financially constrained households and an increase in children's labor supply. Garlick also shows that there is a significant decrease in school enrollment among newly entrepreneurial households. Augsburg et al. (2015) present similar evidence for Bosnia and Herzegovina using a randomized control trial for access to microcredit. They document an increase in the rate of entrepreneurship (in the form of self-employment) accompanied by a decline in schooling and an increase in labor supply of 16- to 19-year-olds in the household's business.

2 Motivating facts from Mexico: Macro and Micro Evidence

In this section, we present some facts on human capital and occupational choice for Mexico, which we use as benchmark country in our paper. These facts guide our subsequent modeling choices in Section 3 and they are used to inform our quantitative exercise in Section 4. We present a combination of micro and macro data on educational choices of households, occupational choices (and their interaction with education) and access to credit. Overall, the evidence presented below paints a picture that is potentially consistent with borrowing constraints affecting households' occupational and educational choices. Ultimately, however, we use the calibrated version of the model we develop in Section 3 to parse the role of financial frictions from other possible channels driving occupational choice and human capital investment such as talent persistence across generations or endogenous wealth accumulation.

We use the case of Mexico as a paradigmatic middle-income country. We start discussing some aggregate features of the Mexican economy that are paramount in most developing countries, such as the existence of a dual productive structure and the lack of financial development. Then we turn to the analysis of micro-data. For this, we make extensive use of the Mexican Family Life Survey (MxFLS), a household survey representative of the Mexican economy.

Productive Structure The productive structure of Mexico is characterized by a dual structure. Khamis (2012) documents the existence of an important informal sector, which tends to be run by self-employed workers who operate at a small scale and seldom use formal contracts. In a similar vein, the McKinsey Global Report (Bolio et al., 2014) classified 95% of the registered companies in Mexico as "traditional," which they characterized as "unlikely to be able to invest in productivity-improving equipment and technology and use manual methods or antiquated machinery." They also link traditional business practices with self-employment, stating that "traditional business may exist to provide a living for the owner and his or her family."[18] In contrast to the traditional sector, the McKinsey Report identifies modern firms as using "standard business practices found across organizations in advanced economies, with formal controls, resource allocation, and management systems. A modern firm typically hires qualified managers and uses machinery and information technology to raise productivity." Modern firms are bigger on average and are concentrated at the right tail of the firm-size distribution.[19]

Financial Development Another salient feature of the Mexican economy is its low level of financial development. For example, domestic credit to the private sector relative to GDP oscillated between 15% and 25% during the period 2000-2010, reaching 31.1% in 2014. Bolio et al. (2014) calculate that the value of outstanding private loans relative to GDP was 33% in Mexico in 2014. The corresponding value for advanced economies is 4.5 times the value of Mexico. In fact, by this measure, Mexico ranks below Brazil and most of its Latin American peers. One plausible explanation for this low level of financial development is the existence of severe credit market imperfections. Indeed, firm surveys conducted by the World Bank estimate that more than half of Mexico's small and medium sized businesses have insufficient access to financial services.[20] Randomized-control trial evaluations have also provided evidence of high returns to capital for small firms in Mexico. For example, in a randomized experiment that gave cash and in-kind grants to small retail firms, McKenzie and Woodruff (2008) estimate the marginal return of investment to be three to five times higher than the market interest rates. McKenzie and Woodruff document that the effects of the intervention were concentrated among firms that were more financially constrained.[21]

There are, however, other potential explanations for the low levels of financial development. For

[18]These businesses have usually less than ten employees and employed around 42% of all registered workers in Mexico in 2009. In 1999, according to Bolio et al. (2014), 39% of registered workers were employed in the traditional sector. Thus, its size has remained fairly stable.

[19]Large modern establishments (defined as having more than 500 employees) employ about 20 percent of the census-registered workforce. In terms of firm dynamics, Bartelsman et al. (2004) find that Mexico has the lowest rate of new company entries among major developed and emerging countries. In addition, Hsieh and Klenow (2014) show that, conditional on firm entry, the life cycle of firms in Mexico exhibits less growth than the U.S. (roughly a third of that in the U.S.). This suggests both important barriers to entry and firm growth in Mexico. Bergin et al. (2009) show that, in 2006, nearly half of Mexico's manufacturing exports and over 20% of its manufacturing value added were produced by maquiladoras, or export assembly plants –which import inputs from abroad, assemble or process the inputs to final outputs and then export the finished goods.

[20]Similarly, the McKinsey Global Report estimates that lack of access to credit for businesses with 10 to 250 employees accounts for most of the "credit gap" in Mexico.

[21]There exists also direct firm survey evidence presented by Beck et al. (2005). They survey firms in 54 different countries to elicit the existence of borrowing constraints and find that Mexico is among the top countries in which firms report facing severe obstacles to obtaining finance. Indeed, low financial development is a pervasive feature of most developing economies. See for example de Mel et al. (2008) and the surveyed evidence in Banerjee and Duflo (2005).

example, very talented households could concentrate all wealth in the economy. If talent is very persistent, then we would observe very low credit even if there were perfect markets. We use the quantitative model developed in Section 3 in which we allow for financial frictions, talent persistence and endogenous wealth accumulation to quantify the different possible channels.

Years of Schooling The average years of education of the adult population in Mexico was 7.1 years in 2000, which represents 60% of the 12 years that the U.S. had in the same year.[22] Most of the difference with the U.S. is explained by differences in secondary and tertiary education. From a more historical perspective, educational attainment has been increasing in Mexico during the twentieth century. The literacy rate among citizens aged ten and older rose from around 40% in 1940 to more than 80% in 1985. Enrollment rates among 13-15 year-olds increased from 69% in 1990 to 77% in 2000. However, in 2007, only 50% of Mexicans between 15 and 19 years old were enrolled in public or private educational institutions.[23]

2.1 Educational Choices: Household Evidence

We next turn our analysis to household-level data to investigate how educational and occupational decisions interact with other household characteristics. We use the Mexican Family Life Survey (MxFLS). The MxFLS is the first longitudinal survey representative of the Mexican population.[24] Over a period of ten years, three rounds have been conducted (in 2002, 2005-2006 and 2009-2012). The first wave was designed by the National Institute of Statistics and Geography (INEGI) and covered a sample of 35,000 individuals from 8,400 households. The follow-up information on originally sampled households is very high: almost 90% were re-interviewed in the second and third waves. Among other variables, the MxFLS provides measures of parents' and children's cognitive ability (Raven's tests), household schooling decisions, occupational decisions, household income and household assets.

We start our analysis of the MxFLS by investigating the correlates of children's schooling decisions. We pay particular attention to the possibility of borrowing constraints playing a role in educational choices. Our baseline sample consists of a panel constructed by linking the first (2002) and last waves (2009-2012) of the MxFLS. This allows us to have information of schooling outcomes of kids that have completed (or are close to completing) their desired level of education in the last wave.

[22]Relative to other Latin American countries, Mexico is in the upper part of the distribution in terms of years of schooling. For example, in 2000, Argentina had 8.8 years on average, Ecuador, 6.4 and Bolivia 5.6. Data on years of education comes from Barro and Lee (2013).

[23]The quality of Mexican education also lags behind to richer countries and many country peers. Combining PISA scores for math, reading and science, Arias (2006) shows Mexico does worse than all developing countries in the sample except for Brazil, both in absolute terms and relative to what one would predict based on expenditure per student in the country. For example, only 0.3% of Mexican students attain an "advanced score"(625 or higher).

[24]The MxFLS is developed and managed by researchers from the Iberoamerican University (UIA), the Center for Economic Research and Teaching (CIDE) and Duke University. Data and additional information are available at http://www.ennvih-mxfls.org/english/index.html.

Table 1: Main Reason for Stopping School Attendance

Cannot afford Expenses	33.9%
Graduation	20.3%
Lack of Skill or Motivation	18.1%
Work to help household expenses	14.4%
Personal Reasons	6.4%
School quality and availability	2.4%
Other (incl. Missing)	4.5%

See online Appendix B for details on data construction.

The MxFLS reports the main reason for stopping school attendance for individuals age 15 and above who do not attend school at the time when being questioned. Table 1 reports the main reason for permanently stopping education. The most common reason mentioned by households (33.9% of the answers) is the cost and difficulties in funding the subsequent years of education, 20.3% report that they graduated with the desired level of education and 14.4% report that the main reason for stopping school attendance is to work to help with the household expenses. Prima facie, the fact that some households report that they cannot afford schooling expenses suggests the existence of market imperfections such as borrowing constraints. Also, for children stopping school to work in order to help household expenses, this can reflect high opportunity costs or the existence of market imperfections preventing households from transfering resources intertemporally.[25]

Expenditures on education are not negligible for the typical Mexican family. We compute the expenditures on education relative to total household expenditures.[26] We find that educational expenditures represent 10% of total household expenditures for the average household and 6% for the median household. Given that educational expenditures represent a sizable share of household expenditures, it may be the case that households borrow and save with the purpose of paying education of their kids. Unfortunately, the MxFLS does not contain information on the purpose of the loans taken by households. We use another representative household survey for Mexico, the Global Findex database, to elicit this information. We find that 18.9% of the households report having borrowed to pay for education and school fees in the last 12 months. Moreover, 28.4% of the interviewed households report to have saved for education or school fees in the last 12 months. Interestingly, poor households report taking fewer loans (15.3%) and saving less for education (20.8%) than rich households (21.4% and

[25]This evidence is also consistent with self-reports from the Progresa/Oportunidades 2013 follow-up survey. In this survey, 22.1% of interviewees report having missed school because they "did not have enough money to afford it," while 4.7% report having missed school to help the household by supplying their labor (at home or in the labor market).

[26]Schooling expenditures comprise school fees but also additional school-related costs such as books, transportation, uniforms, etc.

33.5%, respectively).[27] This may, in part, reflect selection (i.e., richer households having more talented kids) or borrowing constraints (i.e., households not being able to afford educational expenditures or having difficulty in accessing credit to finance it).

To better understand households' decisions, we study how households' schooling decisions correlate with households' characteristics. To this end, we regress years of education of a kid on an array of household characteristics,

$$\text{Education}_{i,2012}^{hh} = \beta_0 + \beta_1 \text{Assets}_{2002}^{hh} + \beta_2 \text{Age}_i + \beta_4 \text{Talent Kid}_i + \beta_5 \text{Talent Parent}^{hh} + \gamma X_i^{hh} + \varepsilon_i^{hh}. \quad (1)$$

$\text{Education}_{i,2012}^{hh}$ denotes the log years of education of kid i belonging to household hh in year 2012, $\text{Assets}_{2002}^{hh}$ denotes log household assets in 2002, Talent Kid_i and $\text{Talent Parent}^{hh}$ denote respectively the average Raven's test scores of parents and kids across waves, Age_i denotes the log age of kids. X_i^{hh} denotes additional control variables in our regression. These are: parents' occupation and education, household debt, number of kids and several interaction terms.[28]

Table 2 reports the results of estimating regression (1). We see that household assets in 2002 are positively correlated with educational outcomes in 2012. Column (1) reports the regression without any additional controls, while (2) and (3) include the discussed controls sequentially. In terms of the controls included in columns (2) and (3), we find that households with more educated parents and more talented kids tend to educate kids longer. Also, households with more household members tend to educate kids less.

The magnitudes of the estimates we find are large. Consider the case of two kids born with identical innate talent in identical families except that one household is at the 10th percentile of the asset distribution and the other, at the 90th. Using our estimates in column (3), the kid born in the household with more assets should receive 60% more years of education. Consider now the case in which the only difference across households is the educational level of parents. Suppose that in one household the educational level of parents is at the 10th decile and it is at the 90th in the other. Then, our estimates imply that, ceteris paribus, the kid born in the more educated household should receive 49% more years of education. Finally, consider the case of two kids, one with innate talent at the 10th percentile and the other, at the 90th. Holding everything else constant, our estimates imply that the more talented kid would obtain 17% more years of education.

Overall, these results imply a positive and significant correlation in the cross-section between kids' years of education, household assets and parental education –which are often used as measures of inter-

[27]The Global Findex database is a representative survey of the Mexican economy in 2014 published by the World Bank and implemented by Gallup. Poor households are defined as the poorest 40% in the population. Rich households are the complementary set. These data are available at http://www.worldbank.org/en/programs/globalfindex.

[28]Tables D.1 and D.2 in the online appendix report the summary statistics of these variables in levels and logs. We favor using assets rather than net assets (defined as assets minus debt) to maximize the number of observations. Net assets and assets are positively correlated.

generational mobility. We find a correlation of 0.51 between years of education of parents and kids. This correlation is higher than the range of 0.15−0.45 observed across the eight studies surveyed in Mulligan (1999).[29] We also find a positive and significant correlation of 0.34 between initial household assets and kids' level of education.

One possible explanation for why household assets in 2002 matter for years of education is the existence of borrowing constraints. The reasoning is that households with more assets–holding all other controls constant (parents' education and innate talent, kid's age and innate talent, etc.)– can more easily pay the education costs of their children (either directly or by taking a loan). To further explore the hypothesis of borrowing constraints being important in education, we estimate regression (1) splitting the sample of households between those with assets below and above the median asset level in our sample (columns 4 and 5, respectively). We find that, for households with assets below the median asset level, the coefficient on assets in 2002 is positive and significant with an elasticity of 1.5. This coefficient implies that increasing assets in 2002 from the 10th percentile to the median would increase years of education by 1.1 years. In contrast, for households with assets above the median, the coefficient on assets is zero.[30]

While we cannot rule out other explanations for why years of education and lagged household assets are only positively correlated for poor households, borrowing constraints appear as a possible explanation. As we discuss in Section 3, a child's education should be independent of household assets in an economy with perfect markets. In particular, for households with a low level of assets that cannot pay educational costs out-of-pocket, achieving a child's optimal educational level would require them to borrow today and repay in the future. In the presence of borrowing constraints, this intertemporal transfer of resources may not be possible. The level of household assets would play a role in determining the amount of investment in education, generating a positive correlation between education and household assets for households with a low level of assets, as we observe in the data.

2.2 Occupational Choices and their Interaction with Educational Choices

Next, we analyze households' occupational choices. We focus on entrepreneurship and study the characteristics of agents selecting into entrepreneurship and their types of businesses. We then analyze the interaction of occupational choices with educational choices.

We use the MxFLS to classify agents in the labor market in three occupational categories: workers, subsistence entrepreneurs and modern entrepreneurs. We differentiate between modern and subsistence entrepreneurs to capture the dual nature of production discussed above. We define subsistence

[29] His meta-study includes the U.S., Germany, Malaysia and Kalamazoo, Michigan.

[30] Table D.3 in the online appendix reports the same regressions by asset quartiles. We find that the effects of assets for the two top quartiles is zero. The most sizable effect (and the only one significantly different from zero) is in the second quartile.

Table 2: Education Policy Function Regressions

	(1)	(2)	(3)	(4) HH Assets Below Median	(5) HH Assets Above Median
Log(Assets)	0.13*	0.03*	0.03*	1.51*	0.01
	(0.02)	(0.01)	(0.01)	(0.58)	(0.01)
Log(Debt)		0.35	0.84*	0.74	0.63
		(0.32)	(0.34)	(0.42)	(0.38)
Log(Parents Educ.)		0.16*	0.16*	0.15*	0.15*
		(0.01)	(0.01)	(0.02)	(0.01)
Log(Kid's Age)		0.03	-0.01	-0.06	-0.02
		(0.03)	(0.03)	(0.06)	(0.03)
Log(Kid's Talent)		0.22*	0.23*	0.36*	0.07
		(0.06)	(0.06)	(0.09)	(0.08)
Log(Parents' Talent)		-0.01	-0.00	0.01	-0.07
		(0.03)	(0.04)	(0.05)	(0.05)
Log(Kid Tal.)×Log(Parent Tal.)		-0.08	-0.05	0.05	-0.22*
		(0.05)	(0.06)	(0.08)	(0.08)
Entrepreneur Dummy			-0.02	-0.03	-0.02
			(0.02)	(0.02)	(0.02)
Number of Household Members			-0.13*	-0.13*	-0.12*
			(0.03)	(0.04)	(0.04)
Observations	5113	4674	3955	1690	2265

Standard errors in parentheses. * denotes a p-value lower than 5%. All regressions include a constant.

entrepreneurs as those reporting to be self-employed or farming their own plot of land. Subsistence entrepreneurs represent 26-30% of our sample of income earners. We define modern entrepreneurs as those who report that their main job is being a boss, employer or business proprietor. Modern entrepreneurs represent 6%-8% of the income earners in the sample.[31] We define workers as those working for someone else. Among non-agricultural entrepreneurs, self-employment is the most prevalent mode of operation. In fact, more than 50% of non-agricultural entrepreneurs report that they run their business at home. Among entrepreneurs who report to be self-employed, we find that many of them report to employ labor, especially other family members.

Albeit imperfect and coarse, this classification allows us to capture some of the features of the dual productive structure of Mexico. Table 3 shows the average number of workers employed, sales and net profits by type of business. We find that modern businesses employ more workers on average.[32]

[31] If we additionally require that they report using formal contracts and/or pay some formal insurance, the fraction of modern entrepreneurs drops to 0.5% of the total sample. These firms tend to employ more workers (around 6 on average) and report monthly sales of around 24,000 pesos, which is about 3 times the sales of average modern businesses.

[32] The difference stems from the fact that they have more non-household members working in the firm.

Sales and net profits are roughly 50% higher for modern entrepreneurs. We also distinguish between agricultural and self-employed subsistence entrepreneurs. Self-employed entrepreneurs constitute the vast majority of subsistence households in our sample (almost 80%).

We compare the firm size distribution of modern entrepreneurs implied by the third wave of the MxFLS with the firm size distribution from the 2008 census of the Mexican National Institute of Statistics and Geography (INEGI). We find that they are quite similar. For example, 90% of establishments have five or less employees according to INEGI, while this number is 89% in the MxFLS. 0.9% of establishments have 50 employees or more according to the census, which is 1.4% in the MxFLS. In Table D.6 in the online appendix we compare also other moments of both distributions and show that they are also similar. This can be explained by the fact that INEGI's census excludes agricultural activity, businesses in rural areas and businesses in mobile units (e.g., street vendors) –see the discussion by Buera et al. (2011) and Busso et al. (2012) among others. Hence, INEGI's census seems to cover mainly those entrepreneurs which we have labeled as modern.

Another dimension we explore is the life cycle aspect of entrepreneurship, i.e. at which point in their lives are agents more likely to become entrepreneurs. We find that the rate of entry of entrepreneurship is increasing over the life cycle. Households whose household head is 45 years old or older have 25% more entrepreneurs relative to households whose household head is younger than 45. Table D.7 (in the online appendix) reports different moments of the firm size distribution across types of entrepreneurs and their age. We see that the median hired labor is zero across the board. Also, we find that firm size remains constant (or slightly decreases) for subsistence firms over the life cycle of entrepreneurs. In contrast, it grows by 30% for modern entrepreneurs when comparing young and old households.[33] Moreover, firm growth is concentrated at the right tail (top 95th percentile).

The greater size and profitability of modern businesses may partly reflect that more talented agents select into modern entrepreneurship. It may also reflect that these entrepreneurs operate a more productive technology (and/or their business practices are better) or that they may be more capitalized (i.e., they may operate a higher capital-labor ratio per worker). Using the MxFLS survey data, we can also document the existence of selection (on observables) into different types of entrepreneurship. Table 4 reports the average educational level and innate talent as measured by Raven test scores. Comparing outcomes across occupations, we find that subsistence entrepreneurs have the lowest average years of education and Raven test scores. At the other extreme, modern entrepreneurs have almost two more years of schooling and they score almost one decile higher in the Raven test than subsistence entrepreneurs.[34] Workers are in the middle ground between modern and subsistence entrepreneurs.

[33] A household is defined as old if the age of the household head is above 45, and young otherwise.

[34] We report years of schooling of the sample for which the household occupation is reported. If we restricted the sample of years of education to have non-missing observations for household current and lagged assets, we would obtain a very similar ranking but average years of education would be 8.3, 7.5 and 8.7, for workers, subsistence and modern, respectively.

Table 3: Business Characteristics

Business Type	Fraction of Households	Employed Workers	Sales	Profits
Modern				
Total	7%	2.92	8372	4580
		(0.47)	(1721)	(567)
Subsistence				
Total	28%	1.96	–	3184
		(0.18)		(209)
Peasant on own plot	6%	2.61	–	1840
		(0.41)		(370)
Self-employed	22%	1.79	5699	3404
		(0.18)	(858)	(235)

Average employment, sales and profits by bins with corresponding standard deviations in parentheses. Monthly profits and sales are measured in thousands of pesos. Employed workers includes family workers. See online Appendix B for details on data construction.

Also, we find that household assets and lagged assets tend to be significantly higher for modern entrepreneurs than for the other occupations. Overall, this evidence suggests that there is selection into different occupations.[35]

As discussed in the beginning of the section, there is ample evidence on the existence of borrowing constraints for firms in Mexico. We present two pieces of evidence from the MxFLS data consistent with borrowing constraints. First, Table 5 reports the sources of the initial means of financing for starting businesses. We see that 68% of all starting businesses relied on household savings and 9% on relatives' savings. In contrast, only 5% used a credit union and 2% used a commercial bank. 5% used ROSCAs. This hints at the importance of self-financing for starting a business.

Second, we run a logit specification on the probability of becoming an entrepreneur on household characteristics (see Table D.4 in the online appendix). As expected from the previous discussion, we find that household assets are positively correlated with the probability of becoming an entrepreneur. If we split the sample between households above and below the median asset level, we find that the coefficient on assets is 19 times larger for households below the median asset levels. Again, this suggests that these poor households may lack access to other forms of financing and have to rely relatively more on asset accumulation to start a business. In Table D.5 (also in the online appendix), we run a multinomial logit specification to differentiate between modern and subsistence entrepreneurs. We find

[35]Table D.5 in the appendix confirms these intuitions by running a logit and multinomial logit on occupational choices with a rich set of controls: modern entrepreneurs tend to be more educated, talented and have higher assets. We note that the years of education and Raven test scores that we report are for agents for which we have household assets. This generates an upward bias on the average number of years of education in particular. However, this bias appears to be uniform across occupations.

Table 4: Agents Characteristics Across Occupations, 2009-2012

		Entrepreneurs	
	Workers	Subsistence	Modern
Quantile of Raven test-score	0.46	0.42	0.52
	(0.01)	(0.01)	(0.02)
Years of schooling	7.4	6.3	8.2
	(0.1)	(0.2)	(0.3)
Household Assets ($t = 2009$)	240	280	345
	(10)	(16)	(30)
Household Assets ($t = 2002$)	164	168	214
	(7)	(10)	(29)

Standard errors in parentheses. Years of schooling are counted starting at age six. Occupational choices are in 2009-2012. Assets measured in hundred-thousand pesos.

Table 5: Fraction of Starting Businesses Financing from...

Household Savings	68%
Relatives	9%
ROSCAs and other private moneylenders	6%
Credit Union	5%
Severance Pay	5%
Sale of non-financial assets	3%
Commercial Banking	2%
Clients' credits	1%
Contribution of non-family member	1%
Others	1%

Note: sources of financing are not mutually exclusive.

that the coefficient on assets is positive in both cases, but twice as large for modern entrepreneurs. This is consistent with the view that modern businesses require more capital to be set-up and operated, as pointed out by Bolio et al. (2014).

Interaction between Educational and Occupational Choices We next explore whether the occupational choice of households is correlated with the educational outcomes of kids. To this end, we augment the regression specification (1) to include dummies for types of entrepreneurship, δ_{Modern} and $\delta_{\text{Subsistence}}$, and the corresponding interactions with household assets,

$$\text{Educ.}_{i,2012}^{hh} = \beta_0 + \beta_1 \text{Assets}_{2002}^{hh} + \delta_{\text{Modern}} + \delta_{\text{Subs.}} + \beta_2 \delta_{\text{Modern}} \text{Assets}_{2002}^{hh} + \beta_3 \delta_{\text{Subs.}} \text{Assets}_{2002}^{hh} + \gamma X_i^{hh} + \varepsilon_i^{hh}, \tag{2}$$

Table 6: Education Policy Function with Modern and Subsistence Entrepreneurship

	(1) Assets Below Median	(2) Assets Above Median
Log(Assets)	1.73*	-0.00
	(0.50)	(0.01)
Modern Entrep. Dummy	0.17*	0.07*
	(0.07)	(0.03)
Subsistence Entrep. Dummy	-0.01	-0.07*
	(0.04)	(0.03)
Log(Assets) x Modern Entrep.	-4.00*	-0.00
	(2.01)	(0.02)
Log(Assets) x Subsist. Entrep.	0.12	0.09*
	(1.31)	(0.04)
Additional Controls	✓	✓

Standard errors in parentheses. * denotes a p-value lower than 5%. Additional controls are the same as in Table 2 (including talent).

where X_i^{hh} denote the same set of controls as in (1) (including the talent measures) and ε_i^{hh} is the error term. In light of the previous results, we report the results directly splitting the sample above and below the median asset level in Table 6. We find a positive correlation between assets and education for households below the median and no correlation for households above the median, as in the original specification reported in Table 2. The positive fixed effect for modern entrepreneurs indicates that households running modern businesses tend to educate their kids more. This may reflect some unobserved heterogeneity that our controls are not able to capture.

We find a large negative coefficient on the interaction of assets and the modern entrepreneur dummy for households below the median level of assets. This implies that poor households running modern businesses tend to educate their kids less. The coefficient of -4.0 implies that, for the median household, a kid whose parents run a modern business obtains 27% less years of education than an observationally equivalent household whose parents do not run a modern business. This implies around 2.7 less years of education for both the average and median household in our sample. In contrast, for subsistence businesses, we do not observe such effects. This result is consistent with the existence of borrowing constraints at the household level, and the necessity of investing differentially more in modern than in subsistence businesses. As suggested by Bolio et al. (2014), modern businesses have to incur higher operating costs than subsistence businesses because of a more intensive use of capital and modern technology.

2.3 Returns to Education

Finally, we estimate the returns to education in our MxFLS sample. We begin by running a Mincer regression on returns to education and analyzing whether returns to education differ across occupations. Using the third wave of the MxFLS, we run the following Mincer-type regression

$$\ln(\text{Earnings})_i = \beta_0 + \beta_1 s_i + \delta_{\text{Modern}}\beta_2 s_i + \delta_{\text{Subs.}}\beta_3 s_i + \gamma X_i + \varepsilon_i, \tag{3}$$

where s_i denotes the years of education of agent i, δ_{Modern} and $\delta_{\text{Subs.}}$ denote dummies taking the value of 1 if the agent is a modern or subsistence entrepreneur and ε_i denotes the error term. We include a broad set of controls, X_i. These are (potential) experience, (potential) experience squared, experience in the current job, gender, a dummy for whether the agent identifies as belonging to an indigenous group, innate talent as measured by the Raven test scores and household assets. We include this latter control as it may affect the occupational choice.

Columns (1)-(3) in Table 7 report the results of our regression. Returns to schooling in the overall sample are around 7−8%. As expected, we find a concave effect of experience. Having a higher score in the Raven test has a positive and significant coefficient in the regression, while being a female or belonging to an indigenous group is correlated with lower returns to education. When we restrict our sample to workers only, we find an estimate of returns to education of 8.3%. For entrepreneurs, we find heterogeneous returns. Subsistence entrepreneurs have a substantially lower return to education, around 5%, while we cannot reject that modern entrepreneurs also have a return of 8.3%.[36]

This result is consistent with the view that technologies operated by these different types of businesses differ in their sensitivity to the educational level of the entrepreneur. Note that in our regression specification we are controlling for talent. Thus, to the extent that our proxy for talent is good, selection based on talent should not be driving our results. However, we cannot rule out the alternative hypothesis that subsistence entrepreneurs systematically under-report their earnings relative to workers and modern entrepreneurs. One concern could be that self-employed entrepreneurs operate mostly in informal settings and are afraid to report their true earnings in the survey. While this is a valid concern, this would also apply to the vast majority of workers and modern entrepreneurs (who report not having or using formal contracts). So, to the extent that the misreporting is common across all groups, it should not affect the returns of subsistence entrepreneurs relative to workers and modern entrepreneurs.

More broadly, as we use ordinary least squares to estimate returns to education, omitted variable bias remains an important concern. To partially address this concern, we have used the random

[36]When we introduce Raven-test scores interacted with occupational modes in this regression, we cannot reject that the estimated coefficients on the interacted Raven tests are statistically different from zero at conventional levels. This suggests that innate talent (as measured by Raven tests) does not have a differential effect across occupations.

allocation of conditional cash transfers to education (Progresa program) as an instrument for years of education to estimate average returns to education (without differentiating across occupations).[37] As has been documented in a number of surveys (e.g. Card, 1999) we find that the average returns to education of the ordinary least-squares (OLS) and the instrumented version (IV) are similar (8.3% vs. 10.9%). If anything, we underestimate the true returns by running OLS. Unfortunately, we lack instruments to separately identify returns to education across occupations.[38]

While the Mincerian equation is the most standard formulation in the estimation of returns to education, it implies a convex human capital production function. Given our interest in using our estimates on returns to education in our quantitative model, we also report the results of using a "log-log" specification for returns to education. That is, we regress the log of earnings on the log of schooling and the log of experience,

$$\ln(\text{Earnings})_i = \beta_0 + \beta_1 \ln s_i + \delta_{\text{Modern}}\beta_2 \ln s_i + \delta_{\text{Subs.}}\beta_3 \ln s_i + \beta_4 \ln(\text{Experience})\gamma X_i + \varepsilon_i. \quad (4)$$

Columns (4) to (6) in Table 7 report the results. The fit as measured by the R^2 is similar compared to that of the standard Mincer specification. This specification has the advantage that it implies a Cobb-Douglas production function of effective units of human capital. When we develop our quantitative model, we use this specification for the human capital production function as it implies a concave human capital production function.

3 Model

We build an overlapping-generations and heterogeneous-agent model with incomplete markets. Households make decisions over their life cycle regarding their children's education, parents' occupation and on how much of their wealth to consume or save. We abstract from aggregate shocks and focus on describing the stationary distribution of our model in a competitive equilibrium. Our economy is populated by households that are heterogeneous in terms of their wealth, schooling levels, innate talent and the stage in their life cycle. Innate talent and schooling affect the productivity of agents in the two possible occupations (entrepreneurs and workers). A household consists of one parent and one child who collectively decide on allocations. Each household chooses the education of the child (or whether she joins the labor force) and whether the parent becomes a worker or an entrepreneur. Conditional on becoming an entrepreneur, a parent can operate a subsistence or a modern technology. Thus, there are two investment opportunities for a household: investing in human capital in the form of schooling

[37]See Angelucci and Giorgi (2009) and Behrman et al. (2011) for details on Progresa/Oportunidades and examples of its use as instrumental variable.

[38]Note that to have valid instruments for occupational choices, we would need instruments that have a monotonic effect across all three occupations.

Table 7: Returns To Education Regressions

	Mincer Specification			Log-Log Specification		
	(1)	(2)	(3)	(4)	(5)	(6)
Years of Schooling	0.068*	0.078*	0.083*			
	(0.007)	(0.010)	(0.010)			
Experience		0.037*	0.040*			
		(0.005)	(0.005)			
Experience*Experience		-0.001*	-0.001*			
		(0.000)	(0.000)			
Yrs Schooling $\times$ Subsist. Entrep.			-0.038*			
			(0.007)			
Yrs Schooling $\times$ Modern Entrep.			-0.010			
			(0.010)			
Log(Years of Schooling)				0.432*	0.710*	0.735*
				(0.038)	(0.071)	(0.072)
Log(Experience)					0.265*	0.290*
					(0.032)	(0.032)
Log(Yrs School.) $\times$ Subsist. Entrep.						-0.183*
						(0.029)
Log(Yrs School.)$\times$ Modern Entrep.						-0.048
						(0.046)
Points in Raven Test		0.391*	0.386*		0.459*	0.452*
		(0.102)	(0.100)		(0.108)	(0.106)
Additional Controls		✓	✓		✓	✓
Observations	8172	6898	6898	8172	6874	6874
R^2	0.061	0.114	0.125	0.052	0.113	0.126

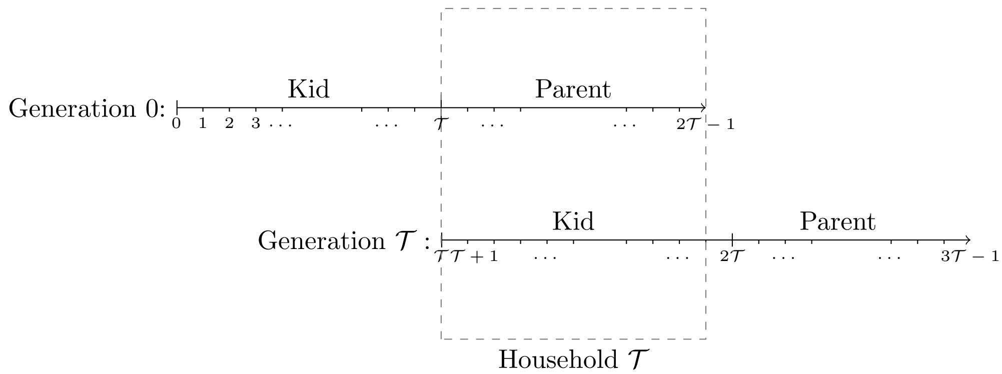
Standard errors in parentheses. * denotes a p-value lower than 5%. Additional controls are dummies for female, married, self-identification with indigenous groups, household assets.

for the child, or investing in the household's business (in case the household decides to operate one).

We begin describing preferences, endowments and demographic characteristics of our economy. Next, we present the different technologies available (schooling, modern and subsistence output production) and discuss at which point of the life cycle each of these technologies can be used. Then we describe how markets operate and introduce a number of market imperfections. Finally, we present a recursive characterization of the household problem and the stationary competitive equilibrium definition.

3.1 Preferences, Endowments and Demographics

Figure 1: Life Cycle for a Generation born at Time 0 and $\mathcal{T}$



Demographics and Life Cycle The unit of decision in our model is a household. A household is composed by two agents: a parent and a child. Agents' lives are divided into two broad stages: youth and adulthood. During the youth stage agents live in the same household as their parents. We refer to an agent in the youth stage as a "kid". In the second stage of their lives agents form their own household and become parents. We refer to them as "parents" or "adults" interchangeably.

Time is discrete in our economy. A kid becomes an adult after living for $\mathcal{T}$ periods (i.e., at age $\mathcal{T}+1$). Upon becoming an adult, she immediately gives birth to one kid, forming a new household. Her former household disappears and her parent dies. Thus, youth and adulthood stages last the same amount of periods and agents live in total $2\mathcal{T}$ periods ($\mathcal{T}$ as kids and $\mathcal{T}$ as parents). We generically index periods by t and denote the period in which an agent is born by τ. With this notation in hand, an agent belonging to the generation born at time τ, is a kid for $t \in [\tau, \tau+\mathcal{T})$ and an adult for $t \in [\tau+\mathcal{T}, \tau+2\mathcal{T})$. This life cycle structure is represented graphically in Figure 1.

Finally, at the aggregate level, our demographic structure implies that *(i)* at any point in time t all households consist of a parent and a kid, and that *(ii)* population is constant. We assume that the continuum measure of household dynasties is one-half. Thus, total population has measure one.

Endowments: Innate Talent, Time and Initial Wealth Each agent is endowed with innate talent θ upon being born. Innate talent θ of an individual is constant over time, unidimensional, positive and–for analytic simplicity–observable within the household. For a given dynasty innate talent evolves across generations. Once a kid is born, she inherits the innate talent of her parent with probability ϕ, while with probability $1-\phi$ she draws a new talent realization from an invariant innate talent distribution $F(\theta)$. Thus, the correlation of innate talent between parents and kids in the population is

ϕ.[39]

Each agent is endowed with one unit of time per period of time t. Finally, each household dynasty is endowed with exogenous initial wealth $a_0 > 0$ at time 0. Household wealth can be positive or negative. When it is positive we also refer to it as household assets. When it is negative, we also refer to it as household debt.

Household Utility An agent's individual period utility is determined by her consumption c,

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma}, \tag{6}$$

with $\sigma \geq 0$.[40] We denote the consumption at time t of a parent p born at time τ by $c_t^{p,\tau}$. Analogously, the consumption of a kid is denoted by $c_t^{k,\tau}$. Note that the time subscript on consumption refers to the time in which an agent is consuming, whereas the superscript denotes the generation. The period utility of a household, U, at time t is defined as the weighted sum of individual period utilities

$$U\left(c_t^{p,\tau}, c_t^{k,\tau+\mathcal{T}}\right) = \lambda u\left(c_t^{p,\tau}\right) + (1-\lambda) u\left(c_t^{k,\tau+\mathcal{T}}\right), \tag{7}$$

where $\lambda \in (0,1)$ denotes the Pareto weight on the consumption of the parent. We assume that the Pareto weight λ is constant over time and identical across households. There exists an aggregate representation of the period utility of a household.

Remark 1. *(Aggregate Representation of Household Preferences) Let $c_t \equiv c_t^{p,\tau} + c_t^{k,\tau+\mathcal{T}}$ denote the total consumption of a household at time t. Let individual utilities be given by (6). Then, the allocation of consumption within the household that maximizes total household's period utility (7) subject to total household consumption being c_t is*

$$U(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}\left(\lambda^{\frac{1}{\sigma}} + (1-\lambda)^{\frac{1}{\sigma}}\right)^{\sigma}. \tag{8}$$

This result implies that we can express households' total period utility at time t as a function of total household consumption c_t (without specifying the actual underlying division of consumption between parents and kids).

Households are forward looking and care about the discounted utility of all subsequent generations. Hence, the value function of a household at time 0, V_0^{HH}, is the current utility of the household

[39] To see this, let μ denote the expected value of θ under F. Denote the innate talent of one generation by y, and the next one by x. Noting that all talents are drawn from the same distribution F, we have that

$$\operatorname{corr}(x,y) = \frac{\mathbf{E}\left[(x-\mu)(y-\mu)\right]}{\sqrt{\mathbf{E}\left[(x-\mu)^2\right]\mathbf{E}\left[(y-\mu)^2\right]}} = \frac{\mathbf{E}\left[xy\right]-\mu^2}{\mathbf{E}\left[(y-\mu)^2\right]} = \frac{\phi\mathbf{E}\left[y^2\right]+(1-\phi)\mu^2-\mu^2}{\mathbf{E}\left[y^2\right]-\mu^2} = \phi. \tag{5}$$

[40] The previous definition holds for $\sigma \neq 1$. If $\sigma = 1$, we define $u(c) = \ln c$.

$U_0^{HH} \equiv U(c_0)$ (defined in 8) plus the discounted present value of the instantaneous utilities of all its dynasty

$$V_0^{HH} \equiv U_0^{HH} + \mathbf{E}_0 \left[\sum_{t=1}^{\infty} \beta^t U_t^{HH} \right], \tag{9}$$

with $\beta \in (0, 1)$. The expectation operator over future utilities represents the uncertainty regarding talent draws of future generations. For the time period in which a household exists there is no uncertainty because the talent of parents and kids has been realized. For example, suppose that a household has been formed at time 0. Then, since a new household of the same dynasty will not be formed until $t = \mathcal{T}$, we can rewrite (9) as

$$V_0^{HH} = \underbrace{U_0^{HH} + \sum_{t=1}^{\mathcal{T}-1} \beta^t U_t^{HH}}_{\text{Current Household}} + \underbrace{\mathbf{E}_0 \left[\sum_{t=\mathcal{T}}^{\infty} \beta^t U_t^{HH} \right]}_{\text{Future Households}}, \tag{10}$$

illustrating that the expectation operator applies when a new household (and kid) is born.

3.2 Technologies

3.2.1 Human Capital Production

Human capital is produced through schooling in our model. We allow returns to schooling to be heterogeneous across occupations. In addition to human capital, we introduce the notion of *effective* human capital. Effective human capital encompasses human capital (schooling), experience and innate talent. We proceed by first describing the human capital formation technology (schooling). Then we specify how human capital (schooling) is combined with experience and innate talent to generate effective human capital.

Human Capital and Schooling Kids accumulate human capital by going to school.[41] In order to obtain s units of human capital, a kid has to spend an amount of time s in school and buy q_s units of schooling services at price $p_{s,t}$ (to be defined in Subsection 3.2.2 below). Thus, both time and material inputs are necessary to generate human capital. Formally,

$$\text{Human Capital} = \min\{s, q_s\}. \tag{11}$$

Anticipating that in equilibrium it is optimal to choose $s = q_s$, we measure human capital by educational attainment in units of time (e.g., years). Thus, we refer to s interchangeably as human capital or time spent in school.

[41] We rule out on-the-job training. Erosa et al. (2010) and the references therein argue that there is no systematic correlation between on-the-job training and income per capita.

Timing of Schooling Kids can go to school for at most $\bar{s}$ periods. This upper bound $\bar{s}$ can be interpreted as the total number of years necessary for completion of primary, secondary and tertiary schooling. Moreover, we assume that $\bar{s} \leq \mathcal{T}$, so that all education is completed during youth.

Recall that each period has a length of one unit of time. Thus, the maximum education a kid can obtain during a period is one, as it takes one unit of time (and one unit of schooling services) to acquire one unit of schooling. This implies that, in order to obtain s units, a kid has to spend time s in school (we do not restrict s to be an integer, i.e., in a given period a kid can go to school only a fraction of the time). We make the assumption that kids cannot return to school after they have dropped out. That is, kids start going to school once they are born and households can choose the length of time they attend school. However, once they drop out and enter the labor market, they cannot go back to school.[42] We also assume that payments to education services within a period are done upfront. That is, if at period t a household wants its kid to obtain 0.75 units of schooling, the payment of the corresponding 0.75 units of educational services has to be made at the beginning of the period.

Assumption 1. *Once a kid drops out of school she cannot go back to school. Payments for schooling are done upfront within the period.*

We can summarize the law of motion for schooling of the kid as follows. Let s_t^τ denote the initial, beginning of period, level of schooling at period t of a kid born at time τ. Let η_t^τ denote the amount of schooling chosen to be acquired during period t and s_{t+1}^τ the initial level of schooling of period $t+1$. Then, the law of motion of s is

$$s_{t+1}^\tau = s_t^\tau + \eta_t^\tau, \qquad s_t^\tau + \eta_t^\tau \leq \bar{s}, \qquad \text{and} \qquad \eta_t^\tau = 0 \quad \text{if} \quad s_t^\tau < t - \tau, \tag{12}$$

for $t \in [\tau, \tau + \mathcal{T})$. The first equation states that the initial level of schooling next period s_{t+1}^τ is the sum of the schooling level coming into the current period, s_t^τ, and the school attendance during the period, η_t^τ. The second equation is the constraint on the total amount of schooling an agent can obtain, $s_{t+1}^\tau \leq \bar{s}$. Assumption 1 on irreversibility of schooling is stated in the third condition. As periods last one unit of time, $t - \tau$ is the age of the kid coming into the period. Thus, if the time of schooling s_t^τ is less than the age of the kid coming into the period, the level of education cannot increase and becomes constant thereafter, $s_{t+1}^\tau = s_t^\tau$.

Occupation-Specific Returns to Schooling We allow schooling to have heterogeneous effects across occupations. That is, schooling may be better for some occupations than others. In particular, if a kid goes to school for $s \in [0, \bar{s}]$ units of time, she increases her effective units by $(1+s)^{\zeta_w}$, $(1+s)^{\zeta_m}$

[42] This assumption is in line with the recent work emphasizing that human capital requires large front-loaded time investments, like formal schooling, and that early human capital investments play a central role (e.g., Heckman et al., 2011 and Elango et al., 2015).

or $(1+s)^{\zeta_n}$ if she chooses to become a worker, a modern or a subsistence entrepreneur, respectively, with $0 < \zeta_i < 1$ (to ensure concavity) for $i = \{w, m, n\}$.

Experience We also allow agents to accumulate experience over their life cycle and improve their effective human capital. We do so in a parsimonious way. An agent that has been out of school and working for $t-\tau-s_t^\tau$ periods augments her human capital by a factor $(t-\tau-s_t^\tau)^{\zeta_{\text{Exp}}}$, with $0 < \zeta_{\text{Exp}} < 1$. This particular formulation of experience is useful in establishing a link between the model and our empirical estimation in Section 2.[43]

Effective Human Capital Human capital, experience and innate talent are combined to generate *effective* human capital. This is the skill that is used in production. We denote by the vector $(\theta_{w,t}, \theta_{m,t}, \theta_{n,t})$ the effective levels of human capital an agent can supply to the market at time t when choosing to become a worker, a modern entrepreneur or a subsistence entrepreneur, respectively,

$$\theta_{w,t} = (1 + s_t^\tau)^{\zeta_w} \theta (t - \tau - s_t^\tau)^{\zeta_{\text{Exp}}}, \tag{13}$$

$$\theta_{m,t} = (1 + s_t^\tau)^{\zeta_m} \theta (t - \tau - s_t^\tau)^{\zeta_{\text{Exp}}}, \tag{14}$$

$$\theta_{n,t} = (1 + s_t^\tau)^{\zeta_n} \theta (t - \tau - s_t^\tau)^{\zeta_{\text{Exp}}}. \tag{15}$$

As we have discussed, we allow for education to have heterogeneous effects across occupations. For an agent with no schooling ($s = 0$), the only relevant margin is her innate ability θ and experience –neither of which is differentiated across occupations.[44]

3.2.2 Schooling Services Production Technology

As we discussed in (11), a kid has to purchase $q_{s,t} = s_t^\tau$ units of schooling services at price $p_{s,t}$ to obtain s_t^τ units of schooling. Schooling services S_t are produced by a representative firm using final good M_t (which can be thought of as providing school infrastructure and materials) and teaching input T_t, which takes the form of human capital. The production function is assumed to be of Cobb-Douglas form,

$$S_t = A_s T_t^{\alpha_s} M_t^{1-\alpha_s}, \qquad 0 < \alpha_s < 1, \quad A_s > 0. \tag{16}$$

3.2.3 Final Good Production Technologies and Occupational Choice

The single final good is produced by firms. Each firm is run by one entrepreneur, who produces the final good using as inputs her entrepreneurial effective human capital, labor and capital. Agents can

[43] Note that we are not allowing returns to experience to be job-specific. Thus, if agents change occupations during their life cycle, they retain the experience obtained in their previous occupation in the new occupation.

[44] We note that we could accommodate heterogeneity in the effect of innate talent across occupations. However, we did not find supportive evidence for this assumption in Section 2.

Table 8: Feasible Occupational Choices for Parents and Kids.

Occupation	Parent	Kid
Student	✗	✓
Entrepreneur	✓	✗
Worker	✓	✓

choose to become entrepreneurs or to work for a wage at any point in time. We make the following assumption on feasible occupational choices.

Assumption 2. *Firms have to be operated by adults. Kids and adults can work for a wage. Worker, modern and subsistence entrepreneur occupations are mutually exclusive within a period t, but can be freely changed across periods over the life cycle of an agent.*

The assumption that occupations are mutually exclusive implies that an adult cannot be simultaneously an entrepreneur and a worker in the same period t. However, agents can change occupations freely across periods. For example, a worker at time t can become an entrepreneur at time $t+1$.[45] Finally, we allow for kids who choose to go to school for only a fraction $0 < \eta_t^\tau < 1$ of their time in period t to work for a wage during the rest of the period, $1 - \eta_t^\tau$.[46] Table 8 summarizes the feasible occupational choices in the economy.

There are two technologies available to produce the final good, which we label as *modern* and *subsistence* technologies. Subsistence technologies do not have any set-up cost, while a fixed cost needs to be incurred to operate a modern technology.

Subsistence Technology The subsistence technology can operate at any level of capital. This technology produces final output combining capital, labor and entrepreneurial skills as (omitting time subscripts)

$$y = \theta_n k^\alpha l^\gamma, \quad \alpha + \gamma < 1, \tag{17}$$

where l is the mass of workers hired and k is the amount of capital used in production.

Modern Technology This technology requires a per-period fixed cost to operate. In addition to the working capital, k, a sunk investment $\bar{k}$ has to be made. The modern technology production function

[45] There is no cost of switching occupations. This simplifying assumption allows us to avoid carrying additional state variables in our problem. This assumption is also made by most of the recent literature on entrepreneurship and development summarized in Buera et al. (2015).

[46] Allowing students to go to school and work in the same period will help us when matching the average years of schooling in the calibration. Previewing our quantitative exercise, a period will be calibrated to 5 years. Hence, allowing households to convexify the schooling decision is important in order to have families choosing levels of education between 5 and 10 years – rather than either 5 or 10 years. This corresponds to the vast majority of households.

is (omitting time subscripts)

$$y = A_m \theta_m k^{\alpha} l^{\gamma}, \quad \alpha + \gamma < 1, \tag{18}$$

where l denotes labor used in production and k denotes the operating capital. Thus, the total capital required to produce is $k + \bar{k}$.

3.3 Markets

Incomplete Financial Markets Agents have access to competitive financial intermediaries. Financial intermediaries receive deposits and make loans to households at rate R_t. Households use loans to finance capital, schooling investments or consumption. Financial markets are incomplete in several dimensions. First, no state-contingent bonds can be purchased. Thus, it is not possible to insure against the risk generated by the realizations of innate talent of future generations within a dynasty.

Second, there are constraints on the stock of debt (i.e., negative wealth) a household can hold. Debt can only be partially rolled over across periods. The financial wealth of a household born at time τ, a_t^τ, has to remain above a lower bound

$$a_t^\tau \geq \underline{a}_t^\tau \tag{19}$$

for $t \in [\tau, \tau + \mathcal{T})$. This lower bound is assumed to be negative or zero, $\underline{a}_t^\tau \leq 0$, and it is allowed to vary over the age of the household. In particular, we assume that in the last period of existence of the household the lower bound on wealth next period is equal to zero. This implies that the debt of a household has to be fully paid off before it disappears. Thus, parents cannot bequeath negative wealth to their offspring (i.e., they have to bequeath zero or positive wealth). In other words, we are allowing for some intertemporal reallocation of household wealth. But, since we are imposing that the lower bound (19) is zero for the last period of the household, this implies that all household debt (and interest accrued from it) has to be paid during the lifetime of a household.

The lower bound on debt, $\underline{a}_t^\tau$, can be interpreted as the debt limit that a household can credibly commit to repay. Thus, if a household has full commitment, $\underline{a}_t^\tau$ is the "natural" bound pinned down by the maximum amount a household can repay without violating nonnegativity of consumption. However, we are not necessarily imposing this "natural" bound. We allow for the limit on debt $\underline{a}_t^\tau$ to be greater than the "natural" limit, i.e., $\underline{a}_{\text{natural},t}^\tau \leq \underline{a}_t^\tau \leq 0$ and, hence, even more constraining.

Third, we allow for additional within-period borrowing. Indeed, this additional source of borrowing is only relevant in equilibrium when the limit on debt is tighter than the natural limit, $\underline{a}_{\text{natural},t}^\tau < \underline{a}_t^\tau$. As we further discuss below (and sketch in Figure 2), households take within-period loans at the beginning of the period and they can repay these loans at the end of the same period or roll over debt to the next period, subject to the lower bound on debt (19). There is a constraint on within-period borrowing: Within a period, agents can borrow up to a limit. This limit has two components that can be interpreted as two alternative sources of borrowing. The first component captures borrowing that is increasing in household wealth. We assume that the amount of borrowing available to households is proportional to their wealth at the beginning of the period minus the lower bound on wealth, $a_t^\tau - \underline{a}_t^\tau$ (recall that $\underline{a}_t^\tau < 0$ and that (19) implies that $a_t^\tau - \underline{a}_t^\tau \geq 0$ for all feasible a_t^τ). We denote this factor of proportionality by $\xi \in [0, \infty)$. Thus, the amount of borrowing from this first component cannot exceed $\xi(a_t^\tau - \underline{a}_t^\tau)$. This implies that wealthier households can borrow more. Note that the presence of the term $\underline{a}_t^\tau$ implies that a household can borrow against future income up to $\underline{a}_t^\tau$. Since future household earnings include kid's future wages, we are effectively allowing for some education loans. We interpret this source of lending in the data as lending requiring a guarantee from the borrower, be it current or future income.

The second component of the borrowing limit is independent of any household characteristic. Households have access to borrowing up to an amount $\bar{a} > 0$ of non-conditional lending. Overall, the maximum level of borrowing within a period is given by the sum of the two components,

$$\xi(a_t^\tau - \underline{a}_t^\tau) + \bar{a}. \tag{20}$$

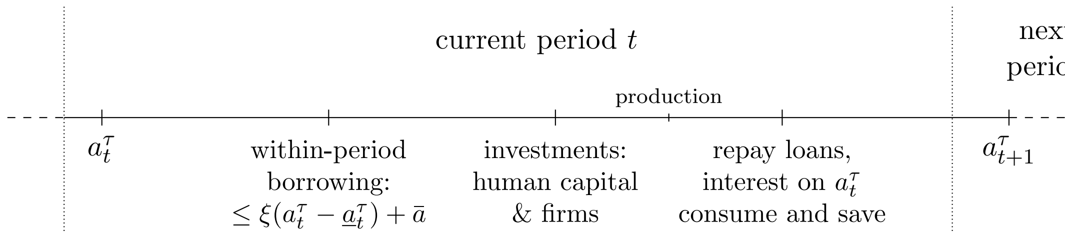
We refer to this borrowing limit (20) as the borrowing constraint. As we have discussed, the first term $\xi(a_t^\tau - \underline{a}_t^\tau)$ is always nonnegative (as $a_t^\tau \geq \underline{a}_t^\tau$) and it increases in a_t^τ. Thus, this second component of the borrowing limit (20) makes within-period borrowing feasible for all households, including those that are at the lower bound of debt, $a_t^\tau = \underline{a}_t^\tau$.

To be clear, the constraint on the lower bound for assets (19) and the within-period borrowing constraint (20) interact in equilibrium to determine the total amount of wealth that agents can mobilize at any given point in time. Since we are imposing that households cannot bequest negative wealth, the equilibrium path of wealth and borrowing of any household has to satisfy this terminal constraint. Thus, for example, if the lower bound on assets is the natural borrowing limit, the within-period borrowing becomes superfluous (because households in equilibrium realize that they cannot take any more loans). Conversely, if the lower bound on assets is zero, all borrowing comes from within period borrowing. More generally, if the amount of within-period borrowing is such that it allows a household to surpass the amount of borrowing determined by the natural borrowing limit, then the borrowing constraint (20) cannot be binding in equilibrium–as it would violate the feasibility of repayment.

Finally, competitive financial intermediaries imply that loan contracts are paid at the gross interest rate, $R_t = r_t + \delta$, where δ denotes the depreciation rate of capital.

Competitive Non-financial Markets All other markets operate under perfect competition.

Figure 2: Timing of Operation of Markets



Timing of Operation of Markets First, households enter period t with wealth a_t^τ (deposited in the financial intermediaries). Recall that household wealth can be either positive or negative. In this latter case, households may enter the period with some unused credit line, $a_t^\tau - \underline{a}_t^\tau > 0$ which can be used as a guarantee for within-period borrowing. Second, households may take loans no greater than (20). Thus, the maximal amount of resources they can mobilize (and spend) in period t is $(1+\xi)(a_t^\tau - \underline{a}_t^\tau) + \bar{a}$. Third, households make investments in human capital and/or rent working capital to operate households' businesses. Production and education takes place. Fourth, households pay back their loans, receive interest on their deposits (this term is negative if a household's initial wealth a_t^τ is negative) and receive wages and/or profits. Finally, they decide how much to consume today and how much to save for next period subject to the lower bound on assets (19). Then, they move into period $t+1$. The timing of operation of markets is reflected in the recursive formulation of the household problem that we analyze in the subsequent section and it is summarized in Figure 2.

3.4 Recursive Formulation of the Household Problem

Households maximize the present value of household utility (9) by choosing a sequence of consumption, savings, occupations, education of kids and production inputs (if they choose to be entrepreneurs) for each period t, subject to a sequence of period budget and borrowing constraints.

Consider a household created at time τ in period $t \in [\tau, \tau + \mathcal{T})$. The household's state is summarized by its current wealth, a_t^τ, and a vector of effective human capital for the parent and innate talent and schooling for the kid. Using the superscript p to denote parent and k for a kid, this vector is composed of the parent's potential effective human capital in the three occupations $(\theta_{e,t}^{p,\tau-\mathcal{T}}, \theta_{m,t}^{p,\tau-\mathcal{T}}, \theta_{n,t}^{p,\tau-\mathcal{T}})$ (where $\tau - \mathcal{T}$ denotes the time the parent was born), the kid's innate talent $(\theta^{k,\tau})$ and her educational level at the beginning of the period s_t^τ.

Denote the vector of effective human capital of the parent and innate talent and education of the kid by

$$z_t^\tau = \left(\theta_{e,t}^{p,\tau-\mathcal{T}}, \theta_{m,t}^{p,\tau-\mathcal{T}}, \theta_{n,t}^{p,\tau-\mathcal{T}}, \theta^{k,\tau}, s_t^\tau\right), \tag{21}$$

where effective talent across occupations is defined in (13) to (15). Then, at any point in time t for which the household exists, $t \in [\tau, \tau + \mathcal{T})$, the household jointly decides the occupation of the parent, the education level and/or labor market participation of the kid and the consumption/savings of the current household that maximizes the value function of the household, $V_t^\tau(a_t^\tau, z_t^\tau)$ defined in (7).

We proceed in two steps to characterize the household problem. First, we write the household value function as the maximum across the value functions conditional on the parent's occupational choice,

$$V_t^\tau(a_t^\tau, z_t^\tau) = \max\left\{V_t^{\tau,\text{Worker}}(a_t^\tau, z_t^\tau), V_t^{\tau,\text{Modern}}(a_t^\tau, z_t^\tau), V_t^{\tau,\text{Subsistence}}(a_t^\tau, z_t^\tau)\right\} \quad \text{for all} \quad t \in [\tau, \tau + \mathcal{T}). \tag{22}$$

Then, we describe the household problem conditional on each of the possible occupational choices by a parent.

Household Problem for Worker Parents Suppose that the household chooses the parent to be a worker during non-terminal period t, $t \in [\tau, \tau + \mathcal{T} - 1)$. Conditional on this occupational choice and the state variables (i.e., wealth coming into the period, a_t^τ, and the vector of effective human capital, z_t^τ), the household problem consists of solving for total household consumption today, c_t^τ, the fraction of time the kid attends school within the period, $\eta_t^\tau \in [0, 1]$ (the remainder is spent working for a wage), and next period's wealth, a_{t+1}^τ,

$$V_t^{\tau,\text{Worker}}(a_t^\tau, z_t^\tau) = \max_{c_t^\tau \geq 0, \eta_t^\tau \in [0,1], a_{t+1}^\tau \geq \underline{a}_{t+1}^\tau} U(c_t^\tau) + \beta \mathbf{E}\left[V_{t+1}^\tau(a_{t+1}^\tau, z_{t+1}^\tau)\right] \qquad \text{subject to} \tag{23}$$

$$a_{t+1}^\tau + c_t^\tau = (1 + r_t)(a_t^\tau - p_{s,t}\eta_t^\tau) + (\theta_{w,t}^{p,\tau-\mathcal{T}} + (1 - \eta_t^\tau)\theta_{w,t}^{k,\tau})w_t, \tag{24}$$

$$p_{s,t}\eta_t^\tau \leq (1 + \xi)(a_t^\tau - \underline{a}_t^\tau) + \overline{a}, \tag{25}$$

$$s_{t+1}^\tau = s_t^\tau + \eta_t^\tau, \qquad s_t^\tau + \eta_t^\tau \leq \bar{s}, \qquad \text{and} \qquad \eta_t^\tau = 0 \quad \text{if} \quad s_t^\tau < t - \tau, \tag{12}$$

where $U(c_t^\tau)$ is the per-period household utility (8), c_t^τ is total household consumption in the period and $\theta_{w,t}^{p,\tau-\mathcal{T}}$ and $\theta_{w,t}^{k,\tau}$ are the effective human capital of the parent and kid when being employed as workers, respectively. These effective human capital measures include innate talent, schooling and experience, as discussed in equation (13). Recall that z_t^τ is a state vector denoting the effective human capital of the parent, the innate talent of the kid and her education level coming into the period. This formulation of the problem makes use of Remark 1, which shows that it is only necessary to keep track of total aggregate consumption, c_t^τ, instead of parent's and kid's consumption separately. As we discussed earlier, there is an expectation operator in equation (23) because the draws of innate talent of the dynasty's future generations have not been realized at time t.

The within period budget constraint is stated in the second line of the problem, (24). We have normalized the price of the consumption/investment good to one. The budget constraint states that household's current wealth (initial wealth, returns to initial wealth and wage income) can either be saved for next period, a_{t+1}^{τ}, or consumed, c_t^{τ}. To better understand the budget constraint, recall that agents enter the period with wealth a_t^{τ}. They can use this wealth to invest in kids' education $p_{s,t}\eta_t^{\tau}$. Whatever is left after this investment, $a_t^{\tau} - p_{s,t}\eta_t^{\tau}$, earns an interest r_t at the end of the period (note that this can be negative, in which case the household pays the interest). Labor income comes from the parent working (and supplying $\theta_{w,t}^{p,\tau}$ units of effective human capital) and the time the kid does not spend in school and works instead, $(1-\eta_t^{\tau})\theta_{w,t}^{k,\tau}$. The wage per unit of effective human capital is w_t. The wage of the kid includes the term $(1-\eta_t^{\tau})$ to reflect that she only works once she stops going to school.

Line (25) states the within-period borrowing constraint. Since in this occupational choice the only possible investment within the period is schooling, the borrowing constraint states that households have an upper bound on how much they can invest in the education of kids. Also note that in the choice set in line (23) we restrict $a_{t+1}^{\tau} \geq \underline{a}_{t+1}^{\tau}$, so that wealth next period has a lower bound (in case a household decides not to fully repay debt this period and enter next period with some debt). Finally, line (12) describes how schooling operates in our model.

Before analyzing the other occupational choices of the parents, we formulate the problem in the last period of existence of the household $t = \tau + \mathcal{T} - 1$. In this stage, since we are assuming dynastic preferences, next period's utility corresponds to the next generation household (i.e., the household that is created by the kid in the current household when she becomes an adult next period). The generational transition is reflected in the superscripts of the state variables and the value functions, which keep track of the creation date of the household,

$$V_t^{\tau,\text{Worker}}(a_t^{\tau}, z_t^{\tau}) = \max_{c_t^{\tau}\geq 0, \eta_t^{\tau}\in[0,1], a_{t+1}^{\tau+\mathcal{T}}\geq 0} U(c_t^{\tau}) + \beta \mathbf{E}\left[V_{t+1}^{\tau+\mathcal{T}}(a_{t+1}^{\tau+\mathcal{T}}, z_{t+1}^{\tau+\mathcal{T}})\right] \quad \text{s.t.} \tag{26}$$

$$a_{t+1}^{\tau+\mathcal{T}} + c_t^{\tau} = (1+r_t)(a_t^{\tau} - p_{s,t}\eta_t^{\tau}) + (\theta_{w,t}^{p,\tau-\mathcal{T}} + (1-\eta_t^{\tau})\theta_{w,t}^{k,\tau})w_t, \tag{27}$$

$$p_{s,t}\eta_t^{\tau} \leq (1+\xi)(a_t^{\tau} - \underline{a}_t^{\tau}) + \overline{a}, \tag{28}$$

$$s_{t+1}^{\tau} = s_t^{\tau} + \eta_t^{\tau}, \qquad s_t^{\tau} + \eta_t^{\tau} \leq \bar{s}, \qquad \text{and} \qquad \eta_t^{\tau} = 0 \quad \text{if} \quad s_t^{\tau} < t - \tau, \tag{12}$$

where s_{t+1}^{τ} is the final schooling level of the kid (before becoming an adult). At time $t+1$ a new household is created in which the kid of the current household becomes a parent, the parent of the current household dies and a new kid is born in the new household. To keep track of this new household being born, the superscript on next period's state variables changes to $\tau + \mathcal{T}$: wealth is denoted by $a_{t+1}^{\tau+\mathcal{T}}$ and the vector of innate talent and schooling by $z_{t+1}^{\tau+\mathcal{T}}$. Note that we are imposing the condition that no negative bequests are possible, $a_{t+1}^{\tau+\mathcal{T}} \geq 0$.

Household Problem for Subsistence Entrepreneur Parents Consider now the same household with the difference that the parent becomes a subsistence entrepreneur in the non-terminal period

$t \in [\tau, \tau + \mathcal{T} - 1)$.[47] In this case, the household problem conditional on the occupational choice is

$$V_t^{\tau,\text{Subsistence}}(a_t^\tau, z_t^\tau) = \max_{c_t^\tau \geq 0, l \geq 0, k \geq 0, \eta_t^\tau \in [0,1], a_{t+1}^\tau \geq \underline{a}_{t+1}^\tau} U(c) + \beta \mathbf{E}\left[V_{t+1}^\tau(a_{t+1}^\tau, z_{t+1}^\tau)\right] \quad \text{s.t.} \tag{29}$$

$$a_{t+1}^\tau + c_t^\tau = (1 + r_t)(a_t^\tau - p_{s,t}\eta_t^\tau - k) + (1 - \eta_t^\tau)\theta_{w,t}^{k,\tau} w_t + \theta_{n,t}^{p,\tau-\mathcal{T}} k^\alpha l^\gamma - w_t l - R_t k, \tag{30}$$

$$p_{s,t}\eta_t^\tau + k \leq (1 + \xi)(a_t^\tau - \underline{a}_t^\tau) + \overline{a}, \tag{31}$$

$$s_{t+1}^\tau = s_t^\tau + \eta_t^\tau, \qquad s_t^\tau + \eta_t^\tau \leq \bar{s}, \qquad \text{and} \qquad \eta_t^\tau = 0 \quad \text{if} \quad s_t^\tau < t - \tau, \tag{12}$$

Equation (29) makes explicit that the household has two additional choice variables relative to the problem of the worker parent: the labor, l, and capital, k, inputs used in the subsistence technology. The budget constraint (30) shows that the parent's source of income is the profit from operating the subsistence technology, $\theta_{n,t}^{p,\tau-\mathcal{T}} k^\alpha l^\gamma - w_t l - R_t k$, where effective human capital in the subsistence occupation $\theta^{p,\tau-\mathcal{T}}$ is defined in (15), R_t is the price of capital charged by financial intermediaries (which is the borrowing rate r_t plus the depreciation rate δ) and l and k denote the amount of labor and capital used by the entrepreneur.

Equation (31) shows that, in this case, the borrowing constraint potentially affects *both* investment in human capital and the capital level of operation. This is an important distinction relative to the case in which the parent decides to become a worker. Now, if the borrowing constraint of the household binds, the marginal unit of household wealth will be invested in a way that tends to equalize the marginal returns of investing in the capital of the firm with the marginal net present value of investing in human capital for the kid.

This captures one of the main trade-offs introduced in our model. In the event that the borrowing constraint is binding, entrepreneurial and human capital investments become intertwined. Which of the two investments becomes more distorted relative to its optimal level depends on the marginal returns of the entrepreneurial and human capital technologies at equilibrium prices. Indeed, in equilibrium, these distortions in human capital and entrepreneurial investments themselves affect equilibrium prices. The human capital formation technology for the kid (12) remains the same, as it is independent of the occupational choice of the parent.

[47]To ease notation we omit the explicit statement and discussion of the household's problem in the final period $t = \tau + \mathcal{T} - 1$ for both types of entrepreneurs. The changes in the notation that would need to be made are analogous to the worker occupation previously discussed.

Household Problem for Modern Entrepreneur Parents Finally, consider the case in which the parent operates a modern technology at time $t \in [\tau, \tau + \mathcal{T} - 1)$. In this case, the household problem is

$$V_t^{\tau,\text{Modern}}(a_t^\tau, z_t^\tau) = \max_{c_t^\tau \geq 0, l \geq 0, k \geq 0, \eta_t^\tau \in [0,1], a_{t+1}^\tau \geq \underline{a}_{t+1}^\tau} U(c) + \beta \mathbf{E}\left[V_{t+1}^\tau(a_{t+1}^\tau, z_{t+1}^\tau)\right] \text{ subject to} \tag{32}$$

$$a_{t+1}^\tau + c_t^\tau = (1 + r_t)(a_t^\tau - p_{s,t}\eta_t^\tau - k - \bar{k}) + (1 - \eta_t^\tau)\theta_{w,t}^{k,\tau} w_t + \theta_{m,t}^{p,\tau-\mathcal{T}} A_m k^\alpha l^\gamma - w_t l - R_t(k + \bar{k}), \tag{33}$$

$$p_{s,t}\eta_t^\tau + k + \bar{k} \leq (1 + \xi)(a_t^\tau - \underline{a}_t^\tau) + \bar{a}, \tag{34}$$

$$s_{t+1}^\tau = s_t^\tau + \eta_t^\tau, \qquad s_t^\tau + \eta_t^\tau \leq \bar{s}, \qquad \text{and} \qquad \eta_t^\tau = 0 \quad \text{if} \quad s_t^\tau < t - \tau, \tag{12}$$

The only difference relative to the problem of the subsistence entrepreneur is the business technology operated by the modern technology. This is reflected in (33) and (34). In this case, the effective human capital used by the parent as an input corresponds to operating a modern technology. The profit from the entrepreneurial activity is net of the fixed capital cost, $\theta_{m,t}^{p,\tau-\mathcal{T}} A_m k^\alpha l^\gamma - w_t l - R_t(k + \bar{k})$, as shown in the budget constraint (33). Also, the borrowing constraint (34) applies to all investments that have to be made at the beginning of the period. Thus, both the set-up cost $\bar{k}$ and the operational capital k enter in the borrowing constraint (34).

Labor and Capital Demands from Entrepreneurs From the solution of the household problem, we obtain policy functions that specify the occupational choices of parents, educational choices and consumption/savings decisions. If a parent becomes an entrepreneur, the solution of the household problem also specifies capital and labor demands. A key distinction across households comes from whether a household operates at the unconstrained optimal capital level or not. If a household has sufficient initial wealth to operate a business at the unconstrained level (i.e., the borrowing constraints (31) or (34) do not bind) factor demands for a generic household (a, z) are (omitting subscripts t, τ, p)

$$k(a, z) = (A_i \theta_i^p)^{\frac{1}{1-\alpha-\gamma}} \left(\frac{\gamma}{w}\right)^{\frac{\gamma}{1-\alpha-\gamma}} \left(\frac{\alpha}{R}\right)^{\frac{1-\gamma}{1-\alpha-\gamma}} + \mathbf{1}_{o(a,z)=\{\text{Modern}\}}\bar{k}, \tag{35}$$

$$l(a, z) = (A_i \theta_i^p)^{\frac{1}{1-\alpha-\gamma}} \left(\frac{\gamma}{w}\right)^{\frac{1-\alpha}{1-\alpha-\gamma}} \left(\frac{\alpha}{R}\right)^{\frac{\alpha}{1-\alpha-\gamma}}, \tag{36}$$

with $i = \{\text{Modern, Subsistence}\}$ and $\mathbf{1}_{o(a,z)=\{\text{Modern}\}}$ denoting an indicator function for a household (a, z) choosing to operate a modern firm. Note that the modern entrepreneurs capital demand includes the fixed cost. These equations demonstrate that the unconstrained demands for capital and labor are independent of household wealth.

Next, consider the case in which the relevant borrowing constraint, (31) or (34), binds for a household operating a subsistence or a modern firm. Denote the equilibrium level of capital used in production (given equilibrium prices) by a household of type (a, z) by $\mathcal{K}(a, z)$. Note that this amount is endogenously determined in the household decision problem when the borrowing constraint binds. The exact level of $\mathcal{K}(a, z)$ is a complicated object that results from balancing the returns to capital for investing in the firm versus the returns to investing in the kid's education. Conditional on a level of capital $\mathcal{K}(a, z)$, the labor demand is

$$l(a, z) = (A_i \theta_i^p)^{\frac{1}{1-\gamma}} \left(\mathcal{K}(a, z) - \mathbf{1}_{o_t = \{\text{Modern}\}} \bar{k}\right)^{\frac{\alpha}{1-\gamma}} \left(\frac{\gamma}{w}\right)^{\frac{1}{1-\gamma}}, \tag{37}$$

which is indeed lower than the optimal level (36). In contrast to the unconstrained case, the initial household wealth matters for the scale of operation. Thus, holding equilibrium prices constant, constrained firms have lower capital and labor demand, less profits and generate less output than their unconstrained counterparts.

As a final remark, we make the following two observations. First, when $\mathcal{K}(a, z)$ is not equal to the unconstrained level derived in (35), the borrowing constraint (equation 31 or 34) is binding in equilibrium. Thus, it is possible that the equilibrium level of education chosen for the kid in the same period, $s(a, z)$, is also sub-optimal. In fact, if borrowing constraints bind, households may even choose a different occupation than the one they would choose if borrowing constraints were absent. Second, suppose that we observe a household that operates a modern firm and is unconstrained in its capital choice. This is not sufficient to ensure that the household is unconstrained in general (conditional on equilibrium prices). There can exist a dynamic inefficiency across generations such that the educational level of the parent operating the business is lower than what the first best would have been in the absence of borrowing constraints. Hence, it is possible that the observed capital demand is lower than the demand of an unconstrained household dynasty (because it would have invested in a higher educational level of the parent, which in turn would imply a larger scale of operation).

3.5 The Schooling Sector Production Problem

Recall that we have assumed the existence of a representative firm operating the schooling technology. This firm operates a constant returns to scale Cobb-Douglas technology. The problem of this firm at time t is to choose materials M_t and teaching input T_t such that

$$\max_{T_t, M_t} \quad p_{s,t} A_s T_t^{\alpha_s} M_t^{1-\alpha_s} - M_t - w_t T_t, \tag{38}$$

where the price of the final good (which we here label materials M_t) is normalized to one. Teaching input is in effective units of human capital–identical to the labor input in the production of final good.

The schooling sector can supply as much schooling as demanded at the cost-minimizing price

$$p_{s,t} = \frac{1}{A_s}\left(\frac{1}{1-\alpha_s}\right)^{1-\alpha_s}\left(\frac{w_t}{\alpha_s}\right)^{\alpha_s}. \tag{39}$$

Using (39) the demand of factors given an output level of schooling services S_t is

$$T_t = \frac{S_t}{A_s}\left(\frac{\alpha_s}{(1-\alpha_s)w_t}\right)^{1-\alpha_s} \tag{40}$$

and $M_t = \frac{S_t}{A_s}\left(\frac{(1-\alpha_s)w_t}{\alpha_s}\right)^{\alpha_s}$. Note that financial market imperfections do not alter the production function of schooling per se because input allocation is always optimal in this sector (conditional on equilibrium prices).

3.6 Market Clearing

Let $\mathcal{F}_t^\tau(a,z)$ denote the joint distribution of wealth and effective human capital at time t over households created at time τ. At time t there are $\mathcal{T}$ joint distributions $\mathcal{F}_t^\tau(a,z)$, $\tau \in (t-\mathcal{T}, t]$. Conditional on a price sequence, we can compute the household problem for each household type (a_t^τ, z_t^τ). Then, we can compute the aggregate demands for this economy by integrating over individual household demands.[48] The labor market clearing condition is given by

$$\underbrace{\sum_{\tau=t-\mathcal{T}+1}^{t}\left(\int_{o_t^\tau(a,z)=\{\text{Subs., Modern}\}} l_t^\tau(a,z)d\mathcal{F}_t^\tau(a,z)\right) + T_t}_{\text{Labor Demand}} = \tag{41}$$

$$\sum_{\tau=t-\mathcal{T}+1}^{t}\left(\underbrace{\int_{o_t^\tau(a,z)=\{\text{Worker}\}} \theta_{w,t}^{p,\tau}(a,z)d\mathcal{F}_t^\tau(a,z)}_{\text{Parents' Labor Supply}} + \underbrace{\int (1-\eta_t^\tau(a,z))\theta_{w,t}^{k,\tau}(a,z)d\mathcal{F}_t^\tau(a,z)}_{\text{Kids' Labor Supply}}\right). \tag{42}$$

where $o_t^\tau(a,z) = \{\text{Subs., Modern}\}$ denotes an indicator function for a household created at time τ running a firm, $l_t^\tau(a,z)$ corresponds to their the labor demand and T_t denotes the total teacher demand (40). The supply of labor consists of the parents' and kids' labor supply. The occupational choice functions $o_t^\tau(a,z)$ and effective human capital levels are derived from the household maximization problem for each household type (a,z).

Similarly, the capital market clearing condition is derived by aggregating households' optimal de-

[48]Recall that we have a continuum of families. Hence, by the law of large numbers, the frequency of each household type is given by $\mathcal{F}_t^\tau(a,z)$.

mand and supply of assets,

$$\underbrace{\sum_{\tau=t-\mathcal{T}+1}^{t}\left(\int_{o_t^\tau(a,z)=\{\text{Subs., Modern}\}}\left(k_t^\tau(a,z)+\mathbf{1}_{o_t^\tau(a,z)=\{\text{Modern}\}}\bar{k}\right)d\mathcal{F}_t^\tau(a,z)\right)}_{\text{Firms' Demand}}$$
$$+\underbrace{\sum_{\tau=t-\mathcal{T}+1}^{t}\left(\int \eta_t^\tau(a,z)p_{s,t}d\mathcal{F}_t(a,z)\right)}_{\text{Education Investment}}=\underbrace{\sum_{\tau=t-\mathcal{T}+1}^{t}\int a d\mathcal{F}_t^\tau(a,z)}_{\text{Asset Supply}}. \tag{43}$$

Schooling market clearing implies that the units of schooling services produced in period t equal the aggregate demand for schooling

$$S_t=\sum_{\tau=t-\mathcal{T}+1}^{t}\int \eta_t^\tau(a,z)d\mathcal{F}_t^\tau(a,z). \tag{44}$$

3.7 Competitive Equilibrium

Given an initial distribution of state variables $\mathcal{F}_0(a,z)\equiv\mathcal{F}_0^{1-\mathcal{T}}(a,z)\times\mathcal{F}_0^{2-\mathcal{T}}(a,z)\times\ldots\times\mathcal{F}_0^{0}(a,z)$ and a sequence of wages, interest rates and schooling prices $\{w_t,r_t,p_{s,t}\}_{t=0}^{\infty}$, a competitive equilibrium is given by a sequence of allocations $\left\{\{c_t^\tau(a,z),s_t^\tau(a,z),\ a_{t+1}^\tau(a,z),k_t^\tau(a,z),l_t^\tau(a,z)\}_{\tau\in(t-\mathcal{T},t]}\right\}_{t=0}^{\infty}$ and occupational choices $\left\{\{o_t^\tau(a_t,z_t)=\{\text{Worker, Subsistence, Modern}\}\}_{\tau\in(t-\mathcal{T},t]}\right\}_{t=0}^{\infty}$ such that *(i)* households maximize utility by solving (22) subject to (23) through (32), *(ii)* the schooling sector maximizes profits (38), *(iii)* the financial intermediary sector makes zero profits, $R_t=r_t+\delta$ and *(iv)* there is market clearing in the labor market (41), capital market (43) and schooling services market (44).[49]

Stationary Competitive Equilibrium In addition to conditions *(i)*-*(iv)*, a stationary competitive equilibrium requires that the joint distribution of wealth and human capital investments is a fixed point of the equilibrium mapping and that prices are constant over time,

$$\mathcal{F}(a,z)\equiv\mathcal{F}_t(a,z)=\mathcal{F}_{t+1}(a,z), \tag{45}$$
$$r_t=r,\qquad w_t=w,\qquad p_{s,t}=p_s, \tag{46}$$

for all t and feasible (a,z). We focus on a stationary competitive equilibrium in the rest of the paper.

[49]By Walras' law, the market clearing condition for final goods is satisfied if these three markets clear. We also impose the standard transversality condition, $\lim_{t\to\infty}\beta^t\frac{\partial U(c_t)}{\partial c_t}c_t=0$. Also, note that our description of the environment imposes a law of motion for the joint distribution of wealth and talent such that the distribution at $2\mathcal{T}$ incorporates the fact that when a new generation is born, with probability ϕ the household retains the same innate talent and with the complementary probability it is re-drawn from $F(\theta)$.

3.8 Discussion of the Mechanics of the Model

To draw intuition on the mechanics of the model, we first characterize household choices under three benchmark models that are particular cases of our model under the assumption of perfect credit and insurance markets. Note that perfect credit implies that household debt can be bequeathed (i.e., there is no non-negativity constraint on bequeathed household wealth) and perfect insurance implies that it is possible to insure against talent shocks of future generations. In the first benchmark model, we shut down human capital acquisition. In the second, we introduce human capital acquisition but abstract from occupational choice. In the third, we combine occupational and schooling choices. In all three cases, perfect markets imply a separation between consumption and production choices. Then we discuss the optimal household choices in the presence of borrowing constraints and incomplete insurance markets. The key feature of this environment is that the separation property no longer holds and household wealth becomes a relevant state variable that influences human capital, occupational choice and firm size. To economize on notation, we abstract from returns to experience in this subsection, i.e., we assume that $\zeta_{\text{Exp}} = 0$. While this component does matter from a quantitative standpoint, the theoretical derivations and insights we want to emphasize are independent of returns to experience. Finally, in online Appendix A.1 we discuss the aggregate representation of final output and TFP in our the economy.

Perfect-Credit and Insurance Benchmark without Human Capital Production Consider an economy with perfect credit and insurance markets and suppose that no human capital technology is available (i.e., $A_s = 0$). Thus, effective human capital is given by innate talent, θ. In this case, the household's problem can be separated in two steps. First, the household maximizes the net income generated within the period by choosing an occupation for the parent while the kid is employed as a worker. Then, income is allocated optimally across periods and within the household.

A parent with innate talent θ chooses the occupation that maximizes her income $\mathcal{I}$ across the three possible occupations,

$$\mathcal{I}^{\text{Worker}}(\theta, w) = \theta w, \tag{47}$$

$$\mathcal{I}^{\text{Subsistence}}(\theta, w, R) = (1-\alpha-\gamma)\left(\theta\left[\frac{\gamma}{w}\right]^{\gamma}\left[\frac{\alpha}{R}\right]^{\alpha}\right)^{\frac{1}{1-\alpha-\gamma}}, \tag{48}$$

$$\mathcal{I}^{\text{Modern}}(\theta, w, R) = (1-\alpha-\gamma)\left(A_m\theta\left[\frac{\gamma}{w}\right]^{\gamma}\left[\frac{\alpha}{R}\right]^{\alpha}\right)^{\frac{1}{1-\alpha-\gamma}} - R\bar{k}, \tag{49}$$

where w and R are the equilibrium unit prices for labor and capital. Selection into different occupations depends only on the innate talent of the parent θ and it is done according to a threshold rule for talent. To see this, suppose that there exists an agent with innate talent $\tilde{\theta}$ who is indifferent between becoming a subsistence entrepreneur and a worker, $\mathcal{I}^{\text{Subsistence}}(\tilde{\theta}, w, R) = \tilde{\theta} w$. It is clear that any agent with talent $\theta > \tilde{\theta}$ strictly prefers being an entrepreneur and an agent with $\theta < \tilde{\theta}$ prefers to become a worker. Likewise, consider the case in which an entrepreneur with talent $\tilde{\theta}$ is indifferent between operating the subsistence or the modern technology. As $\mathcal{I}^{\text{Modern}}(\theta, w, R) - \mathcal{I}^{\text{Subsistence}}(\theta, w, R)$ is increasing in θ, all agents with θ greater (smaller) than $\tilde{\theta}$ strictly prefer to operate the modern (subsistence) technology.[50] Thus, this economy features a sorting equilibrium in which low-talent agents choose to be workers and high-talent agents choose to become entrepreneurs. If both production technologies are operated in equilibrium, high-talent agents sort into modern entrepreneurship.[51]

Schooling Choices with Perfect Credit and Insurance Next, we discuss the case in which there is only educational decisions but no occupational choice problem: all agents supply their effective human capital as labor. We consider an environment in which there is an (unspecified) aggregate production function that pins down wages and interests rates. We consider the household problem of deciding the number of years of education of a kid, s. Because of perfect-credit and insurance markets, the household's human capital investment problem simply requires maximizing the net present value of the investment in human capital. Finally, we make the additional simplifying assumption that the choice of educating within a period is binary (i.e., a kid goes to school during an entire period or not at all). In this case,

$$s(\theta) = \arg \max_{s \in \{0,1,\cdots,\bar{s}\}} \sum_{t=s+1}^{2\mathcal{T}} \frac{(1+s)^{\zeta_w} \theta w}{(1+r)^t} - \sum_{t=0}^{s} \frac{p_s}{(1+r)^t}. \tag{50}$$

where the interest rate is used to discount investments and returns as it represents the opportunity cost of the alternative use of household wealth. We sum from the period an agent stops attending school, $s+1$ to the end of her life $2\mathcal{T}$. The unconstrained educational level $s(\theta)$ is only a function of the type of the kid and it is weakly increasing in θ. This result is due to innate talent and schooling being complements in the production of effective human capital.

Occupational and Schooling Choices with Perfect Credit and Insurance If we allow for occupational choice, we can define the optimal level of education conditional on becoming a worker,

[50] Given the Inada conditions in the production function, it is guaranteed that wages are going to be sufficiently higher in equilibrium so that some agents prefer to become workers. However, whether both technologies are operated in equilibrium depends on parameter values. A necessary condition for both technologies being operated is that $A_m > 1$.

[51] Finally, there exists an aggregate representation for total output of the economy of the form $AK^{\alpha}L^{\gamma}$ in the competitive equilibrium (and corresponding planning problem) of this economy. The specific form of A depends on which technologies are used in equilibrium. See Buera et al. (2011) for a derivation. By removing the within-period borrowing constraint, we are able to reproduce the production chosen by a planner (conditional on a given stock of capital). However, the total capital stock (and, hence, the intertemporal allocation of consumption) can still be distorted as markets to transfer goods across time (and different possible states of nature) are imperfect (assets next-period are not state contingent and restricted to be positive).

subsistence or modern entrepreneur in an analogous manner to the discussion above, (50), where the net present value of wages would be substituted by the corresponding profits for the periods in which the parent chooses to be an entrepreneur.[52] Parents select into different occupations by maximizing the earnings they make across occupations. For a given vector of human capital $(\theta^{p,\tau}_{w,t}, \theta^{p,\tau}_{n,t}, \theta^{p,\tau}_{m,t})$ and equilibrium prices, earnings in the three different occupations–$\mathcal{I}^{\text{Worker}}(\theta^{p,\tau}_{w,t}, w)$, $\mathcal{I}^{\text{Subsistence}}(\theta^{p,\tau}_{n,t}, w, R)$ and $\mathcal{I}^{\text{Modern}}(\theta^{p,\tau}_{m,t}, w, R)$–are defined as in the perfect-markets occupational choice benchmark case, equations (47) to (49). Now, however, sorting across occupations depends on innate talent, education and their interaction. The monotonicity result we derived in the no-schooling case does not necessarily hold because the effect of schooling is heterogeneous across occupations as parametrized by $(\zeta_w, \zeta_n, \zeta_m)$, see equations (13) to (15). For example, it is possible that agents prefer to select into the modern technology even if $A_m < 1$ as long as $\zeta_m > \zeta_n$.[53]

An important implication of the perfect-credit and insurance benchmark is that the education level of a kid depends uniquely on innate talent, $s(\theta)$, and there is no heterogeneity in educational or occupational choices conditional on innate talent. This is not the case in the economy with financial frictions that we study next.

Equilibrium Choices with Financial Frictions We discuss now the case in which households can choose occupations and investments in human capital but they are subject to the financial frictions described in Section 3.3. In this environment, households can be constrained in the two types of investment: educational investments and capital investments. Conditional on equilibrium prices, if the unconstrained levels of schooling and firm operation cannot be attained (i.e., if the borrowing constraints bind), the educational and occupational choices of a household are jointly determined and distorted. Distortions can appear at the extensive and intensive margin of these two choices. Distortions at the extensive margin imply occupational choices that would not be chosen in the unconstrained equilibrium while distortions at the intensive margin imply sub-optimal levels of human and physical capital conditional on a given occupational choice.

A good example of these distortions at the intensive and extensive margin arises when analyzing potential earnings for adults across occupations. In case a household is unconstrained, potential earnings of an adult are given by (13) to (15). In this case, the same considerations as in the perfect-credit and insurance benchmark in terms of sorting apply. However, when the household is constrained, the adult may not be able to operate a modern business altogether if it is not possible to finance the fixed cost (extensive margin distortion). Alternatively, even if the adult can operate it, the size of operation may be depressed because of sub-optimal input choices (intensive margin distortion).[54] This discussion

[52]See online Appendix A.2 for the precise expressions and further discussion.
[53]See online Appendix A.2 for a discussion.
[54]That is, the amounts of labor and capital used in production are lower than for the unconstrained firm, see equation

illustrates how, in an environment with borrowing constraints, a third dimension of heterogeneity needs to be taken into account to analyze occupational choice: household wealth.

Indeed, these considerations on the adult's occupational choice are taken into account by the household when making consumption/saving decisions, schooling investments and entrepreneurship decisions. We proceed by writing down the household problem and showing how these considerations affect household choices. Denote all net income generated in a period within a household by $\mathcal{I}_t^\tau(a_t^\tau, z_t^\tau)$. $\mathcal{I}$ includes net profits and wage income and subsumes the occupational choice of the parent. Using this compact notation the household problem for $t \in [\tau, \tau + \mathcal{T} - 1)$ is

$$\begin{aligned}\max_{c_t^\tau \geq 0, \eta_t^\tau \in [0,1], a_{t+1}^\tau \geq \underline{a}_{t+1}^\tau, l \geq 0, k \geq 0} & U(c_t^\tau) + \beta \mathbf{E}\left[V_{t+1}^\tau(a_{t+1}^\tau, z_{t+1}^\tau)\right] \\ & - \lambda_1\left(a_{t+1}^\tau + c_t^\tau - (1+r)(a_t^\tau - p_s \eta_t^\tau) - \mathcal{I}_t^\tau(a_t^\tau, z_t^\tau)\right) \\ & - \lambda_2((1+\xi)(a_t^\tau - \underline{a}_t^\tau) + \overline{a} - p_s \eta_t^\tau - k + \mathbf{1}_{o_t^\tau(a_t^\tau, z_t^\tau) = \{\text{Modern}\}} \bar{k}),\end{aligned}$$

where $\mathbf{1}_{o_t^\tau(a_t^\tau, z_t^\tau) = \{\text{Modern}\}}$ denotes an indicator function for a household operating a modern technology, λ_1 and λ_2 are the Lagrange multipliers on the budget constraint and the borrowing constraint, respectively. To simplify the exposition, we have omitted the updating rules for education and the upper bound on the years of schooling (equation 12). Suppose that we are in a region where the value functions and $\mathcal{I}$ are differentiable. The first order conditions are

$$U'(c_t^\tau) = \lambda_1, \tag{51}$$

$$\beta \mathbf{E}\left[\frac{\partial V_{t+1}^\tau(a_{t+1}^\tau, z_{t+1}^\tau)}{\partial a_{t+1}^\tau}\right] = \lambda_1(1+r), \tag{52}$$

$$\beta \mathbf{E}\left[\frac{\partial V_{t+1}^\tau(a_{t+1}^\tau, z_{t+1}^\tau)}{\partial \eta_t^\tau}\right] = \lambda_1\left((1+r)p_s - \frac{\partial \mathcal{I}_t^\tau}{\partial \eta_t^\tau}\right) + \lambda_2 p_s, \tag{53}$$

$$\lambda_1 \frac{\partial \mathcal{I}_t^\tau}{\partial k} = \lambda_2 \qquad \text{if} \qquad o_t^\tau(a_t^\tau, z_t^\tau) \in \{\text{Modern, Subsistence}\}. \tag{54}$$

Equations (51) and (52) are the first-order conditions with respect to c_t^τ and a_{t+1}^τ and have a standard form.[55] The other two equations reflect how the investment choices within a period are made and how the borrowing constraint can distort allocations.

Equation (53) shows the trade-off of investing in human capital. The left-hand side captures the future benefits of educational investments: future utility is increasing because the effective type of the future kid (and parent when the new household is created) is higher. The right-hand side reflects the cost. First, there is the pure opportunity cost of using household wealth to invest in education,

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37. The resulting profits are strictly lower than the unconstrained levels.

[55]Note that we are assuming that the lower bound constraint on asset holdings,$a_{t+1}^\tau \geq \underline{a}_{t+1}^\tau$, is not binding. Otherwise, there would be an additional constraint.

$(1+r)p_s$. Second, by sending kids to school, the household has to forgo the labor income of the kid. This effect is captured by $-\partial\mathcal{I}/\partial\eta$. If the borrowing constraint binds, an additional investment wedge appears. This is captured in the third term of the right hand side, $\lambda_2 p_s$. If the parent of the household decides to become a worker, then the Lagrange multiplier λ_2 reflects the shadow value of relaxing the constraints to education.

If the parent of the household becomes an entrepreneur, an alternative use of household wealth appears: investing in the family firm. The value of this investment is captured in the left hand side of (54). Indeed, for this margin to be relevant the entrepreneur needs to be constrained and the net return of investing into the own firm has to be larger than $1+r$. In this case, there exists a trade-off between investing in education and the household firm. In the interior solution we are characterizing, household wealth is allocated to equalize the marginal returns to investing in the household firm or in education.

Since occupational choice is discrete, it is possible that marginal returns of these two investments are not always equalized. As a result, we may obtain a non-monotonic policy function of household wealth on education. Consider, for example, the following comparative static exercise on household assets. At very low levels of assets, it is not profitable to operate a business and the household invests in education. A household with a somewhat higher level of assets may find it profitable to operate a business. The marginal value of investing in the own firm satisfies Inada conditions (while not educating is always an option). Thus, a region may exist in which education of the kid is decreasing in household assets (because investing in the household firm yields higher returns). This behavior is consistent with the evidence presented in Table 6 for educational outcomes of modern entrepreneurs with assets below the median level of assets. Investment in physical and human capital eventually become increasing in total assets–up to the point in which the borrowing constraint stops binding and investments are not increasing in the level of assets.

4 Quantitative Exploration

In this section, we present a quantitative exploration of the model described in Section 3. We make extensive use of the Mexican Family Life Survey (MxFLS) to quantify our model. We use the analysis performed in Section 2 to pin down some parameters of the model ex-ante and to generate most of the moments used to calibrate the rest of the parameters. We outline the fixed-point algorithm used to compute the stationary equilibrium in online Appendix C.

After calibrating the model to the Mexican economy, we describe the performance of the model along several targeted and untargeted dimensions, e.g., educational choices as a function of household characteristics, firm dynamics and intergenerational mobility. We relate our findings to the empirical patterns documented in Section 2. Overall, the calibrated model is able to capture most of the salient facts we have documented in the data. We also perform some counterfactual experiments in Section 5. For example, we show that eliminating the borrowing constraints in our calibrated model would increase aggregate output per capita and increase the share of aggregate output that goes to the middle class.

4.1 Calibration

We impose a subset of parameters on preferences and technology that are constant throughout the quantitative exercises. As we discuss below, some of these parameters are standard in the literature while others are recovered from our analysis of the MxFLS. Finally, we calibrate the remaining set of parameters to jointly match aggregate moments.

We proceed as follows. First, we discuss the model structure that we impose ex-ante (time periods, etc.). Second, we discuss the set of parameters that we impose ex-ante, some of which can be recovered from the MxFLS. Finally, we present the moments we match to pin down the rest of the parameters in the model.

Time Periods We assume that there are 6 periods per life stage (youth and adulthood), i.e., agents live for 12 periods. Each period is calibrated to a length of 5 years. Thus, agents live for 60 years. We set the maximum years of schooling to $\bar{s} = 20$, which is the total amount of years of formal schooling from age 6 until completion of an 8-year college degree.[56] Having 12 periods per agent allows us to explore household life-cycle dynamics in detail. It is also important that agents have a realistic time horizon to rationalize their schooling investments.

Innate Talent Distribution Following Buera and Shin (2013), we assume that innate talent is drawn from a truncated and discretized Pareto distribution. We choose a finer grid for the right tail of the distribution.[57] We assume that there are 10 types of innate talent. We also impose that the lowest type has productivity equal to 1. Thus, the only parameter of the Pareto distribution $F(\theta) = 1 - \theta^{-\nu}$ that remains to be specified is the tail parameter, ν.

Parameters Invariant over Time and across Economies imposed Ex-Ante A number of fairly standard parameters are imposed without calibration. As in Buera and Shin (2013), we let $\sigma = 1.5$. The Pareto weight on a kid, λ, is calibrated to generate 30% of the consumption of an adult

[56] A high-school degree normally takes 12 years while undergraduate tertiary education can range from 2 to 6 years and masters tend to last 1 to 2 years.

[57] We include the types corresponding to the 99th, 99.5th and 99.9th percentile of the innate talent distribution (with their corresponding density) and choose the rest of the types to be evenly spaced between the lowest bound in the support of talent and the 99th percentile.

Table 9: Summary of Modeling Choices and Parameters Imposed Ex-ante

Time		Preferences		Technology		Talent		Human Capital			
$\mathcal{T}$	6	σ	1.5	$\gamma = 2\alpha$		Pareto Distrib.		$\bar{s}$	20	ζ_w	0.735
t	5yrs	λ	0.25	δ	0.266	# Types	10	α_s	0.74	ζ_m	0.735
								ζ_{Exp}	0.29	ζ_n	0.552

(see Krueger and Ludwig, 2013 and the references therein).[58] Following Buera and Shin (2013) we set the one-year depreciation rate to $\delta = 6\%$, which implies a depreciation rate of 26.6% when accumulated over 5 years. We impose that the labor share is twice the size of the capital share in the production function $\gamma = 2\alpha$. This follows Buera and Shin (2013) in maintaining the aggregate ratio of capital to labor shares (as in the NIPA tables). However, we do not pin down the level of α, so that the entrepreneurial share of production is determined in the calibration. Through the lens of the Lucas span-of-control model, changing α implies changing the span of control of managers over the factors of production and their profit share, $1 - \alpha - \gamma$.

Parameters derived from the MxFLS and imposed Ex-Ante We set the parameter governing the probability of inheriting innate talent from the parents to $\phi = 0.47$, which corresponds to the correlation between average Raven tests of parents and kids in the MxFLS. We note that this is within the range of the values reported in Bowles and Gintis (2002) on average correlations in IQ measures between parents and kids.

We also use the MxFLS to determine the parameters of the effective human capital production function in equations (13) to (15). We use the estimates of the returns to education and experience from the log-log specification (4) in Section 2, as they map directly into the Cobb-Douglas specification of our effective human capital technology. Accordingly, we take the estimates from the regression (reported in Table 7) and set $\zeta_w = \zeta_m = 0.735$ and $\zeta_n = 0.552$. Similarly, for returns to experience we set $\zeta_{\text{Exp}} = 0.29$.

In order to specify the schooling production function (16), we use the MxFLS community data set on schools.[59] We use the average ratio of schools' wage bill to total expenditure in education (including families' expenses). We find that $\alpha_s = 0.74$. This number lies between the average staff compensation relative to total educational expenditure in the public sector for the 2000-2010 period reported in the World Development Index. In the U.S. this average is around 69% while in Mexico it is 85%.

Table 9 summarizes the value of all parameters imposed ex-ante.[60]

[58]Normalizing the weight on the parent to 1, it implies a weight on the kid of $\lambda_{kid} = 0.3^{-1.5} \simeq 0.2$

[59]This corresponds to another book of the survey, which is only available for the first wave.

[60]In terms of computation, we have a grid of 21 points for possible educational levels of an individual.

Parameters Calibrated by Matching Moments It remains to calibrate the discount factor β, the sectoral productivities $\{A_m, A_s\}$, the fixed cost of operating a modern technology $\bar{k}$, the tail parameter of the Pareto distribution for innate talent, ν, the span of control parameter $1 - \alpha - \gamma$ through α (as $\gamma = 2\alpha$), the borrowing constraint parameters, ξ and $\overline{a}$, and the lower bound on household debt $\underline{a}_t^{\tau}$. To this end, we target a number of moments of the Mexican economy that we obtain from the MxFLS and, in some cases, complement with additional sources. We simulate our model and compute the moments generated by our model. We minimize the distance between the model-generated moments and those in the data with equal weight given to each moment. Thus, all parameters that we calibrate are jointly determined.[61] Despite this, we motivate the selection of some empirical moments by how they can inform certain model parameters.

Table 10 reports the targeted moments. Our first target is an annual interest rate. We target 6%. The median lending annual interest rate reported by households with annual loans is 8% in the MxFLS. However, it is based on very few observations. Thus, we supplement this information with the World Development Indicators (WDI) data for the real interest rate and the lending interest rate. The MxFLS number squares fairly well with the average lending rate reported in the WDI for the period 2000-2009 of around 9%. On the other hand, the average real interest rate during the period is around 3%. In our model, interest rates reflect both the marginal return to capital and the price of capital (which are identical in our model). However, there appears to be an important wedge between the two in the data. We choose to target an intermediate value and pick the average of the WDI numbers, $(9\% + 3\%)/2 = 6\%$.

Next, we use one moment to inform our choice of the production function of human capital. We target the median household expenditure share in education relative to total expenditure conditional on having a household member going to school, which is 10%. We also target 7.1 average years of schooling.[62] We note that the expenditure share in education that we find for the MxFLS squares well with the one reported by the National Institute of Statistics (INEGI) of 9.4%. To inform the distribution of expenditure in the population, we also target the expenditure share of the top 10% of households, who have a share of 34% in our MxFLS sample. Finally, to discipline occupational choices we target the fraction of entrepreneurs operating the modern (7%) and subsistence technologies (28%).

To guide the calibration of the lower bound on household debt, we compute the average level of debt for households with negative net assets relative to households with positive net assets. We find this number to be -1%. When simulating the model, we make the simplifying assumption that the lower bound on debt is constant across all ages of the household $\underline{a}_t^{\tau} = \underline{a}$ (except for the very last period

[61] For some of the targeted moments we lack an associated measure of its dispersion. Thus we choose to target the levels directly with equal weight.

[62] We note that there is an important trend in years of education in our data. Younger cohorts reach around eight years while older cohorts attain around 6 years. We choose an intermediate range, which coincides with the average years of education in 2000 for agents older than 25 reported in Barro and Lee (2013).

Table 10: Parameters and Moments

Moments	Target	Model	Parameter Value	Description
Yearly interest rate	6%	6%	$\beta = 0.67$	Discount factor
Average debt to asset ratio	29%	25%	$\xi = 0.99$	Borrowing constraint
% loans requiring a guarantee	30%	30%	$\overline{a} = 0.50$	Non-guaranteed loans
Ratio HH debt to assets	-1%	-1%	$\underline{a} = -0.35$	Debt limit
Top 10% expenditure share	34%	35%	$\nu = 7.23$	Pareto tail
Median HH expenditure in educ.	10%	10%	$A_s = 4.75$	Productivity Education
Average years schooling	7.1	7.1	$A_m = 0.85$	Productivity Modern
% of modern entrepren.	7%	6%	$\bar{k} = 78$	Fixed Cost
% of traditional entrepren.	28%	28%	$1 - \gamma - \alpha = 0.39$	Span of control

Note: These parameters are jointly determined by minimizing the distance between moments in the model and the data.

in which it is zero). To guide our calibration on the borrowing constraint, we compute the average debt-to-asset ratio in the MxFLS (29%) and the fraction of loans taken by households that require a guarantee (30%). We obtain this fraction from a different representative survey of the Mexican economy conducted by BANSEFI in 2005 and analyzed in Djankov et al. (2008).[63] Note that in our model agents are indifferent between taking non-conditional within-period loans and loans requiring a guarantee (conditional on the latter being feasible). We make the assumption that there is a pecking order on how households take within-period loans.[64] In our simulation, we attribute all loans that are strictly less than the upper bound on non-conditional lending, $\overline{a}$, to non-conditional loans. This assumption also allows us to match the empirical fact that the majority of loans is non-conditional in our sample.

4.2 Calibration Results and Analysis

We start by discussing the calibration results and some of the parameters we obtain. We then analyze in detail the mechanics of the calibrated model. We also show that the model is capable of matching some untargeted moments. Notably, even though our calibration only used cross-sectional moments, the model generates firm life-cycle profiles consistent with the MxFLS.

[63] Djankov et al. (2008) find that the rate of lending requiring a guarantee is 23% for "unbanked" agents and 39% for "banked" agents. They do not report which fraction of the population corresponds to each category. Given that they report average income for both groups, we impute the fraction of the population below the average between unbanked and banked income to the unbanked and the rest to banked. This turns out to be close to a 50% weight, which we take as benchmark in the end. The World Bank enterprise survey also reports the fraction of collateralized lending for firms in Mexico. For 2010 they report that 67% of the loans to entrepreneurs required collateral. A back of the envelope calculation using the fact that 35% of our sample are entrepreneurs suggests that at least 23.5% of the households are taking loans requiring a guarantee. The MxFLS has an individual survey that asks whether an individual took a loan requiring a guarantee. The response rate to this question is very low. According to these measures in the MxFLS, we estimate that around 15% of the households have loans requiring a guarantee.

[64] This assumption can be rationalized with a small additional verification cost of the guarantee that a household has to pay.

Our calibration results are reported in Table 10. Overall, we are able to match the target moments quite closely. One salient feature of the calibration is that the value of the Pareto tail is much higher (around 50%) than in the standard calibration exercises that do not endogenize human capital formation. This reflects the fact that we do not need to feed the model with vast differences in innate talent across types because these are generated endogenously through human capital formation. In our calibrated model, the ratio of the maximum to the minimum of innate talent is "only" 2.3. In contrast, the endogenous education margin alone can create 9.4-fold differences in productivity between someone with only primary education and someone with a master's degree (when employed as a worker or modern entrepreneur). Finally, recall that experience also contributes to effective human capital. For example, 40 years of experience (which would correspond to the years worked after completing 20 years of education) translates into a $40^{0.29} = 2.9$ fold increase in human capital over the life cycle. Comparing these three contributions shows that endogenous human capital plays the major role in accounting for differences in productivity across agents and, ultimately, inequality. Of course, this is true only if agents choose to educate. Below we find that this is indeed the case, and our model generates a positive mass of agents obtaining 20 years of education.

To illustrate further how endogenizing human capital amplifies differences in productivity, we calculate what the Pareto tail should be if the model only had exogenous differences in innate talent. We find that, in order to match the heterogeneity in effective types generated by endogenous human capital–$2.3 \cdot 9.4 = 21.6$–the tail would have to be around 2.25 which is 3 times "fatter" than the one that we have calibrated.[65]

Another calibrated parameter that differs from calibrations targeting the U.S. economy is the entrepreneurial share in production, $1 - \alpha - \gamma = 0.39$. We find it to be almost twice as large as standard U.S. calibrations, which are around 0.2 (e.g., Buera and Shin, 2013). This may reflect that technologies used in production differ vastly in these two economies.

The magnitude of the calibrated fixed cost of modern technologies, $\bar{k} = 78$, is sizable. It is 3.25 times larger than the household average asset position, which is 24. The parameters governing borrowing constraints, $\{\overline{a}, \underline{a}, \xi\}$, were calibrated to match the moment that 30% of the loans required a guarantee. Since the upper bound on non-conditional loans is $\overline{a} = 0.5$, this implies that 70% of the households take loans smaller than $\overline{a}$. We find the average non-conditional loan to be 0.24, which represents 1% of the average household wealth. For the households taking loans requiring a guarantee, the two parameters governing this type of lending are calibrated to $\xi = 0.99$ and $\underline{a} = -0.35$. This implies that households can borrow up to 99% of their wealth, a_t^τ, plus the lower bound on wealth, $-\underline{a}$. The average guaranteed loan in the calibrated economy is 21.3, which represents almost 90% of the average household wealth.

[65]To see this, recall that the highest type that we draw of our discretized Pareto distribution comes from the 99.9th percentile. This implies that the Pareto tail has to satisfy $v = -\ln(1 - 0.999)/\ln(21.6) = 3.16$. If we wanted to include experience to match the overall differences in effective human capital, the Pareto tail would have to be around 1.7.

Finally, we note that the value of the lower bound on household wealth $\underline{a} = -0.35$ is of the same order of magnitude as non-conditional lending. This implies that the credit line available to households through running debt across periods is similar in magnitude to non-conditional within-period lending.

Untargeted Moments The model generates reasonable predictions along different non-targeted cross-sectional moments. For example, we find that the total debt-to-GDP ratio generated in the calibration is 16%. This number is very close to the average of Mexico for the period 2000-2009 (the period that we have used to obtain our benchmark numbers), which was around 18%. In terms of income inequality, our quantitative model predicts that the top 10% earns 36% of total income. This number is very close to the top 10% income share of 39% reported by ENIGH over the 2000-2009 period.[66]

Also, as we discuss more thoroughly below, the model captures firm dynamics well despite not having targeted any moment along the life-cycle dimension. First, the model predicts that net entry into entrepreneurship increases over the life cycle. As we discussed in Section 2, we find that this is the case in the data, with the rate of entrepreneurship being 25% higher for "old" parents (above 45 years). The model captures this upward trend. However, it overshoots. It predicts, for example, that parents at the fifth period of their adulthood have a rate of entrepreneurship 66% higher than parents in their second period. On the other hand, the quantitative model captures very well firm growth over the life cycle, which was also discussed in Section 2. Our quantitative model generates no growth for subsistence firms (consistent with our empirical results) and substantial growth for modern firms. It predicts a 33% increase in firm size from young to old households, which matches closely the 30% we found in the data.[67]

Human Capital Investments Analyzing the mechanics of the calibrated model in more detail allows us to understand the trade-off that households face in our model and relate it to some of the evidence discussed from the MxFLS. Figure D.1 in the online appendix shows the distribution of human capital in the population. We find that it is bell-shaped and centered around its median value of approximately 6.5 years of education. There is a slight right tail that has a small mass concentration of less than 5% at the highest level of education (20 years). We note also that the fraction of agents choosing not to educate their kids is negligible.

Next, we discuss the behavior of the schooling policy functions at different points of the wealth distribution. This illustrates some of the main mechanisms at play in the model. Figure 3a depicts the

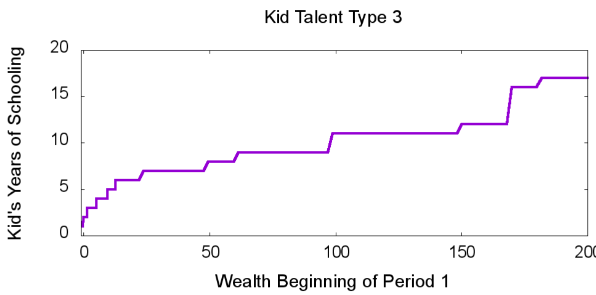
[66]The measure of top income inequality in the MxFLS is extremely granular in the sense that it is very sensitive to the inclusion of very few outliers. As the MxFLS was not designed to be representative of the top income distribution and we are unsure as to whether the very high incomes we find are real or correspond to some entry mistake, we use the numbers from the National Survey of Income and Expenditures (ENIGH), which is designed for these purposes.

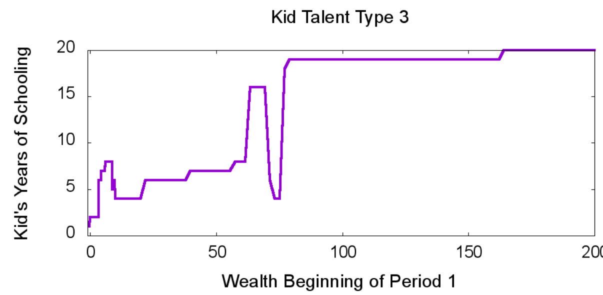
[67]We define young households those households in their first 3 periods, and old, in their last 3.

Figure 3: Educational Policy Functions for Different Household Types

(a) Parent with: Low Schooling, Low Innate Talent

(b) Parent with: Intermediate School., Intermediate Talent





Note: Wealth levels above 200 are omitted from the plot.

optimal level of total schooling s as a function of initial household wealth for a household whose kid has the third lowest talent draw of the the ability distribution (out of ten draws) and whose parent has the lowest levels of schooling and innate talent. We find that the investment in human capital is monotonically increasing as a function of the initial level of household wealth. In fact, Figure D.2 in the online appendix shows that the education policy function for this type of parent is monotonically increasing for all possible talent types of the kids.

Figure 3b shows the same policy function for a kid with the same ability when she is born in a household whose parent has the mean levels of schooling and innate talent. We see that the policy function is also overall increasing in household wealth. However, there exist two dips in the policy function for wealth around 7 and 70. These regions correspond to the points in which the household starts investing in subsistence and modern technologies, respectively. Due to the fixed cost of operation, investment in human capital drops in the range in which the household can barely pay the set-up cost to operate the modern technology. Investment in human capital increases thereafter, as the level of household wealth increases. Thus, the calibrated model generates a negative interaction between kids' education and entrepreneurship, which is in line with our findings in Section 2 (despite not being targeted in the calibration).[68]

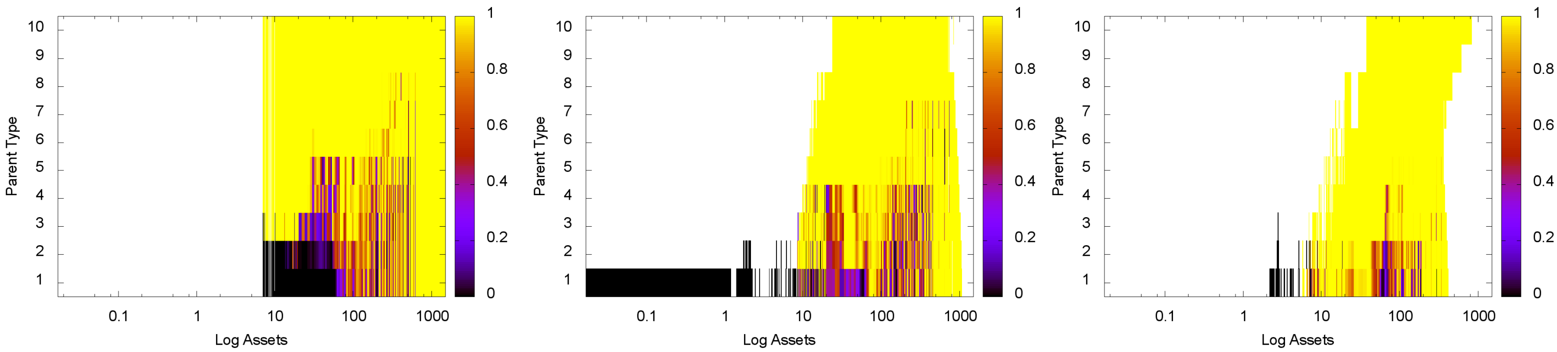
We can further analyze human capital investments by studying the joint distribution of human capital investment over household wealth and the kid's innate talent. We report the heatmaps of this joint distribution in Figures D.4 and D.5 in the online appendix. One important take away is that, holding the level of wealth constant, as the innate talent of the kid increases the years of education also tend to increase–which is also in line with what we documented in Section 2.[69]

[68]Figures D.2 and D.3 in the online appendix show these policy functions for all innate talent types of the kid conditional on the two types of parents described in the main text.

[69]The only exception concerns the top right corner of the heat map. For households with low-talent parents and a very high level of wealth, we see that education investments are inverse-U-shaped in kids innate talent. Thus, they are decreasing in the kid's innate talent for very high levels of talent. This reflects income effects. Intuitively, if these

Figure 4: Fraction of Entrepreneurs as a Function of Wealth and Parents' Innate Talent

(a) Period 1 (b) Period 3 (c) Period 6



Notes: The white region indicates zero density of population at that point. The negative wealth region is omitted.

Life-cycle Considerations The calibrated model also generates substantial heterogeneity in occupational choices across different ages of parents as a function of parents' schooling and innate talent, household wealth and kid's innate talent. To illustrate this heterogeneity, we report a heatmap of the fraction of entrepreneurs as a function of parents' innate talents and households' wealth at different points of the household life cycle in Figure 4.[70] The reason why this can be a fraction (and it is not zero or one) is because households differ in other dimensions (education of the parents, talent of the kids) that are collapsed in this plot.

First we note that, across all periods, parents with more wealth and higher innate talent are more likely to become entrepreneurs. This is consistent with the evidence discussed in Section 2. We briefly note that, among entrepreneurs, we also find that those operating modern technologies tend to be more talented and have a higher level of wealth than the subsistence entrepreneurs. This is shown in Figure D.7 in the online appendix. These patterns of selection into modern entrepreneurship are also consistent with the evidence reported in Section 2.

Figure 4 also shows that the calibrated model generates an important life-cycle component for household wealth. We see that, in the first period, all households start with positive wealth. This can be seen in the white empty region of period 1 in Figure 4a, which reflects that no household in equilibrium enters the first period with less than three units of wealth. As the life cycle elapses, some households deplete most of their wealth. These agents are typically workers, as can be seen in the black

households have a kid with a very high talent draw, they are aware that the kid is going to earn relatively high income in the future and decide to invest less in her human capital and consume more today. However, we deem this region not quantitatively relevant as there are very few low-talent parents with very high levels of wealth and very high-talented kids. We note also that one can easily spot the non-monotonicities in the policy function for the case of parents with medium levels of innate talent and schooling in Figure D.5.

[70]Figure D.6 in the online appendix reports the same plots for all periods of the life cycle.

region of period 3 (Figure 4b). Finally, we observe that all households save as they approach the end of their life (Figure 4c). These savings in the last period of life ensure that newborn households start their first period of life with positive wealth (as can be seen in Figure 4a). This facilitates consumption and investments in education to the new kids' generation (and potentially into a household business).[71]

This household saving behavior demonstrates that resources are transmitted across generations by both human capital investments in kids (that become parents in the next generation) and bequests to the next-generation household (which in our model are savings between the last period of one generation and the first period of the next). Human capital investments in kids affect the future earnings of kids when they become parents. Bequests given to newly born households ensure the possibility of investments in schooling for newborn kids. Bequests also provide insurance for a low innate talent draw of the newborn kid, can be used in some instances for consumption smoothing and to invest into entrepreneurial activities.

The timing of human capital investments introduces an important distinction with the standard self-financing argument. For any adult agent, the human capital they have is sunk at the time they make their occupational choices. Thus, in our model, it is impossible for the household to undo under-investments in parents' education. In contrast, a household can self-finance over the life cycle to escape borrowing constraints in entrepreneurial activity. In equilibrium, households understand the importance of early investments in education and adjust their savings and investment behavior, so that the next household in the dynasty has positive resources in the first period. This suggests also that the role of non-conditional lending (parametrized by $\overline{a}$) and the lower bound on debt, $\underline{a}$, may be insufficient to carry the desired initial household investments without being supplemented with a bequest from the earlier generation.

Firm Dynamics over the Life Cycle We next describe the predictions of the calibrated model regarding entry into (different types of) entrepreneurship and the evolution of firm size over the household's life cycle. These moments have not been targeted in the calibration. Despite this, the calibrated model is able to capture some important dimensions of firm dynamics over the household life cycle (while missing some others, as we discuss below).

Figure 5a shows the evolution of the share of modern and subsistence entrepreneurs over their life cycle. We find that the share of subsistence entrepreneurs increases steadily over households' life cycle, from 14% in the first period to 56% in the last period. This is partly driven by the fact that poor households invest in the schooling of kids during the first periods. After the investment in schooling is done, parents move into subsistence entrepreneurship.[72] Modern entrepreneurship also increases over

[71]Note that in our model it is feasible to bequeath zero wealth to the new generation, but no household chooses to do so at the calibrated parameters. Even though it is possible to have some loans without assets and to incur debt in the first period, the vast majority of households chooses not to do so.

[72]A second mechanism at play is that agents gain experience for each year of work as they age. The way we have modeled

the life-time. Only 5.2% of parents run modern businesses during their first period of parenthood while by the last period of the life cycle 6.4% do. The MxFLS data also features this increase in the rate of entrepreneurship over the life cycle. However, the rate of entrepreneurship over household age appears to be less steep for subsistence entrepreneurs in the data. While our model predicts around a 300% increase from households in their first period to the last, the increase in the MxFLS is ten times less than this (around 30%). On the other hand, entry patterns for modern businesses appear to be more back-loaded in the data than in our simulation, suggesting a steeper age profile than what our model predicts.

Figure 5b shows the average employment levels of modern and subsistence firms (measured in effective labor units) over the life cycle of entrepreneurs. We have normalized their levels to one in the first period. The difference in evolution of employment is stark. The average employment of subsistence businesses remains completely flat over the life cycle (if anything it decreases slightly) while the average employment size of modern firms almost doubles. If we measure firm profit over the life cycle, we would find that they increase steadily and double over the life cycle for modern entrepreneurs while they slightly decline for subsistence workers (see Figure D.8 in the online appendix).[73] These predictions resonate well with the results reported in Section 2. The model is able to capture the fact that firm size remains flat over the life cycle (or if anything slightly decreases) for subsistence firms. The model also predicts that firm size doubles over the life cycle of modern firms. This implies that there is a 33% percent increase in modern firm size between periods 1 to 3 and 4 to 6 of the life cycle, which matches very closely the 30% increase that we found in the MxFLS data.

Another dimension in which the calibrated model fails to capture a feature of the data is in the relative average size of modern and traditional firms. Our model predicts that modern firms are 7 times larger than traditional firms. However, according to the MxFLS measures reported in Table 3 this ratio is on the order of 1.5. We have summarized some of the key successes and failures of the untargeted moments in Table 11.

Inequality and Intergenerational Mobility The model also generates a substantial amount of inequality across agents. For example, the top 10% of household expenditures accounts for 35% of total expenditure (which we target in our calibration) while the bottom 10% represents a mere 3.3% in our calibrated model (versus 1.8% in the household data, which we do not target in our calibration).

We also investigate how inequality propagates across generations in our model. Two possible

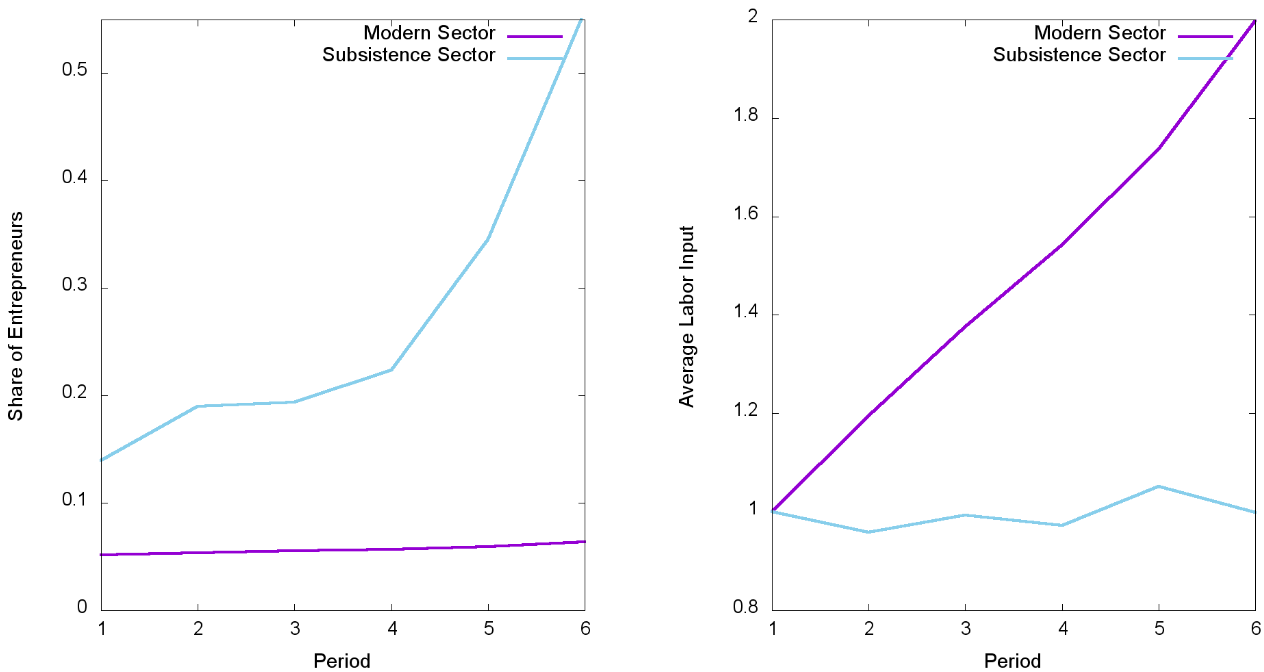
experience is such that it increases their effective type regardless of where they work. Thus, given the complementarity between education and entrepreneurship that is built into our model, this is a second force driving older agents into entrepreneurship.

[73]Figures D.9, D.10, D.11 and D.12 in the online appendix report the optimal capital investment for modern and subsistence entrepreneurs for different household characteristics. We find that conditional on the current level of wealth, the kid's talent does not matter much for the size of the firm. Again, this is consistent with the view of sequential investments, first in human capital and then in entrepreneurial activities.

Figure 5: Entrepreneurship and Firm size over the Life Cycle

(a) Share of Entrepreneurs over Life Cycle

(b) Firm Size over Life Cycle



measures of intergenerational mobility are the correlation between households' initial wealth and kids' final education, and the correlation between parents' and kids' education. We find that the correlation between initial household wealth and kids' education is 0.75. In the MxFLS, we find this correlation to be smaller, 0.34.[74] The correlation between parents' and kids' years of schooling generated by our model is 0.55. In the MxFLS, we find this correlation to be 0.51. In both cases, it is interesting to note that part of this positive correlation is efficient because it is driven by the persistence in the innate talent process across families, while another part is inefficient, as it is driven by financial market imperfections.

Through the lens of the calibrated model, we can quantify how much of the persistence across generations in different outcomes of interest is due to persistence in innate talent and how much arises from the presence of financial frictions at different points of the income and talent distribution. To illustrate this point, we compare the educational outcomes for three generations (i.e., a kid, grandkid and great-grandkid) who have the same draws of innate talents, when the initial kid is born in different families. While doing this exercise, we note that we follow the same decision rules as households in our model: households' educational decisions at time t are taken without knowing the future draws of talent of the generations yet-to-be-born.

[74]As we have alluded before, the value of this correlation is very sensitive to the inclusion of a few outliers. We report here the correlation trimming the top 1% outliers.

Table 11: Untargeted Moments

Moment	Data	Model
Employment Young to Old in Subsistence Firm	0.9	1.03
Employment Young to Old in Modern Firm	1.30	1.44
Ratio Employment Modern to Subsistence	1.5	7
Correlation Parent Kid Education	0.51	0.55
Correlation Household Assets Kid's Education	0.34	0.75

We start by considering a realization of the innate talent process for these three generations of kids such that all of them draw the highest talent. We compare the outcomes of these three generations when the first kid is born to a household in which both assets and parental human capital are in the top or bottom deciles of each respective marginal distribution. For the household at the bottom, we find that the kid would obtain 5 years of education, the grandkid would obtain 8 years of education and the great-grandkid would obtain 19. If the same kid had been born in the top decile decile family, all three generations would have obtained 20 years of education. This heterogeneity in educational outcomes illustrates how financial frictions prevent efficient investments in education for poor families and how these effects propagate across generations.

Now, we describe what happens in the opposite scenario. Suppose that the realization of the innate talent process is such that the three generations draw the lowest talent. In this case, if the kid was born in a bottom decile family, she would obtain 4 years of education while the grandkid and great-grandkid would obtain 1 year of education. If the kid had been born into a top decile family, the sequence of years of education would have been 20, 20 and 20. This shows that human capital investments in kids is a way of transferring income across generations. The kid born into a top decile family receives the maximum amount of education possible in the model despite having the lowest talent. By investing in human capital, the kid can obtain a higher income in the future.

We can also compare the predictions from our simulations of intergenerational mobility with our estimates for kids' years of education as a function of household characteristics from regression (1) in Section 2. The estimated coefficients in the regression imply that a kid born in a household at the top decile of wealth and parents' schooling should receive $1.6 \cdot 1.49 = 2.4$ times more years of education than a kid born in the bottom decile. In our simulations, we find a number of the same order of magnitude, but twice as large: $20/4.5 = 4.4$.

Overall, this exercise illustrates how borrowing constraints in our model are capable of generating low levels of intergenerational mobility. One important implication from this analysis is that introducing human capital coupled with financial frictions endogenously generates a high level of persistence of effective units of human capital across generations.

5 Counterfactual Experiments

In this section we explore the effect of financial frictions and human capital accumulation on the economy. In contrast with the previous discussion on different components of the household life cycle, we focus here on financial frictions and human capital accumulation. We have directly targeted moments on financial frictions and human capital in our calibration. Thus, the strategy we follow to parse the contribution of these mechanisms is to perform counterfactual analysis.

Our first counterfactual is a partial equilibrium exercise in which we relax borrowing constraints holding equilibrium prices constant. This exercise allows us to investigate which are the agents most constrained in the calibrated equilibrium. We find that entrepreneurs are the most constrained agents. We then turn to analyze the effect of relaxing financial constraints in general equilibrium. That is, we let prices adjust to ensure market clearing. We show that the distribution of human capital would become more unequal in this environment; entrepreneurs operating modern technologies would increase their educational level the most relative to the calibrated equilibrium. We also perform another set of counterfactuals in which we improve production and schooling technologies in a Hicks-neutral way. We find that investments in human capital are very responsive to these technological improvements.

Finally, to illustrate the role of endogenous human capital formation, we do a counterfactual in which we shut down schooling holding the rest of parameters at the calibrated values. We show that aggregate output and inequality substantially decrease. Since firms operate at smaller sizes, borrowing constraints play a less important role in this case.

The Role of Financial Constraints at Current Prices To understand the extent to which financial frictions distort household allocations, we start by performing the following counterfactual: Holding the equilibrium prices at the calibrated levels, how would allocations change if agents were not facing borrowing constraints and their debt limit was their natural borrowing limit? Note that this financial regime does not correspond to perfect markets as we maintain the assumptions that all debt has to be paid within the life of a household and there is no insurance for off-spring talent shocks.

In this counterfactual economy, we find that households would like to borrow much more than in our calibrated economy. For example, the debt to asset ratio would be 56% (compared to 25% in the baseline calibration). Debt-to-GDP would increase more than ten-fold. There would be fewer entrepreneurs (11% of the total population) and only 1% would correspond to subsistence entrepreneurs. Entrepreneurs would run more capitalized firms. The ratio of their earnings to workers would increase three-fold relative to the calibrated equilibrium. In this exercise the distribution of schooling would become bi-modal. Entrepreneurs-to-be would be educated to almost the maximal level allowed by the model, 19.8 years on average. This is more than twice the average of 8.7 years of education of entrepreneurs in the baseline model. The rest of the population would have almost no education (0.5

on average) relative to 6.2 years in the baseline simulation. This suggests that at the calibrated model parameters: *(i)* entrepreneurs are the most constrained agents and *(ii)* part of the investment in human capital of (future) workers corresponds to precautionary investments in human capital.

We report the equivalent of Figures 3 and Figure 4 in the online appendix for this exercise. Figure D.13 shows the corresponding educational policy functions. We find that the policy function for education is always higher than our calibration for the same level of assets, innate talent of parents and level of schooling. In fact, for parents with an intermediate level of schooling and innate talent, Figure D.13b shows that the optimal education level is always the maximal level–in contrast with Figure 3b. Figure D.14 in the appendix shows the distributions of occupational choice as functions of household assets and wealth that corresponds to Figure 4. We see that households hold substantially less wealth than in the calibrated economy. Moreover, there is no life-cycle effect under which–as a household gets older–it saves up for the subsequent generation. Indeed, this is the result of the relaxed financial frictions that facilitate lending at any age of the household. Finally, we note that entrepreneurship is more highly concentrated in households that are either wealthy or possess high innate talent.

Removing Borrowing Constraints Next, we analyze the role played by borrowing constraints in our model in general equilibrium. That is, we repeat the previous exercise but with endogenous prices. We maintain the parameter values calibrated to the Mexican economy described in Table 10 except for the financial frictions parameters ξ, $\overline{a}$ and $\underline{a}$, which we vary. Note that we maintain the constraint on non-negativity of wealth next period for the last period of existence of households. Thus, as in the previous counterfactual, this exercise does not correspond to moving the economy to complete markets. Rather, we are going to explore the effect of eliminating borrowing constraints within a period and transferring payments across periods within the lifetime of the household (but not across households that belong to the same dynasty).

First, we explore the role of relaxing borrowing within period, without relaxing the ability of taking on more debt across periods. We do two exercises. First, we increase the value of the parameter ξ so that the within-period borrowing constraint is not binding for any household. Recall that ξ is the factor of proportion used to determine the maximal size of guaranteed lending, $\xi(a - \overline{a})$. We find that this exercise generates an increase in total output of 10.3%. The average human capital stock increases 2% and average years of education increase by a tenth of a year. In contrast, the debt-to-asset ratio is 700 times greater. Both impacts are related to substantial distributional changes. The dispersion in human capital (as measured by the standard deviation) increases by 20%. This reflects the compounded effect of an increase in education of "high" innate ability kids and a decrease in education of relatively "low" innate ability kids. This increase in investment of high ability kids is also reflected in intergenerational mobility measures. The correlation between household wealth and kids' human capital is reduced by

28%, moving from 0.75 to 0.54.

In terms of occupational choices, the total number of entrepreneurs declines to 27% (from 34% in the calibration). Moreover, this decrease comes entirely from a drop in subsistence entrepreneurs; their share is almost cut in half. In contrast, the number of modern entrepreneurs increases by 20%. These changes reflect the combined effects of better-educated entrepreneurs and optimally-scaled firms. As a consequence of the reduction in the number of entrepreneurs, firm size (as measured by employed effective units of human capital) goes up by 8% in the modern sector and 6% in the subsistence. In terms of returns across occupations, we find that the relative earnings gap between workers and entrepreneurs decreases by 5.4%.

These changes in the composition and returns across occupations have a significant impact on inequality. We find that inequality at the top is significantly reduced. The expenditure share going to the top 10% households decreases by 10.4%. The top 10% income share decreases by 10.5%. The expenditure share accruing to the bottom 10% is reduced by 3.1%. However, the level of consumption of households at the bottom 10% increases because aggregate consumption increases by 7.1% (thus undoing the decrease in the share of aggregate consumption accruing to the bottom 10%). Note that this increase in aggregate consumption does not trickle-down one for one to the bottom 10%. Thus, welfare gains are concentrated in the "middle" of the distribution, as the expenditure share increases at the expense of the top and bottom 10%.

The second counterfactual we study involves relaxing non-conditional lending $\overline{a}$. We increase the upper limit on non-conditional lending $\overline{a}$, so that it is not binding for any individual (we maintain the requirement that households have to repay debt before they disappear and the lower-bound constraint on debt $\underline{a} = -0.35$). This generates similar results to the previous counterfactual in which we increased guaranteed lending. The only significant difference is that households accumulate less wealth in this case because lending is now independent of household wealth. For example, there would "only" be a nine-fold increase in the debt to asset ratio relative to the seven-hundred fold increase in the previous counterfactual.

Overall, these two exercises suggest that, in our current calibration, within-period financial frictions distort substantially the distribution of human capital investments across households. The distribution of human capital investments is "too compressed" relative to an environment without within-period borrowing constraints. We have also shown that they substantially distort wealth accumulation and occupational choices.

Finally, we can compute the additional effect of relaxing the lower bound on debt $\underline{a}$ all the way to its "natural" limit. In this exercise, the only financial friction is that households have to repay their debt before they disappear and that there are no state-contingent bonds. We find that in this case average human capital in the economy decreases and becomes more unequally distributed. Entrepreneurs increase their human capital by almost two years while workers decrease their education levels by three years. The number of entrepreneurs also goes down drastically in the economy to around 6% and aggregate output increases by almost 60%.

Improving the Educational and Final Good Production Technology We next explore the effect of Hicks-neutral technological improvements on equilibrium outcomes. We start by analyzing the effect of improving the educational technology. We find that increasing the productivity of the schooling sector, A_s, by 10% holding all other calibrated parameters constant increases average years of education by 3.5%. This effective reduction in the cost of education also has a significant impact on occupational choices. The number of modern entrepreneurs increases by almost 10% and the number of subsistence entrepreneurs declines by more than 11%. Entrants into modern entrepreneurship have high levels of education and, as a result, the average years of education of modern entrepreneurs increases by 0.3 years. The years of education of subsistence and modern entrepreneurs increases by 0.1 years. Aggregate output increases by 2%.

If instead of improving the productivity of schooling technology by 10%, final good production technologies became 10% more productive (i.e., there is a Hicks-neutral technological improvement in output technologies of 10%), years of education would increase by 12%. Modern entrepreneurship would double to 14% and subsistence entrepreneurship would shrink to 2% of households. The scale of operation of modern firms would decrease by around 20% relative to the calibrated equilibrium due to the fact that, in this new equilibrium, almost all types of entrepreneurs would operate this technology.

Overall, these two exercises suggest that investments in education and entrepreneurship are very responsive to changes in the productivity of production functions.

Human Capital Formation We next investigate the role of endogenous human capital formation in generating our results. To do so, we shut down endogenous educational choices in the model, and recompute the equilibrium holding all other parameters constant. Formally, this can be done equivalently by setting either the productivity of the educational sector, A_s, or the returns to education parameters, ζ_w, ζ_s, and ζ_m equal to zero. This experiment informs us of the role of endogenous human capital in generating the observed results, as the only differences across agents come now from innate ability and wealth.

Shutting down endogenous education reduces aggregate output by 88%. In a growth accounting framework, measured TFP decreases by 35% and the remaining drop is accounted for by the reduction on effective human capital stock (which would be composed now only of innate talent and experience).[75] Production is entirely concentrated in subsistence firms and 68% of households operate a subsistence

[75] We follow Buera and Shin (2013) and define TFP as the Solow residual obtained from assuming an aggregate Cobb-Douglas production function with capital share 1/3 and labor share of 2/3, where labor is defined in effective units.

firm. The reason for this is that, at the calibrated parameters, the productivity advantage of modern firms comes from their higher sensitivity to human capital, as the calibrated Hicks-neutral productivity term of the modern sector is $A_m < 1$. The optimal scale of operation is also reduced. This is a consequence of the effective human capital of entrepreneurs being reduced. For example, the share of employment (measured in effective units) accruing to the top 10% firms falls by approximately 50%. This reduction in firm size together with the impossibility of investing in human capital makes borrowing constraints less important in this economy. For example, the debt-to-GDP ratio decreases by 40%. Thus, the measured reduction in TFP not only captures the mechanical decrease in entrepreneurs' human capital but also encapsulates the countervailing effect that operates through a better selection into entrepreneurship due to borrowing constraints being less prevalent.

In terms of inequality, we find that shutting down endogenous human capital accumulation through schooling investment matters disproportionately for top income and expenditure inequality. The top 10% income and expenditure shares are reduced by 47% and 49%, respectively. This exercise reinforces the message from the productivity decomposition between innate talent and endogenous human capital from Section 4.2 and highlights how endogenous human capital formation plays a substantial role in generating the inequality we observe in our baseline calibration.

6 Conclusion

This paper investigates the role of credit market imperfections in the joint determination of human capital and entrepreneurial investments. Using the Mexican Family Life Survey (MxFLS), we document correlation patterns between schooling, occupational choices, household wealth, innate talent of parents and kids and age of household members. Overall, the evidence presented paints a picture potentially consistent with the view that poor households are constrained in their human capital and entrepreneurial investments.

Motivated by our empirical analysis of the MxFLS, we develop a heterogeneous-agent, incomplete-market, overlapping-generations dynasty model. In our model, households are the unit of decision. They are composed of a parent and a kid. At each point of their life cycle, households collectively decide over kids' investment in human capital (schooling) and parents' entrepreneurial investments in modern and subsistence technologies. In the presence of financial constraints these two investment margins are co-determined.

We show that a version of our model calibrated to the MxFLS can account for the broad correlation patterns uncovered in the data, both within and across generations. For example, the model generates a non-monotonic gradient between household assets and kids' education, realistic growth in profits and employment for modern firms only and dynastic persistence across generations in education and wealth. We find that endogenous human capital acquisition accounts for the majority of the inequality generated in our calibrated model. We also conduct counterfactual experiments to analyze the role of different channels. For example, we show that eliminating borrowing constraints in our economy would increase aggregate expenditure and compress the expenditure distribution, benefiting relatively more agents in the middle class.

Going forward, we think that the model we have developed can be a useful tool to evaluate the distributional and aggregate effects of alternative policies. For example, it could be used to evaluate the effect of conditional cash transfers to education (e.g., Progresa/Oportunidades) versus subsidies to entrepreneurship. It would also be highly desirable to obtain causal estimates of the parameters estimated in the household data that are then used in the quantitative model (e.g., returns to schooling by occupation). For this, a promising avenue would be to combine this type of exercise with experimental or quasi-experimental micro data.

Our formulation of financial frictions is not micro-founded. Exploring alternative micro-foundations for borrowing constraints (e.g., Lochner and Monge-Naranjo, 2011, 2012 or Midrigan and Xu, 2014) and their effects on the two investment margins seems a natural next step. We also find that our quantitative results are quite sensitive to the targeted interest rate. Our model assumed competitive financial intermediaries. This implies that the interest rate paid by borrowers coincides with the interest received by lenders. However, the MxFLS data suggests that there is a significant wedge between the two. We conjecture that introducing a wedge between borrowing and lending rates that depresses the returns to saving would amplify the effect of financial frictions. Finally, in this paper, we have restricted our attention to stationary equilibria. We do observe, however, an upward trend in years of education in the Mexican economy, which we cannot account for in the stationary equilibrium. In future work we plan to address the modeling of transitions and wedges between borrowing and lending rates.

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