ISTANBUL BILGI UNIVERSITY
INSTITUTE OF GRADUATE PROGRAMS
ECONOMICS MASTER'S DEGREE PROGRAM

THE EFFECTS OF THE INTERMEDIATION SPREAD ON FORMAL AND INFORMAL ENTREPRENEURSHIP

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İSTANBUL
2021

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Faiz marjının kayıtlı ve kayıtdışı girişimcilikteki etkileri

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Tezin Onaylandığı Tarih : 01/07/2021
Toplam Sayfa Sayısı : 43

Anahtar Kelimeler (Türkçe)

1) Faiz Marjı
2) Girişimcilik
3) Kayıt Dışılık
4) Kredi Kısıtlılığı
5) Kesişen Nesiller

Anahtar Kelimeler (İngilizce)

1) Intermediation Spread
2) Entrepreneurship
3) Informality
4) Credit Constraint
5) Overlapping-Generations

ACKNOWLEDGEMENTS

I thank ;

- My dissertation supervisor, Assoc. Prof. Orhan Erem Ateşağaoğlu, for his unending guidance throughout the whole dissertation process, in addition to the intuitions of the mechanisms in the modelling processes that he provided both in the dissertation processes and in the lectures.

- The jury members for their valuable comments and their patience to participate and endure all the misunderstandings that I may cause in the dissertation defense.

- All current and past members of the economic research center that I am working at, Bahçeşehir Üniversitesi Ekonomik Ve Toplumsal Araştırmalar Merkezi (BETAM), for their continuing encouragement to always mess with the data, and the intuitions that they gave regarding the economic and social outcomes.

- All faculty members of the economics department of Istanbul Bilgi University as they always opened their door to discuss the micro and macro foundations surrounding all the economic entities, and never hesitated to help throughout the dissertation process.

- All students of the M.Sc Program in Economics in Istanbul Bilgi University. It would not be possible to grasp the main points of the economic mechanisms I tried to work out without working side-by-side with them.

- All the members of Graduate Student Affairs and Institute of Graduate Programs of the Bilgi University as their guidance that they gave throughout the dissertation process helped significantly.

- My family and fiancée for their neverlasting support and patience they showed throughout the whole dissertation and lecture processes.

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ABSTRACT

The effects of the intermediation spread on formal and informal entrepreneurship

In this thesis, we attempt to measure the effects of the interest wedge between the deposit and the lending rate on the overall economy in an overlapping generations setup that features the formal and the informal sector. The increases in the magnitude of the interest wedge harm output, lower wages and increase the prevalence of production units that evade taxes and stay small in order to remain undetected. General equilibrium results show that the increases in the intermediation wedge affect capital and labor demand for the formal sector, lower the equilibrium prices and thus, decrease the opportunity cost for the entrepreneurs in the informal sector. The presence of intermediation spread increases the measure of informal producers that would otherwise be either formal producers or workers. It also decreases the scale at which formal entrepreneurs would operate if the intermediation spread was absent. The decreases in wages and interest rates also cripple the incentive to accumulate asset among low skilled agents in the finite-horizon model. As the increases in the user cost of capital combine with the decreases in the return to asset accumulation and being a salaried worker, the amount of external funds that the formal entrepreneurs would benefit goes down.

ÖZET

Faiz marjının kayıtlı ve kayıtdışı girişimcilikteki etkileri

Bu tezde mevduat ve kredi faizi arasındaki marjın etkilerini kayıtlı ve kayıtdışı sektörün birlikte yer aldığı bir keşisen nesiller modeli üstünden inceliyoruz. Bu marjdaki artışlar, toplam üretimi ve ücretli kesimin maaşlarını düşürmenin yanında, vergi kaçıran ve yakalanmamak için ölçeğini küçük tutmak durumunda kalan kayıtdışı sektörün yaygınlığını da artırmaktadır. Marjdaki artışlar üretimin büyük bölümünü içine alan kayıtlı sektördeki işgücü ve sermaye taleplerini ciddi ölçüde etkileyerek denge faktör fiyatlarını düşürdüğü için, özellikle kayıtdışı girişimciliğin fırsat maliyetini düşürmektedir. Marjın varlığı hem kayıtlı girişimciler hem de maaşlılar aleyhine kayıtdışı girişimcilerin oranını arttırmaktadır. Bunun yanında, kayıtlı girişimcilerin girişim ölçeklerini de ciddi ölçüde tahribata uğratmaktadır. Maaşlardaki ve mevduat faizlerindeki düşüş aynı zamanda düşük girişimcilik vasfına sahip birimlerin varlık biriktirme eğilimlerini düşürmektedir. Sermaye talebinde ve arzında birlikte gerçekleşen bu düşüşler nihayetinde kayıtlı girişimcilerin kullanabileceği finansal dış kaynak miktarını azaltmaktadır.

INTRODUCTION

The amount of available external credit, the degree of the prevalence of informal production and the density of small-scale production units differ to an important degree across countries. Despite that the direction of causality between these outcomes is still discussed among many researchers, the interlink between them seems to exist. As the imperfections in the credit market inhibit efficient allocation of resources, they also decrease overall income and the tax base due to the decreases in the benefit from operating in the formal sector. The shrink in the tax base induces governments to rely on other sources of income and tax financial intermediaries, which can pass through this cost to individual producers, resulting in the increases in the measure of informal entrepreneurs that would otherwise operate at a higher scale and pay taxes.

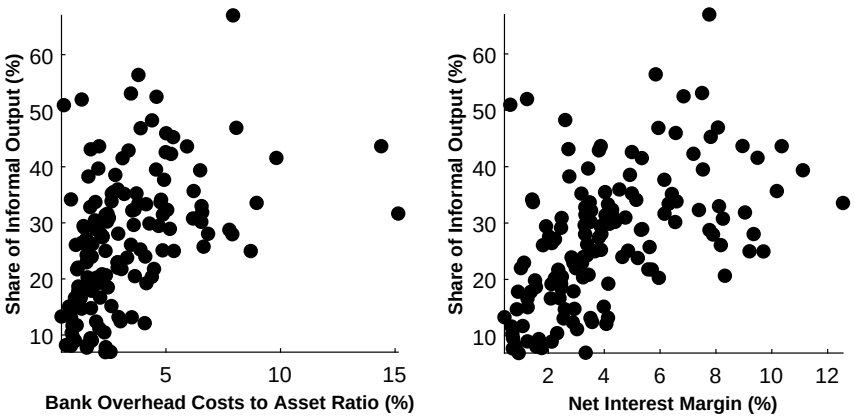
The purpose of this thesis is to calculate the variations in the aggregate outcomes as a result of the movements in the spread between the deposit and lending rates. Mostly, the wedge between the deposit and lending rates reflects the degree of efficiency and competitiveness to which the financial sector channels funds from depositors to borrowers. For the countries in which most of the intermediation activity flows through the banks, the two measures of financial imperfection put forward by Beck, Demirgüç-Kunt, and Levine (2000) are especially important : "The Bank Overhead Costs to Total Asset Ratio" and the "Net Interest Margin". "The Bank Overhead Costs to Total Assets" is defined as "the accounting value of a bank's overhead costs as a share of its total assets" by Beck, Demirgüç-Kunt, and Levine (2000), Beck and Demirgüç-Kunt (2009), and Čihák et al. (2012). "The Net Interest Margin" is defined as the "Accounting value of bank's net interest revenue as a share of its interest-bearing (total earning) assets." by the same authors. Beck and Demirgüç-Kunt (2009) emphasize that both of these measures are higher among poorer countries. Analyzing the period between 1995 and 2007, they also notice that the net interest margin trended down significantly within the upper-middle income countries. D'Erasmo (2016) also reports that credit expansion and the shrink in the

share of the informal output in Brazil were accompanied by the decreases in the 'cost of credit' (net interest margin) and the 'intermediation cost' (banks' overhead costs to total asset ratio) between 2001 and 2007 .

The intermediation cost is quite far from being the sole indicator of financial efficiency (Erosa 2001). Nevertheless, the average wedge per the unit of deposited assets for borrowers comoves with the average size of establishments, and the size of the informal sector. The share of informal output over GDP also seems to interact with financial repression. What is more interesting about this interplay is that both directions of causality between the two outcomes are discussed among researchers (Quintin 2008, Antunes and Cavalcanti 2007, Elgin and Uras 2013, Merlin and Teles 2021). One side of relationship implies that the increase in the relative size of the informal sector almost certainly shrinks the tax base, and induces governments to rely on the taxes on financial intermediaries to offset that shrink. As a result, financial intermediaries pass through this increase in taxes to prospective borrowers and lifts up the cost per unit of fund for borrowers. (Roubini and Sala-i-Martin 1995, Elgin and Uras 2013). The reverse relationship implies that the increases in the intermediation cost limit the available funds the formal entrepreneurs would borrow and cause them to operate at the informal sector (Merlin and Teles 2021). The figure I.1 shows how countries are scattered with respect to the financial intermediation efficiency and the informal sector size. "The Bank Overhead Costs to Total Assets" and "The Net Interest Margin" values across countries are taken from the Financial Structure and Development Dataset gathered by Beck, Demirgüç-Kunt, and Levine (2000), Beck and Demirgüç-Kunt (2009) and Čihák et al. (2012), and further updated until 2017. The size of the informal sector across countries is taken from Medina and Schneider (2018) which gives the estimates for the size of the informal sector between 1991 and 2015. Figure I.1 shows that both measures of financial imperfection is positively related to the size of the informal sector in an economy, especially for those at the lower end, i.e where the size of the informal sector is relatively low. The correlation coefficient between the share of the informal output and bank overhead costs is 0.44 across 140 countries, whereas the correlation coefficient between the

informal sector share and net interest margin is 0.52. At the higher end where the informal sector size is bigger, the positive relation is not that ascertained. Nevertheless, both the intermediation cost and other types of financial repressions seems to move with the informal sector share in an economy across countries.

Figure I.1: Measures of Intermediation Spread and Informal Sector Size in 2015



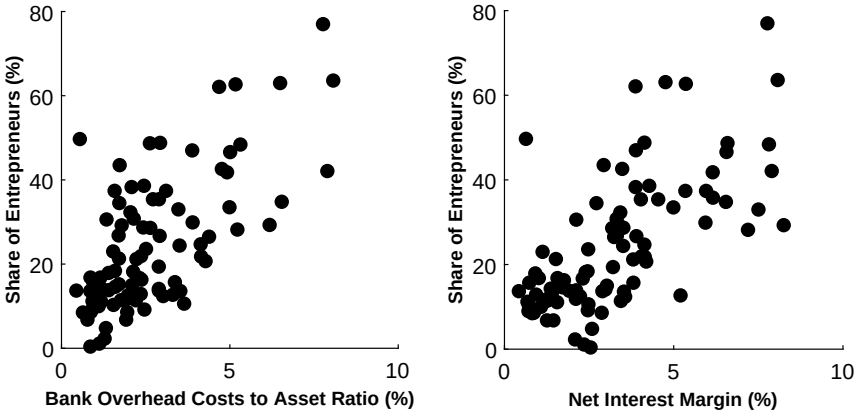
Source : Thorsten et al. (2019), Medina and Schneider (2018)

Furthermore, the combination of low capital intensity in the small-scale production units and prevalence of these establishments reduce the return to the salaried work, cause lower wages and induce relatively low-skilled households to shift their occupation from salaried work to entrepreneurship. As a result, the number of entrepreneurs also increases. Overall, as shown by Erosa (2001), the increases in the wedge between the return to deposits and cost per borrowed amount lower output, increase the density of small-scale production units and the number of entrepreneurs. The decreases in the overall wage also increase inequality, as the share of salaried workers who have to deal with lower wages are high also in the lower-income economies.

The association between the level of the intermediation wedge and the share of entrepreneurs over the labor force is positive. Controlling for the size of the per-capita output, Erosa (2001) emphasizes this association across the manufacturing sectors of the relatively narrow set of countries. Using cross country ILO data (ILOSTAT 2021) regarding the status in employment (where we define the entrepreneur as the own-account worker or employer) and the Financial Development and Structure

Dataset from Beck, Demirgüç-Kunt, and Levine (2000), Beck and Demirgüç-Kunt (2009) and Čihák et al. (2012), the correlation coefficient between the share of entrepreneurs and the bank overhead cost to total assets is calculated as 0.58 within 93 countries for 2015. The relationship between the entrepreneurship rate and net interest margin is not that different, generating a correlation coefficient of 0.69 across the same set of countries. The figure below implies that a linear association seems to fit well. So, in line with Erosa (2001), the relation between the intermediation spread and the rate of business owners is likely to exist at all levels of output per capita.

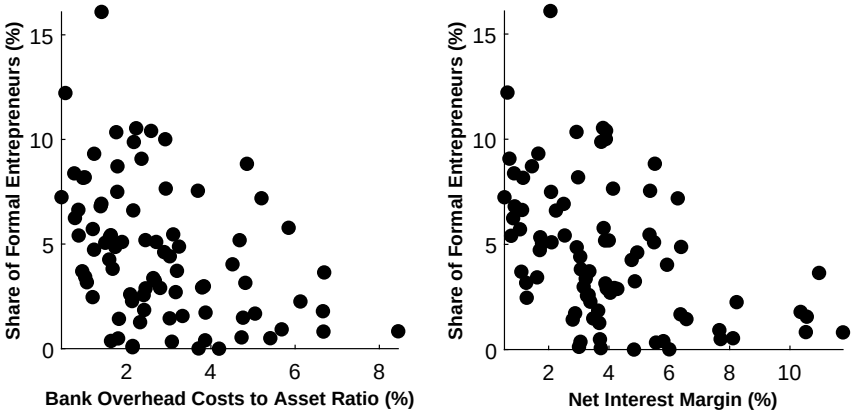
Figure I.2: Measures of Intermediation Spread and Share of Entrepreneurs in 2015



Source : Thorsten et al. (2019), ILOSTAT (2021)

While the share of entrepreneurs in the labor force and measures of financial inefficiency are positively associated, taking the definition of informality based on the enterprise that employers and own-account workers are working at, the association between financial inefficiency and the measure of formal entrepreneurs does not seem positive. The Figure I.3 shows that the measure of formally self-employed (formal employers + formal own-account workers) is negatively associated with both measures of financial inefficiency, namely bank overhead costs to asset ratio and net interest margin. The correlation coefficient between the share of formal entrepreneurs and net interest margin is -0.44, whereas the same coefficient is -0.39 between the share of formal entrepreneurs and bank overhead costs to asset ratio.

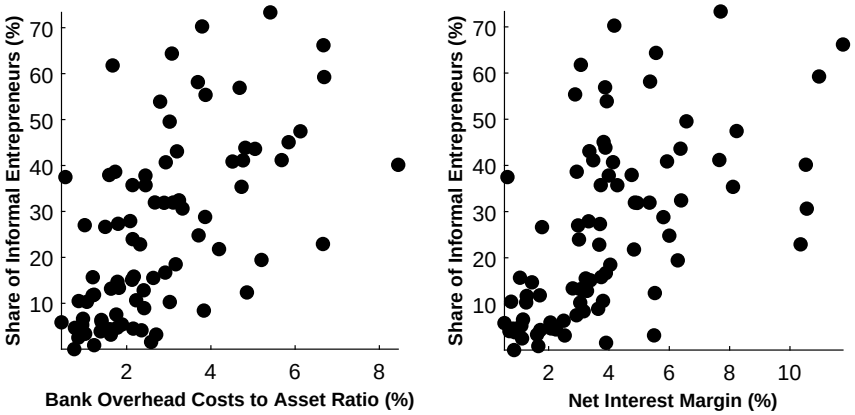
Figure I.3: Measures of Intermediation Spread and Formal Entrepreneurship



Source : Thorsten et al. (2019), ILO - Geneva (2018), ILOSTAT (2021), World Bank (2021b)

The Figure I.4 shows that there is a strong association between the level of financial repression and the share of informal entrepreneurs (informal employer + informal own-account worker) over the labor force. It is no surprise as the share of entrepreneurs over the labor force is positively related to the measures of financial repression while the share of formal entrepreneurs over the labor force is not.

Figure I.4: Measures of Intermediation Spread and Informal Entrepreneurship



Source : Thorsten et al. (2019), ILO - Geneva (2018), ILOSTAT (2021), World Bank (2021b)

1 LITERATURE

Entrepreneurs are especially important in explaining the distribution of wealth among households (Quadrini 2000, Cagetti and De Nardi 2006). Using household data which represent the distribution of income and wealth across households, they show that wealth-income ratios are substantially higher for entrepreneurs, regardless of how they are defined in these surveys. Furthermore, they show that the fraction of households that are entrepreneurs increases with the class of wealth. Taking these into account, both Quadrini (2000) and Cagetti and De Nardi (2006) study what mechanisms might induce such wealth concentration with endogenous choice of occupations between entrepreneurship and salaried worker. Quadrini (2000) explicitly incorporates the intermediation cost in his model and show that, a model with no entrepreneurs that would nevertheless generate the earnings dispersion sufficiently is unable to explain the distribution of wealth among households. Although several mechanisms (bequests, life-cycle framework, heterogeneity in preferences) can be incorporated that would explain the distribution of wealth without entrepreneurs, Quadrini (2000)'s model is also able to explain why the wealth-income ratio and saving rate are higher among entrepreneurs. An ingredient that would generate such high saving rates is the intermediation wedge between the deposit and lending rate. He shows that the intermediation wedge, combined with the size constraint that the entrepreneur would borrow, generates heterogenous marginal returns per assets across entrepreneurs, as financially constrained agents decide to save until the marginal return per asset reaches equals the deposit rate. The higher marginal return per asset induces those entrepreneurs to accumulate wealth until the marginal return equals the risk-free rate of return to deposits. So, higher saving rate for entrepreneurs and endogenous choice of occupation could explain the right-tail of the wealth distribution. Quadrini (2000) also shows that the decrease in the intermediation cost decreases the Wealth Gini, just as in Erosa (2001). Cagetti and De Nardi (2006) endogenize the "project scale", which is drawn exogenously in Quadrini (2000) and incorporate the bequest-motive to a life-cycle model and study the effects of intergenerational altruism and borrowing constraints on wealth distribution, the entry

decision to become entrepreneur and the scale of the project that entrepreneurs invest.

The literature investigating the link between the financial repression and the occupational choice is vast. Evans and Jovanovic (1989) show that the selection into entrepreneurship is not only determined by the entrepreneurial skill of the individual but also the level of her asset that would overcome the liquidity constraint faced by the entrepreneur. As the liquidity constraint is binding especially for those at younger ages, entry into entrepreneurship may depend on individual wealth to an important degree for younger cohorts. Related to the work by Evans and Jovanovic (1989), several papers investigated the relationship between the entry into entrepreneurship and financial constraints. Hurst and Lusardi (2004) find that relationship between household wealth and entry into business ownership is convex, and most of the increases occur within the upper tail of the wealth distribution. Buera (2009) studies the same relationship in a dynamic model. He characterizes that the liquidity constraint and decision to entry into business ownership are related only for those at intermediate skill entrepreneurial levels. Individuals will choose to become workers even if they have high levels of wealth when their entrepreneurial ability is low. He concludes that the probability of becoming an entrepreneur is increasing in wealth in the left tail of the wealth distribution but decreasing in the right tail of the wealth distribution. He concludes that the effects of the financial repression (i.e borrowing constraint) is mostly reflected in the intensive margin rather than the extensive margin. Akyol and Athreya (2009) and Meh (2008) incorporate the intermediation cost as the measure of financial repression and enrich their model with age-dependent worker-productivity processes. Akyol and Athreya (2009) show that while the financial repression (in the form of intermediation cost) affects the scale of businesses, as in Buera (2009), the opportunity cost of self-employment (the benefit from the salaried work) rather affects the rate of self-employment. Surprisingly, both models of Meh (2008) and Akyol and Athreya (2009) reach to the conclusion that the increase in the intermediation costs lowers the share of entrepreneurs. Similar results from Cagetti and De Nardi (2006) lead Quadrini (2009) to question the

relationship between the liquidity constraint and the rate of entrepreneurs in his survey, as lower financial development (either in the decreases in the leverage ratio or the increases in the intermediation costs) result in the lower measure of entrepreneurs in these models, which is opposite of what the cross-country data show.

On the other side, Erosa (2001) and Antunes, Cavalcanti, and Villamil (2008) show that increases in the intermediation cost can result in increases in the share of self-employed workers, which is consistent with the data in that more financially repressed economies feature a higher share of entrepreneurs. Unlike in Cagetti and De Nardi (2006), Antunes, Cavalcanti, and Villamil (2008) allow entrepreneurs to also hire labor and compare partial equilibrium case (i.e only labor market clears.) with the general equilibrium case (i.e both labor and capital markets clear.) in a one-period non-overlapping generations model. They find that the effect of financial repression (enforcement imperfections and intermediation wedges) differs substantially across these partial and general equilibrium cases. In the partial equilibrium case, the increases in the intermediation cost increases the share of entrepreneurs substantially in order to clear the labor market through the decreases in wages. The general equilibrium case buffers this occupational choice shift through the decreases in the interest rate but nevertheless, the share of entrepreneurs increases. Overall, in both cases, the increases in financial repression may increase the measure of entrepreneurs and decrease the average size of establishments simultaneously. The increases in the share of entrepreneurs and decreases in the aggregate output in the partial equilibrium case are more substantial relative to the general equilibrium case. As in Buera (2009), they show that the financial repression affects entry into entrepreneurship for only a small subset of agents. They further make a robustness check through adding a corporate sector which is financially unconstrained like in Cagetti and De Nardi (2006), and reach similar conclusions to them. They remark that the addition of the unconstrained corporate sector more than offsets the decreases in the interest rate as the corporate sector now hires more labor and capital, causing financially constrained entrepreneurs to shift to being a salaried worker as decreases in wages are now limited. So, it seems that the different general equilib-

rium results regarding the measure of entrepreneurs lie in the choice of whether to incorporate a financially unconstrained corporate sector or not. Erosa (2001) also finds that the increases in the intermediation costs decrease capital and labor demand, result in the decreases in the market clearing prices and increase the share of entrepreneurs and wealth Gini. He also shows that the private credit to output ratio goes down significantly as the intermediation cost goes up, and the return to domestic financial assets decreases with the increases in the intermediation cost.

The relation between the financial repression and the prevalence of informality is relatively clear. Straub (2005) features formal and informal lending mechanisms together and shows that the lower liquidation costs in the informal lending sector increases the share of informal sector in the overall economy. He further analyzes the effects of the developments in the imperfect enforcement in the formal sector and shows that the higher efficiency in the formal credit market enhances individuals with lower levels of asset endowment to switch to the formal sector. Quintin (2008) shows that the underdevelopment of the financial sector has stronger effects than the weak tax enforcement to account for the larger informal sector and smaller establishment size in developing countries. Antunes and Cavalcanti (2007) incorporate the regulation cost of operating formally into the model with enforcement frictions of Quintin (2008) and further show that the increases in the regulation costs parameter and the financial repression aggravate the effects of each one alone. Lopez-Martin (2019) analyzes the effect of the limitations in the leverage (collateral constraint) among both formal and informal entrepreneurs in addition to the formal entry costs and minimum capital requirements, and finds that the improvements in the financial sector augment wages, private credit, aggregate capital, TFP and output altogether. Elgin and Uras (2013) try to reason the "inverted U-shape" relationship between the credit-output ratio and the size of the informal sector across countries in their study. Interestingly, the causality direction of the study is opposite of what we tried to work, and they endogenize the intermediation spread through changes in the exogenously determined share of the informal output.

While the effect of the financial repression on the share of informal output is clear,

two works that analyze the effect of the level of intermediation cost on informality explicitly are those of Blackburn et al. (2012) and Merlin and Teles (2021). Merlin and Teles (2021) model the effect of intermediation premia on the size of the informal sector and the share of informal entrepreneurs in a heterogenous agent infinite-horizon setup in which the intermediation premia differ for the formal and the informal sector, and find that equalization of the premia across the formal and informal sector increases both the share of informal entrepreneurs and the size of the informal sector. Blackburn et al. (2012) analyze the effects of the intermediation cost that the financial sector face while making financial contracts with agents who are able to hide their level of assets and their type of skills, and show that the decreases in the screening costs relaxes the intermediaries' constraint to separate low-skilled agents from the high-skilled agents, which would decrease the degree of credit rationing for the high-skilled types and enhance the amount intermediated to the economy as a whole. Further, they show that reductions in the exogenous intermediation cost enhances the share of the formal sector even if the marginal benefit from investing in the "black-market activity" increases with the reductions in the amount of funds in the black-market financial sector.

Taken these into consideration, we think that the articles closest to our thesis are that of Erosa (2001), Antunes and Cavalcanti (2007), Meh (2008), Antunes, Cavalcanti, and Villamil (2015) and Merlin and Teles (2021). We tried to incorporate skill heterogeneity and the informal sector to Erosa (2001)'s overlapping generations model. Unlike one-period lived non-overlapping generations model of Antunes and Cavalcanti (2007), we allowed agents to work for multiple periods and allowed for the internal finance mechanism for entrepreneurs, and we substituted intermediation cost for the regulation cost that apply to both labor and capital hires in the formal sector. What we differ from Meh (2008)'s article is that we substituted the size constrained informal sector for the financially unconstrained corporate sector and we abstracted for the business risks. Though he analyzes the aggregate effects of the changes in the intermediation spread, his main argument is related to the corporate taxation. And his results for entrepreneurship due to the changes in the spread is

opposite of what we found. Our model setup is very close to that of Antunes, Cavalcanti, and Villamil (2015), but they look at the effects of financial subsidies which would lower the financial intermediation premia. Also, we incorporated an informal sector to the model. And finally, we abstracted for the richer set of occupational choices and informal credit mechanisms of Merlin and Teles (2021) and incorporate collateral constraint in the finite-horizon setup, where the internal finance mechanism is limited especially for younger cohorts who start with zero assets, and effects of each kind of repression aggravates their single effect, as seen in the article of Antunes and Cavalcanti (2007). Further, we incorporated an age-dependent labor productivity processes, as Meh (2008) and Akyol and Athreya (2009) did.

2 MODEL

2.1 Households

Households start with zero assets in the beginning of their life cycle. Each period, a new-born cohort replaces the oldest one of the previous period and draws the skill level x from a cumulative distribution $\gamma(x)$. The entrepreneurial skill distribution, $\gamma(x)$, is constant across cohorts. As the entrepreneurial skill is drawn in the very first period, it is persistent over time, i.e there is no shock to x for agents over time. The worker productivity, z_t, differs only across cohorts, in that there is no heterogeneity in z_t among agents within the same cohort. If they choose to be worker, their labor endowment is z_t and they supply this endowment inelastically, as there is no disutility from work. The households' well being is measured by the discounted sum of contemporaneous utility functions with respect to their consumption.

$$\sum_{t=0}^{T} \beta^t u(c_t) \tag{1}$$

The level of consumption is bounded by the 'cash on hand' that the agent has. The individual makes how much to consume in the current period and how much to save for the next period.

$$c_t + a_{t+1} = y(x_t, z_t, a_t, t) + a_t \tag{2}$$

where c_t is the level consumed by the household at period t, and a_t and x_t are asset and entrepreneurial skill level for the agent at t. $y(x_t, z_t, a_t, t)$ depends on these three variables for all households. Each period, households decide whether to become a formal entrepreneur, informal entrepreneur or salaried worker. This occupational choice depends on how much income they get from the occupation. The agents retire at period $R < T$ and get only deposit income from the assets they accumulated until R.

$$y(x_t, z_t, a_t, t) = max\{y_{FE}(x_t, a_t, t), y_{IE}(x_t, a_t, t), y_W(z_t, a_t, t)\} \tag{3}$$

Households choose their occupation in the beginning of the period. If they choose entrepreneurship, they simultaneously choose to operate whether in the formal or the informal sector. Entrepreneurs, whether in formal or informal sector, operates a decreasing returns to scale technology, as in Lucas (1978). There is no shock to the entrepreneurial skill throughout the agents' life cycle.

2.1.1 Formal Entrepreneurs

At period $t < R$, if the agent chooses formal entrepreneurship, the income they get is :

$$y_{FE}(x_t, a_t, t) = (1-\tau)(x_t({k_t}^{\alpha}{n_t}^{1-\alpha})^{\nu} - w_t n_t - r_l l_t - \delta k_t + r_d d_t) \qquad (4)$$

where $\tau, x_t, k_t, n_t, w_t, r_d, r_l, \delta$ are the tax rate, individual-specific skill, the amount of capital and labor hired, wage rate, the return per deposit d_t, the cost per borrowed l_t and depreciation per unit of capital, respectively. α is the measure of capital share of output. The production function is decreasing returns to scale, i.e $\nu < 1$. Also, either due to the transaction costs or the screening costs faced by the financial sector in the economy, the return per asset, r_d is smaller than r_l. This financial imperfection is set exogeneously, $r_l = r_d + \phi$. Formal entrepreneurs are allowed to borrow l_t and they choose what fraction of $a_t + l_t$ to deposit in the financial intermediary and operate with the remaining fraction to earn entrepreneurial income. Formal entrepreneurs also have to provide collateral for the capital they employed ($1/\lambda$, $\lambda > 1$) if they borrow from the financial intermediary.

All of these constraints are reflected in the following equations :

$$k_t + d_t = a_t + l_t \tag{5}$$

$$k_t \leq \lambda a_t \tag{6}$$

$$k_t \geq 0 \tag{7}$$

$$d_t \geq 0 \tag{8}$$

$$l_t \geq 0 \tag{9}$$

When there isn't any friction in the credit market, the capital hiring decision is determined by the x_t. Due to the frictions (intermediation costs and liquidity constraint) and that the agents don't have any wealth in the first period of their life-cycle, the optimal capital choice and marginal return per asset differ across individuals with different skill levels. As $r_d < r_l$, the first order conditions and complementary slackness conditions require that d_t and l_t can't be positive simultaneously, i.e the Lagrange multiplier of (8) and (9) can't be zero simultaneously. That is, the entrepreneur either should borrow with no deposits in the bank, i.e $l_t > 0$ and $d_t = 0$, or should deposit with no amount of loan incurred, $l_t = 0$ and $d_t > 0$, or neither of them, in which case the capital she employed is equal to her asset level, i.e $l_t = 0$ and $d_t = 0$. In the first case, the entrepreneur expands her capital hire until the marginal return equals $(1 - \tau)r_l$. If she is depositor, the marginal earnings is equal to $(1 - \tau)r_d$. When she is neither a borrower nor a depositor, i.e when $l_t = 0$ and $d_t = 0$, the marginal earnings per asset is between $(1 - \tau)r_d$ and $(1 - \tau)r_l$.

The amount that the entrepreneur can borrow is bounded above by her asset level multiplied by some leverage constraint, λ in which $\lambda - 1 > 0$. The constraint only binds if the entrepreneur's optimal level of capital, given her asset and skill, exceeds that bound. In that case, the marginal return exceeds $(1 - \tau)r_l$. This constraint can bind if the after-tax profit net of the opportunity cost from formal entrepreneurship exceeds the wage rate and the net profit from operating in the informal sector.

Below equations come from the first order conditions of the formal entrepreneur

with respect to her choice of labor and capital hire. k_{FE}^{U} corresponds to the capital demand for the formal entrepreneur in the case she is unconstrained and depositor, in that she doesn't need to borrow to operate at the optimal scale. n_{FE}^{U} corresponds to the labor demand for the exact same case. k_{FE}^{B} and n_{FE}^{B} are the capital and labor demand, respectively, of the formal entrepreneur who requires to borrow from the financial intermediary even when the cost of capital is higher than the return per unit of deposit.

$$k_{FE}^{U}{}^{*}(x,a;w,r) = (x\nu)^{(\frac{1}{1-\nu})}(\frac{\alpha}{r_d+\delta})^{\frac{1+\alpha\nu-\nu}{1-\nu}}(\frac{1-\alpha}{w})^{\frac{\nu-\alpha\nu}{1-\nu}} \tag{10}$$

$$n_{FE}^{U}{}^{*}(x,a;w,r) = (x\nu)^{(\frac{1}{1-\nu})}(\frac{\alpha}{r_d+\delta})^{\frac{\alpha\nu}{1-\nu}}(\frac{1-\alpha}{w})^{\frac{1-\alpha\nu}{1-\nu}} \tag{11}$$

$$k_{FE}^{B}{}^{*}(x,a;w,r) = (x\nu)^{(\frac{1}{1-\nu})}(\frac{\alpha}{r_d+\phi+\delta})^{\frac{1+\alpha\nu-\nu}{1-\nu}}(\frac{1-\alpha}{w})^{\frac{\nu-\alpha\nu}{1-\nu}} \tag{12}$$

$$n_{FE}^{B}{}^{*}(x,a;w,r) = (x\nu)^{(\frac{1}{1-\nu})}(\frac{\alpha}{r_d+\phi+\delta})^{\frac{\alpha\nu}{1-\nu}}(\frac{1-\alpha}{w})^{\frac{1-\alpha\nu}{1-\nu}} \tag{13}$$

$$k_{FE}{}^{*}(x,a;w,r) = \begin{cases} k_{FE}^{U}{}^{*}(x,a;w,r) & \text{if } a > k_{FE}^{U}{}^{*}(x,a;w,r) \\ k_{FE}^{B}{}^{*}(x,a;w,r) & \text{if } \frac{k_{FE}^{C}}{\lambda} \leq a < k_{FE}^{B} \\ a & \text{if } k_{FE}^{U} \geq a \geq k_{FE}^{C} \\ \lambda a & \text{if } a < \frac{k_{FE}^{C}}{\lambda} < k_{FE}^{C} \end{cases}$$

The labor demand for the corresponding cases are :

$$n_{FE}{}^{*}(x,a;w,r) = \begin{cases} n_{FE}^{U}{}^{*}(x,a;w,r) & \text{if } a > k_{FE}^{U}{}^{*}(x,a;w,r) \\ n_{FE}^{B}{}^{*}(x,a;w,r) & \text{if } \frac{k_{FE}^{C}}{\lambda} \leq a < k_{FE}^{B} \\ (\frac{xa^{\alpha\nu}((1-\alpha)\nu)}{w})^{\frac{1}{1-(1-\alpha)\nu}} & \text{if } k_{FE}^{U} \geq a \geq k_{FE}^{C} \\ (\frac{x(\lambda a)^{\alpha\nu}((1-\alpha)\nu)}{w})^{\frac{1}{1-(1-\alpha)\nu}} & \text{if } a < \frac{k_{FE}^{C}}{\lambda} < k_{FE}^{C} \end{cases}$$

The net profit that formal entrepreneurs get also depends on her level of asset. The before-tax net profit of the unconstrained entrepreneur, in which case her level of asset is higher than the optimum capital employed, is :

$$\pi_{FE}^{U}{}^{*}(x,a;w,r) = (1-\nu)(x)^{(\frac{1}{1-\nu})}(\frac{\alpha\nu}{r_d+\delta})^{\frac{\alpha\nu}{1-\nu}}(\frac{(1-\alpha)\nu}{w})^{\frac{\nu-\alpha\nu}{1-\nu}} \tag{14}$$

If she needs to borrow from the financial intermediary and her level of wealth is sufficient for borrowing to operate at the optimal scale, the net profit before-tax for the formal entrepreneur is :

$$\pi_{FE}^{B}{}^{*}(x,a;w,r) = (1-\nu)(x)^{(\frac{1}{1-\nu})}(\frac{\alpha\nu}{r_d+\phi+\delta})^{\frac{\alpha\nu}{1-\nu}}(\frac{(1-\alpha)\nu}{w})^{\frac{\nu-\alpha\nu}{1-\nu}} + \phi a \tag{15}$$

The only difference between (14) and (15) is the intermediation cost ϕ incorporated into the profit of constrained formal entrepreneurs.

Taking these into account, the before-tax profits corresponding to the cases above

are :

$$\pi_{FE}{}^{*}(x,a;w,r) = \begin{cases} \pi_{FE}^{U}{}^{*}(x,a;w,r) & \text{if } a > k_{FE}{}^{*} \\ \pi_{FE}^{B}{}^{*}(x,a;w,r) & \text{if } k_{FE}{}^{*} = k_{FE}^{B} \\ \left(\frac{xa^{\alpha\nu}((1-\alpha)\nu)}{w^{(1-\alpha)\nu}}\right)^{\frac{1}{1-(1-\alpha)\nu}}\left(\frac{1-(1-\alpha)\nu}{(1-\alpha)\nu}\right) - (r_d+\delta)a & \text{if } k_{FE}^{*} = a \\ \left(\frac{xk^{\alpha\nu}(\nu-\alpha\nu)}{w^{(\nu-\alpha\nu)}}\right)^{\frac{1}{1-\nu+\alpha\nu}}\left(\frac{1-\nu+\alpha\nu}{\nu-\alpha\nu}\right) - k(r_l+\delta) + \phi a & \text{if } k = a\lambda \end{cases}$$

As all sources of the formal entrepreneurs' earnings are taxed and the tax is collected after the earnings are realized, the capital and labor choice for the formal entrepreneur don't depend on the tax rate. However, the net profit and gross earnings depend on the tax rate. For the entrepreneurs that can borrow optimally, the capital demand, labor demand and the net-profit functions are decreasing and convex in the intermediation cost, ϕ.

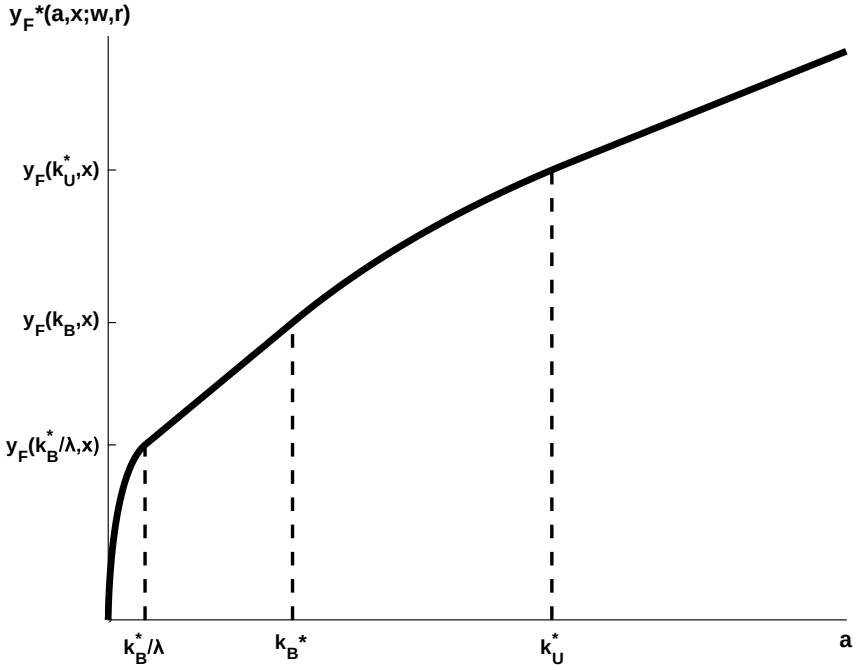
The gross earnings after tax is just the net-of-tax-rate net profit plus the deposit income for the level of wealth the formal entrepreneur has, multiplied by $(1-\tau)$:

$$y_{FE}(x_t, a_t, t < R) = (1-\tau)(\pi_{FE}{}^{*}(x_t, a_t; w, r) + r_d a_t) \tag{16}$$

The earnings-asset function $y_{FE}(x_t, a_t, t < R)$ is given in the figure below. The graph of earnings is very similar to what Meh (2008) showed. Until the individual wealth reaches $\frac{k_{FE}^{B}{}^{*}}{\lambda}$, the marginal return per asset (the slope of the graph) exceeds $(1-\tau)(r_d+\phi)$ and the slope decreases in the level of asset the formal entrepreneur has. Between $\frac{k_{FE}^{B}{}^{*}}{\lambda}$ and a, the slope is $(1-\tau)(r_d+\phi)$, as the individual would borrow the desired amount and operate with $k_{FE}^{B}{}^{*}$, shown in (12).

So, the agent will choose formal entrepreneurship over being a salaried worker if

Figure 2.1: Income-Asset Profile For the Agent with given x



and only if $(1-\tau)\pi_{FE}{}^{*}(x,a;w,r) \geq wz_t$, as the labor income is not taxed in our model.

2.1.2 Informal Entrepreneur

The income for those who choose informal entrepreneurship is :

$$y_{IE}(x_t, a_t, t) = x_t({k_t}^{\alpha}{n_t}^{1-\alpha})^{v} - w_t n_t - \delta k_t + (1-\tau) r_d d_t \tag{17}$$

subject to

$$k_t + d_t = a_t \tag{18}$$

$$k_t \leq \bar{k} \tag{19}$$

$$d_t \geq 0 \tag{20}$$

The informal entrepreneurs are not allowed to borrow, $l_t = 0$. Also, informal entrepreneurs are size constrained, such that once the amount of capital they hire is higher than $\bar{k}$, they are caught with probability 1 and their profits are confiscated. This may be regarded as a function of the strength of government enforcement. Notice that informal entrepreneurs can't avoid the tax charged on deposit income. This feature substantially affects the optimal capital and labor choice of informal entrepreneurs. While they can expand their capital hire until the marginal income from capital reaches $(1-\tau)r_d$, the capital they can employ is bounded above by the exogenous level, $\bar{k}$, as in Ordonez (2014). This bound can be seen as a reflection of the tax collection enforcement parameter, in that the higher enforcement decreases $\bar{k}$.

The optimal capital choice for the unconstrained entrepreneur, in which the optimal capital is below $\bar{k}$ and below her wealth, a, is the following :

$$k_{IE}^{U\ *}(x,a;w,r) = (x\nu)^{(\frac{1}{1-\nu})}(\frac{\alpha}{(1-\tau)r_d+\delta})^{\frac{1+\alpha\nu-\nu}{1-\nu}}(\frac{1-\alpha}{w})^{\frac{\nu-\alpha\nu}{1-\nu}} \tag{21}$$

So, the optimal capital choice for the informal entrepreneur is as follows :

$$k_{IE}{}^{*}(x,a;w,r) = \begin{cases} min\{k_{IE}^{U\ *},\bar{k}\} & \text{if } a \geq k_{IE}^{U\ *} \\ min\{a,\bar{k}\} & \text{if } a < k_{IE}^{U} \end{cases}$$

Notice that the optimal capital choice for the unconstrained formal (10) and unconstrained informal entrepreneur (21) differs only by the tax parameter incorporated into the capital choice for the informal entrepreneur. Ceteris paribus, the optimal capital increases as tax increases for the informal entrepreneur, meaning that as the tax rate increases, unconstrained informal entrepreneurs can hire higher amounts of capital, as the part of the opportunity cost of informal entrepreneurship, $(1-\tau)r_d$, is decreasing in the tax rate.

The profit function net of the opportunity cost for the unconstrained informal en-

trepreneur is quite similar to (14) only with the difference that the tax rate $(1-\tau)$ is in the denominator :

$$\pi_{IE}^{U\,*}(x,a;w,r) = (1-\nu)(x)^{(\frac{1}{1-\nu})}(\frac{\alpha\nu}{(1-\tau)r_d+\delta})^{\frac{\alpha\nu}{1-\nu}}(\frac{(1-\alpha)\nu}{w})^{\frac{\nu-\alpha\nu}{1-\nu}} \quad (22)$$

When $k_{IE}^U > \bar{k}$ and $k_{IE}^U \leq a$, the informal entrepreneur must hire capital no more than $\bar{k}$, as her earnings are confiscated when she operates with the capital higher than $\bar{k}$. Therefore, the net profit of the informal entrepreneur which is size constrained, π_{IE}^{CS*}, is the following :

$$\pi_{IE}^{CS*}(x,a;w,r) = (\frac{x\bar{k}^{\alpha\nu}((1-\alpha)\nu)}{w^{(1-\alpha)\nu}})^{\frac{1}{1-\nu+\alpha\nu}}(\frac{1-\nu+\alpha\nu}{\nu-\alpha\nu}) - ((1-\tau)r_d+\delta)\bar{k} \quad (23)$$

As said above, the informal entrepreneur is not only size-constrained, she may also be asset-constrained as she is excluded from applying for the bank loan. So, even though $k_{IE}^U \leq \bar{k}$, she may be constrained to operate through her level of asset when $k_{IE}^U > a$. In this case, the net profit for the informal entrepreneur, denoted by π_{IE}^{CA}, is :

$$\pi_{IE}^{CA*}(x,a;w,r) = (\frac{xa^{\alpha\nu}((1-\alpha)\nu)}{w^{(1-\alpha)\nu}})^{\frac{1}{1-\nu+\alpha\nu}}(\frac{1-\nu+\alpha\nu}{\nu-\alpha\nu}) - ((1-\tau)r_d+\delta)a \quad (24)$$

Summing up, the net profits for the informal entrepreneur, depending on the level of assets and skills that she has, are the following :

$$\pi_{IE}{}^{*}(x,a;w,r) = \begin{cases} \pi_{IE}^{U\,*}(x,a;w,r) & \text{if } a \geq k_{IE}^{U\,*} \;\&\; k_{IE}^{U\,*} \leq \bar{k} \\ \pi_{IE}^{CA*}(x,a;w,r) & \text{if } a < k_{IE}^{U\,*} \;\&\; a \leq \bar{k} \\ \pi_{IE}^{CS*}(x,a;w,r) & \text{if } a \geq k_{IE}^{U\,*} \;\&\; k_{IE}^{U\,*} > \bar{k} \\ \pi_{IE}^{CS*}(x,a;w,r) & \text{if } a < k_{IE}^{U\,*} \;\&\; a > \bar{k} \end{cases}$$

The informal entrepreneur is able to avoid the tax rate charged on the earnings on her

individual-specific technology. So, the gross earnings that the informal entrepreneur get is :

$$y_{IE}(x_t, a_t, t < R) = {\pi_{IE}}^*(x_t, a_t; w, r) + (1 - \tau)(r_d a_t) \tag{25}$$

2.1.3 Workers

As mentioned above, there is no heterogeneity in labor productivity within cohorts. However, the worker-productivity, z_t is age-dependent in the model. Therefore, age is the only source of heterogeneity in productivity across workers. As there is no disutility from work, they inelastically supply labor services and get the return of w per the efficiency unit that they supplied. So, the gross earnings of the worker in the model is :

$$y_W(z_t, a_t, t < R) = w_t z_t + (1 - \tau) r_d a_t \tag{26}$$

The labor income is not taxed in the model, just for the clarification that the workers at the informal sector are treated the same as the workers in the formal sector. In order not to tax the workers at the informal sector, we chose not to tax the labor income.

Retired agents get only deposit income, taxed at the rate of τ :

$$y_R(x_t, z_t, a_t, t \geq R) = (1 - \tau)(r_d a_t) \tag{27}$$

2.2 Financial Market

Workers deposit their savings in the financial institution and earn an endogenously determined rate of r_d from the financial market. The interest income is taxed after the financial sector pays depositors. Formal and informal entrepreneurs also deposit with the remainder of assets not used in production. Intermediaries lend to formal entrepreneurs who are willing to scale up their operation, while the workers and

informal entrepreneurs are not allowed to borrow. For each unit of capital intermediated, intermediaries face with a constant cost ϕ. The financial sector is assumed to be competitive. So, the zero profit condition will require that loan rate, i.e the unit cost of capital for borrower formal entrepreneurs is $r_l = r_d + \phi$. In the model, ϕ will reflect the efficiency of the financial sector, and be set exogenously. The analyses in the fourth section will look at how the aggregate outcomes (level of output, share of the informal sector, the size of the funds intermediated and the Gini coefficients) can change when the efficiency of the financial sector changes.

2.3 Government

The government taxes all earnings of the formal entrepreneur, in addition to the deposit incomes of workers, retirees and informal entrepreneurs in the model. The acquired tax revenue is used for government consumption, G. In all periods, the government runs a balanced budget.

2.4 Recursive formulation

State variables for all agents are their entrepreneurial skill x_t, their amount of assets a_t and their age t and the level of efficiency worker-unit that the individual has, z_t. When $t < R$, individuals choose between three occupations. So, when $t < R$:

$$V_t(x_t, z_t, a_t) = max\{V_t^W(x_t, z_t, a_t), V_t^{FE}(x_t, z_t, a_t), V_t^{IE}(x_t, z_t, a_t)\}$$

while for $t \geq R$,

$$V_t(a_t) = V_t^R(a_t)$$

The agents don't value the remaining wealth after their death, so :

$$V_{T+1}(x_{T+1}, z_{T+1}, a_{T+1}) = 0 \quad \forall x_{T+1}, z_{T+1}, a_{T+1}$$

Each efficiency-unit of labor is paid w. Their efficiency level is only determined by their age. The problem for the worker at age $t < R$ is :

$$V_t^W(x_t, z_t, a_t) = \max_{c_t, a_{t+1}} u(c_t) + \beta V_{t+1}(x_{t+1}, z_{t+1}, a_{t+1})$$

subject to

$$c_t + a_{t+1} = w_t z_t + (1 + (1-\tau)r_d)a_t \tag{28}$$

$$a_{t+1} \geq 0 \tag{29}$$

$$c_t \geq 0 \tag{30}$$

As the profits and earnings for the formal entrepreneur are specified above, we can display the problem for the formal entrepreneur as this :

$$V_t^{FE}(x_t, z_t, a_t) = \max_{c_t, a_{t+1}} u(c_t) + \beta V_{t+1}(x_{t+1}, z_{t+1}, a_{t+1})$$

subject to

$$c_t + a_{t+1} = (1-\tau)({\pi_{FE}}^*(x_t, a_t; w, r)) + (1 + (1-\tau)r_d)a_t \tag{31}$$

$$c_t \geq 0 \tag{32}$$

$$a_{t+1} \geq 0 \tag{33}$$

The problem for the informal entrepreneur is :

$$V_t^{IE}(x_t, z_t, a_t) = \max_{c_t, a_{t+1}} u(c_t) + \beta V_{t+1}(x_{t+1}, z_{t+1}, a_{t+1})$$

subject to

$$c_t + a_{t+1} = {\pi_{IE}}^*(x_t, a_t; w, r) + (1 + (1 - \tau)r_d)a_t \tag{34}$$

$$c_t \geq 0 \tag{35}$$

$$a_{t+1} \geq 0 \tag{36}$$

Finally, the problem for the retiree at age $t \geq R$ is :

$$V_t^R(a_t) = \max_{c_t, a_{t+1}} u(c_t) + \beta V_{t+1}^R(a_{t+1})$$

subject to

$$c_t + a_{t+1} = (1 + (1 - \tau)r_d)a_t \tag{37}$$

$$c_t \geq 0 \tag{38}$$

$$a_{t+1} \geq 0 \tag{39}$$

2.5 Definition of the equilibrium

The equilibrium for the economy is

- the policy function for workers ;

  $c_t^W(x_t, z_t, a_t), a_{t+1}^W(x_t, z_t, a_t),$

- policy functions for formal entrepreneurs ;

  $c_t^{FE}(x_t, z_t, a_t), a_{t+1}^{FE}(x_t, z_t, a_t), n_t^{FE}(x_t, z_t, a_t), k_t^{FE}(x_t, z_t, a_t)$
  $l_t^{FE}(x_t, z_t, a_t), d_t^{FE}(x_t, z_t, a_t)$

- policy functions for informal entrepreneurs ;

  $c_t^{IE}(x_t, z_t, a_t), a_{t+1}^{IE}(x_t, z_t, a_t), n_t^{IE}(x_t, z_t, a_t), k_t^{IE}(x_t, z_t, a_t), d_t^{IE}(x_t, z_t, a_t)$

- prices, tax rate and productivity draws such that ;

  $w_t, r_d, r_l, \tau, x_t, z_t$

- Given prices and the tax rate τ, w_t, r_{d_t}, r_{l_t}, workers, informal entrepreneurs, and formal entrepreneurs maximize their value by choosing their policies.

- Labor market clears :

$$\sum_{t=0}^{R-1}\sum_{a}\sum_{x} o(x_t, z_t, a_t; w, r) n_t^* = \sum_{t=0}^{R-1}\sum_{a}\sum_{x}(1 - o(x_t, z_t, a_t; w, r)) z_t$$

  where $o(x, a; w, r) = 1$ if the agent is an entrepreneur, zero otherwise.

- Loan market clears

$$\sum_{t=0}^{T}\sum_{a}\sum_{x} o(x_t, z_t, a_t; w, r) l_t^* = \sum_{t=0}^{T}\sum_{a}\sum_{x} d_t$$

3 THE PARAMETER CHOICES

The parameter choices are shown in Table 3.1.The model period is set to 1 year. The agents are assumed have a working-life of 45 periods and die at the end of 56th period. To solve the model, we needed to set the parameters $\beta, \phi, \alpha, \nu, x$ and $\gamma(x)$ and the parameters specifying the contemporaneous utility from consumption. We set contemporaneous utility with respect to the consumption as $u(c_t) = \frac{c_t{}^{(1-\sigma)}}{(1-\sigma)}$ with σ chosen as 2, a standard value in the literature. β is chosen as 0.965 in order for me to get closer to the capital-output ratio of 2.5. The capital share parameter $\alpha\nu$ is taken as 0.33, which is the standard value in the literature. The capital is assumed to depreciate at the rate of 6.2 percent, which is also standard in the literature. The distribution of skills, $\gamma(x)$ are assumed to follow a log-normal distribution with the mean and the standard deviation chosen to get closer to the the fraction of entrepreneurs at ages between 21 and 55. The entrepreneur is defined as the self-employed business owner who actively manages her own business, as in Cagetti and De Nardi (2006).

Parallel to the choice of parameters of the entrepreneurial skill distribution, the span-of-control parameter, ν is chosen to approximate the fraction of entrepreneurs in the population between 1989 and 2016, which we calculated as 8.0 percent. The intermediation cost parameter, is chosen from the variable "Bank Overhead Cost to Total Assets" of the Financial Structure and Development Dataset compiled and updated by Beck, Demirgüç-Kunt, and Levine (2000), Beck and Demirgüç-Kunt (2009) and Čihák et al. (2012), and taken as the average value in the United States between 1996 and 2017, 3 percent. This value also helps the model to get closer to the credit-output ratio in the US. When comparing the aggregate variables across the values of the intermediation cost, the maximum value will be set to 6 percent. Around 25 out of 140 countries feature a wedge between the deposit and lending rate higher than 6 percent. The collateral constraint parameter that specifies the maximum leverage, λ, is selected following the arguments made by Buera (2009), who tries to approximate the entry-decision of prospective entrepreneurs for each wealth levels. With the choice of capital income share and the span-of-control parameter, we chose λ as 5. Finally, the tax rate is set to 25 percent, following Quintin (2008).

Table 3.1: The chosen parameters for the benchmark model

Parameter	Description of the Parameter	Selected Value
β	The discount factor	0.965
δ	The capital depreciation rate	0.062
ν	Span-of-control parameter	0.85
$\alpha\nu$	Capital share of output	0.33
ϕ	The intermediation cost	0.03
μ_x	Mean of the Log of Skill Distribution	-1.2
σ_x	St. Deviation of the Log of Skill Distribution	0.2
λ	The maximum attainable leverage	5
$\bar{k}$	The maximum capital informal sector can hire	1.8
τ	The tax rate	0.25

The age-dependent worker-productivity levels are calculated using the IPUMS website of the study "United States : 1850-2019" (Ruggles et al. 2021) for the year of 2019. The mean earnings of salaried workers at each age is divided by the mean

hours-worked at each age. The values are normalized by the mean of workers' wages between the ages of 21 and 65. The values are shown in Table A.1.

4 RESULTS

4.1 Benchmark Results

Table 4.1 shows to what degree the model's results were able to approximate the statistics of the US, in which the financial markets are relatively developed. Other than the measure of entrepreneurs and the share of the informal sector, all statistics of the model are lower than its data counterpart. The credit output ratio is taken from the World Development Indicators of World Bank (World Bank 2021a) and the data counterpart features its the average value between 2000 and 2019. The data shows that this ratio increased significantly between 1995 and 2000, so the initial point was set to 2000. With decreases in ϕ and increases in λ, the model can shrink the gap between the model and this data counterpart through the demand channel of entrepreneurs. The increases in β can also close this gap through the supply channel, as higher β increases overall savings, shifts supply curve to the right, increases the quantity of capital and decreases the price of funds, r_d.

The data counterpart of capital-output ratio is taken from the US Bureau of Economic Analysis table "Current-Cost Net Stock of Fixed Assets and Consumer Durable Goods" (BEA 2020). The capital is defined as the fixed assets of the private sector and the consumer durable goods. As of 2019, the ratio between this definition of capital and the current-price GDP, taken from OECD (2021), was calculated as 2.57. Higher β in the model would certainly increase this ratio up to the data counterpart.

The untargeted statistics, like income and wealth Gini, are substantially undershot in the model. The data counterpart for the income Gini is taken from the CBO (2020), whereas the data counterpart for the wealth Gini is taken from the Credit Suisse (2019) report. The income Gini would be increased through incorporating

Table 4.1: Model Results and Data Counterparts

Variable	Model	Data
Entrepreneurship Ratio	%8.1	%8.0
Credit Output Ratio	1.75	1.83
Capital Output Ratio	2.49	2.57
Informal Share of Output	%8.2	%8.0
Wealth Gini	0.46	0.85
Income Gini	0.26	0.43

Source : Federal Reserve Board (2021), World Bank (2021a), OECD (2021), BEA (2020), Medina and Schneider (2018), CBO (2020), Credit Suisse (2019)

heterogeneity in the worker productivity within cohorts, z_t, as the only source of worker productivity heterogeneity in the model is the age of workers. The other important component which would increase the income inequality is the dispersion parameter of the skill distribution, σ_x, as the profit functions net of opportunity cost for the entrepreneurs are increasing and convex in x.

The Wealth Gini, we believe would substantially increase through shocks to the entrepreneurial productivity, x. Although the time horizon is finite and there are financial frictions in the model-economy, those with high entrepreneurial skill x save in order to absorb the effects of financial frictions through self-financing. The lower persistence of entrepreneurial productivity x across time, combined with the non-negativity in wealth condition (as in (32)), induces those high-skilled entrepreneurs to save even more to buffer the effects of shocks to their skill. In the finite-horizon setup, Meh (2008) shows that individuals don't choose entrepreneurship even after 15 periods, due to the combination of financial frictions, low initial asset level in the beginning and shocks to the business plan, x in the model. See Quadrini (2000) for similar arguments. Incorporating the bequest motive may increase wealth Gini (Cagetti and De Nardi 2006), and coupling bequest-motive with shocks to the business plan may help the model to get closer to the distribution of wealth seen in the data (Meh 2008). The Wealth Gini may also increase through decreases in the leverage possibility, λ. However, when the span-of-control parameter, ν, and

the capital hiring possibility of the informal sector, $\bar{k}$ is adjusted to match the fraction of entrepreneurs and the share of informal sector, the credit-output and capital-output ratio would decrease. Furthermore, the entrepreneurship-over-the-life-cycle statistics would steepen substantially, as decreases in λ decrease the wage and deposit rate substantially, tighten the constraint 6 for the young individuals and induce sufficiently wealthy and older individuals to choose entrepreneurship over being a salaried worker.

4.1.1 Entrepreneurship Over The Life-Cycle

On the positive side, the model was able to replicate the entrepreneurship over the life cycle statistics to some degree especially for those at ages before 55. As in Erosa (2001) and Meh (2008), all individuals start their life as workers due to the presence of the collateral constraint (6) and that the households start their life with zero assets. Compared to the work of Meh (2008), there is no shock to the entrepreneurial skill in the model. As a result, the most-skilled agents might require lower levels of assets to choose entrepreneurship in the beginning of their life-cycle, despite that their labor earnings in the first period is substantially low (see Table A.1). Therefore, the measure of entrepreneur is not zero even for newer cohorts, compared to what Meh (2008) displayed. Similarly, entrepreneurship rate increases with age, mostly due to the increases in the level of wealth for each individual. As individuals tend to accumulate wealth to overcome the collateral constraint, return to formal entrepreneurship increases in wealth. The increase in wealth not only increases return to formal entrepreneurship, but also the return to informal entrepreneurship, as individuals with lower level of entrepreneurial skill have the tendency to choose self-financing informal sector to operate with sufficient level of assets.

As Akyol and Athreya (2009) argues, the opportunity cost of entrepreneurship (which is wz_t in our model) with z_t differing across time helps substantially to get closer to this statistic, especially for the younger cohorts, where the return to being a salaried worker is lower than the return to salaried workers for older cohorts.

Overall, while modelling x_t as persistent over-time inhibits us to get closer to the wealth distribution in the economy, it helps us to replicate the entrepreneurship-life cycle pattern especially until the age of 55. The statistics from the data are calculated from the SCF data between the years of 1989 and 2016. (Federal Reserve Board 2021, Damico 2021)

Table 4.2: Entrepreneurship Over The Life Cycle

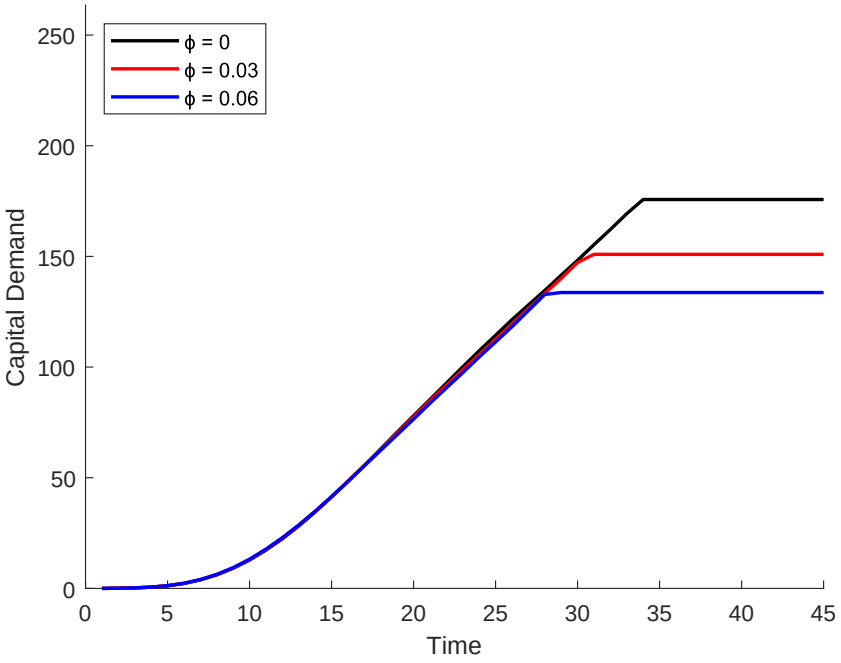
	Model	1989-2016 SCF
<35	%4.6	%4.4
35-44	%8.6	%8.8
45-54	%11.0	%10.8
55+	%8.7	%8.2
Total	%8.1	%8.0

Source : Federal Reserve Board (2021), Damico (2021)

4.2 The effects of the changes in the intermediation cost, ϕ

As individuals start their life with zero assets, all agents who choose formal entrepreneurship in the model require to borrow from the bank to operate at the optimal level. Furthermore, most individuals' capital demand is hit not just by ϕ, but also by the liquidity constraint. Therefore, the formal entrepreneurs hire (12) and (13) at best throughout their life-cycle. As a result, the net profit formal entrepreneurs get at most is shown by (15). As a result, changes in the intermediation cost, ϕ affects their capital demand, labor demand and net profit substantially. Capital demand of the individual with the highest skill level, x_t over her life-cycle with different ϕs are shown in the figure 4.1. Individuals can't avoid the collateral requirement until the half of the working-stage. When they relax their collateral constraint through self-financing (accumulating wealth), at the end of her life-cycle, the formal entrepreneur still needs to borrow from the bank with the cost per unit, $r_d + \phi$. Therefore, ϕ affects the formal entrepreneurs' capital demand especially at the end-stages of their life cycle.

Figure 4.1: Capital Demand Over Time of the Individual with x_{max}



On the contrary, informal entrepreneurs' factor demand and net profit functions are unaffected by the changes in the intermediation spread. The informal entrepreneurs with low-levels of financial wealth are either unconstrained, i.e the amount of capital they hire are shown by (21), or asset constrained, i.e they supply all their wealth in their informal technology as capital. A substantial fraction of informal entrepreneurs are size constrained, in that they still find it profitable to operate with the level of capital $\bar{k}$, as in Ordonez (2014).

The Table 4.3 shows how the aggregate results change with different level of financial development. As can be seen, the direct measure of financial development, the ratio of external credit to GDP, decreases with the intermediation spread between deposit rates and lending rates. Quite intuitively, increases in the wedge decrease the loan demand substantially among prospective and current entrepreneurs. The left-shift of the capital demand curve substantially decreases both the amount of the equilibrium amount of loan and the price of the risk-free asset. This direct effect is compounded by the existence of the informal sector, where individuals operate with their assets accumulated throughout their life-cycle. Especially those with mid-

dle levels of x now choose informal entrepreneurship as they accumulate sufficient levels of asset and avoid the higher levels of ϕ.

The decrease in the credit-output ratio seems relatively lower than what the cross-country data shows. Another part of the explanation why credit-output ratio is too dispersed across countries, which would make similar effects of the increase in ϕ on credits intermediated, would be the cross-country dispersion in the government tax enforcement parameter, $\bar{k}$. The effects of the increase in $\bar{k}$ would be quite similar to the effects of the increase in $\bar{k}$, as higher levels of it would induce would-be formal entrepreneurs to switch their operate to the informal sector, decreasing the loan demand and the equilibrium deposit rate. One thing to note is that the effect of $\bar{k}$ on the equilibrium wage can be different from the effect of higher ϕ, as the labor-intensive informal sector would demand more labor when the size constraint is relaxed. Ordonez (2014) shows that the under complete enforcement, i.e when $\bar{k}$ decreases to zero, the equilibrium wage decreases relative to his benchmark case both in the short and the long run, when the tax rate is constant. On the contrary, the higher ϕ, ceteris paribus, lowers the labor demand of formal entrepreneurs, shown in (13), and decreases equilibrium wages.

The other mechanism that would both increase the share of informal output and decrease the amount intermediated would be the the changes in λ undoubtedly, as the effects of the changes in λ would be no different than the what changed with ϕ, due to that the individuals start with zero assets and their capital demand is bounded by their wealth, as shown in Figure 4.1.

Same arguments can be made for the capital-output ratio, as the higher degree of prevalence of the labor-intensive informal sector coupled with the increase in the cost of capital for formal entrepreneurs lowers capital-output ratio importantly. Higher $\bar{k}$ and lower λ would also aggravate this effect.

As shown in the table above, the factor prices decrease substantially with higher levels of ϕ, as both the labor and capital demand of the formal sector is affected

Table 4.3: Aggregate Variables with Different ϕ's

	ϕ		
Variable	0	0.03	0.06
Relative Y	1.04	1.00	0.97
Relative Wage	1.03	1.00	0.98
Deposit Rate	%5.0	%2.8	%0.6
Entrepreneurship Ratio	%7.2	%8.1	%8.8
Credit Output Ratio	2.03	1.75	1.54
Capital Output Ratio	2.69	2.49	2.35
Informal Share of Output	%2.7	%8.2	%12.4
Wealth Gini	0.43	0.46	0.49
Income Gini	0.24	0.26	0.29
Measure of Informal Entrepreneurs	%0.7	%2.1	%3.2

by that increase. Similar to Erosa (2001), this decreases increase the prevalence of small-scale labor-intensive establishments in the economy. In our model, these small establishments are mostly in the informal sector. Therefore, one thing that differs from what Erosa (2001) showed is that the measure of entrepreneurs increase at the expense of the measure of formal entrepreneurs. In our model, both the number of workers and number of formal entrepreneurs decrease as the result of lower wages, lower risk-free rate, higher cost of capital and lower formal profits. The increase in the cost of capital, $r_d + \phi$, the decrease in the return to asset, r_d, and the decrease in wages all favor informal entrepreneurship. Overall, both the measure of informal entrepreneurs and the share of informal output in the economy expands, as in Merlin and Teles (2021). Setting aside the effect on wages, the increase in $\bar{k}$ and the decrease in the maximum attainable leverage, λ, would increase the share of informal output and the measure of informal entrepreneurs and get us closer to the cross-country dispersion in the share of informal output over GDP.

The saving motive in this model differs across wage-earners and formal entrepreneurs. The only saving motive for workers is to accumulate wealth optimally until the retirement stage in which agents get only deposit income per asset, $(1 - \tau)r_d$. For formal entrepreneurs, financial frictions also induce a saving motive, as they de-

sire to decrease the effects of ϕ and the overcome the leverage constraint, λ. As said above, even the formal entrepreneur with the highest level of x borrows from the financial sector throughout her life-cycle due to the low initial-level of wealth. The increase in ϕ affects the formal entrepreneurs' earnings directly (see (15)). The decreases in wages and interest rates are short of offsetting the effects of ϕ on the net profit. Furthermore, the decreases in wages and interest rates require a higher degree of sacrifice to accumulate wealth for workers. Consequently, as shown in Figure 4.2 and Figure 4.3, the earnings and the wealth of the agent with the lowest x decrease substantially with the increase in ϕ. In the model, workers decide to accumulate wealth especially at the later stages of her life-cycle to wind-off the lower earnings in the retirement period. However, the decrease in r_d and w substantially lowers the cash on hand that the individual has at the later stages of the life-cycle. Significant decrease in r_d lowers the return to asset, which reduces the cash on hand and the amount saved for the next period for workers. Figure 4.2 shows that with the decreases in ϕ, the earnings over the life-cycle both shifts up, as a result of higher w, and steepens, as the result of higher r_d for workers. It is necessary to note that the kinks in the income profile for workers are related to modelling worker productivity as a non-monotone and non-linear process over the life-cycle (See Table A.1)

Figure 4.2: Income-Age Profile For the Agents With x_{min} and x_{max}

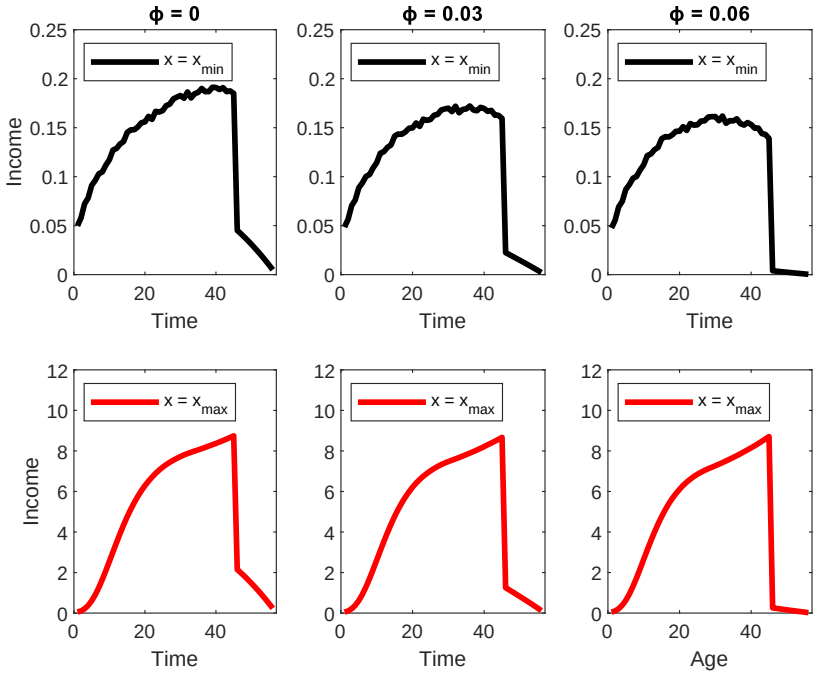
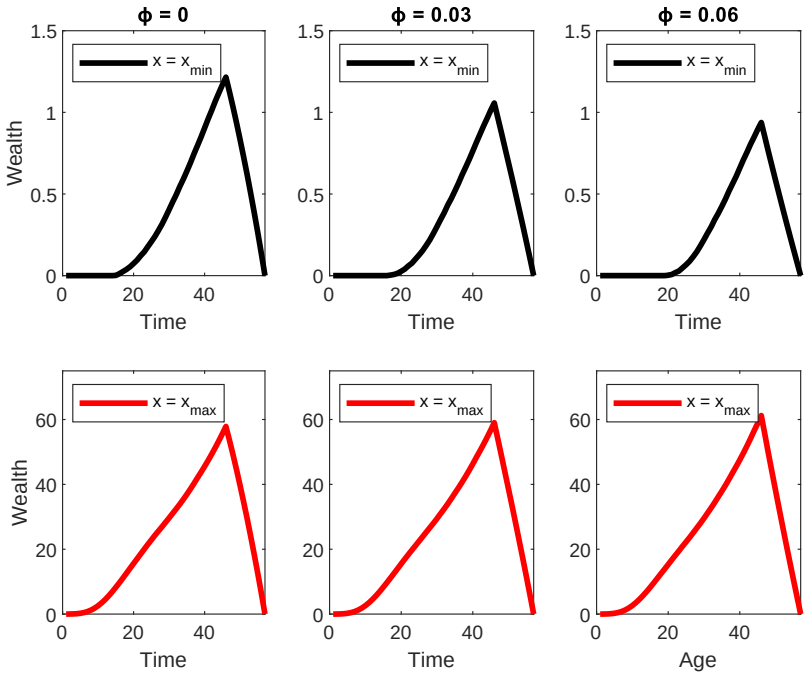


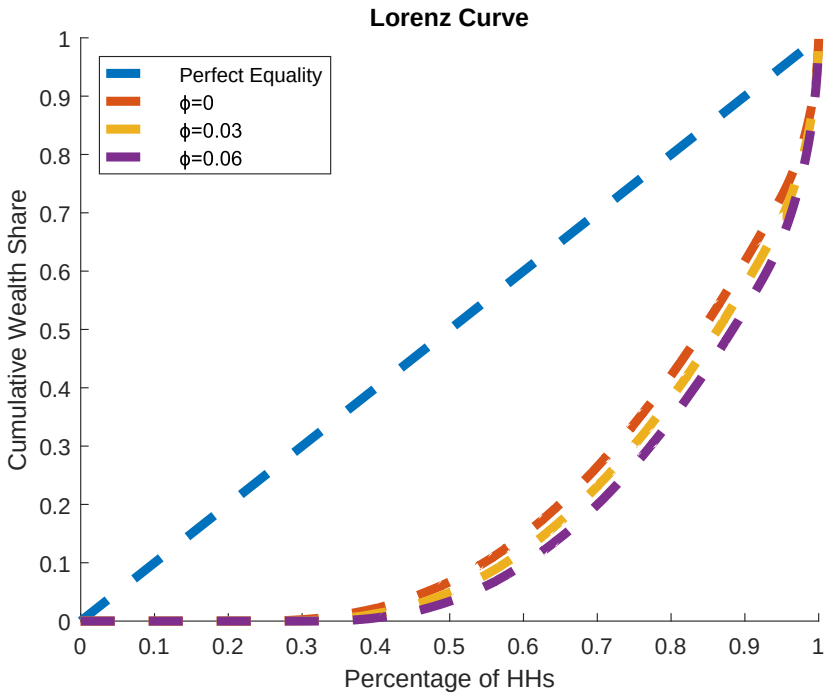
Figure 4.3: Asset-Age Profile For the Agents With x_{min} and x_{max}



Though the wealth Gini and distribution of assets are poorly captured in the model, the direction of changes in the wealth distribution as a result of increase in cost

premium is similar to that of Erosa (2001). First of all, earnings distribution becomes more dispersed as wage goes down. The decrease in wages lowers worker earnings, and even though the revenue of formal entrepreneurs decrease mildly, they tend to save much more to offset the effects of higher ϕ, as the average cost of capital ($r_d + \frac{k^*-a}{k^*}\phi$) decreases with individuals' asset level. As a result, formal entrepreneurs' saving rate increases even though the income they get decreases mildly. Also, to offset the lower rate of return to deposits, resulting from the increase in ϕ, at the retirement stage, formal entrepreneurs' tendency to save increases with ϕ. Overall, the asset level of the highest skilled individual increases mildly at the later stages of the life cycle, as shown in Figure 4.3. As the formal entrepreneurs, who earn more than workers, save more while the workers, who earn less than formal and informal entrepreneurs, earn and save less with the increases in the intermediation cost, the left and right tail of the wealth and income distribution get thicker. Consequently, the aggregate wealth Gini increases with the rises in the intermediation costs, and the Lorenz Curve gets fatter with the level of financial repression.

Figure 4.4: Lorenz Curve in the Economy with different ϕ's



CONCLUSION

Overall, the intermediation spread between the deposit and the lending rate may be one of the explanations why the informal share of output, the degree of credit rationing and the measure of entrepreneurs are higher in the countries where per-capita output is lower. In an overlapping generations setup where the individuals start with zero assets and choose their occupation within their working period, the intermediation spread reduces the price of capital and labor substantially, decreasing the opportunity cost of entrepreneurship and increases the direct cost per loan that the formal entrepreneurs face. As a result, while the measure of formal entrepreneurs decreases, the measure of informal entrepreneur increases substantially, and the net effect becomes positive. The increase in the intermediation spread also shrinks the size that entrepreneurs would want to operate with in the absence of this spread.

The magnitudes of the changes due to the changes in the intermediation spread ϕ are relatively low, in that the intermediation spread could explain what differentiates the per-capital income between the high income and other economies by a mere fraction in our model. We think that the other factors which would explain this divergence could be the level of tax enforcement in the economy, reflected as $\bar{k}$ in our model, and the maximum attainable leverage in the economy overall, reflected as λ in our model. Changes in both across countries may explain the dispersion in the share of informal output, the ratio of credit to output etc. across countries.

APPENDIX

Table A.1: The age-dependent worker-productivity levels

Age	Efficiency-Unit	Age	Efficiency-Unit
21	0.337	44	1.080
22	0.393	45	1.081
23	0.490	46	1.108
24	0.530	47	1.109
25	0.617	48	1.135
26	0.651	49	1.137
27	0.697	50	1.137
28	0.710	51	1.106
29	0.757	52	1.138
30	0.795	53	1.084
31	0.862	54	1.102
32	0.872	55	1.099
33	0.903	56	1.113
34	0.920	57	1.077
35	0.983	58	1.065
36	0.998	59	1.082
37	0.995	60	1.066
38	1.011	61	1.038
39	1.037	62	1.038
40	1.037	63	0.996
41	1.070	64	0.989
42	1.042	65	0.959
43	1.092		

Source : Ruggles et al. (2021)

Solution Algorithm

The model is solved numerically. The individual-specific skill levels take 81 levels between e^{-2} and $e^{-0.4}$. The asset levels a are exogenously discretized with the maximum level higher than ${k_{FE}^{U}}^{*}(x_{max}, a; w, r)$ and not reached at the steady state. To avoid all kinks in the consumption and asset choices over the life cycle, the asset grids are made narrower at the lower levels and coarser at the higher levels. As will be shown in figures below, no-kinks for the asset profile over the life cycle are ensured. To ensure that, the number of asset grids is chosen sufficiently high. Those asset grids followed a power-law with the base parameter chosen sufficiently close to 1. The earnings and profits for level of assets and entrepreneurial skills are specified for each level of asset and skills. Following those earnings, the individual policy functions (asset for the next level and consumption for the current period) are solved using the backward-induction method.

The equilibrium prices r and w are reached using the broyden method found at the MathWorks website (Mjaavatten 2020). Although we didn't use the broyden function from Miranda and Fackler (2004)'s CompEcon toolbox, we benefitted the backstepping operations sufficiently specified in the book, where necessary.

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