Department of Political Economy
King's College London

Programme: Dissertation

Module code: 6SSPP352

Candidate number: A24972

Title of your dissertation: Inequality and Human Capital Accumulation: The Role of Credit Market Imperfections

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Word count: 8790

Date: 01/06/2020

Abstract

This paper investigates the relationship between inequality, credit markets and human capital accumulation. The theory suggests that inequality negatively impacts educational attainment through imperfect credit markets. Based on a panel analysis of 217 countries for the years 1965-2019, this study finds evidence in support of this theory. The study uses the income share of the poorest 20% of the population to measure economic inequality; tertiary education enrolment rates to determine human capital accumulation; and the number of days required to enforce a commercial contract as an indicator of credit market efficiency. The data shows that inefficient credit markets strengthen the negative relationship between inequality and education. This means that the inability to borrow hinders education. Another, slightly less robust finding suggests that in the presence of near-perfect credit markets, inequality has a positive effect on schooling attainment.

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1 Introduction

On a macro-level, imperfect credit markets are seen as one of the key drivers behind the negative relationship between inequality and the national education level (Deininger and Squire 1998). Inspired by a wave of endogenous growth theories, Galor and Zeira (1993) construct a model where initial wealth distribution determines the rate of human capital accumulation through inefficiencies in credit markets. In this model, binding credit constraints force poor individuals to underinvest in education. Galor and Zeira are just one example out of many theoretical contributions which make a similar argument (Banerjee and Newman 1993, Piketty 1997a, see Ehrhart 2009 and Piketty 2000 for a review). Unequal access to credit has solidly entered economic textbooks as the key factor which explains differences in schooling attainment (Ray 1998, Weil 2012).

Similarly, on a micro-level, the inability to borrow is viewed as an important determinant for individual schooling choices. Most of the theoretical work in this direction is grounded in the life-cycle framework (Ando and Modigliani 1963). Deaton and Muellbauer's (1980) criticism encouraged researches to incorporate credit constraints into the life-cycle models. These models add considerable sophistication to the relationship between borrowing constraints and educational decisions. They account for the effects of differences in individual ability, work-leisure preferences and various assumptions regarding consumption choices (Cameron and Taber 2004, Lochner and Monge-Naranjo 2012).

Both micro- and macro-empirical literature provide suggestive evidence in favour of credit market imperfection theory. For example, micro-empirical researchers suspect borrowing constraints to drive the well-documented positive association between parental income and individual schooling choices (Cameron and Heckman 2001, Black and Devereux 2011). On a macro-level, credit market imperfections are blamed for the negative relationship between inequality and average educational attainment among poor people (Cingano 2014). However, in both cases, there exist plausible alternative explanations which cannot be rejected without directly measuring the efficiency of the credit market. Furthermore, except for Perotti's (1994), no other study emphasises the interaction between inequality and borrowing constraints. This paper is an attempt to correct these shortcomings.

This study explicitly takes a macro-economic perspective. The central question it asks is: Does the presence of greater credit market inefficiencies exacerbate the negative relationship between inequality and human capital accumulation?

To find an appropriate measure for credit market imperfections, I survey previous attempts from different branches of literature (McKinnon 1973, King and Levine 1993a, Levine 1999, Jappelli *et al.* 2006) and identify the 'enforcement quality' approach as particularly suitable for the main question of this paper. The idea behind it is that if fleeing loan repayment is costly, fewer people are going to shirk, which encourages lending. Surprisingly, studies that apply this approach to education are virtually non-existent.

This paper uses panel data on 217 countries over a span of 55 years. As a proxy for enforcement quality, it uses data on the number of days required to enforce a commercial contract. The income share of the poorest 20% of the population and the university enrolment rates are used to approximate inequality and human capital accumulation, respectively.

This study finds that inefficient credit markets strengthen the negative relationship between economic inequality and average schooling attainment. So, the inability to borrow does seem to hinder education. This finding is robust to most changes in the statistical specification. Furthermore, the results also suggest, albeit not very robustly, that in the presence of nearly perfect credit markets, the relationship between inequality and education becomes positive. One potential reason behind this is that income differentials motivate individuals to strive towards greater rates of return. In other words, inequality of outcome combined with equality of opportunity incentivises people to invest in human capital. This means that inequality impacts education through two distinct mechanisms - the first drives the negative association, whereas the second drives a positive one. The efficiency of credit markets determines which mechanism prevails.

This paper is organised in the following way. Section 2 reviews the existing literature on the topic. Section 3 categorises the previous attempts to measure credit market imperfections and highlight the best approach. Sections 4 and 5 outline the study design and results, meanwhile Section 6 discusses the implications of the findings. Finally, Section 7 concludes.

2 Literature Review

In this section I first outline the core theory that this study aims to test, namely the Galor and Zeira model. In this outline, I stress the importance of the interaction between inequality and loan market efficiency. I also explore sources of credit market imperfection. Next, I discuss scant empirical literature which deals with these theories. I note that the majority of these studies use indirect methods and find indicative support for the theory. The two studies that attempt to use direct measurement of credit market imperfections either suffer from poor quality data or put less emphasis on the co-dependency of the effect that inequality and credit markets have on education. In the third part of this literature review, I discuss theories alternative to the theory of Galor and Zeira, which focus on the impact of inequality on economic growth. To round off, this review looks at micro-economic literature that explores the effect of borrowing (liquidity) constraints on individual schooling choices.

2.1 Credit Market Imperfections

The core economic model of this paper belongs to Galor and Zeira (1993). It was inspired by Romer's (1986) and Lucas's (1988) endogenous economic growth models and, hence, significantly resembles them. It assumes a standard open economy where a single good can be produced via a skilled or an unskilled process in an infinite discrete timeline. Overlapping generations of identical economic agents are also assumed. These individuals are inter-generationally altruistic, meaning that they leave a bequest to their offspring. In addition, these agents live in two periods – in the first, they either invest in human capital or work as unskilled labourers, whereas in the second they either continue to work or become professionals. In this model, an ability to invest in human capital is determined by the size of the bequest each individual receives. Therefore, in the short run, the initial distribution of wealth determines the level of human capital investment and output. Two crucial assumptions ensure that short-run implications of initial wealth distribution in the Galor and Zeira (1993) model carry over into the long-run. The first is an 'imperfect credit market', which implies that the interest rate is lower for lenders than it is for borrowers. This means that those who inherited a small bequest are going to find it expensive and difficult to borrow money to invest

in education, resulting in credit rationing. The second assumption is quite intuitive and suggests that investments in human capital are non-divisible. This means that to obtain a qualification, an individual has to spend a set amount of resources and cannot spend less for a fraction of a skill. Thus, those individuals whose inheritance is below the certain threshold cannot invest in human capital.

The Galor and Zeira (1993) model has a number of implications. The first is that imperfect capital markets coupled with non-divisibility of human capital investments result in the existence of dynasties, which generation after generation are prevented from receiving an education, and, effectively, remain trapped in poverty. This reduces inter-generational income mobility. The second is the possibility that there exist multiple steady-states aggregate output levels. The one towards which the economy eventually converges rests upon the initial distribution of income. Therefore, a more even wealth distribution leads to higher long-run economic growth. Lastly, although the model does not allow for variations in loan market efficiency, it clearly implies that human capital accumulation is determined by a combination of inequality and credit market imperfections.

A number of credit market imperfection models attempt to apply this kind of logic to physical capital accumulation. For example, Banerjee and Newman (1993), built a similar model to that of Galor and Zeira, but instead of educational choices, they allow individuals to pick an occupation. Occupations, such as entrepreneurship, require an indivisible investment in physical capital. In the presence of imperfect capital markets, individuals who reap higher returns to capital would not be able to invest. These types of models, unfortunately, did not gain much traction. It is widely thought that imperfect credit markets have a greater negative impact on human capital accumulation, so this is what most researchers focus on. For example, Galor and Moav (2004) argue that unlike physical factors of production, human capital is bound by diminishing returns at an individual level since the ability to accumulate it is constrained by people's physiological limits. Aggregate productivity of physical capital, on the other hand, does not depend on how evenly it is distributed among the population. So, individual-level credit constraints have a greater impact on human capital.

Table 4 in the Appendix provides a summary of most credit market imperfection models, which negatively associate inequality and growth. The sources of credit market imperfections can be categorised into two groups: verifiability of output and verifiability of input (Piketty 1997, 197). Verifiability of output refers to the problem where the lender is unable to observe the outcome of the investment the borrower undertakes without incurring a monitoring and enforcement cost. This type of imperfection is prevalent in Galor and Zeira's (1993) and

Banerjee and Newman's (1993) models. The verifiability of input refers to a moral-hazard-type problem. More specifically, the outcome of the investment is determined by the amount of effort the agents put into it. This amount of effort, in turn, is determined by the expected reward. The more an individual borrows to finance a project, the higher the portion of the returns that he or she is compelled to share with investors, and the lower his individual expected return. A moral-hazard type problem, thus, arises when the proportion of the investment that is financed by borrowing is high and the incentive to see this investment through is low. The models of Aghion and Bolton (1997) and Piketty (1997a) are ones that employ this type of definition for credit market imperfections.

2.2 Empirical Evidence

Empirical research of the impact that imperfect credit markets and inequality have on human capital accumulation is surprisingly scant. This provides an opportunity to review most of it in this paper. Studies on this subject can be categorised into those that use direct measures for the quality of credit markets and those that indirectly imply their existence. Both types provide suggestive evidence in favour of the theory that human capital accumulation is negatively impacted by imperfect credit markets and inequality, which then leads to lower economic growth. However, majority of the papers do not acknowledge the co-dependent relationship between inequality and credit market outcomes, which is clearly implied by most theoretical models.

I am going to begin by looking at direct evidence. Perotti (1994), whose research is the main inspiration for this paper, is the first researcher who attempted a direct test for the credit market imperfection models. However, he does not emphasise human capital accumulation. Instead, he is interested in the impact that inequality and credit markets have on investments in general. His study uses 'investment-to-GDP-ratio' as a dependent variable and data on income distribution as a proxy for wealth inequality. To measure the degree of credit market imperfections, Perotti uses Jappelli and Pagano's (1994) dataset on 'down-payment-to-mortgage-size-ratio'. He finds that income inequality is positively associated with the level of investment, while credit market imperfections have a negative association. He also finds that inefficient credit markets strengthen the negative relationship between income inequality and investment level.

Although Perotti's discovery falls in line with this paper's theory, it is rather weak. One problem here is poor data quality of all three variables. Investment to GDP ratio, for instance, includes public investments because a breakdown of the data was not available at the time. This is a problem because credit market imperfections are unlikely to affect public investments. Furthermore, data on inequality do not meet Deininger and Squire's (1996) criteria for being 'high quality', which means that cross-sectional comparability in Perotti's study is, at best, questionable. The last, and perhaps most important, problem lies within Jappelli and Pogano's dataset. It only contains information on high income countries and is known to contain large measurement errors. In his later work, Perotti (1996) attempts to use De Gregorio's (1994) dataset on the ratio of domestic credit to GDP and inconducive results. An even deeper problem with Perotti's (1994) discovery is that the loan-to-value ratio in the mortgage market is not a good measure of credit market imperfections. The reason for this is that the mortgage loan market is not representative of the theoretical credit markets propose in the literature. Firstly, the type of interaction that the lender and borrower have is fundamentally different to what has been described by the models. More specifically, the lender does not face the verifiability of input problem as no work is required to increase the value of the house. Furthermore, the verifiability of output is also not an issue. The asset, in this case the house, is immobile and is not in the direct ownership of the borrower until he repays his loan. In the worst-case scenario, the bank can confiscate the house and re-sell it. Secondly, mortgage markets are regulated to varying degrees across countries (Aalbers 2012). Therefore, cross-sectional differences in the loan-to-value ratios can hardly be reliable proxies for the degree of credit market imperfections.

The second and final attempt to directly measure income inequality in this context is made by Ben-Mimoun (2008). He uses 'total-household-credit-to-GDP-ratio' to measure credit market imperfections, and tertiary education enrolment rates to calculate human capital accumulation. Ben-Mimoun does not put much emphasis on the interaction between inequality and credit markets but nevertheless includes it in the statistical model as a control variable. The results show that total private credit has a significant and positive effect on school enrolment rates, meanwhile inequality has a negative impact. Interestingly, these effects are more prominent in wealthy countries. Unfortunately, Ben-Mimoun's study has limitations that are related to the measure of credit market quality. Conceptually, total household credit is not a measure of the degree of credit market imperfections. For example, in Galor and Zaira's model, total credit given out to people is a determined by the interaction between inequality and imperfect credit markets. As such, there exists an impermissible level of multicollinearity between these variables in Ben-Mimoun's statistical model (see Table 4 in

Appendix). Furthermore, as discussed in the next section, this study has an endogeneity problem that Ben-Mimoun does not explicitly address.

With regards to indirect evidence, Deininger and Squire (1998) use cross-sectional analysis to investigate the relationship between initial wealth inequality, human capital accumulation, and subsequent economic growth. To proxy wealth inequality, they use 'high quality' data on the distribution of land ownership. Deininger and Squire (1998) find that initial wealth inequality has a significant negative effect on economic growth. This effect is more significant in developing countries, whereas when running the regression on the OECD nations, coefficients become insignificant. To rationalise this finding, Deininger and Squire (1998) apply the credit market imperfection theory. They argue that credit markets are less developed in low-income countries. Therefore, the initial distribution of incomes has a greater effect in developing countries. To confirm this, they assert that credit constraints are going to have a more significant effect on human capital than on physical capital accumulation, by logic similar to the one Galor and Moav (2004) utilise. Deininger and Squire (1998) then run a regression where they find a significant, quantitatively important, negative effect of initial inequality in land ownership on the level of secondary education. Furthermore, they also find that education is positively correlated with the level of investment, which in turn affects economic growth. The authors conclude that initial wealth distribution through credit market imperfections negatively affects the level of education in developing countries, leading to a lower level of investment and, finally, a weak economic performance. Unfortunately, Deininger and Squire's findings are prone to criticism. In this particular case, the problem is that indirect measurement opens a door for many convincing alternative explanations. For example, it is not entirely implausible to suggest that land ownership patterns can be greatly affected by differences in industry composition in developing and developed countries. Therefore, an economy that is reliant on agriculture may produce a different pattern in land ownership than a country where services are the predominant industry. Furthermore, it is also reasonable to suggest that agricultural production generates a greater opportunity cost of children being sent to school since they can be a great aid in the field. In this case, there exists an omitted variable, namely industry composition, which affects both land ownership patterns and the rate of human capital accumulation.

The other two notable studies were undertaken by Chambers and Krause (2010) and Cingano (2014). Both of them use very different methods to produce results similar to those of Deininger and Squire (1998). Taken together, all of these studies provide convincing evidence that credit market imperfections are likely to negatively affect human capital but not physical capital formation. Thus, models that emphasise the former, namely Galor and Zeira

(1993), have a stronger claim to the truth. However, as previously mentioned, indirect evidence from these studies does not validate the credit market imperfection theories fully and a reliable direct measurement is still required to complete the puzzle.

2.3 Inequality and Economic Growth

The Galor and Zeira model is part of broader literature, which attempts to understand the effect economic inequality has on economic growth. The majority of empirical literature on this topic finds that inequality has a significantly negative impact on growth (Alesina and Rodrik 1994, Clarke 1995, Knowels 2005, Ostry *et al* 2014). However, there are important papers which disagree with these results (Li and Zou 1998, Forbes 2000). Interestingly, Barro (2000) and Castello (2010) find that inequality has a positive effect in rich countries and a negative effect in poor ones. This hints at the possibility that the relationship between these variables is non-linear. A study by Voitchovsky (2005) finds that inequality at the top level of income distribution is beneficial to growth, whereas the opposite is true for the bottom level of distribution. Further complexity to this relationship is added by Halter *et al* (2014) who finds that the short-term relationship between inequality and growth is positive, meanwhile the long-term relationship is negative. Another intricacy is the pattern that seems appears when cross-sectional data indicates a negative relationship while panel and time-series data produce positive results (Cingano 2014). Overall, these findings point to the fact that inequality affects growth in a complex manner that requires further investigation.

To better understand the relationship between economic inequality and economic growth, researchers steered their efforts towards discovering the driving mechanisms behind it. Neo-classical theory argues that inequality increases economic growth by encouraging higher aggregate savings (Kaldor 1956). At the core of this argument is the assumption the marginal propensity to consume reduces as incomes grow. If wealth is concentrated in the hands of a few individuals, more resources would be saved and, thus, invested. Unfortunately, Barro (2000) does not find support for this theory. The reason for this may be the possibility of a non-linear relationship between income level and the saving rate (Ray 1998).

Theories that point at the negative relationship between inequality and economic growth suggest either political or economic transmission channels. The former relates to the notion that polarisation of incomes and wealth introduces tensions between the rich and the poor.

There are two ways in which these tensions can manifest – high inequality levels can either prompt governments to double down on taxes and transfers (Meltzer and Richard 1981) or generate violent political instability (Acemoglu and Robinson 1999a). Empirical findings do not generally support the first transmission channel (Perotti 1996, Person and Tabellini 1994, Bergh and Henrekson 2011), however, they do consistently support the second theory (Alesina and Perotti 1996, Perotti 1994 & 1996, Knack and Keefer 2000, Keefer and Knack 2002).

Now on to economic transmission channels. The first has already been discussed in section 2.1 on credit market imperfections, meanwhile the second comes from a more recent strand of literature. In his famous book, Rajan (2011) argues that politicians promoted credit expansion to appease the voters because of the rise in inequality. This view was formalised by Kumhof and Ranciere (2011). They created a model where, in response to rising inequality, individuals become increasingly indebted, which eventually resulted in economic crisis. This theory goes against the textbook understanding of the driving mechanisms behind credit expansions. Permanent income and life-cycle hypotheses (Friedman 1957), combined with an assumption of rational expectations, suggest that credit is used by economic agents to smoothen consumption in the face of higher variability in the transitory part of income. Therefore, credit is only related to changes to transitory, not permanent inequality. This means that agents use credit when they need to and do not exploit it to consume beyond their means (Hall 1978, Krueger and Perri 2003 & 2006). Furthermore, an analysis of the credit expansion determinants by Mendoza and Terrones (2008) and Borio and White (2004) show that, although excessive credit does build up in the run up to financial crises, the main causality factors are economic expansion, real exchange rate appreciation, deregulation, stable inflation and low interest rates. Recent literature calls into question the accepted view that inequality is not a determinant for credit expansions. As a first step, van Treeck (2014) argues that the “relative income hypothesis” provides a better theoretical link between demand for credit and inequality, than traditional approaches. According to this theory, economic agents compare their consumption decisions to those of the agents around them and strive to match consumption of wealthier member of the community. If this is the case, inequality does tempt people to live beyond their means. Empirical research into the link between inequality and credit booms produced mixed results. Bordo and Meisner (2012) find no relationships, meanwhile Atkinson and Morelli (2010) and Holscher and Collie (2015) find a positive one.

2.4 Micro-Economic Perspective

Concurrently with the Galor-and-Zeira type macro-economic theories developed an additional strand of literature that takes an explicitly micro-economic perspective. The models used in this approach are based on the influential life-cycle framework, which attempts to explain the decision-making behind consumption, investment, fertility, marriage, labour supply, and various other topics, in the presence of uncertainty. An underlying assumption of this framework is that an individual strives to smoothen consumption over his lifetime (see Browning and Crossley 2001 for a review). One of the central concerns of the life-cycle framework is how liquidity constraints, or the inability to borrow, affect the individual's life choices. Therefore, it was only a matter of time before this framework was applied to decisions about education.

Models based on the life-cycle framework add a considerable degree of sophistication to the relationship between credit constraints and education. First, they relax the assumption of identical individuals and allow for heterogeneity in ability (Becker 1976, Cameron and Taber 2004). In this context, when credit constraints are absent, the decision to invest in higher education would be positively correlated with an individual's ability, independent of his wealth. On the other hand, in the presence of capital market imperfections, education investments for high ability individuals are directly proportional to their wealth and the borrowing limit (Lochner and Monge-Naranjo 2012). Adding consumption opportunities to the mix introduces a wide range of implications as it creates an additional opportunity cost. For example, Lochner and Monge-Naranjo (2011b) argue that higher ability individuals, who expect greater life-time earnings, face a greater opportunity cost in terms of consumption at the schooling age. Therefore, if credit is not available to smoothen the expenditure, an individual is going to decide against attending university. Meanwhile, Belley and Lochner (2007) predict that because of diminishing returns to consumption, wealthily individuals have less incentive to improve their lifestyle via investing in obtaining more skills. Nevertheless, despite the wide variety of life-cycle models, the precise mechanism behind the trade-off between consumption and education choices is unclear.

Most empirical studies in this direction are motivated by the well-researched positive relationship between parental income and individual schooling choices (Mare 1980, Cameron and Heckman 2001, Black and Devereux 2011). There are several plausible explanations for what drives this relationship; however, researchers tend to favour rationalisations based on

credit constraints. Other theories suggest that (1) high-income parents genetically pass greater ability endowment or transmit the right preferences to their children, and (2) rich parents can afford to contribute more time to support a child's early education (McLachlan et al. 2013).

An overwhelming majority of research (at least in English) is focused on the US because of the availability of high-quality micro-level data, namely National Longitudinal Study on Youth (NLSY) and Panel Survey of Income Dynamics (PSID). On the one hand, studies find that, controlling for ability, family income has played a less significant role in the early 1980s than it did in the 2000s (Cameron and Heckman 1998, Carneiro and Heckman 2002). Furthermore, Belley and Lochner (2007) find that an extra 10,000$ in local house prices increased the university enrolment rate by 0.7%. Furthermore, Stinebrickner and Stinebrickner (2008) asked US university students from low income backgrounds directly, whether they would borrow more if they could. Those who said yes were categorised as credit constrained. Later observation highlighted that by the second year of university, the drop-out rates for constrained individuals was 11% higher than any other group.

Attempts to measure the effect of credit constraints directly, through structural (causal) modelling, however, do show different results. Keane and Wolpin (2001) and Johnson (2011) develop structural life-cycle models using NLSY data from 1979 and 1997, respectively. Based on several simulations, these studies conclude that relaxing credit constraints does not affect enrolment rates. With no borrowing limits, young adults prefer to maximise consumption and enjoy more leisure. Overall these studies, along with some others (Cameron and Taber 2004, Navarro 2010) suggest that (1) parents are more willing to pay for their children's education than children themselves and (2) recently, borrowing constraints have become more important, albeit still negligible.

3 Measuring Credit Market Imperfections

There exists evidence of significant cross-country dispersion in the effect of parental income on education, implying that differences exist in credit market efficiency across nations (Filmer and Pritchett 1999). However, directly measuring credit market imperfections is one of the fundamental challenges in this line of research. In this section, I am going to review various attempts at capturing credit market imperfections from a wide range of studies. It appears that macro-level attempts can be categories into two groups: (1) the 'financial depth' approach, and (2) the 'financial development' method. After reviewing some drawbacks of these approaches, I propose and justify an alternative method to measuring credit imperfections, namely 'enforcement quality'. It alleviates some of the methodological concerns posed by the two methods also introduces a few concerns of its own. Finally, I suggest that the solution to the unobservability of credit market imperfections is to apply all three approaches simultaneously.

3.1 Financial Depth

'Financial depth' is the most widely used approach for measuring credit market imperfections. King and Levine (1993a), who started a new branch of research on financial depth – economic growth nexus, are the first to propose this approach. The indicators they suggest are based on monetary and credit aggregates. The most basic ones are 'private-credit-to-GDP-ratio' and 'ratio-of-broad-money-to GDP'. More complex variations include the 'ratio-of-broad-money-to narrow-money' and the 'ratio-of-securities-market-outstandings-to-broad-money' (Lynch 1996). The idea behind these aggregate measures is that if the credit market functions smoothly, more deposits are going to be made, more credit is going to be given out, and more assets are going to be securitised.

The drawback of this approach is that it is subject to endogeneity. The determinants of financial depth are not fully understood but are suspected to be correlated with a wide variety of variables, including inequality, foreign trade, economic development, and the regulatory environment (Borrio and White 2003, Arestis et al. 2014). Therefore, its application is complicated and, in most cases, must be supplemented with the use of instrumental variables.

3.2 Financial Development

'The 'financial development' approach tries to identify structural attributes of credit markets, which theoretically correspond to a higher degree of development. Although the theory behind credit markets provides inconsistent guidance, a consensus on the following points can be observed. First, a low level of market fragmentation is an attribute of a well-developed financial market. This is because market fragmentation is thought to impede information flow. In the same spirit, positive real interest rates with little cross-institution variability indicate that the financial system accurately assesses the degree of resource scarcity. Furthermore, the range and sophistication of financial products is an indicator of the financial market's ability to measure risk more accurately. Lastly, interest rate spreads are theoretically an indicator of the transaction costs associated with lending (McKinnon 1973, Shaw 1973).

Unfortunately, the implementation of this approach has its own complications. These indicators are based on the assumption of the state-intervention-free financial market. In reality, regulations alter the behaviour of the credit markets. For example, interest rate spreads are lower in countries where the state guarantees loans (for example China). Another example is that degree of fragmentation has a lower negative effect on the quality of the financial markets in countries where sharing information on borrowers is compulsory by law. A deep analysis of the interactions between all of these variables is required to create a comparable cross-country index of financial development.

3.3 Enforcement Quality

The 'enforcement quality' approach attempts to approximate how likely it is that the borrower is going to escape repaying the loan. According to Galor and Zeira type models, a high probability of being caught and punished acts as a deterrent to shirking. Thus, strong state enforcement institutions would reduce the extent of the verifiability of output problem. Furthermore, for a long time, researchers have recognised the important role judicial efficiency plays in the development of the capital and credit markets (King and Levine 1993a, Levine 1999). However, this role was only recently explicitly formalised in a model by Jappelli, Pagano and Bianco (2006). This model shows that a higher cost of enforcing a contract is

negatively associated with the total amount of credit available on the market and with the size of the required collateral.

'Enforcement quality' offers a promising method for measuring credit market imperfections because of the peculiar characteristics of human capital investments. First, verifiability of output is a significantly more severe problem for borrowers who intend to invest in schooling. The reason for this is that human capital is inseparable from an individual's body, which has two relevant implications: (1) human capital cannot be confiscated and sold as is the case with physical capital, and (2) human capital is significantly more mobile than physical capital, making it easier to shirk. Therefore, lending for education is bound to be significantly more sensitive to cross-country differences in enforcement and judicial quality.

Second, the verifiability of input problem, which the 'enforcement quality' approach completely neglects, is significantly less severe when applied to education. Efforts put into education are spread across two periods. In the first period, a borrower works towards a qualification and does not concern himself with re-payment. Arguably, verifying that the person is going to work hard towards his degree is not too cost-intensive. It can be relatively easily approximated from secondary and high school academic results. These can also be used to identify higher ability individuals. Therefore, the extent of the verifiability of input problem is partially mitigated.

In the second period, however, verifiability of input comes back into the equation. After graduation, the borrower is ought to find an occupation and repay the loan, which exposes him to the moral-hazard problem. If the borrower knows that a portion of his earnings belongs to the lender, he or she is going to be less motivated to chase a higher salary. Nevertheless, on the theoretical level, this problem is rooted in the fundamental assumptions about the nature of the human character. In other words, if borrowing reduces the incentive to put effort into an investment project, this needs to be the case across time and space. This means that this variable can be omitted from the analysis because it remains constant across observations. Of course, assumptions regarding incentives that drive human behaviour can be questioned. Furthermore, cultural differences might also have an impact. However, currently available data do not allow for this degree of sophistication.

There is a potential complication with this method. The assumption that the verifiability of input problem does not vary across countries does not fully warrant the use of the 'enforcement quality' approach. It also needs to be assumed that uncertainty related to investments in human capital is homogeneous across nations. That is, opportunities available to graduates are the same in different countries. This is a hard assumption to defend;

therefore, there is a need to control for differences in average returns to education. However, finding an appropriate control variable is difficult. Cross country data on 'college premia', although announced, has not yet been published by the World Bank. The research design partially alleviates this issue. Nevertheless, to fully ensure that this does not present a significant problem to the study, I apply the other two approaches to measuring credit market imperfections along with the 'enforcement quality' method, expecting to find similar results.

Jappelli, Pagano and Bianco (2006) propose the following indicators to approximate the judicial efficiency: the sizes of the backlogs of cases in courts and length of trials. With the former, an important issue arises during cross country analysis. It is possible that the composition of backlogged cases varies in different court-systems. So, this study employs the 'length of trials' indicator. Although this indicator can also suffer the same problem as the backlog of cases, datasets exist which focus on the trials of a specific type. This study uses the World Development Indicators dataset from World Bank (2019). It contains information on the 'time required to enforce a contract,' which is sourced from an array of national legal databases. To ensure representativeness and cross country-comparability, legal cases that are included in the calculations are filtered using a strict set of criteria. The two most important ones are (1) the value of the contract needs to be higher than 200% of the average national income or greater than $5,000, and (2) a contract is required to be related to a sale of physical goods in a capital city.

This indicator has limitations; however, it is the best data available in terms of coverage. The main criticism is that the type of contracts that are considered are not specifically related to lending. Another important limitation is that the individuals who require credit to pursue higher education are likely to be in the lower-income brackets. Since the indicator is territorially confined to the national capital cities, it might not be a good proxy for the legal framework outside of the main city where most poor people live. To combat these concerns, I run a test regression which shows that 'time required to enforce a contract' does have a significant negative and quantitatively important effect on the 'credit-to-GDP' ratio (see regression 3 in Table 2). This means that the indicator does have an effect on credit. The test does not fully address the problems that I mentioned; however, it does provide some comfort, especially when no better alternatives exist.

4 Methodology

4.1 Hypotheses and the Empirical Model

This paper aims to understand how inequality, combined with credit market imperfections, affects human capital accumulation. Following the Galor and Zeira (1993) model, I propose the following hypotheses:

H1: Inefficient credit markets strengthen the negative relationship between inequality and human capital accumulation;

H2: In the presence of similar degrees of credit market imperfections, inequality has a negative effect on human capital accumulation;

H3: Given a similar level of inequality, the degree of credit market imperfection has a negative impact on the rate of human capital accumulation.

To test these hypotheses, I adopt an interaction-term-based statistical specification similar to the one proposed by Perotti (1994). The key difference is that this paper uses a country-fixed effects regression model. Such research design helps to control for unobserved country-level differences, which may affect the independent variable. This helps to minimise the possibility of omitted variable bias in the results. The exact model specification is the following:

$$HUMCAP_{it} = \alpha_i + \beta_1 INEQ_{it} + \beta_2 IMP_{it} + \beta_3 INEQ_{it} \times IMP_{it} + \varepsilon_{it}$$

where i indicates a country, t represents a year and α_i is a country-dependent constant. HUMCAP, INEQ and IMP stand for human capital investments, level of inequality and degree of credit market imperfections, respectively. Most importantly, β_3 represents the coefficient of the interaction term between inequality and credit market imperfections.

The term $\beta_1 + \beta_3 IMP_{it}$ represents the effect that inequality has on educational attainment conditional on variations in credit market imperfections. Similarly, $\beta_2 +$

$\beta_3\ INEQ_{it}$ stands for the effect of imperfect credit market on human capital accumulation with the given level of inequality. Therefore, in accordance with H1, one would expect $\beta_3 < 0$. If this is the case, an increase in the degree of credit market imperfections will strengthen the negative effect that inequality has on human capital accumulation, as predicted by the Galor and Zeira model. Furthermore, based on the hypotheses H2 and H3, it is reasonable to expect that $\beta_1 < 0$ and $\beta_2 < 0$. Finally, it needs to be noted that the three hypotheses stated above are not co-dependent. That is, it can very well be the case that H2 and H3 are false when H1 is true.

4.2 Variables and Data

The analysis is based on a panel dataset made up of observations of 217 countries between the years 1965 to 2019. As mentioned earlier, the main indicator for the degree of credit market imperfections is the 'time required to enforce a contract' taken from the World Bank. The 'financial depth' and 'financial development' approaches are represented by the 'domestic-credit-to-private-sector-to-GDP-ratio' and the spread between lending and borrowing interest rates, respectively. These are sourced from the same database.

World Bank estimates for the income share of the poorest 20% of the population are used to indicate income dispersion. It is important to note that nominally income share is a measure of equality, which is the opposite of inequality. In other words, numerical increases in this variable represent a lower level of inequality. Therefore, when using this indicator, the coefficient for the interaction term is expected to have a positive sign. This indicator has an advantage over the standard Gini coefficient because it directly targets the people who are most likely to require assistance from efficient credit markets to obtain an education. Furthermore, Voitchovsky (2005), in her influential study, finds that the profile of income inequality matters for economic growth. More specifically, she found that greater inequality at the bottom of the income distribution has a greater adverse effect on economic performance, while the opposite is true for the inequality at the top. This further justifies targeting the bottom of the income distribution.

To measure the rates of human capital accumulation, this study uses data on the percentage of people within the relevant age group who are enrolled in tertiary education (UNESCO 2019). Since most of the countries provide free and compulsory secondary education, it is reasonable to suggest that capital market imperfections are going to mostly

affect higher education attainment. Furthermore, theoretically, credit constraints coupled with indivisibility of the investment in education would have immediate effect on the individual's ability to enrol. For these reasons, the yearly enrolment rate is a more precise indicator than the traditionally used 'mean years of schooling' from Barro and Lee (2013). Nevertheless, I use the latter for a robustness check.

5 Results

Table 1. Main Results: Predicting Tertiary Enrolment Rates and Mean Years of Schooling

	(1)	(2)	(3)	(4)
	TER_ENROL	TER_ENROL	MEAN_YEARS	MEAN_YEARS
EQUAL	-0.0601636*		-0.880**	
	(-1.84)		(-2.08)	
CONTRACT	-0.0008843***	0.0007556*	-0.00768***	0.00734**
	(-2.68)	(1.96)	(-2.89)	(2.10)
EQUAL × CONTRACT	0.0001138**		0.00115*	
	(2.53)		(2.48)	
GINI		0.0117063		0.160**
		(1.50)		(2.01)
GINI × CONTRACT		-0.0000235**		-0.000204**
		(-2.22)		(-2.46)
Constant	1.597***	-0.213132	13.60***	1.887
	(6.24)	(-0.51)	(4.82)	(0.61)
Country Fixed Effects	Yes	Yes	No	No
Income Fixed Effects	No	No	Yes	Yes
N	296	296	79	79
R-sq	0.184	0.184	0.488	0.481

"t statistics in parentheses"; * p<0.10, ** p<0.05, *** p<0.01

Table 1 presents the main findings of this paper. The first regression shows how variations in the income share of the poorest 20% of the population (EQUAL) and time required to enforce a commercial contract (CONTRACT) affect the tertiary education enrolment rates (TER_ENROL). The coefficient for CONTRACT is significant at the 1% level, whereas coefficients for EQUAL and the interaction term are significant at the 5%. As expected, the interaction term between CONTRACT and EQUAL is positive. This suggests that ineffective credit markets strengthen the positive effect that equality has on enrolment rates,

which is in line with the Galor and Zeira (1993) model. Therefore, the first regression of the table confirms the third hypothesis of this study H1.

In the presence of an interaction term, the interpretation of the coefficients of the main variables does not take the traditional form. For example, the effect CONTRACT on enrolment rates would equal $\beta_1 + \beta_3 CONTRACT$. That is, the standalone coefficient for the measure of equality β_1 represents the effect it would have, given that the time required to enforce a contract is zero. In this context, the unexpectedly negative and significant coefficient for EQUAL rejects the second hypothesis H2. This means that in the presence of a perfect credit market, the greater income share of the poor has a negative effect on the university enrolment rate. Interestingly, this result persists if different measures for inequality and human capital accumulation are used. The standalone coefficient for CONTRACT, which is significant at the 1% level is, as expected, negative. Thus, the results confirm the third hypothesis H3.

The second regression uses an alternative measurement for inequality, namely World Bank estimates for the Gini coefficients (World Bank 2019). Unlike the previous measure of equality, the increases in the numerical value of Gini correlate with an increase in income dispersion; therefore, the coefficient for the interaction term is expected to have a negative sign. Table 1 shows that this is indeed the case, further re-iterating support for the H1. Unlike the first regression, the standalone coefficient for Gini is insignificant. Nevertheless, it displays the contrary to the expected sign, namely, a positive one, showing further defiance from H2. As per the standalone coefficient for CONTRACT, it is statistically significant and has the expected sing, thus supporting H3.

The third and fourth regressions reflect the first and the second when it comes to independent variables. However, they use a different measure of human capital accumulation, namely, mean years of schooling from the Barro and Lee (2013) dataset. Another difference is that instead of controlling for the country-effects, the latter two regressions control for income-level fixed effects. The reason for this is that controlling for country-fixed effects makes all of the coefficients insignificant. The specific distribution of countries across various income level brackets is borrowed from World Bank, which distinguishes between low, lower-middle, upper-middle, and high-income nations.

Results are very close to those of the first and second regressions. More specifically, inefficient credit markets strengthen the negative relationship between inequality and schooling attainment. This is represented by the negative and positive significant interaction terms in the third and fourth regressions, respectively, which provides further evidence for H1. Thus, the inability to borrow does hinder education. In both third and fourth regressions

coefficients for the measures of inequality are statistically significant, but signs are the opposite to what is predicted by the theory. This re-iterates that in the presence of perfect credit markets, inequality increases the mean years of schooling, consistently invalidating H2. Lastly, in terms of H3, the third regression supports it while the fourth does not. In the third regression, income share is used as an indicator of equality and the coefficient for CONTRACT has the expected (negative) sign, whereas, in the fourth regression where inequality is measured using Gini, the sign of the standalone coefficient for the CONTRACT changes to positive. In both cases, this is significant at the 5% level.

The results of the above regressions are not robust to adding time dummy variables. In cases where regions underwent periods of significant structural change, controlling for time-fixed effects would improve the quality of the regression. In Table 3 (see Appendix), I display regressions from Table 1 with added dummy variables for five eleven-year periods. While all of the coefficients maintain the correct sign, they become statistically insignificant. This means estimations, to some extent, are driven by the common time trend. This could be a structural change, which is potentially endogenous to inequality and credit markets. Given all this, the main results remain indicative.

5.1 Additional Evidence

Table 2. Using Alternative Measure for Credit Market Imperfections

	(1)	(2)	(3)
	TER_ENROL	MEAN_YEARS	CREDIT
CREDIT	0.0389**		
	(2.02)		
EQUAL	0.0312**	-0.0133	
	(2.09)	(-0.07)	
EQUAL × CREDIT	-0.0005*		
	(-1.77)		
GINI			-2.693***
			(-4.36)
SPREAD		-0.1642054**	
		(-2.38)	
EQUAL × SPREAD		0.0267864**	
		(2.07)	
CONTRACT			-0.0633**
			(-2.01)
GINI × CONTRACT			0.00174**
			(2.04)
ECON_GROWTH			0.340
			(1.12)
Constant	0.602***	8.310894***	162.9***
	(4.85)	(5.85)	(7.03)
Region Fixed Effects	Yes	No	Yes
Income Level Fixed Effects	No	Yes	No
11-Year-Fixed Effects	No	No	Yes
N	106	73	562
R-sq	0.422	0.521	0.120

"t statistics in parentheses"; * p<0.10, ** p<0.05, *** p<0.01

Notes: ECON_GROWTH represents GDP per capita growth (annual %)

The first and second regressions from Table 2 closely reflect the first and third regressions from Table 1 but use alternative measures for credit market imperfections. Column 1 employs the 'domestic-credit-to-private-sector-to-GDP-ratio' (CREDIT) from the 'financial depth' approach, while column 2 uses the spread between lending and borrowing interest rates from the 'financial development' method. It should be noted that the first regression from Table 2 controls for region-fixed effects instead of country-fixed effects as does its counterpart from Table 1. The reason for this is that controlling for country-fixed effects in this particular case leads to insignificant results.

Both regressions show very similar results to ones presented in Table 1. First, both regression support H1. Note, in particular, the coefficient for the interaction term between EQUAL and CREDIT, which is negative and significant at the 10% level. Since the greater numerical value of CREDIT corresponds to better functioning credit markets, this result supports the first hypothesis. Furthermore, as expected, the interaction term between EQUAL and SPREAD is negative and significant at the 5% level, again confirming H1. As for H2, both regressions re-iterate previous findings. That is, both coefficients for EQUAL are negative. Furthermore, in the first regression, this is significant at the 5% level, whereas in the second it is statistically insignificant. When it comes to H3, both regressions support it with coefficients being significant at the 5% level.

In summary, all regressions show strong support for the first hypothesis this study puts forward (H1). More specifically, coefficients for every interaction term are statistically significant and have the correct sign. In contrast, most regressions consistently allow to reject the second hypothesis H2 and, in some cases, coefficients for measures of inequality are insignificant. As for the third hypothesis, H3, except for the fourth regression in Table 1, it is supported by most estimates. Nevertheless, in some cases, the coefficient is insignificant. Thus, it can be said that H3 is weakly supported by the data compared to other two hypotheses.

6 Discussion

The results show that inefficient credit markets strengthen the negative relationship between inequality and average schooling attainment. This means that the inability to borrow hinders education. This has a range of implications for the many different strands of literature. The following paragraphs are going to discuss them in the contexts of the inequality-growth nexus and the life-cycle framework.

I would like to start with the implications of the Galor and Zeira model. In accordance with the theory, inequality negatively affects human capital accumulation through credit market imperfections. This means that borrowing limits do prevent education opportunities for low income/wealth individuals. As a result, it is very reasonable to suggest that as in the model, credit market imperfections create generational poverty traps, effectively reducing the inter-generational income mobility. This means that efficiently functioning credit markets boost equality of opportunity. It needs to be noted, however, that in the presence of nearly perfect credit market, inequality has a positive impact on educational attainment, which is somewhat contrary to the theory.

The last direct implication of the model is that lower aggregate educational attainment should result in lower economic growth. Surprisingly, the empirical literature is inconclusive with regard to this proposition. On the one hand, there exists a well-documented link between the initial level of education and subsequent long-term economic growth (Deininger and Squire 1998, Hanushek and Woessmann 2015). Furthermore, micro-level literature consistently shows that educated individuals receive higher wages, implying that they are more productive (Pritchett 1999). On the other hand, many researchers point out that educational attainment changes do not correlate with changes in economic growth rates (Dasgupta and Weale 1992). Pritchett (1999) shows that this creates a contradiction between macro- and micro-findings. That is, if educated people are more productive, education should increase aggregate output in a relatively short period of time, which it does not. Therefore, this paper is left with an unsatisfactory answer to the question of whether inequality and credit market imperfections stifle economic growth through their effect on education.

The inability to convincingly show that the credit market imperfections transmission mechanism is the driving force behind the negative relationship between inequality and growth does not diminish the importance of the current results. Perfect credit markets are a

crucial assumption in most endogenous growth models, including those which focus on inequality. The findings in this paper invite a question of whether inefficient financial markets affect the accumulation of physical capital in the same way they affect human capital. The answer to this question may guarantee to the measure of credit market imperfection an entry into standard growth accounting statistical equations. It should be noted, however, that the results are heavily skewed towards demonstrating the effect of the verifiability of output problem.

The closest plausible alternative theory, which can also explain the obtained results, is the political instability transmission channel. As a reminder – this transmission channel states that inequality leads to social unrest, which in turn negatively affects economic growth. It is reasonable to suggest that violent political instability also affects university enrolment rates and the number of days it takes to enforce a contract. If this is the case, the causal links proposed in this study are invalid. To rule this out, I observe that violent social conflicts have not occurred in high-income countries within the studied time period. So, I run a similar regression to the one described in the methodology section (section number?) but now only include wealthy countries (see Table 3 in Appendix). The results are the same as in the main regression, therefore, this alternative theory is rejected.

Contrary to the findings of Keane and Wolpin (2001), Navarro (2010) and Johnson (2011), this study shows that credit constraints do affect the choice to invest in education, and not just the decisions to consume and work. Since these researchers have based their conclusions on structural life-cycle models, the validity of their core assumptions can be questioned. As mentioned earlier, Van Treeck (2014) suggests an alternative to traditional 'permanent income' and 'life-cycle' theories in the form of the 'relative income hypothesis'. As a reminder – this alternative theory states that people's spending decisions reflect those of the richer individuals in their community. This proposition explains why the results reject the second hypothesis, H2, surprisingly well. A few regressions repeatedly showed that given a near perfect credit market, equality has a negative effect on schooling attainment. According to the 'relative income hypothesis,' this can happen because greater equality reduces income and consumption differences between the educated and the uneducated, thus eliminating the incentive to spend time in tertiary education. From a macro-economic perspective, this is similar to the argument made by Mirlees (1971) and Lazear and Rosen (1981), which states that inequality incentivises individuals to work harder, invest and undertake more risks in order to benefit from higher rates of return. Overall, this means that the effect of inequality on educational choices is twofold – on the one hand, inequality encourages people to work harder,

whereas on the other, it limits their opportunities through imperfections in credit markets. The latter seems to have the prevalence.

The results in this study also contribute the micro-literature on the determinants of schooling attainment. It is well established that among other factors, parental income has a significant impact on educational choices. As mentioned earlier, the precise mechanism behind this relationship is unclear. Findings from this paper suggest that higher parental incomes affect education by alleviating the budget constraints that young adults are facing. This serves as evidence that alternative theories bear a less significant influence on educational outcomes. In particular, this means that genetic transfer of ability and cultural transmission of values play a smaller role in explaining variations in schooling choices.

7 Conclusion

Evidence from a broad panel of countries supports the key insight from the Galor and Zeira thesis, which states that inequality affects human capital accumulation through inefficient credit markets. That is, the inability to borrow hinders education. On the other hand, income dispersion was repeatedly shown to positively affect schooling attainment in cases of near-perfect credit markets. This does not contradict the previous finding. It means that inequality affects educational choices through two distinct mechanisms. One has a positive effect, whereas the latter has a negative one. As the degree of credit market imperfections increases, the latter mechanism becomes more prevalent.

This finding invites further research into how the interaction between credit markets and inequality affects the accumulation of physical capital. Furthermore, an improvement of the available data on enforcement quality is needed. Data on the average length of credit market related court trials could be obtained. Moreover, other indicators of this types could serve as better proxies for the quality of the judicial system.

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Appendix

Table 3. Supporting Evidence

	(1)	(2)	(3)	(4)	(5)
	TER_ENROL	MEAN_YEARS	TER_ENROL	CREDIT	CREDIT
EQUAL	-0.00253	-0.411	-0.0591		
	(-0.10)	(-1.13)	(-1.01)		
CONTRACT	-0.000175	-0.00291	-0.00113**		-0.0403185***
	(-0.66)	(-1.11)	(-1.93)		(-11.36)
EQUAL × CONTRACT	0.0000156	0.000532	0.000152*		
	(0.43)	(1.18)	(1.86)		
GINI				-1.565991***	
				(-10.13)	
Constant	0.210	8.667***	1.506*	123.0043***	74.9883***
	(0.67)	(3.61)	(2.51)	(5.92)	(5.21)
Country-Fixed Effects	Yes	No	Yes	Yes	Yes
Income-Level-Fixed Effects	No	Yes	No	No	No
11-Yeas-Fixed Effects	Yes	Yes	No	Yes	Yes
N	296	79	116	1139	2473
R-sq	0.933	0.681	0.879	0.275	0.128

"t statistics in parentheses"; * p<0.10, ** p<0.05, *** p<0.01

Notes: Column 1 and 2 includes eleven-year-period-effects to the regression form the Table 2

Column 3 shows the main regression of the study for high income countries only

Column 4 shows that the effect of GINI on the 'private-credit-to-GDP-ratio'

Column 5 shows the effects of CONTRACT on 'private-credit-to-GDP-ratio'

Table 4. List of Credit Market Imperfection Models

Models	Key Features	Implications
Becker and Tomes (1979) and Loury (1981)	Pioneering works in this direction. Investments in human capital are undertaken by parents only.	Inequality results in lower investment in human capital and low intergenerational skill mobility.
Galor and Zeira (1993)	Introduces indivisibility of investments in human capital.	Initial level of wealth inequality affects inter-generational income mobility, investment in education and the long run steady-state aggregate output level.
Banerjee and Newman (1993)	Considers the effect of credit market imperfections on investments in physical capital.	Greater inequality results in less people having an opportunity undertake their own investment projects.
Durlauf (1996)	Introduces a spatial element.	The parents' neighbourhood choice affects the income outcomes of their children.
Aghion and Bolton (1997)	Adds endogenous equilibrium interest rate.	Wealth distribution affects demand for and supply of credit. In the long-run, ongoing intervention is required to correct the inefficiencies.
Piketty (1997a)	Builds on Aghion and Bolton (1997) model trying to bring it closer to traditional Solow growth model.	Multiple steady-state interest rates exist. Lower interest rates are associates with greater inter-generational mobility and greater aggregate output.
Maoz and Moav (1999)	Puts a greater emphasis on inter-generational mobility.	Growth process improves inter-generational mobility. Redistribution has a positive effect on growth in developing countries while the opposite is true in developed countries.
Mani (2000)	Introduces an aggregate demand.	Initial wealth distribution affects the composition of the demand for goods (basic vs high-tech)
Mookherjee and Ray (2003)	Considers the effects of both divisible and indivisible investments. Furthermore, introduces human capital externalities.	Establish that irrespective on divisibility the persistent inequality is going to exist in the long-run.
Galor and Moav (2004)	Attempts to reconcile neo-classical and credit market imperfection approaches to inequality and growth.	Inequality has a greater negative impact on accumulation of human capital; thus its effects would be more visible in developed countries which rely on it for growth.
Cassar (2007)	Extends the Galor and Zeira (1993) model.	Shows that Galor and Zeira conclusions continue to hold under more realistic assumptions.