Does one need money to make money?

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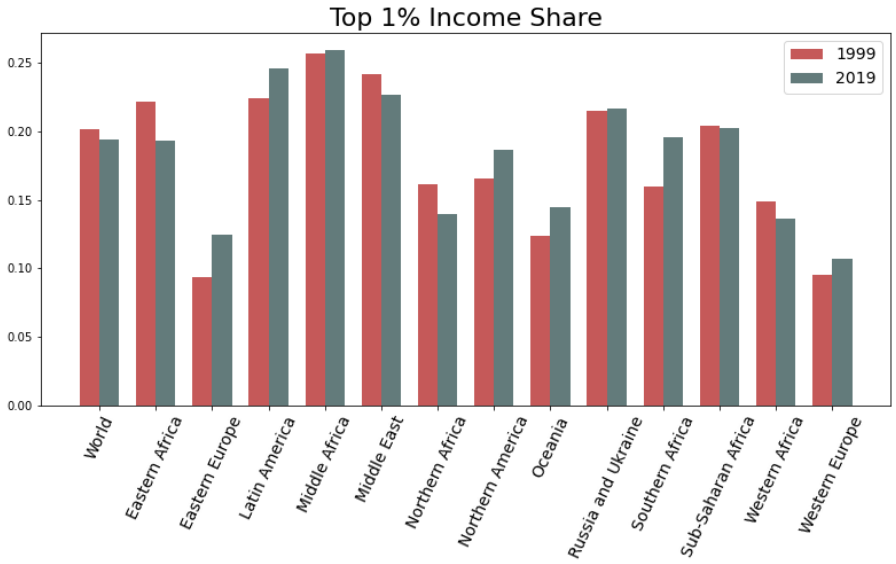
A look into the two-way relationship between innovation and inequality

The fact that the share of wealth held by the top 1% far outweighs the rest, has been no secret over the past two decades. Throughout the 20^{th} century economists were looking to explain why we were seeing an increase in the concentration of wealth amongst the worlds richest. Since 1999, the trend has continued to be part of both social and political discourse. Wealth data is notoriously difficult to capture on an international scale, however as the figure on income inequality below demonstrates, inequality trends are not universal,



From the graph above, we see that worldwide the top 1% share decreased slightly from 1999 to 2019. A deeper look shows that some areas have seen growth, e.g. North American and Western Europe, while others have declined, e.g. Northern Africa and the Middle East. Such within country differentials demonstrate that the story of inequality is is context dependent.

This project aims to investigate one channel through which heterogeneity between countries determines entrepreneurship. This paper will question whether entrepreneurship is driving the changes observed or whether more unequal economies produce more entrepreneurs.

Literature

There is a strong macroeconomic literature which aims to answer the first of these two questions. This body of literature is part of a wider study which aimed to improve modelling on the cause

and effect of wealth concentration among the top 1%. There appear to be two predominant justifications for the relationship between entrepreneurship and wealth inequality.

The role of wealth as a determinant of entrepreneurial choice was well established by Evans and Jovanovic 1989. They demonstrated through a simple theoretical model that an agent will only choose to become an entrepreneur instead of earning a wage if they meet a minimum new worth level. They concluded that liquidity constraints will bind and estimated that potential capital stocks for an entrepreneur are bounded from above at one and a half times their net worth.

Quadrini 2000 presents an alternative explanation for the wealth concentration observed in the data. He presents a model under which entrepreneurs have higher incentives to save and this leads to the concentration of wealth observed. The first of these factors aligns with Evans and Jovanovic 1989 as entrepreneurs look to save a minimum capital requirement. He adds two further factors, that entrepreneurs face greater uninsurable risks and that due to high interest rates paid on borrowing to fund projects, the marginal return on saving increases for entrepreneurs.

The role of borrowing constraints in determining occupational choice is a natural extension of the classic Bewley models. A seminal paper by Hurst and Lusardi 2004 however found that the relationship between wealth and entrepreneurial choice is highly non-linear. They contest the result that borrowing constraints determine entry to entrepreneurial markets since they find that for the bottom 95% of the wealth distribution, wealth and entrepreneurship are uncorrelated and only amongst the top 5% of wealth holders is a positive relationship identified. This would place the majority of the population well below the minimum described by Evans and Jovanovic 1989.

In response, Cagetti and De Nardi 2006 produce a model of entrepreneurial choice with borrowing constraints which is able to replicate an individual's propensity to enter given their initial wealth. Increasingly tight borrowing constraints generate an economy with smaller firms and lower borrowing. Bianchi and Bobba 2013 extend the work of Cagetti, De Nardi and others by examining which financial constraints are most significant in determining entry to entrepreneurial activities. They conclude that policy programs designed to increase the willingness of agents to bear risk through promises of future transfers are most effective in promoting entrepreneurship.

Karen E. Dynan and Zeldes 2004 place the debate presented above in a wider context of estimating the propensity to save for households at different income levels. The incentive for entrepreneurs to save more reflects their findings that the propensity to save is positively correlated with income and that time preference rates are an insufficient justification. Buera 2008 bridges again the link between the role of savings and a minimum wealth requirement. The model he develops examines the effect of financial frictions on small firms, as opposed to other models presented previously. He aims to answer the question whether forward-looking agents proactively save as to overcome borrowing constraints. He identifies a threshold, under which agents are subject to a poverty trap. Above which, in line with previous literature, agents actively save to support future entrepreneurial opportunities.

The literature described here has consistently been supported by strong micro theory and there are numerous cross overs with applied and micro work. One such is the literature which aims to determine who becomes an entrepreneur and what individual or societal characteristics predict entrepreneurship. Bell et al. 2018 show empirically that children from top 1% income families are over 10 times more likely to become inventors, even when controlling for ability. Children with family wealth as fall back option will face lower borrowing or liquidity constraints, thus supporting this channel from wealth to entrepreneurship. They conclude that are numerous lost Einsteins who have hidden talents and ideas but their entrepreneurial spirit is quashed by wider societal influences.

Quadrini 2000 presented his theory on the role of saving preferences in determining wealth inequality as a reverse causality paradigm. I aim to contribute to this prestigious body of literature

by further examining this idea around endogenous entrepreneurial choice by looking at whether inequality drives innovation. Could some of the conflict in theoretical results be a result of underlying endogenous relationships which are not captured by these models?

Entrepreneurship

A central part of the literature discussed above is how to define an entrepreneur. In doing so Cagetti and De Nardi 2006 provide a break down of the scale of wealth inequality when divided over those who are self-employed or business owners. Their results are presented in the first panel, their work was published in 2006 however they present results from the 1989 round[1]. Since 40 years have passed since then I have recreated the table and included my findings for 2019 in the right panel,

	Cagetti and De Nardi		Updated results	
	Percent in Population	Share of Total Wealth	Percent in Population	Share of Total Wealth
Business owners or self-employed	16.7%	52.90%	31.40%	86.39%
All business owners	13.30%	48.80%	27.40%	84.91%
Active business owners	11.50%	41.60%	24.53%	62%
Self-employed	11.10%	39%	21.80%	54.35%
Self-employed and active business owners	60%	33%	17.80%	51.20%

Cagetti and De Nardi 2006 present five different categories of entrepreneur. For all five varieties they find that the fraction of the population is relatively low but the share of total wealth is high. For example, grouping together all individuals who either them or a family member owns a business or are self employed constituted 16.7% of the population in 1989, however they held over half the total wealth. In the forty years since then the fraction of the population has doubled to 31.4% and their share has increased further to 86.39%. These figures are possibly overestimated and should be taken with caution. I have created the total wealth variable, following the FED guidelines, however I may have introduced errors[2]. However, what is clear is that conditional on the definition of total wealth used in this paper, entrepreneurial types dominate wealth ownership.

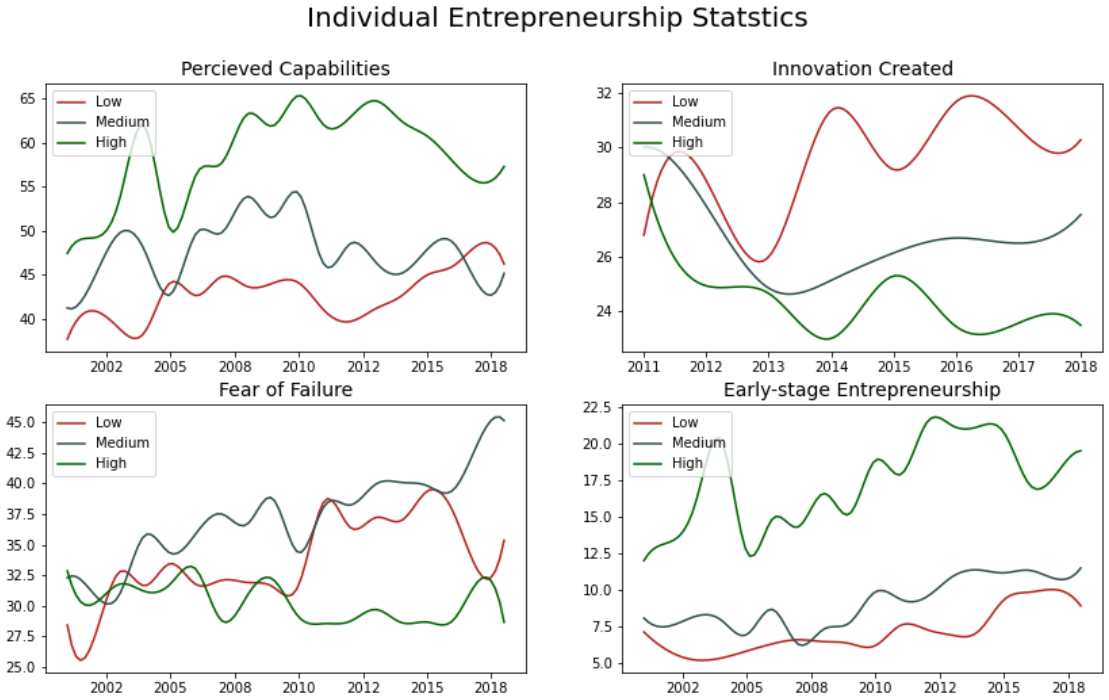
Data

The literature captures the inherent endogeneity between economic outcomes and inequality. Inequality is not only a byproduct of certain economic policies, it is correlated with individual and societal traits. When discussing the effect of economic outcomes on inequality in macroeconomic models care should be taken not to ignore the endogenous relationship between both measures. I have collected data from the Global Entrepreneurship Monitor (GEM) and present the results below. The data presented below has been interpolated using a cubic spline since data is only available at a year intervals and was previously under fitting the time period in question.

[1] They state that the results for 1992 and 1995 were similar.

[2] The full description for creating the total wealth measure is included in the appendix.

Data for 169 countries was collected on a range of measures around entrepreneurship and the Gini coefficients from 2000-2018[3]. The countries were then coded by the Gini coefficient into three quantiles to capture low, medium and high inequality. This allows me to demonstrate how entrepreneurship manifests in societies with varying ranges of inequality. The first are individualistic measures,



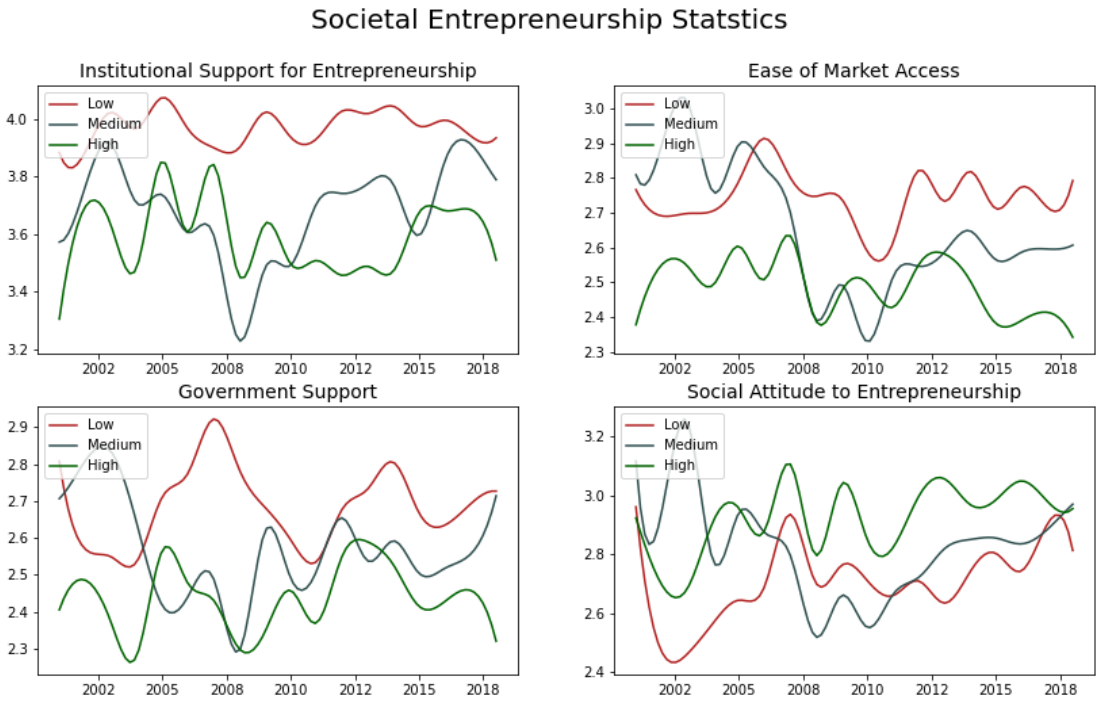
Early stage innovation captures the percentage of adults aged between 18-64 who are either a nascent entrepreneur or the owner-manager of a new business. Innovation created captures the percentage of those involved in early stage entrepreneurship who report their business offers a new product.

This highlights an important difference for the project. The model presented here utilises idiosyncratic risk between agents to capture the choice to become an entrepreneur. I will distinguish between being self employed but in a well establish industry and someone looking to innovate. Unequal economies produce a higher level of basic entrepreneurial activity but appear to imitate more than innovate and therefore are not taking the risks required to access the higher returns from true innovation. I will demonstrate how increased inequality is correlated with reduced innovation which is consistent with the data presented above.

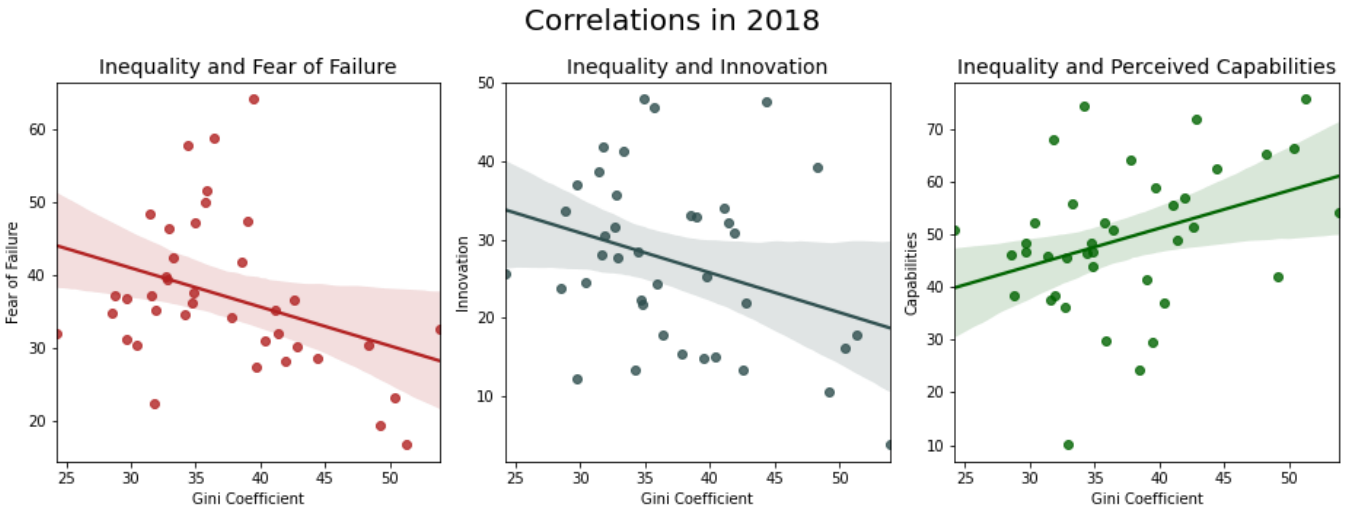
Interestingly, you can see from the figures above that in more unequal economies, people believe that they are more capable and less afraid of choosing entrepreneurship despite almost consistently reporting lower levels of innovation. These social norms lead naturally to taking a wider societal perspective on entrepreneurship. Doing so you see that in more unequal economies there is lower institutional support for entrepreneurship, which includes developed financial markets. In addition there is lower government support and access to markets is more restricted. Despite

[3]Since not all countries provided up to data Gini coefficient data a linear interpolate method was used to fill in missing years. Since countries rarely see drastic changes in inequality levels this method is appropriate.

this, entrepreneurship is viewed more positively than in more equal societies.



This presents us with a puzzle which is clearly demonstrated in the following correlation plot,



Why do individuals facing more unequal, closed and rudimentary markets believe they are more able to be a successful entrepreneur? The following model and analytical sections will attempt to replicate the wealth distribution and entrepreneurial choice seen the the data presented previously and examine the reverse causality and look at how exogenous changes to inequality levels affect entrepreneurship.

The model I present here has certain limitations and the results are not perfect fits to the data observed. The purpose of this project is to firstly reflect the literature findings on entrepreneurial choice and to utilise the model to analyse the effect of parameter changes. The nominal results are not to be taken as an accurate description of current markets however the model does successfully allow us to examine and discuss the channel from inequality to innovation.

Model

I will now present the baseline discrete choice model which captures the entrepreneurial choice used in the project. Later I will present a parameter change which allows me to test the effect of increased inequality on outcomes. The model is populated by a continuum of infinitely lived households, of measure one. In every period, each agent decides whether to enter the entrepreneurial sector or receive a fixed wage as a worker. Borrowing is not permitted such that in each period the agent has their past savings as potential capital to fund their project idea.

Utility

Households maximise expected lifetime utility,

$$\begin{aligned} \max \quad & \mathbb{E}\left\{ \sum_{t=0}^{\infty} \beta^t u(c_t) \right\} \\ \text{s.t.} \quad & c_t = y_t + a_t - q a_{t+1}, \end{aligned} \tag{1}$$

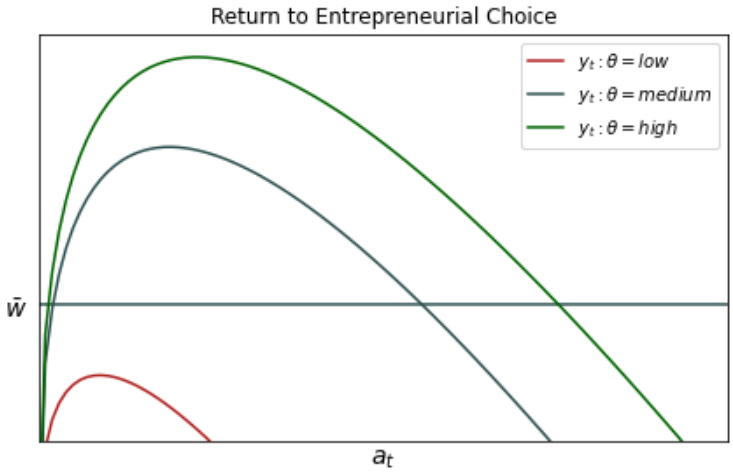
Where $q = \frac{1}{1+r}$ and $u(c_t) = c^{1-\sigma}/1-\sigma$, is specified as the CRRA utility function. This allows us to capture a precautionary savings motive in the model as agents face idiosyncratic uncertainty.

If agents choose to work they receive $y = \bar{w}$, a fixed wage. In the full model this wage is determined in equilibrium subject to the saving decisions of both workers and entrepreneurs. Agents choose to either accept this deterministic labour income or embark on a risky project.

Every period each agent is endowed with a project idea κ. γ represents the increased pay off from successful innovation and for simplicity is constant across projects. The quality of each project is determined by it's probability of success, these are given by the vector $\boldsymbol{\theta}$. If an agent chooses to undertake a risky project they invest their savings as productive capital and receive the output as profit where $k_t = a_t$,

$$y_t = \pi_t(k, \theta) = \gamma \theta k_t^{\alpha} - \bar{w} - (1 + r)k_t$$

The choice is demonstrated in the following theoretical example,



For agents who receive an idea with a low probability of success they will accept the given wage $\bar{w}$ since the payoff is larger. As the probability that an agent's idea will succeed increases, so does their return y_t and such agents choose to enter the entrepreneurial sector. Due to the concavity of the return function, determined by the capital share of income and cost of investment, at the highest asset levels y_t again falls below the given wage.

This could be interpreted in numerous ways such as agents becoming less aggressive as they become richer or agents retiring and accepting a fixed wage once they reach a certain level of wealth. However, this is a limitation of this simple model since this behaviour is not reflected well in the data. An improvement would be to separate the savings and investment process and embed a portfolio choice model such that we can capture the observed behaviour of agents at the top of the wealth distribution in finer detail. Furthermore, clearly this model could be made more realistic and extended to include borrowing however this is sufficient to demonstrate the underlying principles.

The problem will be solved using value function iteration on a discrete approximation of the value function. The agent therefore solves the following recursive problem,

$$
\begin{aligned}
V(k,\theta) &= \max\left\{V^I(k,\theta), V^L(k,\theta)\right\} \\
V^I(k,\theta) &= \max_{a'\in\Gamma}\left\{u(\pi(k,\theta)+a-qa') + \beta\mathbb{E}[V^I(k',\theta)]\right\} \\
\Gamma^I &= \left\{a' : a' \geq 0\right\} \\
V^L(k,\theta) &= \max_{a'\in\Gamma}\left\{u(\bar{w}+a-qa') + \beta\mathbb{E}[V^L(k',\theta)]\right\} \\
\Gamma^L &= \left\{a' : a' \geq 0\right\}
\end{aligned}
$$

The stationary competitive equilibrium will be a value function, $V : \mathcal{Z}\times\mathcal{M}\to\mathcal{R}$, two policy functions on assets and consumption, $a', c : \mathcal{Z}\times\mathcal{M}\to\mathcal{R}$ and two pricing functions, $w, r : \mathcal{M}\to\mathcal{R}$ such that,

1. Given prices, V solves the Bellman equation specified above along with the associated policy functions a', c.

2. Given prices, K satisfies,

$$
\begin{aligned}
r(\Phi) &= F_K(K(\Phi)) - \delta \\
w(\Phi) &= F_L(K(\Phi)) - \delta
\end{aligned}
$$

3. Markets clear,

$$K(H(\Phi)) = \int a'(a, y; \Phi) d\Phi$$

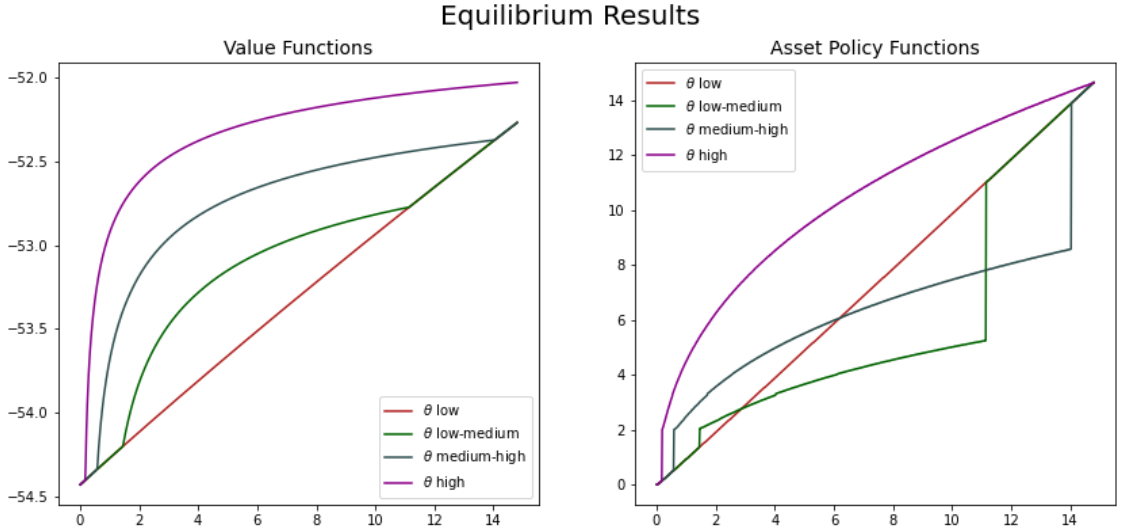
$$\int c(a, y; \Phi) d\Phi + \int a'(a, y; \Phi) d\Phi = F_K(K(\Phi)) + (1 - \delta) K(\Phi)$$

4. The aggregate law of motion H satisfies consistency

I have solved the model in partial equilibrium. The parameter specification used in the following is,

Parameter	Value	
Fixed labour wage	$\bar{y}$	3.35
Intertemporal discount factor	β	0.98
Capital income share	α	0.38
Discount factor	δ	0.063
Probabilities of success	$\boldsymbol{\theta}$	$\begin{bmatrix} 0.2 & 0.3 & 0.4 & 0.6 \end{bmatrix}$
AR(1) correlation	ρ	0.2
AR(1) coefficient of variation	σ_ϵ	0.5
Transition matrix	Γ	$\begin{bmatrix} 0.077 & 0.653 & 0.266 & 0.004 \\ 0.033 & 0.548 & 0.407 & 0.012 \\ 0.012 & 0.407 & 0.548 & 0.033 \\ 0.004 & 0.266 & 0.653 & 0.076 \end{bmatrix}$
r	0.019	
σ	1.5	
γ	20	

Once the value function has been found I compute the long run stationary distribution using Monte Carlo simulation. Using 500 periods and 10000 individuals I repeatedly sample from the distribution and compute optimal savings choices given the policy function found under the partial equilibrium.

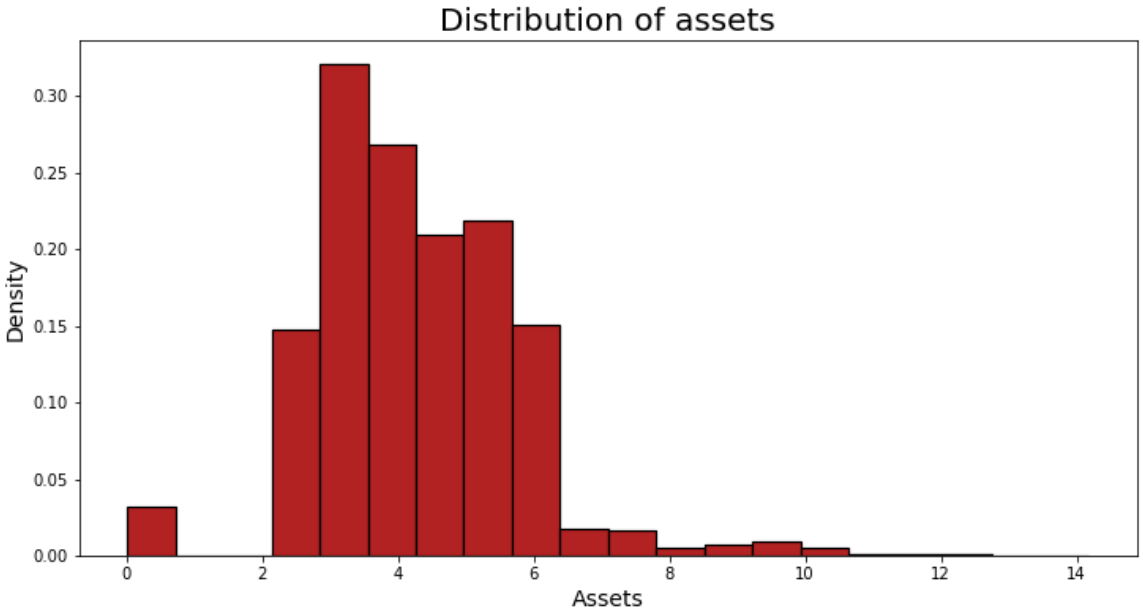


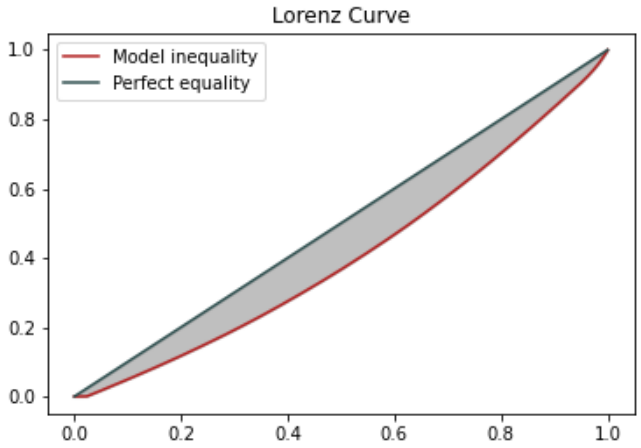
The value function and saving functions both display the channel described above. For the lowest probability of success they never break out of the fixed wage market and their income remains at $\bar{w}$.

The key finding here is that we can see from the left hand corner that as the level of assets increases, agents switch to the entrepreneurial sector. This replicates the conclusions in Evans and Jovanovic 1989 that agents require a minimum asset level to take the decision to become an entrepreneur. Additionally, this supports the findings of Buera 2008 in that agents below a certain threshold of wealth are subject to a poverty trap and unable to save sufficiently to pursue their good ideas. Thus giving credibility to the model produced. The savings functions are of an unusual shape, which reflect the discrete choice and return to standard wage labour market as agents reach an upper asset threshold.

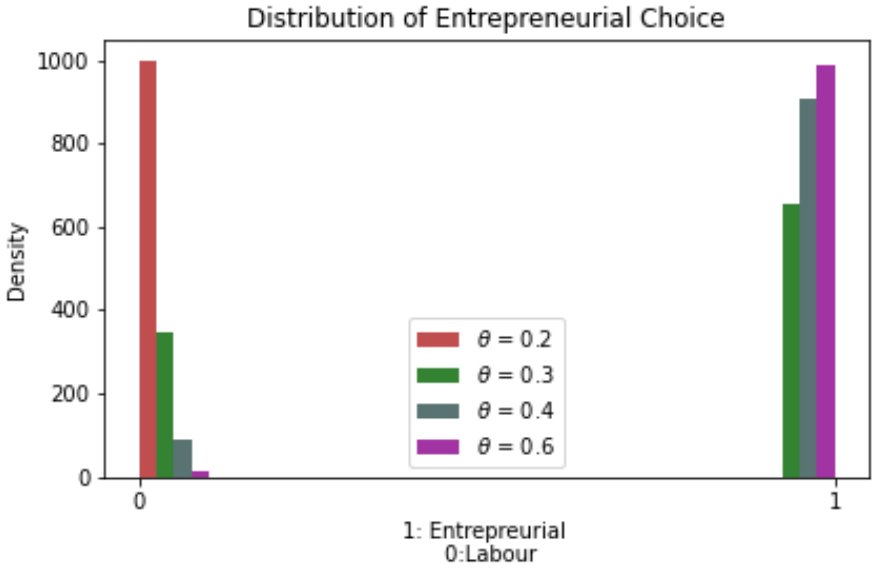
As agents become increasingly wealthy, due to concavity of the profit function and decreasing marginal returns to scale, if agents surpass optimal investment they return to the given wage market. Therefore the lower bound of the economy is well estimated since it reflects literature, however the upper bound should be improved as to give a more realistic outcome.

The asset distribution plot under this baseline economy is given as,





This model specification produces a Gini coefficient of 18.7%. Which is very low in comparison with those observed in the data. Finally the distribution of choices between both markets differentiated by idea quality is presented in the histogram below,



63.8% of people participate in the entrepreneurial sector which is far greater than the percentages found using the Survey of Consumer Finances. We can see that in this baseline model there is already a sub optimal distribution amongst the markets as good ideas are not being pursued. I will return to this point in more detail later on.

Inequality on Innovation

Given the baseline model presented above, we are able to test the outcome from changing parameters within the model and the resulting endogenous distributions. As discussed under the literature section, there is an inherent endogeneity between inequality and economic outcomes. Quadrini 2000; Cagetti and De Nardi 2006; Buera 2008; Bianchi and Bobba 2013; Evans and Jovanovic 1989 and others have examined at the channels from entrepreneurship to inequality and I am interested in examining a reverse causality argument.

I have presented a puzzle in that individuals in more unequal societies believe they are more capable of and less afraid of choosing entrepreneurship and view it as holding a higher social standing. However they innovate less and receive less support. This alongside the regional data presented on the varying trend in the top 1% income share demonstrates that inequality is endogenous to it's local environment. I will test here whether an exogenous shock to the persistence of inequality within an economy determines the level of entrepreneurship.

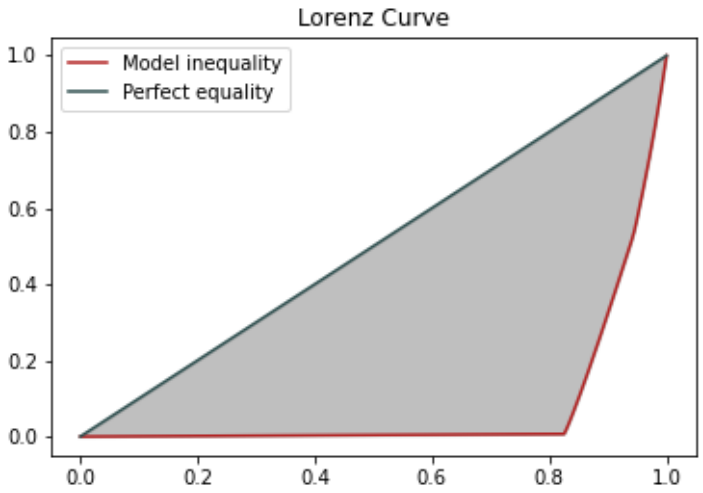
Given the quality of your idea today , the transition matrix is governed by an AR(1) process,

$$\theta_t = \rho\theta_{t-1} + \epsilon_t$$

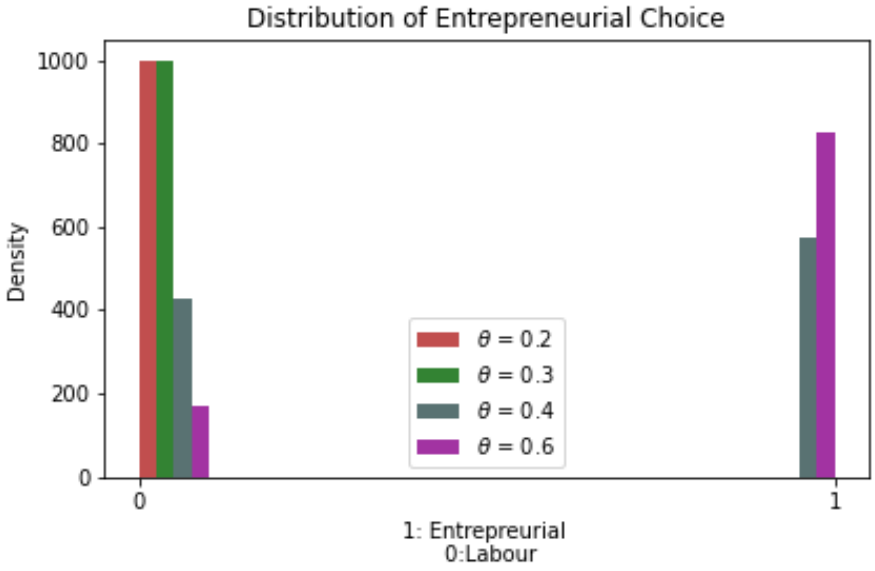
where, $\epsilon_t \sim \mathcal{N}(0, \sigma_\epsilon)$. The Markov chain is a 4-chain process and has been approximated using the method outlined in Tauchen 1986. The key parameter is the coefficient of correlation ρ. Increasing the persistence of shocks will entrench existing inequalities. Those with good ideas today are increasingly likely to receive a good idea tomorrow and social mobility is therefore restricted. The hypothesis from the data presented from the GEM is that increasing the level of inequality in the economy will be correlated with lower innovation rates. To test this hypothesis the changes to the parameter specification specified above are,

Parameter	Value	
AR(1) correlation	ρ	0.6
AR(1) coefficient of variation	σ_ϵ	0.5
Transition matrix	Γ	$\begin{bmatrix} 0.401 & 0.586 & 0.012 & 0 \\ 0.04 & 0.733 & 0.226 & 0.001 \\ 0.001 & 0.226 & 0.733 & 0.04 \\ 0. & 0.012 & 0.586 & 0.401 \end{bmatrix}$

As can be seen from the new transition matrix, Γ, the probability has shifted to the diagonal. In fact, given the worst shock today it is impossible that an agent jumps to the best shock tomorrow. The resulting Gini coefficient from the new asset distribution has increased dramatically from 0.187 to 0.85. As can be seen in the new Lorenz curve



We are interested in the new equilibrium distribution of agents across innovation and sectors associated with this significant increase in inequality,



We see from the graph above that the total number of agents innovating has reduced dramatically as the fraction has flipped from 63.8% previously to now 35.25%. Naturally, access to the entrepreneurial sector is restricted to those with the top ideas.

We can see from the distribution across the sectors that under both specifications agents with good ideas are excluded from the entrepreneurial sector due to a lack of assets. Thus the model accurately captures this part of the literature. This a policy concern for the government since innovation is not optimally distributed by idea quality. Agents with higher asset levels but lower idea qualities participate in the entrepreneurial sector in place of poorer agents with better ideas. Policy should be designed to identify the "lost Einsteins" as Bell et al. 2018 describe them to ensure that the best ideas are pursued and innovation optimised.

Conclusions

This project has attempted to examine the reverse causality between inequality and entrepreneurship. I have presented data which shows that unequal societies feel they are more capable and less afraid of entrepreneurship. They also record higher levels of starting new business but lower levels of innovation. I believe that this represents an inability to take real risks for people at the bottom of the wealth distribution and a that the expected idea quality amongst those who do choose the entrepreneurial sector is sub-optimal.

As to why individuals in more unequal societies look more favourably on entrepreneurship, this may reflect the fact that since wealth is concentrated amongst entrepreneurs, such a career path is associated with success. Why they believe they are more capable of innovation likely speaks to the impact inequality has on social norms. If inequality creates individualistic societies where people have a narrow locus of control where you are responsible for your well being, they may believe that they alone hold the success to entrepreneurship.

The model presented allowed me to test this hypothesis by increasing the persistence of inequality and restrict social mobility. The results of the baseline model support the hypothesis

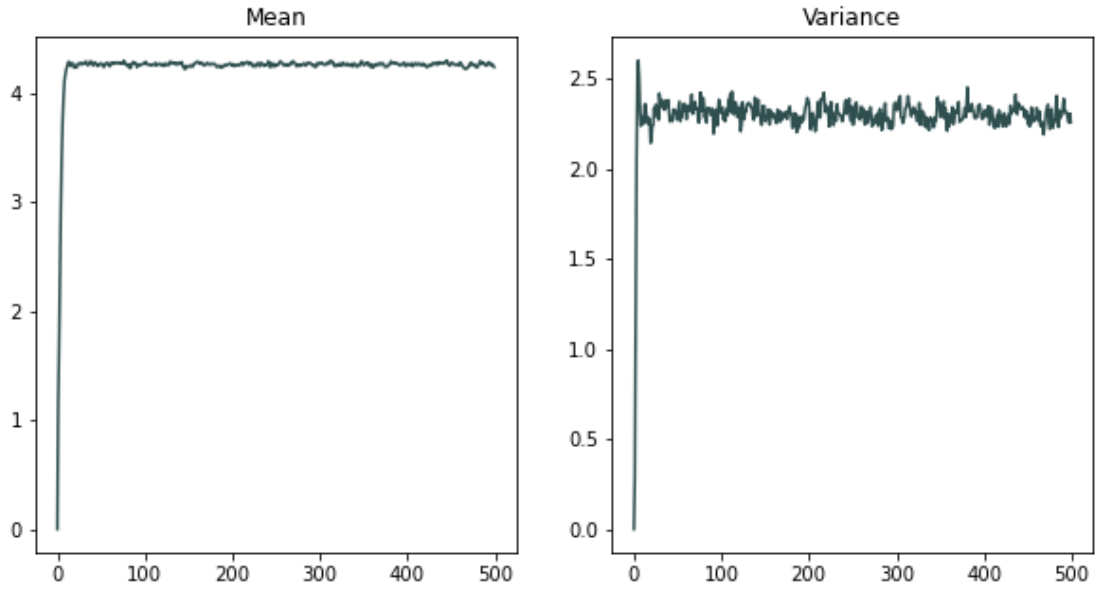
that agents require a minimum asset level before pursing entrepreneurial projects. The alternative specification demonstrated that more unequal societies are have lower levels of innovation.

There are numerous limitations to the project presented here. The first being that the baseline results are not an accurate representation of true wealth inequality and entrepreneurial choice seen in the data. This should be addressed and may stem from the simplistic nature of the model. I have chosen a simple model to allow me to capture the channel in question, however as discussed in the main body it can and should be improved significantly.

Secondly, when addressing endogeneity concerns to demonstrate causality it is imperative to justify the exogeneity of the instrument you are using to change the model. Increasing the persistence of shocks allows me to examine the differences between both stationary distributions however it also feeds into the income process itself which endogenously determines choices.

Appendix

The stationary distribution first and second moments demonstrate that the distribution displayed under the baseline model found using the Monte Carlo process is stationary,



The measure of total wealth is produced as an aggregate of numerous survey responses under the Survey of Consumer Finances (SCF). The survey is conducted triennially. To categorise individuals as entrepreneurs I have followed the approach used by Cagetti and De Nardi 2006 who utilised the following three questions,

1. "Do you work for someone else, are you self-employed, or what?"
2. "Do you (and your family living here) own or share ownership in any privately held businesses, farms, professional practices or partnerships?"
3. "Do you (or anyone in your family living here) have an active management role in any of these businesses?"

The total wealth variable was created by summing the respondents total amounts of checking accounts, savings accounts, retirement plans, mutual funds, bonds, trust and other saving types in line with the information provided on the following link, https://www.federalreserve.gov/econres/scfindex.htm. Any errors are therefore my own. The list of variables I have included are,

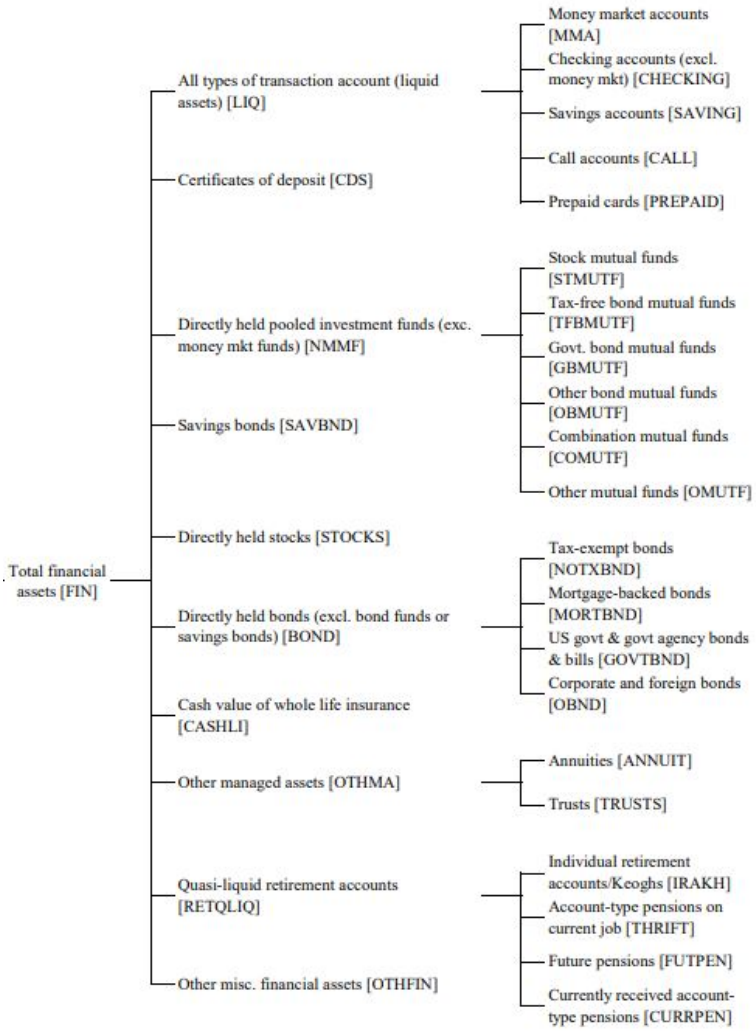


Figure 1: Source: Survey of Consumer Finances

References

Bell, Alex et al. (Nov. 2018). "Who Becomes an Inventor in America? The Importance of Exposure to Innovation*". In: *The Quarterly Journal of Economics* 134.2, pp. 647–713. ISSN: 0033-5533. DOI: 10.1093/qje/qjy028. eprint: https://academic.oup.com/qje/article-pdf/134/2/647/28289414/qjy028.pdf. URL: https://doi.org/10.1093/qje/qjy028.

Bianchi, Milo and Matteo Bobba (Apr. 2013). "Liquidity, Risk, and Occupational Choices". In: *Review of Economic Studies* 80.2, pp. 491–511. eprint: https://academic-oup-com.are.uab.cat/restud/article/80/2/491/1533921?searchresult=1.

Buera, Francisco J. (2008). "Persistency of Poverty, Financial Frictions, and Entrepreneurship". In: eprint: http://www.econ.ucla.edu/fjbuera/papers/paper120071217.pdf.

Cagetti, Marco and Mariacristina De Nardi (Oct. 2006). "Entrepreneurship, Frictions, and Wealth". In: *Journal of Political Economy* 114.5, pp. 835, 870. eprint: https://www.journals.uchicago.edu/doi/full/10.1086/508032?casa_token=tH_yOIho2MEAAAAA\%3A0PVbTV68A0zirX0cFgX0hnjCEOJPGvgjV2kjYeFoBjOXPmvo58mfai8imjN6BPLjzpe9KdLDY.

Evans, David S. and Boyan Jovanovic (1989). "An Estimated Model of Entrepreneurial Choice under Liquidity Constraints". In: *Journal of Political Economy* 97.4, pp. 808–827. ISSN: 00223808, 1537534X. URL: http://www.jstor.org/stable/1832192.

Hurst, Erik and Annamaria Lusardi (2004). "Liquidity Constraints, Household Wealth, and Entrepreneurship". In: *Journal of Political Economy* 112.2, pp. 319–347. ISSN: 00223808, 1537534X. URL: http://www.jstor.org/stable/10.1086/381478.

Karen E. Dynan, Jonathan Skinner and Stephen P. Zeldes (Apr. 2004). "Do the Rich Save More?" In: *Journal of Political Economy* 112.2, pp. 397, 444. eprint: https://www.journals.uchicago.edu/doi/full/10.1086/381475?casa_token=_uZVw-NODG8AAAAA\%3A6cgNE1XV5G7vZlPyxkyG5fb7aDCDLTDCtujlc.

Quadrini, Vincenzo (2000). "Entrepreneurship, Saving, and Social Mobility". In: *Review of Economic Dynamics* 3.1, pp. 1–40. ISSN: 1094-2025. DOI: https://doi.org/10.1006/redy.1999.0077. URL: http://www.sciencedirect.com/science/article/pii/S1094202599900777.

Tauchen, George (1986). "Finite state markov-chain approximations to univariate and vector autoregressions". In: *Economics Letters* 20.2, pp. 177–181. ISSN: 0165-1765. DOI: https://doi.org/10.1016/0165-1765(86)90168-0. URL: http://www.sciencedirect.com/science/article/pii/0165176586901680.