University of New South Wales
School of Economics

Honours Thesis

The pursuit of entrepreneurship: Can Universal Basic Income play a role?

A dynamic model of occupational choice

Author:
Rhea Banerjee
Student ID: z5110013

Supervisors:
Dr Gonzalo Castex
Dr Pei-Cheng Yu

Bachelor of Economics (Econometrics & Economics) (Honours)

22nd November, 2019

Declaration

I declare that this thesis is my own work and that, to the best of my knowledge, it contains no material which has been written by another person or persons, except where acknowledgement has been made. This thesis has not been submitted for the award of any degree or diploma at the University of New South Wales Sydney, or at any other institute of higher education.

....

Rhea Banerjee
22nd November, 2019

Acknowledgements

First I would like to thank my supervisors Dr. Gonzalo Castex and Dr. Pei-Cheng Yu, without whom this thesis would not have existed. PC Yu, you always had your door open for me and a textbook ready to tackle anything your whiteboard couldn't. Gonzalo, you kept me anchored and painstakingly ensured my lines of code made sense. I could never express how grateful I am for all the time and patience you two have provided me.

Thank you Sarah and Pauline for all your wisdom and guidance, and Tess for making the year effortless (effortless in all ways outside of the actual thesis). Thank you Valentyn for giving me something to think about after every presentation, and Gabriele, for being an inspiration since before the year even started.

A big big thank you to the wonderful economics honours cohort of 2019! Each of you played a special role in the making of this year, and I will always cherish our lunches in the sun. A special thank you to all the galz of honz, who have been my powerhouse this year, and to Kate, without whom I would have been lost. Thank you Nick for being you, and giving me a (second) reason to come into the uni everyday.

Thank you to my parents for encouraging every endeavour of mine, and to my younger brother for reminding me of the world outside with an innocent and complete lack of interest in my thesis.

Finally, thank you to my grandparents for having the most profound impact on my life. I dedicate this thesis to you.

Contents

List of Figures

List of Tables

Abstract

Can Universal Basic Income play a role in the pursuit of entrepreneurship? In this paper I approach this question through the lens of a dynamic occupational choice model with heterogeneous agents. I explore the consequences of a tax-funded basic income on the distribution of agents among three occupation states: working, being entrepreneurs, and being unemployed. I compare the distributions under the UBI policy to a benchmark case that is calibrated to ABS labour force data, and find that the policy increases entrepreneurship from 9.3% to 10.6%, increases unemployment from 5.6% to 6.4%, and decreases wage work from 85.1% to 83%. I perform the analysis again for a model with labour disutility and find similar results, with a more modest increase in entrepreneurship. Both, the average skill level and the asset level of entrepreneurs is higher under the UBI policy, and the loss in welfare under the policy that is measured by the Consumption Equivalent Variation is insignificant for both models, at 0.00287% in the presence of labour disutility, and 0.0769% in the absence of it.

1 Introduction

A Universal Basic Income (UBI) is an unconditional, periodic money transfer to the citizens of a region, that is intended to cover their basic living needs. The idea of a minimum income as a welfare system has existed in economics for a long time (Meade, 1935; Friedman, 1962), with historical roots that go as far as the 16th century with Thomas More's *Utopia*. It has recently resurfaced as a possible replacement of means tested transfers such as unemployment benefits, partly due to the trepidation around labour displacing technological advancements, alongside concerns around income inequality. The ineffectiveness of targeted programs in providing socioeconomic stability have also contributed to the regenerated interest in UBI. This has led to pilot experiments in many countries such as Finland, Canada, Netherlands, Kenya, and the United States.

Research so far has considered various possible implications of UBI on poverty alleviation, income inequality reduction, and economic growth (Banerjee et al., 2019; Hoynes and Rothstein, 2019). In the realm of labour economics, there has been research on the intensive and extensive margins of labour supply in response to transfer programs (Saez, 2002). However, there is a major gap in literature on the impacts of UBI on entrepreneurship, which is a major determinant of a country's economic health. This paper bridges this gap by proposing a quantitative framework to analyse the effects of a UBI on entrepreneurship. Specifically, it evaluates the role of a tax-funded UBI in an agent's decision to select into entrepreneurship, where entrepreneurship is measured as the rate of business creation in the economy. Importantly, entrepreneurship is measured only as the business creation rate, rather than any measure of success or innovation.

The link between UBI and entrepreneurship is through wealth constraints. If agents in an economy with a propensity for entrepreneurship have insufficient savings, they might not become entrepreneurs because they are capital constrained, or because they are deterred by the uncertainty of the pursuit. It is this group of people that are the primary interest of the paper, in which I test the extent to which the UBI mitigates consumption constraints and spurs business creation. Since it is difficult to measure this propensity, I use entrepreneurial skill as a proxy for this measure. I conduct the analysis under a framework where agents face no labour disutility of labour, and one where they do, to see how the distributions differ.

The reason for evaluating a UBI rather than a policy targeted at entrepreneurs is three-fold. Firstly, there are lower government administrative and operational costs associated with a non means-tested welfare distribution for everyone. There are also efficiency gains for the welfare recipients, who no longer face application processes, likely resulting in a 100% uptake rate for the UBI policy. Secondly, it is hard to identify those with a propensity for entrepreneurship in an economy. Even if there were a mechanism to do so, it is difficult to prevent adverse selection with a transfer targeted at potential entrepreneurs. Adverse selection in this setting could lead to higher business exit rates once the agents receive their transfer, or might lead to an overall drop in the quality of businesses that persist, if the owners were driven only by the monetary incentive created by the transfer. Finally, there are general equilibrium effects of everyone receiving a basic income that a targeted cash transfer might not capture for entrepreneurship, such as expenditure changes across the whole economy and resource reallocations. A cash transfer targeted towards potential entrepreneurs will also not capture any increases in labour productivity over time due to improved health and education outcomes for low-income households after receiving UBI, which Akee et al. (2010) found through a program similar to UBI. Thus, a UBI has unique ways through which it can encourage business creation, that have not been mapped out well in literature.

The class of models used in this paper is occupational choice models, in which agents choose an occupation type based on their expected lifetime utility from each option. In my dynamic model, the agents are heterogeneous in skills and assets, and choose between wage work, entrepreneurship and unemployment, based on the parameters of the model such as the market wage and the costs incurred in the business.

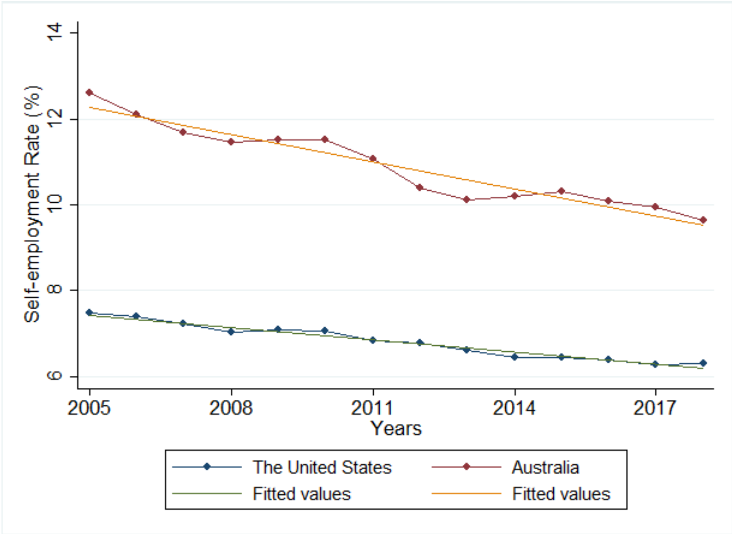
2 Background

I analyse the implications of a UBI policy on entrepreneurship because of the numerous positive contributions of entrepreneurship on an economy, coupled with the declining rates of self-employment. A comprehensive measure of entrepreneurship requires innovation, which the model does not account for; however, the potential for innovation is curbed in an economy where agents are not entering the field of entrepreneurship in the first place.

However, encouraging business creation is healthy only for a particular type of entrepreneurship. Economic literature categorizes business creation as either 'opportunistic', or 'necessity driven'. As per the classification by the Global Entrepreneurship Monitor in 2001, opportunity entrepreneurship refers to the situation in which agents set up businesses in response to a perceived opportunity, while necessity driven entrepreneurship refers to the situation where agents set up businesses in response to a lack of available alternatives in the labour market. Literature suggests that necessity driven entrepreneurship is a result of problematic factors surrounding economic health, such as political turmoil, poverty, or recessions (Fairlie and Fossen, 2018). For simplicity, this paper considers all entrepreneurship as opportunistic. This simplification is justified in the model by allowing the agents to voluntarily choose entrepreneurship if their expected income from doing so is higher than the available labour market alternatives. This framework takes after the model presented by Evans and Jovanovic (1989), in which the classification of opportunity entrepreneurship is also based on a comparison between potential earnings from business ownership, and wage work.

The figures below present a picture of entrepreneurism in Australia and United States. Figure 1 shows the yearly self-employment rates between the years 2005 and 2018. This rate captures people who work for their own enterprises and producers' co-operatives, as a percentage of the employed population. The trend across time is declining for both countries, with a steeper downward trend for Australia. Opportunity type entrepreneurship has positive contributions for an economy, and although it is

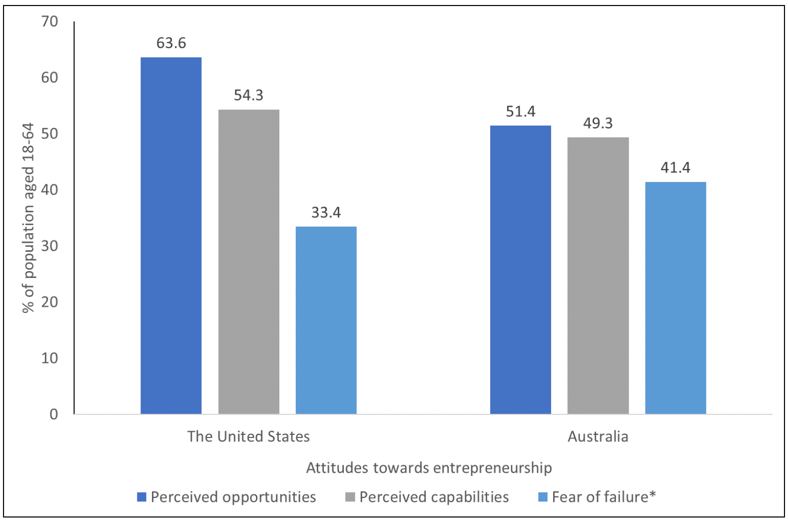
Figure 1: Self-employment rate between 2005 to 2018



Source: Australian Bureau of Statistics (ABS), Bureau of Labour Statistics (BLS)

difficult to extract only this type of entrepreneurship from the data, it makes up a non-significant portion of the entrepreneurship we expect to see in developed countries. Thus, the declining rates across Australia and The United States are a cause of concern that need to be addressed.

Figure 2: Attitudes toward entrepreneurship



Source: Global Entrepreneurship Monitor

Figure 2 shows the results from the research conducted by Global Entrepreneurship Monitor on the attitudes towards entrepreneurship for Australia and The United States. Perceived opportunities are a measure of the proportion of all those aged 18-64 who recognize there is an opportunity for setting up a business that could be profitable.

Perceived capabilities are a measure of the proportion of those aged 18-64 that believe they have adequate skills to pursue such an opportunity. The fear of failure rate is presented as a proportion of those that perceive an opportunity, rather than the entire sample of respondents. The fear of failure is high for both countries, faced by approximately a third of all potential entrepreneurs in The United States and 41.4% of the potential entrepreneurs in Australia. These rates motivate this research since the persistent income provides a cushioning effect when faced with a monetary setback of a persistent income will likely alleviate these fears and spur entrepreneurship. The model embeds this into the analysis by allowing for entrepreneurial uncertainty in a risk aversion framework.

3 Related Literature

Conventional labour economic theory suggests that increases in wealth reduce labour supply at the extensive margin (quantity of labour supplied) due to the income effect in the demand for leisure. A review of unconditional cash transfer programs in Marinescu (2018) suggests that this is mainly unsupported empirically. When supported, the substitution between work and leisure is more evident for agents later in their work life (Price et al., 2016). However, this framework places emphasis only on the quantity of labour supplied and does not provide any insight into an agent's choice of occupation for different levels of wealth. Moreover, there is a paucity in literature surrounding the effects of continued unconditional transfers on entrepreneurship in particular.

The insights into the effects of UBI on the labour market have mostly been restricted to the short term. A notable exception is the Alaska Permanent Fund, from which Alaskan residents have been entitled to a permanent cash dividend since 1982. Jones and Marinescu (2018) show that contrary to conventional theory, the fund led to no decline in employment, but increased part-time work by 17%. The proposed interpretation of the null effect on employment is an increase in consumption that stimulates labour demand and offsets the negative income effect. This positive general equilibrium effect is an important macroeconomic consideration if the increase in consumption also stimulates demand for businesses and thus entrepreneurship. Further evidence of the positive labour market effect is provided by Salehi-Isfahani and Mostafavi-Dehzooei (2018), who show a cash transfer program in Iran has a positive effect on self-employed men, and that there is no evidence of a negative effect on labour supply intensively or extensively, except for the youth. They posit that the positive effect is due to the cash transfers being used to expand businesses. In an interesting study, Van der Linden (2004) uses a dynamic general equilibrium model to show that basic income schemes reduce equilibrium unemployment, when the agents are risk-neutral.

There is also contrasting evidence that suggests that monetary transfers reduce labour supply as per the neoclassical model of labour and leisure. Price et al. (2016) conduct an analysis of the disincentive effects of monetary transfers on the labour market in the long-term, using the Seattle-Denver Income Maintenance Experiment. They attribute the reduction in earnings later in life partly to the greater importance of leisure later in life, and partly to the accumulation of wealth in the long term. The wealth accumulation mechanism is important in my paper in understanding whether the income insurance that UBI provides might deter entrepreneurship, rather than encouraging it.

A fundamental difference between UBI and unemployment benefit is that UBI is universal rather than targeted. The distributive properties of a UBI have been likened to those of a Negative Income Tax (NIT), with higher income earners being taxed more such that the income is effectively redistributed to the low income earners (Harvey, 2006). According to Saez (2002), such a scheme is more beneficial for the labour market on the intensive margin, than on the extensive margin. While a guaranteed income might deter the unemployed to find work, it might allow working agents with a positive propensity to start a business more time to consider the alternative of entrepreneurship, since their labour supply has decreased at the intensive margin. That is, their opportunity cost of starting a business in terms of time spent on wage work is lower with the additional outside option.

A UBI also has implications for other determinants of entrepreneurship, such as physical and human capital. It might allow for the accumulation of physical capital by mitigating credit constraints, which Levy (1993) identifies as a key obstacle to entrepreneurial pursuit in the context of developing countries. In a wider context, Baumol (1968) suggests that the focus of any theoretical model of entrepreneurship should be on the determinants of the entrepreneur's payoffs, because their decision processes and strategic choices are harder to consolidate with real world behaviour. The occupational choice decision in my model follows this logic by framing the agent's decision as an expected income maximization problem. Insofar as human capital is concerned, there is ample evidence to suggest that students face binding credit constraints, which reduce educational attainment (Lochner and Monge-Naranjo, 2012). If entrepreneurial skill is determined both intrinsically and as a function of educational attainment, UBI could then have a positive effect on the selection into entrepreneurship by increasing educational attainment.

4 | Model

A Dynamic Model of Tax Funded UBI

To understand the relationship between UBI and entrepreneurship, I set up a model economy where agents heterogeneous in skills and assets can choose between 3 occupation types. The model is in a dynamic setting to allow agents to accumulate savings over time which might determine their selection into entrepreneurship, and allow for a long run equilibrium analysis. I evaluate the UBI policy in two settings: one where there is no disutility from labour and one where there is a disutility of labour to understand the work incentive effects of additional income. In the absence of labour disutility, agents supply labour inelastically, while in the presence of labour disutility they supply labour elastically as characterised by their labour disutility function.

Demographics

The model economy is set in discrete time with an infinite horizon. There are 3 occupational choices: unemployment, wage work, and entrepreneurship. Agents are heterogeneous in entrepreneurial skills (ϕ), worker skills (ϵ), and assets (a), which make up the state space in the model for an agent i:

$$\theta_i = \{a_i, \phi_i, \epsilon_i\}$$

In every period, agents draw a worker skill and an entrepreneurial skill independently of each other, from uniform distributions over the interval $[0, 1]$. The idiosyncratic shocks are persistent and follow an AR(1) type Markov process, such that the skills evolution process is as follows:

$$\epsilon_{i,t+1} = \rho\epsilon_t + \varepsilon_i, \varepsilon_{i,\epsilon} \sim N(0, \sigma_\varepsilon^2)$$
$$\phi_{i,t+1} = \rho\phi_t + \varepsilon_i, \varepsilon_{i,\phi} \sim N(0, \sigma_\varepsilon^2)$$

with transition matrices as defined:

$$\pi_{\epsilon_i,\epsilon_i'} = Pr(\epsilon_{i,t+1} = \epsilon_i'|\epsilon_{i,t} = \epsilon_i)$$
$$\pi_{\phi_i,\phi_i'} = Pr(\phi_{i,t+1} = \phi_i'|\phi_{i,t} = \phi_i)$$

I use the model to look at a case of high persistence in shocks and low persistence in shocks to understand how the agents' occupational choice distribution might vary in each case. Having less variation in the shock evolution process induces a greater a alignment between the expected skill draw and the actual skill draw in the following period. A greater alignment allows the agent to make more accurate forecasts of their expected income under each occupation, leading to a more well informed labour market decision and likely a different occupational choice distribution in the economy. I test for this persistence effect formally in chapter 8.

Preferences

Agents in the economy derive utility from consumption and disutility from labour. The utility from consumption is identical for all agents and periods, homothetic and takes a CRRA form. The disutility of labour is faced by workers and entrepreneurs, where the elasticity of labour supply is governed by the Frisch elasticity parameter η, and measures an agent's willingness to substitute hours worked for free time, given the number of hours worked. In a life-cycle setting, the parameter determines the degree of curvature in the disutility of labor supply, or the intertemporal elasticity of substitution for labor (IES). Thus the general utility function takes the following form:

$$u(c,n) = \begin{cases} \dfrac{c^{1-\sigma}}{1-\sigma} - \psi \dfrac{n_t^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}} & \text{if } \sigma > 0, \sigma \neq 1 \text{ and } \eta > 0 \\ ln(c) - \psi \dfrac{n_t^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}} & \text{if } \sigma = 1 \text{ and } \eta > 0 \end{cases} \tag{4.1}$$

Technology

There is a single good in the economy, which workers produce in the labour market and entrepreneurs produce outside the labour market, akin to home production. The price of this good is normalized to 1, since there are no other goods in the economy. Workers and unemployed agents obtain this good from the labour market, whereas the entrepreneurs consume their home production of the good.

The profit for the entrepreneurs is a function of their capital investment in the form of assets (a), their entrepreneurial skill (ϕ), and their labour input (n_e). The entrepreneurial skill feeds into profit in two ways: through a productivity parameter that is increasing in skill ($\hat{\phi} = q\phi$), and a recurring cost of capital that is decreasing in the skill ($\hat{\kappa} = \frac{\kappa}{\phi}$). The returns to their asset investment and labour input is governed by α. This results in the following production function for the entrepreneur:

$$\max_{a}\{\hat{\phi}a(1+r)^{\alpha}n_e^{1-\alpha_1} - \hat{\kappa}\}$$

The functional form of profit induces a no arbitrage condition on assets that assumes away savings for the entrepreneur. Thus the entrepreneur either allocates all of their assets for production or all of their assets for consumption, depending on what yields a higher utility.

The production in the labour market takes place exogenously, where workers receive a wage that is scaled by the distribution of the worker skills in the economy. Entrepreneurs are not a part of the labour market since they consume their home production of the good. Time constraints prevented me from setting up a market for the exchange so that the workers and unemployed agents could consume a portion of the production by the entrepreneurs for a price. This is a limitation of the model that I hope to address given more time.

Government

The government provides an unemployment benefit b and a UBI Ω. To fund these, the government has three tax policies at its disposal: an asset tax (τ_a), an income tax (τ_w), and an entrepreneurial profit tax (τ_p). There are no other government expenditures so all of the revenue from these taxes is used to provide the unemployment benefit b or the

UBI Ω. This results in the following government budget constraint for every period:

$$\tau_a\left(\sum a_i^U+\sum a_i^W\right)+\tau_w\left(\int_{\epsilon^*}^{\bar{\epsilon}}w(n_e,\epsilon)dF(w)\right)+\tau_p\left(\int_{\phi^*}^{\bar{\phi}}F^E(\phi,a,n_e)\right)=\Omega_t+b_t$$

The assets of the unemployed and the workers are given by a_i^U and a_i^W respectively, and the assets for the entrepreneurs are used for production. The integration of the worker skill between ϵ^* and $\bar{\epsilon}$ yields portion of agents that choose wage work, where ϵ^* is the worker skill level at which the agent is indifferent between being a worker and being unemployed. The integration of profit between ϕ^* and $\overline{\phi}$ yields the portion of agents that choose entrepreneurship, where ϕ^* is the worker skill level at which the agent is indifferent between being an entrepreneur and being unemployed.

Recursive Household Problem

There are three value functions in the recursive household problem that correspond to the three occupational types. I denote these as $V^i(\theta)$ for $i \in (U, W, E)$ for the unemployed agent, the worker, and the entrepreneur, with the individual state space defined as $\theta \in (a_i, \phi_i, \epsilon_i)$. The solutions to these recursive household problems result in the optimal consumption (c), asset savings (a') and labour supply (n_e, n_w).

1. If agents are unemployed, their lifetime utility is:

$$V^U(\theta)=\max_{\{c,a'\}}\{u(c)+\beta E_{\epsilon,\phi}\max\{V^U(\theta'),V^W(\theta'),V^E(\theta')\}\} \tag{4.2}$$

subject to

$$c_i+a_i'\leq(1-\tau_a)\{a_i(1+r)\}+b+\Omega$$

Agents maximise over the consumption of the two goods and future discounted utility, where β is the discount factor. The agent has an expectation over their draws of worker skill (ϵ) and entrepreneurial skill (ϕ), and makes their occupational choice based on this expectation. The unemployed agent only exits the state of unemployment and enters that of a worker if they draw a high enough worker skill, and enters the state of an entrepreneur if they draw a high enough entrepreneurial skill.

Given the unemployed agent does not work, their utility depends only on consumption. The unemployed agent consumes and saves such that the budget constraint contains the interest accumulated asset that is taxed at the asset tax rate τ_a, the unemployment benefit b that the government provides as welfare, and UBI Ω.

The Euler condition is

$$0 = u'(c) + \beta \left[\int_{\epsilon*(\phi,a)}^{\bar{\epsilon}} \int_{\underline{\phi}}^{\phi*(\epsilon,a)} \frac{\partial V^W}{\partial a'} dF(\epsilon)dF(\phi) + \int_{\underline{\epsilon}}^{\epsilon*(\phi,a)} \int_{\underline{\phi}}^{\phi*(\epsilon,a)} \frac{\partial V^U}{\partial a'} dF(\epsilon)dF(\phi) + \int_{\underline{\epsilon}}^{\epsilon*(\phi,a)} \int_{\phi*(\epsilon,a)}^{\bar{\phi}} \frac{\partial V^E}{\partial a'} dF(\epsilon)dF(\phi) \right]$$

2. If agents are workers, their lifetime utility is:

$$V^W(\theta) = \max_{\{c,a',n_w\}} \{u(c, n_w) + \beta \max\{E_\epsilon[V^W(\theta')|\epsilon' \geq \epsilon^*] + E_\epsilon[V^U(\theta')|\epsilon' < \epsilon^*], E_\phi V^E(\theta')\}\} \tag{4.3}$$

subject to

$$c_i + a_i' \leq (1 - \tau_a)\{a_i(1 + r)\} + (1 - \tau_w)(w.\epsilon)(n_w) + \Omega$$

The agent maximizes current utility over the consumption of the two goods and future utility discounted at rate β. However, now the agent also faces disutility from working. The agent also faces more uncertainty than in the case of unemployment, as they no longer maximize over their occupational choices for every possible draw. Rather, the future occupational decision is now to either stay in the labour market as an employed or unemployed agent, or exit it and become an entrepreneur, based on the agent's expectation of worker skill and entrepreneurial skill.

To understand why this case induces greater uncertainty for the agent than in the unemployed case, consider the case where the agent has chosen to exit the labour market, based on a sufficiently high expectation of their entrepreneurial skill (ϕ). If their skill draw for the following period ends up sufficiently low, then the agent suffers significant losses from the set up costs. Alternatively, if they choose to stay, their utility is determined by whether their expected worker skill in the next period (ϵ') is greater than or lower than the level at which the agent is indifferent between working for a wage and being unemployed (ϵ^*). If (ϵ') is greater or equal to (ϵ^*), they continue working and if it is lower, they go into unemployment.

The worker consumes and saves such that the budget constraint contains the interest accumulated asset that is taxed at the asset tax rate τ_a, a competitive market wage w.ϵ that is taxed at the income tax level τ_w and scaled by the worker's labour input n_w, and UBI Ω. In the model with without labour disutility, there is an inelastic labour supply such that the value of n_w is 1.

The Euler condition is

$$0 = u'(c) + \beta \int_{\phi*(\epsilon,a)}^{\overline{\phi}} \left[\int_{\epsilon*(\phi,a)}^{\overline{\epsilon}} \frac{\partial V^W}{\partial a'} dF(\epsilon) + \int_{\underline{\epsilon}}^{\epsilon*(\phi,a)} \frac{\partial V^E}{\partial a'} dF(\epsilon) \right] dF(\phi)$$
$$\int_{\underline{\phi}}^{\phi*(\epsilon,a)} \left[\int_{\epsilon*(\phi,a)}^{\overline{\epsilon}} \frac{\partial V^W}{\partial a'} dF(\epsilon) + \int_{\underline{\epsilon}}^{\epsilon*(\phi,a)} \frac{\partial V^U}{\partial a'} dF(\epsilon) \right] dF(\phi)$$

3. If agents are entrepreneurs, their lifetime utility is:

$$V^E(\theta) = \max_{\{c,a',n_e\}} \{u(c, n_e) + \beta(E_\phi[V^E(\theta')|\phi' \geq \phi^*] + E_\phi[V^U(\theta')|\phi' < \phi^*])\} \tag{4.4}$$

subject to

$$c_i + a_i' \leq (1 - \tau_p)[\hat{\phi} a(1 + r)^{\alpha_1} n_e^{1-\alpha_1} - \hat{\kappa}] + \Omega$$

where β is the discount factor. Agents are maximizing current utility over the consumption of the two goods and future discounted utility derived from the expectation of their entrepreneurial ability (ϕ). If the agent draws an entrepreneurial ability that is greater than or equal to the level at which they are indifferent between being an entrepreneur and being unemployed (ϕ^*), then they end up as an entrepreneur. On the other hand, if the agent draws an entrepreneurial ability that is lower than (ϕ^*), they end up as unemployed and earn unemployment benefit b. There is no longer an option of wage work because the model tries to mimic real life by introducing a latency period between entrepreneurship and wage work, during which the agent looks for work in the labour market. That is, the agent needs to go through a period of unemployment before entering the labour market as a wage worker. Thus, the utility of the agent depends only on the expectation over entrepreneurial skill.

The budget constraint for the entrepreneurs shows the agent consumes and saves for the next period, earns a profit that is taxed at the entrepreneurial profit tax rate (τ_p), and is scaled by their labour input (n_e), and receives UBI Ω from the government. In the model with without labour disutility, there is an inelastic labour supply such that the value of n_e is 1.

The Euler condition is

$$0 = u'(c) + \beta \left[\int_{\underline{\phi}}^{\phi*(\epsilon,a)} \frac{\partial V^U}{\partial a'} dF(\phi) + \int_{\phi*}^{\bar{\phi}} \frac{\partial V^E}{\partial a'} dF(\phi) \right]$$

Recursive Competitive Equilibrium

Definition 1: *A recursive competitive equilibrium in this economy is a set of value functions* $\{V(U), V(W), V(E)\}$*, policy functions* $\{a'(\theta), c(\theta), n(\theta)\}$*, prices* $\{w, r\}$*, welfare transfers* $\{b, \Omega\}$*, and taxes* $\{\tau_a, \tau_w, \tau_p\}$*, such that:*

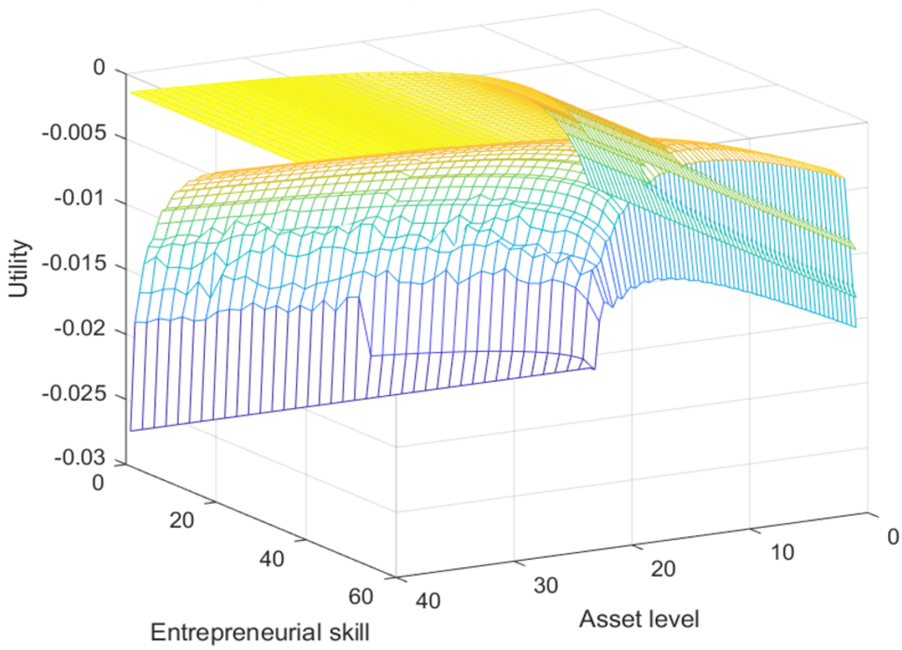
1. *The value functions and policy functions solve the agents' optimization problems, given prices.*
2. *The market for goods clears:* $Y + F^E(\phi, a, n_e) = C_u + C_w + C_e + I$
3. *The prices {r, w} are determined endogenously through the representative market's first order conditions*
4. *The asset market clears:* $I = a^U + a^W + a^E$
5. *The government balances its budget:*

$$\tau_a \left(\sum a_i^U + \sum a_i^W \right) + \tau_w \left(\int_{\epsilon^*}^{\bar{\epsilon}} w(n_e, \epsilon) dF(w) \right) + \tau_p \left(\int_{\phi^*}^{\bar{\phi}} F^E(\phi, a, n_e) \right) = \Omega_t + b_t$$

A visual representation of the occupational choice model

Figure 3 is a visual representation of the dynamic occupational choice model for the inelastic labour supply case. The grid contains the lifetime utilities from each occupation type, for every asset level, entrepreneurial skill level, and a fixed worker level (state space henceforth). The **colour 1** mesh corresponds to an unemployed agent, and **colour 2** corresponds to the wage worker, and the **colour 3** mesh corresponds to the entrepreneur. Given these, the occupational choice decision is as follows: For a given state space, the agent compares the lifetime utilities from each of the occupation types and selects the occupation that yields the greatest utility. Visually, this means the agent selects the occupation type that is the the highest in the 3D space.

Figure 3: Occupational choice decision

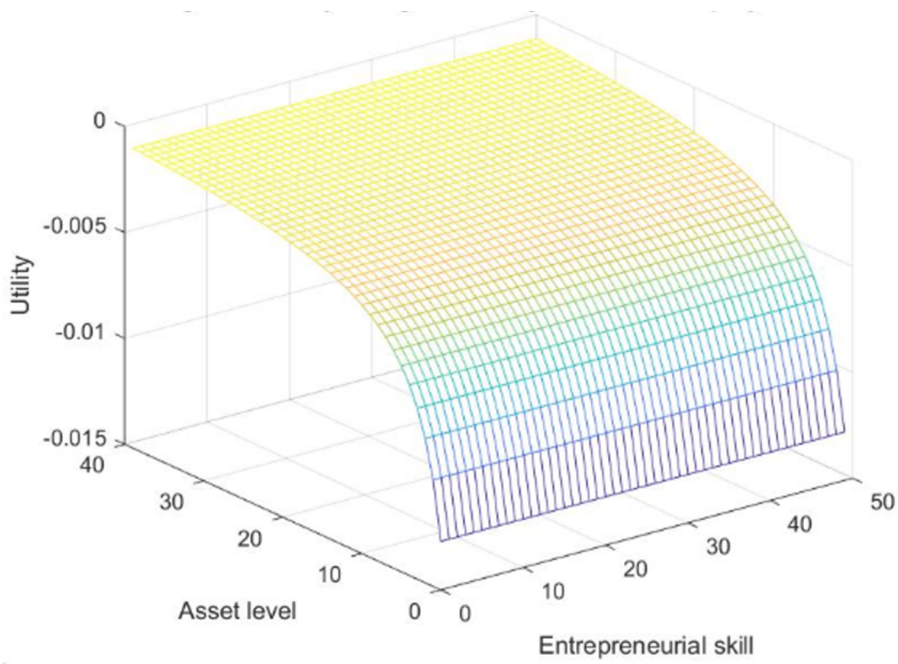


The section of interest is the top right corner of the grid, which presents the space in which agents choose to become entrepreneurs. In this region, the utility mesh for the entrepreneurs given some state space exceeds those of the workers and the unemployed over the same state space. Furthermore, the utility mesh for the entrepreneur is concave up, such that entrepreneurs face utility that is increasing in their skill level, at a decreasing rate. In the following section I break figure 3 down into the 3 lifetime utility components derived from each occupation type, for a visual insight into how the utilities change with the state variables.

A breakdown of the lifetime utilities

Figure 4 displays the lifetime utilities of an unemployed agent for every possible asset level, entrepreneurial skill level, and a worker skill level fixed at the median value. For a fixed worker skill level, an unemployed agent's utility is increasing and concave in their asset level, due to the greater consumption possible in every period with higher assets. Because the mesh captures the lifetime utilities of an unemployed agent in equilibrium, the mesh does not vary with the entrepreneurial skill on the x-axis, or the worker skill tested for by manipulating the worker skill level captured in the 4th dimension). This is because an unemployed agent's consumption possibilities are driven only by their asset savings and the unemployment benefit from the government. However, the decision itself to choose unemployment is a function of both, entrepreneurial skill and worker skill along with the asset level.

Figure 4: Utility for agents if they choose unemployment



Fixed at the median worker skill level

Figure 5 displays the lifetime utilities of a wage worker, for every possible asset level, entrepreneurial skill level, and two different worker skill levels. The black mesh corresponds to the lower worker skill level, and the coloured mesh corresponds to the higher worker skill level. As in the case of the unemployed agent, the lifetime utility for the worker increases concavely with assets. Since the earnings of a wage worker is a function of their worker skills, a higher worker skill level yields a greater lifetime utility for the agent for all levels of assets, with a closing gap for higher assets. This is because rich agents are less dependent on their worker skill driven income to satisfy their consumption needs, relative to their assets. The lifetime utility is unaffected by entrepreneurial skill, because it does not directly influence the consumption possibilities of a wage worker.

Figure 5: Utility for agents if they choose wage work

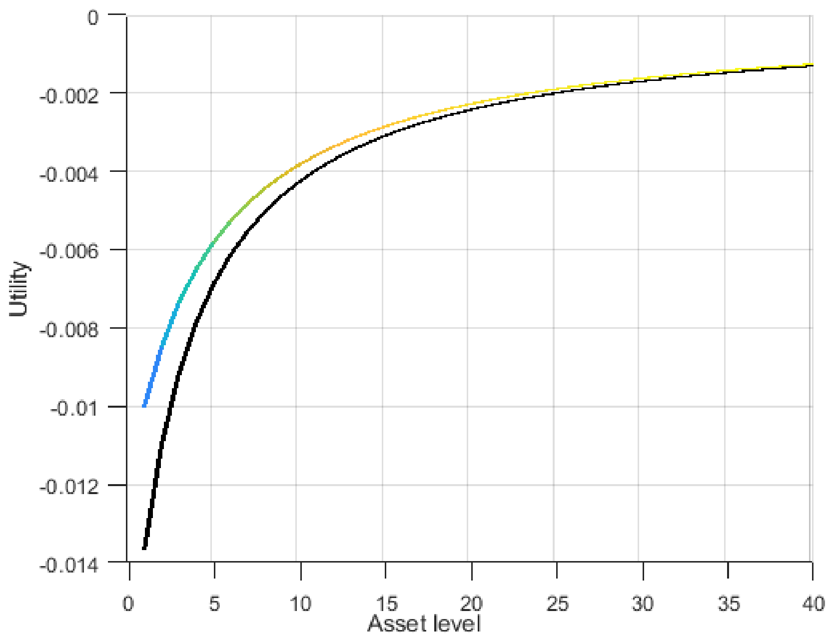
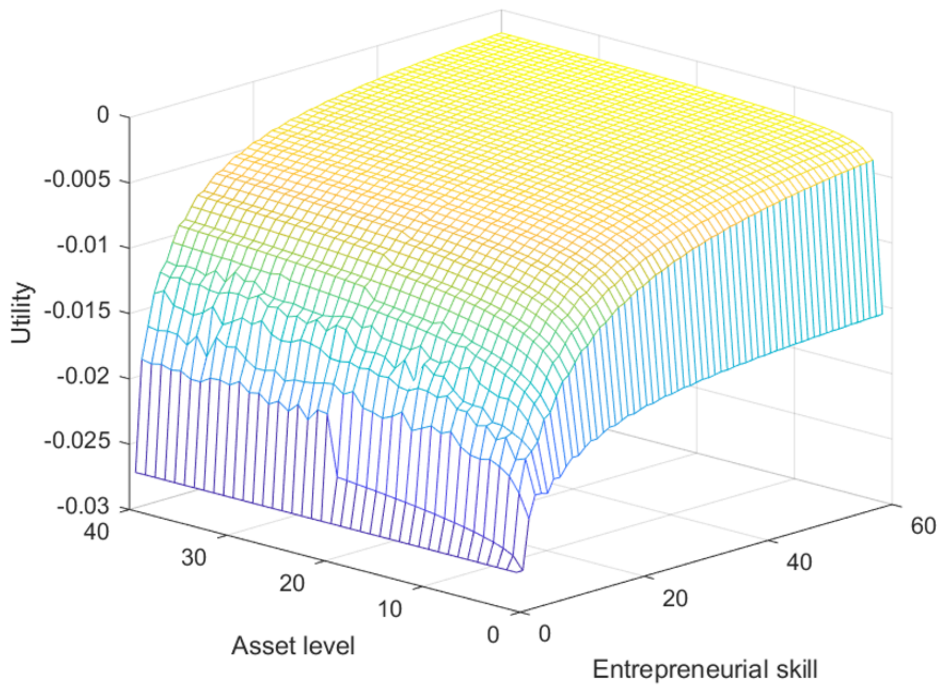


Figure 6 displays the lifetime utilities of an entrepreneur, for every possible asset level, entrepreneurial skill level, and a worker skill level fixed at the median value. Now the function increases concavely with both assets and entrepreneurial skills. Greater assets increase the consumption level for the entrepreneur as in the case for the worker and the unemployed agent, and higher entrepreneurial skills result in higher production, which also increases the consumption level of the entrepreneur. The shape of the mesh shows there is a decreasing marginal return of production with both, assets and entrepreneurial skills, which can be confirmed by the negative value of the second order derivative of the entrepreneur's profit function, with respect to assets. The lifetime utility of the entrepreneur does not change with worker skills, which has been tested for by manipulating the worker skill level captured in the 4th dimension as done for the case of the unemployed agent. This is because the worker skill has no direct role to play in the consumption level of an entrepreneur.

Figure 6: Utility for agents if they choose entrepreneurship



5 | Data

In this section I describe the data used as the target for the calibration of the occupational choice distribution in the benchmark cases of the two models. The proportion of unemployed agents is matched to the unemployment rate in the data, the proportion of wage workers is matched to the paid employment rate, and the proportion of entrepreneurs is matched to the self-employment rate. The calibration is performed for Australian data, but the data for the United States is presented for a comparison. The values are summarised in table 1, alongside the occupational distributions in the benchmark cases.

5.1 Unemployment rate

The unemployment rate for Australia is gathered from the monthly Household Labour Force Survey by the Australian Bureau of Statistics (ABS). The coverage of the survey is approximately 0.32% of the total Australian population and engages only the civilian population identified through the Population Census. The data for quarter 2, 2019 indicates that 5.7% of people in the labour force are unemployed, with the labour force including everyone who is working or actively looking for work.

The unemployment rate for the United States is gathered from the Current Population Survey (CPS) conducted by Bureau of Labour Statistics (BLS). The Current Population Survey engages approximately 60 000 households that are sampled randomly to generate a close approximation of the true population rates, and elicits information about employment status, among other statistics. The data for quarter 2, 2019 indicates that 3.7% of people in the labour force are unemployed.

5.2 Wage worker rate

The wage worker rate in the model is akin to the paid employment rate in the United States. The paid employment rate is calculated as the proportion of the labour force that is engaged in employment the week prior to that when the survey was conducted, including absentees from work in possession of such a job. The threshold for gainful employment is at least one hour of work. ABS data suggests the rate of employment as a proportion of employment is 94.3%. Of this, 9.6% are self-employed, and the remaining 90.4% are paid employees. Thus, the measure of wage workers as a proportion of the labour force is 85.25%. The rate of employment for the United States for quarter 2, 2019 is 96.4% of the labour force, of which 6.3% are self-employed. Thus, the proportion of the labour force that is engaged in paid employment is the remaining 93.7% of all employed people, or 90.32% of the labour force. This measure of employment most closely fits the characteristics of the wage workers in the occupational choice model in this paper.

5.3 Entrepreneurship rate

Entrepreneurship rates in the model are compared to self-employment rates in the data. The ABS rate for Australia is 9.6% of all employed, or 9.05% of the labour force. The corresponding BLS rate of self employment in the United States according to this definition is 6.3% of all employed, or 6.07% of the total labour force. The definition of self employment adopted in this paper is of workers who are employed in their own companies, co-operative members, employers, and unpaid family workers who share the income from the family enterprise but are not paid contractually. The incorporated self employed such as directors of corporate organisations are categorized as wage workers. The self employment rate as defined is well aligned with the characterisation of entrepreneurs in the model, but presents some disparities. It includes owners of established businesses that employ many people, unpaid family members in the farming related activities, and part time enterprise owners.

5.4 Limitations of the Labour Market Data

The BLS and ABS data most closely aligns with the assumptions of the model, though there are some limitations of directly comparing the results of the occupational choice model in the paper to the data presented. Firstly, the model in the paper considers only the three options of unemployment, wage work, and entrepreneurship, all which are mutually exclusive, whereas the labour market data might contain people working multiple jobs that could span across both, wage work and self employment. In these cases, ABS and BLS have pre-allocated conditions such as time spent on each activity that they use to allocate the agents into one of the multiple categories. Secondly, the production technology for entrepreneurs in the model uses only their own labour input for production, rather than a combination of their own labour and hired labour, as in the businesses in the self-employment data. Finally, the measure of unemployment from ABS and BLS does not include the proportion of people who voluntarily wish to remain unemployed, as they are classified in the data as being out of the labour force. This is a limitation of the data for calibration to the benchmark case in the model with labour disutility because the agents in the model can choose to be unemployed if the disutility from working or being unemployed is high enough, given their state space and the unemployment benefit they receive. This limitation is partially mitigated by the fact that a portion of the unemployed agents in the United States evaluate whether it is more beneficial for them to enter the workforce with some employment option in their hand or stay unemployed in anticipation of a better employment opportunity in the future. This is akin to the decision rule of the agents in the model that requires utility maximization over their expectation of their idiosyncratic shocks and thus the future labour market outcomes. Furthermore, some unemployed people in the United States are eligible for unemployment insurance, which feeds into the decision factor of the unemployed agents when considering entering the labour market as a wage worker or becoming an entrepreneur, as in the model in this paper. This explanation accounts for only a portion of the disparities between the way unemployment in characterised in this paper and by the BLS, since The Current Population Survey suggests that that only a quarter of those that are unemployed collect unemployment insurance, and out of those that do not, approximately 60% state it is because they were unaware of it at the time of the survey or thought they were ineligible. Despite the imperfections, the model is as consistent as possible with the data available for the labour market in the United States. As in the case with Unemployment Insurance in the United States, some unemployed people in Australia are eligible for unemployment benefit in the form of Newstart Allowance, contingent upon some factors such as age and household income. Thus the rationale for using this measure of unemployment for comparison to the result from the model is the same as in the case for the United States. However, these limitations do not have large implications for the results of the model. Furthermore, they do not detract from the analysis of how the distribution of the occupations changes upon the introduction of the UBI.

6 Calibration

I calibrate the occupational distribution in the benchmark case with labour disutility, to the occupational distribution given by ABS data. In both models, the benchmark case has no formal government or UBI, but an exogenous unemployment benefit b. The calibration is performed such that the portion of unemployed agents in the model matches the unemployment rate in the data, the proportion of wage workers matches the paid employed rate, and the proportion of entrepreneurs matches the self-employed rate. The UBI analysis in each model is then performed as a comparison to the corresponding benchmark case. Table 1 presents the outcome of this calibration, along with the BLS data for United States for comparison.

Table 1: Benchmark Model Comparison to Data for the United States and Australia

Model			Data		
Occupational choice	Inelastic labour supply	Elastic labour supply	Statistic	Australia	U.S.
Unemployed	5.6%	5.9%	Unemployment	5.7%	3.7%
Wage workers	85.1%	84.9%	Paid employment	*85.3%	90.3%
Entrepreneurs	9.3%	9.2%	Self-employment	9.1%	*6.1%
			TEA rate (2017)	12.2%	13.3%

*The distributions do not perfectly add up to 100% because they have been rounded to the nearest decimal point.

Benchmark values

The values for the benchmark model indicate that approximately 5.5% of agents select unemployment, 86.5% select wage work, and 8% select entrepreneurship. The model proportions are calibrated to the target proportions using the parameter values given in Table 2, where α is the capital output elasticity in the Cobb-Douglas production function, β is the discount rate, r is the rate of interest in the economy, σ is the coefficient of risk aversion in the CRRA utility function, τ_a is the rate of tax on assets, τ_w is the rate of tax on wages, τ_p is the rate of tax on entrepreneurial income, w_ϵ is the mean of the labour efficiency wage in the economy, b is the unemployment benefit, and Ω is UBI. This distribution closely matches the data available for Australia, which indicates that approximately 5.7% are unemployed, 85.3% are in paid employment, and 9% are self-employed. the United States presents a greater disparity with the benchmark model compared to Australian data, but follows a similar occupational distribution pattern and validates the benchmark model as a good base for analysing the effect of UBI on selection into entrepreneurship.

Calibration parameters

Table 2: Key calibration parameters: Benchmark

Parameter		Inelastic labour supply	Elastic labour supply
Capital share	α	0.35	0.35
Discount factor	β	0.96	0.96
Interest rate	r	0.04	0.04
Risk coefficient	σ	2	2
Asset tax	τ_a	0	0
Income tax	τ_w	0	0
Profit tax	τ_p	0	0
Mean Wage	w_ϵ^*	4.5	5
Frisch elasticity	η	-	0.4
Benefit	b	1	1
UBI	Ω	0	0

Notes: The labour efficiency wage $w.\epsilon$ is given by scaling a wage levels $w = 9$ (inelastic labour supply) and $w = 10$ (elastic labour supply) by the distribution of worker skills ϵ. The mean of this vector of wages is reported in the table as w_ϵ. The frisch elasticity model is irrelevant in the inelastic labour supply model because there is no disutility from labour.

Selection of the calibration parameters

I select the calibration parameters in part from economic literature and in part endogenously in the model to facilitate the match of the benchmark occupational distribution to the target rates in Table 1. The parameters that take after economic literature are the capital share α, the discount factor β, and the interest rate r. The risk coefficient σ, mean wage w_ϵ, and unemployment benefit b are selected internally in the model to fit the target distributions. The tax rates τ_a, τ_w , and τ_p and the UBI Ω are 0 in the absence of a formal government in the benchmark model. These parameters enter as positive values in the tax-funded UBI model, where the values are chosen to minimize tax distortions. The income sources w_ϵ, benefit b and UBI proportionally differ in a way that minimizes income distortions. All parameters match across the two models, with the exception of the wage level, which is slightly higher in the model with labour disutility, to fit the target in the data.

7 Results

7.1 Tax-funded UBI Model

I compute the results for the model with labour disutility, and without labour disutility. Across both models, a tax-funded UBI increases the rate of entrepreneurship, increases the rate of unemployment, and decreases the rate of wage work, relative to the benchmark cases. The magnitudes of effect differ for the two models, which are discussed in detail in the following sections.

Table 3: Occupational choice distribution of agents

Occupational choice	Inelastic labour supply		Elastic labour supply	
	Benchmark	Tax-funded UBI	Benchmark	Tax-funded UBI
Unemployed	5.6%	6.4%	5.9%	6.6%
Wage workers	85.1%	*83.0%	84.9%	83.1%
Entrepreneurs	9.3%	*10.6%	9.2%	10.2%

*Numbers have been roundest to the nearest decimal place.

Inelastic labour supply

In the inelastic labour supply case, workers and entrepreneurs do not face any disutility from labour. Compared to the benchmark case, the rate of entrepreneurship in this model increases by approximately 14%, the rate of wage work decreases by approximately 2.5%, and the rate of unemployment increases by approximately 14.3%. These values have been computed for an asset tax rate of 26%, an income tax rate of 17%, and a profit tax rate of 18%. A limitation of this model is that these tax rates have not been calibrated to external data, given time constraints. However, the values have been chosen to minimize tax driven income distortions in the economy, through similar rates for the worker and the entrepreneur. In the absence of labour disutility, the change in the occupational distribution can be attributed to the alleviation of consumption constraints for the entrepreneur with the additional income, and the substitutable relationship between assets and entrepreneurial skill. The alleviation of the consumption constraints allows the entrepreneurs to allocate more of their assets to production, generating a higher income compared to the income earned in the labour market and the unemployment benefit received as an unemployed agent. This results in a greater number of agents choosing to become entrepreneurs, at the cost of unemployed agents and workers. The substitutable relationship between assets and entrepreneurial skills is given by the functional form of the production function for the entrepreneur, and captures the fact that above a minimum skill and asset threshold, the higher the asset level of an entrepreneur, the lower the skill needs to be for them to obtain some profit level $\pi(a, \phi)$. This means that the allocation of the higher assets to production due to the additional income has relaxed the skill condition for an agent to choose entrepreneurship. I explore this substitutable relationship between assets and entrepreneurial skills in detail in section 8.

Elastic labour supply

In the elastic labour supply model, workers and entrepreneurs face a disutility of labour, such that their income generating process is scaled by the amount they work. The disutility is a function of ψ in equation (4.5), which governs the agent's substitution between the labour input and consumption. With labour disutility, the rate of entrepreneurship increases by approximately 12%, the rate of wage work decreases by approximately 0.6%, and the rate of unemployment increases by approximately 24.6%, relative to the benchmark case. In the presence of labour disutility, the percentage increase in entrepreneurship is smaller, likely because the profits are scaled down by the labour disutility. The percentage increase in unemployment is smaller, likely because there are more unemployed agents to begin with. As before, the increase in entrepreneurship can be attributed to the fact that the higher wealth allows some agents in the economy with high enough entrepreneurial skill to divert a portion of their assets from consumption expenditure to capital investment. If this yields a greater value compared to wage work or unemployment, these agents enter the state of entrepreneurship. The decrease in the proportion of wage workers and the increase in the proportion of unemployed agents are likely because the agents with the lowest worker skills who were yielding lower returns from wage work and low entrepreneurial skills entered the state of unemployment upon receiving the UBI. I formally test for these explanations in chapter 8.

Parameters of the model

The table below presents the key parameters of the tax-funded UBI model. All parameters are the same as in the benchmark case, with the exception of taxes and UBI. Due to time constraints, I was unable to calibrate the taxes in the model to the income and business tax rates in the economy. This is a limitation of this paper that I hope to address in the future. However, I have chosen the rates to minimize tax-induced consumption distortions under one occupation, relative to another. The proposed UBI estimates vary widely by country, and there has been no pilot experiment in Australia. Thus I chose the UBI in the model to be a value that is above the unemployment benefit and below the mean wage and profit levels, as the next best alternative.

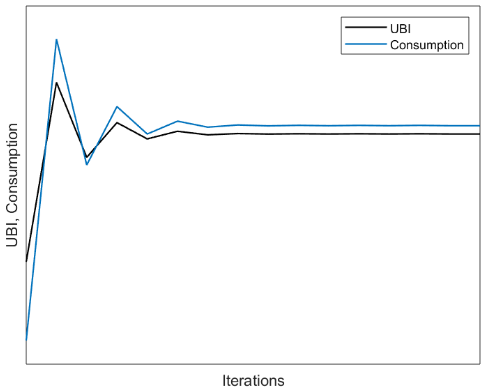
Table 4: Key parameters: tax-funded UBI model

Parameter		Inelastic labour supply	Elastic labour supply
Capital share	α	0.35	0.35
Discount factor	β	0.96	0.96
Interest rate	r	0.04	0.04
Risk coefficient	σ	2	2
Asset tax	τ_a	0.26	0.26
Income tax	τ_w	0.17	0.17
Profit tax	τ_p	0.18	0.18
Mean Wage	w_ϵ^*	4.5	5
Frisch elasticity	η	-	0.4
Benefit	b	1	1
UBI	Ω	3	3

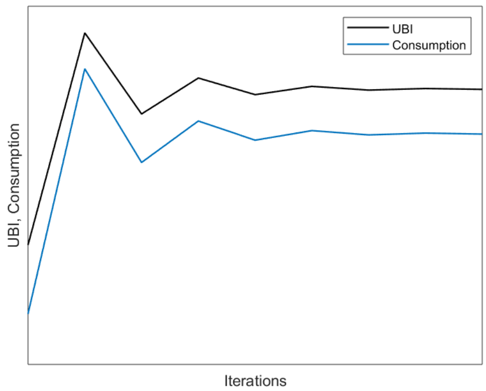
Notes: The parameters that have changed from the benchmark case are taxes τ_a, τ_w, τ_p, and UBI ω. Between the inelastic labour supply and elastic labour supply model, the only parameter that has changed is the frisch elasticity parameter η.

7.2 Consumption and Welfare Analysis

To understand how closely the consumption for workers and unemployed agents follows the UBI they receive and how this differs between the two models, I graph their aggregate consumption path against the UBI as the UBI converges to its equilibrium level. I leave out the entrepreneurs from this aggregate calculation and address them at the end of this section. The initial UBI value dictates the path to convergence but converges to the same equilibrium level for a given set of parameters and has no implications for how closely the consumption follows the UBI, which I verify by performing the analysis for different starting levels. The figures below present the analysis for an initial UBI value of 0. Figure 7a represents the analysis for the model without labour disutility and figure 7b represents the analysis for the model with labour disutility.



(a) No labour disutility



(b) Labour disutility

The figures show that in both models, the aggregate consumption for the workers and the unemployed agents very closely follows the UBI. The consumption paths for the two models are interpretable only in their movements relative to the each other, rather than to the UBI in absolute value, because the units for consumption differ from that of the UBI. That is, where the consumption dips below the UBI does not necessarily imply that the agents save the UBI, but provides a relative comparison to regions where it exceeds the UBI in the same model and in the other model. In the absence of labour disutility, the consumption line dips below the UBI line in some iterations and exceeds it in other iterations, which is dictated by the savings behaviour of the agents, and the skill draw determined earnings for the workers. The difference in the difference between the UBI and the consumption provide an insight into how much workers penalize their consumption because of the disutility they face from working.

I remove entrepreneurs from the calculation of the aggregate consumption because they confound the analysis in one important way. All the entrepreneurs with an entrepreneurial skill level of 0 face infinitely negative consumption because of the functional form of their recurring business cost $\frac{\kappa}{\phi}$. I address this by changing the denominator of this cost function by adding the small positive value 10^{-10}. Performing the analysis with this transformation results in a consumption path which has a negligible variation as the UBI converges to its equilibrium level, but a path that follows the UBI for large artificial shocks to the UBI. A possible explanation for this is that the magnitude of the UBI is small relative to the profit for some entrepreneurs, such that it only spurs a variation in consumption when very large in value. A second possible explanation is that entrepreneurs save the UBI for investment in a period where their skill draw is high, since these savings feed into their profit function. Workers and unemployed agents do not face the same incentive to save the UBI.

Consumption Equivalent Variation

The Consumption Equivalent Variation (CEV) measures how much more an agent in each occupational type in the steady state needs to consume to be indifferent between the welfare in the benchmark and UBI scenarios. In the model with labour disutility, the CEV is almost negligible, with a welfare loss of approximately 0.00287%, and 0.0769% for the model without labour disutility. The losses are derived mainly from the consumption of the entrepreneur in both models.

8 Mechanisms

I attempt to understand the underlying mechanisms behind the results through 3 methods. In the first method I look at how much of the change in the occupational distribution is caused by a pure income effect of the UBI, and how much of it is caused by the relative changes in disposable income due to the tax-funded UBI. I perform the decomposition of the aggregate distribution change separately for the case with and without labour disutility. In the second method I characterise who changes occupations after the introduction of the tax-funded UBI, by computing the average assets and skills of the agents who select into each of these three occupational choices before and after the UBI. In the final method I look at the substitutable relationship between assets and entrepreneurial skill in an agent's decision to select into entrepreneurship. I do this by analytically solving a static model with two occupational choices, in which agents differ in assets and entrepreneurial skill and make their occupational choice decision given these two state variables.

8.1 Decomposing the aggregate effects of the UBI

Agents might be substituting between occupation types after receiving the UBI because of the blanket effect on consumption and utility from receiving additional money, and because of the varying effects in the utilities for the 3 occupation types after accounting for taxes and labour disutility.

In the absence of labour disutility, I find the pure income effect by calculating the change in the occupational distribution relative to the benchmark case, due to a windfall UBI payment. Without taxes, this comparison restricts the mechanism of effect to blanket increase in disposable income for all agents in the economy. The change in the occupational distribution in the model due to a pure income effect is a 7.14% increase in unemployment, a less than 1% decrease in wage work, and a 6.45% decrease in entrepreneurship. I find the change in the occupational distribution due to the changes in relative incomes after accounting for taxes by comparing the final distributions to those in the windfall UBI case. The model suggests this effect leads to a 6.67% increase in unemployment, a 2.70% decrease in wage work, and a 21.84% increase in entrepreneurship. This decomposition suggests that a greater portion of the UBI effect for the wage workers and the entrepreneurs comes from tax distortions. This is not true for the unemployed agents who do not get taxed. Rather, an agent's decision to become unemployed after the UBI is almost equally driven by the pure income effect and the additional effect from a tax driven disincentive to choose wage work or entrepreneurship instead.

In the presence of labour disutility, the additional change above the pure income effect might no longer be restricted to taxes. It might now be partially driven by the additional incentive distortions caused by the disutility from labour. These effects are above those already present from the pure income effect. The pure income effect is similar to the case with no labour disutility, causing a 8.47% increase in unemployment, a less than 1% decrease in wage work, and a 6.52% increase in entrepreneurship. To obtain the additional effect above this pure income effect, I compare the final occupational distribution to the one caused by a windfall UBI, as in the case without labour disutility. The model suggests that this additional effect leads to a 3.13% increase in unemployment, a 2.12% decrease in wage work, and an 18.6% increase in entrepreneurship. Unlike in the case with no labour disutility, the majority of the increase in the unemployment rate is now a result of the pure income effect, in which agents receive additional income and become unemployed. This is because the pure income effect now also captures the disincentive effects from labour disutility. These disincentive effects are also behind the more modest increase in entrepreneurship with the tax-funded UBI. However, the incentive effects of the higher profits due to the UBI outweighs the disincentive effects of the labour disutility, resulting in a net positive increase in entrepreneurship.

8.2 Average characteristics

The characteristics I compute for the agents are average assets, average entrepreneurial skills, and average worker skills, before and after the UBI policy. Whether the average skills and assets have increased or decreased provides insight into who changes occupations the savings behaviour of the agents. These characteristics are presented in tables 4 and 5 for the models with and without labour disutility. In both tables, column 1 contains the average values for the benchmark case, column 2 contains the average values after the introduction of the tax-funded UBI, and column 3 shows the percentage change from the initial allocation. Assets in the model are uniformly distributed between 0 and 100, and the skills are uniformly distributed between 0 and 1.

Model 1: Inelastic labour supply

Table 5 shows the average characteristics for the model without labour disutility

Table 5: Average assets and skills

	Benchmark case	Tax-funded UBI	Change
Unemployed			
Assets	55.192	53.128	-3.75%
Entrepreneurial productivity	0.256	0.249	-2.66%
Worker productivity	0.051	0.059	+16.73%
Workers			
Assets	49.737	49.676	-0.12%
Entrepreneurial productivity	0.488	0.486	-0.31%
Worker productivity	0.575	0.585	+1.81%
Entrepreneurs			
Assets	49.275	50.649	+2.79%
Entrepreneurial productivity	0.757	0.759	+0.21%
Worker productivity	0.087	0.099	+13.96%

Average Assets

In the absence of labour disutility, the average assets are lower for the unemployed agents after the introduction of the tax-funded UBI. This is possible if unemployed agents that exit the state of unemployment have high assets, or if agents that enter the state have low assets, or a combination of these effects. The agents with the high assets that are exiting the state of unemployment enter entrepreneurship if they can generate high profits by diverting their assets towards production, with the UBI filling in for some portion of their consumption needs. This switch to entrepreneurship made by the richer agents would increase the average assets for entrepreneurs, which we observe in the table. The agents that are entering the state of unemployment are those that were at the margin of entrepreneurship and unemployment, or at the margin of wage work and unemployment. These are agents who have skills or assets that are just enough for wage work or entrepreneurship to be beneficial over being unemployed. If asset constrained agents switch at the margin entrepreneurship is no longer profitable with the introduction of the tax, then the average assets of the unemployed agents is expected to decrease, and that for the entrepreneurs is expected to increase. We observe this in the table. These effects only hold true given the functional form of the profit functions and the parameter values in the model.

Average worker skill

Table 5 shows that the average worker skills for the worker are significantly higher than those for the unemployed and the entrepreneurs, both before and after the UBI policy. This is expected given that worker skills are directly proportional to wage income but have no implications for an entrepreneur's utility or an unemployed agent's utility. While the percentage increases in the worker skills are large in magnitude for the unemployed agents and entrepreneurs, this is due to the small initial values of the skills in the benchmark case. It is difficult to test whether these increases are because of the ransom shock process in the evolution of skills or whether they are systematic.

Average entrepreneurial skill

The average entrepreneurial skill level for the entrepreneurs is significantly higher for the entrepreneurs, compared to the unemployed agents and the workers. This is because entrepreneurial skill is directly proportional to the income for the entrepreneur, whereas it has no implications for the utilities for the unemployed agents or the workers. The average entrepreneurial skill level for the unemployed agents is lower after the policy. This is possible through agents on the higher end of the skill spectrum exiting the state of unemployment, or agents on the lower end entering the state. The higher skilled agents who exit the state would go into entrepreneurship if they are able to generate a higher income relative to unemployment benefit b by diverting their assets to production. This is confirmed by the increase in the average entrepreneurial skills for the entrepreneurs.

Model 2: Elastic labour supply

Table 6 presents the average assets and skills for agents in the model with labour disutility.

Table 6: Average characteristics with elastic labour supply

	Benchmark case	Tax-funded UBI	Change
Unemployed			
Assets	56.678	52.111	-8.06%
Entrepreneurial productivity	0.261	0.254	-2.42
Worker productivity	0.047	0.053	+13.03%
Workers			
Assets	49.346	49.507	+0.33%
Entrepreneurial productivity	0.489	0.488	-1.18
Worker productivity	0.5777	0.586	+1.54%
Entrepreneurs			
Assets	51.717	52.652	+1.81%
Entrepreneurial productivity	0.760	0.761	-0.03%
Worker productivity	0.081	0.091	12.42%

Average assets

In the model with labour disutility, unemployed agents start out with the highest amount of assets compared to wage workers and entrepreneurs. This is because of the agents with low skills who are not able to generate a high enough wage income or profit to offset the disincentive effects of labour disutility. With the tax-funded UBI, the average asset level for the unemployed agents decreases significantly. As in the previous model, this is possible through high asset agents exiting the state, low asset agents entering the state, or a combined effect of both. As before, agents might switch from unemployment to entrepreneurship if diverting their assets to production generates a high enough profit relative to the unemployment benefit b. Furthermore, entrepreneurs with low assets who are not generating high enough income to offset the disincentive of the profit tax might switch into unemployment. These agents are at the margin of unemployment and entrepreneurship.

Average worker skill

Once again, the average worker skill is significantly higher for the workers compared to unemployed agents and entrepreneurs because it is a part of the income generating process of the worker. This time, the decrease in the average worker skill level for the unemployed agent is much larger than in the previous model. This decrease is driven by high asset agents exiting the state, by low asset agents entering the state, or by a combination of both. As before, agents at the margin of unemployment and entrepreneurship might tip over into the state of entrepreneurship by diverting assets to production. It is difficult to test for where the additional effect comes from, but might be because the disutility from labour makes only the agents with the highest assets and therefore the highest profit yield make this switch.

Average entrepreneurial skill

The magnitudes of the entrepreneurial skills and the direction of effect for the unemployed, the workers and the entrepreneurs in the model with labour disutility are similar to the model without labour disutility, except in that the magnitude of the increase for the skill level of the entrepreneur is much smaller than in the previous model. I have not been able to test for the mechanism behind this difference that results from the labour disutility in the model.

8.3 The roles of assets and skills in the decision to become and entrepreneur

To understand what drives an agent's decision to become an entrepreneur, I create a static setting in which agents differ in assets and entrepreneurial skill, and make an occupational choice decision between working and being an entrepreneur. I exclude the option of being unemployed for analytical tractability, but this abstraction from the dynamic model does not deter from an understanding of how skills and assets individually and collectively drive an agent's decision to become an entrepreneur. In this section I outline the model and present a visualisation of the results. The full set up of the model and the analytical solution is in appendix A.1.

Analytical Model

There is a single time period in which agents indexed by $i \in [i_1, i_n]$ are heterogeneous in assets (a_i) and entrepreneurial skill (ϕ_i). Agents make an occupation choice between working for a wage w or becoming an entrepreneur and generating a revenue that depends on their capital investment, a fixed start-up cost, and their skill level $\pi(k, \phi)$. Agents gain utility from the consumption of two types of goods: c^W that is produced by the wage workers, and c^E that is produced by the entrepreneurs. The utility over the consumption of the two goods is determined according to a Cobb-Douglas utility function.

Agents make their occupational choice decision by comparing their incomes from wage work and entrepreneurship, given their assets and skill endowment. Along with the state bundle, the parameters that determine the income an agent receives from each occupation, are the market wage w, the return to capital investment α, the start up cost s and the interest rate on assets r. The full solution of the model (Appendix A.1) yields the following occupational choice decision, which depends on whether an agent is capital constrained in their production of the entrepreneurial good or not:

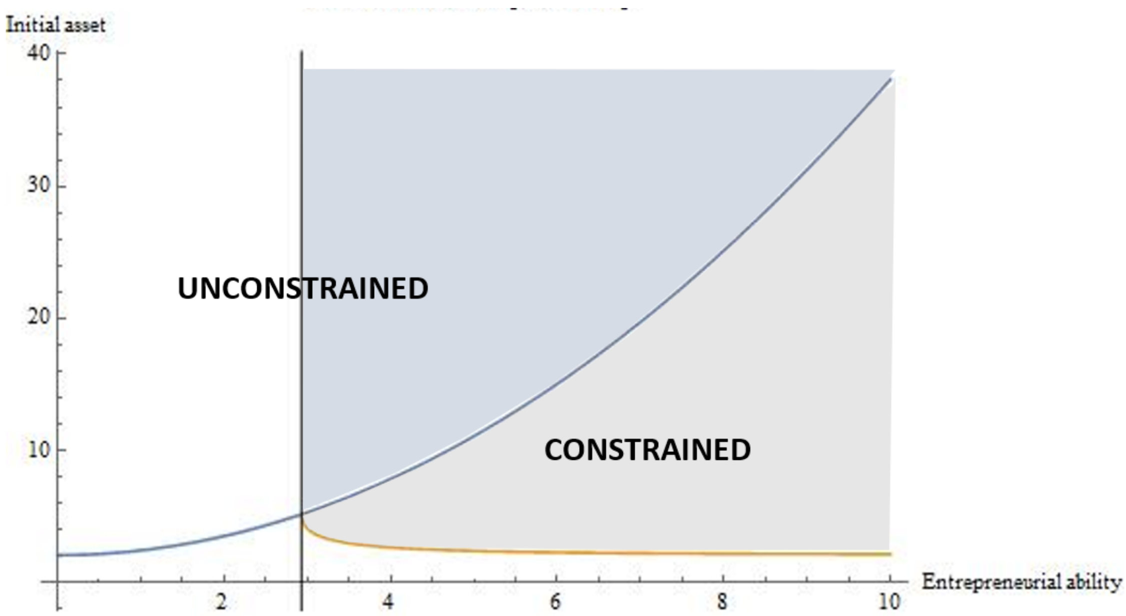
$$\text{Choose } E \text{ if: } \begin{cases} \phi \geq \left(\dfrac{w}{m}\right)^{1-\alpha}, & \text{if } a_i > \frac{(\alpha p \phi)^{\frac{1}{\alpha-1}} + s}{1+r} \quad (8.1) \\ \phi \geq \dfrac{w + a_i(1+r)}{[a(1+r)]^{\alpha}}, & \text{otherwise} \quad (8.2) \end{cases}$$

$$m = \alpha^{\frac{\alpha}{1-\alpha}} - \alpha^{\frac{1}{1-\alpha}}$$

The condition above is given by an agent's comparison of the expected income under each occupational scenario: wage work (W), or entrepreneurship (E). The condition suggests that the occupational choice of the agent depends on both, their asset level and their entrepreneurial skill. Agents with fewer assets and low entrepreneurial skill find it more beneficial to work for wage w, since entrepreneurial success (measured by output y) is a function of both assets and skill. Capital constrained agents find entrepreneurship more beneficial than wage work if their low assets are compensated with a high enough skill. Similarly, less skilled agents might find entrepreneurship more beneficial if they have greater wealth. However, there is a minimum entrepreneurial skill level below which no amount of assets will make entrepreneurship a better option than wage work. This minimum level is given by the equality of equation 8.1.

The figure below is a graphical representation of this substitutable relationship between assets and skills, for the following numerical values: $r = 0.04$, $\alpha = 0.5$, $p = 1$, $s = 0.2$, and $w = 1$. The parameter values for the interest rate, and the rate of return on capital have been chosen as per what is prevalent in economic literature, the value for the price of the entrepreneurial good has been normalized to 1. The price on the worker type good is p_w, but does not feed into the occupational choice decision. The values for the startup cost and wage have been chosen such that the relative incomes and expenditure proportions are reasonable.

Figure 8: Selection into entrepreneurship

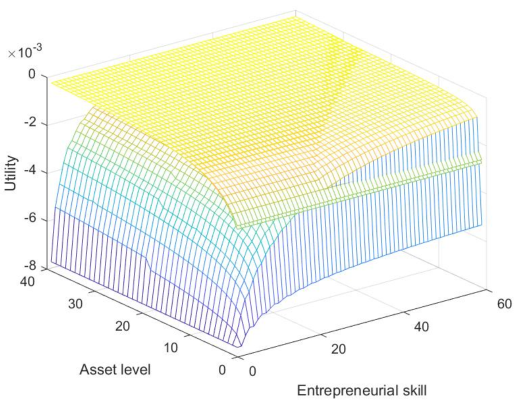


The shaded regions capture the entrepreneurial skill and asset combinations that qualify for entrepreneurship being chosen over wage work, with the blue shaded region corresponding to the capital unconstrained agents, and the grey area corresponding to capital constrained agents. The vertical line is given by equation **??** and represents the minimum skill level agents need for entrepreneurship to be beneficial over wage work. That is, agents with an entrepreneurial skill to the left of this line never choose to start a business, no matter how high their asset holdings are. The model also suggests that the probability of becoming an entrepreneur depends on the initial assets only when the agent is capital constrained. Finally, those with greater initial wealth have greater returns to entrepreneurship compared to those with lower initial wealth because they invest more capital.

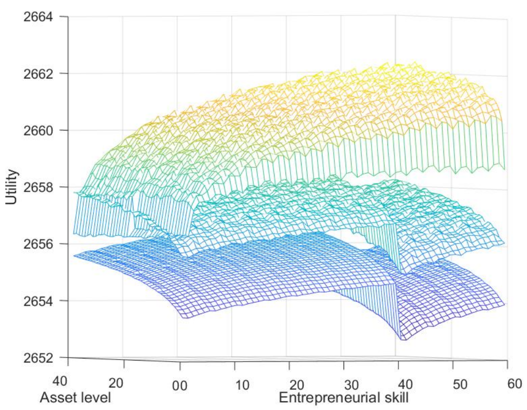
9 Robustness

9.1 Coefficient of relative risk-aversion: σ

The primary analysis in this paper is conducted for a risk aversion coefficient of $\sigma = 2$. I re-do the analysis for two alternative levels of risk-aversion: $\sigma = 2.2$ and $\sigma = 0.9$ to see how the occupational distribution changes. The analysis suggests that the model is robust to small changes in this parameter. The occupational choice decision for $\sigma = 2.2$ as in figure 9a is almost identical to the primary model, with an insignificant change in the occupational distribution. However, a large change in the risk aversion coefficient to $\sigma = 0.9$ results in an occupational choice decision as in figure 9b, in which almost everyone in the model chooses entrepreneurship.



(a) Risk-averse with $\sigma = 2.2$



(b) Risk-averse with $\sigma = 0.9$

This result is expected given that the recurring business cost for entrepreneurs is inversely proportional to their entrepreneurial skill level, and the profit function is directly proportional to it. A less risk averse agent is much more willing to take the risk of failure for a low entrepreneurial skill given the direct mapping between skill and profit. Thus the mesh for the entrepreneur is higher than those for the worker and the unemployed for almost all asset and skill bundles, except where entrepreneurial skills are very low, where agents choose wage work instead. Furthermore, the switch to wage work is more sensitive to decreases entrepreneurial skills than it is to decreases in assets.

This is seen in the upward incline in the intersection of the utility mesh for workers and that for entrepreneurs. No one chooses unemployment in this economy with the given risk aversion parameter.

9.2 More persistent idiosyncratic shocks

Recall that the evolution of skills across periods followed an AR(1) type Markov process as below, with random shocks to skill as given by ε:

Shock process for entrepreneurial skill ϕ:

$$\begin{aligned}\phi_t &= \rho_\phi \phi_{t-1} + \varepsilon_t \\ &= \rho_\phi^N \phi_{t-N} + \sum_{i=0}^{N-1} \rho_\phi^i \varepsilon_{t-i}\end{aligned}$$

Shock process for worker skill ϵ:

$$\begin{aligned}\epsilon_t &= \rho_\epsilon \epsilon_{t-1} + \varepsilon_t \\ &= \rho_\epsilon^N \epsilon_{t-N} + \sum_{i=0}^{N-1} \rho_\epsilon^i \varepsilon_{t-i}\end{aligned}$$

The results in this paper have been performed for a low persistence level ($\rho_\phi = 0.3$ and $\rho_\epsilon = 0.8$). That is, a case where the agents might face a high variation between their skill draw expectations and the actual skill draw in the following period. Table 7 presents the occupational distribution for a more persistent shock process for the inelastic labour model, where agents face lower variation when forming their expectations over their skills.

Table 7: Occupational choice distribution by persistence

Occupational Choice	Benchmark	Tax-funded UBI Model	
		low persistence	high persistence
Unemployed	5.6%	9.8%	6.1%
Wage workers	85.1%	79%	88.7%
Entrepreneurs	9.3%	11.2%	5.1%

Relative to the benchmark model, the tax-funded UBI model with highly persistent skill shocks results in a 4.2 percentage point decrease in entrepreneurship, a 3.6 percentage point increase in wage work, and a 0.5 percentage point increase in unemployment. In contrast the main model with low persistence, there is now a decrease in the rate of entrepreneurship. A possible explanation for this is that the latency period between entrepreneurship and wage work makes it harder for entrepreneurs to transition to working than for workers to transition into being entrepreneurs. This friction means that workers with low entrepreneurial skills will stay in the labour market as workers or unemployed agents for a long time, increasing the proportion of workers in equilibrium. I test for this explanation through an alternative specification of the value function for the entrepreneur in which there is no latency period. This alternative specification is as follows:

$$V^E(\theta) = \max_{\{c,a'\}}\{u(c) + \beta((E_\phi[V^E(\theta')|\phi' \geq \phi^*] + E_\phi[V^U(\theta')|\phi' < \phi^*]), E_\epsilon[V^w(\theta')])\}$$

In this specification entrepreneurs can transition into working without having to go through a period of unemployment first. The shocks are highly persistent as in the previous section, and the budget constraint is unchanged from specification in equation 4.4. The results of this specification compared to the latency period is displayed in Table 8:

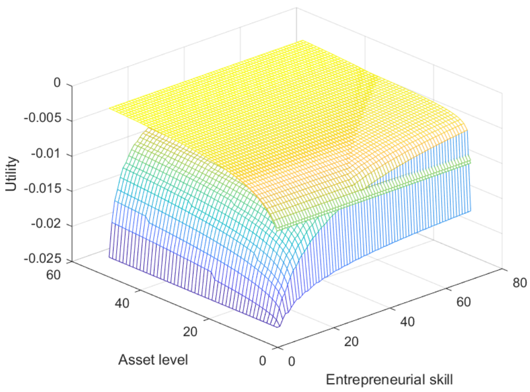
Table 8: Occupational choice distribution by latency

Occupational Choice	Benchmark	Tax-funded UBI Model	
		Latency period	No latency period
Unemployed	5.6%	6.1%	6%
Wage workers	85.1%	88.7%	88.3%
Entrepreneurs	9.3%	5.1%	5.7%

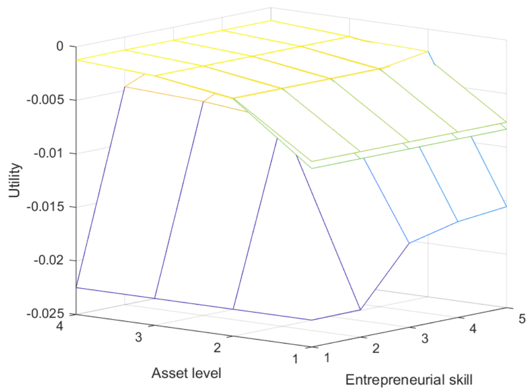
The alternative specification seems to have absorbed only 0.6 percentage points of the decrease in entrepreneurship from the previous specification. The result thus invalidates the latency channel proposed for significant decrease in entrepreneurship under highly persistent shocks. Due to time constraints, I could not test any other explanations behind the result but hope to do so in the future.

9.3 Grid space for assets and skills

The results in this paper have been presented for 50 possible levels of entrepreneurial skills between 0 and 1, 60 possible levels of worker skills between 0 and 1, 40 possible asset levels uniformly distributed between 0 and 1000, and 70 possible savings levels between 0 and 1000. I re-do the analysis for two cases. The first of these is each grid space increased by ten, such that there are 60 possible levels of entrepreneurial skills, 70 possible levels of worker skills, 60 possible asset levels, and 80 possible savings levels. The second case is each grid space reduced to one tenth of the original grid, such that there are 5 possible levels of entrepreneurial skills, 6 possible levels of worker skills, 4 possible asset levels, and 7 possible savings levels. Below is a graphical representation of these two cases:



(a) Grid space increased by ten



(b) Grid space decreased to one-tenth

The graphs indicate the model is robust to small changes in the grid space. When increased by ten, the rate of unemployment increases by 0.2 percentage points, the rate of wage work decreases by 0.3 percentage points, and the rate of entrepreneurs increases by 0.1 percentage points, all of which are minor in magnitude. As expected, the model is not robust to large changes in the grid space. The first implication of a large change in the grid space is that entrepreneurs have less possibilities to save optimally, which would result in a reduction in the rate of entrepreneurs. The second implication of this is that a misalignment between the agents' expectations over their skills draws and their real draws might have greater implications for their utility, since the difference between each skill level is greater. Since this uncertainty manifested most in the lifetime utility of the worker as explained in section 7.4, this would result in a reduction in the rate of wage worker. The reductions will likely be absorbed by an increase in the rate of unemployment. The analysis confirms this with a 8.2 percentage point increase in unemployment, a 0.4 percentage point decrease in the rate of wage work, and a 7.8

percentage point decrease in the rate of entrepreneurship.

9.4 Frisch elasticity parameter

The Frisch elasticity of labor supply (ε_f) measures how the hours worked by an agent responds to changes in income, for a fixed marginal utility of wealth. When applied to the preferences in the dynamic model in this paper which is separable in consumption and hours worked, this elasticity takes the following constant form:

$$\varepsilon_{f,t} = \frac{dn_t/n_t}{dI_t/I_t} \mid \lambda_t = \frac{n_t^{\frac{1}{\eta}}}{n_t\left[\frac{n_t^{\frac{1}{\eta}-1}}{\eta} - 0\right]} = \eta$$

There are no subscripts to distinguish between the workers and entrepreneurs for clarity in the equation, however, the I_t denotes the income earned by wage workers as w, or the income earned by the entrepreneurs through their profit. The elasticity is measured holding constant the marginal utility of wealth, captured above as λ_t, which represent the Lagrange multipliers on the budget constraints for the worker and the entrepreneur. By holding these constant, the elasticity captures the responsiveness to changes in income that are driven through the disutility of work, rather than a combination of the disutility the effects of working less on wealth.

I change $\eta = 0.4$ in my benchmark labour elastic model and find the occupational choice distribution robust to small changes in the parameter. For $\eta = 0.3$, entrepreneurship increases by 0.1 percentage points and for $\eta = 0.5$ there is no change in entrepreneurship. For $\eta = 0.6$, entrepreneurship decreases by 0.1 percentage points. This trend for the entrepreneurs continues as η is decreased or increased further. The proportion of wage workers is also robust to small changes in the parameter, but follows the opposite trend to the entrepreneur. This means that as an agent's working decision becomes more responsive to the changes in their income, there are fewer entrepreneurs and more workers in equilibrium. While it is difficult to test for this formally, a possible explanation is that entrepreneurs face more uncertainty in their income generation due to the role of their skill in determining the cost of and profit from production, such that the higher elasticity results in them responding to income shocks more than a worker responds. This relative difference between the responsiveness by the worker and the entrepreneur will determine their earnings and the final occupational distribution.

10 Discussion

The results of the dynamic model show that a tax-funded UBI from the government can make some agents divert their assets towards businesses. This decision is driven by their expected income from the business, compared to their available alternatives in the labour market. However, this holds true only for agents with an entrepreneurial skill level above a certain threshold. Moreover, the analytical model shows that the output of an agent depends on assets as well as skills only as long as they are capital constrained, and depends only on skills if they have sufficient capital.

This implies that policy for spurring entrepreneurship should target both, skills and assets, and that focusing only one of these two determinants might be sub-optimal in the framework of this model. If focusing on skills, educational policies that increase entrepreneurial skill are valuable, but only for agents sufficiently endowed with an initial asset level in the single period. Thus a more effective policy would also consider the assets of an agent. The static model suggests that any sort of monetary subsidy, universal or targeted towards potential entrepreneurs will increase the number of entrepreneurs in the society. Interestingly, this policy is beneficial only to those with the minimum entrepreneurial skill as given by the vertical line in 8. It suggests that the subsidy programs targeted at groups that have lower education or skill might not be effective in this regard. The difficulty in observing entrepreneurial skill makes such a program extremely difficult to implement, and could lead to adverse selection.

Due to time constraints, I was unable to make the dynamic model a full general equilibrium model, so it remains unclear how providing the additional income to everyone rather than only to entrepreneurs fuels demand and thus entrepreneurship. However, by increasing unemployment in the economy, the model provides some insight into a universal basic income might perform on an aggregate scale. Tables 5 and 6 show that agents who switch to unemployment with the welfare have low entrepreneurial skills, re-iterating the importance of a policy directed at making entrepreneurship more productive from a skills perspective.

The models also consider the roles of risk and uncertainty in an agent's occupational choice decision, by changing the parameter of risk aversion and the persistence of the idiosyncratic shocks for agents. The results highlight that uncertainty over the expected outcomes has an important role to play for an agent's occupational choice decision. Agents who are more risk averse have a greater inertia to become entrepreneurs. This implies that if the UBI provides a cushion to fall back on in the event of a business failure, this inertia for risk averse agents might be reduced.

11 Conclusion

In this paper I explored whether Universal basic Income has a role to play in the decision to become an entrepreneur. I answered this question by computationally solving an occupational choice model for agents that are heterogeneous in assets and skills, and can choose between unemployment, wage work, and entrepreneurship. The conjecture tested was that a UBI might allow potential entrepreneurs to divert their assets to production by alleviating their wealth constraints. I characterized this propensity for entrepreneurship through the entrepreneurial skill of an agent, where a higher skill level corresponds to a greater propensity for entrepreneurship. The analysis was performed in a dynamic setting, for 2 cases: one where agents face no labour disutility, and one where agents face labour disutility in accordance with a neoclassical model of labour-leisure choice.

The results across both models show that the introduction of a tax-funded UBI policy increases the rate of entrepreneurship. The policy also increases the rate of unemployment, and decreases the rate of wage work. The characteristics of the agents who switch occupational states with the UBI indicate the increase in entrepreneurship is due to agents who were asset poor before the policy having more to invest into production and generate greater profits, for all levels of entrepreneurial skills. Thus the unemployed agents and workers who have entrepreneurial skills that are sufficiently high become entrepreneurs.

12 Limitations and further research

The first limitation of my research is that I could not conduct an analysis of how much entrepreneurship rises due the increases in aggregate consumption from the UBI for the worker and the unemployed agent. This is because I was unable to set up a market to facilitate workers and unemployed agents consuming a portion of the good produced by the entrepreneurs. Since the entirety of it is consumed by the entrepreneur, the consumption driven effect is restricted to the entrepreneur. However, the effects of the aggregate consumption for the worker and the unemployed agent has an implication for their own expected income analysis, and thus the final occupational distribution. In time, I hope to endogenise the the labour market wage through the goods production, and set up a market whereby two types of goods can be exchanged, to analyse the demand driven increase in entrepreneurship. Doing so would indicate whether there is a novelty in a universal basic income for everyone over a targeted income for entrepreneurs.

The second limitation of the paper is that the calibration is performed with only the occupational target in the data, rather than for a richer set of parameters. The most crucial of these parameters is the interest rate, the taxes, and the Frisch elasticity parameter, all of which should be determined endogenously or calibrated for a more accurate analysis.

Finally, the computational model has not yet been validated against empirical data on persistent cash transfers and their effects on entrepreneurship. This is partly because data in this field is missing, with the Permanent Alaska Fund being one of the only universal and persistent cash transfer programs available. Nonetheless, a crude validation could still be performed using targeted or non-persistent transfers to see their effects on entrepreneurial pursuit.

A | Appendix

A.1 Analytical model

Preferences

There is a single time period in which agents indexed by $i \in [i_1, i_n]$ are heterogeneous in assets (a_i) and entrepreneurial skill (ϕ_i)

$$\theta_i = \{a_i, \phi_i\}$$

Agents choose between two occupational choices: wage work, for which they receive an exogenous market wage w to produce one unit of a worker good (c^W), or entrepreneurship, for which they earn a revenue for producing an entrepreneurial good (c^E). Agents gain utility from the consumption of these two types of goods. They weight their consumption over these two preferences with parameter γ as captured below:

$$\max_{c^W, c^E} \{\gamma \ln c^W + (1-\gamma) \ln c^E\}$$

All agents earn interest r on their asset a_i so that there are two possibilities for the budget constraint, depending on the occupational choice decision:

$$\begin{aligned} BC_W : p_e c^E + p_w c^W &= a_i(1+r) + w \\ BC_E : p_e c^E + p_w c^W &= a_i(1+r) - s - k + p_e(\phi_i k^\alpha) \end{aligned}$$

If the agent is a worker, then their budget constraint is BC_W, given by the assets after earning interest $a_i(1+r)$ and wage w. If the agent is an entrepreneur, then their budget constraint is BC_E, given by the assets after earning interest $a_i(1+r)$, less a start up cost s for setting up their business, a variable capital k, and the revenue $p_e \phi_i k^\alpha$ generated from production of the entrepreneurial good.. The price at which the entrepreneurial goods are sold is p_e, and the price at which worker goods are sold is p_w. I assume all agents are homogeneous in their worker skill level in the static setting, for analytical tractability.

Technology

Once an agent pays the start up cost s, they can set up their entrepreneurial firm in which the only factor of production is capital. All entrepreneurial firms maximize profit over their capital usage according to the following production function where $\alpha \in (0, 1)$:

$$\max_{k}\{p_e \phi k^{\alpha} - k\}, \text{ s.t.}$$
$$k \leq a(1+r) - s$$

If the optimal solution to the agent's problem does not reach the upper bound, the agent is capital unconstrained, while if it reaches it or exceeds it, the agent is capital unconstrained. That is, when the solution to the entrepreneur's maximization yields an optimal $k^* = (\alpha p_e \phi)^{\frac{1}{1-\alpha}}$ that exceeds $a(1+r) - s$, then the optimal $k^* = a(1+r) - s$. Thus the output given by $y = p_e \phi k^{\alpha}$ depends on the agent's asset level, and can be summarised as the following, where equation A.1 corresponds to the unconstrained agent, and equation A.2 corresponds to the constrained agent:

$$y = \begin{cases} (p_e \phi)^{\frac{1}{1-\alpha}} (\alpha)^{\frac{\alpha}{1-\alpha}}, & \text{if } a > \frac{(\alpha p_e \phi)^{\frac{1}{1-\alpha}} + s}{1+r} \quad \text{(A.1)} \\ p_e \phi [a(1+r) - s]^{\alpha}, & \text{otherwise} \quad \text{(A.2)} \end{cases}$$

With these two income possibilities, the condition for the agent to select into entrepreneurship is the following: At t = 0, choose entrepreneurship if the expected income possibilities in equations A.2 and A.1 exceed the market wage w. I break down this decision rule for the unconstrained and constrained agents separately as follows:

The unconstrained agent selects into entrepreneurship if:

$$w + s < (p_e \phi k)^{\alpha} - k$$
$$w + s < (p_e \phi)^{\frac{1}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}} - (\alpha p_e \phi)^{\frac{1}{1-\alpha}}$$
$$\phi > \frac{1}{p_e} \left(\frac{w+s}{m} \right)^{1-\alpha}$$

$$m = \alpha^{\frac{\alpha}{1-\alpha}} - \alpha^{\frac{1}{1-\alpha}}$$

The constrained agents selects into entrepreneurship if:

$$
\begin{aligned}
w + s &< p_e \phi [a(1+r) - s]^\alpha - a(1+r) + s \\
\phi &> \frac{w + a(1+r)}{p_e [a(1+r) - s]^\alpha}
\end{aligned}
$$

Normalizing the price of the entrepreneurial good such that $p_e = 1$, the conditions above can be summarised as:

$$
\text{Choose } E \text{ if: } \begin{cases} \phi \geq \left(\frac{w+s}{m} \right)^{1-\alpha}, & \text{if } a_i > \frac{(\alpha p_e \phi)^{\frac{1}{\alpha-1}} + s}{1+r} \quad \text{(A.3)} \\ \phi \geq \frac{w + a_i(1+r)}{[a(1+r) - s]^\alpha}, & \text{otherwise} \quad \text{(A.4)} \end{cases}
$$

For the constrained agents, the change in output with changes in skills is given by $\frac{\partial y}{\partial \phi} = \frac{y}{\phi}$, while the change in output with changes in assets are captured as $\frac{\partial y}{\partial a} = \frac{\alpha y}{a}$.

To understand how capital constrained agents substitute between assets and skills in their selection into entrepreneurship, I consider how the skills condition in the agent's decision to become an entrepreneur changes with assets:

$$
\frac{\partial \phi}{\partial a} = \frac{(1+r)[a(1+r) - s]^\alpha] - [w + a(1+r)][\alpha(a(1+r) - s)^{\alpha-1}(1+r)]}{[(a(1+r) - s)^\alpha]^2} \quad \text{(A.5)}
$$

Since the denominator of equation A.5 is positive, whether skills increase or decrease with assets in the optimal condition will depend on the numerator. Suppose first that it is increasing. Then,

$$
\begin{aligned}
(1+r)[a(1+r) - s]^\alpha &> [w + a(1+r)][\alpha(a(1+r) - s)^{\alpha-1}(1+r)] \\
1 &> [w + a(1+r)][\alpha(a(1+r) - s)^{-1} \\
(a(1+r) - s) &> \alpha[w + a(1+r)] \\
a(1+r)(1-\alpha) &> \alpha w + s
\end{aligned}
$$

The LHS of the inequality above is positive for all $\alpha \in [0,1]$, and the RHS is positive for all positive wages and start up costs. Thus, the condition on the skills needed for entrepreneurship to be beneficial over wage work is increasing in assets for any combination of assets, wages and start up costs for which the above inequality holds true.

Suppose now that the skill condition for selection into entrepreneurship is decreasing in assets. Then following from the previous inequality,

$$
\begin{aligned}
\frac{\alpha w + s}{(1+r)(1-\alpha)} &> \frac{(\alpha\phi)^{(\frac{1}{1-\alpha})}}{1+r} + s \\
\frac{\alpha w + s}{1-\alpha} &> \frac{(\alpha\phi)^{\frac{1}{1-\alpha}} + (1+r)s}{1+r} \\
\left(\frac{\alpha}{1-\alpha}\right) w + \left(\frac{1}{1-\alpha}\right) s &> (\alpha\phi)^{\frac{1}{1-\alpha}} + (1+r)s \\
\left(\frac{\alpha}{1-\alpha}\right) w - (\alpha\phi)^{\frac{1}{1-\alpha}} &> s\left((1+r) - \frac{1}{1-\alpha}\right)
\end{aligned}
$$

As before, the condition on the skills needed for entrepreneurship to be beneficial over wage work is increasing in assets for any combination of assets, wages and start up costs for which the above inequality holds true. I plot the condition for the selection into entrepreneurship for values $\alpha = 0.5$, $w = 1$, $s = 0.2$, and $r = 0.04$ for a visual representation of the condition, in figure 8.

Bibliography

Akee, R. K., W. E. Copeland, G. Keeler, A. Angold, and E. J. Costello (2010). Parents' incomes and children's outcomes: a quasi-experiment using transfer payments from casino profits. *American Economic Journal: Applied Economics 2*(1), 86–115.

Banerjee, A., P. Niehaus, and T. Suri (2019). Universal basic income in the developing world. *Annual Review of Economics 11.*

Baumol, W. J. (1968). Entrepreneurship in economic theory. *The American economic review 58*(2), 64–71.

Evans, D. S. and B. Jovanovic (1989). An estimated model of entrepreneurial choice under liquidity constraints. *Journal of political economy 97*(4), 808–827.

Fairlie, R. W. and F. M. Fossen (2018). Opportunity versus necessity entrepreneurship: Two components of business creation.

Friedman, M. (1962). Capitalism and freedom. *University of Chicago*.

Harvey, P. L. (2006). The relative cost of a universal basic income and a negative income tax. *Basic Income Studies 1*(2).

Hoynes, H. W. and J. Rothstein (2019). Universal basic income in the us and advanced countries. Technical report, National Bureau of Economic Research.

Jones, D. and I. Marinescu (2018). The labor market impacts of universal and permanent cash transfers: Evidence from the alaska permanent fund. Technical report, National Bureau of Economic Research.

Levy, B. (1993). Obstacles to developing indigenous small and medium enterprises: an empirical assessment. *The World Bank Economic Review 7*(1), 65–83.

Lochner, L. and A. Monge-Naranjo (2012). Credit constraints in education. *Annu. Rev. Econ. 4*(1), 225–256.

Marinescu, I. (2018). No strings attached: the behavioral effects of us unconditional cash transfer programs. Technical report, National Bureau of Economic Research.

Meade, J. E. (1935). Outline of an economic policy for a labour government. *The collected papers of James Meade 1*, 33–78.

Price, D. J., J. Song, et al. (2016). The long-term effects of cash assistance. *Economics Department, Stanford University*.

Saez, E. (2002). Optimal income transfer programs: intensive versus extensive labor supply responses. *The Quarterly Journal of Economics 117*(3), 1039–1073.

Salehi-Isfahani, D. and M. H. Mostafavi-Dehzooei (2018). Cash transfers and labor supply: Evidence from a large-scale program in iran. *Journal of Development Economics 135*, 349–367.

Van der Linden, B. (2004). Active citizen's income, unconditional income and participation under imperfect competition: a welfare analysis. *Oxford Economic Papers 56*(1), 98–117.