A General Equilibrium Theory of Occupational Choice under Optimistic Beliefs about Entrepreneurial Ability

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Abstract

This paper studies the impact of optimism on occupational choice using a general equilibrium framework. We show that optimism has four main qualitative effects: it leads to a misallocation of talent which lowers output, raises input prices, makes workers better off, and entrepreneurs worse off. The model is calibrated to match salient features of US manufacturing data and empirical evidence on the optimism of US individuals and US nascent entrepreneurs. The calibration shows that the cost of optimism is half percent of output. In contrast, optimism leads to a 5 percent increase in input prices and a 29 percent decline in the mean returns to entrepreneurship.

JEL Codes: D50; H21; J24; L26.

Keywords: General Equilibrium; Entrepreneurship; Optimism.

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1 Introduction

The seminal paper of occupational choice and firm size distribution of an economy is Lucas (1978). Individuals have heterogenous one-dimensional abilities as entrepreneurs and choose between entrepreneurship and paid employment. The most talented individuals become entrepreneurs and the less talented ones become workers. The ability differentials across entrepreneurs give rise to different spans of control (firm sizes). Two main predictions of Lucas' model are that the mean returns to entrepreneurship are greater than average wages and that the return distributions of entrepreneurs and workers have non-overlapping supports.

These two predictions stand in contrast to empirical evidence on the returns to entrepreneurship. First, the returns to entrepreneurship are found, on average, not to be higher than wages.[1] For example, Hamilton (2000) finds that after 10 years in business the median entrepreneurial earnings are 35 percent less than those on a paid job of the same duration. Similarly, Moskovitz and Vissing-Jorgensen (2002) find that the returns to entrepreneurship are, on average, not different from the return on a diversified publicly traded portfolio—the private equity puzzle.[2] Second, the returns to entrepreneurship are found to be highly variable, more than wages, and more than the returns on public equity (Borjas and Bronars (1989), Hamilton (2000), and Moskovitz and Vissing-Jorgensen (2002)). Hence, the empirical return distributions of entrepreneurs and workers have overlapping supports.

Moreover, research on entrepreneurs' traits and expectations casts serious doubts on the assumption that entrepreneurs are rational decision makers. Entrepreneurs are extremely optimistic about the future of their firms. Most businesses fail within a few years (Dunne et al. (1988)). However, entrepreneurs report the odds of their business 'succeeding' to be significantly higher than historically observed and substantially better than the odds of success for other similar businesses (Cooper et al. (1998)).

[1] See Shane and Venkataraman (2000) and Åstebro et al. (2014) for surveys on this topic.

[2] This result was obtained for the 1989-1998 period. However, Kartashova (2014) shows that the private equity puzzle does not extend to the 1989-2010 period.

Direct comparison of entrepreneur expectations to new venture outcomes shows that a representative sample of French entrepreneurs tend to overestimate employment expansion and sales growth (Landier and Thesmar (2009)). Nascent entrepreneurs overestimate the probability that their projects will result in operating ventures and, for those ventures that achieve operation, 62 percent overestimate future sales and 46 percent overestimate the number of employees in the first year of operation (Cassar (2010)). 48.8 percent of a sample of U.S. nascent entrepreneurs think that the likelihood of exit of their venture is zero in five years time (Hyytinen et al. (2014)). Individuals who switch into self-employment have an optimistic view of their future prior to switching into self-employment (Dawson et al. (2014)).

Empirical evidence on entrepreneurs' traits and expectations also shows that entrepreneurs are more optimistic than employees (Arabsheibani et al. (2000), Fraser and Greene (2006), and Koudstaal et al. (2015)). Entrepreneurs expect to live about 2 years longer than non-entrepreneurs after controlling for differences in smoking, race, and education-related mortality risk across groups (Puri and Robinson (2013)). In contrast, entrepreneurs' risk attitudes are indistinguishable from those of wage earners (Wu and Knott (2006), Parker (2009), Holm et al. (2013), and Koudstaal et al. (2016)). Hence, the empirical puzzle of the low mean returns to entrepreneurship compared to average wages cannot be explained by assuming that entrepreneurs have different risk attitudes from those of employees.

In this paper we show that optimism can help explain the empirical puzzle of the low mean returns to entrepreneurship compared to average wages. To do that we build up a fully specified general equilibrium model of occupational choice with labor, capital, and output markets. Each individual in the population can choose between being a paid employee or entering entrepreneurship and managing a firm. The main novelty is the assumption that the population is composed of optimists and realists. The occupational choice of a realist is a standard one but the occupational choice of an optimist is affected by her biased expectations about entrepreneurial ability. Unlike the existing literature, our model allows us to make qualitative as well as quantitative predictions regarding the impact of optimism on output, input prices, and the mean returns to entrepreneurship.

Following Lucas (1978) we model a closed economy with a population of size N and a capital stock of K units of capital. Each individual is endowed with one unit of labor, with capital stock K/N, and with a one-dimensional ability θ drawn from the cumulative distribution function $G(\theta)$. Individuals are risk neutral and maximize their expected returns by choosing occupations. A firm in this economy is one entrepreneur together with the labor and capital under his control. The production function of the firm is characterized by decreasing returns to scale and complementarity between inputs. The ability of the entrepreneur enters into the production function as the total factor productivity. Decreasing returns to scale in labor and capital ensure that the competitive equilibrium exhibits a non-degenerate distribution of firm sizes.

We depart from Lucas (1978) by assuming that a fraction $\lambda \in (0, 1)$ of individuals is optimistic about ability whereas the remaining fraction $1 - \lambda$ is realistic. Realists know their ability is θ whereas optimists think, mistakenly, that their true ability is $\gamma\theta$, with $\gamma > 1$. Hence, realists who enter entrepreneurship know the true production function of their firms, whereas optimists believe their firms are more productive than they really are.[3]

We solve the competitive equilibrium assuming a generalized Cobb-Douglas production function and a Pareto distribution of ability. The generalized Cobb-Douglas technology is a standard assumption in general equilibrium models of occupational choice. The Pareto distribution has been shown to provide a good approximation for real world firm size distributions.

[3] Chapter 2 of Parker (2009) discusses in detail the main extensions of Lucas' (1978) model. Kanbur (1979) studies the role of learning about ability on entrepreneurship. Kilhstrom and Laffont (1979) study the role of risk aversion on entrepreneurship. Bewley (1989) studies the role of uncertainty (or ambiguity) aversion on entrepreneurship. Jovanovic (1994) studies the joint role of heterogeneous entrepreneurial and working abilities on entrepreneurship. Finally, Lazear (2005) studies the role of entrepreneurial and specialist abilities on entrepreneurship.

The competitive equilibrium is characterized by: (i) a cut-off ability level $\hat{\theta}_R$ such that realists with ability less than $\hat{\theta}_R$ become workers and those with ability greater than $\hat{\theta}_R$ become entrepreneurs, (ii) a cut-off ability level $\hat{\theta}_O$ such that optimists with ability less than $\hat{\theta}_O$ become workers and those with ability greater than $\hat{\theta}_O$ become entrepreneurs, (iii) a market clearing wage that equates labor demand to supply, and (iv) a rental cost of capital that equates capital demand to supply.

In equilibrium, optimists are more likely to become entrepreneurs than realists and entrepreneurs are more likely to be optimists than employees. These two predictions match empirical evidence on the expectations of entrepreneurs and employees. We also show that optimism leads to a misallocation of talent. Optimists crowd out realists from entrepreneurship. The misallocation of talent implies that the lowest ability entrepreneurs are less talented at running a firm than the highest ability workers. This is an empirically attractive implication of the model since, in reality, the return distributions of entrepreneurs and workers have overlapping supports (see Åstebro et al. (2014)).

Optimism raises the equilibrium wage since it leads to an expansion of labor demand and a contraction of labor supply. Optimism also raises the rental cost of capital since it leads to an expansion of capital demand and capital supply is exogenous. The misguided occupational and input choices of optimists create a distortion in the economy which lowers output. Furthermore, the existence of optimists lowers the average ability of the pool of entrepreneurs. In contrast, optimism has no impact on the number of workers, entrepreneurs, relative input prices, and the firm size distribution. Finally, optimism lowers the mean returns to entrepreneurship as it reduces output, raises input prices, and leaves the number of entrepreneurs unchanged.

The model is calibrated to match salient features of US manufacturing data. The production function and the capital stock are calibrated following Atkeson and Kehoe (2005) and Adler (2016). The model implies a direct link between firm size, measured by employment, and entrepreneurial ability. More precisely, when ability follows a Pareto distribution with a shape parameter ρ, then firm size follows a Pareto distribution with shape parameter $\xi = \rho(1-\eta)$, where η is the degree of decreasing returns to scale. Hence, we approximate the firm size distribution with a Pareto distribution and use the estimated ξ together with η to calibrate ρ. The fraction of optimists λ and the intensity of optimism γ are calibrated using empirical evidence on the expectations of US individuals and US nascent entrepreneurs.

The calibration shows that the cost of optimism to the US manufacturing sector is about half percent of output. In contrast, optimism leads to a 5 percent increase in input prices and a 29 percent decline in the mean returns to entrepreneurship. Moreover, the ratio of the mean returns to entrepreneurship to the average wage predicted by the model is much closer to the one observed in the data when optimism is taken into account than when it is not.

We discuss the robustness of the qualitative implications of our model to a number of extensions: if the return to entrepreneurship is stochastic rather than deterministic; if individuals have heterogeneous abilities both as workers and as entrepreneurs; and if the occupational choice is extended to consider also firms run by owners without employees.

The reminder of the paper proceeds as follows. Section 2 reviews related literature. Section 3 sets up the model. Section 4 characterizes the competitive equilibrium. Section 5 calibrates the model. Section 6 discusses the main assumptions of the model and extensions. Section 7 concludes the paper. All proofs can be found in the Appendix.

2 Related Literature

In this section we explain how our work contributes to the literature on occupational choice and entrepreneurship. We focus on the studies that address the puzzle of the low mean returns to entrepreneurship compared to average wages. We distinguish between three types of approaches: general equilibrium models without learning, general equilibrium models with learning, and partial equilibrium models.

2.1 General Equilibrium Models without Learning

Manove (2007) proposes a model where agents can either be entrepreneurs or a workers. Entrepreneurs start their business with an initial stock of capital, which can be used for consumption or for production. There is no external market for capital. Entrepreneurs instead hire labor from a perfectively competitive market, and the difference between production, net of the cost of labor, and consumption adds up to the stock of capital. Like in our model, agents are either realist or unrealistic optimists. While the model is dynamic, it abstracts from learning about the true production function. Manove (2007) shows that optimist entrepreneurs may stay in business in the steady state, and by bidding up wages they increase the welfare of workers and decrease the welfare of realistic entrepreneurs. The effect on output is ambiguous: the overutilization of external resources (labor) reduces output, while the overutilization of internal resources (savings) increases output. The main differences between Manove (2007) and our model are that, in our model, agents are heterogeneous in terms of their actual entrepreneurial ability, and they hire both labor and capital from the external market. We show that optimism leads to a misallocation of resources, where some entrepreneurs may earn less than the market wage. We also calibrate the model to show that optimism leads to a decrease in output, higher input prices, and a large decrease in the mean returns to entrepreneurship.

Rigotti et al. (2011) study the role of pessimism on technology choice. Individuals choose to be entrepreneurs or employees and between employing a traditional technology or a new one which has ambiguous returns. A firm is an entrepreneur-employee pair operating a particular technology. Individuals differ in their degree of pessimism. Rigotti et al. (2011) find that firms employing new technologies are run by less pessimistic entrepreneurs and employ less pessimistic employees. In contrast, firms employing traditional technologies are run by more pessimistic entrepreneurs and employ more pessimistic employees.

2.2 General Equilibrium Models with Learning

Vereshchagina and Hopenhayn (2009) consider a life-cycle model in which individuals can switch back and forth between entrepreneurship and paid employment. Entrepreneurship is risky and paid employment provides a fixed outside option. Individuals face financing constraints and because of them they take more risk at low wealth levels than at high wealth levels. Vereshchagina and Hopenhayn show that the combination of occupational choice and financing constraints can lead entrepreneurs to display risk-taking behavior. Hence, entrepreneurs operate in an environment that leads them to engage in risky investment even in the absence of a return premium.

Campanale (2010) considers a life-cycle occupational and portfolio choice model with learning. The key assumption is that the quality of a business project is not precisely known upon entry and is learned over time. The model shows that entry and private equity allocation for the majority of entrepreneurs can be rationalized even with negative expected premia on individual business investment. Since individuals can switch back to paid-employment, they find it worthwhile experimenting with entrepreneurship to find out if the project is good even if initially the expected return is low. Campanale quantifies the amount of risk premia that would justify entry into entrepreneurship in this environment, and finds that it is still substantially larger than what we see in the data.

Poschke (2013) proposes a life-cycle model in which individuals differ in their efficiency as workers and in the productivity of the firms they start. Whereas efficiency as a worker is known, the productivity of entrepreneurial projects can only be found after implementing them. Poschke shows that the option to abandon bad projects attracts low-ability agents into entrepreneurship.

Overall, these models show that learning about ability can explain the observed low mean returns to entrepreneurship. We show that optimism provides an alternative explanation for the observed low mean returns to entrepreneurship. In addition, we provide a quantitative assessment of the impact of optimism on output, input prices, and on the mean returns to entrepreneurship.

2.3 Partial Equilibrium Models

In de Meza and Southey (1996) individuals choose between working in a safe occupation or undertaking a project with a risky return. Entrepreneurs must select the right mix of self-finance and debt-finance from risk neutral banks to develop their projects. All individuals have the same ability or probability of success of their projects. Banks and realistic entrepreneurs know a project's true probability of success but optimistic entrepreneurs overestimate it. Banks can distinguish between optimists and realists. They show that optimists become entrepreneurs, select maximum internal finance, any form of external finance is a standard debt contract, and that optimism can lead to excessive lending.

Manove and Padilla (1999) study the role of optimism on investment and on the credit market but, unlike de Meza and Southey (1996), assume that banks cannot differentiate optimists from realists. They find that, in the presence of optimists, perfectly competitive banks may be insufficiently conservative in their dealings with entrepreneurs, even if entrepreneurs themselves may practice self-restraint to signal realism. In addition, they show that the use of collateral requirements by banks may reduce the efficiency of the credit market.

Coval and Thakor (2005) study the role of optimism and pessimism on financial intermediation. They consider a model where individuals do not have enough wealth to self-finance a project. Realists correctly assess a project's probability of success, optimists overestimate it and pessimists underestimate it. They show that realists form a financial intermediary that raises funds from pessimists (who become investors in the intermediary) and lends to optimists (who become entrepreneurs).

These studies focus mostly on the impact of optimism on credit markets and financial intermediation. The main differences between these models and ours are that, we use a general equilibrium approach, our agents have heterogeneous entrepreneurial ability, and hire both labor and capital from the external market. We show that optimism raises input prices and lowers output and can lead to a sharp decrease in the mean returns to entrepreneurship.

3 Set-up

The economy consists of a continuum of risk-neutral individuals. The population is of size N and the capital stock is of K units of capital. Individuals derive utility from consumption and can earn income either as workers or by running their own firm. Each individual is endowed with 1 unit of labor, with capital stock K/N, and with a one-dimensional ability θ drawn from the cumulative distribution function $G(\theta)$ with support on $[\theta_m, \infty)$, with $0 < \theta_m < \infty$.

If an individual with ability θ becomes a worker he supplies his unit of labor on the labor market, receives the competitive wage w for his unit of labor, and receives the competitive rental rate of capital for renting his capital K/N. Hence, a wage worker ends up with an income

$$w + rK/N.$$

If an individual with ability θ becomes an entrepreneur he can use without cost a technology defined by the continuous production function

$$y = \theta f(l, k),$$

where y is output, l is labor, and k is capital. Following Lucas (1978), θ enters into the production function as the total factor productivity (TFP). Any individual can run at most one firm. We assume that f is twice continuously differentiable with $f_l > 0$, $f_k > 0$, $f_{ll} < 0$, $f_{kk} < 0$. This production function combines as inputs one entrepreneur, who is essential to operate the firm, l homogeneous employees, and k units of homogeneous capital. The production function exhibits decreasing returns to scale in the variable inputs, labor and capital, so that the competitive equilibrium exhibits a non-degenerate firm size distribution. This assumption implies that the size of firms is finite. This could be due for instance to limits in entrepreneurs' span of control: as activity expands, it becomes more difficult to control, and the marginal product of the variable inputs diminishes.

Entrepreneurs hire labor at the competitive wage rate w and rent capital at the competitive rental cost of capital r. Hence, an entrepreneur who employs l workers and rents k units of capital earns a profit of

$$\pi(\theta, w, r) = p\theta f(l, k) - wl + r(K/N - k).$$

From now on the price of output p is normalized to be 1. Individuals can belong to one of two types: those with optimistic beliefs and realists. A fraction $\lambda \in (0, 1)$ of the population has optimistic beliefs about their ability as entrepreneurs and a fraction $1 - \lambda$ has realistic beliefs. The perceived profit of an entrepreneur who employs l workers and rents k units of capital is

$$\pi(\gamma\theta, w, r) = \gamma\theta f(l, k) - wl + r(K/N - k), \tag{1}$$

where $\gamma \geq 1$. The parameter γ measures the strength or intensity of optimistic beliefs. Entrepreneurs for whom $\gamma = 1$ are realists, and those with $\gamma > 1$ are optimists. The greater γ is, the more optimistic entrepreneurs overestimate their abilities and their future profits.[4] The distributions of entrepreneurial ability of realists and optimists are identical and are assumed to be independent. Hence, realists and optimists are equally endowed in terms of their entrepreneurial abilities.

An individual who becomes an entrepreneur will choose to employ $l(\gamma\theta; w, r)$ workers and $k(\gamma\theta; w, r)$ units of capital where $l(\gamma\theta; w, r)$ and $k(\gamma\theta; w, r)$ are the values of l and k that solve the following problem

$$\max_{l,k}[\gamma\theta f(l, k) - wl + r(K/N - k)].$$

The first-order conditions to this problem are

$$\gamma\theta f_l(l, k) = w. \tag{2}$$

[4] This specification of optimistic beliefs is analytically tractable. Furthermore, under it optimism coincides with overestimation of ability. The strongest cross-national covariate of an individual's entrepreneurial propensity is whether the person believes herself to have the sufficient skills and knowledge to start a business (Koellinger et al. (2007)). The probability of becoming an entrepreneur increases with a person's confidence in his/her ability to perform entrepreneurship related tasks (Cassar and Friedman (2009)). Entrepreneurs are more overconfident about their abilities than non-entrepreneurs: 59 percent of entrepreneurs, 56 percent of the managers, and 52 percent of the employees overestimate their performance on a cognitive ability test (Koudstaal et al. (2015)).

and

$$\gamma\theta f_k(l,k) = r. \tag{3}$$

It follows from (2), the assumption of decreasing returns to labor, $f_{ll} < 0$, and complementarity between ability and labor, i.e., $f_{l\theta} > 0$, that entrepreneurs with a higher θ hire more workers: $\partial l(\gamma\theta, w, r)/\partial\theta = -\gamma f_{l\theta}/f_{ll} > 0$. Similarly, it follows from (3), the assumption of decreasing returns to capital, $f_{kk} < 0$, and complementarity between ability and capital, i.e., $f_{k\theta} > 0$, that entrepreneurs with a higher θ hire more capital: $\partial k(\gamma\theta, w, r)/\partial\theta = -\gamma f_{k\theta}/f_{kk} > 0$. It also follows from (2) that an optimistic entrepreneur will demand more labor than a realist with the same ability. Similarly, it follows from (3) that an optimistic entrepreneur will demand more capital than a realist with the same ability.

A realist with ability θ chooses to become a worker at wage w and rental cost of capital r when

$$\theta f(l(\theta, w, r), k(\theta, w, r)) - wl(\theta, w, r) - rk(\theta, w, r) \leq w. \tag{4}$$

He selects to be an entrepreneur if

$$\theta f(l(\theta, w, r), k(\theta, w, r)) - wl(\theta, w, r) - rk(\theta, w, r) \geq w, \tag{5}$$

and he is indifferent if the equality holds in (4) and (5).[5] An optimist with perception of ability $\gamma\theta$ chooses to become a worker at wage w and rental cost of capital is r when

$$\gamma\theta f(l(\gamma\theta, w, r), k(\gamma\theta, w, r)) - wl(\gamma\theta, w, r) - rk(\gamma\theta, w, r) \leq w. \tag{6}$$

He selects to be an entrepreneur if

$$\gamma\theta f(l(\gamma\theta, w, r), k(\gamma\theta, w, r)) - wl(\gamma\theta, w, r) - rk(\gamma\theta, w, r) \geq w, \tag{7}$$

and he is indifferent if the equality holds in (6) and (7).

[5] The term rK/N cancels out because an agent receives the rental price of his K/N unit of capital both when he decides to be a worker and an entrepreneur.

Since there are only three markets—output, labor, and capital—by Walras' Law, general equilibrium is realized when the labor and capital markets clear. At the equilibrium wage, the labor demanded by individuals who choose to become entrepreneurs equals that supplied by individuals who choose to become workers. At the equilibrium rental cost of capital, the capital demanded by individuals who choose to become entrepreneurs equals the exogenous capital stock of the economy, K.

Formally, a competitive equilibrium is (i) a partition $\{[\theta_m, \hat{\theta}_R], [\hat{\theta}_R, \infty)\}$ of $[\theta_m, \infty)$ where for all $\theta \in [\theta_m, \hat{\theta}_R]$ (4) holds and for all $\theta \in [\hat{\theta}_R, \infty)$ (5) holds, (ii) a partition $\{[\theta_m, \hat{\theta}_O], [\hat{\theta}_O, \infty)\}$ of $[\theta_m, \infty)$ where for all $\theta \in [\theta_m, \hat{\theta}_O]$ (6) holds and for all $\theta \in [\hat{\theta}_O, \infty)$ (7) holds, (iii) a wage w for which labor demand equals labor supply

$$(1-\lambda)\int_{\hat{\theta}_R}^{\infty} l(\theta, w, r) g(\theta) d\theta + \lambda \int_{\hat{\theta}_O}^{\infty} l(\gamma\theta, w, r) g(\theta) d\theta = \left[(1-\lambda)G(\hat{\theta}_R) + \lambda G(\hat{\theta}_O)\right], \tag{8}$$

and (iv) a rental cost of capital r for which capital demand equals the exogenous capital supply

$$N\left[(1-\lambda)\int_{\hat{\theta}_R}^{\infty} k(\theta, w, r) g(\theta) d\theta + \lambda \int_{\hat{\theta}_O}^{\infty} k(\gamma\theta, w, r) g(\theta) d\theta\right] = K \tag{9}$$

In equilibrium, realists with ability below $\hat{\theta}_R$ become workers whereas those with ability above $\hat{\theta}_R$ become entrepreneurs. Similarly, optimists with ability below $\hat{\theta}_O$ become workers whereas those with ability above $\hat{\theta}_O$ become entrepreneurs. We refer to a realist with ability $\hat{\theta}_R$ as the *marginal realistic entrepreneur*. We refer to an optimist with ability $\hat{\theta}_O$ as the *marginal optimistic entrepreneur*.

4 Competitive Equilibrium

In this section we determine the competitive equilibrium under a generalized Cobb-Douglas production function and a Pareto distribution of ability.

The production function is given by

$$y = \theta f(l, k) = \theta l^{\alpha} k^{\beta}, \text{ with } \alpha + \beta \equiv \eta \in (0, 1).$$

Hence, the variable inputs, labor and capital, are combined under a generalized Cobb-Douglas production function with decreasing returns to scale. This is a standard assumption in general equilibrium occupational choice models with heterogeneous ability (see, Evans and Jovanovic (1989), Murphy et al. (1991), de Meza and Southey (1996), Manove (2007), and Poschke (2013)).

The Pareto distribution has been shown to provide a good approximation for the US firm size distribution (see Axtell (2001), Helpman et al. (2004), Rossi-Hansberg and Wright (2007), and Luttmer (2007)). Since Lucas (1978) produces a size distribution for firms that inherits the properties of the distribution of ability in the population, we solve the model assuming that ability is distributed according to a Pareto cumulative distribution:

$$G(\theta) = 1 - \left(\frac{\theta_m}{\theta}\right)^{\rho}, \text{ for } \theta \geq \theta_m > 0, \tag{10}$$

where $\rho > 0$ is the shape parameter and θ_m is the scale parameter that marks a lower bound on ability. The density is given by $g(\theta) = \rho\theta_m^{\rho}\theta^{-\rho-1}$. Furthermore, the mean and variance are equal to $E(\theta) = \theta_m\rho/(\rho-1)$ and $V(\theta) = \theta_m^2\rho/(\rho-1)^2(\rho-2)$, respectively. Hence, the mean exists as long as $\rho > 1$ and the variance exists as long as $\rho > 2$.

The perceived profit of an entrepreneur with ability θ and perception of ability $\gamma\theta$ is

$$\pi(\gamma\theta, l, k) = \gamma\theta l^{\alpha}k^{\beta} - wl + r(K/N - k), \tag{11}$$

where $\gamma \geq 1$. Hence, an entrepreneur with perception of ability $\gamma\theta$ chooses to employ l workers and k units of capital where l and k are the solution to

$$\max_{l,k} \left[\gamma\theta l^{\alpha}k^{\beta} - wl + r(K/N - k)\right].$$

The first-order conditions are

$$\alpha\gamma\theta l^{\alpha-1}k^{\beta} = w,$$

and

$$\beta\gamma\theta l^{\alpha}k^{\beta-1} = r.$$

Solving for l and k we obtain the input demands:

$$l(\gamma\theta, w, r) = (\gamma\theta)^{\frac{1}{1-\eta}} \left(\frac{\alpha}{w}\right)^{\frac{1-\beta}{1-\eta}} \left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\eta}}, \tag{12}$$

and

$$k(\gamma\theta, w, r) = (\gamma\theta)^{\frac{1}{1-\eta}} \left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\eta}} \left(\frac{\beta}{r}\right)^{\frac{1-\alpha}{1-\eta}}. \tag{13}$$

The input demands determine the size of the firm given the ability of the entrepreneur, the wage, the rental cost of capital, and the entrepreneur's perception of ability. We see from (12) and (13) that entrepreneurs' input demands are greater among those with higher ability θ. That is, more talented entrepreneurs run larger firms than less talented entrepreneurs, irrespective of whether firm size is defined in terms of labor or capital. We also see from (12) and (13) that, for a given ability level, optimists (those with $\gamma > 1$) run larger firms than realists (those with $\gamma = 1$). Substituting (12) and (13) into (11) and we obtain the perceived reduced form profit of an entrepreneur:

$$\pi(\gamma\theta, w, r) = \gamma^{\frac{1}{1-\eta}} \theta^{\frac{1}{1-\eta}} (1-\eta) \left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\eta}} \left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\eta}} + r\frac{K}{N}. \tag{14}$$

We see from (14) that the assumption of decreasing returns to scale, i.e., $\eta \in (0, 1)$, implies that the perceived reduced form profit of an entrepreneur is an increasing and convex function of θ. The returns to paid employment are given by

$$w + r\frac{K}{N} \tag{15}$$

The ability of the marginal realistic entrepreneur, $\hat{\theta}_R$, is obtained by setting $\gamma = 1$ in (14) and equating this to (15). Hence, a realist with ability $\hat{\theta}_R$ is indifferent between being an entrepreneur and a worker when

$$\hat{\theta}_R{}^{\frac{1}{1-\eta}} (1-\eta) \left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\eta}} \left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\eta}} = w. \tag{16}$$

The ability of the marginal optimistic entrepreneur, $\hat{\theta}_O$, is obtained by equating (14) to (15). Hence, an optimist with perception of ability $\gamma\hat{\theta}_O$ and ability $\hat{\theta}_O$ is indifferent between being an entrepreneur and a worker when

$$\gamma^{\frac{1}{1-\eta}}\hat{\theta}_O^{\frac{1}{1-\eta}}(1-\eta)\left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\eta}}\left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\eta}} = w. \tag{17}$$

Since the perceived reduced form profit of an entrepreneur is an increasing and convex function of θ it follows from (16) and (17) that there exist a unique ability cut-off between realistic entrepreneurs and realistic workers–$\hat{\theta}_R$ is unique–and an unique ability cut-off between optimistic entrepreneurs and optimistic workers–$\hat{\theta}_O$ is unique. In addition, it follows from (16), (17), and $\gamma > 1$ that:

$$\hat{\theta}_O = \frac{\hat{\theta}_R}{\gamma} < \hat{\theta}_R, \tag{18}$$

i.e., the marginal optimistic entrepreneur has a lower ability than the marginal realistic entrepreneur. This results holds regardless of the ability distribution and implies that optimists are more likely to become entrepreneurs than realists.[6] This is in line with Puri and Robinson (2007) who find that optimism is an important determinant of self-employment after controlling for a range of family, demographic, and wealth characteristics. Inequality (18) also implies that entrepreneurs are more likely to be optimists than workers. In fact, the fraction of optimistic entrepreneurs is equal to

$$\frac{E_O}{E} = \frac{\lambda\left[1-G(\hat{\theta}_O)\right]}{(1-\lambda)\left[1-G(\hat{\theta}_R)\right]+\lambda\left[1-G(\hat{\theta}_O)\right]},$$

and the fraction of optimistic workers to

$$\frac{L_O}{L} = \frac{\lambda G(\hat{\theta}_O)}{(1-\lambda)G(\hat{\theta}_R)+\lambda G(\hat{\theta}_O)}.$$

[6] The probability an optimist becomes an entrepreneur is $\Pr(E|O) = \Pr(E\cap O)/\Pr(O) = \lambda(1-G(\hat{\theta}_O))/\lambda = 1-G(\hat{\theta}_O)$. The probability a realist becomes an entrepreneur is $\Pr(E|R) = \Pr(E\cap R)/\Pr(R) = (1-\lambda)(1-G(\hat{\theta}_R))/(1-\lambda) = 1-G(\hat{\theta}_R)$. It follows from (18) that $\Pr(E|O) > \Pr(E|R)$.

It follows from (18) that $E_O/E > L_O/L$. This result is valid no matter the ability distribution and is in line with the empirical evidence in Arabsheibani et al. (2000), Fraser and Greene (2006), Puri and Robinson (2013), and Koudstaal et al. (2015).[7]

Equations (8), (9), (16), and (17), form a system of four equations and four unknowns ($\hat{\theta}_R$, $\hat{\theta}_O$, w, r) which defines a unique competitive equilibrium. Solving (16) and (17) for the unique cut-offs $\hat{\theta}_R$ and $\hat{\theta}_O$ and substituting these into (8) and (9) we obtain the unique equilibrium vector of input prices (w^*, r^*). Finally, from $(\hat{\theta}_R, \hat{\theta}_O, w^*, r^*)$ we obtain the equilibrium output level Y^*. The existence and uniqueness of the equilibrium, a standard result in Lucas (1978), is not affected by the presence of optimists. Proposition 1 describes the competitive equilibrium.

Proposition 1: *If the production function is a generalized Cobb-Douglas, i.e.,* $f(l, k, \theta) = \theta l^\alpha k^\beta$, *with* $\alpha + \beta = \eta \in (0, 1)$, *entrepreneurial ability is distributed according to a Pareto cumulative distribution, i.e.,* $G(\theta) = 1 - (\theta_m/\theta)^\rho$ *for* $\theta \geq \theta_m > 0$, *where* $\rho > 1/(1 - \eta)$, *and*

$$\frac{1 - \lambda + \lambda\gamma^\rho}{\gamma^\rho} \geq \frac{\rho(1 - \eta) - 1}{\rho(1 - \beta) - 1}, \tag{19}$$

then there exists a unique competitive equilibrium where the marginal realistic entrepreneur has ability

$$\hat{\theta}_R = \theta_m(1 - \lambda + \lambda\gamma^\rho)^{\frac{1}{\rho}} \left[\frac{\rho(1 - \beta) - 1}{\rho(1 - \eta) - 1}\right]^{\frac{1}{\rho}}, \tag{20}$$

[7] Arabsheibani et al. (2000) compare entrepreneurs' and employees' expectations of future prosperity to actual outcomes using a sample from the British Household Panel Survey (BHPS) during the years 1990-96. They find that entrepreneurs are 4.6 times as likely to forecast an improved financial position but experience a deterioration than to forecast a deterioration but experience an improvement. In contrast, for employees the ratio was only 2.9. Fraser and Greene (2006) find that self-employed Britons have higher income expectations than employees during the years 1984-99, but the difference diminishes with experience. Koudstaal et al. (2015) run a lab-in-the field experiment in the Netherlands and find that 58 percent of entrepreneurs can be classified as 'very optimistic,' i.e., have a score of 18 or more in the Revised Life Orientation Test, a commonly used measure of dispositional optimism. In contrast, only 32 percent of employees can be classified as 'very optimistic.'

the marginal optimistic entrepreneur has ability

$$\hat{\theta}_O = \theta_m \frac{(1-\lambda+\lambda\gamma^\rho)^{\frac{1}{\rho}}}{\gamma} \left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}}, \tag{21}$$

the wage is

$$w^* = \theta_m \alpha^\alpha \beta^\beta (1-\eta)^{1-\eta} (1-\lambda+\lambda\gamma^\rho)^{\frac{1}{\rho}} \left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}} \left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^{-\beta}, \tag{22}$$

the rental cost of capital is

$$r^* = \theta_m \alpha^\alpha \beta^\beta (1-\eta)^{1-\eta} (1-\lambda+\lambda\gamma^\rho)^{\frac{1}{\rho}} \left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}} \left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^{1-\beta}, \tag{23}$$

the number of workers is

$$L^* = \frac{\alpha\rho}{\rho(1-\beta)-1} N, \tag{24}$$

and the output level is

$$Y^* = \theta_m \alpha^\alpha (1-\eta)^{1-\eta} N^{1-\beta} K^\beta \frac{1-\lambda+\lambda\gamma^{\rho-1}}{(1-\lambda+\lambda\gamma^\rho)^{1-\frac{1}{\rho}}} \left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}} \left[\frac{\rho}{\rho(1-\beta)-1}\right]^{1-\beta}. \tag{25}$$

Assumption (19) implies that the marginal optimistic entrepreneur has ability greater than θ_m and thus ensures that the competitive equilibrium is well defined. Equations (20) and (21) show us that the existence of optimists leads to a misallocation of talent. In a competitive equilibrium without optimists (where $\lambda = 0$ or $\gamma = 1$) the marginal entrepreneur has ability

$$\hat{\theta}_0 = \theta_m \left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}},$$

which implies that individuals with ability $[\theta_m, \hat{\theta}_0]$ become workers and individuals with ability $[\hat{\theta}_0, \infty)$ become entrepreneurs. Hence, in the competitive equilibrium without optimists the ablest people become entrepreneurs. In a competitive equilibrium with optimists we have

$$\theta_m \leq \hat{\theta}_O < \hat{\theta}_0 < \hat{\theta}_R, \tag{26}$$

that is, realists with ability $[\theta_m, \hat{\theta}_R]$ and optimists with ability $[\theta_m, \hat{\theta}_O]$ become workers whereas realists with ability $[\hat{\theta}_R, \infty)$ and optimists with ability $[\hat{\theta}_O, \infty)$ become entrepreneurs. Hence, the presence of optimists replaces some above the benchmark cutoff $\hat{\theta}_0$ realistic entrepreneurs by some below the benchmark cutoff $\hat{\theta}_0$ optimistic entrepreneurs. Note that this crowding-out effect does not affect the ablest people. In addition, in a competitive equilibrium with optimists, the income distributions of workers and entrepreneurs have overlapping supports. This happens because the lowest ability entrepreneur (an optimist with ability $\hat{\theta}_O$) is less talented at running a firm than the highest ability worker (a realist with ability $\hat{\theta}_R$). This is an empirically attractive implication of the model since in reality the income distributions of workers and entrepreneurs have overlapping supports.

Equation (22) shows that an increase in the fraction of optimists raises the market clearing wage. The intuition behind this result is as follows. Wage effects can occur through two channels: through firm's derived demand for labor and through labor-supply decisions of individuals, who must choose to be either workers or entrepreneurs. The fact that optimists overestimate their ability implies that, for given input prices, the demand for labor of an optimist is higher than the demand for labor of a realist of the same ability. This leads to an expansion of labor demand. An optimist is, for given input prices, more attracted to entrepreneurship than a realist of the same ability. This leads to a contraction of labor supply. The expansion of labor demand and contraction of labor supply raise the market clearing wage.

Equation (23) shows that an increase in the fraction of optimists raises the rental cost of capital. The fact that optimists overestimate their ability implies that, for given input prices, the demand for capital of an optimist is higher than the demand for capital of a realist of the same ability. This leads to an expansion of capital demand. Since the supply of capital is fixed the expansion of capital demand raises the rental cost of capital.

Equation (24) shows that a change in the fraction of optimists has no impact on the equilibrium number of workers and entrepreneurs (since $E^* = N - L^*$). This result is somewhat surprising. On the one hand, an increase in the fraction of optimists lowers the number of realistic entrepreneurs, but, on the other hand, it raises the number of optimistic entrepreneurs. Hence, at first sight, an increase in the fraction of optimists seems to have an ambiguous effect on the number of entrepreneurs. However, these two effects exactly off set each other, that is, there is a full crowding out effect. Equations (22) and (23) tells us that a change in the fraction of optimists has no impact on relative input prices since

$$\frac{w^*}{r^*} = \frac{K}{N}\frac{\rho(1-\beta)-1}{\rho\beta}.$$

Finally, a change in the fraction of optimists also has no impact on the firm size distribution (the proof of this result can be found in Appendix B). Note that the marginal optimist entrepreneur's perceived ability is equal to the actual ability of the marginal realistic entrepreneur, i.e., $\gamma\hat{\theta}_O = \hat{\theta}_R$. This implies that these entrepreneurs hire the same amount of labor (and capital). Hence, the minimum size of firms run by optimists is identical to the minimum size of firms run by realists. The predictions that optimism has no impact on the equilibrium number of workers, entrepreneurs, relative input prices, and the firm size distribution are due to the assumption that ability follows a Pareto distribution.[8]

We now discuss the impact optimism on output, on the average ability of the pool of entrepreneurs, and on the mean returns to entrepreneurship. In equilibrium, the average ability of the pool of entrepreneurs, $E(\theta|E^*)$, is the weighted average of the mean abilities of realistic and optimistic entrepreneurs, that is,

$$E(\theta|E^*) = \frac{E_R^*}{E^*}E(\theta|\theta \geq \hat{\theta}_R) + \frac{E_O^*}{E^*}E(\theta|\theta \geq \hat{\theta}_O) = \frac{E_R^*}{E^*}\frac{\rho}{\rho-1}\hat{\theta}_R + \frac{E_O^*}{E^*}\frac{\rho}{\rho-1}\hat{\theta}_O,$$

where $E^* = E_R^* + E_O^* = N - L^*$. In equilibrium, the mean returns to entrepreneurship

[8] If, for example, ability follows a uniform distribution, then a change in the fraction of optimists changes the number of workers, entrepreneurs, relative input prices, and the firm size distribution.

is

$$\bar{\pi}^* = \frac{\Pi^*}{E^*} = \frac{1}{E^*}\left[Y^* - w^*L^* - r^*\left(1 - \frac{E^*}{N}\right)K\right],$$

where Π^* denotes aggregate profits in the economy.

Proposition 2: *If the production function is a generalized Cobb-Douglas, i.e., $f(l,k,\theta) = \theta l^\alpha k^\beta$, with $\alpha + \beta = \eta \in (0,1)$, entrepreneurial ability is distributed according to a Pareto cumulative distribution, i.e., $G(\theta) = 1 - (\theta_m/\theta)^\rho$ for $\theta \geq \theta_m > 0$, where $\rho > 1/(1-\eta)$, and (19) holds, then the existence of optimists lowers: (i) output, (ii) the average ability of the pool of entrepreneurs, and (iii) the mean returns to entrepreneurship.*

The economic intuition behind Proposition 2 is straightforward. We know from Lucas (1978) that, in the absence of distortions, the competitive equilibrium maximizes output. The misguided occupational and input choices of optimists create a distortion in the economy which lowers output. The existence of optimists lowers the average ability of the pool of entrepreneurs due to the full crowding out effect.[9] Finally, the existence of optimists lowers the mean returns to entrepreneurship since it reduces output, raises input prices, and leaves the number of entrepreneurs unchanged.

To close this section we compare the mean returns to entrepreneurship of realists to those of optimists. In equilibrium, the mean returns to entrepreneurship of realists is

$$\bar{\pi}_R^* = \frac{\int_{\hat{\theta}_R}^{+\infty} \pi(\theta, l(\theta, w^*, r^*), k(\theta, w^*, r^*))g(\theta)d\theta}{\int_{\hat{\theta}_R}^{+\infty} g(\theta)d\theta},$$

and the mean returns to entrepreneurship of optimists is

$$\bar{\pi}_O^* = \frac{\int_{\hat{\theta}_O}^{+\infty} \pi(\theta, l(\gamma\theta, w^*, r^*), k(\gamma\theta, w^*, r^*))g(\theta)d\theta}{\int_{\hat{\theta}_O}^{+\infty} g(\theta)d\theta}.$$

[9] Note that the presence of optimists raises the average ability of the pool of realistic entrepreneurs as a result of the higher equilibrium wage.

Proposition 3: *If the production function is a generalized Cobb-Douglas, i.e.,* $f(l,k,\theta) = \theta l^{\alpha} k^{\beta}$*, with* $\alpha + \beta = \eta \in (0,1)$*, entrepreneurial ability is distributed according to a Pareto cumulative distribution, i.e.,* $G(\theta) = 1 - (\theta_m/\theta)^{\rho}$ *for* $\theta \geq \theta_m > 0$*, where* $\rho > 1/(1-\eta)$*, and (19) holds, then the mean returns to entrepreneurship of realists are greater than the mean returns to entrepreneurship of optimists.*

This result is consistent with empirical evidence that shows that optimism is on average bad for firm performance (Landier and Thesmar (2009)), and that entrepreneurs' level of optimism has, on average, a negative relationship with the performance of their new ventures (Hmieleski and Baron (2009)). In addition, Dawson et al. (2015) examine how entrepreneurs' forecasts predict entrepreneurship performance using the BHPS during the years 1991-2008 and find that optimists, on average, earn less than pessimists.

5 Calibration

This section calibrates the model to illustrate quantitatively the general equilibrium effects of optimism. The calibration parameterizes the economy to match salient features of US manufacturing data and is summarized in Table I.

Following Atkeson and Kehoe (2005) we set η to 0.85. Following Adler (2016), given η equal to 0.85, a value of 0.612 for α matches labor's average income share (including managerial compensation) in US manufacturing between 1998 and 2005. Again, following Atkeson and Kehoe (2005) and Adler (2016) we assume a capital-output ratio K/Y of 1.46 which together with a value for Y of 0.62032 in the model without optimists ($\lambda = 0$) implies a capital stock K of 0.906. The population is normalized to 1.

If the production function is a generalized Cobb-Douglas and ability follows the Pareto cumulative distribution (10), then firm size, measured by employment, follows the Pareto cumulative distribution

$$S(l) = 1 - \left(\frac{\alpha}{1-\eta}\right)^{\rho(1-\eta)} l^{-\rho(1-\eta)}, \text{ for } l \geq \alpha/(1-\eta),$$

where $\rho(1-\eta)$ is the shape parameter and $\alpha/(1-\eta)$ is the minimum firm size.[10]

Table I

Parameters of the Model

Parameter	Value	Description
Standard parameters		
η	0.85	decreasing returns to scale
α	0.612	labor's average income share
β	0.238	capital's average income share
K	0.906	capital stock
N	1	population
ρ	7.2	shape of ability distribution
θ_m	1	lower bound for ability
Behavioral parameters		
λ	0.5	fraction of optimists
γ	1.0832	intensity of optimism

According to data from the Census Bureau in 2000 there were 306,303 manufacturing firms and the average manufacturing firm employed 53 workers (see pp. 209 in Alder (2016)). To perform the calibration we take the minimum firm size to have 4 employees. We choose this value for two reasons. First, the bin in the Census Bureau of the smallest manufacturing firms encompasses firms that employ between 1 and 4 workers. Second, the model predicts a minimum firm size equal to $\alpha/(1-\eta) = 0.612/0.15 = 4.08$ workers. Letting $\xi = \rho(1-\eta)$, the method of moments' estimate for ξ is the solution to $53 = 4\xi/(\xi - 1)$. The solution is $\xi = 1.0816$ which implies $\rho = \xi/(1-\eta) = 1.0816/0.15 \simeq 7.2$. The scale parameter θ_m can be chosen arbitrarily and we set it equal to 1.

[10] This result is derived in Appendix B.

We are left with the behavioral parameters λ and γ to calibrate. Recall that λ represents the fraction of optimists and γ the intensity of optimistic beliefs. The ideal data to calibrate λ and γ would consists of representative samples of entrepreneurs and employees with measures of optimism based on expectations and realized financial outcomes in the US manufacturing sector. We are unaware of such data so we take the following approach. First, we assume that entrepreneurs and employees in the US manufacturing sector have similar optimistic expectations as the American population. Second, we use empirical evidence on the fraction of optimists in the US to calibrate λ. Third, we use empirical evidence on the expectations of US nascent entrepreneurs to calibrate E_O^*/E^*. Fourth, using the values for λ, E_O^*/E^*, and ρ we calibrate the intensity of optimistic beliefs γ to satisfy

$$\frac{E_O^*}{E^*} = \frac{\lambda\gamma^\rho}{1-\lambda+\lambda\gamma^\rho}. \tag{27}$$

The empirical evidence shows that the majority of US individuals have optimistic expectations for the future and overestimate their ability to start a new business. Michalos (1988) finds, using Gallup Polls, that over the course of a decade, on average, 50 percent of Americans every year expected the next year to be better. Koellinger et al. (2007) report, using the Global Entrepreneurship Monitor (GEM) project, that 55 percent of Americans believe they have sufficient skills to start a new business. More recently, Gallagher et al. (2013) find that 50.86 percent Americans expect their future income to be higher than their current income. Hence, we calibrate λ to be 50 percent.[11]

The empirical evidence also shows that a very large majority of US nascent entrepreneurs are optimistic. Cooper et al. (1988) report that 81 percent of a sample of US entrepreneurs who had recently become business owners perceive their chances of success as 7 out of 10 or better. Cassar (2010) finds that 62 percent of a sample of US nascent entrepreneurs from the Panel Study of Entrepreneurial Dynamics (PSED)

[11] In Appendix C we show that the results of the calibration are robust to alternative values for λ.

who achieve operation overestimate projected first-year sales. More recently, Hyytinen et al. (2014) report that 48.8 percent of a sample of US nascent entrepreneurs from the PSED think that the likelihood of exit of their venture is zero in five years time. We take our estimate for the percentage of optimistic entrepreneurs as equal to the average of the estimates in these three studies, that is, we take $E_O^*/E^* = 0.64$. Setting $\lambda = 0.5$, $E_O^*/E^* = 0.64$, and $\rho = 7.2$ in (27) and solving for γ we obtain $\gamma = 1.0832$. The competitive equilibrium is well defined since $\rho > 1/(1-\eta)$ and inequality (19) are not violated.

Table II summarizes the results of the calibration. The first column lists the variables. The second and the third columns report the competitive equilibrium without and with optimists, respectively. The fourth column reports the percent change in the variables common to both models.

Table II

Calibration

	Model $\lambda = 0$ Lucas (1978)	Model $\lambda = 0.5$ $\gamma = 1.0832$	Percent change
Output (Y^*)	1.36500	1.35850	-0.48
Wage (w^*)	0.85055	0.89026	4.67
Rental cost of capital (r^*)	0.35858	0.37532	4.67
Mean returns ($\bar{\pi}^*$)	11.80800	8.42000	-28.69
Mean returns of realists ($\bar{\pi}_R^*$)	-	12.35900	-
Mean returns of optimists ($\bar{\pi}_O^*$)	-	6.20430	-
Share of workers (L^*)	0.98217	0.98217	0
Ability of mg realistic entrep. ($\hat{\theta}_R$)	-	1.83110	-
Ability of mg entrep. ($\hat{\theta}$)	1.74940	-	-
Ability of mg optimistic entrep. ($\hat{\theta}_O$)	-	1.69040	-
Share of entrep. (E^*)	0.01783	0.01783	0
Share of optimistic entrep. (E_O^*/E^*)	0	0.64	64

The calibration tells us that optimism leads to a 0.48 percent decline in output, a

4.67 percent increase in input prices, and a 28.69 percent decline in the mean returns to entrepreneurship. These estimates show us that while the cost of optimism to the US manufacturing sector is only approximately 0.5 percent, its cost to entrepreneurs is of an order of magnitude 60 times higher. As we have seen, optimism leads to a sharp decline in the mean returns to entrepreneurship due to three reasons. First, the fall in output due to the misguided occupational and input choices of optimists. Second, the large increase in input prices. Third, the fact that optimism leaves the number of entrepreneurs unchanged. Finally, the calibration shows that the mean returns to entrepreneurship of realists is about twice as much as that of optimists.

This calibration is able to capture an important relation between profits and wages in the US manufacturing sector in 2000. Online data from the Federal Reserve Bank of St. Louis (FRED Economic Data) reports that the corporate profit of the US manufacturing sector after taxes in 2000 was 112 billion USD. Diving this by the number of manufacturing firms, $306,303$, the mean corporate profit of the US manufacturing sector after taxes in 2000 was $365,650$ USD. The St. Louis Fed data also shows that the wages paid in the US manufacturing sector in 2000 were 745 billion USD. Dividing the wage bill by the number of workers, 16.4 million, the average wage paid in the US manufacturing sector in 2000 was $45,427$ USD. Hence, the mean corporate profit after taxes was approximately 8 times higher than the average wage. From Table II, if there are no optimists, the mean returns to entrepreneurship is approximately 14 times higher than the wage. However, in the presence of optimists, the mean returns to entrepreneurship is approximately 9.5 times higher than the wage. Hence, taking optimism into account brings the model closer to the data in this important dimension.

6 Discussion

In this section, we discuss the main assumptions of the model and some extensions.

We assume that the returns from entrepreneurship are deterministic. It is possible to extend the model by including a random component ε in entrepreneurial revenues. For example, letting $y = \theta f(l,k) + \varepsilon$, where ε has mean 0 and variance $0 < \sigma^2 < \infty$. Since individuals are risk neutral all results are left unchanged as long as there is no optimism about the realization of ε. If individuals are not only optimistic about θ but also about ε, then entrepreneurship would be more attractive relative to paid employment. In this case the main qualitative effects of optimism would still hold but its quantitative effects would be larger.

We assume individuals have different abilities to run a firm and the same productivity (or ability) as workers. This implies that different entrepreneurs obtain different amounts of profit but that all workers are paid the same wage. This is a natural simplification since the empirical evidence shows that the returns to entrepreneurship are much more variable than wages (Borjas and Bronars (1989), Hamilton (2000)). Still, the model could be extended by letting individuals have different abilities in both occupations. Following Jovanovic (1994), we could let the returns to paid employment be equal to $w\psi(\theta)$ where $\psi(\theta)$ is the wage-working ability of an individual with ability θ.[12] If ψ is a strictly increasing function (good entrepreneurs are also good workers), then optimists would overestimate the returns to entrepreneurship as well as the returns to paid employment.[13] Since these two effects would partially cancel out, the main qualitative effects of optimism would still hold but its quantitative

[12] Jovanovic (1994) generalizes Lucas (1978) by allowing for heterogeneous working abilities, i.e., the labor income of a worker is given by wy where y represents working ability. Working ability y is correlated with entrepreneurial ability θ if $y = \psi(\theta)$. Jovanovic shows that when ψ is either (i) strictly decreasing or (ii) strictly increasing and not very steep at high levels of θ, then the best potential entrepreneurs are drawn into entrepreneurship. In contrast, when ψ is strictly increasing and very steep at high levels of θ, then the best potential entrepreneurs end up as wage workers.

[13] The empirical evidence supports the assumption that entrepreneurial and wage-working abilities are positively correlated, i.e., ψ is a strictly increasing function. See Murphy et al. (1991), Javanovic (1994), and Braguinsky et al. (2011).

effects would be smaller.[14]

In our model an entrepreneur hires workers and rents capital to produce output. However, the empirical evidence shows that many firms have no employed workers, i.e., the owners of these firms are self-employed without employees (see Braguinsky et al. (2011) and Salas-Fumas et al. (2014)). The model could also be extended to incorporate this third type of occupational choice. This could be done by assuming that the returns of firms without employed workers are given by $B + \theta$, where $B > 0$ represents a non-pecuniary benefit like the utility derived from "being your own boss" (see Hurst and Pugsley (2011) and Åstebro et al. (2014)). In this case, realists with ability θ such that $w > \max\{B + \theta, \pi(\theta, w, r)\}$ would become workers, those with ability θ such that $B + \theta > \max\{w, \pi(\theta, w, r)\}$ would open a firm without employed workers, and those with ability θ such that $\pi(\theta, w, r) > \max\{B + \theta, w\}$ would become entrepreneurs. Similarly, optimists with perception of ability $\gamma\theta$ such that $w > \max\{B + \gamma\theta, \pi(\gamma\theta, w, r)\}$ would become workers, those with perception of ability $\gamma\theta$ such that $B + \gamma\theta > \max\{w, \pi(\gamma\theta, w, r)\}$ would open a firm without employed workers, and those with perception of ability $\gamma\theta$ such that $\pi(\gamma\theta, w, r) > \max\{B + \gamma\theta, w\}$ would become entrepreneurs.

We focus on differences in ability and optimism as the main determinants which explain who becomes an entrepreneur and who works as an employee. There are of course many other factors which could influence this choice. For example, entrepreneurial effort (and the disutility of exerting it), access to funds needed to create a firm, risk aversion, and learning about ability. We do not model entrepreneurial effort and therefore we rule out any positive effects of optimism on entrepreneurial effort like the ones found in Manove (2007). If ability and effort are complements, then optimistic entrepreneurs would provide more effort than realistic ones. In this case the impact of optimism on the returns to entrepreneurship and on output would be ambiguous. We assume individuals are risk neutral so we cannot discuss the role

[14] We are assuming here that ψ is strictly increasing and not very steep at high levels of θ. In this case the most talented individuals become entrepreneurs. In contrast, when ψ is strictly increasing and very steep at high level of θ, the most talented individuals become workers.

that risk aversion together with optimism might play in the decision to become an entrepreneur or a worker. In addition, our model is static so we rule out the possibility that optimists learn their true abilities over time. We believe these are interesting avenues for future research.

7 Conclusion

We present a fully specified general equilibrium model of occupational choice where a fraction of individuals are optimistic about their entrepreneurial ability. We find that optimism has four qualitative effects: it leads to a misallocation of talent which lowers output, drives up input prices, makes workers better off, and entrepreneurs worse off. The model also predicts that optimism has no impact the number of workers, the number of entrepreneurs, relative input prices, and the firm size distribution.

We calibrate the model to match salient features of US manufacturing data. We find that optimism can significantly change the distribution of income by lowering the mean returns to entrepreneurship and driving up the wage. The calibration shows that the cost of optimism to the US manufacturing sector is about half percent of output. In contrast, optimism leads to a 5 percent increase in input prices and a 29 percent decline in the mean returns to entrepreneurship. Moreover, the ratio of the mean returns to entrepreneurship to the mean wage predicted by the model is much closer to the one observed in the data when optimism is taken into account than when it is not.

Appendix A

Proof of Proposition 1: The first step to determine the competitive equilibrium is to find out the labor market equilibrium condition. The labor demand from realistic entrepreneurs is

$$\begin{aligned} L_R^D &= N(1-\lambda)\int_{\hat{\theta}_R}^{\infty} l(\theta,w,r)g(\theta)d\theta \\ &= N(1-\lambda)\left(\frac{\alpha}{w}\right)^{\frac{1-\beta}{1-\eta}}\left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\eta}}\int_{\hat{\theta}_R}^{\infty}\theta^{\frac{1}{1-\eta}}\rho\theta_m^{\rho}\theta^{-\rho-1}d\theta \\ &= N(1-\lambda)\left(\frac{\alpha}{w}\right)^{\frac{1-\beta}{1-\eta}}\left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\eta}}\rho\theta_m^{\rho}\left[\frac{\theta^{\frac{1}{1-\eta}-\rho}}{\frac{1}{1-\eta}-\rho}\right]_{\hat{\theta}_R}^{\infty} \\ &= N(1-\lambda)\left(\frac{\alpha}{w}\right)^{\frac{1-\beta}{1-\eta}}\left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\eta}}\rho\theta_m^{\rho}\frac{\hat{\theta}_R^{\frac{1}{1-\eta}-\rho}}{\rho-\frac{1}{1-\eta}}. \qquad (28) \end{aligned}$$

The labor demand from optimistic entrepreneurs is

$$\begin{aligned} L_O^D &= N\lambda\int_{\hat{\theta}_O}^{\infty} l(\gamma\theta,w,r)g(\theta)d\theta = N\lambda\left(\frac{\alpha}{w}\right)^{\frac{1-\beta}{1-\eta}}\left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\eta}}\gamma^{\frac{1}{1-\eta}}\int_{\hat{\theta}_O}^{\infty}\theta^{\frac{1}{1-\eta}}\rho\theta_m^{\rho}\theta^{-\rho-1}d\theta \\ &= N\lambda\left(\frac{\alpha}{w}\right)^{\frac{1-\beta}{1-\eta}}\left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\eta}}\gamma^{\frac{1}{1-\eta}}\rho\theta_m^{\rho}\frac{\hat{\theta}_O^{\frac{1}{1-\eta}-\rho}}{\rho-\frac{1}{1-\eta}}. \qquad (29) \end{aligned}$$

From (28) and (29), labor demand is equal to

$$L^D = L_R^D + L_O^D = N\left(\frac{\alpha}{w}\right)^{\frac{1-\beta}{1-\eta}}\left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\eta}}\frac{\rho\theta_m^{\rho}}{\rho-\frac{1}{1-\eta}}\left[(1-\lambda)\hat{\theta}_R^{\frac{1}{1-\eta}-\rho}+\lambda\gamma^{\frac{1}{1-\eta}}\hat{\theta}_O^{\frac{1}{1-\eta}-\rho}\right].$$

Since each worker provides a unit of labor, labor supply is

$$\begin{aligned} L^S &= N\left[(1-\lambda)L_R^S+\lambda L_O^S\right] = N\left[(1-\lambda)\int_{\theta_m}^{\hat{\theta}_R} g(\theta)d\theta + \lambda\int_{\theta_m}^{\hat{\theta}_O} g(\theta)d\theta\right] \\ &= N\left[(1-\lambda)G(\hat{\theta}_R)+\lambda G(\hat{\theta}_O)\right] = N\left[(1-\lambda)(1-\theta_m^{\rho}\hat{\theta}_R^{-\rho})+\lambda(1-\theta_m^{\rho}\hat{\theta}_O^{-\rho})\right] \\ &= N\left[1-\theta_m^{\rho}\left[(1-\lambda)\hat{\theta}_R^{-\rho}+\lambda\hat{\theta}_O^{-\rho}\right]\right]. \end{aligned}$$

In equilibrium, labor demand must equal labor supply:

$$\left(\frac{\alpha}{w}\right)^{\frac{1-\beta}{1-\eta}} \left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\eta}} \frac{\rho\theta_m^\rho}{\rho - \frac{1}{1-\eta}} \left[(1-\lambda)\hat{\theta}_R^{\frac{1}{1-\eta}-\rho} + \lambda\gamma^{\frac{1}{1-\eta}}\hat{\theta}_O^{\frac{1}{1-\eta}-\rho}\right]$$
$$= 1 - \theta_m^\rho \left[(1-\lambda)\hat{\theta}_R^{-\rho} + \lambda\hat{\theta}_O^{-\rho}\right]. \tag{30}$$

The second step to determine the competitive equilibrium is to find out the capital market equilibrium condition. The capital demand from realistic entrepreneurs is

$$\begin{aligned} K_R^D &= N(1-\lambda)\int_{\hat{\theta}_R}^{\infty} k(\theta, w, r) g(\theta) d\theta \\ &= N(1-\lambda)\left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\eta}} \left(\frac{\beta}{r}\right)^{\frac{1-\alpha}{1-\eta}} \int_{\hat{\theta}_R}^{\infty} \theta^{\frac{1}{1-\eta}} \rho\theta_m^\rho \theta^{-\rho-1} d\theta \\ &= N(1-\lambda)\left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\eta}} \left(\frac{\beta}{r}\right)^{\frac{1-\alpha}{1-\eta}} \rho\theta_m^\rho \frac{\hat{\theta}_R^{\frac{1}{1-\eta}-\rho}}{\rho - \frac{1}{1-\eta}}. \end{aligned} \tag{31}$$

The capital demand from optimistic entrepreneurs is

$$\begin{aligned} K_O^D &= N\lambda \int_{\hat{\theta}_O}^{\infty} k(\gamma\theta, w, r) g(\theta) d\theta \\ &= N\lambda \left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\eta}} \left(\frac{\beta}{r}\right)^{\frac{1-\alpha}{1-\eta}} \gamma^{\frac{1}{1-\eta}} \int_{\hat{\theta}_O}^{\infty} \theta^{\frac{1}{1-\eta}} \rho\theta_m^\rho \theta^{-\rho-1} d\theta \\ &= N\lambda \left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\eta}} \left(\frac{\beta}{r}\right)^{\frac{1-\alpha}{1-\eta}} \gamma^{\frac{1}{1-\eta}} \rho\theta_m^\rho \frac{\hat{\theta}_O^{\frac{1}{1-\eta}-\rho}}{\rho - \frac{1}{1-\eta}}. \end{aligned} \tag{32}$$

From (31) and (32), capital demand is equal to

$$\begin{aligned} K^D &= K_R^D + K_O^D \\ &= N\left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\eta}} \left(\frac{\beta}{r}\right)^{\frac{1-\alpha}{1-\eta}} \frac{\rho\theta_m^\rho}{\rho - \frac{1}{1-\eta}} \left[(1-\lambda)\hat{\theta}_R^{\frac{1}{1-\eta}-\rho} + \lambda\gamma^{\frac{1}{1-\eta}}\hat{\theta}_O^{\frac{1}{1-\eta}-\rho}\right]. \end{aligned}$$

In equilibrium, capital demand must equal the exogenous capital supply:

$$\left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\eta}} \left(\frac{\beta}{r}\right)^{\frac{1-\alpha}{1-\eta}} \frac{\rho\theta_m^\rho}{\rho - \frac{1}{1-\eta}} \left[(1-\lambda)\hat{\theta}_R^{\frac{1}{1-\eta}-\rho} + \lambda\gamma^{\frac{1}{1-\eta}}\hat{\theta}_O^{\frac{1}{1-\eta}-\rho}\right] = K/N. \tag{33}$$

The third step to determine the competitive equilibrium is to find out $\hat{\theta}_R$ and $\hat{\theta}_O$. A realist with ability $\hat{\theta}_R$ is indifferent between being an entrepreneur and a worker when

$$\hat{\theta}_R \left[l(\hat{\theta}_R, w, r)\right]^{\alpha} \left[k(\hat{\theta}_R, w, r)\right]^{\beta} - wl(\hat{\theta}_R, w, r) + r\left[K/N - k(\hat{\theta}_R, w, r)\right] = w + rK/N,$$

or

$$\alpha^{\alpha}\beta^{\beta}(1-\eta)^{1-\eta}\hat{\theta}_R = w^{1-\beta}r^{\beta}. \tag{34}$$

An optimist with perception of ability $\theta^* = \gamma\hat{\theta}_O$ and ability $\hat{\theta}_O$ is indifferent between being an entrepreneur and a worker when

$$\gamma\hat{\theta}_O \left[l(\gamma\hat{\theta}_O, w, r)\right]^{\alpha} \left[k(\gamma\hat{\theta}_O, w, r)\right]^{\beta} - wl(\gamma\hat{\theta}_O, w, r) + r\left[K/N - k(\gamma\hat{\theta}_O, w, r)\right] = w + rK/N,$$

or

$$\alpha^{\alpha}\beta^{\beta}(1-\eta)^{1-\eta}\gamma\hat{\theta}_O = w^{1-\beta}r^{\beta}. \tag{35}$$

It follows from (34) and (35) that

$$\alpha^{\alpha}\beta^{\beta}(1-\eta)^{1-\eta}\gamma\hat{\theta}_O = \alpha^{\alpha}\beta^{\beta}(1-\eta)^{1-\eta}\hat{\theta}_R,$$

or

$$\hat{\theta}_O = \frac{1}{\gamma}\hat{\theta}_R. \tag{36}$$

Substituting (34) and (36) into (30) we obtain

$$\alpha\rho\theta_m^{\rho}(1-\lambda+\lambda\gamma^{\rho})\hat{\theta}_R^{\frac{1}{1-\eta}-\rho} = (1-\eta)\hat{\theta}_R^{\frac{1}{1-\eta}}\left(\rho - \frac{1}{1-\eta}\right)\left[1 - \theta_m^{\rho}(1-\lambda+\lambda\gamma^{\rho})\hat{\theta}_R^{-\rho}\right],$$

or

$$\alpha\rho\theta_m^{\rho}(1-\lambda+\lambda\gamma^{\rho}) = (1-\eta)\left(\rho - \frac{1}{1-\eta}\right)\left[\hat{\theta}_R^{\rho} - \theta_m^{\rho}(1-\lambda+\lambda\gamma^{\rho})\right],$$

or

$$\begin{aligned}
\hat{\theta}_R^{\rho} &= \frac{\alpha\rho\theta_m^{\rho}(1-\lambda+\lambda\gamma^{\rho})}{(1-\eta)\left(\rho-\frac{1}{1-\eta}\right)} + \theta_m^{\rho}(1-\lambda+\lambda\gamma^{\rho}) \\
&= \theta_m^{\rho}(1-\lambda+\lambda\gamma^{\rho})\left[\frac{\alpha\rho}{(1-\eta)\left(\rho-\frac{1}{1-\eta}\right)} + 1\right] \\
&= \theta_m^{\rho}(1-\lambda+\lambda\gamma^{\rho})\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}.
\end{aligned}$$

Hence, the ability of the marginal realistic entrepreneur is

$$\hat{\theta}_R = \theta_m (1 - \lambda + \lambda\gamma^\rho)^{\frac{1}{\rho}} \left[\frac{\rho(1-\beta) - 1}{\rho(1-\eta) - 1} \right]^{\frac{1}{\rho}}. \tag{37}$$

Note that (37), $\rho > 1/(1-\eta)$, and $\eta = \alpha + \beta \in (0,1)$, imply $\hat{\theta}_R > \theta_m$. From (36) and (37) the ability of the marginal optimistic entrepreneur is

$$\hat{\theta}_O = \frac{1}{\gamma} \theta_m (1 - \lambda + \lambda\gamma^\rho)^{\frac{1}{\rho}} \left[\frac{\rho(1-\beta) - 1}{\rho(1-\eta) - 1} \right]^{\frac{1}{\rho}}.$$

From (30) and (33) we have

$$\left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\eta}} \left(\frac{\beta}{r}\right)^{\frac{1-\alpha}{1-\eta}} \frac{1 - \theta_m^\rho \left[(1-\lambda)\hat{\theta}_R^{-\rho} + \lambda \hat{\theta}_O^{-\rho} \right]}{\left(\frac{\alpha}{w}\right)^{\frac{1-\beta}{1-\eta}} \left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\eta}}} = \frac{K}{N},$$

or

$$1 - \theta_m^\rho \left[(1-\lambda)\hat{\theta}_R^{-\rho} + \lambda \hat{\theta}_O^{-\rho} \right] = \frac{K}{N} \left(\frac{\alpha}{w}\right)^{\frac{1-\beta-\alpha}{1-\eta}} \left(\frac{\beta}{r}\right)^{\frac{\beta-1+\alpha}{1-\eta}},$$

or

$$\frac{\alpha}{w} \frac{r}{\beta} \frac{K}{N} = 1 - \theta_m^\rho \left[(1-\lambda)\hat{\theta}_R^{-\rho} + \lambda \hat{\theta}_O^{-\rho} \right],$$

or

$$\frac{\alpha}{w} \frac{r}{\beta} \frac{K}{N} = 1 - \left[\frac{\rho(1-\eta) - 1}{\rho(1-\beta) - 1} \right],$$

or

$$r = w \frac{N}{K} \frac{\beta\rho}{\rho(1-\beta) - 1} \tag{38}$$

Substituting (38) into (34) we obtain

$$\alpha^\alpha \beta^\beta (1-\eta)^{1-\eta} \theta_m (1 - \lambda + \lambda\gamma^\rho)^{\frac{1}{\rho}} \left[\frac{\rho(1-\beta) - 1}{\rho(1-\eta) - 1} \right]^{\frac{1}{\rho}} = w^{1-\beta} \left[w \frac{N}{K} \frac{\beta\rho}{\rho(1-\beta) - 1} \right]^\beta.$$

Solving this equality with respect to w we obtain the equilibrium wage:

$$w^* = \alpha^\alpha \beta^\beta (1-\eta)^{1-\eta} \theta_m (1 - \lambda + \lambda\gamma^\rho)^{\frac{1}{\rho}} \left[\frac{\rho(1-\beta) - 1}{\rho(1-\eta) - 1} \right]^{\frac{1}{\rho}} \left[\frac{N}{K} \frac{\beta\rho}{\rho(1-\beta) - 1} \right]^{-\beta}. \tag{39}$$

The equilibrium rental cost of capital is equal to

$$
\begin{aligned}
r^* &= w^* \frac{N}{K} \frac{\beta\rho}{\rho(1-\beta)-1} \\
&= \frac{\alpha^\alpha \beta^\beta (1-\eta)^{1-\eta} \theta_m (1-\lambda+\lambda\gamma^\rho)^{\frac{1}{\rho}} \left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}}}{\left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^\beta} \frac{N}{K} \frac{\beta\rho}{\rho(1-\beta)-1} \\
&= \alpha^\alpha \beta^\beta (1-\eta)^{1-\eta} \theta_m (1-\lambda+\lambda\gamma^\rho)^{\frac{1}{\rho}} \left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}} \left[\frac{N}{K} \frac{\beta\rho}{\rho(1-\beta)-1}\right]^{1-\beta} \quad (40)
\end{aligned}
$$

The equilibrium labor force is equal to

$$
\begin{aligned}
L^* &= N\left[1-\theta_m^\rho \left[(1-\lambda)\hat{\theta}_R^{-\rho} + \lambda\hat{\theta}_O^{-\rho}\right]\right]. \\
&= N\left[1-\theta_m^\rho (1-\lambda+\lambda\gamma^\rho)\hat{\theta}_R^{-\rho}\right] \\
&= N\left[1-\frac{\rho(1-\eta)-1}{\rho(1-\beta)-1}\right] \\
&= N\frac{\alpha\rho}{\rho(1-\beta)-1}.
\end{aligned}
$$

The equilibrium output level is

$$
\begin{aligned}
Y^* &= (1-\lambda)N\int_{\hat{\theta}_R}^\infty \theta[l(\theta,w^*,r^*)]^\alpha [k(\theta,w^*,r^*)]^\beta g(\theta)d\theta \\
&\quad + \lambda N \int_{\hat{\theta}_O}^\infty \theta[l(\gamma\theta,w^*,r^*)]^\alpha [k(\gamma\theta,w^*,r^*)]^\beta g(\theta)d\theta.
\end{aligned}
$$

This can be simplified to

$$
\begin{aligned}
Y^* &= N\left(\frac{\alpha}{w^*}\right)^{\frac{\alpha}{1-\eta}} \left(\frac{\beta}{r^*}\right)^{\frac{\beta}{1-\eta}} \left[(1-\lambda)\int_{\hat{\theta}_R}^\infty \theta^{\frac{1}{1-\eta}} g(\theta)d\theta + \lambda\gamma^{\frac{\eta}{1-\eta}} \int_{\hat{\theta}_O}^\infty \theta^{\frac{1}{1-\eta}} g(\theta)d\theta\right] \\
&= N\left(\frac{\alpha}{w^*}\right)^{\frac{\alpha}{1-\eta}} \left(\frac{\beta}{r^*}\right)^{\frac{\beta}{1-\eta}} \left[(1-\lambda)\rho\theta_m^\rho \frac{\hat{\theta}_R^{\frac{1}{1-\eta}-\rho}}{\rho-\frac{1}{1-\eta}} + \lambda\gamma^{\frac{\eta}{1-\eta}}\rho\theta_m^\rho \frac{\hat{\theta}_O^{\frac{1}{1-\eta}-\rho}}{\rho-\frac{1}{1-\eta}}\right] \\
&= N\left(\frac{\alpha}{w^*}\right)^{\frac{\alpha}{1-\eta}} \left(\frac{\beta}{r^*}\right)^{\frac{\beta}{1-\eta}} \frac{\rho\theta_m^\rho}{\rho-\frac{1}{1-\eta}} (1-\lambda+\lambda\gamma^{\rho-1})\hat{\theta}_R^{\frac{1}{1-\eta}-\rho} \\
&= N\left(\frac{\alpha}{w^*}\right)^{\frac{\alpha}{1-\eta}} \left(\frac{\beta}{r^*}\right)^{\frac{\beta}{1-\eta}} \frac{\rho\theta_m^{\frac{1}{1-\eta}}}{\rho-\frac{1}{1-\eta}} \frac{1-\lambda+\lambda\gamma^{\rho-1}}{(1-\lambda+\lambda\gamma^\rho)^{1-\frac{1}{\rho(1-\eta)}}} \left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho(1-\eta)}-1}.
\end{aligned}
$$

Substituting w^* and r^* by (39) and (40), respectively, and simplifying terms we obtain

$$\begin{aligned} Y^* &= N\alpha^\alpha\beta^\beta\theta_m \frac{1}{(1-\eta)^\eta}\frac{\rho}{\rho-\frac{1}{1-\eta}}(1-\lambda+\lambda\gamma^\rho)^{\frac{1-\rho}{\rho}}(1-\lambda+\lambda\gamma^{\rho-1})\times \\ & \left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1-\rho}{\rho}}\left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^{-\beta} \\ &= N^{1-\beta}K^\beta\alpha^\alpha\theta_m(1-\eta)^{1-\eta}\frac{1-\lambda+\lambda\gamma^{\rho-1}}{(1-\lambda+\lambda\gamma^\rho)^{1-\frac{1}{\rho}}}\left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}}\left[\frac{\rho}{\rho(1-\beta)-1}\right]^{1-\beta} \end{aligned}$$

For the equilibrium to be well defined we must have that

$$\hat{\theta}_O \geq \theta_m,$$

or

$$\frac{1}{\gamma}\theta_m(1-\lambda+\lambda\gamma^\rho)^{\frac{1}{\rho}}\left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}} \geq \theta_m$$

or

$$(1-\lambda+\lambda\gamma^\rho)\left[\rho(1-\beta)-1\right] \geq \gamma^\rho\left[\rho(1-\eta)-1\right],$$

or

$$\frac{1-\lambda+\lambda\gamma^\rho}{\gamma^\rho} \geq \frac{\rho(1-\eta)-1}{\rho(1-\beta)-1}.$$

Q.E.D.

Proof of Proposition 2:

(i) We know from Proposition 1 that output in a competitive equilibrium with optimists is

$$Y^* = \theta_m\alpha^\alpha(1-\eta)^{1-\eta}N^{1-\beta}K^\beta\frac{1-\lambda+\lambda\gamma^{\rho-1}}{(1-\lambda+\lambda\gamma^\rho)^{1-\frac{1}{\rho}}}\left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}}\left[\frac{\rho}{\rho(1-\beta)-1}\right]^{1-\beta}.$$

Setting $\lambda = 0$ (or $\gamma = 1$) in (25) we obtain output in the competitive equilibrium without optimists:

$$Y_0^* = \theta_m\alpha^\alpha(1-\eta)^{1-\eta}N^{1-\beta}K^\beta\left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}}\left[\frac{\rho}{\rho(1-\beta)-1}\right]^{1-\beta}.$$

Hence, the existence of optimists (the case $\lambda > 0$ and $\gamma > 1$) lowers output provided that

$$\frac{1-\lambda+\lambda\gamma^{\rho-1}}{(1-\lambda+\lambda\gamma^{\rho})^{1-\frac{1}{\rho}}} < 1,$$

when $\rho > 1$, $\gamma > 1$, and $\lambda \in (0,1)$. Define

$$\psi(\lambda) = \frac{1-\lambda+\lambda\gamma^{\rho-1}}{(1-\lambda+\lambda\gamma^{\rho})^{1-\frac{1}{\rho}}}. \tag{41}$$

We prove this result by showing that (a) $\psi(0) = \psi(1) = 1$, (b) $\psi\prime(0) < 0$, (c) $\psi\prime(1) > 0$, and (d) there exists only one $\lambda \in (0,1)$ such that $\psi\prime(\lambda) = 0$. Results (a), (b), (c), and (d) imply that: $\psi(\lambda)$ is convex in $[0,1]$, $\psi(\lambda)$ attains a maxima of 1 at $\lambda = 0$ and at $\lambda = 1$, and $\psi(\lambda)$ attains a minimum at an $\lambda \in (0,1)$. Hence, $\psi(\lambda) < 1$ when $\rho > 1$, $\gamma > 1$, and $\lambda \in (0,1)$. Substituting $\lambda = 0$ in (41) we have $\psi(0) = 1$. Substituting $\lambda = 1$ in (41) we obtain $\psi(1) = 1$. Hence, $\psi(0) = \psi(1) = 1$. This proves (a). Next, we show that $\psi'(0) < 0$ when $\rho > 1$ and $\gamma > 1$. The first derivative of $\psi(\lambda)$ with respect to λ is:

$$\psi'(\lambda) = \frac{\gamma^{\rho-1} - \left(1-\frac{1}{\rho}\right)\gamma^{\rho} - \frac{1}{\rho} + \frac{\lambda}{\rho}(\gamma^{\rho-1}-1)(\gamma^{\rho}-1)}{(1-\lambda+\lambda\gamma^{\rho})^{2-\frac{1}{\rho}}}. \tag{42}$$

From (42) we have

$$\psi'(0) = \gamma^{\rho-1} - \left(1-\frac{1}{\rho}\right)\gamma^{\rho} - \frac{1}{\rho}.$$

Define

$$\varphi(\gamma) = \gamma^{\rho-1} - \left(1-\frac{1}{\rho}\right)\gamma^{\rho} - \frac{1}{\rho}.$$

Setting $\gamma = 1$ in $\varphi(\gamma)$ we obtain $\varphi(1) = 0$. Taking the derivative of $\varphi(\gamma)$ with respect to γ we obtain

$$\varphi'(\gamma) = (\rho-1)\gamma^{\rho-2} - \left(1-\frac{1}{\rho}\right)\rho\gamma^{\rho-1} = -(\rho-1)\gamma^{\rho-1}\left(1-\frac{1}{\gamma}\right) < 0,$$

when $\rho > 1$ and $\gamma > 1$. If $\varphi(1) = 0$ and $\varphi'(\gamma) < 0$ when $\rho > 1$ and $\gamma > 1$, then $\varphi(\gamma) < 0$ when $\rho > 1$ and $\gamma > 1$. Since $\psi'(0) = \varphi(\gamma)$ it follows that $\psi'(0) < 0$ when

$\rho > 1$ and $\gamma > 1$. This proves (b). Next, we show that $\psi'(1) > 0$ when $\rho > 1$ and $\gamma > 1$.

From (42) we have

$$\psi'(1) = \frac{\left[\gamma^{\rho-1} - \left(1 - \frac{1}{\rho}\right)\gamma^{\rho} - \frac{1}{\rho}\right] + \frac{1}{\rho}(\gamma^{\rho-1} - 1)(\gamma^{\rho} - 1)}{\gamma^{2\rho-1}} = \frac{\rho - 1 + \gamma^{\rho} - \rho\gamma}{\rho\gamma^{\rho}}.$$

Define

$$\omega(\gamma) = \rho - 1 + \gamma^{\rho} - \rho\gamma.$$

Setting $\gamma = 1$ in $\omega(\gamma)$ we obtain $\omega(1) = 0$. Taking the derivative of $\omega(\gamma)$ with respect to γ we obtain

$$\omega'(\gamma) = \rho(\gamma^{\rho-1} - 1) > 0,$$

when $\rho > 1$ and $\gamma > 1$. If $\omega(1) = 0$ and $\omega'(\gamma) > 0$ when $\rho > 1$ and $\gamma > 1$, then $\omega(\gamma) > 0$ when $\rho > 1$ and $\gamma > 1$. Since $sign\,(\psi'(1)) = sign\,(\omega(\gamma))$ it follows that $\psi'(1) > 0$ when $\rho > 1$ and $\gamma > 1$. This proves (c). Finally, we show that there exists only one $\lambda \in (0, 1)$ such that $\psi\prime(\lambda) = 0$. From (42), $\psi'(\lambda) = 0$ is equivalent to

$$\gamma^{\rho-1} - \left(1 - \frac{1}{\rho}\right)\gamma^{\rho} - \frac{1}{\rho} + \frac{\lambda}{\rho}(\gamma^{\rho-1} - 1)(\gamma^{\rho} - 1) = 0.$$

Hence, the unique λ which solves $\psi'(\lambda) = 0$ is equal to

$$\tilde{\lambda} = \frac{-\rho\gamma^{\rho-1} + (\rho - 1)\,\gamma^{\rho} + 1}{(\gamma^{\rho-1} - 1)(\gamma^{\rho} - 1)}. \tag{43}$$

We see from (43) that $\tilde{\lambda} > 0$ since $-\rho\gamma^{\rho-1} + (\rho - 1)\,\gamma^{\rho} + 1 = -\rho\psi'(0)$, and, as we have shown above, $\psi'(0) < 0$. We now show that $\tilde{\lambda} < 1$. This is the case as long as

$$(\gamma^{\rho-1} - 1)(\gamma^{\rho} - 1) > -\rho\gamma^{\rho-1} + (\rho - 1)\,\gamma^{\rho} + 1,$$

or

$$\frac{1}{\gamma}\gamma^{2\rho} - \frac{1}{\gamma}\gamma^{\rho} - \gamma^{\rho} + 1 > -\rho\gamma^{\rho-1} + \rho\gamma^{\rho} - \gamma^{\rho} + 1,$$

or

$$\frac{1}{\gamma}\gamma^{\rho}(\gamma^{\rho} - 1) > \rho\gamma^{\rho}(1 - \gamma^{-1}),$$

or

$$\gamma^\rho - \rho\gamma + \rho - 1 > 0,$$

which is true since $\gamma^\rho - \rho\gamma + \rho - 1 = \omega(\gamma)$, and, as we have shown above, $\omega(\gamma) > 0$. This proves (d).

(ii) The average ability of the pool of entrepreneurs in a competitive equilibrium without optimists is

$$E(\theta|\theta \geq \hat{\theta}_0) = \frac{\int_{\hat{\theta}_0}^{+\infty} \theta g(\theta) d\theta}{\int_{\hat{\theta}_0}^{+\infty} g(\theta) d\theta} = \frac{\rho}{\rho - 1}\hat{\theta}_0. \tag{44}$$

In a competitive equilibrium with optimists, the average ability of the pool of realistic entrepreneurs is

$$E(\theta|\theta \geq \hat{\theta}_R) = \frac{\int_{\hat{\theta}_R}^{+\infty} \theta g(\theta) d\theta}{\int_{\hat{\theta}_R}^{+\infty} g(\theta) d\theta} = \frac{\rho}{\rho - 1}\hat{\theta}_R,$$

and the average ability of the pool of optimistic entrepreneurs is

$$E(\theta|\theta \geq \hat{\theta}_O) = \frac{\int_{\hat{\theta}_O}^{+\infty} \theta g(\theta) d\theta}{\int_{\hat{\theta}_O}^{+\infty} g(\theta) d\theta} = \frac{\rho}{\rho - 1}\hat{\theta}_O.$$

Hence, the average ability of the pool of entrepreneurs in a competitive equilibrium with optimists is equal to

$$\begin{aligned}
E(\theta|E^*) &= \frac{E_R^*}{E^*}E(\theta|\theta \geq \hat{\theta}_R) + \frac{E_O^*}{E^*}E(\theta|\theta \geq \hat{\theta}_O) \\
&= \frac{(1-\lambda)\theta_m^\rho \hat{\theta}_R^{-\rho}}{(1-\lambda)\theta_m^\rho \hat{\theta}_R^{-\rho} + \lambda\theta_m^\rho \hat{\theta}_O^{-\rho}} \frac{\rho}{\rho-1}\hat{\theta}_R + \frac{\lambda\theta_m^\rho \hat{\theta}_O^{-\rho}}{(1-\lambda)\theta_m^\rho \hat{\theta}_R^{-\rho} + \lambda\theta_m^\rho \hat{\theta}_O^{-\rho}} \frac{\rho}{\rho-1}\hat{\theta}_O \\
&= \frac{1-\lambda}{1-\lambda+\lambda\gamma^\rho}\frac{\rho}{\rho-1}\hat{\theta}_R + \frac{\lambda\gamma^\rho}{1-\lambda+\lambda\gamma^\rho}\frac{\rho}{\rho-1}\hat{\theta}_O. \qquad (45)
\end{aligned}$$

It follows from (44) and (45) that $E(\theta|E^*) < E(\theta|\theta \geq \hat{\theta}_0)$ as long as

$$\frac{1-\lambda}{1-\lambda+\lambda\gamma^\rho}\frac{\rho}{\rho-1}\hat{\theta}_R + \frac{\lambda\gamma^\rho}{1-\lambda+\lambda\gamma^\rho}\frac{\rho}{\rho-1}\hat{\theta}_O < \frac{\rho}{\rho-1}\hat{\theta}_0$$

or

$$\frac{1-\lambda}{1-\lambda+\lambda\gamma^\rho}(1-\lambda+\lambda\gamma^\rho)^{\frac{1}{\rho}} + \frac{\lambda\gamma^{\rho-1}}{1-\lambda+\lambda\gamma^\rho}(1-\lambda+\lambda\gamma^\rho)^{\frac{1}{\rho}} < 1$$

or

$$\frac{1-\lambda+\lambda\gamma^{\rho-1}}{(1-\lambda+\lambda\gamma^{\rho})^{1-\frac{1}{\rho}}}<1,$$

which we know to hold from part (i). This proves result (ii).
(iii) The result follows directly from the definition of mean returns to entrepreneurship and Proposition 1. *Q.E.D.*

Proof of Proposition 3: The mean returns to entrepreneurship of realists is:

$$\begin{aligned}
\bar{\pi}_R &= E(\pi(\theta, l(\theta, w^*, r^*), k(\theta, w^*, r^*))|\theta \geq \hat{\theta}_R) \\
&= \frac{\int_{\hat{\theta}_R}^{+\infty} \pi(\theta, l(\theta, w^*, r^*), k(\theta, w^*, r^*))g(\theta)d\theta}{\int_{\hat{\theta}_R}^{+\infty} g(\theta)d\theta} \\
&= \frac{\left(\frac{\alpha}{w^*}\right)^{\frac{\alpha}{1-\eta}}\left(\frac{\beta}{r^*}\right)^{\frac{\beta}{1-\eta}}(1-\eta)\,\rho\theta_m^{\rho}\int_{\hat{\theta}_R}^{+\infty}\theta^{\frac{1}{1-\eta}}\theta^{-\rho-1}d\theta}{G(+\infty)-G(\hat{\theta}_R)} + r^*\frac{K}{N} \\
&= \frac{\left(\frac{\alpha}{w^*}\right)^{\frac{\alpha}{1-\eta}}\left(\frac{\beta}{r^*}\right)^{\frac{\beta}{1-\eta}}(1-\eta)\,\rho\theta_m^{\rho}\int_{\hat{\theta}_R}^{+\infty}\theta^{\frac{1}{1-\eta}}\theta^{-\rho-1}d\theta}{1-\left[1-\left(\frac{\theta_m}{\hat{\theta}_R}\right)^{\rho}\right]} + r^*\frac{K}{N} \\
&= \left(\frac{\alpha}{w^*}\right)^{\frac{\alpha}{1-\eta}}\left(\frac{\beta}{r^*}\right)^{\frac{\beta}{1-\eta}}(1-\eta)\,\rho\frac{\hat{\theta}_R^{\frac{1}{1-\eta}}}{\rho-\frac{1}{1-\eta}} + r^*\frac{K}{N} \\
&= \alpha^{\frac{\alpha}{1-\eta}}\beta^{\frac{\beta}{1-\eta}}(w^*)^{-\frac{\alpha}{1-\eta}}(r^*)^{-\frac{\beta}{1-\eta}}(1-\eta)\,\rho\frac{\hat{\theta}_R^{\frac{1}{1-\eta}}}{\rho-\frac{1}{1-\eta}} + r^*\frac{K}{N} \\
&= \alpha^{\frac{\alpha}{1-\eta}}\beta^{\frac{\beta}{1-\eta}}w^{-\frac{\eta}{1-\eta}}\hat{\theta}_R^{\frac{1}{1-\eta}}\left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^{-\frac{\beta}{1-\eta}}(1-\eta)\,\frac{\rho}{\rho-\frac{1}{1-\eta}} + r^*\frac{K}{N} \\
&= \alpha^{\frac{\alpha}{1-\eta}}\beta^{\frac{\beta}{1-\eta}}\left[\theta_m\alpha^{\alpha}\beta^{\beta}(1-\eta)^{1-\eta}(1-\lambda+\lambda\gamma^{\rho})^{\frac{1}{\rho}}\left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}}\left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^{-\beta}\right]^{-\frac{\eta}{1-\eta}} \\
&\times\left[\theta_m(1-\lambda+\lambda\gamma^{\rho})^{\frac{1}{\rho}}\left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}}\right]^{\frac{1}{1-\eta}}\left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^{-\frac{\beta}{1-\eta}}\frac{\rho\,(1-\eta)}{\rho-\frac{1}{1-\eta}} + r^*\frac{K}{N} \\
&= \frac{\rho\theta_m\alpha^{\alpha}\beta^{\beta}(1-\eta)^{2-\eta}}{\rho(1-\eta)-1}(1-\lambda+\lambda\gamma^{\rho})^{\frac{1}{\rho}}\left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}}\left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^{-\beta} + r^*\frac{K}{N}
\end{aligned} \tag{46}$$

Substituting r^* into (46) we have

$$\begin{aligned}\bar{\pi}_R &= \rho\theta_m\alpha^\alpha\beta^\beta(1-\eta)^{1-\eta}(1-\lambda+\lambda\gamma^\rho)^{\frac{1}{\rho}}\left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}}\left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^{-\beta} \\ &\quad\times\left[\frac{1-\eta}{\rho(1-\eta)-1}+\frac{\beta}{\rho(1-\beta)-1}\right].\end{aligned}$$

The mean returns to entrepreneurship of optimists is:

$$\begin{aligned}\bar{\pi}_O^* &= E(\pi(\theta, l(\gamma\theta, w^*, r^*), k(\gamma\theta, w^*, r^*))|\theta \geq \hat{\theta}_O) \\ &= \frac{\int_{\hat{\theta}_O}^{+\infty}\pi(\theta, l(\gamma\theta, w^*, r^*), k(\gamma\theta, w^*, r^*))g(\theta)d\theta}{\int_{\hat{\theta}_O}^{+\infty}g(\theta)d\theta} \\ &= \frac{\left(\frac{\alpha}{w^*}\right)^{\frac{\alpha}{1-\eta}}\left(\frac{\beta}{r^*}\right)^{\frac{\beta}{1-\eta}}\left(\gamma^{-1}-\eta\right)\gamma^{\frac{1}{1-\eta}}\rho\theta_m^\rho\int_{\hat{\theta}_O}^{+\infty}\theta^{\frac{1}{1-\eta}}\theta^{-\rho-1}d\theta}{G(+\infty)-G(\hat{\theta}_O)}+r^*\frac{K}{N} \\ &= \frac{\left(\frac{\alpha}{w^*}\right)^{\frac{\alpha}{1-\eta}}\left(\frac{\beta}{r^*}\right)^{\frac{\beta}{1-\eta}}\left(\gamma^{-1}-\eta\right)\gamma^{\frac{1}{1-\eta}}\rho\theta_m^\rho\int_{\hat{\theta}_O}^{+\infty}\theta^{\frac{1}{1-\eta}}\theta^{-\rho-1}d\theta}{1-\left[1-\left(\frac{\theta_m}{\hat{\theta}_O}\right)^\rho\right]}+r^*\frac{K}{N} \\ &= \frac{\left(\frac{\alpha}{w^*}\right)^{\frac{\alpha}{1-\eta}}\left(\frac{\beta}{r^*}\right)^{\frac{\beta}{1-\eta}}\left(\gamma^{-1}-\eta\right)\gamma^{\frac{1}{1-\eta}}\rho\theta_m^\rho\frac{\hat{\theta}_O^{\frac{1}{1-\eta}-\rho}}{\rho-\frac{1}{1-\eta}}}{\left(\frac{\theta_m}{\hat{\theta}_O}\right)^\rho}+r^*\frac{K}{N} \\ &= \alpha^{\frac{\alpha}{1-\eta}}\beta^{\frac{\beta}{1-\eta}}(w^*)^{-\frac{\alpha}{1-\eta}}(r^*)^{-\frac{\beta}{1-\eta}}\left(\gamma^{-1}-\eta\right)\gamma^{\frac{1}{1-\eta}}\rho\frac{\hat{\theta}_O^{\frac{1}{1-\eta}}}{\rho-\frac{1}{1-\eta}}+r^*\frac{K}{N} \\ &= \alpha^{\frac{\alpha}{1-\eta}}\beta^{\frac{\beta}{1-\eta}}(w^*)^{-\frac{\eta}{1-\eta}}\hat{\theta}_O^{\frac{1}{1-\eta}}\left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^{-\frac{\beta}{1-\eta}}\left(\gamma^{-1}-\eta\right)\gamma^{\frac{1}{1-\eta}}\frac{\rho}{\rho-\frac{1}{1-\eta}}+r^*\frac{K}{N} \\ &= \alpha^\alpha\beta^\beta(1-\eta)^{-\eta}\theta_m(1-\lambda+\lambda\gamma^\rho)^{\frac{1}{\rho}}\left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}}\left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^{\frac{\beta\eta}{1-\eta}}\times \\ &\quad \gamma^{-\frac{1}{1-\eta}}\left(\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right)^{-\frac{\beta}{1-\eta}}\frac{\rho\left(\gamma^{-1}-\eta\right)\gamma^{\frac{1}{1-\eta}}}{\rho-\frac{1}{1-\eta}}+r^*\frac{K}{N} \\ &= \frac{\rho\theta_m\alpha^\alpha\beta^\beta(1-\eta)^{1-\eta}}{\rho(1-\eta)-1}\frac{(1-\lambda+\lambda\gamma^\rho)^{\frac{1}{\rho}}}{\left(\gamma^{-1}-\eta\right)^{-1}}\left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}}\left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^{-\beta}+r^*\frac{K}{N}\end{aligned} \tag{47}$$

Substituting r^* into (47) we have

$$\begin{aligned}\bar{\pi}_O^* &= \frac{\rho\theta_m\alpha^\alpha\beta^\beta(1-\eta)^{1-\eta}}{\rho(1-\eta)-1}\frac{(1-\lambda+\lambda\gamma^\rho)^{\frac{1}{\rho}}}{(\gamma^{-1}-\eta)^{-1}}\left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}}\left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^{-\beta} \\ &\quad +\theta_m\alpha^\alpha\beta^\beta(1-\eta)^{1-\eta}(1-\lambda+\lambda\gamma^\rho)^{\frac{1}{\rho}}\left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}}\left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^{1-\beta}\frac{K}{N},\end{aligned}$$

or

$$\begin{aligned}\bar{\pi}_O^* &= \rho\theta_m\alpha^\alpha\beta^\beta(1-\eta)^{1-\eta}(1-\lambda+\lambda\gamma^\rho)^{\frac{1}{\rho}}\left[\frac{\rho(1-\beta)-1}{\rho(1-\eta)-1}\right]^{\frac{1}{\rho}}\left[\frac{N}{K}\frac{\beta\rho}{\rho(1-\beta)-1}\right]^{-\beta} \\ &\quad \times\left[\frac{\gamma^{-1}-\eta}{\rho(1-\eta)-1}+\frac{\beta}{\rho(1-\beta)-1}\right].\end{aligned}$$

Comparing (46) to (47) we see that the mean returns to entrepreneurship of realists is greater than the mean returns to entrepreneurship of optimists as long as

$$(1-\eta)^{2-\eta} > (1-\eta)^{1-\eta}\left(\gamma^{-1}-\eta\right),$$

or

$$1-\eta > \frac{1}{\gamma}-\eta,$$

which is always the case when $\gamma > 1$. *Q.E.D.*

Appendix B: Pareto Firm Size Distribution

In this appendix we show that if ability is distributed according to a Pareto distribution so is firm size. We start by doing it in the model without optimists. After that we show that the result also holds in the model with optimists.

Setting $\gamma = 1$ in the first-order conditions of an entrepreneur's problem we have

$$k = \frac{\beta}{\alpha}\frac{w}{r}l.$$

The scale of a firm is given by

$$\beta\gamma\theta l^\alpha k^{\beta-1} = r,$$

or

$$\beta\gamma\theta l^{\alpha}\left(\frac{\beta}{\alpha}\frac{w}{r}l\right)^{\beta-1}=r,$$

or

$$\theta=\frac{1}{\gamma}\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta}l^{1-\eta}. \tag{48}$$

Let $S(l)$ denote the probability that a randomly select firm has fewer than l employees. Then under (48) $S(l)$ will be the probability that θ is less than $\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta}l^{1-\eta}$ conditional on $\theta\geq\hat{\theta}_0^*$, or

$$\begin{aligned}
S(l) &= \Pr\left[\theta\leq\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta}l^{1-\eta}|\theta\geq\hat{\theta}_0^*\right]\\
&= \frac{G\left[\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta}l^{1-\eta}\right]-G(\hat{\theta}_0^*)}{1-G(\hat{\theta}_0^*)}
\end{aligned}$$

for $l\geq$ and 0 otherwise. If ability is distributed according to a Pareto cumulative distribution function $G(\theta)=1-\theta_m^{\rho}\theta^{-\rho}$ we have

$$\begin{aligned}
S(l) &= \frac{G\left[\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta}l^{1-\eta}\right]-G(\hat{\theta}_0^*)}{1-G(\hat{\theta}_0^*)}\\
&= \frac{1-\theta_m^{\rho}\left[\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta}l^{1-\eta}\right]^{-\rho}-\left[1-\theta_m^{\rho}(\hat{\theta}_0^*)^{-\rho}\right]}{1-\left[1-\theta_m^{\rho}(\hat{\theta}_0^*)^{-\rho}\right]}\\
&= 1-\frac{\left[\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta}l^{1-\eta}\right]^{-\rho}}{(\hat{\theta}_0^*)^{-\rho}}\\
&= 1-(\hat{\theta}_0^*)^{\rho}\left[\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta}\right]^{-\rho}l^{-\rho(1-\eta)}\\
&= 1-(\hat{\theta}_0^*)^{\rho}\left(\frac{w^{1-\beta}r^{\beta}}{\alpha^{1-\beta}\beta^{\beta}}\right)^{-\rho}l^{-\rho(1-\eta)}.
\end{aligned}$$

Using the equilibrium condition

$$w^{1-\beta}r^{\beta} = \alpha^{\alpha}\beta^{\beta}(1-\eta)^{1-\eta}\hat{\theta}_0^*,$$

we have

$$\begin{aligned} S(l) &= 1-(\hat{\theta}_0^*)^{\rho}\left[\frac{(1-\eta)^{1-\eta}\hat{\theta}_0^*}{\alpha^{1-\eta}}\right]^{-\rho} l^{-\rho(1-\eta)} \\ &= 1-\left(\frac{\alpha}{1-\eta}\right)^{\rho(1-\eta)} l^{-\rho(1-\eta)}. \end{aligned}$$

We now show that optimism does not have an impact on the firm size distribution. Note that if $\theta_r < x$:

$$\begin{aligned} \Pr(X<x) &= \Pr(X_o<x)\lambda + \Pr(X_r<x)(1-\lambda) \\ &= \left[1-\left(\frac{\hat{\theta}_O}{x}\right)^{\alpha}\right]\lambda + \left[1-\left(\frac{\hat{\theta}_R}{x}\right)^{\alpha}\right](1-\lambda) \\ &= -\lambda\left(\frac{\hat{\theta}_O}{x}\right)^{\alpha} + 1-(1-\lambda)\left(\frac{\hat{\theta}_R}{x}\right)^{\alpha} \\ &= 1-\lambda\left(\frac{\hat{\theta}_O}{x}\right)^{\alpha} - (1-\lambda)\left(\frac{\hat{\theta}_R}{x}\right)^{\alpha} \\ &= 1-\left[\lambda\left(\hat{\theta}_O\right)^{\alpha} - (1-\lambda)\left(\hat{\theta}_R\right)^{\alpha}\right]\left(\frac{1}{x}\right)^{\alpha} \\ &= 1-\left[\frac{\left(\lambda\hat{\theta}_O^{\alpha} - (1-\lambda)\hat{\theta}_R^{\alpha}\right)^{\frac{1}{\alpha}}}{x}\right]^{\alpha}. \end{aligned}$$

If $\hat{\theta}_O < x < \hat{\theta}_R$:

$$\Pr(X<x) = \Pr(X_o<x) = 1-\left(\frac{\hat{\theta}_O}{x}\right)^{\alpha}$$

Note that the marginal optimist entrepreneur perceived ability is $\gamma\hat{\theta}_O = \hat{\theta}_R$. Therefore, the firm size associated to this entrepreneur is the same as that associated to the marginal realist entrepreneur. The firm size distribution can be derived as follows:

$$l > \left[\gamma\hat{\theta}_O\left(\frac{w}{\alpha}\right)^{\beta-1}\left(\frac{r}{\beta}\right)^{-\beta}\right]^{\frac{1}{1-\eta}}$$

or, using the equilibrium condition, $w^{1-\beta}r^{\beta} = \alpha^{\alpha}\beta^{\beta}(1-\eta)^{1-\eta}\gamma\hat{\theta}_O$,

$$l > \left[\gamma\hat{\theta}_O\left(\frac{1}{\alpha}\right)^{\beta-1}\left(\frac{1}{\beta}\right)^{-\beta}\alpha^{-\alpha}\beta^{-\beta}(1-\eta)^{\eta-1}\gamma^{-1}\hat{\theta}_O^{-1}\right]^{\frac{1}{1-\eta}}$$

or

$$l > \left[\left(\frac{\alpha}{1-\eta}\right)^{1-\eta}\right]^{\frac{1}{1-\eta}}$$

or

$$l > \frac{\alpha}{1-\eta}.$$

Then

$$\begin{aligned}
\Pr(S < l) &= \Pr\left(\theta \leq \frac{1}{\gamma}\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta} l^{1-\eta}\,\middle|\,\theta \geq \hat{\theta}_O\right)\lambda \\
&\quad + \Pr\left(\theta \leq \left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta} l^{1-\eta}\,\middle|\,\theta \geq \hat{\theta}_R\right)(1-\lambda) \\
&= \frac{1-\theta_m^{\rho}\left(\frac{1}{\gamma}\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta} l^{1-\eta}\right)^{-\rho} - \left(1-\theta_m^{\rho}\hat{\theta}_O^{-\rho}\right)}{1-\left(1-\theta_m^{\rho}\hat{\theta}_O^{-\rho}\right)}\lambda \\
&\quad + \frac{1-\theta_m^{\rho}\left(\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta} l^{1-\eta}\right)^{-\rho} - \left(1-\theta_m^{\rho}\hat{\theta}_R^{-\rho}\right)}{1-\left(1-\theta_m^{\rho}\hat{\theta}_R^{-\rho}\right)}(1-\lambda) \\
&= \frac{1-\theta_m^{\rho}\left(\frac{1}{\gamma}\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta} l^{1-\eta}\right)^{-\rho} - \left(1-\theta_m^{\rho}\hat{\theta}_O^{-\rho}\right)}{1-\left(1-\theta_m^{\rho}\hat{\theta}_O^{-\rho}\right)} \\
&\quad + \frac{1-\theta_m^{\rho}\left(\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta} l^{1-\eta}\right)^{-\rho} - \left(1-\theta_m^{\rho}\gamma^{-\rho}\hat{\theta}_O^{-\rho}\right)}{1-\left(1-\theta_m^{\rho}\gamma^{-\rho}\hat{\theta}_O^{-\rho}\right)}(1-\lambda)
\end{aligned}$$

or

$$
\begin{aligned}
\Pr(S<l) &= 1-\left[\lambda\frac{\left(\frac{1}{\gamma}\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta}l^{1-\eta}\right)^{-\rho}}{\hat{\theta}_O^{-\rho}}\right]-\left[(1-\lambda)\frac{\left(\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta}l^{1-\eta}\right)^{-\rho}}{\gamma^{-\rho}\hat{\theta}_O^{-\rho}}\right]\\
&= 1-\left\{\left[\lambda\frac{\left(\frac{1}{\gamma}\right)^{-\rho}}{\hat{\theta}_O^{-\rho}}\right]+\left[(1-\lambda)\frac{1}{\gamma^{-\rho}\hat{\theta}_O^{-\rho}}\right]\right\}\left(\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta}\right)^{-\rho}l^{-\rho(1-\eta)}\\
&= 1-\hat{\theta}_O^{\rho}\left(\frac{\left(\frac{w}{\alpha}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta}}{\gamma}\right)^{-\rho}l^{-\rho(1-\eta)}\\
&= 1-\hat{\theta}_O^{\rho}\left(\frac{\left(\frac{1}{\alpha}\right)^{1-\beta}\left(\frac{1}{\beta}\right)^{\beta}\alpha^{\alpha}\beta^{\beta}(1-\eta)^{1-\eta}\gamma\hat{\theta}_O}{\gamma}\right)^{-\rho}l^{-\rho(1-\eta)}\\
&= 1-\left(\left(\frac{1}{\alpha}\right)^{1-\beta}\left(\frac{1}{\beta}\right)^{\beta}\alpha^{\alpha}\beta^{\beta}(1-\eta)^{1-\eta}\right)^{-\rho}l^{-\rho(1-\eta)}\\
&= 1-\left(\frac{\alpha}{1-\eta}\right)^{\rho(1-\eta)}l^{-\rho(1-\eta)}.
\end{aligned}
$$

Therefore the firm size distribution is the same that would apply in the absence of optimism. The intuition is that the marginal optimist behaves, in terms of labor demand, as the marginal realist, under the assumption that the ability distribution is the same for optimists and realists, the labor market is the same, etc.

Appendix C: Alternative Values for Fraction of Optimists

In this appendix we report two alternative calibrations of the model. We keep the standard parameters in Table I fixed and only change the behavioral parameter λ. More precisely, we consider two alternative values for the fraction of optimistic individuals: 30 and 70 percent. Hence, we focus on the following two configurations for the behavioral parameters: ($\lambda = 30$, $\gamma = 1.0832$) and ($\lambda = 70$, $\gamma = 1.0832$). The calibration ($\lambda = 30$, $\gamma = 1.0832$) gives us a lower bound for the general equilibrium effects of optimism since, relative to the benchmark calibration in Table II, it lowers the fraction of optimists while it keeps the intensity of optimistic beliefs constant. The calibration ($\lambda = 70$, $\gamma = 1.0832$) gives us an upper bound for the general equilibrium effects of optimism since, relative to the benchmark calibration in Table II, it raises the fraction of optimists while it keeps the intensity of optimistic beliefs constant.

Table III

Calibration with $\lambda = 0.3$ and $\gamma = 1.0832$

	Model $\lambda = 0$ Lucas (1978)	Model $\lambda = 0.3$ $\gamma = 1.0832$	Percent change
Output (Y^*)	1.36500	1.35870	-0.46
Wage (w^*)	0.85055	0.87569	2.96
Rental cost of capital (r^*)	0.35858	0.36918	2.96
Mean returns ($\bar{\pi}^*$)	11.80800	9.53770	-19.23
Mean returns of realists ($\bar{\pi}^*_R$)	-	12.15500	-
Mean returns of optimists ($\bar{\pi}^*_O$)	-	6.10280	-
Share of workers (L^*)	0.98217	0.98217	0
Ability of mg realistic entrep. ($\hat{\theta}_R$)	-	1.80110	-
Ability of mg entrep. ($\hat{\theta}$)	1.74940	-	-
Ability of mg optimistic entrep. ($\hat{\theta}_O$)	-	1.66280	-
Share of entrep. (E^*)	0.01783	0.01783	0
Share of optimistic entrep. (E^*_O/E^*)	0	0.43245	43.25

We see from Table III that if the fraction of optimists is 30 percent instead of 50 percent, then optimism leads to smaller drop in output, a smaller increase in input prices, and a smaller decrease in the mean returns to entrepreneurship. However, the magnitude of the quantitative effects remains similar to those found for the benchmark calibration. Optimism always leads to a relatively small decrease in output, a large increase in input prices, and a very large decrease in the mean returns to entrepreneurship.

Table IV

Calibration with $\lambda = 0.7$ and $\gamma = 1.0832$

	Model $\lambda = 0$ Lucas (1978)	Model $\lambda = 0.7$ $\gamma = 1.0832$	Percent change
Output (Y^*)	1.36500	1.36020	-0.35
Wage (w^*)	0.85055	0.90348	6.22
Rental cost of capital (r^*)	0.35858	0.38089	6.22
Mean returns ($\bar{\pi}^*$)	11.80800	7.50980	-36.40
Mean returns of realists ($\bar{\pi}^*_R$)	-	12.54300	-
Mean returns of optimists ($\bar{\pi}^*_O$)	-	6.29650	-
Share of workers (L^*)	0.98217	0.98217	0
Ability of mg realistic entrep. ($\hat{\theta}_R$)	-	1.85830	-
Ability of mg entrep. ($\hat{\theta}$)	1.74940	-	-
Ability of mg optimistic entrep. ($\hat{\theta}_O$)	-	1.71550	-
Share of entrep. (E^*)	0.01783	0.01783	0
Share of optimistic entrep. (E^*_O/E^*)	0	0.80576	80.58

We see from Table IV that if the fraction of optimists is 70 percent instead of 50 percent, then optimism leads to smaller drop in output, a larger increase in input prices, and a larger decrease in the mean returns to entrepreneurship. However, the magnitude of the quantitative effects remains similar to those found for the benchmark calibration. Optimism always leads to a relatively small decrease in output, a large increase in input prices, and a very large decrease in the mean returns to entrepreneurship.

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