The Allocation of Talent to Financial Trading versus Production: Welfare and Employment Effects of Trading in General Equilibrium*

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Abstract

We incorporate occupational choice between finance and entrepreneurship into the Grossman-Stiglitz (1980) noisy rational expectations equilibrium model. Sophisticated agents produce output and create jobs as entrepreneurs or contribute to informational efficiency in financial markets as informed traders. Finance possibly attracts too much talent, for instance if the amount of noise in the economy is small, so that the asset price at a rational expectations equilibrium is highly informative anyway. The main beneficiaries of the allocation of talent to entrepreneurial activity are workers, whose wage and employment prospects improve when more sophisticated agents choose to become entrepreneurs.

JEL classification: G14, J24

Key words: market efficiency, asymmetric information, allocation of talent, occupational choice

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1 Introduction

The recent financial turbulence has sparked a discussion about the social benefits of financial trading. At the policy level, the discussion centers around the question of whether, in view of explicit safety nets and implicit state guarantees, financial institutions have incentives to take excessive risks. A different concern, which might be of equal importance for long-term growth and economic welfare, is that the financial sector attracts too much talent, which could produce larger social benefits in different occupations. This paper presents a general equilibrium model that addresses this issue. Asset prices fluctuate due to shocks to macroeconomic fundamentals and stochastic noise trader demand. A class of "sophisticated" agents become either traders or entrepreneurs (or neither). Entrepreneurs produce output and create jobs. Claims to the values they create are traded in a financial market. Traders contribute to informational efficiency by acquiring information about fundamentals. Agents that become neither entrepreneurs nor traders act as uninformed investors. Trading possibly, though not necessarily, attracts too much talent in the model. For instance, sophisticated agents and uninformed traders are better-off in the absence of financial trading if they have a long position in the risky asset at equilibrium with occupational choice (OC) and the volatility of noise trader demand is sufficiently low. Probably the most important effect of measures which alter the incentives to become a trader or an entrepreneur is not on the agents who face this choice but on production sector workers: they benefit more strongly from the creation of jobs by entrepreneurs than from enhanced informational efficiency of asset prices. A production economy version of our model lends support to this view: depending on whether there is full employment or unemployment due to wage rigidity, an increase in the number of entrepreneurs benefits workers by raising their wage or aggregate employment, respectively.

Concerns that the financial sector attracts too much talent are fueled by empirical observations that high wages draw a large number of graduates into finance. Goldin and Katz (2008) observe that the proportion of male Harvard graduates from selected classes who work in the finance sector 15 years after graduation rose from 5 percent for early-1970s cohorts to 15 percent for early-1990s cohorts. According to the *Harvard Magazine*, the figure peaked at more than 20 percent in 2007, before labor demand collapsed with the onset of the subprime crisis.[1] Competition for talent does not stop when students have decided to specialize in science or engineering. Shortly before the financial crisis, serial entrepreneur and writer Vivek Wadhwa observed in his testimony to the the U.S. House of Representatives that "[T]hirty to forty percent of Duke Masters of Engineering

[1] Elizabeth Gudrais, "Flocking to Finance", *Harvard Magazine*, May-June 2008, http://harvardmagazine.com/2008/05/flocking-to-finance.html.

Management students were accepting jobs outside of the engineering profession. They chose to become investment bankers or management consultants rather than engineers".[2] Similarly, the *Economist* reports that "[M]ost of the world's top hedge funds prefer seasoned traders, engineers and mathematicians, people with insight and programming skills, to MBAs".[3] Célérier and Vallée (2013) remark in their empirical study of French graduate engineers that a sizeable portion of the post-2000 graduates worked in the City of London or on Wall street. Oyer (2008, p. 2622) finds "mixed evidence that initial jobs on Wall Street lead Stanford MBAs to start fewer businesses". He adds that there is path dependence in OC: workers drawn into the financial sector by random events tend to stay there. While fierce competition for talent is undisputed, opinions diverge on whether this is a good thing. Esther Duflo replied to concerns that regulations would constrain the financial sector in the aftermath of the financial crisis: "Is there a risk of discouraging the most talented to work hard and innovate in finance? Probably. But it would almost certainly be a good thing."[4] At *The Economist's* 2013 Buttonwood Gathering, Robert Shiller ("When you study finance you are studying how to make things happen") and Wadhwa ("Google – not Goldman Sachs – deserves our best minds")[5] exchanged opinions. Beck et al. (2014) find that in a broad cross section of countries financial intermediation (measured as the ratio of private credit to GDP) is positively correlated with economic growth, while the size of the financial sector (measured by its value added share in GDP) is insignificant if intermediation is controlled for.

Our model incorporates OC between finance and entrepreneurship into the noisy rational expectations equilibrium (REE) model of Grossman and Stiglitz (1980, henceforth: "GS"). The notion of informed trading is precisely the one mentioned, but not formalized, in Murphy et al.'s (1991, p. 506) classic paper on the allocation of talent:

> "Trading probably raises efficiency since it brings security prices closer to their fundamental values ... But the main gains from trading come from the transfer of wealth to the smart traders ... Even though efficiency improves, transfers are the main source of returns in trading."

Baumol (1990, p. 915) takes a similar position. The reason why the allocation of talent to finance can be excessive when the amount of noise in the economy is small is as follows: As long as there are

[2] Quoted from Philippon (2010, p. 159).

[3] Philip Delves Broughton, "Think twice", *The Economist*, January 2011, http://www.economist.com/whichmba/think-twice.

[4] *Vox*, October 8, 2008, http://www.voxeu.org/article/too-many-bankers.

[5] Washington Post, November 1, 2013, http://www.washingtonpost.com/blogs/innovations/wp/2013/11/01/google-not-goldman-sachs-deserves-our-best-minds/

traders, their private information about the asset's fundamental leaks to the public almost perfectly, while without traders there is no information in the market at all. Asset supply is larger without traders, if after banning traders all agents become entrepreneurs. As agents are risk-averse, both effects result in an expected asset price that is lower without traders. At the same time, however, the asset price in an REE with traders is stochastic, while it is almost certain without traders. If entrepreneurs gain more from the vanishing uncertainty about the price they get for their firm than they lose from the decreasing expected price, their rents increase if the opportunity to become a trader did not exist. Furthermore, traders' and uninformed investors' (who typically demand a positive amount of assets) gains from trading are higher without traders, as their benefits from a lower expected price outweight the additional risks they face. Notably, excessive allocation of talent to finance occurs despite the fact that there is no other financial market imperfection besides the standard REE information asymmetry and informed trading ameliorates this problem by conveying information on macroeconomic fundamentals.

The model most closely related to ours is Bolton et al. (2016). In their model, a class of agents has the option to become "dealers" and thus acquire the ability to assess the quality of newly issued stocks and buy them over-the-counter from originators. "Cream skimming" by dealers worsens the average quality of assets traded in the organized exchange. If there are agents with a sufficiently low cost of becoming dealers, then there is an equilibrium with a positive mass of dealers. As cream skimming is pure rent-seeking in the baseline model, too much talent is allocated to this activity. If moral hazard in firms is incorporated in the model, the dealers perform a socially beneficial task by providing incentives for originators to supply high-quality assets. The allocation of talent to finance is still excessive if, for instance, it is sufficiently costly for originators to produce high-quality assets. In an earlier version of the paper, Bolton et al. (2012) derive similar results in a variant of the model with OC between becoming a dealer or an originator. Our model complements Bolton et al.'s (2016), in that it focuses on traders' activity, not in OTC markets, but in organized exchanges, where their trading activity at least partially reveals the information they produce to other market participants. Bolton et al. (2016, p. 3) conjecture that "the standard framework of trading in financial markets first developed by Grossman and Stiglitz (1980) ... seems to suggest that the financial sector could be too small." Our analysis derives conditions under which trading is excessive, even though it produces valuable information that leaks out to other traders, taking into account the opportunity cost of trading in terms of reduced entrepreneurial activity.[6]

[6] The limitations of our analysis are analogous as in Bolton et al. (2016). There is no moral hazard due to implicit or explicit state guarantees. There is no leverage, traders trade only on their own account. The only input required to set up a firm is entrepreneurial labor, so there is no financial intermediation. Entrepreneurs set up and run firms,

Phillipon (2010) and Cahuc and Challe (2012) present alternative models of the allocation of talent to finance. Other than Bolton et al. (2012, 2016) and our paper, they emphasize the financial intermediation role of the financial sector and the focus is not on the question of whether the financial sector is too big. Philippon (2010) embeds OC into an endogenous growth model with externalities emanating from investment. Once these externalities are internalized by means of an investment subsidy, there is no need for a preferential tax treatment of the financial sector: second-best can be achieved with a uniform income tax on income generated in the real and financial sectors. Cahuc and Challe (2012) integrate OC into the neoclassical overlapping-generations growth model. Only agents who specialize in finance are able to make loans to entrepreneurs. In the standard overlapping generations model without OC, asset bubbles can remove dynamic inefficiency due to over-investment by crowding out real investments. Cahuc and Challe (2012) consider a bubble on an intrinsically worthless asset that can only be traded by financiers. The bubble raises financiers' profits, thereby crowding out employment in the real sector. If financial intermediaries are able to extract large rents, this effect outweighs the former crowding out effect, and bubbles lose their beneficial role.

The paper is organized as follows. Section 2 introduces the model. Section 3 derives the price function and agents' expected utilities. Sections 4 and 5 characterize the equilibrium without and with noise trader shocks, respectively. Section 6 embeds the model in a general equilibrium setup with a labor market. Sections 7–9 investigate the welfare effects of trading activity and the question of whether the financial sector should be taxed. Section 10 concludes. Details of the algebra are delegated to the Appendix.

2 Model

Consider a CARA-Gaussian economy with three dates, "early", "intermediate", and "late". There are three types of agents: a continuum of rational agents indexed by the interval $[0, L]$ $(L > 0)$, who choose between becoming an informed trader (often called "traders") or an entrepreneur; a continuum of uninformed traders indexed by the interval $[0, M]$ $(M > 0)$, who also act rationally; and noise traders. There is a single homogeneous consumption good. Prices are quoted in terms of this consumption good. Rational agents are endowed with e (> 0) units of the good early, uninformed traders with e_M units. Rational agents and uniformed traders are characterized by the CARA utility function $U(\pi) = -\exp(-\rho\pi)$, where π is late consumption and ρ (> 0) is the coefficient of absolute risk aversion. Each agent has access to a storage technology that transforms

no distinction is made between engineering and management tasks.

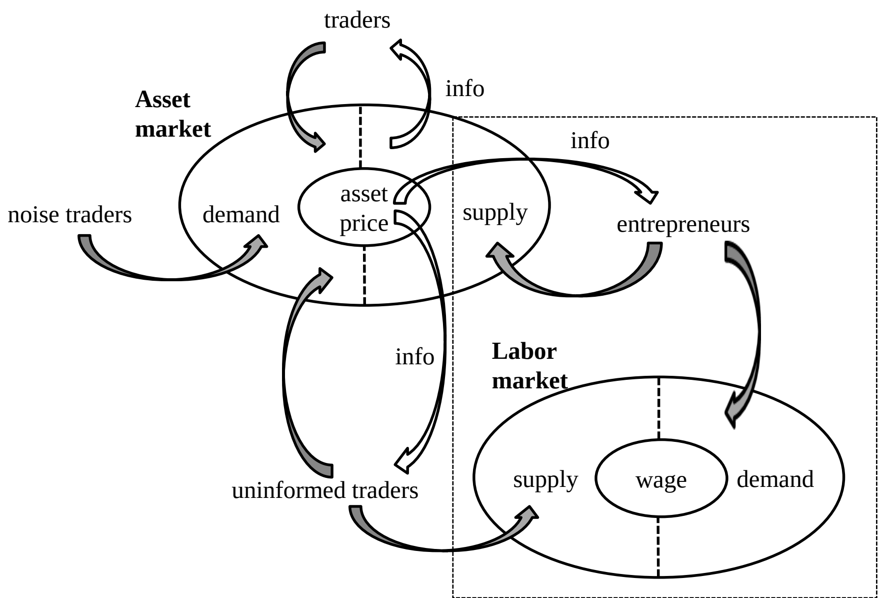

Figure 1: Structure of the model

endowments one-for-one into late consumption.

Rational agents face an OC decision: they become entrepreneurs or informed traders. There is no physical cost of becoming an entrepreneur or a trader. They choose the occupation whose payoff profile yields the highest expected utility. They also have the option not to become an entrepreneur or an informed traders, in which case they act like the uninformed traders (since becoming an informed trader is costless, they choose to do so only if private information has no value). As a reference point for the investigation of whether trading is beneficial, we also consider the variant of the model without OC, in which agents do not have the opportunity to become traders.

Each entrepreneur sets up firms indexed by the interval $[0, 1/a]$ $(a > 0)$. Let the mass of rational agents who decide to become entrepreneurs be denoted L_E. Then the mass of firms is L_E/a, and for each entrepreneur, the subset of firms he owns has measure zero, so entrepreneurs have no market power. Each firm produces θ units of output late. θ is a macroeconomic shock, which is uniform across firms. It is the sum of two independent jointly normal random variables: $\theta = s + \varepsilon$, where $s \sim \mathrm{N}(\bar{s}, \sigma_s^2)$ and $\varepsilon \sim \mathrm{N}(0, \sigma_\varepsilon^2)$ (in Section 6, we consider a production economy, in which output θ depends on unskilled labor input). Since entrepreneurial labor is the only input required to start a business, entrepreneurs do not need finance, and there is no financial intermediation.

At the intermediate date, shares in the firms are traded in a competitive stock market. Following GS, noise traders inelastically demand $\nu \sim \mathrm{N}(\bar{\nu}, \sigma_\nu^2)$ units of the risky asset (see also Grossman, 1976,

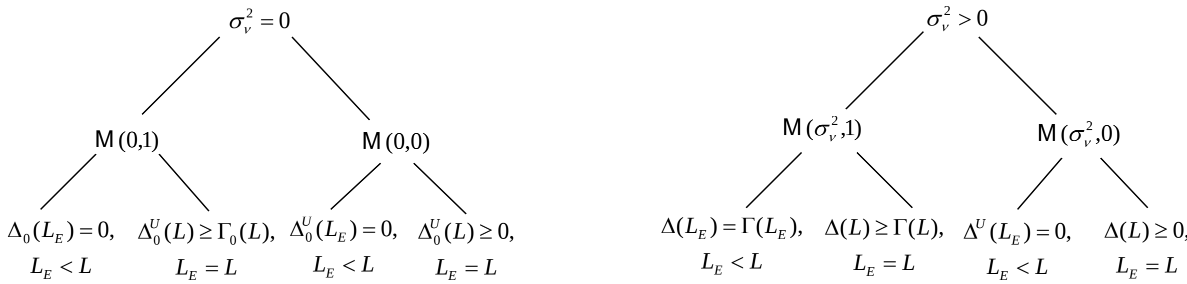

Figure 2: Model variants

and Hellwig, 1980). Traders observe s and face residual uncertainty ε about firms' payoff. They are the only agents who acquire information about s, thereby contributing to the informational efficiency of the stock market. Entrepreneurs and uninformed traders observe neither s nor ε nor the other agents' trades. So they cannot tell if a high stock market value of the firms is due to large demand by noise traders or by rational traders, having favorable private information about profitability.[7]

Figure 1 depicts the structure of the model. The novel elements are inside the dashed rectangle. The baseline version with exogenous output per firm θ adds an OC decision between entrepreneurship and trading to the GS model and endogenizes asset supply. Section 6 considers an extension of the model, in which firms demand and uninformed traders supply labor. This version of the model allows the analysis of the labor market effects of entrepreneurship.

We have to distinguish four model variants according to whether the variance of noise trader demand is zero or positive and whether there is OC or not. In each case either a fraction of or all rational agents become entrepreneurs. We denote the economies that obtain when the variance of noise trader demand is σ_ν^2 and there is OC or not as $\mathsf{M}(\sigma_\nu^2, 1)$ and $\mathsf{M}(\sigma_\nu^2, 0)$, respectively. Figure 2 illustrates the different cases we have to consider.

3 Price function and expected utilities

This section defines equilibrium and derives agents' asset demands, the price function that relates the asset price to macroeconomic shocks, and agents' expected utilities.

[7]Since there are no firm-specific shocks, this information structure does not entail that traders have information about individual firms that entrepreneurs do not have.

Equilibrium

The mass of firms and, hence, the supply of stocks is L_E/a. Let P denote the stock market value of each firm and I_E, I_T, and I_M entrepreneurs', traders', and uninformed traders' stock holdings, respectively. Rational agents make their OC and investment decisions so as to maximize expected utility conditional on available information. Consumption is $\pi_E = e + P/a + (\theta - P)I_E$ for entrepreneurs, $\pi_T = e + (\theta - P)I_T$ for traders, and $\pi_M = e_M + (\theta - P)I_M$ for uninformed traders. While traders know s when they make their investment decision, entrepreneurs and uninformed traders can only use the price level P they observe to infer information about s. Throughout the paper, we focus on equilibria at which the mass of entrepreneurs L_E is positive, since otherwise the asset supply is zero. Moreover, in the model variants with OC $\mathsf{M}(\sigma_\nu^2, 1)$ we focus on equilibria at which rational agents become either entrepreneurs or traders (and not uninformed traders). We argue that this entails no loss of generality.[8] In model variants without OC, agents who do not become entrepreneurs act as uninformed traders. (L_E, I_E, I_T, I_M, P) is an *equilibrium* (an REE) of $\mathsf{M}(\sigma_\nu^2, 1)$ with $\sigma_\nu^2 > 0$ if I_E maximizes $\mathrm{E}[U(\pi_E)|\, P]$, I_T maximizes $\mathrm{E}[U(\pi_T)|\, s, P]$, I_M maximizes $\mathrm{E}[U(\pi_M)|\, P]$, the market for the risky asset clears (i.e., $L_E/a = L_E I_E + (L - L_E)I_T + M I_M + \nu$), OC is optimal (i.e., $\mathrm{E}[U(\pi_E)] = \mathrm{E}[U(\pi_T)]$ and $0 < L_E \leqslant L$ or $\mathrm{E}[U(\pi_E)] \geqslant \mathrm{E}[U(\pi_T)]$ and $L_E = L$), and becoming an uninformed trader is not preferred to becoming an entrepreneur (i.e., $\mathrm{E}[U(\pi_E)] \geqslant \mathrm{E}[U(\pi_M)]$). An *equilibrium* $\mathsf{M}(\sigma_\nu^2, 0)$ is defined similarly. I_T and the condition that it is chosen optimally drop out of the definition, and the asset market clearing condition becomes $L_E/a = L_E I_E + (L - L_E + M)I_M + \nu$. We denote equilibrium L_E with OC by L_E^T and without OC by L_E^U.

Demands and price function

The optimal investment levels are

$$I_E = I_M = \frac{\mathrm{E}(\theta|\, P) - P}{\rho\,\mathrm{var}(\theta|\, P)}, \quad I_T = \frac{s - P}{\rho\,\sigma_\varepsilon^2} \tag{1}$$

[8] The fact that there is no heterogeneity among rational agents ex ante and some of them become entrepreneurs means that expected utility is no higher for traders than for entrepreneurs, so we do not address the issue of excessive pay in finance. Philippon and Reshef (2012, Section V) challenge the condition that expected utilities equalize at an equilibrium with incomplete specialization. They argue that the striking pay rise in the financial sector starting in the 1990s has been such that expected utility is higher in that sector. Bolton et al. (2012) provide an explanation for high pay in finance: agents differ with regard to the cost of becoming a dealer, so all dealers except the marginal one get higher expected utility than entrepreneurs. Oyer (2008, pp. 2620–2621), by contrast, holds that "the IB [investment banking] pay premium is a compensating differential for the type of work". Recent headlines emphasize severe competition for engineers, which may cause a readjustment of high-talent agents' compensation in finance and other sectors.

(see the Appendix). Substitution into the market clearing condition for the risky asset yields

$$P = \frac{\frac{L-L_E}{\rho\sigma_\varepsilon^2}s + \frac{L_E+M}{\rho\,\mathrm{var}(\theta|\,P)}\,\mathrm{E}(\theta|\,P) - \left(\frac{L_E}{a} - \nu\right)}{\frac{L-L_E}{\rho\sigma_\varepsilon^2} + \frac{L_E+M}{\rho\,\mathrm{var}(\theta|\,P)}} = \frac{w + \frac{L_E+M}{\rho\,\mathrm{var}(\theta|\,w)}\,\mathrm{E}(\theta|\,w) - \frac{L_E}{a}}{\frac{L-L_E}{\rho\sigma_\varepsilon^2} + \frac{L_E+M}{\rho\,\mathrm{var}(\theta|\,w)}}, \tag{2}$$

where

$$w \equiv \frac{L-L_E}{\rho\sigma_\varepsilon^2}s + \nu. \tag{3}$$

From the updating rule for the mean of a normal random variable,

$$\mathrm{E}(\theta|\,w) = \bar{s} + \frac{\mathrm{cov}(\theta, w)}{\mathrm{var}(w)}[w - \mathrm{E}(w)]. \tag{4}$$

Another important consequence of normality is that $\mathrm{var}(\theta|\,w)$ is non-random: from $\mathrm{var}(\theta|\,w) = \mathrm{var}(s|\,w) + \sigma_\varepsilon^2$ and the updating rule $\mathrm{var}(s|\,w) = \sigma_s^2 - [\mathrm{cov}(s,w)]^2/\mathrm{var}(w)$, it follows that

$$\mathrm{var}(\theta|\,w) = \sigma_s^2 - \frac{[\mathrm{cov}(s,w)]^2}{\mathrm{var}(w)} + \sigma_\varepsilon^2. \tag{5}$$

From (4) and (5), the equilibrium price P in (2) is a linear function of w.

Expected utilities

Let

$$z \equiv \frac{\mathrm{E}(\theta|\,w) - P}{[2\,\mathrm{var}(\theta|\,w)]^{\frac{1}{2}}}. \tag{6}$$

z measures expected payoff relative to risk for financial investment conditional on w (it is $P/\sqrt{2}$ times the Sharpe ratio). An entrepreneur's expected utility conditional on P is

$$\mathrm{E}[U(\pi_E)|\,P] = -\exp(-\rho e)\exp\left(-\rho\frac{P}{a} - z^2\right).$$

(see the Appendix). From (2)–(5), z is a linear function of w. It can be shown that the linear dependence is negative (see the Appendix), so that $\mathrm{cov}(P,z) = -[\mathrm{var}(P)\,\mathrm{var}(z)]^{1/2}$. Using the law of iterated expectations and Lemma 1 in Demange and Laroque (1995, p. 252), we obtain the following expression for an entrepreneur's unconditional expected utility:

$$\begin{aligned} -\log\{-\mathrm{E}[U(\pi_E)]\} \quad = \quad & \rho e + \overbrace{\frac{\rho}{a}\left[\mathrm{E}(P) - \frac{\rho}{2a}\,\mathrm{var}(P)\right]}^{=\mathsf{GE}} \\ & + \underbrace{\frac{\left[\mathrm{E}(z) - \frac{\rho}{a}\,\mathrm{cov}(P,z)\right]^2}{1 + 2\,\mathrm{var}(z)} + \frac{1}{2}\log\left[1 + 2\,\mathrm{var}(z)\right]}_{=\mathsf{GT}_E} \end{aligned} \tag{7}$$

(see the Appendix). For the sake of convenience, we often call $-\log\{-\mathrm{E}[U(\pi)]\}$ "expected utility" in what follows. If agents merely stored and consumed their endowment e, their expected utility would be given by ρe. If entrepreneurs sold the $1/a$ initial ownership share of their firm and carried out no further financial transactions, they would get extra expected utility $-\log\{-\mathrm{E}[U(e+P/a)]\}-\rho e = (\rho/a)[\mathrm{E}(P) - \rho/(2a)\,\mathrm{var}(P)] \equiv \mathsf{GE}$. These "gains from entrepreneurship" are uniquely determined by the first two moments of the random asset price P. Define the additional terms in (7) as the "gains from trading" for entrepreneurs GT_E. GT_E reflects the marginal impact of an entrepreneur's trade in the stock market on his expected utility. GT_E depends on the first two moments of z and on its covariance with the P. This covariance matters because changes in w (linearly) affect both the price P at which entrepreneurs sell their firms and the expected payoff-risk ratio z. This effect is not present in GS, where agents are not engaged in entrepreneurial activity, and makes the application of the lemma from Demange and Laroque (1995) necessary.

An uninformed trader's unconditional expected utility is obtained analogously:

$$-\log\{-\mathrm{E}[U(\pi_M)]\} = \rho e + \underbrace{\frac{[\,\mathrm{E}(z)]^2}{1+2\,\mathrm{var}(z)} + \frac{1}{2}\log\left[1+2\,\mathrm{var}(z)\right]}_{=\mathsf{GT}_M}. \tag{8}$$

This is (7) without the P/a terms, which result from entrepreneurs' sales of ownership shares in their firms. The final two terms in the sum on the right-hand, GT_M say, give the uninformed trader's gains from trading. As $\mathrm{cov}(P,z)$ is negative, $\mathsf{GT}_E > \mathsf{GT}_M$ whenever $\mathrm{E}(z) \geqslant 0$ (as can be seen in (A.11), this condition is satisfied if $\bar{\nu} \leqslant L_E/a$, i.e., if noise trader demand does not exceed total asset supply). Under this condition, even though entrepreneurs trade on the same information as uninformed traders, they derive greater benefits from their trades, since fluctuations in z provide a hedge against the entrepreneurial risk they carry.

A trader's expected utility conditional on P is

$$\mathrm{E}[U(\pi_T)|\,P] = -\exp(-\rho e)\left[\frac{\sigma_\varepsilon^2}{\mathrm{var}(\theta|\,w)}\right]^{\frac{1}{2}}\exp\left(-z^2\right).$$

Using the law of iterated expectations, it follows that

$$\begin{aligned}-\log\{-\mathrm{E}[U(\pi_T)]\} \quad &= \quad \rho e + \overbrace{\frac{1}{2}\log\left[\frac{\mathrm{var}(\theta|\,w)}{\sigma_\varepsilon^2}\right]}^{=\mathsf{GI}} \\ &\quad + \frac{[\,\mathrm{E}(z)]^2}{1+2\,\mathrm{var}(z)} + \frac{1}{2}\log\left[1+2\,\mathrm{var}(z)\right] \end{aligned} \tag{9}$$

(see the Appendix). The sum on the right-hand side can be rewritten as $\rho e + \mathsf{GI} + \mathsf{GT}_M$, where $\mathsf{GI} \equiv (1/2)\log[\mathrm{var}(\theta|\,w)/\sigma_\varepsilon^2]$ represents the "gains from being informed", i.e., having information about s ($\mathsf{GI} \geqslant 0$, since $\mathrm{var}(\theta|\,w) \geqslant \sigma_\varepsilon^2$).

4 Equilibrium with no noise

This section analyzes the case of non-random noise trader demand: $\nu = \bar{\nu}$ and $\sigma_\nu^2 = 0$. We start with the version of the model with OC, i.e., with model $\mathsf{M}(0,1)$, and subsequently consider $\mathsf{M}(0,0)$. As pointed out by GS, the subcases with and without informed traders have to be treated separately.

Occupational choice

We focus on equilibria with a positive mass of entrepreneurs (i.e., $L_E > 0$). To begin with, suppose further that a subset of rational agents with positive mass decide to become traders (i.e., $L_E < L$). Given $\nu = \bar{\nu}$, w defined in (3) fully reveals s to entrepreneurs and uninformed traders. From (3) and (4), $\mathrm{E}(\theta|\, w) = s$. From (5), $\mathrm{var}(\theta|\, w) = \sigma_\varepsilon^2$. So I_E equals I_T, as given by (1). From the market clearing condition for the risky asset (2),

$$P = s - \frac{\rho\sigma_\varepsilon^2}{L+M}\left(\frac{L_E}{a} - \bar{\nu}\right). \tag{10}$$

A higher price discount $s - P = \rho\sigma_\varepsilon^2 I_T$ is required to compensate agents for the risk of a larger investment position I_T, so the equilibrium price is a decreasing function of the equilibrium amount of assets held by entrepreneurs, traders and uninformed traders $L_E/a - \bar{\nu}$ (the part of asset supply not held by noise traders). From (6), since $\mathrm{E}(\theta|\, w) - P = s - P$ is non-random, z is non-random, even though both s and P are risky. In fact, from (6) and (10),

$$z = \left(\frac{\sigma_\varepsilon^2}{2}\right)^{\frac{1}{2}} \frac{\rho}{L+M}\left(\frac{L_E}{a} - \bar{\nu}\right). \tag{11}$$

As $\mathrm{cov}(P, z) = 0$, the gains from trade are identical for all agents (i.e., $\mathsf{GT}_E = \mathsf{GT}_M$) and there is no benefit from being informed (i.e., $\mathsf{GI} = 0$). At an equilibrium with a positive mass of traders, (17) must hold with equality: $(\mathsf{GE} + \mathsf{GT}_E) - \mathsf{GT}_M = \mathsf{GI}$. Hence, using $\mathsf{GE} = (\rho/a)[\mathrm{E}(P) - \rho/(2a)\,\mathrm{var}(P)]$, $\mathsf{GT}_E = \mathsf{GT}_M$, $\mathsf{GI} = 0$, and (10),

$$\underbrace{\frac{\rho}{a}\left[\bar{s} - \frac{\rho\sigma_\varepsilon^2}{L+M}\left(\frac{L_E}{a} - \bar{\nu}\right) - \frac{\rho\sigma_s^2}{2a}\right]}_{=\Delta_0(L_E)} = 0 \tag{12}$$

at an equilibrium with $0 < L_E < L$. The left-hand side of (12) maps L_E in the interval $[0, L)$ to the reals. Denote this mapping as $\Delta_0(L_E)$. Then we have:

PROPOSITION 4.1: *Let $\Delta_0(0) > 0$. If there is $L_E^T < L$ such that $\Delta_0(L_E^T) = 0$, then $L_E = L_E^T$, $I_E = I_T$, $I_M = I_T$, I_T given by (1), and P given by (10) are the unique equilibrium of $\mathsf{M}(0,1)$ with $L_E < L$.*

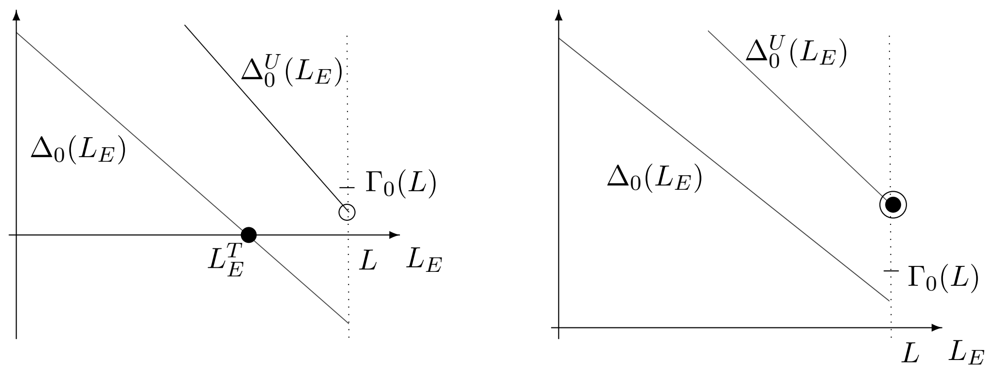

Figure 3: Equilibrium with no noise

Equilibrium with no noise is illustrated in the left panel of Figure 3. The downward-sloping function $\Delta_0(L_E)$ gives the expected utility of an entrepreneur relative to an uninformed trader's, GE. The expected utility differential for a trader compared to an uninformed trader GI is zero. So equilibrium occurs at the point of intersection of $\Delta_0(L_E)$ and the horizontal axis (see the filled circle).

That rational agents do not earn any rents at an equilibrium with both entrepreneurs and traders (as $\mathsf{GE} = \mathsf{GI} = 0$) is an unattractive property of the model with no noise, since it renders it difficult to interpret competition for talent as competition for the "best and brightest". There will be rents for rational agents at an equilibrium with positive noise trader shocks.

The fact that, other than in GS, a fully revealing REE possibly exists in the absence of noise is due to the fact that the only cost of becoming a trader is the opportunity cost of not becoming an entrepreneur $\mathsf{GE} = 0$. The equilibrium would vanish if there were a positive cost of becoming a trader compared to an uninformed trader.

The focus on equilibria at which no rational agent becomes an uninformed trader is without loss of generality. Though each entrepreneur would be no worse-off if he chose to stay uninformed, the equilibrium mass of entrepreneurs L_E (and, hence, equilibrium (L_E, I_E, I_T, I_M, P)) is uniquely determined by condition (12) that $\mathsf{GE} = 0$. There is one indeterminacy: the mass of traders can be anywhere in the interval $(0, L - L_E]$ (the remaining agents being uninformed traders), since the price is fully informative for any positive value.

No traders

If there are no traders, no market participant observes s, and the asset price is uninformative: $w = \nu$, $\mathrm{E}(\theta|\, w) = \bar{s}$ and $\mathrm{var}(\theta|\, w) = \sigma_s^2 + \sigma_\varepsilon^2$. Agents' asset demand is

$$I_E = I_M = \frac{\bar{s} - P}{\rho(\sigma_s^2 + \sigma_\varepsilon^2)}. \tag{13}$$

The asset price equates asset supply L_E/a and asset demand:

$$\frac{\rho}{a}P = \underbrace{\frac{\rho}{a}\left[\bar{s} - \frac{\rho\left(\sigma_s^2 + \sigma_\varepsilon^2\right)}{L+M}\left(\frac{L_E}{a} - \bar{\nu}\right)\right]}_{=\Delta_0^U(L_E)}. \tag{14}$$

For future reference, we denote the right-hand side of (14) as $\Delta_0^U(L_E)$. From (6), z is also non-random:

$$z = \frac{\bar{s} - P}{[2(\sigma_s^2 + \sigma_\varepsilon^2)]^{\frac{1}{2}}}. \tag{15}$$

An entrepreneur's expected utility (7) is

$$-\log\{-\mathrm{E}[U(\pi_E)]\} = \rho e + \frac{\rho}{a}P + z^2. \tag{16}$$

The second and third terms on the right-hand side represents the gains from entrepreneurship GE and gains from trading GT_E, respectively. An uninformed trader's expected utility is $-\log\{-\mathrm{E}[U(\pi_M)]\} = \rho e + z^2$. The gains from trading GT_M are identical as for entrepreneurs.

We analyze an equilibrium at which rational agents do not stay inactive, so that, in the absence of traders, there are L entrepreneurs, the asset supply is L/a, and the asset price satisfies $(\rho/a)P = \Delta_0^U(L)$. In order for an equilibrium to prevail, a single agent must not have an incentive to become a trader. A single agent who decides to become a trader observes s and invests $I_T = (s-P)/(\rho\sigma_\varepsilon^2)$. His unconditional expected utility is given by

$$-\log\{-\mathrm{E}[U(\pi_T)]\} = \rho e + \underbrace{\frac{1}{2}\log\left(\frac{\sigma_s^2 + \sigma_\varepsilon^2}{\sigma_\varepsilon^2}\right)}_{=\Gamma_0(L)} + z^2$$

(see the Appendix). It does not pay to become a trader if $\mathsf{GE} = \Delta_0^U(L)$ is no less than $\mathsf{GI} = (1/2)\log[(\sigma_s^2 + \sigma_\varepsilon^2)/\sigma_\varepsilon^2]$. Denote this latter expression as $\Gamma_0(L)$. Then we have:

PROPOSITION 4.2: *If $\Delta_0^U(L) \geqslant \Gamma_0(L)$, then $L_E = L$, I_E given by (13), $I_T = I_E$, $I_M = I_E$, and P given by (14) are the unique equilibrium of $\mathsf{M}(0,1)$ with $L_E = L$. Otherwise an equilibrium of $\mathsf{M}(0,1)$ with $L_E = L$ does not exist.*

The assertion of Proposition 4.2 is similar as in GS, where an equilibrium without traders exists if the (exogenous) cost of information is sufficiently large. Here, the opportunity cost of trading, i.e., of setting up a firm, has to be sufficiently large in order for an equilibrium to exist. Evidently, this requires $P > 0$, so that entrepreneurs are strictly better-off than if they stayed uninformed: $\mathsf{GE} = (\rho/a)P > 0$. Other than an equilibrium with $L_E < L$, this type of equilibrium would survive the introduction of a sufficiently small positive cost of not being uninformed (viz., if the cost is no greater than the equilibrium value of GE).

The right panel of Figure 3 illustrates a situation where the GS paradox re-arises. $\Delta_0(L_E)$ is positive for all $L_E < L$. If $L - L_E > 0$ agents became traders, GI would be zero, since the price is fully informative, whereas GE is positive. So an equilibrium with traders does not exist. However, since $\Gamma_0^U(L) > \Delta_0(L)$, it is beneficial for a single agent to become a trader when no-one else does, so that an equilibrium without traders does not exist either.

It may also happen that multiple equilibria exist. If the conditions of Proposition 4.1 are satisfied and $\Delta_0^U(L) \geqslant \Gamma_0(L)$, then an equilibrium with $L_E < L$ and an equilibrium with $L_E = L$ coexist.

The focus on equilibria without inactive agents is again without loss of generality, since entrepreneurs are better-off than uninformed traders at equilibrium.

No occupational choice

In the absence of an OC decision, (14) and (15) determine P and z, respectively.

PROPOSITION 4.3: *(i) If there is $L_E^U < L$ such that $\Delta_0^U(L_E^U) = 0$, then then $L_E = L_E^U$, I_E given by (13), $I_M = I_E$, and P given by (14) are the unique equilibrium of $\mathsf{M}(0,0)$. (ii) If $\Delta_0^U(L) \geqslant 0$, then $L_E = L$, I_E given by (13), $I_M = I_E$, and P given by (14) are the unique equilibrium of $\mathsf{M}(0,0)$.*

In the former case, the gains from entrepreneurship GE are zero, and the $L - L_E^U$ rational agents who act as uninformed traders are as well-off as the entrepreneurs. In the latter case, all rational agents are active as entrepreneurs and $\mathsf{GE} > 0$ implies that this is preferred to being inactive. Uniqueness of equilibrium follows from the fact that (14) is strictly deceasing in L_E.

One would expect that in the absence of OC the equilibrium mass of entrepreneurs rises. While this is not generally true, the following result provides a simple sufficient condition.

PROPOSITION 4.4: *Suppose L_T^E and L_E^U exist. Then $L_T^E < L_E^U$ if*

$$L - a\bar{\nu} < \frac{L + M}{2}.$$

This follows straightforwardly from (12) and (14) (see the Appendix). A simple set of sufficient conditions is $L < M$ and $\bar{\nu} > 0$, i.e., that the supply of "high potentials" falls short of the mass of uninformed traders and noise traders do not short the asset.

5 Equilibrium with noise

This section analyzes the model with positive noise trader shocks. We start with the model variant with OC, i.e., $\mathsf{M}(\sigma_\nu^2, 1)$, and then turn to the model without OC, i.e., $\mathsf{M}(\sigma_\nu^2, 0)$.

Occupational choice

From (7) and (9), the unconditional expected utility of an entrepreneur is no less than the unconditional expected utility of a trader (i.e., $\mathrm{E}[U(\pi_E)] \geqslant \mathrm{E}[U(\pi_T)]$) exactly if

$$\underbrace{\frac{\frac{\rho}{a}\operatorname{cov}(P,z)\left[\frac{\rho}{a}\operatorname{cov}(P,z) - 2\,\mathrm{E}(z)\right]}{1 + 2\operatorname{var}(z)} + \frac{\rho}{a}\left[\mathrm{E}(P) - \frac{\rho}{2a}\operatorname{var}(P)\right]}_{=\Delta(L_E)} \geqslant \underbrace{\frac{1}{2}\log\left[\frac{\operatorname{var}(\theta|\, w)}{\sigma_\varepsilon^2}\right]}_{=\Gamma(L_E)}. \tag{17}$$

Equation (17) says that, compared to uninformed trading, becoming an entrepreneur is no less attractive than becoming a trader: $(\mathsf{GE} + \mathsf{GT}_E) - \mathsf{GT}_M \geqslant (\mathsf{GI} + \mathsf{GT}_M) - \mathsf{GT}_M$. $\mathsf{GI} \geqslant 0$ implies that $\mathsf{GE} + \mathsf{GT}_E \geqslant \mathsf{GT}_M$ if (17) holds. That is, if despite the benefits of being informed, agents are no better-off as traders than as entrepreneurs, then they are certainly not better-off by becoming an uninformed investor. Equations (2)–(5) determine the moments and the covariance of P and z as continuous functions of L_E alone (closed-form solutions are in the Appendix). Denote the composite function obtained from substituting these functions into the left-hand side of (17) as $\Delta(L_E)$. From (3) and (5), $\operatorname{var}(\theta|\, w)$ is also a continuous function of L_E alone (closed-form solution in the Appendix). Denote the function resulting from substituting this function into the right-hand side of (17) as $\Gamma(L_E)$. Since L_E also uniquely determines I_E, I_T, and P via (1) and (2), we have:

PROPOSITION 5.1: *Let $\sigma_\nu^2 > 0$. (i) If there is $L_E^T < L$ such that $\Delta(L_E^T) = \Gamma(L_E^T)$, then L_E^T, I_E, I_T, and I_M given by (1), and P given by (2) are an an equilibrium of $\mathsf{M}(\sigma_\nu^2, 1)$. (ii) If $\Delta(L) \geqslant \Gamma(L)$, then $L_E = L$, I_E and I_M given by (1), and P given by (2) are an equilibrium of $\mathsf{M}(\sigma_\nu^2, 0)$.*

The two types of equilibria are illustrated in Figure 4. The left and right panels refer to cases (i) and (ii), respectively. The filled circles represent the equilibrium mass of entrepreneurs L_E and the equilibrium difference in the expected utilities of entrepreneurs and uninformed traders $(\mathsf{GE} + \mathsf{GT}_E) - \mathsf{GT}_M$.

$\Delta(0) > \Gamma(0)$ is sufficient to ensure existence of equilibrium. Together with continuity of $\Delta(L_E)$ and $\Gamma(L_E)$, this condition implies that either there is $L_E^T < L$ such that $\Delta(L_E^T) = \Gamma(L_E^T)$ or else $\Delta(L) \geqslant \Gamma(L)$. Multiplicity of equilibria cannot be ruled out. There exist parameterizations of the model such that the functions $\Delta(L_E)$ and $\Gamma(L_E)$ intersect twice.

An equilibrium $(L_E^T, I_E, I_T, I_M, P)$ with a positive mass of traders would also be an equilibrium if, following GS, we introduced a physical cost of not being an uninformed trader no greater than $\Delta(L_E^T)$.

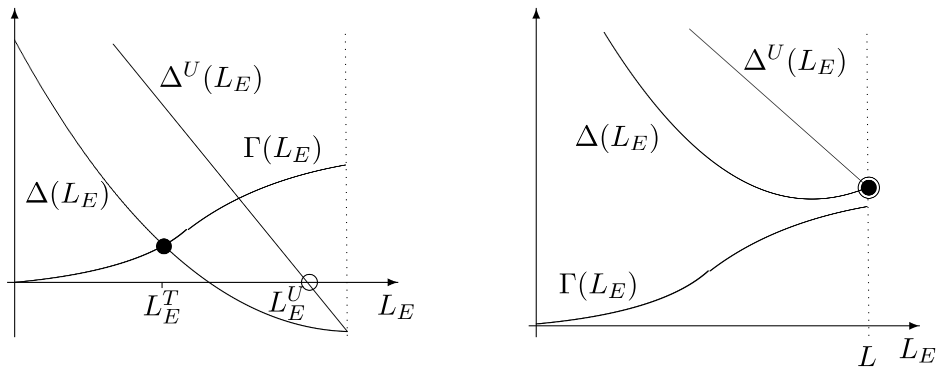

Figure 4: Equilibrium with noise

Since the expected utility differential for entrepreneurs compared to uninformed traders $\Delta(L_E)$ $(= (\mathsf{GE} + \mathsf{GT}_E) - \mathsf{GT}_M)$ is positive at equilibrium, the assumption that all rational agents become either entrepreneurs or traders is without loss of generality.

No occupational choice

In the absence of an OC decision (i.e., in model $\mathsf{M}(\sigma_\nu^2, 0)$ with $\sigma_\nu^2 > 0$), since no-one gathers information about s, the price is uninformative: $\mathrm{E}(\theta|\, P) = \bar{s}$ and $\mathrm{var}(\theta|\, P) = \sigma_s^2 + \sigma_\varepsilon^2$. Entrepreneurs' optimal investment level in (1) is given by (13), and the price function is given by (14) with ν instead of $\bar{\nu}$. As in $\mathsf{M}(\sigma_\nu^2, 1)$, the left-hand side of (17) gives the expected utility differential for entrepreneurs compared to uninformed traders $(\mathsf{GE} + \mathsf{GT}_E) - \mathsf{GT}_M$. However, since the price function as well as z are different than in the case with occupational choice, the moments of P and z that appear on the left-hand side of (17) are different. The Appendix derives closed-forms solutions for the moments as functions of L_E alone. Denote the composite function that results from substituting these moments into the left-hand side of (17) as $\Delta^U(L_E)$. In the Appendix, we show that $\Delta^U(L_E)$ is a linear, decreasing function that satisfies $\Delta^U(L) = \Delta(L)$.

PROPOSITION 5.2: *Let $\sigma_\nu^2 > 0$. (i) If $\Delta^U(L_E^U) = 0$ for some $L_E^U < L$, then $L_E = L_E^U$, I_E given by (13), $I_M = I_E$, and P given by (14) with ν instead of $\bar{\nu}$ are the unique equilibrium of $\mathsf{M}(\sigma_\nu^2, 0)$. (ii) If $\Delta^U(L) \geqslant 0$, then $L_E = L$, I_E given by (13), $I_M = I_E$, and P given by (14) are the unique equilibrium of $\mathsf{M}(\sigma_\nu^2, 0)$.*

Because of continuity of $\Delta^U(L_E)$, $\Delta^U(0) > 0$ is sufficient for existence of equilibrium. Uniqueness of equilibrium follows from the fact that $\Delta^U(L_E)$ is monotonically decreasing.

Equilibrium without OC is illustrated by the unfilled circles in Figure 4. (i) At the former type of equilibrium (see the left panel), a subset of the rational agents become entrepreneurs, the other

$L - L_E^U$ (> 0) agents act as uninformed traders, and agents are equally well-off in both positions. (ii) At the latter type of equilibrium (right panel), all rational agents become entrepreneurs and are better-off than uninformed traders.

Small noise trader shocks

...

6 Wages and employment

Entrepreneurs create jobs for workers paying wages which exceed what they could earn outside the firm sector (see Clark, 2005, for a long-term perspective on the role of industrialization for workers' wages). In the present section we consider an extension of our model in which entrepreneurs create jobs for unskilled workers.[9]

Production economy

We maintain all assumptions made in Sections 4 and 5, respectively, unless stated otherwise. Uninformed traders are now endowed with one unit of unskilled labor each and thus called workers. Rational agents do not require unskilled labor to set up firms or to gather information. They do not supply unskilled labor if they decide to become neither an entrepreneur nor an informed trader but act as an uninformed trader. We analyze the model both with a perfect labor market and for several common wage setting regimes which give rise to unemployment. In both cases, wages are determined before uncertainty resolves, so the wage rate W is non-stochastic, and a worker's initial wealth is $e_M + W$. The disutility of working is equivalent to D ($\geqslant 0$) units of consumption, so the aggregate supply of labor is M for $W \geqslant D$ and zero otherwise.

As before, an entrepreneur sets up $1/a$ firms early. The level of employment per firm m and the wage paid W are also determined early. Firm output and profit are $Y = \tilde{\theta} + F(m)$ and $\theta \equiv Y - Wm$, respectively. F is twice continuously differentiable, strictly increasing, and strictly concave. $\tilde{\theta}$ is the sum of two independent jointly normal random variables $\tilde{s} \sim \mathrm{N}(\hat{s}, \sigma_s^2)$ and $\varepsilon \sim \mathrm{N}(0, \sigma_\varepsilon^2)$. As before, traders observe $\tilde{s}$ at the intermediate date, while entrepreneurs and uninformed traders do not. The assumption that the impact of $\tilde{\theta}$ on firm profit θ is additive is necessary in order to preserve the single-asset framework of Section 2 (see the Appendix).[10]

Full employment

[9] Since all firms are alike in our model, we do not address the issue of whether job creation is greater in small or in large firms (cf. Neumark et al., 2011; Haltiwanger et al., 2013).

[10] Biais et al. (2010) analyze a multi-asset version of GS.

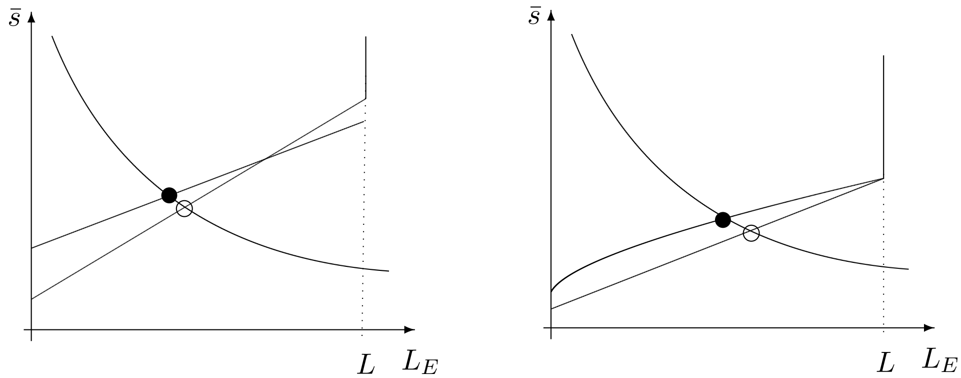

Figure 5: Full employment equilibrium

Denote the full employment version of the production economy as model $\mathsf{F}(\sigma_\nu^2, j)$, with j equal to 0 or 1, depending on whether there is OC or not. Let $\hat{M} \equiv M/(L_E/a)$ denote the number of workers per firm. Each firm employs $\hat{M}$ workers and pays them the wage rate $\hat{W} = F'(\hat{M})$ in $\mathsf{F}(\sigma_\nu^2, j)$. For simplicity, let $D = 0$, so that workers supply their labor for any positive wage rate. $(L_E, I_E, I_T, I_M, P, m, W)$ is an *equilibrium* if, in addition to the conditions stated in Sections 4 or 5, employment m maximizes $\theta \equiv Y - Wm$ and the labor market clears (i.e., $m = \hat{M}$).

Define

$$s \equiv F\left(\frac{aM}{L_E}\right) - F'\left(\frac{aM}{L_E}\right)\frac{aM}{L_E} + \tilde{s} \tag{18}$$

and

$$\bar{s} \equiv F\left(\frac{aM}{L_E}\right) - F'\left(\frac{aM}{L_E}\right)\frac{aM}{L_E} + \hat{s}. \tag{19}$$

$s + \varepsilon$ is firm profit given full employment. s is normal with mean $\mathrm{E}(s) = \bar{s}$ and variance σ_s^2. An increase in L_E decreases firm size $\hat{M}$ and, therefore, $\bar{s}$ ($d\bar{s}/dL_E = F''(\hat{M})\hat{M}^2/L_E < 0$). With these definitions, the equilibrium analysis in Sections 4 and 5 goes through without modification. So we have:

PROPOSITION 6.1: *Let s and $\bar{s}$ be given by (18) and (19), respectively. Then if (L_E, I_E, I_T, I_M, P) is an equilibrium of $\mathsf{M}(\sigma_\nu^2, j)$, then $(L_E, I_E, I_T, I_M, P, \hat{M}, \hat{W})$ is an equilibrium of $\mathsf{F}(\sigma_\nu^2, j)$.*

Figure 5 illustrates the determination of the equilibrium values of L_E and $\bar{s}$. The left panel applies to model $\mathsf{F}(0, j)$, i.e., the model with no noise trader shocks. The downward-sloping curve depicts the relation between $\bar{s}$ and L_E implied by (19). The upward-sloping lines depict the relations between $\bar{s}$ and L_E at an equilibrium of $\mathsf{M}(0, j)$ with $L_E < L$. The flatter line applies to the model with

OC (i.e., $j = 1$; s. (12)), the steeper one applies in the absence of OC (i.e., $j = 0$; s. (14)). For sufficiently large values of $\bar{s}$, equilibria of $\mathsf{M}(0,1)$ and $\mathsf{M}(0,0)$ are characterized by $L_E = L$, as illustrated by the vertical line segment. The filled and unfilled circles represent equilibria of $\mathsf{F}(0,1)$ and $\mathsf{F}(0,0)$, respectively, with $L_E < L$. Clearly, with or without OC, there is at most one such equilibrium. These equilibria have the expected comparative statics properties. Parameter changes which raise GE in (12) or (14), respectively, shift the upward-sloping lines to the right. Parameter changes which raise the expected firm profit in (19) shift the downward-sloping curve upward. In either case the equilibrium mass of entrepreneurs L_E rises.

The right panel of 5 applies to the model with stochastic noise trader demand. Since equilibrium of $\mathsf{M}(\sigma_\nu^2, 1)$ is not generally unique for $\sigma_\nu^2 > 0$, the same holds true for $\mathsf{F}(\sigma_\nu^2, 1)$. By contrast, there is at most one equilibrium of $\mathsf{F}(\sigma_\nu^2, 0)$. This follows from the fact that L_E is an increasing (linear) function of $\bar{s}$ at an equilibrium of $\mathsf{M}(\sigma_\nu^2, 0)$ with $L_E \leqslant L$ (see the Appendix). For sufficiently large values of $\bar{s}$, equilibria of $\mathsf{M}(\sigma_\nu^2, 1)$ and $\mathsf{M}(\sigma_\nu^2, 0)$ are characterized by $L_E = L$ (see the vertical line segment). This follows from the fact that increases in $\bar{s}$ raise $E(P)$ and do not affect the other moments in (17) (see the Appendix). If $\Delta(L_E)$ intersects $\Gamma(L_E)$ from above, then the corresponding equilibrium of $\mathsf{M}(\sigma_\nu^2, 1)$ has the expected comparative statics properties. Any parameter change that raises L_E at an equilibrium of $\mathsf{M}(\sigma_\nu^2, j)$ or expected firm profit given by (19) raises L_E at an equilibrium of $\mathsf{F}(\sigma_\nu^2, j)$ then. From the fact that increases in $\bar{s}$ raise L_E at an equilibrium of $\mathsf{M}(\sigma_\nu^2, 0)$ with $L_E < L$, it follows that the equilibrium of $\mathsf{F}(\sigma_\nu^2, 0)$ has the expected comparative statics properties.

Because of diminishing marginal productivity, wages rise when the number of firms increases: $d\hat{W}/dL_E = -F''(\hat{M})\hat{M}/L_E > 0$. Therefore, any parameter change that raises L_E increases workers' wages. Historically this is probably the most important effect of entrepreneurship. In current circumstances this points to a cost of allocating talent to trading rather than entrepreneurship.

As in the model without production, the equilibrium mass of entrepreneurs tends to be higher without than with OC. In particular, in the case of no noise trader shocks the condition of Proposition 4.4 is sufficient for $L_E^U > L_E^T$ (see the Appendix).

Small NT shocks...

Wage setting

While historically the main benefit of entrepreneurial activity is to raise workers' wages to unprecedented levels, at a shorter-term perspective it helps to create and secure jobs in the presence of union wage claims or other sources of wage rigidity. The present section modifies our model accordingly.

To keep things simple again, we focus on specifications for which the wage rate is rigid in that it does not respond to changes in the mass of firms L_E/a. An increase in the mass of entrepreneurs then does not affect employment at the firm level (the intensive margin), but it increases aggregate employment by raising the mass of firms (the extensive margin). To show that our results do not hinge on the specific type of wage rigidity, we consider two union and two efficiency wage models, labeled $\mathsf{U}_1(\sigma_\nu^2, j)$–$\mathsf{U}_4(\sigma_\nu^2, j)$.

$\mathsf{U}_1(\sigma_\nu^2, j)$: Workers are organized in decentralized firm-level unions. They are spread evenly across firms, so there are $\hat{M}$ workers per firm. Unions monopolistically set the wage rate. Firms have the "right to manage" and choose the profit maximizing level of employment (cf. McDonald and Solow, 1981). If there is unemployment, the probability of being employed is $m/\hat{M}$ for each worker. Unions maximize workers' expected utility, taking their assets demand as given. It can be shown that the gains from trading are separable from the gains of having a job, so that unions maximize

$$\frac{m}{\hat{M}}\left\{1 - \exp\left[-\rho(W - D)\right]\right\} - 1 \tag{20}$$

(see the Appendix). For simplicity, F is Cobb-Douglas: $F(m) = m^{1-b}$, where $0 < b < 1$. $(L_E, I_E, I_T, I_M, P, m, W)$ is an *equilibrium* if, in addition to the conditions stated in Section 3, employment m maximizes $F(m) - Wm$, W maximizes (20) given the optimal choice of m, and there is unemployment (i.e., $m < \hat{M}$).

$\mathsf{U}_2(\sigma_\nu^2, j)$: Employees can "work" or "shirk" at their workplace (cf. Shapiro and Stiglitz, 1984)...

$\mathsf{U}_3(\sigma_\nu^2, j)$: Unions are organized as in $\mathsf{U}_1(\sigma_\nu^2, j)$. Firms have the right-to-manage. Rather than maximizing a utility function, firm-level unions set the wage rate W such that the wage bill Wm is maximal (cf. Dunlop, 1944)...

$\mathsf{U}_4(\sigma_\nu^2, j)$: Firm output is $Y = F[E(W)m]$, where $E(W)$ is the effort provided by workers given the wage they receive (cf. Solow, 1979)...

Unemployment

Models $\mathsf{U}_1(\sigma_\nu^2, j)$–$\mathsf{U}_4(\sigma_\nu^2, j)$ have in common that the condition that employment maximizes $F(m) - Wm$ and the respective wage setting assumption jointly determine the wage rate $\tilde{W}$ and employment per firm $\tilde{M}$, independently of the other variables which make up an equilibrium $(L_E, I_E, I_T, I_M, P, m, W)$ (see the Appendix). This block-recursive structure of the models allows a simple characterization of their equilibria. Analogously as in the full employment case (cf. (18)), define $s \equiv F(\tilde{M}) - \tilde{W}\tilde{M} + \tilde{s}$. Since $\tilde{M}$ and $\tilde{W}$ are constants, s is normal with mean

$$\bar{s} \equiv F(\tilde{M}) - \tilde{W}\tilde{M} + \hat{s} \tag{21}$$

and variance σ_s^2.

PROPOSITION 6.2: *Let $\bar{s}$ be given by (21). Then for $k = 1, \ldots, 4$, if (L_E, I_E, I_T, I_M, P) is an equilibrium of $\mathsf{M}(\sigma_\nu^2, j)$ and $\tilde{M} < \hat{M}$, then $(L_E, I_E, I_T, I_M, P, \tilde{M}, \tilde{W})$ is an equilibrium of $\mathsf{U}_k(\sigma_\nu^2, j)$.*

Parameter changes that increase L_E at an equilibrium of $\mathsf{M}(\sigma_\nu^2, j)$ increase L_E at an equilibrium of $\mathsf{U}_k(\sigma_\nu^2, j)$, since $\bar{s}$ does not change (see (21)). The increase in the mass of entrepreneurs raises aggregate employment $\tilde{M}L_E/a$ (since employment at the firm level $\tilde{M}$ does not change) – entrepreneurship creates jobs.

Changes in labor market parameters which reduce the equilibrium wage rate (and leave the production function unaffected) increase employment per firm $\tilde{M}$. This has a positive feedback effect on expected firm profit: $d\bar{s}/d\tilde{W} = [F'(\tilde{M}) - \tilde{W}]d\tilde{M}/d\tilde{W} - \tilde{M}$ or, using the condition for profit maximization, $d\bar{s} = -\tilde{M}d\tilde{W} > 0$. If the mass of entrepreneurs L_E is an increasing function of $\bar{s}$ in $\mathsf{M}(\sigma_\nu^2, j)$, then the equilibrium number of firms also goes up, so that employment grows both at the intensive and at the extensive margin.

From the fact that $\bar{s}$ is independent of L_E (see (21)), it follows that the condition of Proposition 4.4 is sufficient for $L_E^U > L_E^T$ and that if $(L_E, I_E, I_T, I_M, P, \tilde{M}, \tilde{W})$ is an equilibrium of $\mathsf{U}_k(0, j)$, then there is an equilibrium of $\mathsf{U}_k(\sigma_\nu^2, j)$ with a mass of entrepreneurs close to L_E for σ_ν^2 positive but sufficiently small.

7 Expected utilities

This section compares agents' expected utilities at equilibria with and without OC.

No noise

Consider first the model without noise and without a labor market. Suppose $\mathsf{M}(0,1)$ has an equilibrium with $L_E^T < L$ entrepreneurs, since otherwise removing OC makes no difference. Recall from Section 4 that since the price is fully revealing, $\mathsf{GI} = 0$ and traders' expected utility is $\mathsf{GT}_M = z^2$, where z is given by (11) with $L_E = L_E^T$. Since z is safe, GT_E also equals GT_M, and the condition that entrepreneurs and traders are equally well-off says $\mathsf{GE} = 0$. From (7) and (11), entrepreneurs' expected utility with OC is

$$-\log\{-\mathrm{E}[U(\pi_E)]\} = \rho e + \frac{\sigma_\varepsilon^2}{2}\left[\frac{\rho}{L+M}\left(\frac{L_E^T}{a} - \bar{\nu}\right)\right]^2, \tag{22}$$

and the right-hand side also gives traders' and uninformed traders' expected utility.

In the absence of OC (i.e. model $\mathsf{M}(0,0)$), the equilibrium mass of entrepreneurs L_E^U can be less than or equal to L (see Proposition 4.3). Entrepreneurs' expected utility in equilibrium then is equal to

$$-\log\{-\mathrm{E}[U(\pi_E)]\} = \rho e + \Delta_0^U(L_E^U) + \frac{\sigma_s^2 + \sigma_\varepsilon^2}{2}\left[\frac{\rho}{L+M}\left(\frac{L_E^U}{a} - \bar{\nu}\right)\right]^2, \tag{23}$$

where $\Delta_0^U(L_E^U)$ equals zero if $L_E^U < L$ and is greater than zero if $L_E^U = L$.

The following results provides simple sufficient conditions which imply that expected utility is lower with than without OC.

PROPOSITION 7.1: *Rational agents' expected utility is lower at an equilibrium of* $\mathsf{M}(0,1)$ *with* $L_E = L_E^T$ *than at an equilibrium of* $\mathsf{M}(0,0)$ *with* $L_E = L_E^U$ *if* $L_E^U \geqslant L_E^T$ *and* $L_E^T/a > \bar{\nu}$.

The impact of doing away with OC on entrepreneurs' expected utility can be decomposed into three effects. From (1) and (6), the gains from trading GT_E are given by $z^2 = \mathrm{var}(\theta|\, w)(\rho I_E)^2/2$. They are increasing in both the conditional payoff variance $\mathrm{var}(\theta|\, w)$ and asset holdings I_E. That the conditional payoff variance has a positive effect on expected utility is due to the fact that the equilibrium price discount is more than sufficient to compensate entrepreneurs for the additional risk they carry. The first reason why expected utility is higher in $\mathsf{M}(0,0)$ than in $\mathsf{M}(0,1)$ is that the conditional payoff variance is higher ($\sigma_s^2 + \sigma_\varepsilon^2$ as opposed to σ_s^2; cf. (22)–(23)). This relates to other models in which availability of information is not necessarily welfare-enhancing, such as Hirshleifer (1971) and Hu and Quin (2013).[11] The second effect of doing away with OC is that agents' asset holdings rise (the conditions of the proposition ensure that the squared term in (23) is larger than the squared term in (22)). This reflects the real effects of entrepreneurship for trading: additional asset supply creates scope for additional beneficial trades.[12] At an equilibrium of $\mathsf{M}(0,0)$ with $L_E^U = L$, there is a third effect of no OC: GE becomes positive. GE is given by the second term in the sum on the right-hand side of (23) in this case, which coincides with $\Delta_0^U(L) > 0$. Uninformed traders' expected utility at an equilibrium of $\mathsf{M}(0,0)$ with $L_E^U < L$ is given by (23) without the $\Delta_0^U(L_E^U)$ term. It immediately shows that $\mathrm{E}[U(\pi_M)]$ is greater without OC.

Proposition 7.1 provides a set of two simple sufficient conditions which ensure that rational agents are better-off without than with OC in the absence of noise trader shocks: the mass of rational agents who become entrepreneurs does not fall, and rational agents do not short the asset in the

[11] The result that availability of information can hurt risk sharing opportunities, shown by Hirshleifer (1971), is also called the Hirshleifer effect. Hu and Quin (2013) find this effect for the rational agents in the Grossman (1976) model. We find the same for the GS (1980) model without noise volatility.

[12] One might think that in essence this effect remains present if traders stay allowed and one just increases the mass of entrepreneurs by a little. This is, however, not the case, as at least entrepreneurs would be worse off (see the Appendix). The reason for this is that there is an interdependency between the availability of information and the welfare effects of a changing mass of entrepreneurs, to which we will come back in section 8.

aggregate (supply exceeds noise trader demand). An alternative set of sufficient conditions is $\bar{\nu} > 0$ and $L_E^T/a > \bar{\nu}$, i.e., neither noise traders nor rational agents go short (see the Appendix).

A corollary of Proposition 7.1 is that if $\sigma_\nu^2 = 0$ and there are multiple equilibria (cf. the remarks to Proposition 4.2), then agents' expected utility is higher at the equilibrium with $L_E = L$ if $L_E^T/a > \bar{\nu}$. This follows directly from the fact that expected utility at an equilibrium of $\mathsf{M}(0,1)$ with $L_E = L$ coincides with expected utility at an equilibrium of $\mathsf{M}(0,0)$.

The consideration of labor market effects reinforces the conclusion of Proposition 7.1. Entrepreneurs' expected utility at equilibria of the production economies is given by (22)–(23). In the model with full employment uninformed traders' expected utility $-\log\{-\mathrm{E}[U(\pi_E)]\}$ contains the additional component $\rho\hat{W}$. Since L_E is higher at the equilibrium of $\mathsf{F}(0,0)$ than at the equilibrium of $\mathsf{F}(0,1)$ under the conditions of Proposition 7.1 and $\hat{W}$ is an increasing function of L_E, there is an additional benefit from not having OC, viz., raising workers' income.

In the models with unemployment uninformed traders' expected utility $-\log\{-\mathrm{E}[U(\pi_M)]\}$ contains the additional component minus the logarithm of minus (20) with $m = \tilde{M}$, $\hat{M} = Ma/L_E$, and $W = \tilde{W}$. This expression is greater at an equilibrium of $\mathsf{U}_k(0,0)$ than at the equilibrium of $\mathsf{U}_k(0,1)$. This follows from the fact that $\hat{M}$ is larger without OC (since L_E is higher), while $\tilde{M}$ and $\tilde{W}$ are identical. Increasing entrepreneurial activity at an equilibrium without OC improves workers' employment prospects.

The conclusions for the production economies would not hold under the alternative sufficient condition, i.e., $\bar{\nu} > 0$ instead of $L_E^U > L_E^T$.

Small noise trader shocks

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8 Welfare

A full welfare analysis has to take into account noise traders' well-being, which clashes with the assumption that their behavior is not derived from optimization. In this section, we assume that noise traders have the same utility function $U(\pi) = -\exp(-\rho\pi)$ as rational agents (the analogous assumption is made in a different context with risk neutral agents by Albagli et al., 2014, p. 8)[13] and discuss aggregate welfare.

[13] Dow and Gorton (2008) survey fully rational models in which noise trader demand is derived from stochastic liquidity needs or portfolio churning by asset managers.

Pareto improvement

Suppose there are N identical noise traders, so that each invests $I_N = \nu/N$ and final wealth is $\pi_N = e_N + (\theta - P)I_N$, where e_N is the initial endowment. Consider first the case of no noise trader shocks.

At an equilibrium of $\mathsf{M}(0,0)$ with L_E^U entrepreneurs, noise traders' (transformed) expected utility exceeds the value at an equilibrium of $\mathsf{M}(0,1)$ with L_E^T entrepreneurs by

$$\rho\left\{\frac{\rho}{L+M}\left[\sigma_s^2\left(\frac{L_E^U}{a}-\bar{\nu}\right)+\sigma_\varepsilon^2\frac{L_E^U-L_E^T}{a}\right]I_N-\frac{\rho}{2}\sigma_s^2 I_N^2\right\} \tag{24}$$

(see the Appendix). The first term in the sum in braces is the change in expected payoff $\mathrm{E}[(\theta - P)I_N]$. $\sigma_s^2 I_N^2$ is the change in $\mathrm{var}[(\theta - P)I_N]$. The formula also applies to the production economies with full employment or unemployment.

The conditions of Proposition 7.1 together with $\bar{\nu} > 0$ imply that the term in brackets in (24) is positive. Noise trader expected utility is then positive for I_N positive and small enough. This follows from the fact the linear effect of investment on expected return dominates the quadratic impact on the variance of final wealth for I_N small.[14] As opposed to the rational agents, availability of information possibly, but not necessarily decreases noise traders' welfare.

Using a variant of the Demange-Laroque (1995) lemma, one can express noise trader expected utility as a function of L_E and model parameters for $\sigma_\nu^2 > 0$ (see the Appendix). Small NT shocks..

PROPOSITION 8.1: *If the conditions of Proposition 7.1 are satisfied and noise traders do not short the asset (i.e. $\bar{\nu} > 0$), then the equilibrium of $\mathsf{M}(0,0)$ is Pareto-preferred to the equilibrium of $\mathsf{M}(0,1)$ for I_N sufficiently small.*

The analogous results holds true in the production economies.

Social welfare function

To investigate the welfare effects of financial trading when alternatives cannot be Pareto-ranked, we now introduce a social welfare function. This will also allow us to determine the optimum mass of entrepreneurs and shed further light on its connection to the availability of information. We define social welfare S as the weighted sum of agents' transformed expected utilities: $-\log\{-\mathrm{E}[U(\pi_i)]\}$. As the transformed expected utilities are linear in endowments, only a weighted sum specification rules out redistributional motives. We distinguish two cases. In the first case the $L - L_E$ rational agents who do not become entrepreneurs become traders, so

$$S = \sum_i \#_i \left(-\log\{-\mathrm{E}[U(\pi_i)]\}\right), \tag{25}$$

[14] For instance, for $L/a > (3/2)\bar{\nu}$, a sufficient condition is $N > L + M$.

where $i \in \{E, T, M, N\}$ and $\#_i$ is the mass of type-i agents, i.e., $\#_E = L_E$, $\#_T = L - L_E$, $\#_M = M$, and $\#_N = N$. In the second case the $L - L_E$ rational agents who do not become entrepreneurs act as uninformed traders, so $\#_T = 0$ and $\#_M = M + L - L_E$.

We perform a second-best welfare analysis: a planner can determine the mass of rational agents who become entrepreneurs and whether the remaining rational agents act as informed or as uninformed traders but takes agents' investment decisions and the resulting asset price as given. The resulting economies with no labor market, full employment, and unemployment are denoted as $\mathsf{M}(\sigma_\nu^2, j)$, $\mathsf{F}(\sigma_\nu^2, j)$, and $\mathsf{U}_k(\sigma_\nu^2, j)$, respectively, with $j = T$ when the non-entrepreneurs are informed traders and $j = U$ otherwise. S^T and S^U denote social welfare as a function of L_E in the two cases, respectively. The formulas in Section 3 give agents' expected utilities as functions of L_E alone, and substitution into (25) yields social welfare as a function of L_E. As usual, consider first the case of no noise trader shocks:

PROPOSITION 8.2: *Let $\sigma_\nu^2 = 0$.*

(i) Suppose a solution $L_E^T < L$ to $\Delta_0(L_E^T) = 0$ exists, a solution $(L_E^T, \bar{s})$ with $L_E^T < L$ to $\Delta_0(L_E^T) = 0$ and (19) exists, and a solution $L_E^T < L$ to $\Delta_0(L_E^T) = 0$ with $\bar{s}$ given by (21) exists. Then L_E^T maximizes S^T on $[0, L)$ in $\mathsf{M}(0, T)$ and $\mathsf{F}(0, T)$, and L_E^T falls short of the value that maximizes S^T in $\mathsf{U}_k(0, T)$ $(k = 1, \ldots, 4)$.

(ii) Suppose a solution $L_E^U < L$ to $\Delta_0^U(L_E^U) = 0$ exists, a solution $(L_E^U, \bar{s})$ with $\bar{s}$ given by (19) and $L_E^U < L$ exists, and a solution $L_E^U < L$ with $\bar{s}$ given by (21) exists. Then L_E^U maximizes S^U on $[0, L]$ in $\mathsf{M}(0, U)$ and $\mathsf{F}(0, U)$, and L_E^U falls short of the value that maximizes S^U in $\mathsf{U}_k(0, U)$ $(k = 1, \ldots, 4)$.

(iii) $S^T(L) = S^U(L)$ in all versions of the model.

Proof: See the Appendix. ||

(i) The first part of the proposition says that with non-stochastic noise trader demand the equilibrium mass of entrepreneurs at an equilibrium with OC and with $L_E^T < L$ maximizes social welfare on $[0, L)$, subject to the constraint that non-entrepreneurs become traders exactly if there are no labor market frictions. (ii) Analogously, the mass of entrepreneurs at an equilibrium without OC maximizes social welfare subject to the constraint that non-entrepreneurs act as uninformed traders exactly if there are no labor market frictions. (iii) For $L_E = L$, there is no difference between $\mathsf{M}(0, T)$ and $\mathsf{M}(0, U)$ (and the corresponding production economies) because there are no rational agents who do not become entrepreneurs.

L_E^U, L_E^T and S^U, S^T are continuous functions of σ_ν^2. So for σ_ν^2 small, the equilibrium mass of entrepreneurs without OC is close to L_E^U and the equilibrium mass of entrepreneurs with OC is

Figure 6: Social welfare

close to L_E^T. The ensuing levels of social welfare are close to $S^U(L_E^U)$ and $S^T(L_E^T)$, respectively. Taking the information structure as given, in the frictionless models (i.e. the basic model and the model with full employment) the equilibrium size of the financial sector is optimal when considering all agents' (including noise traders') expected welfare. Only if there are frictions, inefficiencies arise. The result that, for σ_ν^2 small, there is too little entrepreneurship at the equilibria of $\mathsf{U}_k(\sigma_\nu^2, T)$ and $\mathsf{U}_k(\sigma_\nu^2, U)$ is reminiscent of Greenwald and Stiglitz (1993) and Arnold (2002): macroeconomic problems are the outcome of the interplay between frictions in financial and labor markets.

Welfare effects of information availability

Different levels of social welfare, and of maximum social welfare, are obtained depending on whether the non-entrepreneurs become traders or uninformed traders. The following result compares the welfare maxima of $\mathsf{M}(0,T)$ and $\mathsf{M}(0,U)$ (cf. Figure 6).

PROPOSITION 8.3: *The difference $S^T - S^U$ in the maximum values of social welfare in economies $\mathsf{M}(0,T)$ and $\mathsf{M}(0,U)$ is negative if one of the following holds:*

(a) $L_E^U \geqslant L_E^T$ and

$$\frac{L_E^U}{a} > \left(1 + \frac{L+M}{N}\right)^{\frac{1}{2}} \bar{\nu}.$$

(b) $\bar{\nu} \geqslant 0$ and

$$L_E^T > a\bar{\nu} + \frac{1}{2}(L+M)aI_N.$$

(c) $\bar{\nu} \geqslant 0$*,* $(L_E^T/a - \bar{\nu}) > 0$ *and*

$$aI_N < 1.$$

The same holds true for $\mathsf{F}(0,T)$ *versus* $\mathsf{F}(0,U)$ *and for* $\mathsf{U}_k(0,T)$ *versus* $\mathsf{U}_k(0,U)$ *(*$k = 1, \ldots, 4$*).*

Proof: See the Appendix. ||

The conditions stated above resemble the conditions (or the alternative conditions, respectively) for a rational agents' welfare improvement, taken together with the ones for a noise traders' welfare improvement, in case that traders are banned. If these pareto conditions (cf. proposition 8.1) hold, one immediately sees that proposition 8.3 holds too. Even more, proposition 8.3 can still hold when the pareto-conditions fail. For the production economies, note that while the alternative conditions for proposition 7.1 together with the ones for noise traders' welfare improvement were not sufficient for pareto-improvement, they are sufficient for an increase in social welfare S.

If proposition 8.3 holds, the unique second best optimum for the case of non-stochastic noise trader demand entails that L_E^U rational agents become entrepreneurs and the others uninformed traders. All that has to be done in order to decentralize this second best optimum as a market equilibrium is to ban trading. This also holds in case that $L_E^U = L$ (see the right panel of Figure 7), as the conditions for proposition 8.3 ensure $S^U(L_E^T) > S^T(L_E^T)$ (see the Appendix) and S^T, S^U are both hump shaped with their maximimizing values for L_E being equal to the equilibrium values for L_E (cf. Proposition 8.2).

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Large noise trader shocks

The closed-form solutions for all moments of P and z as functions of L_E (see the Appendix) allow numerical analysis of the welfare effects of trading for large noise trader shocks. Numerical experimentation shows that the result that the financial sector is too big is not restricted to the analytically tractable case of small noise trader shocks.

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9 Taxes

In the former two sections we assumed the existence of a planner who is able to directly control OC. In this section we show that controlling OC is also possible through indirect measures, such as appropriate taxation. For simplicity we assume taxes to be uniformly redistributed to all agents in the economy. Negative taxes, i.e. subsidies, are assumed to be uniformly collected from all agents.

Denote the tax on entrepreneurs by τ_E and the tax on traders by τ_T. We start with the case of positive noise trader shocks.

Noise trader shocks

The definition of equilibrium in Section 5 applies without modification for $\tau \neq 0$. The condition which states that agents are no worse-off as entrepreneurs than as traders becomes

$$\Delta(L_E) - \rho\tau_E \geqslant \Gamma(L_E) - \rho\tau_T, \tag{26}$$

where $\Delta(L_E)$ and $\Gamma(L_E)$ are defined as before.

PROPOSITION 9.1: *Let* $\sigma_\nu^2 > 0$.

(a) Be $\tau_T < \Gamma(0)/\rho$. *If* τ_E *is such that (26) holds with equality for an* $0 < L_E < L$, *then an equilibrium with both entrepreneurs and traders exists. If* τ_E *is such that (26) holds for* $L_E = L$, *then an equilibrium with only entrepreneurs exists.*

(b) Be $\tau_T > \Gamma(L)/\rho$. *If* τ_E *is such that (26) holds and* $\Delta(L_E) - \rho\tau_E = 0$ *for an* $0 < L_E < L$, *then an equilibrium with both entrepreneurs and uninformed investors exists.*

(c) Be $\tau_T = \Gamma(L_E)/\rho$ *for an* $0 < L_E < L$ *at which also (26) holds with equality. Then an equilibrium with entrepreneurs, traders and uninformed investors exists.*

(d) No OC, i.e. banning traders, is equivalent to a prohibitive tax on traders (and $\tau_E = 0$*). Independent of whether any given allocation of talent was attained through direct control or appropriate taxation, social welfare is the same for both cases.*

Proposition 9.1 says that all kinds of talent allocation can be implemented through appropriate taxation of entrepreneurs and traders. As $\Gamma(L_E) \geqslant 0$ and strictly increasing in L_E, the condition for τ_T in (a) ensures that traders are always better off than uninformed investors. The mass of entrepreneurs can be freely varied through setting appropriate values for τ_E. Similarly, the condition for τ_T in (b) ensures that traders are always worse off than uninformed investors. Again, the mass of entrepreneurs can be freely varied through setting appropriate values for τ_E. Part (c) says that also equilibria with all kinds of agents are implementable through setting appropriate values for τ_T and τ_E. Note that the proposition delivers sufficient conditions for implementing all kinds of talent allocation, not necessary ones.

For part (d), the reason why banning traders is equivalent to a prohibitive tax $\tau_T > \Gamma(L)/\rho$ (and leaving $\tau_E = 0$) is obvious: Taxation only exists as a threat, in effect there are no taxes collected. The reason why social welfare remains the same, independent of whether any given OC status has been attained through direct control or through taxation, are CARA preferences and our specific definition of social welfare. Taxes may lead to some agents being better and some worse off than in case of direct OC control, but with CARA preferences this does not affect their behaviour and because of taxation being a "zero-sum game" and the SWF being linear in endowments, SWF values do not change. The optimal taxation is thus τ_T, τ_E such that the optimal, directly controlled OC allocation rearises. Parts (a)-(c) ensure that such taxation exists.

No Noise

Proposition 9.2 carries over to the case of no noise. Because $GI = 0$, all taxes $\tau_T > 0$ are prohibitive regarding traders, while all taxes $\tau_T \leqslant 0$ are prohibitive regarding uninformed investors (w.l.o.g.).

PROPOSITION 9.2: *Let* $\sigma_\nu^2 = 0$.
(a) Taxes $\tau_T = \tau_E = 0$ *lead to the optimum of* S^T,$\hat{S}^T$ *on* $[0, L)$*. Taxes* $\tau_T > 0$, $\tau_E = 0$ *lead to the optimum of* S^U, $\hat{S}^U$.
(b) Taxes $\tau_T = 0$, $\tau_E < 0$ *lead to the optimum of* $\tilde{S}^T$ *on* $[0, L)$*. Taxes* $\tau_T > 0$, $\tau_E < 0$ *lead to the optimum of* $\tilde{S}^U$.

The proposition follows directly from Proposition 8.2 and Proposition 9.1 (d). For $\tau_T > 0$, the concrete value of τ_T is irrelevant. The optimum value of τ_E for $\tau_E < 0$ can be approximated (see the Appendix). Under the conditions of Proposition 8.3, social welfare with $\tau_T > 0$ is higher than with $\tau_T = 0$.

10 Conclusion

We incorporate occupational choice between finance and entrepreneurship into the Grossman-Stiglitz (1980) noisy rational expectations equilibrium model. Sophisticated agents produce output and create jobs as entrepreneurs or contribute to informational efficiency in financial markets as informed traders. Finance possibly attracts too much talent, for instance if the amount of noise in the economy is small, so that the asset price at a rational expectations equilibrium is highly informative anyway. The main beneficiaries of the allocation of talent to entrepreneurial activity are workers, whose wage and employment prospects improve when more sophisticated agents choose to become entrepreneurs.

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Appendix

The derivations below make use of Lemma 1 in Demange and Laroque (1995, p. 252), which says that for normal random variables x and y,

$$\mathrm{E}\left[\exp\left(x - y^2\right)\right] = \frac{\exp\left\{\mathrm{E}(x) + \frac{1}{2}\,\mathrm{var}(x) - \frac{[\mathrm{E}(y)+\mathrm{cov}(x,y)]^2}{1+2\,\mathrm{var}(y)}\right\}}{[1 + 2\,\mathrm{var}(y)]^{\frac{1}{2}}}. \tag{A.1}$$

Equation (1):

Making use of (A.1) with y identically equal to zero, we have

$$\mathrm{E}[U(\pi_E)|\, P] = -\exp\left(-\rho\left\{e + \frac{P}{a} + [\mathrm{E}(\theta|\, P) - P]\, I_E\right\} + \frac{\rho^2}{2}\mathrm{var}(\theta|\, P) I_E^2\right). \tag{A.2}$$

Maximizing with respect to I_E yields the first equation in (1). Given that uninformed traders trade on the same information as entrepreneurs, $I_M = I_E$ follows from the fact that optimum investment does not depend on initial wealth. Similarly, using $\mathrm{E}(\theta|\, s) = s$ and $\mathrm{var}(\theta|\, s) = \sigma_\varepsilon^2$,

$$\mathrm{E}[U(\pi_T)|\, s, P] = -\exp\left\{-\rho\left[e + (s - P)I_T\right] + \frac{\rho^2}{2}\sigma_\varepsilon^2 I_T^2\right\}, \tag{A.3}$$

and maximization with respect to I_T yields the second equation in (1).

Equations (7) and (9):

Substituting for I_E from (1) into (A.2) yields

$$\mathrm{E}[U(\pi_E)|\, P] = -\exp\left\{-\rho e - \rho\frac{P}{a} - \frac{[\mathrm{E}(\theta|\, P) - P]^2}{\mathrm{var}(\theta|\, P)} + \frac{1}{2}\frac{[\mathrm{E}(\theta|\, P) - P]^2}{\mathrm{var}(\theta|\, P)}\right\}.$$

The expression in the main text follows from collecting terms and the definition of z. Taking expectations, using the law of iterated expectations, we obtain

$$\mathrm{E}[U(\pi_E)] = -\exp(-\rho e)\,\mathrm{E}\left[\exp\left(-\rho\frac{P}{a} - z^2\right)\right]. \tag{A.4}$$

Since P and z are normal, we can apply (A.1) to get

$$\mathrm{E}\left[\exp\left(-\rho\frac{P}{a} - z^2\right)\right] = \frac{\exp\left\{\mathrm{E}\left(-\rho\frac{P}{a}\right) + \frac{1}{2}\,\mathrm{var}\left(-\rho\frac{P}{a}\right) - \frac{\left[\mathrm{E}(z)+\mathrm{cov}\left(-\rho\frac{P}{a},\, z\right)\right]^2}{1+2\,\mathrm{var}(z)}\right\}}{[1 + 2\,\mathrm{var}(z)]^{\frac{1}{2}}}.$$

Substituting this into (A.4) and rearranging terms gives

$$\mathrm{E}[U(\pi_E)] = -\exp(-\rho e)\frac{\exp\left\{-\frac{\rho}{a}\,\mathrm{E}(P) + \frac{1}{2}\left(\frac{\rho}{a}\right)^2\,\mathrm{var}(P) - \frac{\left[\mathrm{E}(z)-\frac{\rho}{a}\,\mathrm{cov}(P,z)\right]^2}{1+2\,\mathrm{var}(z)}\right\}}{[1 + 2\,\mathrm{var}(z)]^{\frac{1}{2}}},$$

which can be rewritten as (7). An uninformed trader's expected utility is obtained analogously; the terms containing P/a drop out.

Similarly, substituting for I_T from (1) into (A.3) yields

$$\mathrm{E}[U(\pi_T)|\, s, P] = -\exp\left\{-\rho e - \left[\frac{s-P}{(2\sigma_\varepsilon^2)^{\frac{1}{2}}}\right]^2\right\}. \tag{A.5}$$

Set $y \equiv (s-P)/(2\sigma_\varepsilon^2)^{1/2}$. Notice that $\mathrm{E}(s|\,P) = \mathrm{E}(\theta|\,P)$ and $\mathrm{var}(s|\,P) = \mathrm{var}(\theta|\,P) - \sigma_\varepsilon^2$, so that $\mathrm{E}(y|\,P) = [\mathrm{E}(\theta|\,P) - P]/(2\sigma_\varepsilon^2)^{1/2}$ and $\mathrm{var}(y|\,P) = [\mathrm{var}(\theta|\,P) - \sigma_\varepsilon^2]/(2\sigma_\varepsilon^2)$. Applying the law of iterated expectations to (A.5) and using (A.1), we obtain

$$\mathrm{E}[U(\pi_T)|\,P] = -\exp(-\rho e)\frac{\exp\left\{-\frac{\frac{[\mathrm{E}(\theta|\,P)-P]^2}{2\sigma_\varepsilon^2}}{\frac{\mathrm{var}(\theta|\,P)}{\sigma_\varepsilon^2}}\right\}}{\left[\frac{\mathrm{var}(\theta|\,P)}{\sigma_\varepsilon^2}\right]^{\frac{1}{2}}}.$$

The expression in the main text follows upon rearranging terms and using the definition of z. Taking expectations, again making use of the law of iterated expectations and (A.1), yields

$$\mathrm{E}[U(\pi_T)] = -\exp(-\rho e)\left[\frac{\sigma_\varepsilon^2}{\mathrm{var}(\theta|\,w)}\right]^{\frac{1}{2}}\frac{\exp\left\{-\frac{[\mathrm{E}(z)]^2}{1+2\,\mathrm{var}(z)}\right\}}{[1+2\,\mathrm{var}(z)]^{\frac{1}{2}}},$$

which can be rewritten as (9).

Expected utility of a single trader in $\mathsf{M}(0,1)$:

A trader's expected utility conditional on s is given by (A.5). Taking expectations, using (A.1) with x identically equal to zero, the fact that P is safe, and (15) yields the expression in the main text.

Proof of Proposition 4.4:

Proof: $L_E^U < L$ implies

$$\bar{s} - \frac{\rho(\sigma_s^2+\sigma_\varepsilon^2)}{L+M}\left(\frac{L}{a} - \bar{\nu}\right) < 0.$$

Together with the condition of Proposition 4.4, it follows that

$$\bar{s} - \frac{\rho(\sigma_s^2+\sigma_\varepsilon^2)}{2a} < 0. \tag{A.6}$$

From (12) and (14),

$$\Delta_0^U(L_E^T) = -\frac{\rho}{a}\frac{\sigma_s^2}{\sigma_\varepsilon^2}\left[\bar{s} - \frac{\rho(\sigma_s^2+\sigma_\varepsilon^2)}{2a}\right].$$

Suppose $L_E^U \leqslant L_E^T$. Since $\Delta_0^U(L_E)$ is a decreasing function, this implies $\Delta_0^U(L_E^T) \leqslant 0$. This contradicts (A.6), so $L_E^U > L_E^T$. ||

The functions $\mathbf{\Delta(L_E)}$ and $\mathbf{\Gamma(L_E)}$:

Let

$$\alpha \equiv \frac{L - L_E}{\rho \sigma_\varepsilon^2}, \ \beta \equiv \frac{L_E + M}{\rho \operatorname{var}(\theta |\, w)}, \ \gamma \equiv \frac{1}{\alpha^2 \sigma_s^2 + \sigma_\nu^2}. \tag{A.7}$$

Then,

$$\begin{aligned}
\operatorname{var}(\theta|\, w) &= \gamma \sigma_s^2 \sigma_\nu^2 + \sigma_\varepsilon^2 && \text{(A.8)}\\
\mathrm{E}(P) &= \bar{s} - \frac{\frac{L_E}{a} - \bar{\nu}}{\alpha + \beta} && \text{(A.9)}\\
\operatorname{var}(P) &= \frac{1}{\gamma}\left(\frac{1 + \alpha\beta\gamma\sigma_s^2}{\alpha + \beta}\right)^2 && \text{(A.10)}\\
\mathrm{E}(z) &= \frac{\frac{L_E}{a} - \bar{\nu}}{(\alpha + \beta)\left[2\left(\gamma\sigma_s^2\sigma_\nu^2 + \sigma_\varepsilon^2\right)\right]^{\frac{1}{2}}} && \text{(A.11)}\\
\operatorname{var}(z) &= \frac{\gamma\left(\sigma_\nu^2\right)^2}{(\alpha + \beta)^2 2\left(\gamma\sigma_s^2\sigma_\nu^2 + \sigma_\varepsilon^2\right)} && \text{(A.12)}\\
\operatorname{cov}(P, z) &= -\frac{(1 + \alpha\beta\gamma\sigma_s^2)\sigma_\nu^2}{(\alpha + \beta)^2\left[2\left(\gamma\sigma_s^2\sigma_\nu^2 + \sigma_\varepsilon^2\right)\right]^{\frac{1}{2}}}. && \text{(A.13)}
\end{aligned}$$

Note that $\bar{s}$ affects only $\mathrm{E}(P)$.

By definition, $w = \alpha s + \nu$, so $\operatorname{var}(w) = \alpha^2\sigma_s^2 + \sigma_\nu^2$ and $\operatorname{cov}(s, w) = \alpha\sigma_s^2$. Substituting this into (5) yields

$$\operatorname{var}(\theta|\, w) = \sigma_s^2\left(1 - \frac{\alpha^2\sigma_s^2}{\alpha^2\sigma_s^2 + \sigma_\nu^2}\right) + \sigma_\varepsilon^2.$$

Equation (A.8) follows from the definition of γ in (A.7). $\operatorname{var}(\theta|\, w)$ converges to σ_ε^2 as σ_ν^2 goes to zero.

According to the updating rule for the mean of a normal random variable, $\mathrm{E}(\theta|\, w) = \mathrm{E}(\theta) + [\operatorname{cov}(\theta, w)/\operatorname{var}(w)][w - \mathrm{E}(w)]$. Using $\mathrm{E}(\theta) = \bar{s}$, $\operatorname{var}(w) = \alpha^2\sigma_s^2 + \sigma_\nu^2$, $\operatorname{cov}(\theta, w) = \alpha\sigma_s^2$, and the definitions of w, α, and γ,

$$\mathrm{E}(\theta|\, w) = \bar{s} + \alpha\gamma\sigma_s^2\left[\alpha(s - \bar{s}) + \nu - \bar{\nu}\right]. \tag{A.14}$$

This can be used to rewrite (2) as

$$P = \frac{\alpha s + \nu + \beta\left\{\bar{s} + \alpha\gamma\sigma_s^2\left[\alpha(s - \bar{s}) + \nu - \bar{\nu}\right]\right\} - \frac{L_E}{a}}{\alpha + \beta}$$

or, rearranging terms,

$$P = \bar{s} + \frac{(1 + \alpha\beta\gamma\sigma_s^2)\left[\alpha(s - \bar{s}) + \nu - \bar{\nu}\right] - \left(\frac{L_E}{a} - \bar{\nu}\right)}{\alpha + \beta}. \tag{A.15}$$

Equation (A.9) follows upon taking expectations.

The variance of P is

$$\mathrm{var}(P) = \frac{\left(1+\alpha\beta\gamma\sigma_s^2\right)^2\left(\alpha^2\sigma_s^2+\sigma_\nu^2\right)}{(\alpha+\beta)^2}.$$

Using the definition of γ, we obtain (A.10).

Substituting $\mathrm{E}(\theta|\,w)$ from (A.14) and P from (A.15) into the definition of z yields

$$z = \frac{\bar{s}+\alpha\gamma\sigma_s^2\left[\alpha(s-\bar{s})+\nu-\bar{\nu}\right]-\bar{s}-\frac{(1+\alpha\beta\gamma\sigma_s^2)[\alpha(s-\bar{s})+\nu-\bar{\nu}]-\left(\frac{L_E}{a}-\bar{\nu}\right)}{\alpha+\beta}}{\left[2\left(\gamma\sigma_s^2\sigma_\nu^2+\sigma_\varepsilon^2\right)\right]^{\frac{1}{2}}}.$$

Simplifying terms, using $1-\alpha^2\gamma\sigma_s^2=\gamma\sigma_\nu^2$, we get

$$z = \frac{-\gamma\sigma_\nu^2\left[\alpha(s-\bar{s})+\nu-\bar{\nu}\right]+\frac{L_E}{a}-\bar{\nu}}{(\alpha+\beta)\left[2\left(\gamma\sigma_s^2\sigma_\nu^2+\sigma_\varepsilon^2\right)\right]^{\frac{1}{2}}}. \tag{A.16}$$

Taking expectations yields (A.11).

The variance of z is

$$\mathrm{var}(z) = \frac{\gamma^2\left(\sigma_\nu^2\right)^2\left(\alpha^2\sigma_s^2+\sigma_\nu^2\right)}{(\alpha+\beta)^2 2\left(\gamma\sigma_s^2\sigma_\nu^2+\sigma_\varepsilon^2\right)}$$

Equation (A.12) follows from the definition of γ.

From (A.15) and (A.16),

$$\mathrm{cov}(P,z) = \frac{1+\alpha\beta\gamma\sigma_s^2}{\alpha+\beta}\frac{-\gamma\sigma_\nu^2}{(\alpha+\beta)\left[2\left(\gamma\sigma_s^2\sigma_\nu^2+\sigma_\varepsilon^2\right)\right]^{\frac{1}{2}}}\left(\alpha^2\sigma_s^2+\sigma_\nu^2\right).$$

Equation (A.13) follows from the definition of γ. Using (A.10) and (A.12), (A.13) can be rewritten as $\mathrm{cov}(P,z) = -[\mathrm{var}(P)\,\mathrm{var}(z)]^{1/2}$, which proves that P and z are perfectly negatively correlated.

Moments of P and z with no OC:

The first and second moments of P and z without OC are:

$$\begin{aligned}
\mathrm{E}(P) &= \bar{s}-\frac{\rho(\sigma_s^2+\sigma_\varepsilon^2)}{L+M}\left(\frac{L_E}{a}-\bar{\nu}\right) && \text{(A.17)}\\
\mathrm{var}(P) &= \left(\frac{\rho}{L+M}\right)^2(\sigma_s^2+\sigma_\varepsilon^2)^2\sigma_\nu^2 && \text{(A.18)}\\
\mathrm{E}(z) &= \frac{\rho}{L+M}\left(\frac{\sigma_s^2+\sigma_\varepsilon^2}{2}\right)^{\frac{1}{2}}\left(\frac{L_E}{a}-\bar{\nu}\right) && \text{(A.19)}\\
\mathrm{var}(z) &= \left(\frac{\rho}{L+M}\right)^2\frac{(\sigma_s^2+\sigma_\varepsilon^2)}{2}\sigma_\nu^2 && \text{(A.20)}\\
\mathrm{cov}(P,z) &= -\left(\frac{\rho}{L+M}\right)^2\frac{(\sigma_s^2+\sigma_\varepsilon^2)^{\frac{3}{2}}}{2^{\frac{1}{2}}}\sigma_\nu^2. && \text{(A.21)}
\end{aligned}$$

Equations (A.17) and (A.18) follow immediately from (14).

Inserting $\mathrm{E}(\theta|\, w) = \bar{s}$ and $\mathrm{var}(\theta|\, w) = \sigma_s^2 + \sigma_\varepsilon^2$ into the definition of z in (6) yields

$$z = \frac{\rho}{L+M}\left(\frac{\sigma_s^2+\sigma_\varepsilon^2}{2}\right)^{\frac{1}{2}}\left(\frac{L_E}{a}-\nu\right). \tag{A.22}$$

Equations (A.19) and (A.20) follow immediately.

Equations (14) and (A.22) yield (A.21).

Equations (A.17)-(A.21) hold true for all $L_E \leqslant L$. This is because, in the absence of OC, there is no jump in the informational efficiency of prices at $L_E = L$.

It is easily checked that the moments in (A.17)-(A.21) coincide with their counterparts (A.9)-(A.13) for $L_E = L$, so that $\Delta^U(L) = \Delta(L)$.

Differentiating the composite function defined by (17) and (A.17)–(A.21) shows that $\Delta^U(L_E)$ is a linear, decreasing function:

$$(\Delta^U)'(L_E) = \left(\frac{\rho}{a}\right)^2 \frac{(\sigma_s^2+\sigma_\varepsilon^2)}{L+M}\left[\frac{\left(\frac{\rho}{L+M}\right)^2(\sigma_s^2+\sigma_\varepsilon^2)\sigma_\nu^2}{1+\left(\frac{\rho}{L+M}\right)^2(\sigma_s^2+\sigma_\varepsilon^2)\sigma_\nu^2}-1\right] < 0.$$

Notice that, since $\mathrm{E}(P)$ is a linear function of $\bar{s}$ and the other moments are independent of $\bar{s}$, the equilibrium value of L_E is a linear function of $\bar{s}$.

Proof that entrepreneurs maximize profit

Suppose all firms employ m workers and make profit $\theta = \tilde{\theta} + F(m) - Wm$. Consider a single firm which deviates with employment $m' \neq m$. Shares in this firm are a different asset than shares in the other firms. So one has to determine the price of this new asset and check if employment m' and the issuance of this asset are beneficial to entrepreneurs.

Given the fact that the productivity shock is additive, an arbitrage argument is sufficient in order to price the asset. The deviating firm makes profit $\theta' = \theta + \delta$, where $\delta \equiv F(m') - F(m) - W(m' - m)$. Since the firm's profit differs from the other firms' profit by the non-random amount δ, buying a fraction λ of the firm's shares at cost $\lambda P'$ generates the same cash flow as buying a fraction λ of one of the other firms at cost λP and storing $\lambda\delta$. Hence, arbitrage-freeness implies $P' = P + \delta$.

The final wealth of an entrepreneur who employs m' workers in each of his firms is $\pi_E' = e + P'/a + (\theta - P)I_E = \pi_E + \delta/a$. Since the price differential δ is non-random, we have

$$\mathrm{E}[U(\pi_E')] = \exp\left(-\rho\frac{\delta}{a}\right)\mathrm{E}[U(\pi_E)].$$

So the entrepreneurs' objective is to maximize δ or, equivalently, profit $F(m') - Wm'$.

Equilibrium mass of entrepreneurs with and without OC with full employment

$L_E^U < L$ and the condition of Proposition 4.4 jointly imply that (A.6) holds with $\bar{s}^U$ instead of $\bar{s}$:

$$\bar{s}^U - \frac{\rho(\sigma_s^2+\sigma_\varepsilon^2)}{2a} < 0. \tag{A.23}$$

From (12) and (14),

$$\Delta_0^U(L_E^T) = -\frac{\rho}{a}\frac{\sigma_s^2}{\sigma_\varepsilon^2}\left[-\frac{\sigma_\varepsilon^2}{\sigma_s^2}\left(\bar{s}^U - \bar{s}^T\right) + \bar{s}^T - \frac{\rho\left(\sigma_s^2 + \sigma_\varepsilon^2\right)}{2a}\right].$$

Suppose $L_E^U \leqslant L_E^T$. This implies $\bar{s}^U \geqslant \bar{s}^T$ and $\Delta_0^U(L_E^T) \leqslant 0$ (since $\bar{s}$ and $\Delta_0^U(L_E)$ are decreasing functions of L_E). This contradicts (A.23), so $L_E^U > L_E^T$.

Proof of wage rigidity in models $\mathsf{U}_1(\sigma_\nu^2, \mathbf{j})$–$\mathsf{U}_4(\sigma_\nu^2, \mathbf{j})$:

$\mathsf{U}_1(\sigma_\nu^2, j)$: The same argument as above proves that firms choose the profit maximizing level of employment $m = (F')^{-1}(W)$ if unions set a uniform wage W. If a union deviates with a wage rate $W' \neq W$, firm profit becomes $\theta' = \theta + \delta$, where $\delta = F(m') - F(m) - W'm' + Wm$, and arbitrage implies that the firm value is $P' = P + \delta$. By the same argument as above, firms choose $m' = (F')^{-1}(W')$. Hence, unions anticipate that firms react to the wage they set by choosing employment on the standard labor demand curve.

A worker's expected utilty is

$$\mathrm{E}[U(\pi_M)] = \exp(-\rho e_M)\left(\frac{m}{\hat{M}}\left\{1 - \exp\left[-\rho(W - D)\right]\right\} - 1\right)\mathrm{E}\left\{\exp\left[-\rho(\theta - P)I_M\right]\right\} \qquad \text{(A.24)}$$

Unions maximize (20) (i.e., the middle term in the product on the right-hand side), since this is conducive to workers' expected utility, irrespective of their subsequent investment decision.

The firm's labor demand curve is

$$m = \left(\frac{1-b}{W}\right)^{\frac{1}{b}}.$$

Maximization of (20) subject to this constraint is equivalent to maximization of

$$bW^{-\frac{1}{b}}\left\{-\exp\left[-\rho(W - D)\right] + 1\right\}.$$

Setting the derivative equal to zero yields

$$W^{-\frac{1}{b}-1}\exp\left[-\rho(W - D)\right]\left\{1 + \rho bW - \exp\left[\rho(W - D)\right]\right\} = 0.$$

There is a unique positive $\tilde{W}$ ($> D$) such that the condition holds for $W = \tilde{W}$, and the derivative changes from positive to negative at $\tilde{W}$, so that $\tilde{W}$ maximizes expected utility. Employment is $\tilde{M} = [(1-b)/\tilde{W}]^{1/b}$. There is unemployment if $\tilde{M} < \hat{M}$.

$\mathsf{U}_2(\sigma_\nu^2, j)$: ...

$\mathsf{U}_3(\sigma_\nu^2, j)$: ...

$\mathsf{U}_4(\sigma_\nu^2, j)$: ...

Alternative sufficient condition in Proposition 7.1(i):

Substitution of L_E^T and L_E^U into (22) and (23), respectively, shows that entrepreneurs' expected utility is higher with no OC exactly if

$$\bar{s}^2 > \frac{\sigma_s^2 + \sigma_\varepsilon^2}{\sigma_\varepsilon^2} \left(\bar{s} - \frac{\rho \sigma_s^2}{2a} \right)^2 .$$

$L_E^T/a > \bar{\nu}$ implies that the term in parentheses on the right-hand side is positive. So, rearranging terms, the above inequality can be written as

$$\bar{s} < \frac{\rho}{a} \left[\sigma_\varepsilon^2 + \frac{\sigma_s^2 + (\sigma_s^2 + \sigma_\varepsilon^2)^{\frac{1}{2}} (\sigma_\varepsilon^2)^{\frac{1}{2}}}{2} \right]. \tag{A.25}$$

From (12), $L_E^T < L$ and $\bar{\nu} > 0$ jointly imply

$$\bar{s} < \frac{\rho}{a} \left(\sigma_\varepsilon^2 + \frac{\sigma_s^2}{2} \right).$$

This implies the validity of (A.25).

No pareto-improvement from a small increase of the mass of entrepreneurs:

Starting from the equilibrium L_E^T, a small increase in L_E decreases entrepreneurs' welfare, even if the conditions of Prpoposition 7.1 hold.

$$\begin{aligned} \frac{\partial - ln(-E(U(\pi_E)))}{\partial L_E}\Big|_{L_E = L_E^T} &= -\frac{\rho^2}{a^2} \frac{\sigma_\varepsilon^2}{L+M} + \frac{\rho^2}{a} \frac{\sigma_\varepsilon^2}{L+M} \frac{L_E^T/a - \bar{\nu}}{L+M} \\ &= \frac{\rho^2 \sigma_\varepsilon^2}{a(L+M)} \left(I_E^T - \frac{1}{a} \right). \end{aligned}$$

I_E^T is the final asset position of an entrepreneur and $1/a$ his initial asset position (from his own firm). As entrepreneurs in net typically sell some amount of their assets, it is $I_E^T < 1/a$.

Equation (24):

For $\sigma_\nu^2 = 0$, from (10) and (14), respectively,

$$\theta - P = \frac{\rho \sigma_\varepsilon^2}{L+M} \left(\frac{L_E^T}{a} - \bar{\nu} \right) + \varepsilon \tag{A.26}$$

at an equilibrium of $\mathsf{M}(0,1)$ and

$$\theta - P = s - \bar{s} + \frac{\rho \left(\sigma_s^2 + \sigma_\varepsilon^2 \right)}{L+M} \left(\frac{L_E^U}{a} - \bar{\nu} \right) + \varepsilon \tag{A.27}$$

at an equilibrium of $\mathsf{M}(0,0)$ with $L_E^U < L$ entrepreneurs.

Using $\pi_N = e_N + (\theta - P)\bar{\nu}/N$ and (A.26), noise traders' expected utility in the case with OC can be written as

$$\mathrm{E}[U(\pi_N)] = -\exp(-\rho e_N)\,\mathrm{E}\left(\exp\left\{\left[\frac{\rho\sigma_\varepsilon^2}{L+M}\left(\frac{L_E^T}{a} - \bar{\nu}\right) + \varepsilon\right]\frac{\bar{\nu}}{N}\right\}\right).$$

As final wealth is normal, we can apply (A.1) to get

$$-\log\{-\mathrm{E}[U(\pi_N)]\} = \rho e_N + \rho\frac{\bar{\nu}}{N}\frac{\rho\sigma_\varepsilon^2}{L+M}\left(\frac{L_E^T}{a} - \bar{\nu}\right) - \frac{1}{2}\left(\rho\frac{\bar{\nu}}{N}\right)^2\sigma_\varepsilon^2. \tag{A.28}$$

Following the same steps, using (A.27) instead of (A.26), we get noise traders' expected utility in the absence of OC:

$$-\log\{-\mathrm{E}[U(\pi_N)]\} = \rho e_N + \rho\frac{\bar{\nu}}{N}\frac{\rho(\sigma_s^2 + \sigma_\varepsilon^2)}{L+M}\left(\frac{L_E^U}{a} - \bar{\nu}\right) - \frac{1}{2}\left(\rho\frac{\bar{\nu}}{N}\right)^2(\sigma_s^2 + \sigma_\varepsilon^2). \tag{A.29}$$

Subtracting (A.28) from (A.29) yields (24). With L instead of L_E^U the formulas also apply to the case in which all rational agents become entrepreneurs with no OC.

Since (10) and (14) are also valid in the production economy with full employment or unemployment, the formulas are also valid in these models.

Noise trader utility for $\sigma_\nu^2 > 0$:

For the calculation of noise traders' expected utility when $\sigma_\nu^2 > 0$, we need a variant of the Demange-Laroque (1995) lemma (A.1): for normal random variables x and y,

$$\mathrm{E}\left[\exp\left(x + y^2\right)\right] = \frac{\exp\left\{\mathrm{E}(x) + \frac{1}{2}\,\mathrm{var}(x) + \frac{[\mathrm{E}(y) + \mathrm{cov}(x,y)]^2}{1 - 2\,\mathrm{var}(y)}\right\}}{[1 - 2\,\mathrm{var}(y)]^{\frac{1}{2}}} \tag{A.30}$$

for $\mathrm{var}(y) < 1/2$. $\mathrm{E}[\exp(x + y^2)]$ does not exist otherwise.

Proof: By direct calculation

$$\mathrm{E}\left[\exp\left(x + y^2\right)|\, y\right] = \exp\left(y^2\right)\exp\left[\mathrm{E}(x|\, y) + \frac{1}{2}\mathrm{var}(x|\, y)\right]\int_{-\infty}^{\infty}\frac{\exp\left(-\frac{\{x - [\mathrm{E}(x|\, y) + \mathrm{var}(x|\, y)]\}^2}{2\mathrm{var}(x|\, y)}\right)}{[2\pi\,\mathrm{var}(x|\, y)]^{\frac{1}{2}}}dx.$$

The integral is unity, since the integrand is the density of $\mathrm{N}[\mathrm{E}(x|\, y) + \mathrm{var}(x|\, y), \mathrm{var}(x|\, y)]$. Using the updating rules for normal random variables, it follows that

$$\begin{aligned}\mathrm{E}\left[\exp\left(x + y^2\right)|\, y\right] \;&=\; \exp\left[y^2 + \frac{\mathrm{cov}(x,y)}{\mathrm{var}(y)}y\right] \\ &\quad\cdot\exp\left[\mathrm{E}(x) + \frac{1}{2}\mathrm{var}(x) - \frac{\mathrm{cov}(x,y)}{\mathrm{var}(y)}\mathrm{E}(y) - \frac{1}{2}\frac{\mathrm{cov}(x,y)^2}{\mathrm{var}(y)}\right].\end{aligned} \tag{A.31}$$

The unconditional expectation of the first exponential on the right-hand side can be rewritten as

$$\begin{aligned}
\mathrm{E}\left\{\exp\left[y^2 + \frac{\mathrm{cov}(x,y)}{\mathrm{var}(y)}y\right]\right\} &= \frac{\exp\left[\frac{2\,\mathrm{E}(y)\,\mathrm{cov}(x,y)+\mathrm{cov}(x,y)^2+2\,\mathrm{E}(y)^2\mathrm{var}(y)}{2[1-2\mathrm{var}(y)]\mathrm{var}(y)}\right]}{[1-2\,\mathrm{var}(y)]^{\frac{1}{2}}} \\
&\quad \cdot \int_{-\infty}^{\infty} \frac{\exp\left\{-\frac{\left[y-\frac{\mathrm{E}(y)+\mathrm{cov}(x,y)}{1-2\,\mathrm{var}(y)}\right]^2}{2\frac{\mathrm{var}(y)}{1-2\mathrm{var}(y)}}\right\}}{\left[2\pi\frac{\mathrm{var}(y)}{1-2\mathrm{var}(y)}\right]^{\frac{1}{2}}} dy.
\end{aligned}$$

The integral is unity, since the integrand is the density of $\mathrm{N}\{[\mathrm{E}(y) + \mathrm{cov}(x,y)]/[1 - 2\,\mathrm{var}(y)],\ \mathrm{var}(y)/[1-2\mathrm{var}(y)]\}$. So applying the law of iterated expectations to (A.31) yields (A.30). ||

A noise traders' expected utility conditional on ν is

$$\mathrm{E}[U(\pi_N)\,|\nu] = -\exp(-\rho e_N)\exp\left[-\rho(\theta-P)\frac{\nu}{N}\,\Big|\,\nu\right].$$

Applying (A.1) or (A.30) with $x = (\theta - P)\nu/N$ (which is normal) and $y = 0$ yields

$$\mathrm{E}[U(\pi_N)\,|\nu] = -\exp(-\rho e_N)\exp\left[-\rho\frac{\nu}{N}\mathrm{E}(\theta-P|\,\nu) + \frac{1}{2}\left(\rho\frac{\nu}{N}\right)^2\mathrm{var}(\theta-P|\,\nu)\right]$$

or, using $\mathrm{E}(\theta|\,\nu) = \bar{s}$ and the standard updating rules,

$$\begin{aligned}
\mathrm{E}[U(\pi_N)\,|\nu] &= -\exp(-\rho e_N)\exp\Bigg(\overbrace{-\rho\frac{\nu}{N}\left[\bar{s}-\mathrm{E}(P)+\frac{\mathrm{cov}(P,\nu)}{\sigma_\nu^2}\bar{\nu}\right]}^{=\Phi} \\
&\quad \underbrace{+\,\rho\left(\frac{\nu}{N}\right)^2\left\{\frac{\mathrm{cov}(P,\nu)}{\sigma_\nu^2}N + \frac{\rho}{2}\left[\mathrm{var}(\theta-P) - \frac{(\mathrm{cov}(\theta-P,\nu))^2}{\sigma_\nu^2}\right]\right\}\Bigg)}_{=\Psi^2}.
\end{aligned}$$

Let Φ be defined as the first term in the sum in the second exponential and Ψ as the square root of the second term, so that

$$\begin{aligned}
\mathrm{E}(\Phi) &= -\rho\frac{\bar{\nu}}{N}\left[\bar{s}-\mathrm{E}(P)+\frac{\mathrm{cov}(P,\nu)}{\sigma_\nu^2}\bar{\nu}\right] \\
\mathrm{var}(\Phi) &= \left[\frac{\mathrm{E}(\Phi)}{\bar{\nu}}\right]\sigma_\nu^2 \\
\mathrm{E}(\Psi) &= \rho^{\frac{1}{2}}\frac{\bar{\nu}}{N}\left\{\frac{\mathrm{cov}(P,\nu)}{\sigma_\nu^2}N + \frac{\rho}{2}\left[\mathrm{var}(\theta-P) - \frac{(\mathrm{cov}(\theta-P,\nu))^2}{\sigma_\nu^2}\right]\right\}^{\frac{1}{2}} \\
\mathrm{var}(\Psi) &= \left[\frac{\mathrm{E}(\Psi)}{\bar{\nu}}\right]\sigma_\nu^2 \\
\mathrm{cov}(\Phi,\Psi) &= \frac{\mathrm{E}(\Phi)\mathrm{E}(\Psi)}{\bar{\nu}^2}\sigma_\nu^2.
\end{aligned}$$

Since both Φ and Ψ are normal, from the law of iterated expectations and (A.30),

$$\mathrm{E}[U(\pi_N)] = -\exp(-\rho e_N) \frac{\exp\left\{\mathrm{E}(\Phi) + \frac{1}{2}\operatorname{var}(\Phi) + \frac{[\mathrm{E}(\Psi)+\operatorname{cov}(\Phi,\Psi)]^2}{1-2\operatorname{var}(\Psi)}\right\}}{[1-2\operatorname{var}(\Psi)]^{\frac{1}{2}}}. \tag{A.32}$$

$\mathrm{E}(P)$ is given by (A.9). From (A.15), the other moments in the definitions of Φ and Ψ are

$$\begin{aligned}
\operatorname{cov}(P,\nu) &= \frac{1+\alpha\beta\gamma\sigma_s^2}{\alpha+\beta}\sigma_\nu^2 \\
\operatorname{var}(\theta-P) &= \left(1-\alpha\frac{1+\alpha\beta\gamma\sigma_s^2}{\alpha+\beta}\right)^2\sigma_s^2 + \left(\frac{1+\alpha\beta\gamma\sigma_s^2}{\alpha+\beta}\right)^2\sigma_\nu^2 + \sigma_\varepsilon^2 \\
\operatorname{cov}(\theta-P,\nu) &= -\frac{1+\alpha\beta\gamma\sigma_s^2}{\alpha+\beta}\sigma_\nu^2.
\end{aligned}$$

Given (A.7) and these formulas, $\mathrm{E}[U(\pi_N)]$ can be expressed as a composite function of L_E alone.

Continuity of noise trader expected utility at $\sigma_\nu^2 = 0$:

...

Proof of Proposition 8.2:

(i) Consider first the case in which the $L - L_E$ rational agents who do not become entrepreneurs become traders, i.e. $\mathsf{M}(0,T)$. As shown in Section 4, $-\log\{-\mathrm{E}[U(\pi_E)]\} = \rho e + \mathsf{GE} + \mathsf{GT}_E$, where GE is given by the left-hand side of (12), and $\mathsf{GT}_E = z^2$ with z given by (11). $-\log\{-\mathrm{E}[U(\pi_T)]\} = \rho e + z^2$, as $\mathsf{GI} = 0$. Uninformed investors' expected utility is $-\log\{-\mathrm{E}[U(\pi_M)]\} = \rho e_M + z^2$. Noise traders' welfare $-\log\{-\mathrm{E}[U(\pi_N)]\}$ is given by (A.28). Using these results, social welfare S^T can be expressed as a function of L_E:

$$S^T(L_E,\bar{s}) = \rho(Le + Me_M + Ne_N) + L_E\Delta_0(L_E) + \frac{\rho^2\sigma_\varepsilon^2}{2(L+M)}\left[\left(\frac{L_E}{a}\right)^2 - \left(1+\frac{L+M}{N}\right)\bar{\nu}^2\right] \tag{A.33}$$

for $L_E < L$. Taking the derivative yields

$$\frac{\partial S^T(L_E,\bar{s})}{\partial L_E} = \Delta_0(L_E) \tag{A.34}$$

and $\partial^2 S^T(L_E,\bar{s})/\partial L_E^2 < 0$. That is, S^T us a hump-shaped function of L_E with its maximum at L_E^T. In $\mathsf{F}(0,T)$, uninformed investors' expected utility is $-\log\{-\mathrm{E}[U(\pi_M)]\} = \rho(e_M + \hat{W}) + z^2$, and social welfare is

$$\hat{S}^T(L_E,\bar{s}) = S^T(L_E,\bar{s}) + \rho\hat{W}M,$$

where $\bar{s}$ is given by (19), i.e., it depends on L_E. Accordingly, differentiating with respect to L_E yields

$$\frac{d\hat{S}^T(L_E,\bar{s})}{dL_E} = \frac{\partial\hat{S}^T(L_E,\bar{s})}{\partial L_E} + \frac{\partial\hat{S}^T(L_E,\bar{s})}{\partial\bar{s}}\frac{d\bar{s}}{dL_E} + \rho\frac{d\hat{W}}{dL_E}M.$$

Using $\partial\hat{S}^T/\partial L_E = \partial S^T/\partial L_E$, $\partial\hat{S}^T/\partial\bar{s} = \rho L_E/a$,

$$\frac{d\bar{s}}{dL_E} = \left[F'(\hat{M}) - \hat{W}\right]\frac{d\hat{M}}{dL_E} - \frac{d\hat{W}}{dL_E}\hat{M},$$

$F'(\hat{M}) = \hat{W}$, and $\hat{M} = M/(L_E/a)$, it follows that

$$\frac{d\hat{S}^T(L_E,\bar{s})}{dL_E} = \frac{\partial S^T(L_E,\bar{s})}{\partial L_E}.$$

Given (A.34), $\Delta_0(L_E) = 0$ at equilibrium implies $d\hat{S}^T(L_E,\bar{s})/dL_E = 0$.
In $\mathsf{U}_k(0,T)$, a worker is employed with probability $\tilde{M}/\hat{M}$, in which case he gets extra payoff $\tilde{W} - D$. From (A.24) with $m = \tilde{M}$ and $W = \tilde{W}$, social welfare is

$$\tilde{S}^T(L_E,\bar{s}) = S^T(L_E,\bar{s}) - M\log\left(\frac{\tilde{M}}{\hat{M}}\left\{\exp[-\rho(\tilde{W} - D)] - 1\right\} + 1\right), \tag{A.35}$$

and $\bar{s}$ is given by (21), i.e., it does not depend on L_E. $\partial S^T(L_E,\bar{s})/\partial L_E = \Delta_0(L_E) = 0$ at equilibrium. The second term on the right-hand side is decreasing in $\hat{M} = M/(L_E/a)$ (since the term in braces is negative) and, hence, increasing in L_E. It can be shown that $\tilde{S}^T(L_E,\bar{s})$ attains a maximum at a value of L_E beyond the equilibrium value.
(ii) Next, suppose the $L - L_E$ non-entrepreneurs act as uninformed traders. Social welfare S^U in $\mathsf{M}(0,U)$ can be expressed as

$$\begin{aligned} S^U(L_E,\bar{s}) &= \rho(Le + Me_M + Ne_N) + L_E\Delta_0^U(L_E) \\ &\quad + \frac{\rho^2(\sigma_s^2+\sigma_\varepsilon^2)}{2(L+M)}\left[\left(\frac{L_E}{a}\right)^2 - \left(1 + \frac{L+M}{N}\right)\bar{\nu}^2\right] \end{aligned} \tag{A.36}$$

for $L_E \leqslant L$ then. Taking the derivative yields

$$\frac{\partial S^U(L_E,\bar{s})}{\partial L_E} = \Delta_0^U(L_E)$$

and $\partial^2 S^U(L_E,\bar{s})/\partial L_E^2 < 0$. That is, if there is $L_E^U < L$ such that $\Delta_0^U(L_E^U) = 0$, then it maximizes $S^U(L_E,\bar{s})$ on $[0,L]$. Otherwise S^U is monotonically increasing on the interval $[0,L]$. In $\mathsf{F}(0,U)$ social welfare $\hat{S}^U(L_E,\bar{s})$ encompasses the additional term $\rho\hat{W}M$ representing the contribution of wage income to uninformed traders' expected utility. Using the same results as in the previous case, it follows that $d\hat{S}^U(L_E,\bar{s})/dL_E = \partial S^U(L_E,\bar{s})/\partial L_E$. In $\mathsf{U}_k(0,U)$ social welfare encompasses the log term on the right-hand side of (A.35), which is increasing in L_E, so that $d\tilde{S}^U(L_E^U,\bar{s})/dL_E > 0$.
(iii) For $L_E = L$, P and z and, hence, the expected utilities and $S^T(L)$ and $S^U(L)$, coincide in $\mathsf{M}(0,T)$ and $\mathsf{M}(0,U)$, as the question of what the rational agents who do not become entrepreneurs do becomes meaningless. The same holds true for the production economies.

Proof of Proposition 8.3:

The difference between social welfare in $\mathsf{M}(0,U)$ and $\mathsf{M}(0,T)$ is

$$\frac{\rho^2(\sigma_s^2+\sigma_\varepsilon^2)}{2(L+M)}\left[\left(\frac{L_E^U}{a}\right)^2-\left(1+\frac{L+M}{N}\right)\bar{\nu}^2\right]-\frac{\rho^2\sigma_\varepsilon^2}{2(L+M)}\left[\left(\frac{L_E^T}{a}\right)^2-\left(1+\frac{L+M}{N}\right)\bar{\nu}^2\right]. \quad \text{(A.37)}$$

(a)

Consider models $\mathsf{M}(0,T)$ and $\mathsf{M}(0,U)$. We know that $S^T(L_E,\bar{s})$ attains its maximum on $[0,L)$ for $L_E = L_E^T$ such that $\Delta_0(L_E^T) = 0$ (the hump shape ensures that the maximum exists, even though the domain is not compact) and $S^U(L_E,\bar{s})$ attains its maximum on $[0,L)$ for $L_E = L_E^U$ such that $\Delta_0^U(L_E^U) = 0$. From (A.33) and (A.36), the difference in the maximum welfare levels $S^U - S^T$ is given by (A.37). Clearly, $S^U - S^T > 0$ if $L_E^U > L_E^T$ and the latter term in square brackets is positive. Since $\hat{W}$ is increasing in L_E, the condition $L_E^U > L_E^T$ implies that the extra social welfare $\rho\hat{W}M$ is smaller in model $\mathsf{F}(0,T)$ than in $\mathsf{F}(0,U)$. Similarly, since the extra term in (A.35) is increasing in L_E, it is smaller in $\mathsf{U}_k(0,T)$ than in $\mathsf{U}_k(0,U)$.

(b), (c)

Entrepreneurs:

The difference between entrepreneurs' expected utility without and with OC for any given value of L_E is

$$-\frac{\rho^2\sigma_s^2}{a(L+M)}\left(\frac{L_E}{a}-\bar{\nu}\right)+\frac{\rho^2\sigma_s^2}{2a^2}+\frac{\rho^2\sigma_s^2}{2(L+M)^2}\left(\frac{L_E}{a}-\bar{\nu}\right)^2,$$

which can be written as

$$\rho^2\sigma_s^2\left[\frac{(L+M-L_E+a\bar{\nu})^2}{2a^2(L+M)^2}\right]>0. \quad \text{(A.38)}$$

It follows that entrepreneurs expected utility without OC is higher than with OC for all $0 < L_E < L$. Condition (A.38) is not affected by introducing a labour market.

Traders and Uninformed Investors:

The difference between uninformed investors' and traders' expected utilities in case of No OC and OC for any given value of L_E is

$$\frac{\rho^2\sigma_s^2}{2(L+M)^2}\left(\frac{L_E}{a}-\bar{\nu}\right)^2>0. \quad \text{(A.39)}$$

It follows that rational agents that do not become entrepreneurs and uninformed investors are better off without OC for all $0 < L_E < L$. For the rational agents, condition (A.39) is not affected by introducing a labour market. The reason why the condition is also unaffected for the initial uninformed investors, is that their additional utility from working for any given value of L_E is the same with and without OC.

Noise Traders:

(i) The difference between noise traders' expected utility without and with OC for any given value of L_E is

$$\frac{\rho^2\sigma_s^2}{L+M} I_N \left(\frac{L_E}{a} - \bar{\nu}\right) - \frac{1}{2}\rho^2\sigma_s^2 I_N^2.$$

In general it is not clear, whether they are better off with or without OC. Without short selling, i.e. if $\bar{\nu} > 0$ and $(L_E/a - \bar{\nu}) > 0$, noise traders prefer no OC to OC for

$$L_E > a\bar{\nu} + \frac{1}{2}(L+M)aI_N. \tag{A.40}$$

As we know that equilibrium L_E maximizes social welfare (in the models without unemployment), equilibrium L_E^T greater than the expression on the right hand side of (A.40) is sufficient for overall maximum social welfare being attained at the equilibrium L_E^U. Formally, this condition is not affected by introducing a labour market with full employment, but note that L_E^T changes. The condition also stays viable for the models with unemployment, as optimum L_E is greater than equilibrium L_E in that case.

(ii) Alternatively, let again $\bar{\nu} > 0$ and $(L_E/a - \bar{\nu}) > 0$. At $L_E = a\bar{\nu}$, the difference between social welfare without and with OC is

$$\frac{1}{2}\rho^2\sigma_s^2\bar{\nu}\left(\frac{1}{a} - I_N\right), \tag{A.41}$$

which is greater than zero for $aI_N < 1$.

One can show that the difference between social welfare without and with OC is increasing until

$$L_E = \frac{1}{2}(L+M) + a\bar{\nu}. \tag{A.42}$$

We know that all agents are better off without OC if (A.40) holds. If $aI_N < 1$, (A.42) is greater than the right hand side of (A.40). Summing up: For $aI_N < 1$, social welfare at $L_E = a\bar{\nu}$ is higher without OC. The difference between social welfare without and with OC then increases at least until the value of L_E, beyond which all agents prefer no OC to OC. So for $aI_N < 1$, social welfare is higher without OC if equilibrium L_E^T is greater than $a\bar{\nu}$. Overall maximum social welfare is then attained at the equilibrium L_E^U (in the models without unemployment). Again, formally this condition is not affected by introducing a labour market with full employment, but note that L_E^T changes. As before, the condition also stays viable for the models with unemployment, as optimum L_E is greater than equilibrium L_E in that case.

Agents' risk with and without information

Be $\sigma_\nu^2 = 0$ and agents do not go short in the asset, i.e. $\bar{\nu} > 0$ and $L_E/a - \bar{\nu} > 0$. Entrepreneurs' final wealth is given by $\pi_E = I_E\theta + (1/a - I_E)P$. The difference in the variance of final wealth without and with OC is given by

$$\left(I_E^2 - \frac{1}{a^2}\right)\sigma_s^2 < 0, \tag{A.43}$$

so for any given value of L_E, entrepreneurs carry less risk without OC.

(Uninformed) Traders' final wealth is given by $\pi_{T/M} = I_T(\theta - P)$. It is $I_T = I_M = I_E$. The difference in the variance of final wealth without and with OC is given by

$$I_E^2\sigma_s^2 > 0, \tag{A.44}$$

so for any given value of L_E, (uninformed) traders carry more risk without OC.

Noise traders' final wealth is given by $\pi_N = I_N(\theta - P)$. The difference in the variance of final wealth without and with OC is given by

$$I_N^2\sigma_s^2 > 0, \tag{A.45}$$

so noise traders carry more risk without OC.

Optimum tax on entrepreneurs in $U_k(0,1)$

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