Markups and Inequality*

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Abstract

We characterize optimal product market policy in an unequal economy in which firm ownership is concentrated and markups increase with firm market shares. We study the problem of a utilitarian regulator who designs revenue-neutral interventions in the product market. We show that optimal policy increases product market concentration. This is because policies that encourage larger producers to expand improve allocative efficiency, increase the labor share and the equilibrium wage. We derive these results both in a static Mirrleesian setting in which we impose no constraints on the shape of interventions, as well as in a dynamic economy with capital and wealth accumulation. In our dynamic economy optimal policy reduces wealth and income inequality by redistributing market share and profits from medium-sized businesses, which are primarily owned by relatively rich entrepreneurs, to larger diversified corporate firms.

Keywords: entrepreneurs, inequality, markups, misallocation, redistribution.

JEL classifications: D4, E2, L1.

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1 Introduction

The United States has experienced a sharp increase in product market concentration, profits and measured markups in recent decades.[1] Since firm ownership is highly concentrated, a growing concern is that markups redistribute income from workers towards firm owners, thus increasing inequality. This led to numerous calls for rethinking competition policy to explicitly incorporate distributional concerns, in addition to concerns for economic efficiency.[2]

Existing work on markups, such as Atkeson and Burstein (2008), Bilbiie et al. (2012, 2018) and Edmond et al. (2018), assumes perfect consumption sharing and thus abstracts from distributional considerations. In such a setting markups only distort production by introducing two sources of inefficiency. First, the aggregate markup acts as a uniform tax on production. Second, firms with higher market shares charge higher markups, and the resulting dispersion in marginal products reduces allocative efficiency and aggregate productivity. In this environment a policy that subsidizes production in proportion to markups restores efficiency. Even though this policy increases concentration and profits, it makes the representative consumer, who owns all firms, unambiguously better off. This policy prescription ignores, however, the tradeoff between equity and efficiency that arises in an unequal economy.

Our paper departs from the representative consumer framework. We study optimal product market policies in an economy that matches the degree of inequality in the United States and in which firm ownership is highly concentrated and markups increase with firm market shares. Our main finding is that optimal policy leads to greater product market concentration. Policies that encourage larger producers to expand not only improve allocative efficiency, but also increase the labor share and the equilibrium wage, thus redistributing income from the relatively rich firm owners to the relatively poor workers, increasing utilitarian welfare.

We develop our argument in two steps. The first part of the paper studies a static economy in which we use a mechanism design approach to characterize optimal product market interventions. We show that the optimal allocations can be implemented using size-dependent production subsidies and taxes. Moreover, a simple parametric subsidy function can achieve the bulk of the gains from unrestricted regulation. The second part of the paper considers a richer dynamic economy in which private business owners compete alongside corporate firms. This model reproduces the wealth and income inequality in the United States

[1] De Loecker et al. (2018), Hall (2018a), Autor et al. (2017), Hartman-Glaser et al. (2018).

[2] Stiglitz (2012), Atkinson (2015), Baker and Salop (2015) and Khan and Vaheesan (2016).

and is therefore more amenable to quantitative analysis. For computational tractability, here we restrict attention to policies in the simple parametric class. Though optimal policy once again leads to greater product market concentration, it reduces wealth and income inequality by redistributing market share and profits from medium-sized businesses, which are primarily owned by entrepreneurs, to larger diversified corporate firms. Since in our model, as in the data, entrepreneurs are richer on average, this reallocation reduces inequality.

Throughout the paper we study the problem of a utilitarian regulator implicitly guided by concerns for both efficiency and redistribution. Importantly, we restrict attention to *revenue-neutral* interventions. The regulator can thus shape the firm size and markup distribution, but cannot raise revenue from firms to fund direct transfers to consumers. We impose revenue-neutrality in order to isolate the impact of product market policy. Absent this restriction, the regulator would still find it optimal to increase product market concentration by taxing smaller firms more than larger ones, but would increase the average output tax, thus raising revenue to finance lump-sum transfers. Though the resulting policy would further distort the labor wedge, utilitarian social welfare would increase.[3] The reason we do not study such policies is that they can be mimicked by higher income taxes, the study of which is beyond the scope of this paper.[4] Our focus is therefore solely on characterizing optimal product market policy in an unequal economy, taking the existing tax and transfer system as given. Since absent distributional concerns optimal product market policies restore allocative efficiency, it stands to reason that our result that optimal product market interventions would increase concentration would survive in economies with a more generous tax and transfer system than the current status quo.

The static economy we study consists of two types of agents, workers and entrepreneurs. Workers are heterogeneous in their labor market efficiency and choose how many hours to work at the equilibrium wage. Entrepreneurs differ in their ability, hire labor, and supply a differentiated variety of a good. The assumptions we make on the demand system imply that the demand elasticity a producer faces decreases in its market share, so larger producers charge higher markups. Our framework thus parsimoniously captures the trade-off between efficiency gains and markups that is at the heart of the debate about product market policies.

We build on the approach of Baron and Myerson (1982) who study the problem of regulating a single monopolist. In contrast to their work, we consider the problem of regulating

[3] See an earlier version of this paper, Boar and Midrigan (2019), for an illustration.

[4] See da Costa and Maestri (2019), Kaplow (2019), Kushnir and Zubrickas (2019), Jaravel and Olivi (2021) and Eeckhout et al. (2021) who study income taxation in economies with imperfectly competitive markets.

all firms in a general equilibrium setting. We assume that the regulator does not observe the ability of individual entrepreneurs and thus faces incentive compatibility constraints. These constraints generate informational rents, which increase with the equilibrium wage and the amount of output the regulator prescribes that the entrepreneur produces.

We use optimal control techniques to characterize the optimal distortions in producers' quantity choices as a function of entrepreneurial ability. Since we restrict attention to interventions in the product market, the regulator recognizes that it can only increase the welfare of workers indirectly by increasing the equilibrium wage. The regulator therefore balances the following tradeoff between equity and efficiency. On one hand, reducing the market share of a productive entrepreneur allows the regulator to redistribute to less productive entrepreneurs and to workers. On the other hand, this reduces productivity and wages.

A robust result that emerges is that optimal regulation entails a higher degree of product market concentration compared to the status quo. Though optimal interventions do not fully restore allocative efficiency, the degree of product market concentration is nearly as large as that implied by the efficient allocations. Perhaps counter-intuitively, product market concentration is higher when the regulator places a higher weight on the welfare of workers. This is because product market interventions that encourage larger firms to expand bid up the demand for labor and therefore the equilibrium wage.

We show that one can implement the optimal policy with an output subsidy schedule. Though this schedule is highly non-linear, it can be well approximated by a simple three-parameter subsidy function.[5] These parameters determine the lump-sum transfer to individual producers, the average marginal subsidy and the slope of the marginal subsidy schedule, thus allowing us to provide a sharper intuition for the tradeoffs the regulator faces.

Our static model is purposefully simple in order to highlight the key tradeoffs between equity and efficiency entailed by product market interventions. We show, however, that our results extend to a richer dynamic setting in which we introduce capital and wealth accumulation, a corporate sector whose ownership is diversified, and a government which provides some redistribution via income taxes and transfers. We restrict product market interventions to the three-parameter subsidy class and calculate optimal regulation explicitly taking into account that product market reforms generate long-lasting transition dynamics. We find that optimal intervention greatly increases the market share of the largest firms, substantially reducing misallocation. The equilibrium wage increases by 3.2%, while consumption-equivalent

[5]See Heathcote and Tsujiyama (2019) for an analogous exercise in the context of labor income taxation.

welfare increases by 2.2%.

Our result that policies which encourage firms to expand are welfare-improving is robust to many perturbations of the model. An earlier version of the paper, Boar and Midrigan (2019), considered extensions of our dynamic model in which entrepreneurs are subject to financial constraints, in which firm ownership is either perfectly diversified or fully concentrated, and alternative ways of modelling entry, and reached similar conclusions. To save on space, here we do not report the results of these experiments and study a simplified version of the model in which entrepreneurs do not face collateral constraints.

For tractability, in this paper we study a model of monopolistic competition with a continuum of atomistic firms. This setting cannot be therefore used to study mergers among rivals that sell closely substitutable varieties. We showed in Boar and Midrigan (2019) that such mergers would unambiguously reduce welfare in an Atkeson and Burstein (2008) model of oligopolistic competition if they are not accompanied by efficiency gains. Nevertheless, policies that encourage firms to expand production on the intensive margin benefit consumers through the same channel at play here, namely higher equilibrium wages. We also showed there that size-dependent subsidies increase utilitarian welfare even in a setting in which firm size is determined not only by fundamental differences in productivity, quality or demand, but also by wedges other than markups that distort the production allocation across firms. As long as markups increase with firm size, size-dependent subsidies that encourage larger producers to expand generate efficiency and wage gains.

We conclude that product market concentration is not necessarily costly, even in an environment with highly unequal firm ownership. What is costly is dispersion in the marginal product of factors of production across firms and wedges that depress the equilibrium wage and the return on capital. Optimal product market interventions reduce these wedges and in doing so increase product market concentration. Our results thus caution against the widely-held view that reducing concentration and the market power of large firms necessarily improves the welfare of the poor. Though less concentration indeed reduces market power and markups in our model, the interventions required to reduce the market share of large firms have the unintended consequence of also reducing the labor share, aggregate productivity and the equilibrium wage.

Though we focus on the distortions due to markups, our framework and our results are more general and are not driven by our assumption of monopolistic competition or Kimball demand. We show in the paper that a regulator that places a high weight on the welfare of the workers may choose to increase product market concentration even in an economy without markups, thus accepting a moderate degree of product market misallocation in exchange for a higher labor share and equilibrium wage.

Related Work. In addition to the work on markups and optimal taxation discussed above, our paper builds on studies of wealth and income inequality, originating with Castaneda et al. (2003) and more recently Benhabib et al. (2017) and Hubmer et al. (2018). This line of research typically assumes perfect competition in the product market or that markups are constant. Several notable exceptions are the work of Brun and Gonzalez (2017) and Colciago and Mechelli (2019) who study the effect of increasing markups in Bewley-Aiygari models with homogeneous firms. In contrast to their work, we explicitly model firm heterogeneity and study optimal product market interventions. A recent paper by Dworczak et al. (2020) also considers a mechanism design approach to characterize the tradeoff between allocative efficiency and redistribution in a setting in which buyers and sellers differ in their valuation of the good. In contrast to their paper, which studies a market for a single good, we study a production economy with a large number of goods and account for the general equilibrium effects of regulation.

Our paper is also related to a large literature on product market misallocation and size-dependent policies (Guner et al., 2008, Restuccia and Rogerson, 2008, Hsieh and Klenow, 2009, Jones, 2011, Baqaee and Farhi, 2018). We show that in our economy, concerns for inequality prevent optimal product market interventions from fully eliminating misallocation.

The remainder of the paper proceeds as follows. Section 2 describes the static economy we study. Section 3 solves the optimal regulation problem. Section 4 extends the analysis to a dynamic setting. Section 5 concludes.

2 Static Model

For clarity we study the simplest environment that captures the interplay between markups and inequality and allows us to highlight the key forces that shape optimal product market interventions. The insights we derive here carry to the richer dynamic model we study in Section 4.

The economy is inhabited by two types of agents, a measure $1-\omega$ of workers and a measure ω of entrepreneurs. Workers are heterogeneous in their labor market ability e and choose how many hours to work at a wage W. Entrepreneurs are heterogeneous in their entrepreneurial ability z. They hire labor, supply a differentiated variety of a good and receive income from profits. We first describe the problem of the agents, characterize the equilibrium in the absence of product market interventions, and discuss the distortions due to markups.

2.1 Workers

Workers have preferences of the form

$$u(c,h) = \frac{c^{1-\theta}}{1-\theta} - \frac{h^{1+\gamma}}{1+\gamma},$$

where c denotes consumption and h hours worked. The parameters θ and γ represent the coefficient of relative risk aversion and the inverse of the Frisch elasticity of labor supply. Their budget constraint is

$$c = Weh.$$

Solving the workers' problem gives their optimal hours and consumption choices

$$h(e,W) = (We)^{\frac{1-\theta}{\gamma+\theta}} \qquad \text{and} \qquad c(e,W) = (We)^{\frac{1+\gamma}{\gamma+\theta}}. \tag{1}$$

The welfare of workers thus increases with the equilibrium wage

$$v(e,W) = u\left(c\left(e,W\right),\ h\left(e,W\right)\right) = \frac{\gamma+\theta}{(1-\theta)(1+\gamma)} W^{\frac{(1-\theta)(1+\gamma)}{\gamma+\theta}} e^{\frac{(1-\theta)(1+\gamma)}{\gamma+\theta}}.$$

2.2 Entrepreneurs

Entrepreneurs do not work and have preferences of the form

$$u(c) = \frac{c^{1-\theta}}{1-\theta}.$$

They differ in their ability z and operate a production technology

$$y = zl^{\eta}, \tag{2}$$

where l is labor input, y is output and $\eta \leq 1$ is the span-of-control parameter. Their budget constraint is

$$c = \pi = p(y)y - Wl,$$

where π are profits, the entrepreneurs' only source of income, and $p(y)$ is the inverse demand function faced by an entrepreneur. To derive this demand function, we next describe the assumptions we make on the market structure.

Market Structure. We assume that a perfectly competitive final good sector aggregates differentiated varieties produced by entrepreneurs. Each entrepreneur is the only supplier of a given variety. The technology of the final good sector is implicitly defined by the Kimball aggregator

$$\int_0^\omega \Upsilon\left(\frac{y_i}{Y}\right) \mathrm{d}i = 1, \tag{3}$$

where Y is the output of the final good, whose price we normalize to 1, and ω is the mass of entrepreneurs. The function $\Upsilon(q)$ is strictly increasing and concave. We follow Klenow and Willis (2016) in assuming an aggregator of the form

$$\Upsilon(q) = 1 + (\sigma - 1) \exp\left(\frac{1}{\varepsilon}\right) \varepsilon^{\frac{\sigma}{\varepsilon}-1} \left[\Gamma\left(\frac{\sigma}{\varepsilon}, \frac{1}{\varepsilon}\right) - \Gamma\left(\frac{\sigma}{\varepsilon}, \frac{q^{\varepsilon/\sigma}}{\varepsilon}\right)\right],$$

where $\Gamma(s, x)$ is the upper incomplete gamma function.[6]

Taking the prices p_i of the differentiated varieties as given, final good producers choose how much of each variety y_i to buy in order to maximize profits

$$\max_{\{y_i\}} Y - \int_0^\omega p_i y_i \, \mathrm{d}i,$$

subject to the Kimball production function (3). The solution to this problem gives rise to the demand function

$$p\left(y_i\right) = \Upsilon'\left(\frac{y_i}{Y}\right) D, \tag{4}$$

where

$$D = \left(\int_0^\omega \Upsilon'\left(\frac{y_i}{Y}\right) \frac{y_i}{Y} \, \mathrm{d}i\right)^{-1}$$

is an endogenously determined demand index.

The Klenow and Willis (2016) functional form implies a demand elasticity

$$-\frac{\Upsilon'(q)}{\Upsilon''(q) q} = \sigma q^{-\frac{\varepsilon}{\sigma}},$$

which falls with the entrepreneur's relative quantity $q = y/Y$ or, equivalently, market share. The Kimball specification of the demand system is widely used in both macroeconomics and international economics (Chari et al., 2000, Gopinath and Itskhoki, 2010, Edmond et al., 2018). We note that such a demand system can be micro-founded by explicitly modeling consumer search frictions (Benabou, 1988). In addition, models of oligopolistic competition (Atkeson and Burstein, 2008) give rise to a similar negative relationship between market

[6] See Matsuyama and Ushchev (2020) for a general characterization of homothetic demand systems that imply variable markups.

shares and demand elasticities. We think of this specification as capturing in a parsimonious way the view that firms that monopolize charge higher markups, but note that by setting $\varepsilon = 0$ the model nests the more conventional CES specification with constant markups.

Entrepreneur's Optimal Quantity Choice. Substituting the demand function (4) into the profit function gives an individual entrepreneur's profit maximization problem

$$\max_{y} D\Upsilon'\Big(\frac{y}{Y}\Big)y - W\left(\frac{y}{z}\right)^{\frac{1}{\eta}}. \tag{5}$$

The optimal output choice $y(z)$ is then implicitly given by

$$D\Upsilon'\Big(\frac{y}{Y}\Big) = \frac{\sigma}{\sigma - \left(\frac{y}{Y}\right)^{\frac{\varepsilon}{\sigma}}}\frac{1}{\eta}W\left(\frac{y}{z}\right)^{\frac{1}{\eta}}\frac{1}{y}, \tag{6}$$

where the left-hand side is equal to the firm's price and the right-hand side is the product of the markup

$$m(q) = \frac{\sigma}{\sigma - q^{\frac{\varepsilon}{\sigma}}}$$

and the marginal cost $\frac{1}{\eta}W\left(\frac{y}{z}\right)^{\frac{1}{\eta}}\frac{1}{y}$. If $\varepsilon > 0$, the entrepreneur's optimal markup increases in the relative output $q = y/Y$. For future reference, we let $m(z) = m(q(z))$ denote the optimal markup charged by an entrepreneur with ability z.

2.3 Equilibrium

Letting $H(e)$ denote the distribution of workers' labor market efficiency and aggregating their optimal choices in (1) gives the aggregate labor supply

$$L^w(W) = (1-\omega)\left(\int_0^\infty e^{\frac{1+\gamma}{\gamma+\theta}}\,\mathrm{d}H(e)\right)W^{\frac{1-\theta}{\gamma+\theta}}$$

and total consumption of workers

$$C^w(W) = (1-\omega)\left(\int_0^\infty e^{\frac{1+\gamma}{\gamma+\theta}}\,\mathrm{d}H(e)\right)W^{\frac{1+\gamma}{\gamma+\theta}}.$$

Let $F(z)$ denote the distribution of entrepreneurial ability and $f(z)$ the corresponding density. Integrating the labor choices of individual entrepreneurs gives the aggregate production function

$$Y = ZL^\eta.$$

Here

$$Z = \left(\omega\int_0^\infty \left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}}\,\mathrm{d}F(z)\right)^{-\eta} \tag{7}$$

denotes aggregate productivity and $L = \omega \int_0^\infty l(z)\, \mathrm{d}F(z)$ is the aggregate demand for labor.

Integrating (6) across producers gives the following relationship between the equilibrium wage and the marginal product of labor in the aggregate

$$W = \frac{1}{\mathcal{M}} \eta \frac{Y}{L}, \tag{8}$$

where $\eta Y/L$ is the aggregate marginal product of labor and the *aggregate markup* $\mathcal{M}$ is[7]

$$\mathcal{M} = \left(\omega \int_0^\infty \frac{1}{m(z)} p(z) q(z)\, \mathrm{d}F(z) \right)^{-1}. \tag{9}$$

2.4 Markup Distortions and Implications for Inequality

We next discuss the sources of inefficiency introduced by markups. In this economy markups generate two production distortions. First, as equation (8) shows, the *level* of the aggregate markup $\mathcal{M}$ acts as a uniform tax on overall employment and depresses the equilibrium wage W relative to the marginal product of labor $\eta Y/L$.[8] Second, *dispersion* in markups generates dispersion in the marginal product of labor and reduces aggregate productivity.

To see this second effect, consider the problem of allocating a given amount of labor L across entrepreneurs in order to maximize aggregate output Y subject to the the production function implicitly defined by the Kimball aggregator and the labor resource constraint. Formally,

$$\max_{y(z),\, Y} Y \tag{10}$$

$$\text{subject to} \quad \omega \int_0^\infty \Upsilon\left(\frac{y(z)}{Y}\right) \mathrm{d}F(z) = 1, \tag{11}$$

$$\omega \int_0^\infty \left(\frac{y(z)}{z}\right)^{\frac{1}{\eta}} \mathrm{d}F(z) = L \tag{12}$$

The first-order conditions of this problem imply that the efficient relative output allocations satisfy

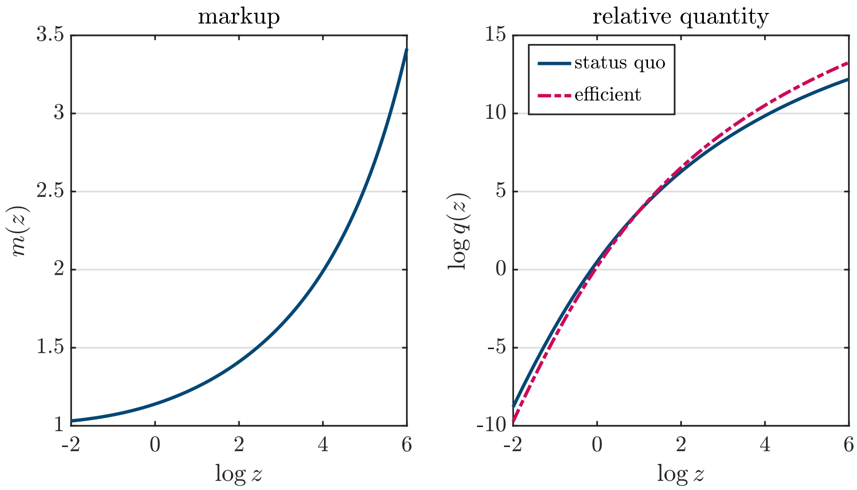
$$\Upsilon'(q)\, q = \Lambda \left(\frac{q}{z}\right)^{\frac{1}{\eta}}, \tag{13}$$

where $\Lambda = \frac{1}{\eta} \frac{\nu Y^{\frac{1}{\eta}-1}}{D}$ depends on output, the demand index and the multiplier ν on the labor resource constraint. At the optimum, the marginal valuation of an additional unit of a variety is equal to the marginal cost of producing it. In contrast, the quantity chosen by the

[7] See, for example, Edmond et al. (2018) for the derivation.

[8] Here we normalize the price of goods to unity, so markups depress the equilibrium wage. Equivalently, we could normalize the wage to unity, in which case higher markups increase the price of the final good.

Figure 1: Comparison of Decentralized and Efficient Quantity Choices



entrepreneur equates the marginal valuation of the variety (its price) to a markup over the marginal cost

$$\Upsilon'(q)\, q = m(q)\Lambda \left(\frac{q}{z}\right)^{\frac{1}{\eta}},$$

and is therefore distorted by markups. Here $\Lambda = \frac{1}{\eta}\frac{WY^{\frac{1}{\eta}-1}}{D}$ depends on the equilibrium wage, output and the demand index. If markups vary across firm, aggregate productivity falls.

Figure 1 illustrates the impact markups have on relative quantities. The left panel of the figure shows that markups increase with entrepreneurial ability z because more productive entrepreneurs produce more and have a larger market share. The right panel of the figure contrasts the entrepreneurs' relative output choices under the status quo to the efficient ones that maximize aggregate productivity. More productive entrepreneurs sell too little compared to the efficient allocations, while unproductive entrepreneurs sell too much.

In the absence of distributional concerns, the two markup distortions would depress household welfare by implicitly taxing labor supply and by reducing aggregate productivity. In our economy in which households are heterogeneous, markups have an additional effect because they redistribute income from workers to firm owners. To see this, notice that the consumption of workers is equal to

$$C^w = WL = \frac{\eta}{\mathcal{M}}Y,$$

and decreases in the aggregate markup, while the consumption of entrepreneurs is equal to

$$C^e = Y - WL = \left(1 - \frac{\eta}{\mathcal{M}}\right)Y$$

Table 1: Parameter Values

Assigned			Calibrated		
θ	1	CRRA coefficient	σ_e^2	1.01	std. dev. Gaussian term, workers
γ	2	inverse Frisch elasticity	λ_e	2.34	rate exponential term, workers
η	0.85	span of control	σ_z^2	0.23	std. dev. Gaussian term, entrep.
ε/σ	0.15	super-elasticity of demand	λ_z	3.13	rate exponential term, entrep.
ω	0.12	fraction entrepreneurs	σ	8.81	demand elasticity at $q = 1$

and increases in the aggregate markup. In addition, since higher ability entrepreneurs earn higher markups and profits, dispersion in markups increases inequality among entrepreneurs. Notice that by allowing for decreasing returns to scale in production, we allow for the possibility that firm profits arise due to both markups as well as managerial span-of-control.

2.5 Parameterization

Since the solution to this model is not attainable in closed form, we use numerical methods to characterize the equilibrium and solve for the optimal degree of product market intervention. Though our main results are not driven by specific parameter choices, we find it useful to center our discussion around some empirically plausible parameter values. We then conduct a battery of robustness checks to demonstrate the generality of our results.

As Table 1 shows, we assume that preferences are logarithmic in consumption, a Frisch elasticity of labor supply of 0.5, and a span-of-control parameter η of 0.85. We set ε/σ equal to 0.15 following Edmond et al. (2018) who use several data sources and obtain estimates of the super-elasticity of demand in the neighborhood of this value. This number is also consistent with the estimates surveyed by Klenow and Willis (2016). Finally, we set the share of entrepreneurs to $\omega = 0.117$, the fraction of respondents in the 2013 SCF who own a private pass-through business.[9] Though this number is lower than the fraction of tax returns that claim business income, we follow Quadrini (2000), Cagetti and De Nardi (2006) and the large ensuing literature on entrepreneurship which targets this narrower measure.

We calibrate the remaining parameters to match salient features of income inequality in the 2013 SCF data, reported in Table 2. These parameters characterize the distribution of labor market efficiency and entrepreneurial ability, as well as the demand elasticity σ of a firm with relative size $q = 1$.[10] We follow Heathcote and Tsujiyama (2019) in assuming that

[9] See the Appendix for details.

[10] Recall that a firm's demand elasticity is $\sigma q^{-\frac{\varepsilon}{\sigma}}$.

Table 2: Moments Used in Calibration

	Data	Model
Income share of entrepreneurs	0.31	0.32
Gini income, all households	0.64	0.64
Gini income, workers	0.58	0.58
Gini income, entrepreneurs	0.68	0.68
Income share top 1%, all households	0.22	0.21
Income share top 1%, workers	0.13	0.14
Income share top 1%, entrepreneurs	0.24	0.23

the logarithm of idiosyncratic efficiency is drawn from an exponentially modified Gaussian distribution with parameters λ_i and σ_i for both workers ($i = e$) and entrepreneurs ($i = z$). Here σ_i represents the standard deviation of the Gaussian component and λ_i the rate coefficient of the exponential component. We choose these parameters to match the income share of entrepreneurs, the income Gini coefficients for all households, as well as for workers and entrepreneurs in isolation, and the income shares of the richest 1% of households in all sub-groups. As Table 2 shows, the model matches the targeted moments well.

Our choice of parameters implies that the aggregate markup is equal to 25%, a number similar to the cost-weighted average reported by Edmond et al. (2018) and to the estimate of Hall (2018b) for 2013. In addition, the implied losses from misallocation are equal to 0.73%.

3 Regulator's Problem

We consider the problem of a regulator who designs optimal product market interventions. Following the Mirrleesian approach to optimal taxation, we assume that the regulator does not observe the ability of individual entrepreneurs and thus faces incentive compatibility constraints. We characterize the optimal allocations chosen by the regulator under the assumption that the interventions are *revenue-neutral* so that the net amount of transfers to entrepreneurs is equal to zero. We derive a Diamond-Saez-type formula that describes the solution to the regulator's problem. Since, as typical in optimal taxation problems, the solution to the regulator's problem is not attainable in closed form, even more so in our setting where the wage W and the demand index D are determined in equilibrium, we resort to numerical methods to illustrate its properties.

Though we mostly focus on the incomplete-information benchmark, we briefly describe the allocations the regulator would choose in the absence of informational frictions. Our approach builds on Baron and Myerson (1982) who study the problem of regulating a single monopolist. We extend their analysis to a general equilibrium setting and study the problem of a utilitarian regulator who regulates all producers and is implicitly guided by equity, in addition to efficiency considerations.

3.1 Complete Information

We find it instructive to first analyze the problem of a regulator that has complete information about each entrepreneur's ability. The regulator chooses how to allocate production $y(z)$ and consumption $c(z)$ across entrepreneurs, recognizing that its prescription for how much it requires entrepreneurs to produce determines aggregate output Y and the equilibrium wage W. The regulator can only intervene in the product market, so it can only affect the welfare of workers by changing the equilibrium wage. Assuming a utilitarian objective and letting

$$V^w(W) = (1-\omega)\int_0^\infty v(e,W)\,\mathrm{d}H(e) \tag{14}$$

denote the overall welfare of workers and α the relative weight the regulator places on the utility of entrepreneurs, the problem of the regulator is

$$\max_{y(z),\,c(z),\,Y,\,W} V^w(W) + \alpha\omega\int_0^\infty \frac{c(z)^{1-\theta}}{1-\theta}\,\mathrm{d}F(z) \tag{15}$$

$$\text{subject to} \quad \omega\int_0^\infty \Upsilon\left(\frac{y(z)}{Y}\right)\mathrm{d}F(z) = 1, \tag{16}$$

$$\omega\int_0^\infty \left(\frac{y\left(z\right)}{z}\right)^{\frac{1}{\eta}}\mathrm{d}F(z) = L^w(W), \tag{17}$$

$$C^w(W) + \omega\int_0^\infty c(z)\,\mathrm{d}F(z) = Y. \tag{18}$$

The first two constraints are the aggregate production function and the labor resource constraint. The last constraint is the aggregate resource constraint which is implied by the requirement that interventions are revenue-neutral.

The solution to this problem implies that the regulator equates consumption across all entrepreneurs, so that $c(z) = c^e$, and chooses production to equate the marginal benefit from each variety to the marginal cost of producing it

$$\Upsilon'\left(q(z)\right)q(z) = \Lambda\left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}}, \tag{19}$$

where $\Lambda = \frac{1}{\eta}\frac{\nu Y^{\frac{1}{\eta}-1}}{D}$ depends on output, the demand index, as well as the marginal rate of substitution between labor and consumption ν, or equivalently, the ratio of the multipliers on the labor and goods resource constraints.[11] Equation (19) gives the relative output choices $q\left(z,\,\Lambda\right)$ as a function of the entrepreneur's productivity and Λ. The latter is the unique solution to the restriction implied by the Kimball aggregator

$$\omega\int_0^{\infty}\Upsilon\left(q\left(z,\,\Lambda\right)\right)\,\mathrm{d}F(z)=1. \tag{20}$$

Note that equations (19) and (20) are identical to (13) and (11), which implies that the regulator chooses the relative quantities that maximize allocative efficiency, that is, aggregate productivity.

Consider next how the regulator chooses the total amount of output that it requires entrepreneurs to produce. The regulator recognizes that its choice of Y determines aggregate labor demand and the equilibrium wage W. The optimality condition that determines W is

$$\frac{\partial V^w\left(W\right)}{\partial W}=\alpha\left(c^e\right)^{-\theta}\left[\frac{\partial C^w\left(W\right)}{\partial W}-\eta\frac{Y}{L}\frac{\partial L^w\left(W\right)}{\partial W}\right]. \tag{21}$$

The left-hand side is the marginal benefit of a higher wage given by the increase in the overall welfare of workers V^w. The right-hand side is the marginal cost due to a decline in the resources available for entrepreneurial consumption, evaluated at their marginal utility $\alpha\left(c^e\right)^{-\theta}$. All else equal, higher wages raise the consumption of workers and translate into a one-for-one decline in the consumption of entrepreneurs, an effect captured by the first term on the right-hand side. Higher wages also increase labor supply and therefore output, an effect captured by the second term.

In general, the wage is not equal to the marginal product of labor. To see why this is the case, we note that with logarithmic preferences, $\theta=1$, equation (21) implies that

$$\frac{C^w}{1-\omega}=\frac{c^e}{\alpha}, \tag{22}$$

so the per-capita consumption of workers is equal to $1/\alpha$ times the per-capita consumption of entrepreneurs. The labor share is therefore equal to

$$\frac{WL}{Y}=\frac{1-\omega}{1-\omega+\omega\alpha}.$$

The regulator can only implement this desired labor share by influencing the equilibrium wage. If the regulator places a high weight on workers, optimal regulation implies a greater

[11] See the Appendix for derivations.

Table 3: Product Market Concentration and Inequality

	Baseline	Complete information	Incomplete information $\alpha = 0.1$	Incomplete information $\alpha = 1$
Labor share	0.68	0.88	0.71	0.66
Sales share top 1% entrepreneurs	0.19	0.23	0.24	0.22
Sales share top 5% entrepreneurs	0.40	0.45	0.47	0.43
Sales share top 10% entrepreneurs	0.52	0.58	0.60	0.55
Income share top 1% entrepreneurs	0.24	0.01	0.36	0.26
Income share top 5% entrepreneurs	0.46	0.05	0.62	0.46
Income share top 10% entrepreneurs	0.58	0.10	0.74	0.57
Losses from misallocation, %	0.73	0	0.30	0.11

demand for labor, which raises the equilibrium wage above the marginal product. Conversely, the lower the welfare weight on workers, the lower is the demand for labor, which can reduce the equilibrium wage below the marginal product. Thus, in contrast to the representative agent framework of Edmond et al. (2018), in an economy with inequality a regulator would choose to introduce a wedge between the wage and the marginal product of labor even in the absence of information frictions.

Nevertheless, the regulator implements the efficient relative quantity allocation $q(z)$. This leads to greater product market concentration than under the status quo. However, since the regulator can impose type-specific transfers, more product market concentration does not translate into more income inequality between entrepreneurs.

We illustrate these results in the first two columns of Table 3 which contrast the degree of product market concentration and income inequality in the baseline economy and under the complete information allocations. For this example we set $\alpha = 1$, so the labor share is equal to the population share of workers, namely 0.88. Implementing the efficient allocations increases the sales share of the largest firms. For example, the sales share of the largest 5% of producers increases from 0.40 to 0.45. More product market concentration does not, however, translate into more income inequality among entrepreneurs, which with complete information can be perfectly eliminated.

3.2 Incomplete Information

We next assume that the regulator does not know an individual entrepreneur's ability. Its choice of consumption $c(z)$ and output $y(z)$ must therefore satisfy incentive compatibility constraints that ensure that an entrepreneur with ability z indeed chooses to produce the quantity $y(z)$ and receive the consumption $c(z)$ prescribed by the regulator.

Let $\tau(z)$ be a transfer received by an entrepreneur who claims to have ability z. The entrepreneur's consumption when it truthfully reveals its type is

$$c(z) = D\Upsilon'\left(\frac{y(z)}{Y}\right) y(z) - W\left(\frac{y(z)}{z}\right)^{\frac{1}{\eta}} + \tau(z), \tag{23}$$

where the first two terms are the revenue net of the labor costs. If this entrepreneur instead reports ability $\hat{z}$, it receives transfers $\tau(\hat{z})$ and consumption

$$c(\hat{z}, z) = D\Upsilon'\left(\frac{y(\hat{z})}{Y}\right) y(\hat{z}) - W\left(\frac{y(\hat{z})}{z}\right)^{\frac{1}{\eta}} + \tau(\hat{z}). \tag{24}$$

Without loss of generality we invoke the revelation principle and focus on a truth-telling mechanism. The regulator's problem is to maximize the objective in (15), subject to the production function (16), the labor resource constraint (17), the aggregate resource constraint (18), as well as the incentive compatibility constraints

$$c(z, z) \geq c(\hat{z}, z) \quad \text{for all } z, \hat{z}. \tag{25}$$

As earlier, the aggregate resource constraint follows from our requirement that the regulator's interventions are revenue-neutral, so that $\int_0^\infty \tau(z)\,\mathrm{d}F(z) = 0$.[12]

We pursue a first-order approach and replace the global constraints in (25) with the local constraints

$$\left.\frac{\partial c(\hat{z}, z)}{\partial \hat{z}}\right|_{\hat{z}=z} = 0. \tag{26}$$

We then verify numerically that the solution to this relaxed problem indeed satisfies the global constraints in equation (25) at the grid points used to discretize the productivity space. The local incentive constraints imply that the entrepreneur's consumption varies with productivity according to

$$c'(z) = \frac{1}{\eta} W\left(\frac{y(z)}{z}\right)^{\frac{1}{\eta}} \frac{1}{z}. \tag{27}$$

[12]Note that the individual rationality constraints do not bind here because entrepreneurs have no other source of income and have preferences that satisfy the Inada conditions.

As in the Mirrleesian optimal taxation literature, more productive entrepreneurs earn information rents and enjoy more consumption. These rents increase with the equilibrium wage W, and the amount of labor the regulator prescribes that the entrepreneur hires, $l(z) = (y(z)/z)^{\frac{1}{\eta}}$. Intuitively, the larger the wage payments, $Wl(z)$, the larger are the gains from misreporting productivity and saving on labor costs, and therefore the higher is the consumption the regulator must allocate to avoid deviations.

We show in the Appendix, using optimal control techniques, that the solution to the regulator's problem is characterized by the following condition that determines relative quantities across producers

$$\Upsilon'\left(q\left(z\right)\right)q\left(z\right) = \left(1 + \underbrace{\mu\left(z\right)\frac{\frac{1}{\eta}\frac{W}{z}\left(1-F\left(z\right)\right)}{\nu f\left(z\right)}}_{\xi(z)}\right)\frac{1}{\eta}\frac{\nu Y^{\frac{1}{\eta}-1}}{D}\left(\frac{q\left(z\right)}{z}\right)^{\frac{1}{\eta}}. \tag{28}$$

The optimal relative quantity choice is distorted relative to the efficient one in equation (13) by a wedge $\xi(z)$ that balances the regulator's tradeoff between equity and efficiency. The expression for the wedge shares many similarities to that in the Mirrleesian taxation literature.[13] The term

$$\mu\left(z\right) = 1 - \frac{1}{\lambda}\frac{1}{1-F\left(z\right)}\int_z^\infty \alpha c\left(x\right)^{-\theta} f\left(x\right)\,\mathrm{d}x$$

depends on the ratio of the average marginal utility of consumption of entrepreneurs with ability above z, namely $\frac{1}{1-F(z)}\int_z^\infty \alpha c\left(x\right)^{-\theta} f\left(x\right)\,\mathrm{d}x$, to the regulator's valuation of an additional unit of consumption, λ, and therefore captures the desire to redistribute from producers with ability greater than z to less productive entrepreneurs and workers. The term $\frac{1}{\eta}\frac{W}{z}\left(1-F\left(z\right)\right)$ represents the amount of consumption that the regulator can collect from all entrepreneurs with ability greater than z by distorting the production of entrepreneurs with ability equal to z. To understand why this is the case, note that the incentive compatibility constraint can be rewritten as $c'(z) = \frac{1}{\eta}\frac{W}{z}l(z)$ so by marginally reducing employment for entrepreneurs with productivity z, the regulator is able to reduce the consumption of all entrepreneurs with productivity above z by $\frac{1}{\eta}\frac{W}{z}$ times the mass of such entrepreneurs, $1 - F(z)$. The redistributive gains from distortions must be balanced against the output losses from reducing employment. Since the mass of producers with productivity z is equal to $f(z)$, these losses, evaluated at the marginal rate of substitution between employment and consumption, ν, amount to $\nu f(z)$.

[13] Diamond (1998), Saez (2001), Golosov et al. (2016), Heathcote and Tsujiyama (2019), Sachs et al. (2020).

The marginal rate of substitution between employment and consumption (the ratio of the multipliers on the labor and output resource constraints) is equal to

$$\nu = \eta \frac{Y}{L} - \frac{1}{L} \omega \int c'(z) \, \mu(z) \, (1 - F(z)) \, \mathrm{d}z.$$

The first term is equal to the marginal product of labor in the aggregate. The second term recognizes that increasing overall employment requires more unequal consumption allocations and subtracts the ensuing cost of inequality.

Finally, assuming $\theta = 1$, we can write the per-capita consumption of workers as[14]

$$\frac{C^w}{1-\omega} = \frac{1}{\alpha} \left(\int_0^\infty c(z)^{-1} f(z) \, \mathrm{d}z \right)^{-1} - \frac{\omega}{1-\omega} \int \mu(z) \, c'(z) \, (1 - F(z)) \, \mathrm{d}z. \tag{29}$$

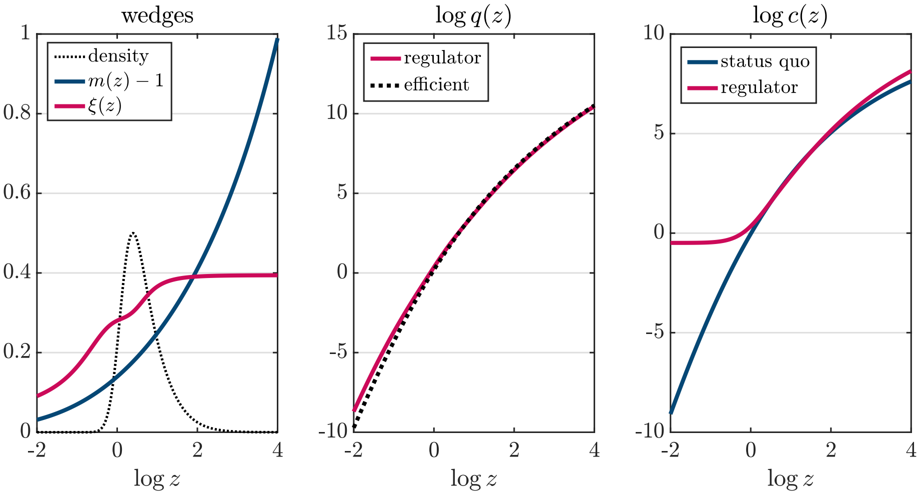
The first term on the right-hand side is the harmonic average of entrepreneurs' consumption, adjusted by the relative weight α. The second term represents the distributional costs of increasing the consumption of workers. The regulator can only do so indirectly by increasing the equilibrium wage which, recall, tightens the incentive compatibility constraint. Informational frictions therefore generate an additional tradeoff relative to that in the complete information case in equation (22). On one hand, increasing the consumption of workers requires higher equilibrium wages and therefore prescribes that entrepreneurs hire more labor. On the other hand, an increase in employment raises the informational rents received by productive entrepreneurs.

We next illustrate the allocations chosen by the regulator and contrast them with those under the status quo.[15] We first assume a preference weight $\alpha = 1$ on the welfare of entrepreneurs. The left panel of Figure 2 shows that the optimal wedge $\xi(z)$ is upward sloping, reflecting that equity considerations dominate efficiency concerns in our environment with a fat-tailed distribution of ability. Importantly, the optimal wedge is flatter than the markup wedge under the status quo. Since allocative efficiency requires that the wedge is constant across firms, the regulator's allocations feature less misallocation and therefore a higher level of aggregate productivity. This result is reflected in the quantity choices of the regulator, shown in the middle panel of the figure, which closely mimic the efficient allocations. Finally, notice in the right panel of the figure that the regulator increases the consumption of both

[14] See the Appendix for a more general characterization with $\theta \neq 1$.

[15] As pointed out by Heathcote and Tsujiyama (2019), the solution to Mirrleesian optimal tax problems can be highly sensitive to the number of nodes used in discretization. We therefore solve the system of differential equations that characterize the optimal allocations using 25,000 Gauss-Legendre nodes and weights to discretize the distribution of ability. Increasing the number of nodes to 100,000 makes no meaningful difference to the results.

Figure 2: Optimal Allocations Under Incomplete Information, $\alpha = 1$



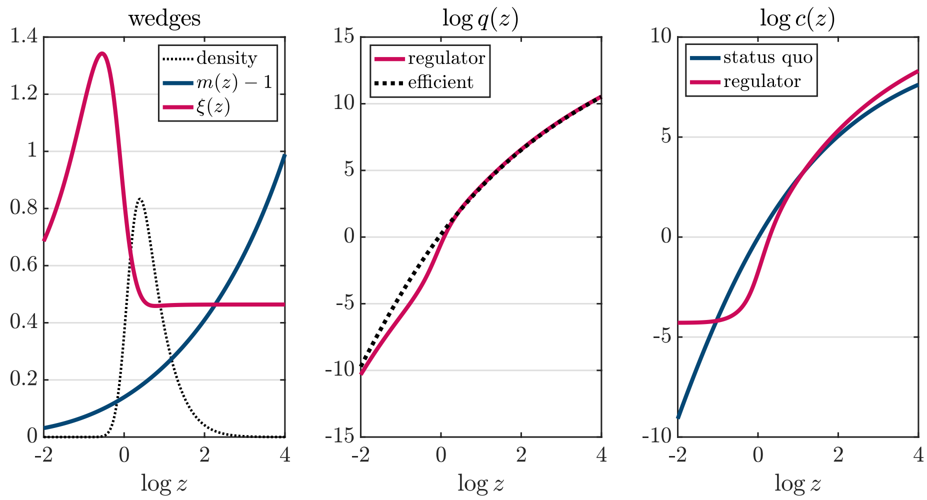
Notes: For visual clarity, we truncate the range of ability z. The wedge starts at zero at the low end of the distribution and eventually declines to zero, reflecting the well-known result of no distortions at the top. We report the sales-weighted density of z, $f(z)\Upsilon'(q(z))q(z)$ in the left panel of the figure.

the low- and high-ability entrepreneurs relative to the status quo. The former experience an increase in consumption that reflects the regulator's equity concerns. The latter extract the informational rents needed to implement a more efficient output allocation.

Figure 3 illustrates the optimal allocations when the weight on the welfare of entrepreneurs α is equal to 0.1. The optimal wedge schedule is now downward sloping in the high-density region of the ability space, reflecting the regulator's stronger desire to redistribute from entrepreneurs to workers by increasing the equilibrium wage. The regulator achieves redistribution by raising the distortion on all entrepreneurs. Efficiency requires, however, that the increase in distortions is relatively smaller at the top, resulting in a downward sloping wedge schedule. Despite differences in the shape of the wedge schedules for different values of α, the middle panel of the figure shows that the regulator's quantity allocations mimic the efficient allocations closely, especially for high productivity entrepreneurs who account for the bulk of output in the economy. The right panel of the figure shows that low- and high-ability entrepreneurs once again benefit from the optimal intervention, with those in the middle of the ability distribution experiencing a decline in consumption relative to the status quo.

Table 3 summarizes the implications of optimal regulation for income inequality and product market concentration. Optimal regulation implies a higher degree of product market concentration, as measured by the sales share of the largest producers. This concentration is comparable to that implied by the efficient allocations under complete information and much greater than under the status quo. Informational frictions prevent the regulator from

Figure 3: Optimal Allocations Under Incomplete Information, $\alpha = 0.1$



Notes: For visual clarity, we truncate the range of ability z. The wedge starts at zero at the low end of the distribution and eventually declines to zero, reflecting the well-known result of no distortions at the top. We report the sales-weighted density of z, $f(z)\Upsilon'(q(z))q(z)$ in the left panel of the figure.

increasing the labor share and require an increase in income inequality across entrepreneurs. Perhaps counter-intuitively, both product market concentration and income inequality are higher when the regulator places a higher weight on the welfare of workers. As explained above, that income inequality is higher is a consequence of the greater informational rents extracted by productive entrepreneurs in an environment with higher wages. Lastly, note that the losses from misallocation, though positive, are much smaller under the optimal allocations compared to the baseline.

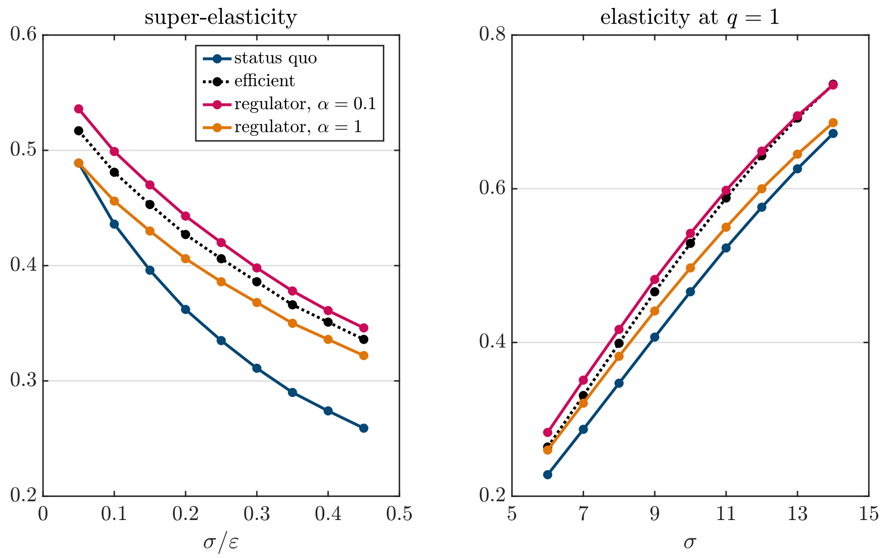
3.3 Robustness

We next argue that our result that optimal regulation features more product market concentration than under the status quo is robust to perturbations of the parameters governing the distribution of markups and idiosyncratic labor and entrepreneurial ability.

Figure 4 shows how product market concentration, measured by the sales share of the largest 5% of producers, changes as we vary the super-elasticity parameter σ/ε (left panel) and the parameter σ governing the elasticity of demand (right panel).[16] We make two observations. First, the optimal degree of product market concentration is greater than under the status quo throughout the parameter space. Second, optimal product market concentration is higher, the higher is the weight on the welfare of workers. A regulator with

[16]We kept the level of the aggregate markup unchanged in this experiment, by adjusting the value of σ when perturbing σ/ε.

Figure 4: Top 5% Sales Share: Demand Elasticity



$\alpha = 0.1$ increases product market concentration above the level that maximizes allocative efficiency, while the opposite is true when $\alpha = 1$.

Figure 5 repeats this exercise by varying the fraction of entrepreneurs (left panel), by scaling the variance of ability of both entrepreneurs and workers (middle panel), and by changing the relative importance of the Gaussian, as opposed to exponential component of the ability distribution (right panel). As earlier, optimal regulation implies more product market concentration, more so the higher the welfare weight on workers.

Economy Without Markups. For completeness, we briefly illustrate that optimal product market interventions increase product market concentration even in an economy without markups ($\Upsilon(q) = q$). In the absence of markups the status quo allocations satisfy allocative efficiency. Nevertheless, a utilitarian regulator may distort allocations to achieve redistribution, setting

$$y(z) = \left(1 + \mu(z)\, \frac{\frac{1}{\eta}\frac{W}{z}\,(1 - F(z))}{\nu f(z)}\right)^{\frac{\eta}{\eta-1}} \left(\frac{\nu}{\eta}\right)^{\frac{\eta}{\eta-1}} z^{\frac{1}{1-\eta}}.$$

Figure 6 shows the optimal wedges introduced by the regulator.[17] As in the economy with markups, wedges are downward-sloping when $\alpha = 0.1$. In contrast, they are nearly flat when $\alpha = 1$. Table 4 shows that when $\alpha = 0.1$ optimal regulation increases product market concentration relative to the status quo, thus generating misallocation. In contrast, when

[17] We re-calibrated the parameters of the ability distribution to reproduce the same moments as in the economy with markups.

Figure 5: Top 5% Sales Share: Ability Distribution

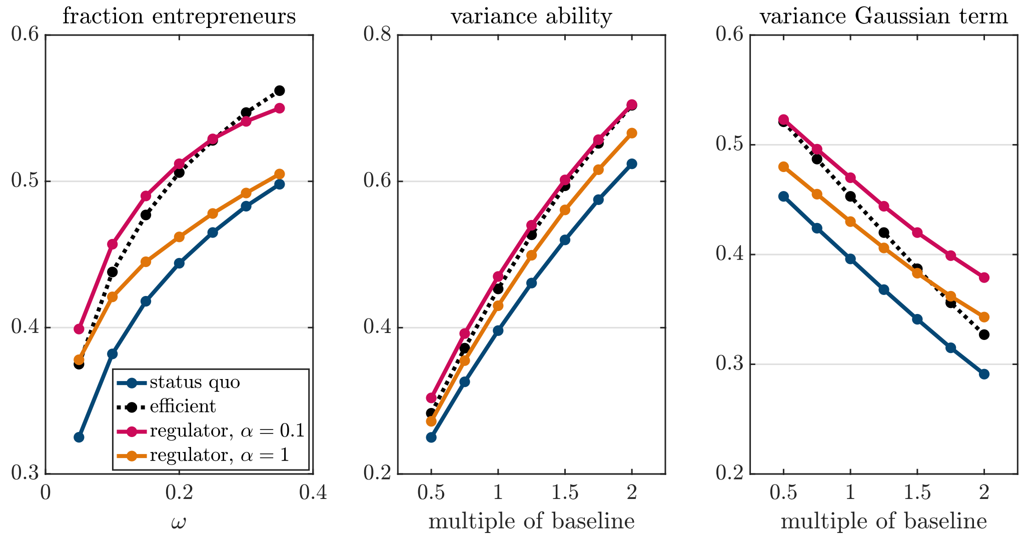
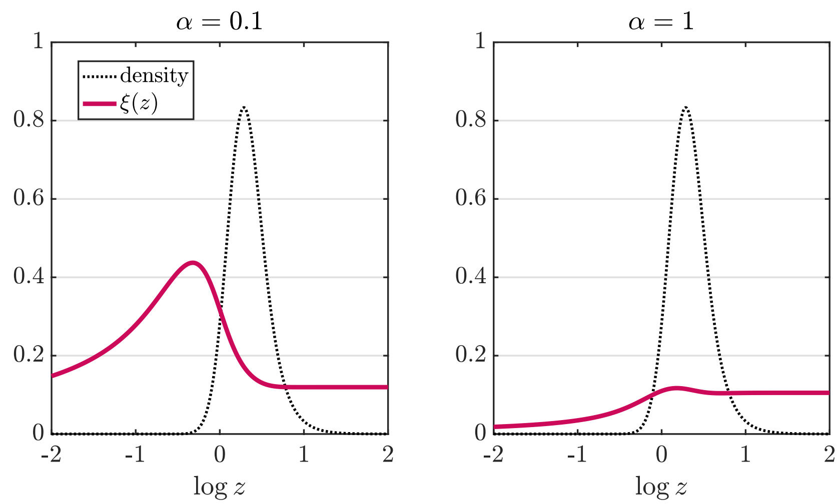


Figure 6: Wedges in Economy Without Markups



$\alpha = 1$ the degree of product market concentration is very close to that under the status quo.

3.4 Implementation and Intuition

We next show how the optimal product market interventions derived above can be decentralized using an output subsidy schedule. We then show that this schedule is well-approximated by a simple function characterized by three parameters that can be intuitively interpreted.

Unrestricted Subsidy. Instead of the regulator choosing a menu of consumption and output allocations that satisfy the incentive constraints, we can equivalently recast the regulator's problem as choosing a function that specifies the after-subsidy revenue $S(y)$ of an

Table 4: Optimal Product Market Interventions in Economy Without Markups

	Baseline	Incomplete information	
		$\alpha = 0.1$	$\alpha = 1$
Sales share top 1% entrepreneurs	0.23	0.28	0.24
Sales share top 5% entrepreneurs	0.44	0.52	0.45
Sales share top 10% entrepreneurs	0.57	0.66	0.58
Losses from misallocation, %	0	0.50	0.01

entrepreneur who produces y units of output.[18] We note that the assumption that entrepreneurial ability z is private information precludes the regulator from conditioning $S(\cdot)$ on profits.[19]

The entrepreneur maximizes profits

$$S(y) - W\left(\frac{y}{z}\right)^{\frac{1}{\eta}}.$$

Solving the entrepreneur's optimal output choice and comparing the resulting first-order condition with equation (28) reveals that the optimal subsidy function satisfies

$$S'(y) = \frac{p(y)}{1+\xi(z(y))}\frac{W}{\nu},$$

where $p(y)$ is the inverse demand function in (4) and $z(y)$ is the ability of an entrepreneur who at the optimal allocation produces y units of output. This differential equation, together with the constraint that $S(y)$ is revenue-neutral, so that

$$\int_0^\infty S(y(z))\,\mathrm{d}F(z) = \int_0^\infty p(y(z))y(z)\,\mathrm{d}F(z),$$

pins down the optimal subsidy function that decentralizes the regulator's allocations.

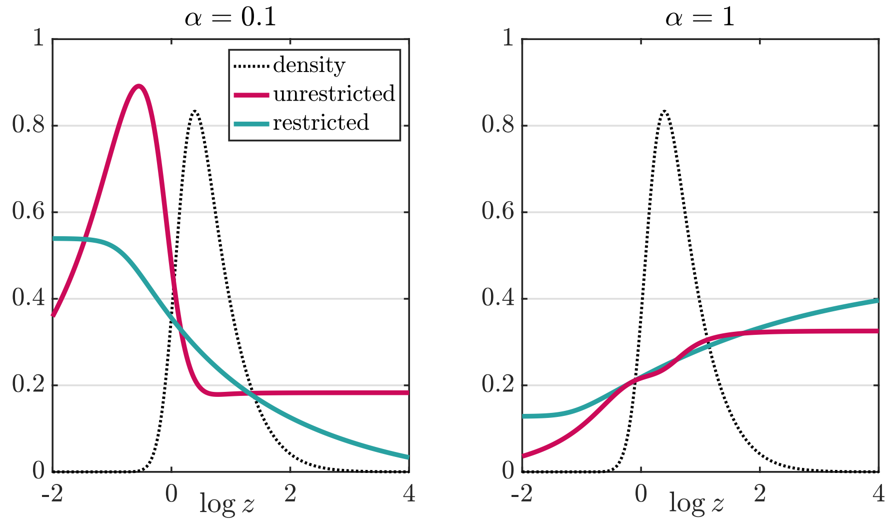
Restricted Subsidy. We next show that a much simpler parametric subsidy function can achieve most of the welfare gains attainable using the unrestricted one. Specifically, let

$$\hat{S}(y) = \tau_0 + \frac{\tau_1}{1+\tau_2}\Upsilon\left(\frac{y}{Y}\right)^{1+\tau_2}$$

[18] We study a quantity subsidy $S(y)$, as opposed to a sales subsidy $S(p(y)y)$, because optimal policy may prescribe that efficient entrepreneurs produce a relative quantity q that is sufficiently high to imply a demand elasticity $\sigma q^{-\varepsilon/\sigma}$ less than unity. Since in this region sales fall with the quantity produced, there does not exist a single-valued sales subsidy function that implements the regulator's optimal allocations.

[19] In the absence of informational frictions, the regulator can implement the efficient allocations in Section 3.1 by imposing a 100% profit tax which would finance the output subsidies needed to restore efficiency.

Figure 7: Wedge Between Price and Marginal Cost



be the after-subsidy revenue received by an entrepreneur who produces y units of output. Here τ_0 determines the lump-sum transfer, τ_1 determines the average level of marginal subsidies and τ_2 determines the slope of the marginal subsidy schedule.

The optimal quantity of a producer who faces this subsidy schedule satisfies

$$p\left(y(z)\right) y(z) = \frac{1}{\tau_1 \Upsilon\left(q(z)\right)^{\tau_2}} \frac{1}{\eta} W l(z),$$

so the wedge between the firm's price and its marginal cost is equal to $\frac{1}{\tau_1 \Upsilon(q(z))^{\tau_2}}$ and decreases with τ_1. Moreover, since $\Upsilon(\cdot)$ is an increasing function, the wedge declines (increases) with a producer's relative output whenever $\tau_2 > 0$ (< 0). We find this formulation intuitively appealing because by setting $\tau_2 = 0$ the regulator can recover the efficient allocations that entail no product market misallocation. More generally, τ_2 determines how a given amount of labor is allocated *across* producers and thus the overall degree of product market concentration. In turn, τ_1 determines the aggregate wedge between the wage and the marginal product of labor, and therefore the overall demand for labor. Finally, for any given choice of τ_1 and τ_2, τ_0 adjusts to ensure revenue neutrality.

Figure 7 contrasts the wedge between the producer's price and marginal cost implied by the unrestricted optimal policy chosen by the regulator and that implied by the optimally chosen restricted subsidy. As the right panel shows, when $\alpha = 1$ the wedge implied by the restricted subsidy closely aligns with that under the optimal policy in the high-density region of the ability distribution. In this case $\tau_2 = -0.018$, so the wedge increases with firm size, implying a lower degree of product market concentration compared to the efficient

Table 5: Comparison of Unrestricted and Restricted Optimal Subsidy

	$\alpha = 0.1$		$\alpha = 1$	
	unrestricted	restricted	unrestricted	restricted
Sales share top 1%	0.24	0.26	0.22	0.21
Sales share top 5%	0.47	0.50	0.43	0.43
Sales share top 10%	0.60	0.63	0.55	0.56
Labor share	0.71	0.71	0.66	0.66
Change in wage, %	5.16	4.24	-1.68	-1.65
Welfare gains, cev, %	3.32	2.88	0.96	0.96

allocations.

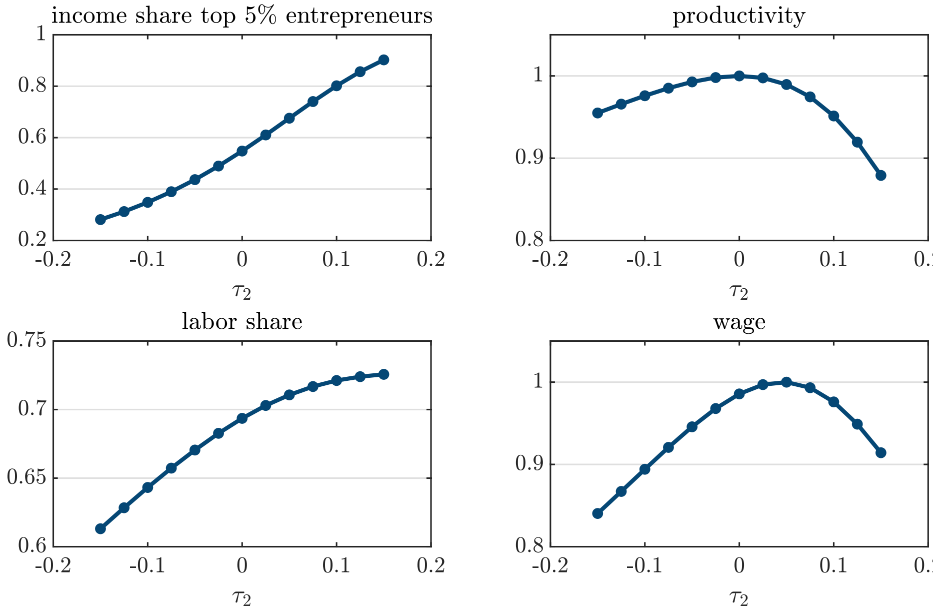
Although the restricted schedule does not reproduce the non-linear shape of the optimal policy when $\alpha = 0.1$, it shares the feature of the optimal policy that the wedge declines with ability in the high-density region of the distribution. In this case $\tau_2 = 0.033$, so the wedge decreases with firm size, implying a greater degree of product market concentration compared to the efficient allocations.

Table 5 compares the allocations under the restricted and unrestricted optimal policies. Notice that irrespective of the value of α, the restricted schedule generates similar levels of product market concentration as the unrestricted one. In addition, the labor share and the equilibrium wage change by similar amounts relative to the status quo. Most importantly, the restricted schedule achieves nearly the same welfare gains as the unrestricted one. For example, when $\alpha = 0.1$, the restricted schedule increases utilitarian welfare by 2.9% consumption-equivalent units, only slightly less than the 3.3% achieved by the unrestricted optimal policy.[20] When $\alpha = 1$ the restricted policy generates the same welfare gains as the unrestricted one, approximately 1%.

Intuition. We find this simple three-parameter subsidy schedule useful because it allows us to provide sharper intuition for the tradeoffs the regulator faces in determining the degree of product market concentration. To build intuition, consider the following comparative statics experiment in which, for clarity, we fix the lump-sum transfer at zero and trace out the implications of increasing τ_2 while reducing τ_1 to ensure revenue neutrality.

[20] We calculate the consumption-equivalent welfare gains using the approach of Benabou (2002). Specifically, we first calculate the constant amount of consumption $\bar{c}$ every household would have to receive so that society achieves the same level of utilitarian welfare as under the equilibrium allocations. We then define the welfare gains as the percent change in $\bar{c}$. See Boar and Midrigan (2020) for details.

Figure 8: Comparative Statics, τ_2



As the upper-left panel of Figure 8 shows, a higher τ_2, which implicitly subsidizes larger producers at the expense of smaller ones, has a cost: it leads to higher income inequality among entrepreneurs. In addition, a higher τ_2 changes aggregate productivity Z, as illustrated in the upper-right panel of the figure. Since $\tau_2 = 0$ recovers the efficient allocations, aggregate productivity is maximized at this point.

Consider next the relationship between τ_2 and the labor share, which is proportional to the employment-weighted average of the producer-level wedges between price and marginal cost:

$$\frac{WL}{Y} = \eta \underbrace{\left(\int_0^\infty \frac{1}{\tau_1 \Upsilon \left(q\left(z\right)\right)^{\tau_2}} \frac{l(z)}{L} \,\mathrm{d}F\left(z\right) \right)^{-1}}_{\Omega}.$$

As the lower-left panel of Figure 8 shows, a higher τ_2 leads to a higher labor share, even though τ_1 falls in response to ensure revenue-neutrality. Intuitively, a higher τ_2 rewards entrepreneurs who produce more, thus bidding up the demand for labor.

The result that subsidies that encourage producers to expand lead to an increase in the labor share is not driven by our assumption of monopolistic competition, Kimball demand, or heterogeneity in productivity. To see this, consider an economy with identical firms with technology $y = l^\eta$. Consider an intervention that changes the producer's after-subsidy revenue to $\frac{\tau_1}{1+\tau_2} y^{1+\tau_2}$. It is straightforward to see that if for a given τ_2 we choose τ_1 to ensure revenue neutrality, so that $\frac{\tau_1}{1+\tau_2} Y^{1+\tau_2} = Y$, the labor share is equal to $WL/Y = \eta(1+\tau_2)$. This size-dependent subsidy effectively increases the span-of-control to $\eta(1+\tau_2)$, reducing the income share of producers.

We finally discuss the consequences of a higher τ_2 for the equilibrium wage. The expression for the labor share implies that

$$W = \eta \frac{Y}{L} \Omega = \eta Z \Omega L^{\eta - 1}.$$

Since we assume logarithmic preferences, labor supply is policy invariant, so the wage is proportional to $Z\Omega$. As the lower-right panel of Figure 8 indicates, the wage is hump-shaped in τ_2. When τ_2 is low, the wage increases with τ_2, owing to the increase in both productivity and the demand for labor. However, if τ_2 is sufficiently high, the wage declines with τ_2 due to the decline in productivity.

To summarize, if product market concentration is too low relative to the efficient allocations, revenue-neutral interventions that encourage producers to expand have a cost – higher inequality among entrepreneurs, as well as a benefit – higher equilibrium wage. The larger the regulator's weight on the welfare of workers, the more the benefits outweigh the costs, and therefore the larger the degree of product market concentration chosen by the regulator.

4 Dynamic Model

We have purposely abstracted above from a number of features in order to highlight the key tradeoffs between equity and efficiency entailed by product market interventions. We next enrich the model by introducing three additional ingredients. First, we allow for capital and wealth accumulation to study the implications of product market interventions for wealth inequality. Second, we assume that entrepreneurs co-exist with corporate firms, so that the ownership of firms is more diversified compared to our static model. Third, we assume a government that provides some redistribution via taxes and transfers. We use this setting to study the optimal degree of product market interventions in the restricted class considered above and show that our main result that optimal regulation features a greater degree of product market concentration than under the status quo is robust in this richer setting.[21]

As earlier, the economy is inhabited by workers and entrepreneurs. Entrepreneurs have the option to work and earn labor income, in addition to profits from the business. Private

[21] In an earlier version of this paper, Boar and Midrigan (2019), we considered a number of additional extensions, such as allowing for financial constraints and an incorporation choice by entrepreneurs, oligopolistic competition, mergers, as well as heterogeneity across firms in idiosyncratic distortions. Since our main insights are robust to these extensions, we abstract from them here. We have also studied sales subsidies as opposed to quantity subsidies and drew similar conclusions.

business owners and corporate firms compete among themselves. As earlier, each firm supplies a differentiated variety of a good and charges a markup that increases with its market share. We abstract from aggregate uncertainty and study optimal unanticipated policy reforms, taking into account the transition dynamics between steady states.

4.1 Households

Households seek to maximize their life-time utility given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{c_t^{1-\theta}}{1-\theta} - \frac{h_t^{1+\gamma}}{1+\gamma} \right)$$

subject to the budget constraint

$$(1+\tau_s)c_t + a_{t+1} = i_t - T\left(i_t\right) + a_t,$$

where a_{t+1} are savings, τ_s is a consumption tax, and

$$i_t = r_{t-1}a_t + W_t e_t h_t + \pi_t\left(z_t\right),$$

is pre-tax income, derived from the return on asset holdings, work and profits from the business for the mass ω of entrepreneurs. Households save with perfectly competitive financial intermediaries at a risk-free rate r_t. Financial intermediaries use the resources obtained from households to purchase capital, shares in corporate firms and a risk-free government bond. The income tax schedule is

$$T\left(i_t\right) = i_t - (1-\tau)\frac{i_t^{1-\xi}}{1-\xi} - \iota_t, \tag{30}$$

where τ governs the level and ξ the slope of the marginal tax schedule, while ι_t is a lump-sum transfer. This specification has been shown to approximate well the U.S. tax and transfer system (Heathcote et al., 2017 and Boar and Midrigan, 2020). We assume that labor efficiency and entrepreneurial ability follow independent Markov processes with transition probabilities $H(e_{t+1}|e_t)$ and $F(z_{t+1}|z_t)$.

4.2 Final Good Firms

The final good Y_t is used for consumption, C_t, investment X_t and government spending G, so the aggregate resource constraint is

$$Y_t = C_t + X_t + G.$$

As earlier, the final good is assembled using the Kimball (1995) production function

$$\int_0^{\omega} \Upsilon\left(\frac{y_{it}}{Y_t}\right) \mathrm{d}i + \int_{\omega}^{\omega+N_t} \Upsilon\left(\frac{y_{it}}{Y_t}\right) \mathrm{d}i = 1,$$

where the second term adds the varieties produced by the mass N_t of corporate firms. The optimal input choices of the final good producers give rise to identical demand curves as in our static model. We implicitly assume that private businesses compete alongside corporate firms in the product market.[22]

4.3 Intermediate Goods Producers

Each variety $i \in [0, \omega + N_t]$ is produced by a single producer, either corporate or privately-owned. The technology with which a producer with ability z_t operates is

$$y_t = z_t \left(k_t^{\alpha} l_t^{1-\alpha}\right)^{\eta}.$$

The firm maximizes profits,

$$\pi_t = p_t(y_t)y_t - W_t l_t - R_t k_t,$$

and chooses a price equal to a markup over its marginal cost. The relative quantity of a producer satisfies

$$\Upsilon'\left(q_t\right) q_t = m\left(q_t\right) \frac{1}{\eta} \frac{\left(\frac{R_t}{\alpha}\right)^{\alpha} \left(\frac{W_t}{1-\alpha}\right)^{(1-\alpha)}}{D_t} Y_t^{\frac{1}{\eta}-1} \left(\frac{q_t}{z_t}\right)^{\frac{1}{\eta}},$$

where the marginal cost depends on a geometric weighted average of the rental cost of capital R_t and labor W_t and $m(q_t) = \sigma/(\sigma - q_t^{\varepsilon/\sigma})$ is the markup.

Corporate and privately-held firms produce with identical technology, so they only differ in their ownership structure and tax treatment. Unlike private firms, which are pass-through businesses, corporate firms are subject to a corporate profit tax. For ease of exposition only, we assume that the productivity of corporate firms is constant over time. This assumption is without loss of generality since the ownership of these firms is fully diversified and only the stationary distribution of their productivity matters for equilibrium outcomes.

Corporate firms exit with exogenous probability φ, so their mass evolves according to

$$N_{t+1} = (1-\varphi)(N_t + \vartheta_t),$$

[22] See Smith et al. (2018), who show that the two types of firms coexists across U.S. industries. An earlier draft of our paper showed that the impact of product market interventions is similar in economies without either corporations or entrepreneurs.

where the mass of entrants ϑ_t is pinned down by a free entry condition as in Hopenhayn (1992),

$$\mathcal{K}_t \geq \int_0^\infty Q_t(z)\,\mathrm{d}F^c(z).$$

The right-hand side of this expression is the expected return to creating a new variety, where

$$Q_t(z) = \frac{1-\varphi}{1+r_t}\left[Q_{t+1}(z) + (1-\tau_c)\pi_{t+1}(z)\right]$$

is the price of a claim to the after-tax profits of a firm with productivity z, and τ_c is the corporate profit tax rate. Upon entering, a corporate firm draws its productivity from a distribution $F^c(z)$, so the expected return to entry is equal to $\int_0^\infty Q_t(z)\,\mathrm{d}F^c(z)$. The left-hand side of the free-entry condition, $\mathcal{K}_t$, is the cost of creating a new variety, which we denominate in units of the final good.

We follow Gutierrez et al. (2019) in assuming that entry costs increase with the mass of entrants, so entry responds inelastically to changes in the environment. Specifically,

$$\mathcal{K}_t = \bar{\mathcal{K}}\vartheta_t^{\frac{1}{\phi}},$$

where $\bar{\mathcal{K}}$ determines the average level of entry costs, and ϕ determines the elasticity of entry rates to changes in the value of corporate firms. If ϕ is finite, a shock that changes the profitability of firms leads to an increase in the value of corporate firms and therefore the wealth of their owners, an effect absent in Hopenhayn (1992).

4.4 Government

The government issues a time-invariant stock of debt B. It finances interest on this debt and an exogenously given amount of government spending G using personal income, consumption and corporate profit taxes, so its budget constraint is

$$r_{t-1}B + G = T_t^i + T_t^s + T_t^c.$$

4.5 Financial Intermediaries

For notational convenience, we assume that households deposit their savings with financial intermediaries who use these resources to purchase capital, government bonds and shares in corporate firms. Since this is a closed economy, these must add up to the savings of the households.

Letting $Q_t = \int_0^\infty Q_t(z)\,\mathrm{d}F^c(z)$ denote the price of a claim to a diversified portfolio of corporate firms and $\Pi_t = (1-\tau_c)\int \pi_t(z)\,\mathrm{d}F^c(z)$ the dividends on such a claim, the budget constraint of the financial intermediary is

$$K_{t+1} + B_{t+1} - A_{t+1} + Q_t S_{t+1} = (R_t + 1 - \delta)\,K_t + (1 + r_{t-1})\,(B_t - A_t) + (Q_t + \Pi_t)\,(1-\varphi)\,S_t,$$

where S_t denotes the number of shares held. In equilibrium

$$S_{t+1} = N_t + \vartheta_t$$

and

$$N_t = (1-\varphi)\,S_t.$$

Here A_t is the total assets of the households, K_{t+1} is the capital stock and B_{t+1} is the government debt purchased by the intermediary in period t. Since financial intermediaries can choose K_{t+1} freely, the return on capital is equal to

$$R_{t+1} = r_t + \delta.$$

4.6 Equilibrium

For notational convenience, we let $z = 0$ denote the ability of a household that cannot operate a business, and summarize a household's state with the triplet (a, e, z) that encodes its wealth, labor market and entrepreneurial ability.

An equilibrium consists of: *(i)* aggregate prices W_t, R_t, r_t, Q_t, *(ii)* consumption, saving and labor supply decisions for households $c_t\,(a,e,z)$, $a_{t+1}\,(a,e,z)$, $h_t\,(a,e,z)$, *(iii)* employment, capital, output and price choices of producers $l_t\,(z)$, $k_t\,(z)$, $y_t\,(z)$, $p_t\,(z)$, *(iv)* measures of households over their idiosyncratic states $n_t\,(a,e,z)$, and *(v)* mass of corporate firms N_t and new entrants ϑ_t, such that

1. Given prices, the households' consumption, saving and labor supply decisions maximize their life-time utility and the production choices maximize firm profits.

2. Total output satisfies the Kimball aggregator
$$\int \Upsilon\left(\frac{y_t\,(z)}{Y_t}\right)\,\mathrm{d}n_t\,(a,e,z) + N_t \int \Upsilon\left(\frac{y_t\,(z)}{Y_t}\right)\,\mathrm{d}F^c\,(z) = 1.$$

3. Markets clear period by period. The labor market clearing condition is
$$\int l_t\,(z)\,\mathrm{d}n_t\,(a,e,z) + N_t \int l_t\,(z)\,\mathrm{d}F^c\,(z) = \int e h_t\,(a,e,z)\,\mathrm{d}n_t\,(a,e,z)\,.$$

The asset market clearing condition is

$$\int a_{t+1}\left(a,z,e\right)\mathrm{d}n_t\left(a,z,e\right) = K_{t+1} + Q_t S_{t+1} + B.$$

The capital market clearing condition is

$$\int k_t\left(z\right)\ \mathrm{d}n_t\left(a,e,z\right) + N_t \int k_t\left(z\right)\ \mathrm{d}F^c\left(z\right) = K_t.$$

The goods market clears by Walras' Law. We note that investment includes both investment in physical capital, as well as in creating new corporate firms, $X_t = K_{t+1} - (1-\delta)K_t + \mathcal{K}_t \vartheta_t$.

4. The budget constraints of the financial intermediary and of the government are satisfied period by period.

5. The law of motion for the measure $n_t\left(a,e,z\right)$ evolves according to an equilibrium mapping dictated by the households' optimal savings choice and the stochastic process for labor market efficiency and entrepreneurial ability.

6. The mass of corporations evolves according to

$$N_{t+1} = \left(1-\varphi\right)N_t + \vartheta_t,$$

and the mass of new entrants ϑ_t satisfies the free-entry condition.

4.7 Markup Distortions

The production choices of individual firms give an aggregate production function

$$Y_t = Z_t\left(K_t^{\alpha}L_t^{1-\alpha}\right)^{\eta},$$

where aggregate productivity is a harmonic weighted average of individual productivities

$$Z_t = \left(\int \left(\frac{q_t\left(z\right)}{z}\right)^{\frac{1}{\eta}} \mathrm{d}n_t\left(a,e,z\right) + N_t \int \left(\frac{q_t\left(z\right)}{z}\right)^{\frac{1}{\eta}} \mathrm{d}F^c(z)\right)^{-\eta}.$$

Markups once again distort the relative output choices $q_t(z)$ of individual producers and reduce aggregate productivity.

In addition, markups implicitly tax labor and capital, the demand for which is given by

$$W_t = \eta\left(1-\alpha\right)\frac{1}{\mathcal{M}_t}\frac{Y_t}{L_t} \qquad \text{and} \qquad R_t = \eta\alpha\frac{1}{\mathcal{M}_t}\frac{Y_t}{K_t},$$

where the aggregate markup depends on the markups $m_t(z)$ of individual producers

$$\mathcal{M}_t = \left(\int \frac{1}{m_t\left(z\right)}p_t(z)q_t\left(z\right)\ \mathrm{d}n_t\left(a,e,z\right) + N_t \int \frac{1}{m_t\left(z\right)}p_t(z)q_t\left(z\right)\ \mathrm{d}F^c\left(z\right)\right)^{-1}.$$

4.8 Parameterization

We next describe how we choose parameters for our quantitative analysis. We assume the economy is in a steady-state in 2013, so we target statistics for this year.

Assigned Parameters. We assume logarithmic preferences and a Frisch elasticity of labor supply of 0.5. We set the elasticity of capital in production α equal to 1/3 and the span of control parameter η equal to 0.85. We assume that a period is one year and set the depreciation rate of capital $\delta = 0.06$. As earlier, we assume that the fraction of entrepreneurs is equal to $\omega = 0.117$, the fraction of respondents in the 2013 SCF who own a private pass-through business. We set $\varepsilon/\sigma = 0.15$, consistent with the evidence in Edmond et al. (2018). We set $\phi = 0$, which implies that entry into the corporate sector is inelastic, so the number of new entrants is constant over time. This is a conservative assumption because it implies the largest response of stock prices to product market interventions and thus an upper bound on the distributional costs that determine the equity-efficiency tradeoff of such policies.[23] We set the exit rate $\varphi = 0.04$, to match that exiting firms account for approximately 4% of employment according to the Statistics of US Businesses.[24] We summarize these parameter choices in the left panel of Table 6.

As for the tax parameters, we use the estimates of the income tax function from Boar and Midrigan (2020), $\tau = 0.255$, $\xi = 0.049$ and $\iota = 0.164$. These are derived from the CBO data on pre- and post-tax income for various income groups. They imply that the median marginal tax rate is equal to 0.26, the marginal tax rate at the 95^{th} percentile is 0.34, and the lump-sum transfer is equal to 0.16 of per-capita GDP. We follow Bhandari and McGrattan (2018) and set the sales and corporate profit tax, $\tau_s = 0.065$ and $\tau_c = 0.36$, consistent with the United States tax code. The unanticipated product market interventions we consider give rise to one-time unexpected capital gains due to the change in the rental rate of capital and the value of corporate firms. We assume that these are taxed at a rate of $\tau_k = 0.20$, the capital gains tax in the United States in 2013. Finally, we set the stock of government debt B equal to 100% of GDP, as in the US data.

[23] See our earlier draft, Boar and Midrigan (2019), which considers the opposite scenario with perfectly elastic entry and no changes in stock prices, and obtains similar implications of product market interventions.

[24] Since we abstract from aggregate uncertainty and therefore equity premia, absent exit and therefore entry the model would greatly overstate the market value of corporate firms.

Table 6: Parameter Values in Dynamic Model

Assigned			Calibrated		
θ	1	CRRA	β	0.965	discount factor
γ	2	inverse Frisch	ρ_e	0.987	AR(1) e
α	1/3	capital elasticity	σ_e	0.148	std. dev. e shocks
η	0.85	span of control	ρ_z	0.973	AR(1) z
δ	0.06	capital depreciation rate	σ_z	0.139	std. dev. z shocks
ω	0.117	fraction of entrepreneurs	σ	12.21	demand elasticity at $q = 1$
ε/σ	0.15	super-elasticity of demand	μ_c	1.343	mean productivity corporations
ϕ	0	elasticity entry rate	$\bar{\mathcal{K}}$	0.068	fixed entry cost / GDP
φ	0.04	exit rate, corporations			

Calibrated Parameters. We choose the remaining parameters to match salient facts about the distribution of wealth and income in the United States and the relative size of the corporate sector. We assume that labor market and entrepreneurial ability follow independent AR(1) processes with persistence parameters ρ_e and ρ_z and Gaussian innovations with standard deviation σ_e and σ_z, respectively. We assume that the productivity of corporate firms is drawn from a normal distribution with mean μ_c and variance $\sigma_z^2/(1 - \rho_z^2)$, the unconditional variance of entrepreneurial productivity. The parameter μ_c thus determines how much more productive and larger are corporate firms on average.

In addition to these five parameters, we calibrate the discount factor β, the fixed cost of entry $\bar{\mathcal{K}}$, and the parameter σ governing the demand elasticity to minimize the distance between a number of moments in the model and in the data. We report the parameter values in the right panel of Table 6 and the moments we target in Table 7. We target the average wealth to income ratio, the share of wealth and income held by entrepreneurs, the wealth and income Gini coefficients for all households, as well as separately for entrepreneurs and workers. All these statistics were computed using the 2013 SCF.

We associate entrepreneurial firms in our model with privately-held pass-through businesses in the data, so the 11.7% fraction of entrepreneurs does not include owners of C-corporations. Similarly, we associate corporate firms in our model with C-corporations in the data, regardless of whether they are privately held or publicly listed. Though imperfect, this mapping allows us to capture two key distinctions between pass-through businesses and C-corporations in the data: their tax status (pass-through vs. double taxation) and the concentration of ownership.[25] We therefore choose the fixed cost of creating a new corporate

[25] See Dyrda and Pugsley (2018) for a detailed discussion.

firm $\bar{\mathcal{K}}$ and the mean productivity μ_c of corporate firms to match the 63% sales share of C-corporations and the 5% share of businesses that are C-corporations in the data, as reported by Dyrda and Pugsley (2018) for 2012, the latest year in their sample.

As Table 7 reports, the model matches the targeted moments well. As in the data, entrepreneurs are much wealthier and earn more income than workers. The model matches the Gini coefficients of both wealth and income. As is well-known, absent a fat-tailed distribution of ability shocks, the model cannot reproduce the very top wealth and income shares. For example, the top 1% of households hold 35% of all wealth in the data and 28% in the model. We show however that our results are robust to introducing a super-star state that allows the model to match inequality at the very top.

Table 7: Moments Used to Calibrate Dynamic Model

	Data	Model		Data	Model
Wealth to income ratio	6.57	6.58	Gini wealth, entrepr.	0.78	0.78
Wealth share of entrepr.	0.46	0.46	Gini income, entrepr.	0.68	0.68
Income share of entrepr.	0.31	0.31	Gini wealth, workers	0.83	0.82
Gini wealth, all hhs	0.85	0.85	Gini income, workers	0.59	0.59
Gini income, all hhs	0.64	0.64	Fraction of corporate firms	0.05	0.05
			Sales share corporate firms	0.63	0.63

The right panel of Table 6 reports the values of the calibrated parameters. The discount factor is $\beta = 0.965$. To match the large degree of inequality in the data the model requires very persistent processes for both entrepreneurial ($\rho_z = 0.973$) and labor market ability ($\rho_e = 0.987$). The standard deviations of the innovations are equal to $\sigma_z = 0.139$ and $\sigma_e = 0.148$. In the robustness section below we compare our model's implications for the volatility and persistence of labor and business income with those computed by DeBacker et al. (2020) using IRS data and report results from an alternative parameterization that reproduces their estimates.

Finally, the value of $\bar{\mathcal{K}}$ implies that entry costs amount to 6.6% of GDP. The elasticity parameter σ, identified by the income share of entrepreneurs, implies that the aggregate markup is equal to 1.22. Intuitively, the higher markups are, the larger the profits and therefore the income share of entrepreneurs in our economy.

4.9 Optimal Product Market Interventions

Recall that the restricted subsidy schedule considered in Section 3.4 captures the vast majority of the welfare gains achievable by the Mirrleesian regulator in a static setting. Motivated by this result, we consider a regulator who contemplates a once-and-for-all unanticipated product market intervention of this form. Specifically, the regulator levies size-dependent subsidies or taxes which change the producer's post-tax revenue to

$$\hat{S}_t(y) = \left(\tau_0 + \frac{\tau_1}{1+\tau_2}\Upsilon\left(\frac{y}{Y_t}\right)^{1+\tau_2}\right) Y_t.$$

The regulator takes into account that its intervention alters the paths for the equilibrium wages and interest rates as the economy transitions to the new steady state. Letting $\boldsymbol{\pi} = (\tau_0, \tau_1, \tau_2)$ denote the parameters describing the intervention, $c_{it}(\boldsymbol{\pi})$ and $h_{it}(\boldsymbol{\pi})$ denote the implied equilibrium paths for consumption and hours, determined as described in Section 4.6, and

$$V_0(\boldsymbol{\pi}) = \int \sum_{t=0}^{\infty} \beta^t u\left(c_{it}(\boldsymbol{\pi}),\, h_{it}(\boldsymbol{\pi})\right) \mathrm{d}i$$

denote the utilitarian objective, the problem of the regulator is to choose $\boldsymbol{\pi}$ to maximize $V_0(\boldsymbol{\pi})$, subject to the constraint that the intervention is revenue-neutral at all dates, so that subsidies on some firms are financed by taxes on other firms,

$$\int \left(\hat{S}_t(y_t(z)) - p_t(z)y_t(z)\right) \mathrm{d}n_t(a,e,z) + N_t \int \left(\hat{S}_t(y_t(z)) - p_t(z)y_t(z)\right) \mathrm{d}F^c(z) = 0.$$

We implicitly assume that the subsidy an individual firm receives does not depend on its incorporation status and that the regulator places the same welfare weight on entrepreneurs and workers. Because a particular policy intervention $\boldsymbol{\pi}$ changes equilibrium prices, it also changes the amount of revenue that the government collects in taxes. We assume that this additional revenue is rebated lump-sum to all households, so ι_t adjusts at each date to ensure that the government budget constraint is satisfied. We do not restrict τ_0 to be positive and thus allow the regulator to impose lump-sum taxes on producers. The regulator takes into account, however, the individual rationality constraints: it cannot force firms to operate if they receive negative profits. Thus, for every choice of $\boldsymbol{\pi}$ we solve for the fraction of firms that find it optimal to produce given a particular intervention, and calculate the equilibrium in the product and labor markets given the endogenously determined mass of producers. Scaling the post-tax revenue function by output Y_t is convenient because it ensures that aggregate productivity Z_t, the wedge Ω_t between factor prices and their marginal product,

Table 8: Optimal Product Market Intervention in Dynamic Model

	Status quo	Optimal
Change in output, %	–	1.03
Change in wage, %	–	3.17
Interest rate, %	3.95	4.07
Losses from misallocation, %	0.72	0.05
Sales share top 1% firms	0.52	0.61
Sales share top 5% firms	0.87	0.92
Sales share corporations	0.63	0.70
Wealth share entrepreneurs	0.46	0.38
Income share entrepreneurs	0.31	0.26
Gini Wealth	0.85	0.82
Gini Income	0.64	0.62
Change in welfare, cev, %	–	2.17
Fraction households better off	–	0.93
Change in welfare workers, cev, %	–	2.97
Change in welfare entrepreneurs, cev, %	–	-3.72

and the value of τ_0 needed to ensure revenue-neutrality jump immediately to a new constant level after the policy reform.

The regulator finds it optimal to set $\tau_1 = 0.795$ and $\tau_2 = 0.009$. The lump-sum transfer $\hat{S}(0)$ implied by revenue-neutrality amounts to 2.2% of per-capita GDP. Since the values of τ_1 and τ_2 are not directly interpretable, we note that they imply that the median marginal subsidy is equal to -23.7%, while the 99.9^{th} percentile is equal to 3.9%. The regulator subsidizes the largest 1% of producers by taxing the remaining firms. In doing so, the regulator reduces the wedge between factor prices and their marginal product in the aggregate from 1.22, the aggregate markup under the status quo, to 1.20. Moreover, since τ_2 is nearly zero, the regulator eliminates almost entirely the dispersion in the marginal product of labor and capital across producers.

Table 8 reports the effect of implementing the optimal product market intervention. With the exception of the welfare gains, which take into account transition dynamics, all other statistics reflect steady-state comparisons. As in the static model, optimal product market regulation increases the equilibrium wage, by 3.17%. The interest rate increases as well, from 3.95% to 4.07%, as does output, by 1.03%. Because the regulator eliminates most misallocation, aggregate productivity increases by 0.67%.

Consistent with the predictions of the static model, the regulator increases product market concentration. For example, the sales share of the largest 1% of producers increases from 52% to 61%. Since corporate firms are larger than privately-held firms, the subsidies on large producers increase the corporate sales share from 63% to 70%. Interestingly, optimal regulation reduces long-run inequality: the wealth and income Gini coefficients fall from 0.85 to 0.82 and from 0.64 to 0.62, respectively. This result reflects the loss of market share of the relatively smaller businesses owned by entrepreneurs, whose wealth and income shares fall from 0.46 to 0.38 and from 0.31 to 0.26, respectively.

Before discussing the welfare implications of optimal regulation, we first summarize, in Figure 9, the transition dynamics of the key macroeconomic aggregates. We note that output jumps by 1% in the immediate aftermath of the optimal policy reform, while consumption responds more gradually, owing to an increase in investment. The consumption of workers increases by a large amount, 5% on average in the long-run, while that of entrepreneurs falls by more than 10% eventually. Wages increase by approximately 2% on impact and continue increasing due to the additional capital accumulation that results from the reduction in product market distortions. The stock market value of corporate firms increases substantially, by approximately 7%, owing to the subsidies to larger producers. Interest rates overshoot their long-run level and gradually decline as households accumulate more wealth.

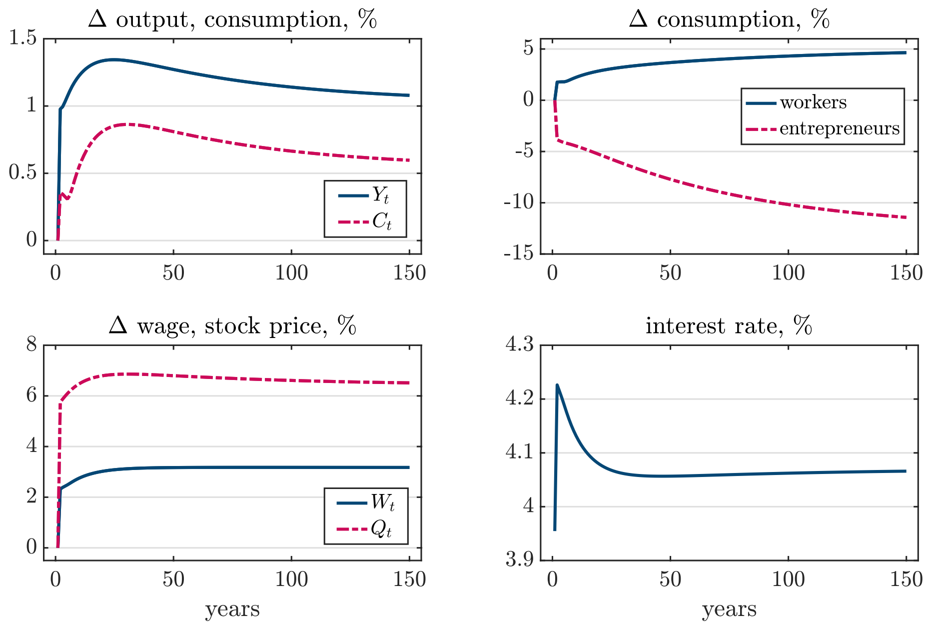
Consider finally the welfare implications of optimal regulation. Utilitarian welfare, expressed in consumption-equivalent units, increases by 2.2%. The majority of households, 93%, are better off. The gains from the reform disproportionately accrue to the workers, whose welfare increases by 3%. Entrepreneurs experience an average welfare loss of 3.7%.

These results once again reinforce our earlier conclusions that product market concentration is not necessarily costly, even in an environment with highly unequal firm ownership. What is costly is dispersion in the marginal product of factors of production across firms and a large wedge between factor prices and their marginal products. Optimal regulation reduces these wedges and in doing so actually increases product market concentration. Though the largest producers benefit from such interventions at the expense of medium-sized firms, the median household is better off due to higher wages.

4.10 Robustness

Our result that policies that encourage firms to expand are welfare-improving is robust to many perturbations of the model. In an earlier draft of this paper, Boar and Midrigan (2019),

Figure 9: Transition Dynamics After Optimal Intervention



we assumed that entrepreneurs are subject to financial constraints, that firm ownership is either perfectly diversified or fully concentrated and alternative ways of modelling entry, and reached similar conclusions. We show in the Appendix that our results are also robust to alternative parameterizations of the processes for entrepreneurial and labor market ability. In particular, we allow for a fat-tailed distribution of ability to better match top income and wealth inequality and consider an alternative parameterization that targets statistics reported by DeBacker et al. (2020) using IRS data on labor and business income.

5 Conclusions

We study optimal product market interventions in an economy that matches the degree of inequality in the United States and in which firms ownership is highly concentrated and markups increase with firm market share. We proceed in two steps. First, we use a mechanism design approach to characterize optimal regulation in a static setting. Second, we extend the analysis to a richer dynamic setting with capital and wealth accumulation that is more amenable to quantitative analysis. Throughout the analysis, we take the general equilibrium and distributional effects of interventions into account.

A robust result that emerges is that optimal regulation nearly restores allocative efficiency and leads to more product market concentration than under the status quo. In addition to increasing aggregate productivity, optimal regulation raises the labor share, bids up the equilibrium wage and thus benefits most households.

We conclude that product market concentration is not costly in and of itself, even in an environment in which firms are owned by a small fraction of households. What is costly is dispersion in the marginal product and wedges that depress the equilibrium wage and the return on capital. Optimal regulation reduces these wedges and in doing so actually increases product market concentration. Our results therefore caution against the widely-held view that reducing concentration and the market power of large firms would necessarily improve the welfare of the poor. Though policies that reduce concentration indeed reduce market power and markups, they have the unintended consequence of also reducing the labor share, aggregate productivity and the equilibrium wage.

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Online Appendix

Markups and Inequality

Not For Publication

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This appendix provides detailed derivations for our optimal regulation results in Section 3, describes the SCF data we used to parameterize the model, and reports the parameter values and moments for the two perturbations considered in the robustness section in the dynamic economy.

1 Optimal Regulation

We first analyze the case of complete information and then turn to the economy with private information.

1.1 Complete Information

The problem under complete information is described in equations (15)–(18) in the text. The Lagrangean is

$$\max_{q(z),c(z),W,Y} V^w(W) + \alpha\omega \int_0^\infty \frac{c\left(z\right)^{1-\theta}}{1-\theta} f\left(z\right) \mathrm{d}z + \lambda \left[Y - C^w\left(W\right) - \omega \int_0^\infty c\left(z\right) f\left(z\right) \mathrm{d}z\right]$$

$$+\kappa \left[\omega \int_0^\infty \Upsilon\left(q\left(z\right)\right) f\left(z\right) \mathrm{d}z - 1\right] + \nu \left[L\left(W\right) - Y^{\frac{1}{\eta}} \omega \int_0^\infty \left(\frac{q\left(z\right)}{z}\right)^{\frac{1}{\eta}} f\left(z\right) \mathrm{d}z\right]$$

The FOC with respect to $c\left(z\right)$ is

$$\alpha c\left(z\right)^{-\theta} = \lambda,$$

so all entrepreneurs receive the same level of consumption

$$c(z) = c^e.$$

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The FOC with respect to $q(z)$ is

$$\kappa\Upsilon'(q(z)) = \nu Y^{\frac{1}{\eta}} \frac{1}{\eta} \left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}-1} \frac{1}{z},$$

or arranging terms,

$$\Upsilon'(q(z))\, q(z) = \frac{1}{\eta} \Lambda \left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}},$$

where $\Lambda = \frac{\nu Y^{\frac{1}{\eta}}}{\kappa}$. To find Λ, we note that this expression implicitly determines the relative quantity choice as a function of productivity and Λ, $q(z;\Lambda)$. We can therefore find Λ by requiring that the Kimball aggregator is satisfied. That is, Λ is the implicit solution to

$$\omega \int_0^\infty \Upsilon(q(z;\Lambda))\, f(z)\, \mathrm{d}z = 1.$$

Once we have the relative quantity choice, we calculate Z from equation (7) in text and use the resource constraint to rewrite the regulator's problem as

$$\max_W V^w(W) + \alpha\omega \frac{\left[\frac{ZL(W)^\eta - C^w(W)}{\omega}\right]^{1-\theta}}{1-\theta}.$$

The FOC with respect to W is

$$\frac{\partial V^w(W)}{\partial W} = \alpha (c^e)^{-\theta} \left[\frac{\partial C^w(W)}{\partial W} - \eta Z L(W)^{\eta-1} \frac{\partial L^w(W)}{\partial W}\right].$$

When $\theta = 1$, as assumed in the paper, L^w is constant, so this expression simplifies to

$$(1-\omega)\frac{1}{W} = \alpha (c^e)^{-\theta} \frac{C^w(W)}{W},$$

which implies that

$$\frac{C^w(W)}{1-\omega} = \frac{c^e}{\alpha}.$$

1.2 Economy with Private Information

We now assume that the regulator does not observe productivity z. Without loss of generality, we invoke the revelation principle and constrain the regulator to choose functions $c(z)$ and $q(z)$ that ensure truth-telling.

Let $\tau(z)$ denote a subsidy received by a firm that claims to be of type z and sells $q(z)$ units of output as prescribed by the regulator. The producer's consumption, if it reports truth-fully, is

$$c\left(z\right)=DY\left[\Upsilon'\left(q\left(z\right)\right)q\left(z\right)-\frac{WY^{\frac{1}{\eta}-1}}{D}\left(\frac{q\left(z\right)}{z}\right)^{\frac{1}{\eta}}+\tau\left(z\right)\right].$$

If the producer claims instead to have productivity $\hat{z}$, it receives

$$c\left(\hat{z},z\right)=DY\left[\Upsilon'\left(q\left(\hat{z}\right)\right)q\left(\hat{z}\right)-\frac{WY^{\frac{1}{\eta}-1}}{D}\left(\frac{q\left(\hat{z}\right)}{z}\right)^{\frac{1}{\eta}}+\tau\left(\hat{z}\right)\right]$$

units of consumption. Following the first-order approach, the local incentive constraint is

$$\left.\frac{\partial\hat{c}\left(\hat{z},z\right)}{\partial\hat{z}}\right|_{\hat{z}=z}=0=DY\left[\left(\Upsilon''\left(q\left(z\right)\right)q\left(z\right)+\Upsilon'\left(q\left(z\right)\right)-\frac{1}{\eta}\frac{WY^{\frac{1}{\eta}-1}}{D}\left(\frac{q\left(z\right)}{z}\right)^{\frac{1}{\eta}}\frac{1}{q\left(z\right)}\right)q'\left(z\right)+\tau'\left(z\right)\right].$$

Differentiating the expression for $c(z)$ with respect to z and imposing the local incentive constraint gives

$$c'\left(z\right)=WY^{\frac{1}{\eta}}\frac{1}{\eta}\left(\frac{q\left(z\right)}{z}\right)^{\frac{1}{\eta}}\frac{1}{z}.$$

The Lagrangean is

$$\max_{c(z),q(z),W,Y}V^{w}\left(W\right)+\alpha\omega\int_{0}^{\infty}\frac{c\left(z\right)^{1-\theta}}{1-\theta}f\left(z\right)\mathrm{d}z+$$

$$\int_{0}^{\infty}\hat{\mu}\left(z\right)\left[c'\left(z\right)-\frac{1}{\eta}WY^{\frac{1}{\eta}}\left(\frac{q\left(z\right)}{z}\right)^{\frac{1}{\eta}}\frac{1}{z}\right]\mathrm{d}z+\lambda\left[Y-C^{w}\left(w\right)-\omega\int_{0}^{\infty}c\left(z\right)f\left(z\right)\mathrm{d}z\right]$$

$$+\kappa\left[\omega\int_{0}^{\infty}\Upsilon\left(q\left(z\right)\right)f\left(z\right)\mathrm{d}z-1\right]+\hat{\nu}\left[L^{w}\left(W\right)-\omega Y^{\frac{1}{\eta}}\int_{0}^{\infty}\left(\frac{q\left(z\right)}{z}\right)^{\frac{1}{\eta}}f\left(z\right)\mathrm{d}z\right],$$

where $\hat{\mu}\left(z\right)$ is the multiplier on the IC constraint and we now use $\hat{\nu}$ to denote the multiplier on the labor resource constraint.

Consider the term $\int_0^\infty\hat{\mu}\left(z\right)c'\left(z\right)\mathrm{d}z$. Integrating by parts and using the transversality conditions $\hat{\mu}\left(0\right)=\hat{\mu}\left(\infty\right)=0$ gives

$$\int_{0}^{\infty}\hat{\mu}\left(z\right)c'\left(z\right)\mathrm{d}z=-\int_{0}^{\infty}\hat{\mu}'\left(z\right)c\left(z\right)\mathrm{d}z,$$

which allows us to rewrite the Lagrangean as

$$\max_{c(z),q(z),W,Y} V^w(W) + \alpha\omega \int_0^\infty \frac{c(z)^{1-\theta}}{1-\theta} f(z)\,\mathrm{d}z - \int_0^\infty \hat{\mu}'(z)\,c(z)\,\mathrm{d}z$$

$$-\frac{1}{\eta} W Y^{\frac{1}{\eta}} \int_0^\infty \hat{\mu}(z) \left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}} \frac{1}{z}\mathrm{d}z + \lambda \left[Y - C^w(w) - \omega \int_0^\infty c(z) f(z)\,\mathrm{d}z\right]$$

$$+\kappa \left[\omega \int_0^\infty \Upsilon(q(z)) f(z)\,\mathrm{d}z - 1\right] + \hat{\nu} \left[L^w(W) - \omega Y^{\frac{1}{\eta}} \int_0^\infty \left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}} f(z)\,\mathrm{d}z\right].$$

The FOC with respect to $c(z)$ is

$$\alpha\omega c(z)^{-\theta} f(z) - \hat{\mu}'(z) - \lambda\omega f(z) = 0,$$

or

$$\hat{\mu}'(z) = \omega \left[\alpha c(z)^{-\theta} - \lambda\right] f(z).$$

The FOC with respect to $q(z)$ is

$$-\frac{1}{\eta} W Y^{\frac{1}{\eta}} \frac{1}{\eta} \hat{\mu}(z) \left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}} \frac{1}{z}\frac{1}{q(z)} + \kappa\omega\Upsilon'(q(z)) f(z) - \hat{\nu}\omega Y^{\frac{1}{\eta}} \frac{1}{\eta} \left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}} \frac{1}{q(z)} f(z) = 0.$$

The FOC with respect to Y is

$$-\frac{1}{\eta}\frac{1}{\eta} W Y^{\frac{1}{\eta}-1} \int_0^\infty \hat{\mu}(z) \left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}} \frac{1}{z}\mathrm{d}z + \lambda - \hat{\nu}\omega \frac{1}{\eta} Y^{\frac{1}{\eta}-1} \int_0^\infty \left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}} f(z)\,\mathrm{d}z = 0.$$

The FOC with respect to W is

$$\frac{\partial V^w(W)}{\partial W} - \lambda \frac{\partial C^w(W)}{\partial W} + \hat{\nu} \frac{\partial L^w(W)}{\partial W} - \frac{1}{\eta} Y^{\frac{1}{\eta}} \int_0^\infty \hat{\mu}(z) \left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}} \frac{1}{z}\mathrm{d}z = 0.$$

To derive equation (28) in the text, we note that, since $\hat{\mu}(\infty) = 0$,

$$\hat{\mu}(z) = -\int_z^\infty \hat{\mu}'(x)\,dx = \omega \int_z^\infty \left[\lambda - \alpha c(x)^{-\theta}\right] f(x)\,\mathrm{d}x.$$

Moreover, since $\hat{\mu}(0) = 0$ we have

$$\hat{\mu}(0) = \omega \int_0^\infty \left[\lambda - \alpha c(z)^{-\theta}\right] f(z)\,\mathrm{d}z = 0,$$

which implies that

$$\lambda = \alpha \int_0^\infty c(z)^{-\theta} f(z)\,\mathrm{d}z.$$

Consider next the Y FOC:

$$\hat{\nu}\omega\frac{1}{\eta}Y^{\frac{1}{\eta}-1}\int_0^\infty \left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}} f(z)\,\mathrm{d}z = \lambda - \frac{1}{\eta}\frac{1}{\eta}WY^{\frac{1}{\eta}-1}\int_0^\infty \hat{\mu}(z)\left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}}\frac{1}{z}\mathrm{d}z.$$

Since $Z^{-\frac{1}{\eta}} = \omega\int_0^\infty \left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}} f(z)\,\mathrm{d}z$ we can simplify this expression to

$$\hat{\nu}\frac{1}{\eta}Y^{\frac{1}{\eta}-1}Z^{-\frac{1}{\eta}} = \lambda - \frac{1}{\eta}\frac{1}{\eta}WY^{\frac{1}{\eta}-1}\int_0^\infty \hat{\mu}(z)\left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}}\frac{1}{z}\mathrm{d}z,$$

so the multiplier on the labor resource constraint is

$$\hat{\nu} = \eta Y^{1-\frac{1}{\eta}}Z^{\frac{1}{\eta}}\lambda - \frac{1}{\eta}WZ^{\frac{1}{\eta}}\int_0^\infty \hat{\mu}(z)\left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}}\frac{1}{z}\mathrm{d}z.$$

Since

$$\eta Y^{1-\frac{1}{\eta}}Z^{\frac{1}{\eta}} = \eta\frac{Y}{L},$$

the marginal rate of substitution between employment and consumption is equal to

$$\nu = \frac{\hat{\nu}}{\lambda} = \eta\frac{Y}{L} - \frac{1}{\lambda}\frac{1}{\eta}WZ^{\frac{1}{\eta}}\int_0^\infty \hat{\mu}(z)\left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}}\frac{1}{z}\mathrm{d}z.$$

Let

$$\mu(z) = \frac{\hat{\mu}(z)}{\lambda\omega(1-F(z))} = 1 - \frac{1}{\lambda}\frac{1}{1-F(z)}\int_z^\infty \alpha c(x)^{-\theta} f(x)\,\mathrm{d}x$$

and recall that $c'(z) = WY^{\frac{1}{\eta}}\frac{1}{\eta}\left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}}\frac{1}{z}$. We can therefore write

$$\nu = \eta\frac{Y}{L} - \left(\frac{Z}{Y}\right)^{\frac{1}{\eta}}\omega\int_0^\infty \frac{\hat{\mu}(z)}{\omega\lambda(1-F(z))}WY^{\frac{1}{\eta}}\frac{1}{\eta}\left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}}\frac{1}{z}(1-F(z))\,\mathrm{d}z$$

or

$$\nu = \eta\frac{Y}{L} - \frac{1}{L}\omega\int_0^\infty \mu(z)c'(z)(1-F(z))\,\mathrm{d}z.$$

We can finally rewrite the $q(z)$ FOC as

$$\kappa\Upsilon'(q(z))\,q(z) = \hat{\nu}\frac{1}{\eta}Y^{\frac{1}{\eta}}\left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}} + \frac{1}{\eta}WY^{\frac{1}{\eta}}\frac{\hat{\mu}(z)}{\omega f(z)}\frac{1}{\eta}\left(\frac{q(z)}{z}\right)^{\frac{1}{\eta}}\frac{1}{z},$$

which implies

$$\Upsilon'\left(q\left(z\right)\right)q\left(z\right)=\left(1+\mu\left(z\right)\frac{\frac{1}{\eta}\frac{W}{z}\left(1-F\left(z\right)\right)}{\nu f\left(z\right)}\right)\frac{\hat{\nu}}{\kappa}\frac{1}{\eta}Y^{\frac{1}{\eta}}\left(\frac{q\left(z\right)}{z}\right)^{\frac{1}{\eta}}.$$

To find κ, we multiply the $q\left(z\right)$ FOC by $q\left(z\right)$ and integrate across all producers:

$$-\frac{1}{\eta}WY^{\frac{1}{\eta}}\frac{1}{\eta}\int_0^\infty\hat{\mu}\left(z\right)\left(\frac{q\left(z\right)}{z}\right)^{\frac{1}{\eta}}\frac{1}{z}\mathrm{d}z+\kappa\omega\int_0^\infty\Upsilon'\left(q\left(z\right)\right)q\left(z\right)f\left(z\right)\mathrm{d}z-\hat{\nu}\omega Y^{\frac{1}{\eta}}\frac{1}{\eta}\int_0^\infty\left(\frac{q\left(z\right)}{z}\right)^{\frac{1}{\eta}}f\left(z\right)\mathrm{d}z=0.$$

Similarly, multiplying the Y FOC by Y gives

$$-\frac{1}{\eta}\frac{1}{\eta}WY^{\frac{1}{\eta}}\int_0^\infty\hat{\mu}\left(z\right)\left(\frac{q\left(z\right)}{z}\right)^{\frac{1}{\eta}}\frac{1}{z}\mathrm{d}z+\lambda Y-\hat{\nu}\omega\frac{1}{\eta}Y^{\frac{1}{\eta}}\int_0^\infty\left(\frac{q\left(z\right)}{z}\right)^{\frac{1}{\eta}}f\left(z\right)\mathrm{d}z=0.$$

Combining these two expressions and using the definition of the demand index,

$$D=\frac{1}{\omega\int_0^\infty\Upsilon'\left(q\left(z\right)\right)q\left(z\right)f\left(z\right)\mathrm{d}z},$$

implies

$$\kappa=\lambda YD,$$

which gives equation (28) for $q\left(z\right)$ in the text:

$$\Upsilon'\left(q\left(z\right)\right)q\left(z\right)=\left(1+\mu\left(z\right)\frac{\frac{1}{\eta}\frac{W}{z}\left(1-F\left(z\right)\right)}{\nu f\left(z\right)}\right)\frac{1}{\eta}\frac{\nu Y^{\frac{1}{\eta}-1}}{D}\left(\frac{q\left(z\right)}{z}\right)^{\frac{1}{\eta}}.$$

Having solved for $q\left(z\right)$, we use the ICC to find the consumption of each entrepreneur,

$$c\left(z\right)=c\left(0\right)+\frac{1}{\eta}WY^{\frac{1}{\eta}}\int_0^z\left(\frac{q\left(x\right)}{x}\right)^{\frac{1}{\eta}}\frac{1}{x}\mathrm{d}x,$$

where the lump-sum transfer $c\left(0\right)$ adjusts to ensure revenue neutrality

$$C^w\left(W\right)+\omega\int c\left(z\right)f\left(z\right)\mathrm{d}z=Y.$$

To find the optimal choice of W, we note that aggregating workers' optimal consumption and hours choices gives

$$C\left(W\right)=\left(1-\omega\right)\left(\int e^{\frac{1+\gamma}{\gamma+\theta}}\mathrm{d}H\left(e\right)\right)W^{\frac{1+\gamma}{\gamma+\theta}},$$

$$L(W) = (1-\omega)\left(\int_0^\infty e^{\frac{1+\gamma}{\gamma+\theta}} \mathrm{d}H(e)\right) W^{\frac{1-\theta}{\gamma+\theta}},$$

and the overall welfare of workers is

$$V^w(W) = (1-\omega)\frac{\gamma+\theta}{(1-\theta)(1+\gamma)} W^{\frac{(1-\theta)(1+\gamma)}{\gamma+\theta}} \int e^{\frac{(1-\theta)(1+\gamma)}{\gamma+\theta}} \mathrm{d}H(e).$$

The FOC for W can therefore be written

$$\frac{\partial V^w(W)}{\partial W} - \lambda \frac{\partial C^w(W)}{\partial W} + \hat{\nu}\frac{\partial L^w(W)}{\partial W} - \frac{1}{W}\omega\lambda \int_0^\infty \mu(z)\, c'(z)\,(1-F(z))\,\mathrm{d}z = 0.$$

When $\theta = 1$, we have

$$V^w(W) = (1-\omega)\left(\log W + \int_0^\infty \log e \,\mathrm{d}H(e) - \frac{1}{1+\gamma}\right),$$

$$C^w(W) = (1-\omega)\left(\int_0^\infty e \,\mathrm{d}H(e)\right) W,$$

and

$$L^w(W) = (1-\omega)\left(\int_0^\infty e\,\mathrm{d}H(e)\right),$$

so the FOC with respect to W reduces to

$$\frac{1-\omega}{W} - \lambda \frac{C^w(W)}{W} - \frac{1}{W}\omega\lambda \int_0^\infty \mu(z)\, c'(z)\,(1-F(z))\,\mathrm{d}z = 0,$$

or

$$\frac{C^w(W)}{1-\omega} = \frac{1}{\lambda} - \frac{\omega}{1-\omega}\int_0^\infty \mu(z)\, c'(z)\,(1-F(z))\,\mathrm{d}z.$$

Since

$$\lambda = \alpha \int_0^\infty c(z)^{-1} f(z)\,\mathrm{d}z,$$

this reduces to equation (29) in text.

2 Survey of Consumer Finances

The Survey of Consumer Finances (SCF) is a survey conducted by the National Opinion Research Center at the University of Chicago. This survey is well suited for characterizing the earnings, income, and wealth concentration at the top because it over-samples rich households. The unit of observation we use is the household. Each wave of the survey samples more than 6,000 households and is representative of the US economy.

Sample Selection. As is standard in the literature, we exclude households with negative income. In addition, we focus on a sample of households in which the household head is between 22 and 79 years old.

Wealth. Our measure of household wealth is the variable constructed by the Federal Reserve for its Bulletin article which accompanies each wave of the SCF. Wealth is defined as total net worth, which equals assets minus debt. Assets includes both financial and non-financial assets. Financial assets include checking and savings accounts, stocks held directly and indirectly, bonds, etc. Non-financial assets, among others, include the value of houses and other real state, the value of farm and private businesses owned by the household.[3] Debt include both housing debt (e.g. mortgages), debt from lines of credit or credit cards, installment loans, etc.

Income. Our measure of income includes all sources of income excluding government transfers (e.g. social security and unemployment benefits) and excluding other (non classified) sources of income. Thus, we include wage income, income from businesses, income from interests and dividends, from capital gains, rent income and income from pensions and annuities.

Definition of entrepreneurs. In contrast to Cagetti and De Nardi (2006), we consider a broader measure of entrepreneurship that includes all households in which the household head owns a business, excluding those who own C-corporations.[4]

3 Robustness Economies

We show that our results are also robust to alternative parameterizations of the processes for entrepreneurial and labor market ability. In particular, we allow for a fat-tailed distribution of ability to better match top income and wealth inequality and consider an alternative parameterization that targets statistics reported by DeBacker et al. (2020) using IRS data on labor and business income.

3.1 Super-Star Ability State

As is well known, matching top wealth and income inequality in an incomplete markets economy like ours requires departures from a Gaussian distribution of ability. Following

[3]The value of houses, real state and businesses is self-reported. E.g. with respect to housing the survey asks: "What is the current value of this (home and land/apartment/property)?". For businesses the survey asks: "What is the net worth of (your share of) this business?"

[4]The exact question in the survey is: (does the household head) "own privately-held businesses?" The SCF reports the legal status of up to two businesses own by the household. We identify households as owners of C-corporations if at least one of their businesses is reported to be a C-corporation.

Castaneda et al. (2003), we consider an extension with a super-star state that allows the model to match the top income and wealth shares.

An agent can be in either a normal or a super-star state. In the normal state labor market ability follows an AR(1) process as earlier. In the super-star state, labor market ability is relatively high, $\bar{e}$ times higher than the average. We assume that agents transit from the normal to the super-star state with probability p_e and remain in the super-star state with probability q_e. When agents return to the normal state, they draw a new ability level from the ergodic distribution associated with the AR(1) process. An analogous process for entrepreneurial ability is characterized by parameters ρ_z, σ_z, p_z, q_z and $\bar{z}$.

To calibrate the additional parameters describing the super-star state, we augment the original set of moments we target with statistics describing the wealth and income shares of the top 1% of households, as well as the top 1% of workers and entrepreneurs in isolation. Table 1 reports the calibrated parameter values in this economy. Table 2 shows that the model reproduces the targeted moments well. For example, the top 1% of households hold 35% of all wealth in the data, 37% in this calibration, and 28% in our baseline model without a super-star state.

The second column of Table 3 reports the effects of implementing the optimal product market regulation in this version of the model. The regulator now sets the lump-sum transfer to firms equal to zero, while the values of τ_1 and τ_2 are nearly the same as in the baseline parameterization. Once again, the regulator subsidizes larger firms and increases their market share by 0.09. Wages, output and productivity increase slightly more, as does overall welfare, which increases by 2.3% compared to 2.2% in the baseline model. Workers benefit more and experience a welfare gain of 3.7% compared to 3%. Entrepreneurs lose much more now and experience a welfare loss of 7.6% compared to 3.7% in the baseline model.

3.2 Matching Moments on Labor and Business Income from IRS

Our baseline parameterization targets moments describing wealth and income inequality in the 2013 SCF. We now consider an alternative that targets statistics describing the persistence and volatility of labor and business income computed by DeBacker et al. (2020) using a large panel of income tax returns for the 1987-2009 period. These researchers estimate error-component models to describe the processes for labor and business income. They do so by first applying an inverse hyperbolic sine transformation to business income and a logarithmic transformation to labor income. They then remove the component of income accounted for by observable characteristics and fit a process characterized by a fixed effect and an AR(1) component to the residuals. The first column of Table 5 reports the implied persistence, unconditional standard deviation and the standard deviation of changes of transformed income implied by their estimates.

We apply identical transformations to data on labor and business income from our model and find that while our baseline parameterization reproduces the persistence of business income, it generates a standard deviation that is twice as high. We also find that our baseline model predicts too much persistence in labor income (a serial correlation of 0.99 compared to 0.91 in the IRS data) and 75% larger unconditional dispersion. We conjecture that these discrepancies are accounted for by several factors. First, our baseline model abstracts from additional sources of dispersion in wealth, such as heterogeneity in rates of return, that would arise, for example, in the presence of financial frictions. Second, our baseline model targets inequality moments for 2013, while the DeBacker et al. (2020) estimates use data that go back as far as 1987 when inequality was much lower. Third, our baseline model targets broad measures of inequality, while DeBacker et al. (2020) remove the component accounted for by observable characteristics.

We argue, however, that our results are robust to the parameters describing the process for labor and entrepreneurial ability. To that end, we calibrate a version of our model to match the moments implied by the DeBacker et al. (2020) estimates. In addition to these moments, we target a broader measure of entrepreneurship which includes all households who file some source of business income, namely 25%, the number they report for 2009, the latest year in their sample. We also target that 10% of all income is business income, as DeBacker et al. (2020) report.

Table 4 shows the calibrated parameters in this economy. Notice that the persistence of both labor and entrepreneurial ability is substantially lower than in our baseline model. Table 5 shows that our alternative calibration reproduces all these targets well, but, as Table 6 shows, it fails to match the large degree of wealth and income inequality in the SCF data. We also note that this parameterization implies a much lower markup (1.14 compared to 1.22 in our baseline) and losses from misallocation (0.28% compared to 0.72% in our baseline), owing to the lower dispersion in productivity.

The third column of Table 3 reports the effects of implementing the optimal product market regulation in this version of the model. The regulator now imposes a lump-sum tax on producers which amounts to 1.25% of per-capita GDP, thus forcing the least productive 1% of firms to shut down. The regulator sets $\tau_1 = 0.87$ and $\tau_2 = 0.006$, once again subsidizing larger firms, even more than required to restore allocative efficiency, thereby increasing concentration. The model's implications for wages, output and productivity are similar to our baseline. Overall welfare increases by less now (0.8% compared to 2.2% in the baseline), but once again workers greatly benefit from optimal regulation. Their welfare increases by 2.6%, very similar to the 3% increase in the baseline model.

We therefore conclude that our results are robust to changes in the process for labor and entrepreneurial ability.

Table 1: Parameter Values in Economy with Super-Star State

β	0.967	discount factor
ρ_e	0.986	AR(1) e
σ_e	0.144	std. dev. e shocks
p_e	2.2e-6	prob. enter super-star e state
q_e	0.986	prob. stay super-star e state
$\bar{e}$	6.008	log ability super-star e state, rel. mean
ρ_z	0.972	AR(1) z
σ_z	0.141	std. dev. z shocks
p_z	2.9e-6	prob. enter super-star z state
q_z	0.980	prob. stay super-star z state
$\bar{z}$	2.930	log ability super-star z state, rel. mean
σ	12.30	demand elasticity at $q = 1$
μ_c	1.340	mean productivity corporations
$\bar{\mathcal{K}}$	0.068	fixed entry cost / GDP

Table 2: Moments Used to Calibrate Economy with Super-State State

	Data	Model		Data	Model
Wealth to income ratio	6.57	6.61	Wealth share top 1%	0.35	0.37
Wealth share of entrepr.	0.46	0.46	Income share top 1%	0.22	0.23
Income share of entrepr.	0.31	0.31	Wealth share top 1% entrepr.	0.24	0.23
Gini wealth, all hhs	0.85	0.86	Income share top 1% entrepr.	0.23	0.23
Gini income, all hhs	0.64	0.63	Wealth share top 1% workers	0.31	0.30
Gini wealth, entrepr.	0.78	0.78	Income share top 1% workers	0.16	0.16
Gini income, entrepr.	0.68	0.66	Fraction of corporate firms	0.05	0.05
Gini wealth, workers	0.83	0.84	Sales share corporate firms	0.63	0.63
Gini income, workers	0.59	0.57			

Table 3: Optimal Product Market Intervention, Robustness

	Baseline	Super-star state	IRS moments
$\hat{S}(0)$, rel. per-capita GDP, %	2.22	0.00	-1.25
τ_1	0.795	0.791	0.871
τ_2	0.009	0.010	0.006
Change in sales share top 1% firms	0.09	0.09	0.06
Change in steady-state wage, %	3.17	3.87	2.81
Change in steady-state output, %	1.03	1.48	1.36
Change in aggregate productivity, %	0.67	0.71	0.25
Change in welfare, cev, %	2.17	2.30	0.83
Change in welfare workers, cev, %	2.97	3.69	2.58
Change in welfare entrepreneurs, cev, %	-3.72	-7.56	-4.26

Table 4: Parameter Values in Economy Calibrated to IRS Data

β	0.971	discount factor
ρ_e	0.908	AR(1) e
σ_e	0.217	std. dev. e shocks
ρ_z	0.960	AR(1) z
σ_z	0.091	std. dev. z shocks
σ	14.20	demand elasticity at $q = 1$
μ_c	1.054	mean productivity corporations
$\bar{\mathcal{K}}$	0.059	fixed entry cost / GDP

Table 5: Calibration to IRS Data

	Data	Model
Fraction with business income	0.25	0.25
Share business income in all income	0.08	0.10
Business Income Process		
Standard deviation	2.11	2.12
Autocorrelation	0.96	0.96
Standard deviation of changes	0.60	0.60
Labor Income Process		
Standard deviation	0.71	0.69
Autocorrelation	0.91	0.90
Standard deviation of changes	0.30	0.30

Table 6: Untargeted Moments in Economy Calibrated to IRS Data

	Data	Model		Data	Model
Wealth to income ratio	6.57	6.63	Wealth share top 1%	0.35	0.08
Wealth share of entrepr.	0.46	0.35	Income share top 1%	0.22	0.05
Income share of entrepr.	0.31	0.35	Wealth share top 1% entrepr.	0.24	0.08
Gini wealth, all hhs	0.85	0.57	Income share top 1% entrepr.	0.23	0.05
Gini income, all hhs	0.64	0.36	Wealth share top 1% workers	0.31	0.05
Gini wealth, entrepr.	0.78	0.60	Income share top 1% workers	0.16	0.04
Gini income, entrepr.	0.68	0.36	Fraction of corporate firms	0.05	0.05
Gini wealth, workers	0.83	0.54	Sales share corporate firms	0.63	0.65
Gini income, workers	0.59	0.33			

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