Financial Development and Wage Inequality: Theory and Evidence

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8 October 2008

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October 2008

Abstract

We argue that financial market development contributed to the rise in the skill premium and residual wage inequality in the US since the 1980s. We present an endogenous growth model with imperfect credit markets and establish how improving the efficiency of these markets affects modes of production, innovation and wage dispersion between skilled and unskilled workers. The experience of US states following banking deregulation provides empirical support for our hypothesis. We find that wages of college educated workers increased by between 0.5 - 1.2 % following deregulation while those of workers with a high school diploma fell by about 2.2 %. Similarly, residual (or within-group) inequality increased. The 90-50 percentile ratio of residuals from a Mincerian wage regression and their standard deviation increased by 4.5% and 1.8%, respectively.

JEL Classification: E25, J31, G24
Key Words: Skill Premium, Residual Wage Inequality, Financial Deregulation

*We thank Daron Acemoglu, Roland Benabou, Jim Feyrer, Phil Levine, Ross Levine, and David Weil for helpful comments and suggestions. Participants at the Western Economic Association Meetings, 2006; MidWest Macro Meetings, 2007; North American Summer Meetings of the Econometric Society, 2007; the Society for Economic Dynamics (SED), 2007; the NBER Summer Institute (Income Distribution and Macroeconomics Group), 2007; the European Economic Association Meetings, 2007; and the Clemson Brownbag Group provided valuable comments and feedback at various stages of this research. All errors are our own.

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1 Introduction

In recent years the increase in wage inequality in the US has received a lot of attention from economists. Researchers have documented the rise since the 1980s in overall wage inequality, differentials between wages of college degree and high school diploma holders (between group inequality), as well as the increase in wage differentials measured within education and experience groups (residual or within group inequality).[1] The factors usually identified with the increase in wage inequality are trade, changes in labor market institutions, technological progress, and organizational change. In this paper we study the role of financial development as an independent source of the increase in wage inequality. We consider financial development as a combination of changes in regulatory policy and financial innovation that provided easier access to finance for firms (particularly start-ups). We develop a model that links financial development to wage outcomes and we test the predictions of the model using state-level data from the US during the recent period of financial deregulation.

The interaction between entrepreneurial finance, organizational change, and technological progress has become an increasingly important component of the innovation and technology adoption process in the US in recent decades. Following the 1979 amendment to the Employee Retirement Income Security Act (ERISA), which permitted pension funds to invest in risky asset vehicles such as venture capital, the amount of capital flowing into venture capital firms increased substantially (Gompers & Lerner, 2004, Chapter 1). Subsequently, venture capital financing was found to have a positive impact on innovation (Kortum & Lerner, 2000). Dynan et al. (2006) document the greater ease with which firms and households can access credit markets in the US during this period thanks to financial innovation and changes in government policy. Black and Strahan (2002) show that entrepreneurial activity (measured by the rate of new business incorporations) increased following banking deregulation across the US in the 1980s.

Associated with these developments was a change in organizational form in the US economy. Smaller firms employing workers of relatively similar skill levels rose in prominence, whereas the large scale corporations that mixed workers of differing skills declined. Kremer & Maskin (1996) document that the correlation between wages of US manufacturing workers in the same plant rose from 0.76 in 1975 to 0.80 in 1986 and argue that this "segregation by skill" contributed to the rise in wage inequality. The coincident timing of these developments suggests that financial development may have facilitated the change in organizational form (and thus the widening of the wage distribution) by promoting the emergence of smaller, innovative start-up firms.

We build on these insights and construct a model which demonstrates that financial development leads to organizational change (in the sense of a reallocation of workers by skill levels across firms), which leads to the widening of the wage distribution. Specifically, finan-

[1] Autor, Katz and Kearney (2008.

cial development drives up the skilled/unskilled wage differential (between group inequality) and can also increase within group inequality.

The second part of the paper confronts these predictions with evidence from the US. The results of our individual-level specifications as well as state-level panels confirm the theoretical predictions of the model. We find that the states which deregulated their banking sector earlier also experienced larger increases in the skill premium.[2] Furthermore, we find that deregulation of the banking sector is associated with an increase in overall as well as upper tail residual wage inequality.

The estimated effects of deregulation are also economically meaningful. We find that wages of college educated workers increased by between 0.5 - 1.2 % following deregulation, while those of workers with a high school diploma fell by about 2.2 %. Similarly, residual (or within-group) inequality increased. The 90-50 percentile ratio of residuals from a Mincerian wage regression and their standard deviation increased by 4.5% and 1.8%, respectively, following deregulation.

These results strongly suggest that financial development, so far not acknowledged as a contributing factor, may in fact have been quite important for the changes in the wage distribution over the last several decades. As Dynan et al. (2006) have documented, there have been other important developments in US financial markets besides state deregulation of banking. To the extent that the changes have affected wage outcomes in a similar way to banking deregulation, the overall role played by financial development in shaping the wage distribution is possibly even larger than what we find.

The paper is organized as follows. Section 2 summarizes the related literature and discusses the developments in the US economy over the last few decades that have motivated our analysis. The model is presented in Section 3. We describe the data used in our analysis in Section 4. The results are presented in Section 5. Section 6 concludes.

2 Explanations for rising wage inequality in the US

There exists an extensive literature documenting and attempting to explain the rise in wage inequality over the last 25 years in the US, the UK and several other countries. The sources identified with the increase in wage inequality in the US are trade, changes in labor market institutions such as the minimum wage and unionization, technological progress, and organizational change. A number of studies have questioned the importance of trade as an explanation for the rise in inequality in the US since the relative price of skill-intensive goods has not increased to the extent that would explain the rise in inequality (Acemoglu, 2002). Studies have also documented that the bulk of the increase in inequality has been in the

[2] Beck, Levine and Levkov (2007) show that even though deregulation increased the gap between skilled and unskilled wages, it reduced overall income inequality (calculated based on the distribution of annual income) through its effects on hours worked and labor force participation rates at different percentiles of the wage rate distribution, as well as across genders. In this paper, we focus specifically on the wage rate since we are interested in studying how changes in financial markets altered the returns to different components of human capital in the labor market (i.e. the wage gap between skilled and unskilled labor).

upper tail of the wage distribution, which would not be directly affected by changes in the minimum wage or by de-unionization (Autor, Katz and Kearney, 2008).

Our research complements previous studies on the impact of technological progress and organizational change on wage inequality, and attempts to add to this body of work by focusing more explicitly on the role of financial markets. Papers that study the role of technology in causing the increased dispersion in wages often rely on the idea of skill-biased technological change - SBTC (Acemoglu, 1998; Krusell et al. 2000). The idea is that technological progress over the recent decades has disproportionately improved the productivity of skilled workers. Aghion, Howitt and Violante (2002) argue that the introduction of computers, a general purpose technology, has raised the transferability of skills across different sectors of the economy. Better educated workers, who can adapt more easily, therefore command a higher premium since the demand for their labor has increased across the economy. There indeed appears to be substantial empirical evidence of skill-bias in the computing and telecommunications technologies that have been implemented in advanced industrial countries in recent times (Autor, Katz, and Krueger, 1998; Berman, Bound, and Machin, 1998; Machin and Van Reenen, 1998).

An explanation for the impact of technology on inequality that addresses both between and within group inequality is that of ability biased technical change (Galor and Moav, 2000). In their paper, Galor and Moav consider that workers differ not just by skill (defined as educational attainment), but also by innate cognitive ability. If high skilled workers have higher ability on average and if rapid technological progress raises the return to ability, then the relative wage of skilled workers (between group inequality) increases with the acceleration of technological change.[3] Since in their model labor is non-homogenous within skill groups, they go beyond providing an explanation for the rise of between group inequality. At times when the rate of technological progress accelerates, higher ability workers can adapt more rapidly to the transition and their wages increase relative to lower ability workers within the same educational attainment category (leading to higher within group inequality).

These explanations do not address the role of financial markets. One exception is Galor and Moav (2000), who examine the effect of improvements in financial markets on inequality in their model. However, their focus is on how reductions in capital market imperfections increase human capital investment and the relative supply of skilled workers by making costly education more widely accessible.[4] Our model incorporates imperfect capital markets and studies how improvements in their functioning (brought on, for example, by financial deregulation, new financial products that allow for great diversification of risk, improvements in

[3]Galor and Tsiddon (1997) study the relationship between technological progress, intergenerational mobility, and cyclical movements in inequality. They argue that major technological inventions raise the return to ability, promote intergenerational mobility, and increase earnings inequality between high skill and low skill workers. In periods of less major innovation (i.e. when the inventions are made more "user-friendly" and accessible across the ability distribution), differences in innate ability are less important for differences in earnings, inequality declines but also becomes more persistent across generations.

[4] An earlier contribution that emphasized the connections between capital market imperfections, human capital investment, and inequality is Galor and Zeira (1993).

monitoring technologies) affect organizational change, growth and inequality. The increased flow of entrepreneurial finance following financial development facilitates the emergence of entrepreneurial start-ups - small companies focused on innovation (either in terms of developing new technologies, or in terms of adapting technologies developed elsewhere, or in terms of providing business practice solutions such as accounting or legal advice to manufacturing firms). In turn, the innovations delivered by the start-ups lead to a shift in production methods as high skilled workers cluster together and separate from low skilled workers. As high skilled workers get reallocated across firms, the skill premium increases.

Previous researchers have also studied organizational change as a factor driving inequality (Kremer and Maskin, 1996; Acemoglu, 1999). These papers emphasize that the quality of jobs created by firms (i.e. their hiring decisions) are driven by the supply of skills in the labor market. As the mean skill level rises, firms that previously hired both high and low skill workers now start focusing only on one or other type in their hiring decisions, and the composition of jobs changes. Garicano and Rossi-Hansberg (2006) develop a theory of hierarchical organizations with sorting of workers by skill and use to it explain the evolution of wage inequality in the US in the 1980s. They argue that the common underlying force driving the decline in firm size and the rise in inequality in the US is a reduction in the "costs of acquiring and communicating information" (p. 1412) that have come about due to the widespread adoption of e-mail, cellphones, and wireless networks. While these papers explain how the changing composition of jobs and sorting of workers across firms can lead to higher inequality, they do not address a potentially important contributor to organizational change - financial development. Our model makes explicit the connections between financial development, changes in organization of production, and the widening of the wage distribution in the US in the last 30 years.

3 Model

We present an endogenous growth model with imperfect capital markets and establish how financial development, which increases the availability of funding for new innovative firms, (in a sense to be made more precise below) affects growth, organizational change and the dispersion in wages between skilled and unskilled workers. Less skilled workers are employed in manufacturing the final good. Skilled workers, on the other hand, either work in manufacturing or in an innovation / entrepreneurial sector.[5] Firms in the manufacturing sector produce final output using one of two production methods - one which combines skilled and unskilled workers (we refer to this as the "old economy") and the other which combines skilled workers with an expanding variety of intermediate goods (we call this the "new economy"). The intermediate goods are developed and produced by firms in the innovation

[5]Throughout the paper, when we discuss less skilled workers we have in mind people with education attainment at the level of high school diploma holders and those who have not completed high school.

sector.

We interpret organizational change as a shift in the composition of employment across firms away from those with a more balanced mix of skilled and unskilled workers and towards those with either a more high skill-intensive or a more low skill-intensive workforce. In the context of our model this bifurcation will arise as skilled workers reallocate away from the old economy firms towards the new economy firms. This will increase the share of skilled employment in these high skill-intensive firms.

Although the model emphasizes new varieties of "intermediate goods", the outcomes of the innovative activities cover, more generally, adapting new technologies and business ideas to the local environment, supply-chain support, legal and strategy consulting, and business practice innovations in accounting and processing of payments - all of which boost productivity in the new economy manufacturing firms. Technological progress takes place through the expansion in the number of intermediate goods, in the style of Romer (1990). When the variety of intermediate goods increases, the relative productivity of skilled workers in the new economy rises and they get reallocated away from firms in the old economy. As the number of skilled workers in the old economy firms decreases, the relative productivity of unskilled workers falls and the skill premium in wages increases. The key point is unskilled workers' productivity increases in the number of skilled workers employed in the old economy. As the skilled workers leave this sector, the unskilled wage falls.[6]

Our model also generates wage inequality within the group of skilled workers. We assume that skilled workers have innovative ideas for new intermediate goods. However they lack the funds to develop their ideas. Without outside financing, skilled workers cannot commercialize their projects. Due to credit market imperfections, not every skilled worker will be able to raise the necessary finance. Entry into the innovation sector is therefore restricted by the rationing of finance. This drives a wedge between the wages of skilled workers in manufacturing and the wages of skilled workers in the innovation sector.

The imperfections in credit markets arise because of asymmetric information between creditors / financiers and skilled workers with innovative ideas. Households, in particular, cannot monitor the activities of skilled workers in the innovation sector perfectly. Specialized financial intermediaries therefore borrow from households and finance innovation projects. Due to heterogeneity of projects as well as variation in the prior expertise of financial intermediaries, not every intermediary is appropriate for every project. The appropriate financial intermediary can mitigate the problems of asymmetric information and imperfect monitoring due to prior experience or expertise with projects of a similar nature. Financial intermediaries therefore engage in costly search as they look for an appropriate project to finance. We model this process using a reduced form matching function approach borrowed from the

[6] Kremer and Maskin (1996) argue that organizational change has contributed to widening inequality as higher skilled workers match with other high skilled workers in smaller, specialized firms. Previously, the prevalence (and dominance) of large-scale companies ensured that high skilled workers mixed with low skilled workers. Low skill workers benefitted in these large corporations, since their productivity (and wages) were boosted by working along side high skill workers.

labor literature.[7]

Within this set-up, financial development (i.e. a reduction in credit market imperfections) is associated with the availability of better screening and monitoring technology, improvements in risk diversification among financial intermediaries, and greater flow of funds to entrepreneurial firms. In the model, all of these changes translate into more a efficient matching process and ultimately a larger number of successful matches between financiers and skilled workers. We show below that financial development will affect the allocation of skilled workers across sectors, increase the skilled/unskilled wage differential (between group inequality), and can also widen the gap in wages between skilled manufacturing workers and skilled workers in the innovation sector (within group inequality).

3.1 The basic set-up

There is one final good produced by competitive firms with access to two types of production technologies - one which combines unskilled labor and skilled labor (the old economy) and the other which combines skilled labor with an expanding variety of intermediate goods (the new economy). This final good is used for consumption, entrepreneurial investment, and for manufacturing intermediate goods. Time is continuous and the economy is populated by infinitely lived agents of two types - skilled and unskilled. Unskilled workers can only be employed in manufacturing the final good, whereas skilled workers can also work in the innovation sector. There are constant measures of both types of workers, L and H respectively.

Households

Households maximize present discounted value of linear utility with a discount rate ρ. This pins down the interest rate.

3.2 Production, Innovation and Growth

Final Goods Producers

The final good is manufactured by perfectly competitive firms with access to two types of production technologies. In the new economy technology, firms employ skilled labor together with an expanding variety of intermediate goods x_j, $j \in [0, A]$ according to

$$Y_{Nt} = H_{Nt}^{1-\alpha} \int_0^{A_t} x_{jt}^{\alpha} \, dj, \quad 0 < \alpha < 1.$$

In the old economy technology, firms combine skilled and unskilled labor according to a CES production technology

$$Y_{Ot} = B_t \left[H_{Ot}^{\rho} + L^{\rho} \right]^{\frac{1}{\rho}}, \quad \rho < 1,$$

[7] Wasmer and Weil (2005) and Jerzmanowski and Nabar (2007) follow a similar approach.

where B_t is a technology parameter which captures spillovers from innovation in the new economy sector. We assume $B_t \leq A_t$ for all t.

Skilled labor is mobile between the old economy firms and the new economy firms. Skilled workers are allocated across sectors so that, in equilibrium, skilled wages are equalized across old and new economy firms.

Let $p_{j,t}$ represent the price of intermediate good j, w_{Lt} denote the wage of unskilled workers and w_{Ht} be the wage of skilled workers. Profit-maximization in the competitive final goods sector and wage equalization for skilled workers in manufacturing lead to the following conditions in factor markets:

$$p_{jt} = \alpha H_{Nt}^{1-\alpha} x_{jt}^{\alpha-1}, \tag{1}$$

$$w_{Lt} = B_t \left[H_{Ot}^{\rho} + L^{\rho}\right]^{\frac{1-\rho}{\rho}} L^{\rho-1}, \tag{2}$$

$$w_{Ht} = (1-\alpha) H_{Nt}^{-\alpha} \int_0^{A_t} x_{jt}^{\alpha}\, dj \quad \text{(skilled wage in the new economy firms)}, \tag{3}$$

$$= B_t \left[H_{Ot}^{\rho} + L^{\rho}\right]^{\frac{1-\rho}{\rho}} H_{Ot}^{\rho-1} \text{ (skilled wage in the old economy firms)}. \tag{4}$$

Intermediate Goods Producers

This component of the framework builds on the expanding variety endogenous growth model of Romer (1990). Each unit of intermediate goods costs one unit of final output to produce. Intermediate goods producers hold perpetual monopoly rights. At each point in time, they maximize the flow profit

$$\pi_{jt} = (p_{jt} - 1)x_{jt} = \alpha H_{Nt}^{1-\alpha} x_{jt}^{\alpha} - x_{jt}.$$

The optimal choice of x_{jt} is

$$x_{jt} = \alpha^{\frac{2}{1-\alpha}} H_{Nt}. \tag{5}$$

In equilibrium, the amount of intermediate good produced is identical across all sectors. It follows that all intermediate goods are priced at the same mark-up over marginal cost

$$p_{jt} = \frac{1}{\alpha},$$

and the flow profits

$$\pi_{jt} = \frac{(1-\alpha)}{\alpha} \alpha^{\frac{2}{1-\alpha}} H_{Nt}, \tag{6}$$

are also identical across all intermediate sectors in equilibrium.

Innovation and Growth

Skilled workers have ideas for new varieties of intermediate goods but they need to obtain finance to experiment and commercialize their projects. As described previously, the moral hazard problem that arises due to imperfect observability of innovation effort implies that this is not a frictionless process. The specialized financial intermediaries, venture capital firms, therefore incur costs in searching for the appropriate skilled worker to match with. If a successful match is formed, the skilled worker begins working on the project and, with flow probability η, produces a measure δA of ideas for new intermediate goods. The parameter δ measures the productivity of skilled workers in the innovation sector and A captures the "giants' shoulders" spillover from past research.

Let N_t be the number of skilled workers with finance (and therefore also the number of firms in the innovation sector). The aggregate growth in the number of varieties is given by

$$\dot{A}_t = \eta\delta \, A_t \, N_t = \eta\delta \, A_t(H - H_{Ot} - H_{Nt}), \tag{7}$$

where the second equality follows from the market clearing condition for skilled workers:

$$H = N_t + H_{Ot} + H_{Nt}.$$

As the number of intermediates A_t expands, the productivity parameter for the old economy evolves according to

$$\frac{\dot{B}_t}{B_t} = \lambda \left(\frac{A_t}{B_t}\right)^{\frac{1}{\gamma}}, \quad 0 < \gamma < 1. \tag{8}$$

The growth rate of B_t is a function of the gap between the two productivity indexes, A_t and B_t. As the gap gets larger, the bigger is the spillover effect and the growth rate of B_t increases exponentially. In the limit, with a very large gap, the spillover effect is infinite.[8] Figure (1) plots the growth rates of the two productivity parameters against their ratio. The growth rate of A_t is independent of the ratio $\frac{A_t}{B_t}$, whereas the growth rate of B_t increases exponentially with this ratio. Along the Balanced Growth Path (BGP), with a constant number of research firms N, we will have

$$\frac{\dot{B}_t}{B_t} = \frac{\dot{A}_t}{A_t} = \eta\delta \; N,$$

and the steady state ratio $\frac{A_t}{B_t}$ follows as

$$\frac{A_t}{B_t} = \left(\frac{\eta\delta \; N}{\lambda}\right)^{\gamma} = Z \text{ (a constant)}. \tag{9}$$

We assume that the economy is always in the range of N where $\lambda < \eta\delta \, N$ to ensure that $Z > 1$.[9]

[8] The formulation of the spillover effect is similar to the treatment of imitation costs in Barro and Sala-i-Martin's (1997) leader-follower model of cross-country technology diffusion. Also see Weil (2005, Chapter 8) for more discussion.

[9] This amounts to assuming λ is small relative to $\eta\delta$.

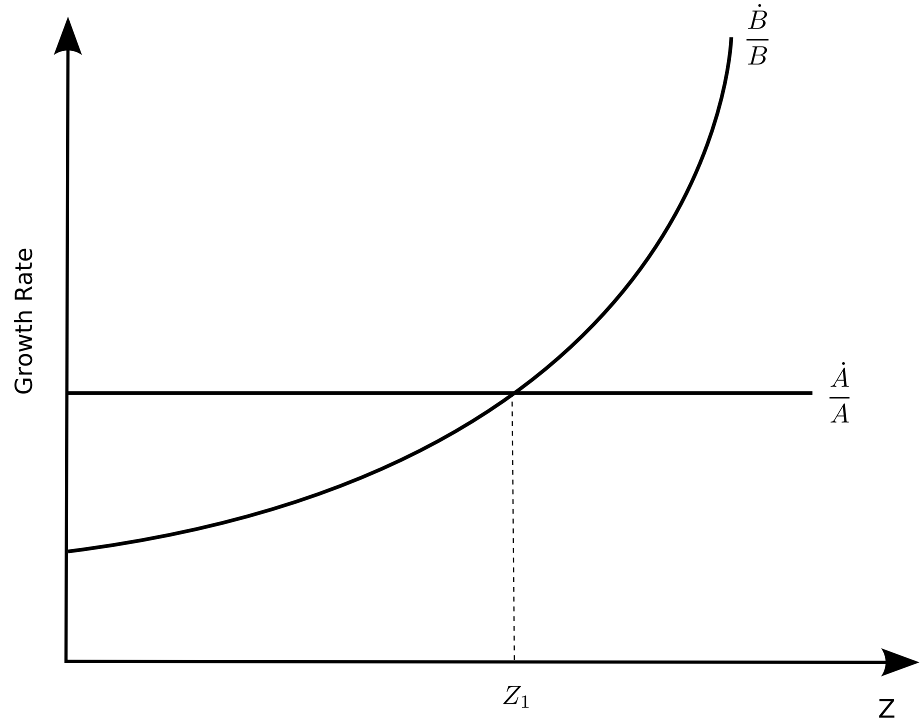

Figure 1: Determination of the steady state growth of productivity levels A and B and the productivity gap $Z \equiv A/B$.

3.3 The Capital Market

Ideas and Financing: the Matching Process

We assume that skilled workers can work in their current jobs in manufacturing while waiting to be matched with an appropriate financial intermediary. The number of new entrepreneurial firms that are formed in each instant as a result of the search and matching process is given by the following matching function

$$M_t = \zeta \, F_t^{\phi} (H - N_t)^{\,1-\phi}, \tag{10}$$

where F_t is the number of financial intermediaries seeking skilled workers, $H - N_t$ is the total number of skilled workers seeking financing (i.e. all skilled workers in manufacturing), and $\zeta \geq 0$ indexes the efficiency of the matching process. Note that with $\zeta = 0$, no matches are possible and no new entrepreneurial firms are formed. All skilled workers are employed in manufacturing and productivity growth stalls.

The matching function (10) summarizes in a reduced form all of the frictions involved in forming a successful match.[10] Since matching involves costly search, a successful match earns economic rents which are divided between the skilled worker and the financier in a manner

[10]See Petrongolo and Pissarides (2001) for a discussion on the microfoundations of matching functions, especially their usefulness in models of trades done under asymmetric information such as the situation we study here.

to be described below. In this set-up, we represent financial development as an increase in ζ, whereby a larger number of successful matches is formed for a given number of searching financial intermediaries and unmatched skilled workers. We study the implications of an increase in ζ for the allocation of skilled workers across sectors as well as wage outcomes for skilled and unskilled workers in the comparative statics below.[11]

Define $\theta = (H - N_t)/F_t$, i.e. the ratio of unmatched skilled workers to financial intermediaries. Then the probability of a financial intermediary being matched to a skilled worker is given by

$$\frac{M_t}{F_t} = \zeta \left(\frac{H - N_t}{F_t} \right)^{1-\phi} = \zeta\, \theta^{1-\phi} \equiv f(\theta), \tag{11}$$

and the probability of a skilled worker getting matched to a financial intermediary is

$$\frac{M_t}{H - N_t} = \frac{f(\theta)}{\theta}, \tag{12}$$

where $f' > 0$.

The number of entrepreneurial firms evolves according to

$$\dot{N}_t = M_t - \eta N_t, \tag{13}$$

where ηN is the measure of entrepreneurial firms that innovate and thus cease working on a project.

3.4 The Labor Market

Our focus is on labor market outcomes. In particular, we are interested in how the skill premium responds to changes in financial markets.

Skilled Wages

Substituting for x_{jt} from (5) into (3) we get

$$w_{Ht} = (1 - \alpha)\alpha^{\frac{2\alpha}{1-\alpha}} A_t. \tag{14}$$

In equilibrium, the wage of skilled labor is equalized across the old and new economy sectors and is proportional to the productivity level in the new manufacturing sector.

Wage Result 1: *The productivity-adjusted wage of skilled workers in manufacturing ($\tilde{w}_H = \frac{w_H}{A}$) is independent of N, the number of innovating firms.*

[11] Although for the purposes of our model we emphasize financial development, a change in ζ might equally be thought of as representing a change in labor market regulations or rules to incorporate a new entrepreneurial firm, both of which would affect the number of successful employer-worker matches for skilled workers. Ultimately, the question of whether changes in ζ represent financial development, alterations to labor laws, or reforms to business entry rules, is an empirical one, which we address in the data analysis below.

Combining the expressions from (4) and (14), in equilibrium:

$$(1-\alpha)\alpha^{\frac{2\alpha}{1-\alpha}} A_t = B_t \left[H_{Ot}^{\rho} + L^{\rho}\right]^{\frac{1-\rho}{\rho}} H_{Ot}^{\rho-1}. \tag{15}$$

As A_t grows, skilled labor is drawn out of the old economy by the higher wage. H_o declines and H_N increases. However, there is a limit to how long this reallocation will continue. The labor market equilibrium condition in (15) defines H_o as a decreasing function of the ratio $\frac{A_t}{B_t}$. In steady state, for a given number of entrepreneurial firms N, from equation (9) we see that the ratio $\frac{A_t}{B_t}$ assumes the constant value Z. It follows that the allocation of skilled workers to the old and new economy sectors (H_o, H_N) will be stable in steady state.

Compensation of skilled workers in the innovation sector

Consider now the determination of the wage in the innovation sector. As is standard in the search literature (see, for example, Pissarides, 1985), we assume that the wage ω that innovating firms pay to skilled workers is an outcome of a Nash bargaining process between the financial intermediary and the skilled worker. Suppose that $\beta \in (0,1)$ measures the bargaining power of workers and $1-\beta$ measures the bargaining power of financial intermediaries.

Let S_t be the value of a financial intermediary without a skilled worker (i.e. in searching state), let J_t be the value of a financial intermediary with a skilled worker, let U_t be the value for a skilled worker of being in the unmatched state, and finally let V_t be the value to the worker of being in a match. Let ω_t be the wage of innovative skilled workers. In addition, assume that if an innovation occurs the entire value (PDV of profits) goes to the financial intermediary.[12] Let κA_t be the search cost incurred by a venture capital firm, which increases with the amount of intermediates since the level of expertise required to find the appropriate match rises with the level of productivity. This leads to the following arbitrage equations:

$$\rho\, J_t = -\omega_t + \eta\left(\frac{\delta\, A_t\, \pi_t}{\rho} - J_t\right) + \dot{J}_t, \tag{16}$$

$$\rho\, S_t = -\kappa\, A_t + f(\theta)\,(J_t - S_t) + \dot{S}_t, \tag{17}$$

$$\rho\, V_t = \omega_t + \eta\,(U_t - V_t) + \dot{V}_t, \tag{18}$$

$$\rho\, U_t = w_{Ht} + f(\theta)/\theta\,(V_t - U_t) + \dot{U}_t. \tag{19}$$

All these equations are simple arbitrage conditions equating the flow return from holding an asset to the return from lending the asset's value at the interest rate ρ. For example, the flow return for an innovating firm is equal to the sum of the wage cost ($-\omega_t$), the expected

[12] This can be thought of as a risk-sharing arrangement, whereby the worker gets paid a wage during the experimentation stage even when there is no tangible output to show for the work, but once the innovation is made, its entire profit stream gets captured by the financial intermediary.

gain (the perpetual stream of monopoly profits from a measure δA_t of new blueprints), and the appreciation in the value of the asset ($\dot{J}$).

In order to obtain a closed form for the the wage we impose the balanced growth path assumption (we discuss off-BGP dynamics in Appendix C). We drop time subscripts to simplify notation. To find the wage, denote the total productivity-adjusted surplus[13] from a match by $\widetilde{D} = \widetilde{J} - \widetilde{S} + \widetilde{V} - \widetilde{U}$. The solution to the Nash bargaining process calls for the following division of the surplus:

$$\widetilde{V} - \widetilde{U} = \beta\, \widetilde{D}, \tag{20}$$

$$\widetilde{J} = (1-\beta)\, \widetilde{D}, \tag{21}$$

where, by free entry, we impose $\widetilde{S} = 0$.

Using the arbitrage equations and the solutions to the bargaining process, we get the following expression for the productivity-adjusted value of the wage $\widetilde{\omega}$ (see Appendix A for details of the derivation):

$$\widetilde{\omega} = \beta \left(\frac{\eta\, \delta\, \pi}{\rho} + \frac{\kappa}{\theta} \right) + (1-\beta)\widetilde{w}_{H}. \tag{22}$$

This expression indicates that the wage in the innovation sector is a weighted average of $\widetilde{w}_H$, the reservation wage of skilled workers (the wage they would earn in manufacturing), and $\left(\frac{\eta\,\delta\,\pi}{\rho} + \frac{\kappa}{\theta}\right)$ which is the sum of the expected PDV of profits in productivity adjusted terms and the average search cost per unmatched skilled worker.[14] Three factors contribute to the compensation earned by a skilled worker in the innovation sector: the forgone wage in manufacturing, the expected value of the successful innovations the skilled worker can potentially come up with, and the saving of subsequent search costs for the financial intermediary once a successful match occurs. The greater the bargaining power of workers (β close to 1), the closer they get to extracting the full productivity-adjusted expected value of the measure δA of successful innovations they come up with as well as for saving the firm the cost of subsequent search. On the other hand, if skilled workers have low bargaining power (i.e. β close to 0), then the wage $\widetilde{\omega}$ is close to the wage of skilled workers in the manufacturing sector $\widetilde{w}_H$ (in productivity-adjusted terms). In general, the costly search creates economic rents associated with a successful match and skilled workers in the entrepreneurial sector are able to bargain for a wage higher than their reservation wage

[13]The productivity-adjusted surplus is simply the value normalized by productivity. For example $\widetilde{J} = J/A$.

[14] The expected PDV of profits associated with a measure $\delta\, A$ of ideas for new intermediate goods is $\eta \delta A \pi / \rho$ (where η is the instantaneous flow probability of success). In productivity-adjusted terms, the expected PDV of profits is $\frac{\eta\,\delta\,\pi}{\rho}$. As for the average search cost, note that when the number of searching financial intermediaries is F, the total search cost incurred by them is κF. If the number of unmatched skilled workers is $H - N$, the search cost per unmatched skilled worker is $\frac{\kappa F}{H-N}$. In Section 3.3, the ratio of unmatched skilled workers to searching financial intermediaries $\left(\frac{H-N}{F}\right)$ was defined as θ. From this it follows that $\frac{F}{H-N} = \frac{1}{\theta}$ and that the search cost per unmatched skilled worker (i.e. the average search cost) is $\frac{\kappa}{\theta}$.

For more on the interpretation of the solution to the Nash bargaining problem, see Pissarides (2000, p.17).

$$\widetilde{w}_{H} < \widetilde{\omega} < \frac{\eta\,\delta\,\pi}{\rho},$$

i.e. there is wage inequality within the group of skilled workers.

How does the skilled wage in the innovation sector depend on N? First note that as shown in Appendix A, when search costs are zero there are no economic rents associated with a successful match. Workers in the innovation sector get paid the marginal product of their labor (the expected value of innovation):

$$\widetilde{\omega} = \frac{\eta\,\delta\,\pi}{\rho}.$$

Under this assumption, the wage will behave the same way as profit per product line π, which is an inverted U-shaped function of N. As N rises, so does the productivity gap Z between the two manufacturing sectors, and this draws skilled labor out of the old economy and into the new economy firms. The market size for innovation therefore increases, and so does the profit per product line. Eventually, however, N is high enough that any further increase in the number of innovating firms takes place at the expense of both old and new economy firms: there is a net outflow of skilled labor from new economy manufacturing firms, and this reduces the market size for innovation and profit per line.

In Appendix D we show that there exists a certain threshold number H^* of skilled workers in the old economy such that

$$d\pi/dN > 0 \text{ only if } H_0 > H^* \;.$$

It follows that if the allocation of skilled labor across old and new economy firms is such that $H_0 > H^*$, profit per line, and thus the wage of skilled workers in the innovation sector, increase in response to an increase in the number of entrepreneurial firms.[15] For the case of non-zero search costs, the skilled wage in the innovation sector will increase for an additional reason as financial markets improve – the rising average search cost – κ/θ.[16] However, this effect will be dominated by the profit effect as long as the search cost κ is low relative to profits from innovation.

Wage Result 2: *The productivity-adjusted wage of skilled workers in the innovating sector, $\tilde{\omega}$, is an inverted-U shaped function of N.*

Unskilled wages

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[15] An interesting implication is that continued improvements of financial markets (or acceleration of technological progress) may reduce profits.

[16] This cost rises because $H - N$, the pool of skilled workers with projects but without funding, shrinks as the number of matches increases. At the same time, the number of intermediaries (F) increases. Together, these changes reduce the ratio $\theta = (H - N)/F$ and therefore increase κ/θ.

The productivity-adjusted wage of unskilled workers is given by

$$\widetilde{w}_{Lt} = \frac{B_t}{A_t}\left[H_{Ot}^{\rho} + L^{\rho}\right]^{\frac{1-\rho}{\rho}} L^{\rho-1}, \tag{23}$$

which is increasing in H_o and decreasing in A/B. Both of these variables depend on N – more innovation and faster growth draws skilled labor out of the old manufacturing sector and increases the productivity gap between the old and new manufacturing sectors. In steady state, since both H_o and A/B are stable, the productivity-adjusted wage of unskilled workers will be constant. However, it still holds that comparing across two steady states, the productivity-adjusted wage of unskilled workers will be associated negatively with the steady state number of entrepreneurial firms. It follows that

Wage Result 3: *The productivity-adjusted wage of unskilled workers, $\tilde{w}_L$, is strictly decreasing in N.*

Note that the absolute level of the unskilled wage $B_t\left[H_{Ot}^{\rho} + L^{\rho}\right]^{\frac{1-\rho}{\rho}} L^{\rho-1}$ will fall as the number of skilled workers in the old economy declines, but will grow with productivity B as the old sector benefits from the spillover. It is therefore possible that the wage of unskilled workers initially falls, but in steady state (once H_o stabilizes) it will rise at the rate at which B increases. Thus the model does not rule out an absolute decline in real wages of unskilled workers followed by a rebound (which is consistent with the pattern in the US data for wages at the 20th percentile and below over the last 25 years – Yellen, 2006).

Skill premium

From (4) and (23), the skill premium in manufacturing is given by

$$\frac{\widetilde{w}_{Ht}}{\widetilde{w}_{Lt}} = \left(\frac{H_{ot}}{L}\right)^{\rho-1}, \tag{24}$$

which is diminishing in the ratio $\frac{H_{ot}}{L}$, and therefore increases as the ratio $\frac{H_{ot}}{L}$ falls. In the steady state, the skill premium in manufacturing is constant since H_o stabilizes.

In the comparative statics below we will show that as financial markets improve, the steady state ratio $\frac{H_o}{L}$ declines. The intuition for this result is that as financial markets improve, more entrepreneurial firms are formed and the growth rate of the new economy productivity parameter, A, increases with the more rapid expansion of varieties of intermediate goods. As the wage of skilled labor in the new economy rises (equation 14), skilled workers prefer to move to those firms. Additionally, some of the skilled workers from the old economy firms get matched with financiers and move into the innovation sector. Thus the number of skilled workers in the old economy firms declines on account of the combination of exit to the research sector and to the new economy firms.

The skill premium calculated as the ratio of the average wage of skilled workers to the wage of unskilled workers

$$\frac{\frac{N}{H}\widetilde{\omega}+\left(1-\frac{N}{H}\right)\widetilde{w}_H}{\widetilde{w}_L}=\frac{N}{H}\frac{\widetilde{\omega}}{\widetilde{w}_L}+\left(1-\frac{N}{H}\right)\frac{\widetilde{w}_H}{\widetilde{w}_L}$$

also increases when financial markets improve and more entrepreneurial firms are formed. Since we have that $\widetilde{w}_H<\widetilde{\omega}$, an increase in N – keeping wages constant – would lead to an increase in the average skill premium simply by the composition effect. In addition, however, we have that $\tilde{w}_L$ falls and – if N is not too high – $\widetilde{\omega}$ increases (wage result 2). Thus, as long as N is not too high, the average skill premium increases unambiguously when more entrepreneurial firms are formed. For higher values of N, $\widetilde{\omega}$ falls (wage result 2). If this fall is enough to offset the fall in $\widetilde{w}_L$, as is likely to be the case for very high values of N, the skill premium may fall.

Within-group inequality

Empirical studies of wage inequality in the US have argued that rising residual, or within-group, inequality is a major component of the increased dispersion in overall wage inequality (Autor, Katz and Kearney, 2008). These studies have also documented that the rise in residual inequality appears to be largely above the median of the residual wage distribution (i.e. in the upper tail of the distribution, among mainly college educated workers). In our model heterogeneity among skilled workers arises on account of the two different occupations that are open to them (working in manufacturing or in the innovation sector).

Our model generates predictions on conditions under which within-group inequality (the ratio of $\frac{\widetilde{\omega}}{\widetilde{w}_H}$) will increase when financial markets improve. Improvements in financial markets lead to a higher number of successful matches (i.e. N increases). Recall that the productivity-adjusted wage of skilled workers in manufacturing $\widetilde{w}_H$ is constant regardless of the number of entrepreneurial firms (wage result 1). If the productivity-adjusted wage of skilled workers in the innovation sector increases with N, within-group inequality (the ratio of $\frac{\widetilde{\omega}}{\widetilde{w}_H}$) will increase. Above we have established that when workers have some bargaining power, the wage in the innovation sector will be higher than the wage of skilled workers in manufacturing and will be an inverted U-shaped function of N. Thus, if the innovating sector is not too large (N is not too high), within-group inequality will increase with N. Eventually, as most skilled workers are employed in the innovating sector, within group inequality will decline.

Summary

The model predicts an increase in the skill premium in response to financial development since skilled workers are drawn out of the old economy firms as the number of intermediate goods expands more rapidly with the improved functioning of financial markets. Furthermore, as long as profits increase with N, the model predicts that the wages of skilled workers in the innovation sector also increase when their bargaining power is greater than zero.[17] This has two implications. First, within group inequality among skilled workers increases. Second, the skill premium calculated on the basis of the wages of all skilled workers also increases.

3.5 Balanced Growth Path

Along the balanced growth path, $\dot{N} = 0 \Rightarrow N = M/\eta$. Furthermore, the asset values grow at the same rate as productivity

$$\frac{\dot{J}}{J} = \frac{\dot{V}}{V} = \frac{\dot{U}}{U} = \frac{\dot{A}}{A} = \eta\delta N.$$

(henceforth we drop time subscripts since we are focusing on the BGP).

Our hypothesis is that improvements in financial markets (i.e. an increase in ζ) contribute to entry of more entrepreneurial firms, faster growth, and widening wage inequality. In order to demonstrate this, we first derive a two-equation system in (J, N) which will help us pin down the equilibrium value of N.

The first equation of the system is derived from the free entry condition on the financial intermediation sector. Free entry into financial intermediation implies $S = 0$ and, from (17), it follows that

$$J = \frac{\kappa A}{f(\theta)},$$

where κA is the instantaneous search cost incurred by a financial firm and $f(\theta)$ is the flow probability that the firm will be matched with a skilled worker. Dividing by A to convert the above value function into a productivity-adjusted value and substituting for $f(\theta)$ from equation (11) we get

$$\widetilde{J} = \frac{\kappa}{\zeta\,\theta^{1-\phi}} \tag{25}$$

where $\theta = (H - N)/F$ is the ratio of unmatched skilled workers to financial intermediaries.

Recall from equation (12) that the probability of a skilled worker matching with a financial intermediary is $\frac{M}{H-N} = \frac{f(\theta)}{\theta} = \frac{\zeta\,\theta^{1-\phi}}{\theta}$. Along the balanced growth path $\dot{N} = 0$, and therefore $M = \eta N$. Let $\vartheta(N)$ denote the probability of a skilled worker matching with a financial intermediary along the balanced growth path. This probability is given by:

$$\vartheta(N) \equiv \frac{\eta\,N}{H - N} = \zeta\theta^{-\phi}, \tag{26}$$

---

[17] As described above, as long as there are enough skilled workers in the old economy sector ($H_0 > H^*$), profits per line π, and thus the wage of skilled workers in the innovation sector, will increase in response to improvements in financial markets. Since the share of corporate profits in GDP has been increasing in the US economy over the last several years (based on data from the FRED database of the Federal Reserve Bank of St. Louis we calculate that the corporate profit share of GDP has climbed from its historic average of roughly 6% in the late 1970s to close to 10% in recent years), in terms of our model, this suggests that the US economy has been operating to the right of the threshold H^*. We note, however, that this is not conclusive since total profits $\eta\delta\pi$ may go up even if profit per line π falls if, for example, the productivity of innovation activities, δ, increases.

where $\vartheta'(N) > 0$. From this expression we see that the ratio of unmatched skilled workers to financial intermediaries along the balanced growth path follows as $\theta = \vartheta(N)^{-1/\phi}\,\zeta^{1/\phi}$, and therefore the probability that a financial firm will be matched with a skilled worker along the balanced growth path is:

$$f(\theta) = \zeta\,\theta^{1-\phi} = \zeta\left(\vartheta(N)^{-1/\phi}\,\zeta^{1/\phi}\right)^{1-\phi} = \zeta^{1/\phi}\vartheta(N)^{-(1-\phi)/\phi}.$$

Substituting for $f(\theta)$ in (25), the equilibrium condition becomes

$$\widetilde{J} = \frac{\kappa}{f(\theta)} = \frac{\kappa}{\zeta^{1/\phi}\vartheta(N)^{-(1-\phi)/\phi}} = \kappa\,\vartheta(N)^{(1-\phi)/\phi}\zeta^{-1/\phi} \tag{FE}$$

We refer to this relationship as the *free entry* condition (FE). It is upward sloping in the (J, N) space (from equation 26, $\vartheta'(N) > 0$). As the value of research firms increases, more financial intermediaries enter in search of a match until the value of a searching firm is driven back down to zero. Since the number of financial intermediaries increases, the number of matches (M) increases and so does the number of research firms in equilibrium ($N = M/\eta$).

The second relationship between $\widetilde{J}$ and N along the balanced growth path is derived from equation (16). Dividing through by A and using $\dot{J} = \eta\delta N J$ we obtain the following expression for $\widetilde{J}$:

$$\widetilde{J} = \frac{\eta\,\delta\,\pi/\rho - \widetilde{\omega}}{\rho + \eta - \eta\,\delta\,N} \tag{27}$$

As we show in Appendix B, combining condition (27) with the above expression for the wage of researchers (equation 22) yields

$$\widetilde{J} = \frac{(1-\beta)\left(\frac{\eta\,\delta\,\pi}{\rho} - \widetilde{w}_{H}\right) - \beta\frac{\kappa}{\theta}}{\rho + \eta - \eta\,\delta\,N} \tag{JJ}$$

The expression, which we denote JJ, indicates that the value of an entrepreneurial firm increases in the bargaining power of financial intermediaries $(1 - \beta)$, the present value of future profits from an innovation, and the productivity of research effort, δ. The value is also increasing in the term $\eta\,\delta\,N$ which captures the "standing on the shoulders" effect associated with innovating later rather than sooner, when there is a larger number of preceding innovations to benefit from. The value is decreasing in the discount rate ρ and the flow probability of innovation η (a higher η implies a higher flow probability of the entrepreneurial firm dissolving). The value is also decreasing in the bargaining power β of skilled workers and the average search cost $\frac{\kappa}{\theta}$. [18]

[18] An alternative way of introducing financial development would be to alter the division of rents as represented by $(\beta, 1-\beta)$. However, a priori it is not clear whether an increase or a decrease in β would represent financial development. On the one hand, if financial development is thought of as being associated with better governance, improved monitoring, etc. and therefore a larger share of the rents captured by the financier, then this would be represented by a decline in β. On the other hand, if financial development in more searching intermediaries, then skilled workers might be more inclined to wait for an appropriate match and their bargaining power would increase. This would be represented by an increase in β. Since the interpretation with changes in the division of rents is ambiguous, instead we represent financial development with an increase in the efficiency of the matching process (i.e. an increase in ζ).

For a plausible set of parameter values, the JJ-locus plots the productivity-adjusted value of an entrepreneurial firm $\left(\widetilde{J}\right)$ as an inverted-U shaped function of the number of entrepreneurial firms (N) in the relevant range of N. To see this, simplify by assuming that β is zero (workers have no bargaining power). The numerator of expression (JJ) depends on N only through profits per line, π. As discussed before, initially – starting from a low number of entrepreneurial firms – an increase in N is associated with a net inflow of skilled workers into the new economy sector. As the pool of skilled workers who use intermediate goods expands, the value of an additional intermediate good (i.e. of an innovation) increases. This causes π and thus $\widetilde{J}$ to increase. Beyond a certain threshold size of the innovation sector (number of entrepreneurial firms), a further expansion in the number of firms will be associated with a net outflow of skilled workers from the new economy sector. The innovation sector grows by drawing skilled workers out of both the old and new economy sectors. As the pool of skilled workers who use intermediate goods in the new economy sector shrinks, the value of an additional intermediate good and $\widetilde{J}$ fall.[19]

Equations (FE) and (JJ) form a system in J and N which determines the BGP equilibrium as depicted in Figure 2. In fact, there can be two steady state equilibria. As discussed in Appendix C, the steady state to the left of SS_1 is an unstable equilibrium. We therefore focus on SS_1. Note that the intersection can occur in either the upward or downward sloping part of the JJ curve.

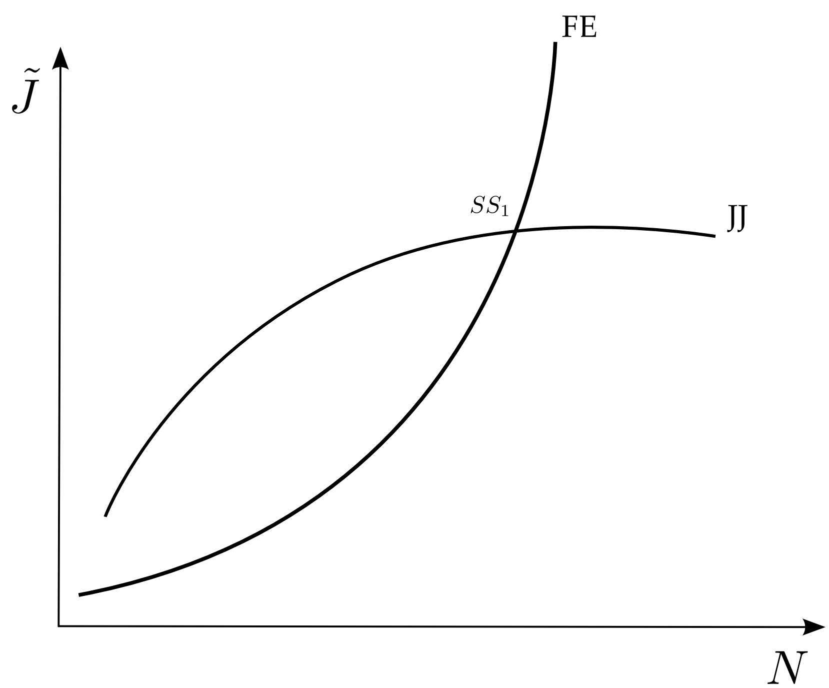


Figure 2: The determination of balanced growth path values of number of entrepreneurial firms, N, and productivity-adjusted value of an entrepreneurial firm, $\widetilde{J}$.

[19]The effect of N in the denominator is to increase J further, but it's not enough to offset the falling market size effect.

Comparative Statics

The key comparative static experiment we want to focus on is a reduction in financing frictions (i.e. an increase in the parameter ζ of the matching function from Equation 10), illustrated in Figure 3 as a shift to the right in the FE curve. The probability of a successful match increases with the improvement in financial markets, drawing a larger number of skilled workers into the innovation sector. At every level of $\widetilde{J}$, there is a higher number of entrepreneurial firms in equilibrium. The increase in the number of entrepreneurial firms leads to a faster expansion in the variety of intermediate goods ($\frac{\dot{A}_t}{A_t}$ rises as shown in Figure 4). Since the steady state ratio of relative productivity $\frac{A_t}{B_t}$ increases, this drives up the wages of skilled labor in the manufacturing sector. As N rises, H_O – the employment of skilled workers in the old sector – falls and the skill premium increases (Equation 24). As for the absolute level of the unskilled wage, it may initially fall as the number of skilled workers in the old economy (H_O) declines. However, in the long run all wages grow at a faster steady state rate due to the accelerated pace of innovation (which results from greater financial sophistication and the employment of skilled workers in the innovation sector).

The steady state effect on wages of skilled workers in the innovation sector depends in an important way on what happens to profits. If the equilibrium occurs in the upward sloping part of the JJ curve (SS_B), profits increase with the reduction in financing frictions. When skilled workers have some bargaining power, with improvements in the functioning of financial markets their wage will increase relative to the wage of skilled workers in manufacturing. Within group inequality will therefore increase. Ultimately the model predicts that the equilibrium must move to the downward sloping part (SS_C), after which profits will begin to decline. As profits fall, the wage of skilled workers in the innovation sector will also eventually decline relative to the wage of skilled workers in manufacturing, and within group inequality will decrease.[20]

Figure 5 shows a numerical simulation of the model. The six subfigures plot how the steady state levels of several key model variables respond to greater financial development, i.e. an increase in ζ. As discussed above, the size of the innovation sector increases (Figure 5(a)) and the skilled employment in old economy firms declines (Figure 5(b)). Skilled employment in new economy firms increases initially but starts declining for higher values of ζ, reflecting the initial net inflow of skilled workers into new economy firms and subsequently the net outflow as more skilled workers get matched with financial intermediaries (Figure 5(c)). Profits follow the same pattern (Figure 5(d)). The skill premium, as measured by the ratio of manufacturing skilled wage relative to unskilled wage, increases uniformly (Figure 5(e)).

[20]Even if the balanced growth path level of (productivity-adjusted) skilled wages in the innovation sector falls, it will still increase initially. To see this observe that it takes time for N to rise and so initially profits are unchanged. At the same time the inflow of financiers into the market is immediate (F jumps) so that θ falls immediately. From equation (22) it follows that the wage in the innovative sector jumps up.

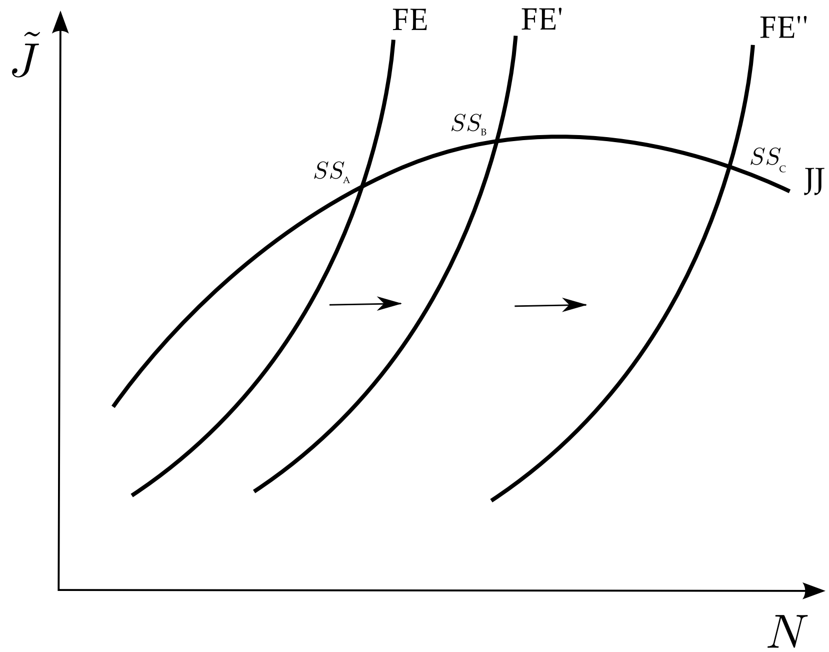


Figure 3: Improvement in matching efficiency of financial markets (increase in ζ) - comparative statics.

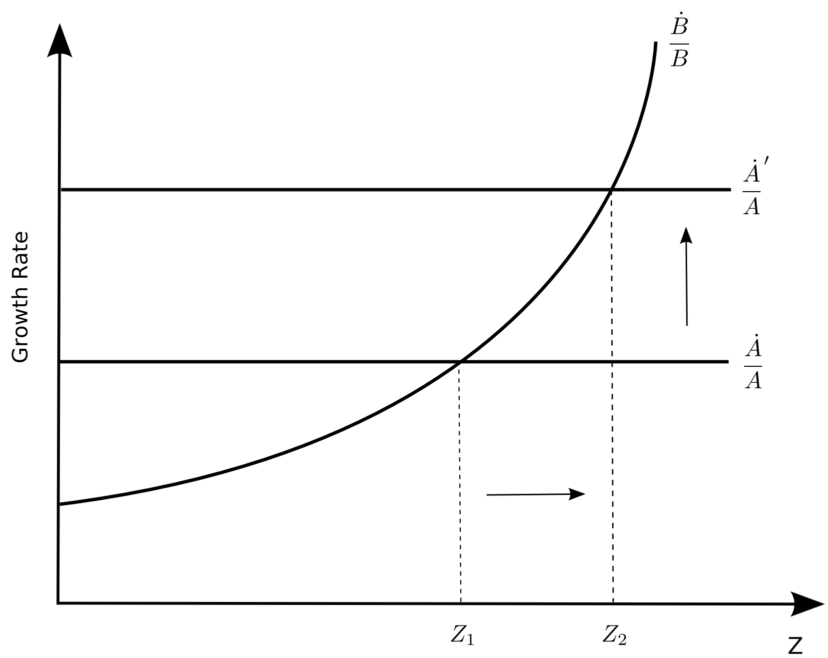
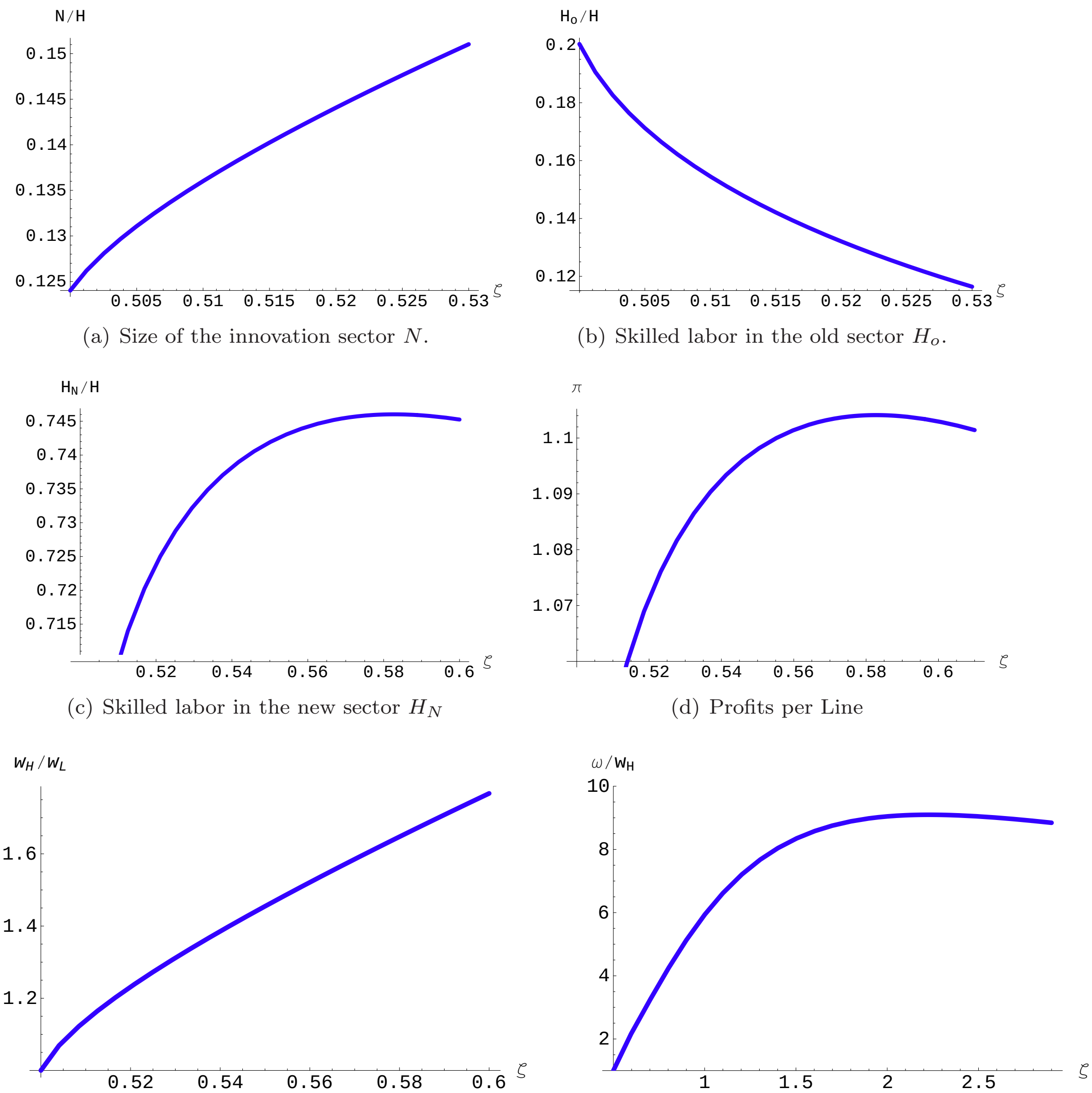


Figure 4: Financial development and changes in the steady state ratio $Z = \frac{A_t}{B_t}$.

Within group inequality initially rises but eventually starts to decline (Figure 5(f)).[21]

[21] For the parameters used here, the decline in within group inequality sets in at a higher value of financial development than the decline in profits does (compare Figures 5(d) and 5(f)), indicating that within group wage inequality can continue to increase for a while even with falling profits. This is because, as mentioned above, the skilled wage in the innovating sector rises also due to an increase in average search costs (κ/θ) brought about by a fall in the ratio $\theta = (H - N)/F$.



(a) Size of the innovation sector N.

(b) Skilled labor in the old sector H_o.

(c) Skilled labor in the new sector H_N

(d) Profits per Line

(e) Skill premium in manufacturing w_H/w_L.

(f) Within group wage inequality ω/w_H.

Figure 5: Numerical simulation of the model. The effect of financial innovation (increase in ζ) on the balanced growth path values of the key variables.

4 Data

The model presented above predicts that, *ceteris paribus,* a greater degree of financial market development is associated with a higher skill premium. It is also possible that the within group inequality among skilled workers increases. This section describes the state-level data we use from the US to test these predictions.

Our financial development variable is a measure of financial deregulation based on Black and Strahan (2001) who document the timing of legal changes in state-level regulations concerning bank branching.[22] We focus on the period 1977-2006. The coverage begins in 1977 since prior to this time it is difficult to identify state of residence in the data.[23]

Starting from 1970, a number of states deregulated their banking sector by permitting out-of-state holding companies to consolidate their in-state subsidiaries into branches of one bank company, as well as by allowing intrastate expansion of branches. Jayaratne and Strahan (1996) demonstrate that these changes improved the quality of intermediation and had a positive impact on state-level growth rates. Furthermore, they argue that the timing of deregulation was not influenced by state-level economic indicators. We conjecture that the changes in the banking industry improved the flow of finance to in-state businesses and subsequently affected wage outcomes as outlined in the theory section. Black and Strahan (2002) show that entrepreneurial activity (measured by the rate of new business incorporations) increased following banking deregulation across the US in the 1980s, which is consistent with one aspect of the theory outlined above - the entry of new entrepreneurial / innovation firms in response to financial development. The results we present below provide evidence that financial deregulation is also associated with changes in wage outcomes as suggested by our hypothesis. In our baseline regressions in the next section, we use the date when instrastate branching was permitted as the initial year of financial deregulation. In separate regressions we also use the date when cross-border mergers and acquisitions of banks were allowed (interstate deregulation) as the initial year of financial deregulation.

We use March Current Population Surveys (CPS) for worker characteristics and wages. Our sample construction procedure follows Autor et al. (2008). We use a sample of white male civilian workers between 25 and 54 years old. We exclude self-employed workers as well those who report part-time employment or having worked less than 40 weeks. We also drop the observations with allocation earnings. We multiply top-code earnings values by 1.5 and exclude observations with hourly wage less than \$2.8 (in 2000 dollars). All nominal variables are deflated using the personal consumption expenditures deflator and we use CPS weights in all our regressions.

In order to ensure comparability in educational attainment through 1991 with the data

[22] Black and Strahan (2001) studied the impact of deregulation on the relative wages of men and women and women's share of managerial positions within the banking industry.

[23] Black and Strahan (2001) document dates of deregulation up to 1996. The one additional state that introduced intrastate deregulation after 1996 was Iowa, in 1999 (Levine et al. 2007).

from 1992 onward (when the coding of this variable changed in the CPS), we use the re-coded educational attainment variable EDUCREC which classifies workers (including those surveyed prior 1992) into nine categories based on the number of years of schooling reported. The nine categories are zero or preschool; grades 1-4; grades 5-8; grade 9; grade 10, grade 11; grade 12; 1-3 years of college; 4 + years of college. We classify workers into four categories based on educational attainment reported under EDUCREC: less than high school (grades 1-4; grades 5-8; grade 9; grade 10, grade 11); high school diploma holder (grade 12); some college (1-3 years of college); college and advanced degree holder (4+ years of college). In some specifications we combine the first two groups together into an "unskilled" category and the latter two groups into a "skilled" category.

We calculate potential experience from the age of the worker and the years of education. We assign years of education based on Lange and Topel (2006), who attach the following discrete values to the nine educational categories in EDUCREC: 0, 2.5, 6.5, 9, 10, 11, 12, 14, 16. The years of potential experience then follows as the age of the worker less years of education minus six. For example, a worker who is 50 years old and has 12 years of education is given 32 years of potential experience. We exclude workers with zero or less potential experience. With regard to occupation, we pool the occupations reported in the CPS into 10 categories according to the classification system ranging from professional to labor-intensive occupations.

5 Empirical Evidence

This section presents results from two separate tests of our hypothesis. First, we test the relationship between the skilled-unskilled wage gap (skill premium) and financial deregulation by estimating individual-level Mincerian wage regressions with data from the March Current Population Surveys (CPS). Second, we test the relationship between residual (within group) inequality and deregulation. In all of the specifications we follow Black and Strahan (2001) in dropping South Dakota and Delaware since the large presence of credit card companies in these states makes them outliers.

In terms of testing the model presented above, our hypothesis is that state-level financial development affects outcomes in the entrepreneurial sector and the labor market at the level of the state. Two important caveats with connecting the theory to the empirics are as follows. It is possible that entrepreneurial firms may be able to access finance from out-of-state, which would confound our empirical analysis. However, since we emphasize a broad range of innovative activities that includes adapting new technologies to the local environment, implementing new business ideas that cater to the local clientele, as well as support services such as bill processing and legal consulting, the entrepreneurial firms we have in mind are small start-ups which are less likely to attract the attention of large, out-of-state financiers. Furthermore, to the extent that high skill workers can migrate across state boundaries, the empirical analysis may not detect an association between state-level financial development and labor market outcomes at the level of the state. In the presence of migration, the estimates we present below are therefore lower bounds on the true effect. [24]

5.1 Skill Premium

We estimate the effect of deregulation on wages through individual level Mincerian wage regressions.[25] Here we can directly allow for differential effects of deregulation on individuals with different educational attainments. Recall that our model predicts that the skilled-unskilled wage gap will rise following deregulation. This happens because wages of skilled workers (those with some college or more education) rise on average while the wages of unskilled workers (those with high school diplomas and less than high school) fall.

The baseline specification employed is:

$$w_{ist} = \alpha_s + \mu_t + \gamma E_{ist} + \delta D_{st} + \theta D_{st} E_{ist} + X_{ist}\beta + \epsilon_{ist} \tag{28}$$

where w is the logarithm of weekly real wage, α_s and μ_t are the state and year effects, respectively. D_{st} is the binary variable for banking deregulation that takes on the value 1 if state s has deregulated its banking sector by time t, E_{ist} is the categorical variable representing the education attainment of individual i resident in state s in year t. X_{ist} represents a vector of individual level controls: experience, experience squared, their interactions with educational attainment, and occupation. To capture the secular rise in the skilled-unskilled gap that is unrelated to deregulation we allow the time effects to be specific to each education category.

The results are reported in Table 1. The omitted category for education attainment is less than high school completed. The baseline results in Column 1 indicate that deregulation had a negative impact on wages for workers with relatively low levels of education. The interactions between deregulation and the education attainment categories (all significant at the 1% level) show that the effect of deregulation turned positive only for those workers with some college and higher levels of education (i.e. the skilled workers).

The point estimates show that the wages of college graduates went up by 1.2% while those of workers with only high school diploma fell by 2.2%, which implies a 3.4% increase in the skilled-unskilled wage gap. This is an economically significant change since it accounts for

[24] For example, high skill workers can migrate from Maine to Massachusetts. If Massachusetts deregulates earlier and the skill premium in the state rises according to the mechanism presented above, this may attract high skill workers from Maine. The increased supply of high skill workers can then act to dampen the rise of the skill premium in Massachusetts, while the scarcity of those workers in Maine serves to drive up the skill premium there. With perfect mobility, the skill premium would be equalized and our empirical analysis would find no association between deregulation and changes in the skill premium.

[25] Black and Strahan (2001) use a similar approach to study the impact of banking deregulation on wages and the share of women in managerial employment within the banking industry. Their interest is in testing whether prior to deregulation workers captured economic rents within the regulated banking industry and if banks practised discrimination against women workers.

Δ Skilled-Unskilled Wage Gap	+3.0%	+3.1%	+3.0%	+2.9%	+2.9%
High School	0.049*	0.034	0.031	0.027	0.028
	(0.025)	(0.023)	(0.023)	(0.023)	(0.020)
Some College	0.109***	0.029	0.025	0.022	0.024
	(0.028)	(0.026)	(0.026)	(0.026)	(0.021)
College	0.249***	0.075***	0.073***	0.072***	0.071***
	(0.030)	(0.028)	(0.028)	(0.028)	(0.021)
Deregulation	-0.066***	-0.057***	-0.050***	-0.051***	.
	(0.013)	(0.012)	(0.012)	(0.012)	.
Dereg. x HS	0.044***	0.030**	0.029**	0.027**	0.024***
	(0.014)	(0.012)	(0.012)	(0.012)	(0.007)
Dereg. x SC	0.072***	0.058***	0.054***	0.051***	0.049***
	(0.015)	(0.014)	(0.014)	(0.013)	(0.008)
Dereg. x Coll.	0.078***	0.061***	0.059***	0.056***	0.053***
	(0.018)	(0.016)	(0.016)	(0.016)	(0.008)
State Fixed Effects	YES	YES	YES	YES	NO
Year Fixed Effects (× Edu.)	YES	YES	YES	YES	NO
State-specific Trend	NO	NO	YES	YES	NO
State-specific Trend Sqr.	NO	NO	NO	YES	NO
State-year Fixed effects	NO	NO	NO	NO	YES
Occupation	NO	YES	YES	YES	YES
R sq.	0.29	0.35	0.35	0.35	0.36
N	427,329	427,329	427,329	427,329	427,329

Table 1: Skill Premium; Including education category-specific time effects to capture the the faster rise of skilled wages. All regressions excluding South Dakota and Delaware; Additional controls are experience, experience squared and their interactions with education. Standard errors clustered at state-year level;* p<0.10, ** p<0.05, *** p<0.01

8% of the rise in the skilled-unskilled wage gap in our sample. These results are robust to including occupation as an additional control (Column 2).

To allow for the possibility that states may experience different trends in wages over this period which may also be correlated with the timing of deregulation, in Column 3 we include a state-specific time trend and, in Column 4, we include its square as well. In both specifications, the effect of deregulation continues to be positive for workers with college education. Although the magnitude of the effect for college graduates is smaller (a 0.5 % increase), the wages of high school graduates fall by 2.4%, again resulting in an almost 3% rise in the wage gap. Finally, in Column 5, we include state-year fixed effects to control for state-wide influences on the labor market that may vary over time, such as changes in labor laws or taxation of businesses. With state-year fixed effects we cannot identify the level effect of deregulation (as deregulation is constant within a state-year category), but the interaction terms can still inform us about the relative effect of deregulation on wages of different educational groups. The the estimates of the coefficients on interaction terms are almost identical in magnitude and significance to the ones estimated in the preceding three columns: again we find that banking deregulation has a positive effect on the skilled-unskilled wage gap, increasing it by 2.9%.

An alternative way of timing the deregulation of the banking sector is to use the date when cross-border mergers and acquisitions of banks were allowed (interstate deregulation) as the initial year of financial deregulation. In Table 2, we use the same specification (Equation 28) used in Table 1. The difference is that now D_{st}, the binary variable for banking deregulation, takes on the value 1 if state s has permitted cross-border mergers and acquisitions in its banking sector by time t. In all specifications, the point estimates are smaller but they again show an increase in wages of college educated workers (between .3% and .8%) and a fall in wages of workers with only high school education (between -2.3% and $-\ 0.7\%$). However, the effects of interstate deregulation are not statistically significant, suggesting that intrastate changes are more closely associated with wage outcomes within the state.

We also estimate Equation 28 using the date of either intrastate or interstate deregulation as the initial year of deregulation. We find evidence of a widening of the skill premium (represented by the difference in log wages) associated with deregulation. The results are similar to the ones reported in Table 1 (where we used intrastate regulatory changes to time the onset of banking deregulation).[26]

We also run the specifications separately within education categories. The results from the preceding tables indicated that the effect of deregulation was negative for workers with high school diplomas and less than high school completed, but that it was positive for workers with some college and higher levels of educational attainment. We therefore combine workers with high school diplomas and less than high school completed into the category of

[26]We also estimate the wage regressions separately by region, splitting the sample into the four divisions of West, Midwest, South, and Northeast. The results indicate the largest increase in skilled-unskilled wage gap in the West and an actual narrowing of the gap in the Northeast. Results are available from the authors.

Δ Skilled-Unskilled Wage Gap	+2.0%	+2.2%	+2.3%	+2.3%	+2.5%
High School	0.061**	0.042*	0.038*	0.034	0.034*
	(0.025)	(0.023)	(0.023)	(0.023)	(0.020)
Some College	0.128***	0.044*	0.039	0.036	0.037*
	(0.028)	(0.026)	(0.026)	(0.026)	(0.021)
College	0.270***	0.090***	0.089***	0.087***	0.085***
	(0.030)	(0.027)	(0.027)	(0.027)	(0.021)
Deregulation	-0.020	-0.021	-0.005	-0.011	.
	(0.025)	(0.024)	(0.023)	(0.024)	.
Dereg. x HS	-0.003	-0.002	-0.002	-0.004	-0.013
	(0.027)	(0.024)	(0.024)	(0.024)	(0.013)
Dereg. x SC	-0.001	-0.000	-0.001	-0.002	-0.009
	(0.032)	(0.029)	(0.029)	(0.029)	(0.015)
Dereg. x Coll.	0.017	0.020	0.021	0.019	0.012
	(0.033)	(0.031)	(0.031)	(0.031)	(0.015)
R sq.	0.29	0.35	0.35	0.35	0.36
N	427,329	427,329	427,329	427,329	427,329
State Fixed Effects	YES	YES	YES	YES	NO
Year Fixed Effects (× Edu.)	YES	YES	YES	YES	NO
State-specific Trend	NO	NO	YES	YES	NO
State-specific Trend Sqr.	NO	NO	NO	YES	NO
State-year Fixed effects	NO	NO	NO	NO	YES
Occupation	NO	YES	YES	YES	YES

Table 2: Skill Premium; Interstate Deregulation. Including education category-specific time effects to capture the the faster rise of skilled wages. All regressions excluding South Dakota and Delaware; Additional controls are experience, experience squared and their interactions with education. Standard errors clustered at state-year level;* p<0.10, ** p<0.05, *** p<0.01

Δ Skilled-Unskilled Wage Gap	+3.3%	+3.1%	+2.9%	+2.8%	+2.8%
High School	0.050**	0.036	0.032	0.028	0.029
	(0.025)	(0.023)	(0.023)	(0.023)	(0.020)
Some College	0.111***	0.032	0.028	0.025	0.027
	(0.028)	(0.026)	(0.026)	(0.026)	(0.021)
College	0.251***	0.076***	0.075***	0.073***	0.072***
	(0.030)	(0.028)	(0.028)	(0.028)	(0.021)
Deregulation	-0.066***	-0.057***	-0.052***	-0.048***	.
	(0.015)	(0.014)	(0.014)	(0.014)	.
Dereg. x HS	0.034**	0.020	0.021	0.020	0.018**
	(0.017)	(0.014)	(0.014)	(0.014)	(0.008)
Dereg. x SC	0.061***	0.045***	0.041**	0.039**	0.038***
	(0.018)	(0.016)	(0.016)	(0.016)	(0.009)
Dereg. x Coll.	0.067***	0.051***	0.050**	0.048**	0.046***
	(0.021)	(0.020)	(0.020)	(0.020)	(0.009)
R sq.	0.29	0.35	0.35	0.35	0.36
N	427,329	427,329	427,329	427,329	427,329
State Fixed Effects	YES	YES	YES	YES	NO
Year Fixed Effects (× Edu.)	YES	YES	YES	YES	NO
State-specific Trend	NO	NO	YES	YES	NO
State-specific Trend Sqr.	NO	NO	NO	YES	NO
State-year Fixed effects	NO	NO	NO	NO	YES
Occupation	NO	YES	YES	YES	YES

Table 3: Skill Premium; Intra & Inter Deregulation. Including education category-specific time effects to capture the the faster rise of skilled wages. All regressions excluding South Dakota and Delaware; Additional controls are experience, experience squared and their interactions with education. Standard errors clustered at state-year level;* p<0.10, ** p<0.05, *** p<0.01

	Intra		Inter		Intra & Inter	
Δ Skilled-Unskilled Wage Gap	+0.3%	+1.4%	+0.5%	+2.2%	+0.3%	+1.4%
Unskilled	-0.014**	-0.024***	-0.025***	-0.031***	-0.014**	-0.024***
	(0.007)	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)
R sq.	0.08	0.08	0.08	0.08	0.08	0.08
N	214,179	214,179	214,179	214,179	214,179	214,179
Skilled	-0.011	-0.010	-0.020**	-0.009	-0.011	-0.010
	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)	(0.008)
R sq.	0.11	0.11	0.11	0.11	0.11	0.11
N	213,150	213,150	213,150	213,150	213,150	213,150
State Fixed Effects	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES
State-specific Trend	YES	YES	YES	YES	YES	YES
State-specific Trend Sqr.	NO	YES	NO	YES	NO	YES

Table 4: Coefficients on deregulation in wage regressions for skilled ("college" and "some college") and unskilled ("high school" and "high school dropouts") categories and the implied change in the skilled-unskilled wage gap; Deregulation measures: columns 1-2 intra-state, columns 3-4 inter-state, and columns 5-6 inter & intra. The dependent variable is log weekly wage. All regressions excluding South Dakota and Delaware; Additional controls are experience and experience squaregd. Standard errors clustered at state-year level;* p<0.10, ** p<0.05, *** p<0.01

less skilled workers. The other category of skilled workers includes those with some college as well as college and higher degree holders. All specifications control for experience and experience squared. Table 4 reports the coefficient on banking deregulation from each of the specifications. In the first two columns, we use intrastate deregulation. In Columns 3 and 4 we use the timing of interstate deregulation. In Columns 5 and 6 we use the date of either intrastate or interstate deregulation as the initial year of deregulation. With each measure of deregulation we also control for state-specific trends and their square.

Here we find that for all three measures of deregulation the skill premium increased following deregulation, although the magnitudes are smaller. While the effect of deregulation on wages is negative and significant within the group of less skilled workers, it is insignificant (except for one of the six specifications) for the group of skilled workers. Although splitting the sample in this way leads to a statistically insignificant effect of deregulation on skilled wages, in combination with the findings on wages of unskilled workers the evidence suggests a widening of the skill premium. These results are in line with the predictions of the theory: banking deregulation is associated with an increase in the skilled-unskilled wage gap.

5.2 Participation

The results in Table 1 indicate that deregulation is associated with an increase in the wages of workers with some college and higher educational attainments while it is associated with a decrease in the wages of workers with high school diplomas and lower levels of educational attainment. The theory outlined above indicates that an increase in the relative demand for skilled workers lies behind these patterns. An alternative explanation is that changes in labor supply drive the observed wage outcomes. One could imagine that even in the absence of the mechanism described in our model, deregulation could affect the skill premium if it affected the relative supplies of skilled and unskilled labor. Recall that in the old economy firms the skill premium is inversely proportional to the H/L ratio (equation (24)). In particular, if the labor force participation of less skilled workers increased relative to the labor force participation of skilled workers over this period (for example if deregulation had a bigger impact on less skilled workers than skilled workers in terms of drawing them into the workforce), the increase in the relative supply of less skilled workers could drive down their wages relative to the wages of skilled workers. In Table 5, we study the impact of deregulation on labor force participation and the supply of different types of workers.

In our sample for these specifications, we now also include workers who report zero weeks worked, workers who report part-time work, and those who have reported working for less than 40 weeks (non full-year workers). We also include workers with low reported weekly wages as they often are in the part-time, low hours category. The additional controls included in the regressions reflect other determinants of labor supply decisions - marital status, the number of children under the age of five, and the non-wage annual income. We combine the high school diploma holders and the high school dropouts into the category of low skilled

	Unskilled			Skilled		
LF Participation	0.001	0.001	0.000	0.000	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R sq.	0.00	0.00	0.00	0.00	0.00	0.00
N	253,113	253,113	253,113	235,987	235,987	235,987
Hours	0.013***	0.019***	0.023***	0.002	0.015***	0.020***
	(0.005)	(0.006)	(0.007)	(0.004)	(0.005)	(0.006)
R sq.	0.06	0.06	0.06	0.05	0.05	0.05
N	253,113	253,113	253,113	235,987	235,987	235,987
Full-time/Part-time	0.005***	0.005**	0.005*	0.003**	0.003	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
R sq.	0.02	0.02	0.02	0.02	0.02	0.02
N	248,044	248,044	248,044	233,408	233,408	233,408
State Fixed Effects	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES
State-specific Trend	NO	YES	YES	NO	YES	YES
State-specific Trend Sqr.	NO	NO	YES	NO	NO	YES

Table 5: Labor supply variables: full/part-time indicator, labor force participation and log hours worked. The reported coefficients are on intrastate deregulation. Columns 1-3 unskilled workers, columns 4-6 skilled workers. Additional regressors are education level (categorical), experience, experience squared (and their interactions with eduction), marital status, number of children under 5 in the household and the interaction of marital status and the number of children. All regressions excluding South Dakota and Delaware; Additional controls are experience, experience squared and their interactions with education. Standard errors clustered at state-year level;* $p<0.10$, ** $p<0.05$, *** $p<0.01$

workers (Columns 1 -3). College and advanced degree holders are classified in the category of high skilled workers (Columns 4-6).

We study three different outcomes - a binary variable which takes on the value 1 if the worker was in the labor force in the preceding week; the number of hours worked in the preceding week for the respondents who were employed in the preceding year; for the respondents who were employed, a binary variable which takes on the value 1 if the worker worked full time (defined as 35 hours per week or more). Columns 1-3 report the results for the low skilled workers. For the two binary outcomes, we report results from a linear probability specification. The first column reports the baseline specification with state fixed effects and calendar year fixed effects included in the regression. The second column includes state-specific trends, and the third column also includes the square of the state-specific trend. This order is repeated for Columns 4 - 6.

As the results from the top panel indicate, in our sample there is no significant effect of intrastate deregulation on labor force participation either for low skill workers or for high skill workers in any of the specifications. This suggests that our results in Table 1 are not being driven by shifts in the composition of the labor force. In particular, we find no evidence of an increase in labor force participation of low skill workers or a decrease in labor force participation for high skill workers following deregulation, suggesting that shifts in relative supply of skills could not be driving the increase in the skill premium associated with deregulation.

In the middle panel of the table we examine the effect of deregulation on hours worked. Here we find an increase in the hours worked for both low skill and high skill workers. The coefficient for the low skill workers is always significant at the 1% level, whereas the coefficient for the high skill workers is significant at the 1% level in two out of the three specifications. However, since the increase is very similar for both categories, it appears that the relative supply of skilled workers did not decrease following deregulation, making it unlikely that supply changes are driving our findings on the movement of relative wages.

In the bottom panel of Table 5, we study the effect of deregulation on the choice of full-time versus part-time work among the respondents who were employed in the preceding year. We find an increase in the probability that both low and high skilled workers are employed full-time following deregulation, although in the case of high skilled workers the coefficient is statistically significant only in one specification. However, since the probability of working full-time goes up for both categories of workers following deregulation (and this effect is significant in the baseline regressions for both groups), we cannot infer that the relative supply of high skill workers fell (and therefore their relative wage increased) as they switched to part-time employment.

We conclude that changes in relative supply (i.e. quantities) are unlikely to be driving the results on wages reported in the previous sub-section.

5.3 Residual Inequality

Our second test of the model's predictions examines the relationship between various measures of residual inequality and banking deregulation. We implement a two-stage empirical approach that exploits the panel nature of state-level variables.

In the first stage we use March CPS data over the same sample and time period to estimate the Mincerian wage regression using Equation (28). We then extract the residuals from this regression and aggregate up to the state-year level to get three measures of residual wage inequality: the log residual 90th percentile / 50th percentile ratio (a measure of upper tail residual inequality), the log residual 90th percentile / 10th percentile ratio and the standard deviation of residuals (both measures of overall residual inequality). We examine the within-state time variation in these measures of inequality in the second stage regression. The specification used is

$$\widehat{\sigma}_{st} = +\alpha_s + \mu_t + \delta D_{st} + X_{st}\beta + \upsilon_{st}. \tag{29}$$

The dependent variable $\widehat{\sigma}_{st}$ is respectively the log residual 90th percentile / 50th percentile ratio, the log residual 90th percentile / 10th percentile ratio, and the log of the standard deviation of residuals. The covariates include α_s- a state fixed effect that captures time-invariant state-specific attributes that affect the dependent variable, μ_t - a time dummy that captures macroeconomic shocks affecting all states in year t as well as the country-wide time-variation in residual inequality, D_{st} is the banking deregulation dummy variable, and X_{st} is a vector of state-level controls that includes the growth rate of Gross State Product and the state unemployment rate. Since our unit of observation is at the state-year level, we are unable to control for state-year fixed effects, but we do control for state-specific time trends and their squares in the specifications. Again, we drop Delaware and South Dakota from the dataset, which leaves us with 49 states (including Washington, DC) over 30 years for a total of 1470 state-year observations.

	P90-50	P90-10	Std. Dev.	P90-50	P90-10	Std. Dev.	P90-50	P90-10	Std. Dev.
Panel A: Baseline									
Deregulation	0.021	0.010	0.005	0.044**	0.028***	0.020**	0.045**	0.029**	0.018*
	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
R sq.	0.54	0.56	0.65	0.60	0.63	0.71	0.62	0.65	0.73
N	1,470	1,470	1,470	1,470	1,470	1,470	1,470	1,470	1,470
Panel B: With Controls									
Deregulation	0.019	0.009	0.004	0.042**	0.027**	0.019*	0.042**	0.026*	0.014
	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Per capita GSP growth	0.072	-0.036	0.006	0.070	-0.059	-0.008	0.065	-0.047	-0.002
	(0.11)	(0.08)	(0.08)	(0.11)	(0.08)	(0.08)	(0.11)	(0.08)	(0.08)
Unemployment Rate	-0.003	-0.004	-0.003	-0.002	-0.003	-0.003	-0.003	-0.006*	-0.005*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
R sq.	0.54	0.56	0.65	0.60	0.63	0.71	0.62	0.65	0.73
N	1,470	1,470	1,470	1,470	1,470	1,470	1,470	1,470	1,470
State Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
State-specific Trend	NO	NO	NO	YES	YES	YES	YES	YES	YES
State-specific Trend Sqr.	NO	NO	NO	NO	NO	NO	YES	YES	YES

Table 6: Residual Inequality (log 90/50 and 90/10 percentile ratios and log standard deviation of residuals from equation 28); All regressions excluding South Dakota and Delaware; Standard errors clustered at state level;* p<0.10, ** p<0.05, *** p<0.01

The results are reported in Table 6; panel A reports the results without additional controls and panel B adds Gross State Product growth and the state unemployment rate. In Columns 1-3 we include only state and year fixed effects, in Columns 4-6 we add a state-specific trend and in Columns 7-9 we additionally include its square. Except for the specification without trend we find that the effect is positive and significant for both upper tail residual inequality and overall residual inequality. Also, consistent with our hypothesis, the magnitude of the effect is largest in the case of the upper-tail residual inequality measured by the 90th percentile / 50th percentile wage ratio. For example, in Column 7 we find that it rises by 4.5% following deregulation, which accounts for 14% of the increase in the average of this measure between 1977 and 2006.

In the bottom panel of Table 6, we include the growth rate of Gross State Product and the state unemployment rate as additional controls. The results are robust to the inclusion of these state-level variables that proxy for the strength of the state labor market. We conclude that the evidence is indicative of a positive association between deregulation and measures of residual inequality. The point estimates suggest that the relationship is strongest in the case of upper tail residual inequality, which is consistent with our hypothesis.

	P90-50	P90-10	Std. Dev.	P90-50	P90-10	Std. Dev.	P90-50	P90-10	Std. Dev.
Panel A: Interstate									
Deregulation	0.006	-0.003	-0.013	0.031*	0.020*	0.007	0.028†*	0.020*	0.006
	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
R sq.	0.55	0.58	0.66	0.60	0.64	0.72	0.62	0.65	0.74
Panel B: Intra & Interstate									
Deregulation	0.017	0.009	0.003	0.040**	0.028***	0.016*	0.038**	0.026**	0.014
	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
R sq.	0.54	0.56	0.65	0.60	0.63	0.71	0.62	0.65	0.73
N	1,470	1,470	1,470	1,470	1,470	1,470	1,470	1,470	1,470
State Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
State-specific Trend	NO	NO	NO	YES	YES	YES	YES	YES	YES
State-specific Trend Sqr.	NO	NO	NO	NO	NO	NO	YES	YES	YES

Table 7: Residual Inequality (log 90/50 and 90/10 percentile ratios and log standard deviation of residuals from equation 28); Intra & Inter State deregulation takes a value of one in the first year either deregulation takes place. All regressions excluding South Dakota and Delaware; Standard errors clustered at state level;†* p <0.11,* p<0.10, ** p<0.05, *** p<0.01

In Table 7 we report results on residual inequality using alternative ways of timing the initial year of deregulation. The specification used is Equation (29). In the top panel, D_{st}, the binary variable for banking deregulation, takes on the value 1 if state s has permitted cross-border mergers and acquisitions in its banking sector (interstate deregulation) by time t. While the association between interstate deregulation and various measures of residual inequality is not as strong as seen previously with instrastate deregulation, we still find some evidence of a significant (at the 10% level) relationship between deregulation and upper tail residual inequality (Column 5), as well as between deregulation and overall residual inequality measured by the 90-10 percentile differential (Columns 7 and 8).

In the bottom panel, we use the date of either intrastate or interstate deregulation as the initial year of deregulation. As the results indicate, the effects are similar to the ones we find when we use intrastate deregulation. The use of these alternative ways of timing the initial year of deregulation suggests that intrastate deregulation has a stronger association with residual inequality in the manner predicted by our theory, whereas the association is not as strong with interstate deregulation.[27]

We take the above results across several specifications as highly suggestive of a relationship between financial development and residual wage inequality as predicted by our model. In our model, the quality of the financial market has a single dimension expressed by the efficiency of the matching process. An improvement in this quality is predicted to increase both the return to skill as well as within group inequality (if wages of workers in the innovation sector rise with the increase in N). In the empirical analysis we use banking deregulation as an indicator of improvements in financial intermediation. In the data we see evidence of banking deregulation associated with a rise in the skill premium, residual inequality, and upper tail residual inequality. Since banking deregulation is just one aspect of financial development, it may be the case that different types of financial innovation affect the two aspects of wage dispersion (overall and residual) in different ways. We leave this for future research to explore.

6 Conclusion

Although considerable research has been done on the causes of widening wage inequality in the US in the last two decades, little attention has been paid to the role of financial markets in this process. The last two decades have also been a time of increasing financial deregulation and the emergence of specialized financial intermediaries that focus on high risk

[27]We also estimate the residual wage inequality regressions separately by region, splitting the sample into the four divisions of West, Midwest, South, and Northeast. The effects within the Midwest and the West are similar to the ones reported here - deregulation is associated with an increase in all three measures of residual inequality. For the Northeast and the South, the coefficients are not significant, with the exception of regressions that use the 90-10 differential as the outcome. For the South, we find that banking deregulation is associated with a statistically significant decline (at the 5% level) in the 90-10 differential. This effect is not robust, however. Significance drops once we include state-specific trends and the square of state-specific trends. Results are available from the authors.

investment, typically in the form of small, innovative start-ups. In this paper, we argue for an independent role played by financial markets in facilitating these changes.

Empirical tests of the hypothesis provide support for our claims regarding the relationship between financial development and wage inequality. Using a measure of banking deregulation across US states, we find that the effect of deregulation is economically meaningful. Consistent with our hypothesis that financial market development benefits high skilled workers relatively more than low skilled workers, we find that wages of workers with college and more advanced degrees benefited from deregulation, whereas the effect of deregulation on wages was negative for workers with lower levels of education (high school diploma holders). We also find that deregulation leads to greater residual inequality (specifically, upper tail residual inequality), which is consistent with our hypothesis that financial market development increases within group inequality among skilled workers. The estimated effects of deregulation are economically meaningful. We find that wages of college educated workers increased by between 0.5 - 1.2 % following deregulation, while those of workers with a high school diploma fell by about 2.2 %. Similarly, residual (or within-group) inequality increased. The 90-50 percentile ratio of residuals from a Mincerian wage regression and their standard deviation increased by 4.5% and 1.8%, respectively, following deregulation.

These results suggest that financial development, so far not emphasized as a contributing factor, may in fact have been quite important for the changes in the US wage distribution over the last few decades. The overall impact of financial development on the wage distribution is likely to be even larger than what we find because of other important developments in financial markets in the US during this period besides state deregulation of banking (for example, the gradual weakening of the Glass-Steagall Act starting from the mid-1980s).

A Compensation of skilled workers in the innovation sector

As is standard in the search literature, we assume that the wage ω that innovating firms pay to skilled workers is an outcome of a Nash bargaining process. Let β measure the bargaining power of skilled workers and $1-\beta$ measure the bargaining power of financial intermediaries. Along the balanced growth path the productivity-adjusted asset values for an entrepreneurial firm, a searching financial intermediary, a matched skilled worker and an unmatched skilled worker are, respectively,

$$\rho\,\widetilde{J} = -\widetilde{\omega} + \eta\left(\frac{\delta\,\pi}{\rho} - \widetilde{J}\right) + \eta\delta N\widetilde{J} \tag{30}$$

$$\rho\,\widetilde{S} = -\kappa\, + f(\theta)\left(\widetilde{J} - \widetilde{S}\right) + \eta\delta N\widetilde{S} \tag{31}$$

$$\rho\,\widetilde{V} = \widetilde{\omega} + \eta\left(\widetilde{U} - \widetilde{V}\right) + \eta\delta N\widetilde{V} \tag{32}$$

$$\rho\,\widetilde{U} = \widetilde{w}_{H} + f(\theta)/\theta\left(\widetilde{V} - \widetilde{U}\right) + \eta\delta N\widetilde{U} \tag{33}$$

To find the wage, denote the total productivity-adjusted surplus from a match by $\widetilde{D} = \widetilde{J} - \widetilde{S} + \widetilde{V} - \widetilde{U}$. The solution to the Nash bargaining process calls for the following division of the surplus:

$$\widetilde{V} - \widetilde{U} = \beta\,\widetilde{D}, \tag{34}$$

$$\widetilde{J} = (1-\beta)\,\widetilde{D}, \tag{35}$$

where, by free entry, we have $\widetilde{S} = 0$.

Adding equations (30) and (32) and rearranging we get

$$\widetilde{J} + \widetilde{V} - \widetilde{U} = \frac{\eta\,\delta\,\pi/\rho - (\rho - \eta\delta N)\widetilde{U}}{\rho + \eta - \eta\,\delta\,N} = \widetilde{D} \tag{36}$$

Similarly, rearranging the productivity-adjusted equation (32) we can obtain

$$\widetilde{V} - \widetilde{U} = \frac{\widetilde{\omega} - (\rho - \eta\delta N)\widetilde{U}}{\rho + \eta - \eta\,\delta\,N} \tag{37}$$

Substitute (36) and (37) in (34) to get

$$\frac{\widetilde{\omega} - (\rho - \eta\delta N)\widetilde{U}}{\rho + \eta - \eta\,\delta\,N} = \beta\left(\frac{\eta\,\delta\,\pi/\rho - (\rho - \eta\delta N)\widetilde{U}}{\rho + \eta - \eta\,\delta\,N}\right)$$

which can be rearranged to get

$$\widetilde{\omega} = \beta\frac{\eta\,\delta\,\pi}{\rho} + (1-\beta)(\rho - \eta\,\delta\,N)\,\widetilde{U} \tag{38}$$

This expression for the wage paid to skilled workers in the innovation sector can be simplified further. From (31) we have that $\widetilde{J} = \frac{\kappa}{f(\theta)}$ (since $\widetilde{S} = 0$). Furthermore, from the

Nash bargaining solution we have $\widetilde{V}-\widetilde{U}=\beta\left(\widetilde{J}+\widetilde{V}-\widetilde{U}\right)$. In other words, $\widetilde{V}-\widetilde{U}=\frac{\beta}{1-\beta}\frac{\kappa}{f(\theta)}$. Substitute for $\widetilde{V}-\widetilde{U}$ in (33) to get

$$(\rho-\eta\delta N)\,\widetilde{U}\;=\widetilde{w}_{H}+\frac{\beta}{1-\beta}\frac{\kappa}{\theta}$$

Substitute in (38) to get

$$\widetilde{\omega}=\beta\left(\frac{\eta\,\delta\,\pi}{\rho}+\frac{\kappa}{\theta}\right)+(1-\beta)\widetilde{w}_{H} \tag{39}$$

which is the expression for the wage paid to skilled workers in the innovation sector.

Notice that when search costs are zero ($\kappa=0$), there are no economic rents associated with a match. From (31) we have that $\widetilde{J}=\frac{\kappa}{f(\theta)}$ (since $\widetilde{S}=0$). Substitute in (30) and rearrange to get

$$\frac{\eta\delta\;\pi}{\rho}-\widetilde{\omega}-\frac{\rho+\eta-\eta\,\delta\,N}{f(\theta)}\kappa=0$$

When $\kappa=0$, this equation reduces to $\frac{\eta\delta\,\pi}{\rho}-\widetilde{\omega}=0$.[28] In this competitive setting, skilled workers employed in the innovation sector are paid their marginal product, the expected value of innovation $\frac{\eta\,\delta\,\pi}{\rho}$. Equation 39 indicates that in this case,$(1-\beta)\;\widetilde{\omega}=(1-\beta)\widetilde{w}_{H}$ and therefore that $\widetilde{\omega}=\widetilde{w}_{H}=\frac{\eta\,\delta\,\pi}{\rho}$.

B The JJ Equation

Substitute for $\widetilde{Z}-\widetilde{U}$ from (37) into (36) to get

$$\widetilde{J}+\frac{\widetilde{\omega}-(\rho-\eta\delta N)\widetilde{U}}{\rho+\eta-\eta\,\delta\,N}=\frac{\eta\,\delta\,\pi/\rho-(\rho-\eta\delta N)\widetilde{U}}{\rho+\eta-\eta\,\delta\,N},$$

from where

$$\widetilde{J}=\frac{\eta\,\delta\,\pi/\rho}{\rho+\eta-\eta\,\delta\,N}-\frac{\widetilde{\omega}}{\rho+\eta-\eta\,\delta\,N}$$

Substitute for $\widetilde{\omega}$ from (39) and rearrange to get

$$\widetilde{J}=\frac{\eta\,\delta\,\pi/\rho}{\rho+\eta-\eta\,\delta\,N}-\frac{\beta\left(\frac{\eta\,\delta\,\pi}{\rho}+\frac{\kappa}{\theta}\right)+(1-\beta)\widetilde{w}_{H}}{\rho+\eta-\eta\,\delta\,N}$$

$$\widetilde{J}=\frac{(1-\beta)\left(\frac{\eta\,\delta\,\pi}{\rho}-\widetilde{w}_{H}\right)-\beta\frac{\kappa}{\theta}}{\rho+\eta-\eta\,\delta\,N}.$$

which is the expression for the JJ locus (JJ). When search costs are zero, $\kappa=0$ and $\widetilde{w}_{H}=\frac{\eta\,\delta\,\pi}{\rho}$. The expression above confirms that in this case, since there are no economic rents associated with a successful match, the value of the entrepreneurial firm is zero.

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[28] Formally, we also have that $f(\theta)\to 0$ as $\kappa\to 0$. However, using L'Hospital's rule one can show that the third term on the left converges to 0.

C Steady State Stability

The equilibrium of our model can be analyzed as a dynamical system in three variables N, θ, and Z. To see this observe that using equations (11) - (13) we can obtain an equation for the evolution of N:

$$\dot{N} = \frac{(H-N)\,\zeta}{\theta^{\phi}} - N\,\eta \tag{40}$$

From the definition of Z ($\equiv \frac{A}{B}$, the relative productivity of new and old manufacturing sectors), we have $\dot{Z}/Z = \dot{A}/A - \dot{B}/B$. Using (7) and (8) we obtain an equation for the evolution of Z,

$$\dot{Z} = Z\left(N\,\delta\,\eta - \lambda\left(\frac{Z}{\mu}\right)^{\frac{1}{\gamma}}\right). \tag{41}$$

Next, differentiate $\widetilde{J} = \kappa/f(\theta)$ (dropping tildes to avoid clutter) to obtain

$$\dot{J}/J = -f'(\theta)/f(\theta)\dot{\theta},$$

and use equations (16) - (21) to derive an equation for the evolution of θ

$$\begin{aligned}\frac{\dot{\theta}}{\theta} =& [(-1+\alpha)\,\left(\alpha^2\right)^{\frac{\alpha}{1-\alpha}}\beta\,\zeta\,\theta^{1-\phi} \\ &+\left((1-\alpha)\,\alpha^{-1+\frac{2}{1-\alpha}}\left(H-N-\frac{L}{\left(-1+\left(Z\,(1-\alpha)\,(\alpha^2)^{\frac{\alpha}{1-\alpha}}\right)^{\frac{\rho}{1-\rho}}\right)^{\frac{1}{\rho}}}\right)\beta\,\delta\,\zeta\,\eta\,\theta^{1-\phi}\right)/r \\ &+N\,\delta\,\eta\,\kappa-(r+\eta)\,\kappa-\frac{(1-\beta)\,\zeta\,\kappa}{\theta^{\phi}}]/(\kappa\,(1-\phi))\end{aligned}$$

This is a nonlinear system in three variables. We analyze it numerically by linearizing it around the steady state. Our results (available upon request) show that for reasonable parameter values the steady state analyzed above, SS_1, is saddle-path stable while the other steady state is unstable.

D Financial development and within-group inequality

This section outlines conditions under which profits, and therefore the wage of skilled workers in the innovation sector, increase in response to an increase in the number of entrepreneurial firms N. In particular, we show that there exists a threshold H_O^* allocation of skilled workers to the old economy firms such that

$$d\pi/dN, d\widetilde{\omega}/dN \begin{cases} >0 & when \quad H_O > H^* \\ =0 & when \quad H_O = H^* \\ <0 & when \quad H_O < H^* \end{cases}$$

Recall from equation (6) that profits π are proportional to H_N, implying that $d\pi/dN = dH_N/dN$. Furthermore, since

$$H_N = H - H_O - N,$$

we have that

$$d\pi/dN = dH_N/dN = -dH_O/dN - 1.$$

This expression will be positive if $dH_O/dN < -1$.

To see the conditions under which $dH_O/dN < -1$, recall that the skilled labor market arbitrage condition (15) implicitly defines H_0 as a function of N. From (15) we have

$$\left[H_{Ot}^{\rho} + L^{\rho}\right]^{\frac{1-\rho}{\rho}} H_{Ot}^{\rho-1} = (1-\alpha)\left(\frac{1}{\alpha^2}\right)^{\frac{\alpha}{1-\alpha}} \frac{A_t}{B_t}. \tag{42}$$

From (9) we also have that in the steady state, the ratio $\frac{A_t}{B_t}$ is given by

$$Z = \left(\frac{n\delta N}{\lambda}\right)^{\gamma}.$$

Substitute for the steady state $\frac{A_t}{B_t}$ in (42) to get

$$\left[H_{Ot}^{\rho} + L^{\rho}\right]^{\frac{1-\rho}{\rho}} H_{Ot}^{\rho-1} = (1-\alpha)\left(\frac{1}{\alpha^2}\right)^{\frac{\alpha}{1-\alpha}} \left(\frac{n\delta N}{\lambda}\right)^{\gamma}. \tag{43}$$

Differentiating both sides of the expression with respect to N, it follows that

$$dH_O/dN = -\frac{(1-\alpha)\alpha^{2\alpha/(\alpha-1)}\frac{\gamma\eta\delta}{\lambda}(\frac{\eta\delta N}{\lambda})^{\gamma-1}}{(1-\rho)(H_O^{\rho} + L^{\rho})^{(1-\rho)/\rho} H_O^{\rho-2}(1 - \frac{1}{1+(L/H_O)^{\rho}})}.$$

In order for $d\pi/dN > 0$, we need $dH_O/dN < -1$. In other words, we need

$$(1-\alpha)\alpha^{2\alpha/(\alpha-1)}\frac{\gamma\eta\delta}{\lambda}(\frac{\eta\delta N}{\lambda})^{\gamma-1} > (1-\rho)(H_O^{\rho} + L^{\rho})^{(1-\rho)/\rho} H_O^{\rho-2}(1 - \frac{1}{1+(L/H_O)^{\rho}})$$

The RHS is decreasing in H_O, and it is infinite when $H_O = 0$. The LHS is decreasing in N, and it is therefore increasing in H_O. It is zero when H_O is zero. The two sides of the expression are graphed as shown below in Figure (6).

To the right of H_O^*, H_N and profits increase with N. As N goes up, skilled workers are reallocated away from old economy firms and the net inflow into the new economy firms is positive (H_N rises). In addition, if skilled workers have some bargaining power, as we have argued previously, wage $\widetilde{\omega}$ will also increase. Since $\widetilde{\omega}_H$ is constant regardless of the number of entrepreneurial firms (wage result 1 in the main text), as $\widetilde{\omega}$ increases within group inequality (measured by the ratio $\frac{\widetilde{\omega}}{\widetilde{\omega}_H}$) will also increase.

However, we know that as N increases, the number of skilled workers in the old economy (HO) falls. Starting from an initial allocation to the right of H^*, as financial markets improve and N increases, if N becomes sufficiently big (so that HO becomes sufficiently small and is to the left of the threshold H_O^*), the economy eventually ends up in the region where H_N and profits decrease with N. As we have argued in the main text, data on profits / GDP for the US suggest that for the period of analysis, in terms of our model the economy has been operating to the right of H^*. The model therefore delivers the prediction that within-group inequality increases in response to an improvement in financial markets.

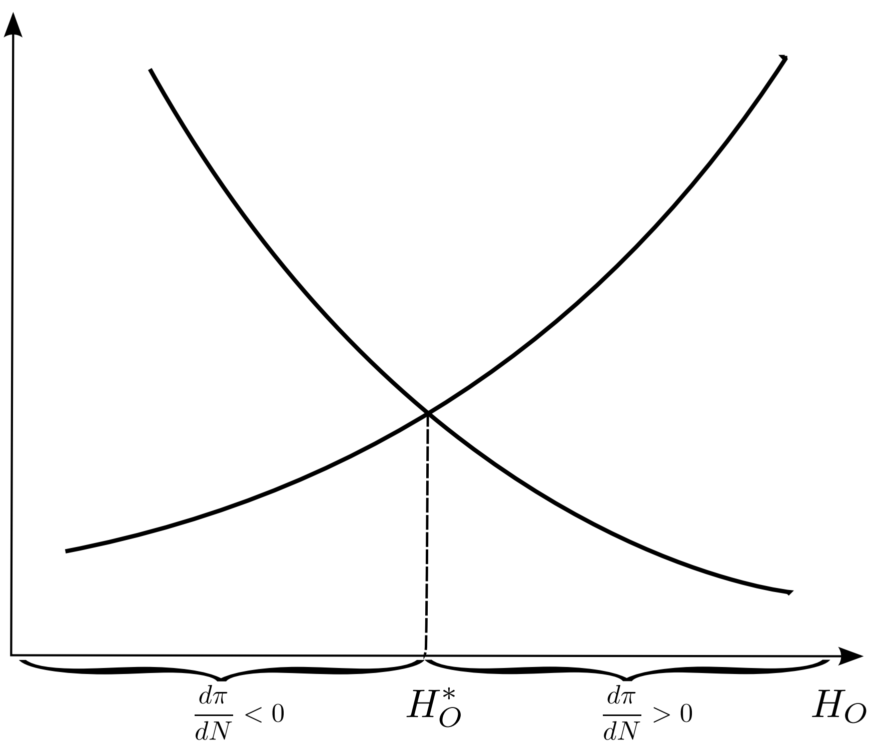

Figure 6: Threshold allocation of skilled workers to the old economy firms (when $HO > H_O^*$, profits rise with an increase in N).

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