Financial Intermediation, Labour Allocation and Productivity: Towards explaining wage inequality and productivity slowdown *

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Abstract

The role of the financial sector on the performance of modern economies remains contestable. We analyse the relationship between inter-industrial wage inequality, specifically comparing wages in finance and manufacturing, and aggregate economic growth. Using the U.S. panel data at the state level from 1977 to 2015, we find a significant and robust negative effect of an increase in relative wage in the financial sector compared to the manufacturing industry on the subsequent economic growth. We construct a tractable equilibrium model of financial intermediation, entrepreneurship, relative wage and output that is capable of explaining these empirical regularities. The main intuition is that the competitive organization of the financial sector yields a size externality which implies higher wages in finance relative to the productive sector combined with lower overall productivity as an increasing financial sector erodes the innovative basis of the economy. In fact, such an inefficiency would not arise with a self-reflective financial sector, e.g., because of a monopolistic structure. Our model suggests that if remuneration in finance were attached with overall productivity of the economy this may ameliorate the size externality. Therefore, our model lends support for post-crisis wage schemes in banks that delay bonus payments to later periods.

!PRELIMINARY!

Keywords: financial intermediation, wage inequality, labour allocation, growth

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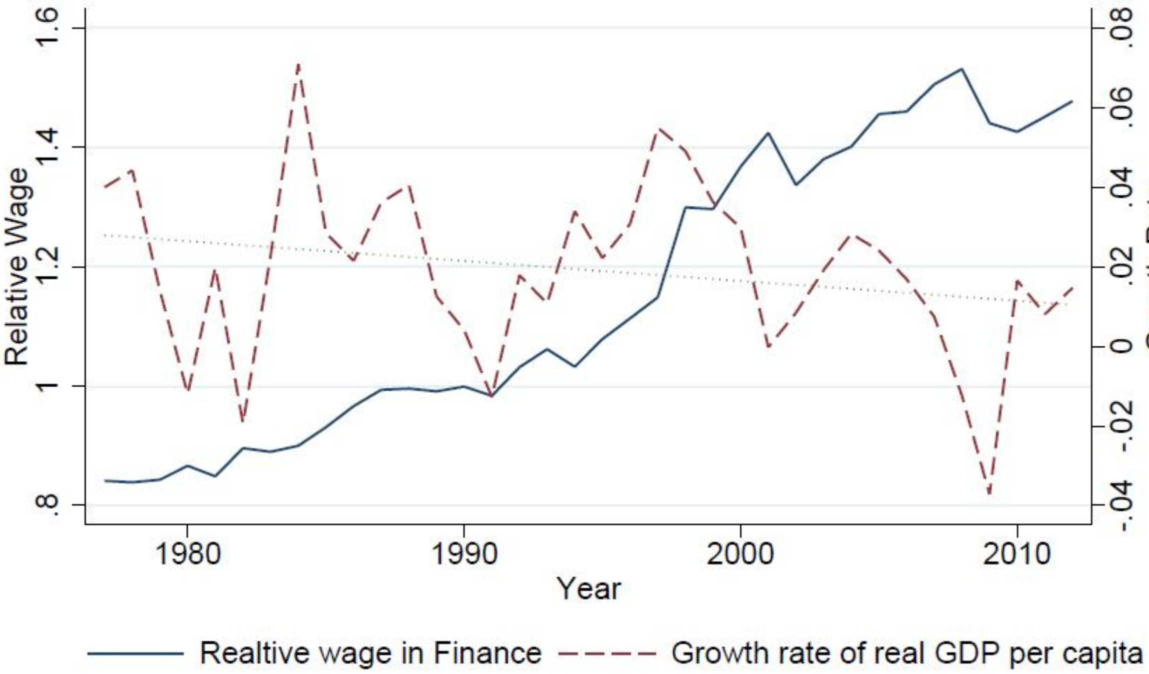
1 Introduction

Over the last century, the financial industry has grown substantially in many industrialized countries by various measures. The financial sector as a percentage of the U.S. GDP has increased from 1 percent in the mid-nineteenth century to about 8.4 percent in 2010 (Kedrosky and Strangler, 2011). Not only did the financial industry grow, but also the wages increased in this sector in both absolute and relative terms. While in 1980 financial employees in the United States earned about the same as comparable workers in other industries, in 2006 an average wage in the financial sector was 70 percent higher (Philippon and Reshef, 2012). Furthermore the authors emphasize that *relative* wages in finance compared to the rest of the private sector have followed an U-shaped pattern over the last century. It is a central conclusion of Philippon and Reshef (2013) that this rise in relative wages can at best partly be explained by the increase in the relative skill-intensity in the financial sector. Moreover, the question of whether this rise of the financial sector has a positive impact on economic growth has caused much debate over the years, especially after the financial crisis of 2007-2009.

This paper studies the relationship between financial intermediation, entrepreneurship and economic productivity (growth), constructing a tractable equilibrium model that helps understanding the observed empirical regularities. We motivate our theoretical model by observed empirical regularities, such as inter-industrial wage inequality, specifically comparing between finance and manufacturing, and economic growth using U.S. data from 1977 to 2015. Figure 1 reports the evolution of the relative wage in the financial sector compared to the manufacturing sector on the left axis and the growth rate of real GDP per capita on the right axis in the United States over the time period of 1977-2015. It is evident that on average during this time period the relative wage in the financial sector increased while the growth rate of real GDP per capita decreased. Figure **??** shows the sectoral employment shares of the financial sector and the manufacturing sector on the left axis and the total employment on the right axis in the United States for the same time period. It is apparent that the employment share of the manufacturing sector decreased over time whereas the employment share of the financial sector remained roughly constant. Since the absolute employment increased in both sectors, it follows that the number of employees in the financial sector must have grown faster than in the manufacturing industry. In this study, we want to examine the relationship between the empirical patterns suggested by these pictures both econometrically and theoretically.

We document a significant negative correlation between relative wage in the financial

Figure 1: Relative Wage in Finance and Growth Rate in the U.S.

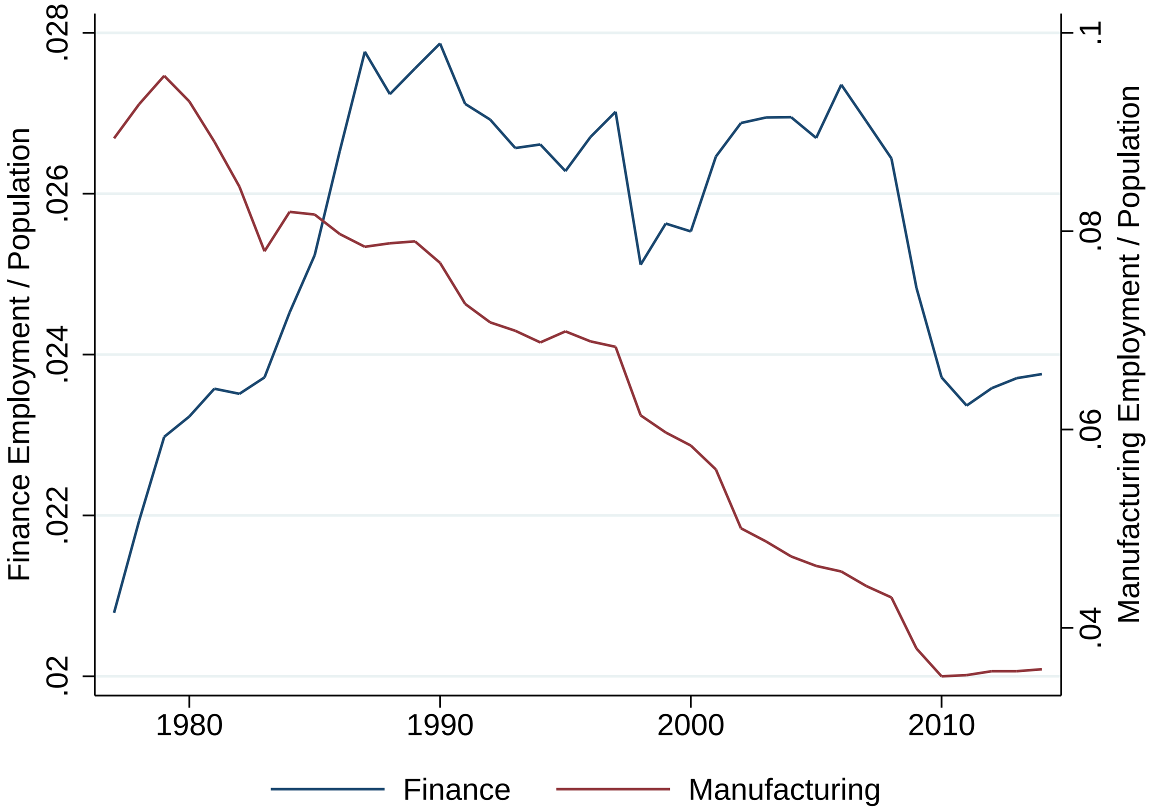


Note: This figure depicts the relative wage in finance, which is a ratio of the average wage in the financial sector to the average wage in the manufacturing sector, on the left axis and growth rate of real GDP per capita on the right axis as an average over all U.S. states excluding Washington D.C. Data sources: U.S. Census Bureau and U.S. Bureau of Economic Analysis.

sector compared to the manufacturing sector and the subsequent economic growth. This correlation turns out to be robust to different estimation methods, model specifications, and control variables. A similar while somewhat less robust result holds for the case of the relative sector size as measured by the number of employees or by the number of establishments in both sectors. These empirical findings stand in a sharp contrast to the previous studies on the relationship between finance and growth suggesting a positive correlation between financial development and economic growth. A well-functioning financial intermediation facilitates efficient allocation of capital, risk sharing, and information transmission, and herewith promotes technological innovation and fosters growth (see e.g. Levine, 1997; Beck et al., 2000; Beck et al., 2007). While most of these studies focus on the impact of financial frictions on economic output and the allocation of capital, this paper asserts that financial development has an important impact on the labour market and the allocation of human capital. We are convinced that the previous studies on the finance-growth nexus neglect the role of "upgraded wages" observed in recent years in the financial and business sectors.

This study hypothesizes that an important driving force behind the observed negative

Figure 2: Sectoral Employment in the U.S.



Note: This figure depicts the employment share in finance and manufacturing.Shares are the ratio of the number of employees in the that sector to the total number of employees. The left axis depicts the employment share for finance, the right axis the employment share of manufacturing. In the data, we excluded Washington D.C. Data source: County Business Patterns from U.S. Census Bureau.

correlation was the inefficient allocation of talent due to the fact that the financial sector paid relatively higher wages compared to the manufacturing sector wages, while we also seek to explain why such higher wages indeed were feasible. With an increased complexity in the financial activities, the financial sector and the entrepreneurial sector are competing for the same employees (Shu, 2013). In the theoretical part of our study we develop a two-sector equilibrium model, where financial intermediaries screen the potential entrepreneurs and provide financing to the most promising innovation projects. Since labour is a scarce resource in our model, the financial sector absorbs inefficiently many workers from the labour pool, due to the relatively higher wages, and in the competitive equilibrium the employment size in the financial sector is beyond the socially desirable optimum. The model exhibits the inverted U-shaped relationship between the aggregate output and the growing financial sector relative to the manufacturing sector as measured by the relative wage or the relative employment, which is consistent with the empirical findings of this study. This paper is organized as follows. Section 2 reviews the latest and the most relevant articles for our study. Section 3 develops our two-sector model with which we seek to explain an increasing wage gap jointly with a strongly growing financial sector. The model also predicts a negative correlation between relative wages in finance and economic growth which we assess in section 4.

2 Literature Review

A pioneering study on the allocation of talent and its implication for growth is the study by Murphy, Shleifer, and Vishny (1991). The authors develop a model of the allocation of talent between two sectors: productive and rent-seeking. They argue: "the allocation of talent has significant effects on the growth rate of an economy. ... The flow of some of the most talented people in the United States today into law and financial services might then be one of the sources of our low productivity growth. When rent-seeking sectors offer the ablest people higher returns than productive sectors offer, income and growth can be much lower than possible" (Murphy et al., 1991, p. 506). When talented people become entrepreneurs in the productive sector, they improve technology, and thereby contribute to productivity and foster growth. In contrast, in the rent-seeking sectors such as law, financial services, government bureaucracy, etc. most of the income is generated by the redistribution of wealth and not by wealth creation. If such sectors attract talented people by offering higher rewards, technological progress in the productive sector falls and the economy might stagnate. Indeed, the evidence shows that countries with a higher proportion of students with an engineering major grow faster, whereas countries with a higher proportion of students with a law major grow slower. Maloney and Caicedo (2017), confirm this buy showing for the U.S. that a one standard deviation increase in engineers in 1880 accounts for a 16% increase in US county income today. In addition, Acemoglu (1995) argues that the relative rewards of the different professions are a key factor in the allocation of talent. He develops an equilibrium model of the allocation of talent between productive activities such as entrepreneurship and unproductive activities, which bring positive return to the individual but not to society (such as rent-seeking). The existence of rent seeking creates a negative externality on productive agents, which implies that relative rewards are endogenously determined. More rent-seeking in a society reduces the return to both entrepreneurship and rent-seeking. If the relative return to entrepreneurship decreases faster, multiple equilibria may arise, and society may get trapped in a 'rent-seeking' steady state equilibrium.

King and Levine (1993) construct an endogenous growth model in which financial systems evaluate prospective entrepreneurs and fund the most promising projects. Similar to our theoretical model a more-developed financial system improves the probability of successful innovation also in their model. An important difference between their model and ours is that we relax the (unrealistic) assumption of equal wages across the sectors, and labour is a scarce resource in our model, which results in different predictions. While better financial systems in the King and Levine's (1993) model always accelerate economic growth, our model generates an inverted U-shaped relationship between financial development and productivity growth. Cecchetti and Kharroubi (2015) study in a theoretical model the real effects of financial sector growth, and conclude that a country's financial system causes lower productivity growth. As they argue, the reason might be that the financial sector competes with the rest of the economy with resources. In addition to that, high collateral, low productivity projects benefit disproportionately from financial sector growth, and that leads to overall lower productivity in the economy.

A recent study by Bolton, Santos, and Scheinkman (2011) proposes an equilibrium occupational choice model, where agents can choose to work either in the real sector (become entrepreneurs) or in the financial sector, which is segmented into two types of markets: organized, transparent markets and informal, opaque, over-the-counter markets (OTC). The talented employees in the financial industry are better able to determine the value of assets entrepreneurs put up for sale and can cream-skim the most valuable assets. The excessively high informational rents obtained by informed dealers (talents) in the OTC markets tend to attract too much talent to the financial industry. Moreover, the OTC markets tend to undermine the organized exchange markets, where only the less valuable assets are traded. Similarly, Shakhnov (2014) builds an occupational choice model, where agents are heterogeneous in terms of capital and talent. Talented agents can efficiently match investors with entrepreneurs by becoming bankers in financial intermediation, but they do not internalize the negative effect on the pool of talented entrepreneurs. As a result, the financial sector is inefficiently large in the equilibrium, and this inefficiency increases with wealth inequality. Thus, the model explains the simultaneous growth of wealth inequality and the financial industry observed in the U.S. during recent decades.

While the studies mentioned above focus primarily on the size of the financial sector, Axelson and Bond (2013) provide a dynamic equilibrium model based on the single friction of moral hazard that explains why employees in the financial sector are overpaid. They argue that many jobs in finance naturally feature large amounts of capital per employee as well as effort that is hard to monitor. This leads to overpayment of workers in the financial sector relative to workers with identical skills in other sectors, even when both labour and product markets are fully competitive. Moreover, the overpayment of workers depends on the labour force conditions when they enter the labour market, and this has life-long effects on a worker's career. Their model predicts that workers who enter the labour force in bad economic times have to work harder and are less likely to get an overpaid job, implying countercyclical productivity. Furthermore, the model predicts a misallocation of talent: overpaying jobs, like investment banking, attract talented workers whose skills might be socially more valuable elsewhere.

In recent years, there has been an increasing amount of empirical literature on the financial sector and its impact on economic growth. These studies provide significant evidence that during the last decades the financial industry has enormously increased in many advanced economies. They also find that there is either not a clear relation or even a negative relation between the growing financial sector, measured by e.g. the ratio of private credits to GDP or employment share in finance, and aggregate productivity growth in the cross-section of developed countries. This stands in contrast to the previous studies on the finance-growth nexus finding a positive relationship between financial development and economic growth. For an extensive literature review see Levine (2003, 2005).

Capelle-Blancard and Labonne (2011) use data for 24 OECD countries over the period of 1970-2008 and GMM estimation techniques to study the relationship between economic growth and the deepening of the financial sector based on its inputs rather than its outputs (e.g. relative employment in the financial sector). Their results confirm the absence of a positive relationship between financial deepening and economic growth for the OECD countries. Cecchetti and Kharroubi (2012) examine the impact of the size and growth of the financial system on aggregate productivity growth. Based on a sample of 50 developed and emerging economies over the period of 1980-2009, they find that the impact of financial development on growth depends on the level of aggregate economic development. That is, at low levels, a larger financial sector is associated with higher productivity growth, whereas in advanced economies more banking and more credit are associated with lower growth. The authors conclude "the level of financial development is good only up to a point, after which it becomes a drag on growth" (Cecchetti and Kharroubi, 2012, p. iii). Similarly, Gruendler and Weitzel (2013) use data from 188 countries between 1960 and 2010 and apply GMM (3SLS) estimation techniques to find that the financial system exerts a positive effect on economic growth in developing economies, whereas this effect vanishes or even becomes negative in advanced economies. Law and Singh (2014) show that there is a threshold effect in the finance-growth relationship using data from 87 developed and developing countries from 1980 to 2010 and a dynamic panel threshold method. Specifically, they find that the level of financial development is beneficial to growth only up to a certain threshold level, beyond which further financial development tends to adversely affect growth. The authors conclude that it is more important for policy makers to determine an "optimal" level of financial development than to simply carry on expanding the financial sector in order to facilitate economic growth.

A notable work by Philippon and Reshef (2012) investigates wages, education and occupations in the U.S. financial industry over the period of 1909-2006. They find that the financial industry is a high-skill and high-wage industry relative to the rest of the private sector in the periods before financial regulations were introduced and after these regulations were removed. During the depression era from the mid 1930s until the 1980s wages and skill intensity are similar in the financial sector and the rest of the economy. For instance, by 2006 the skill-premium for financial workers reaches 50% and for CEOs in finance 250%. In the another study Philippon (2011) measures the cost of financial intermediation as the sum of all profits and wages paid to financial intermediaries as a share of GDP and shows that the U.S. financial industry has become less efficient over the past century. The unit cost of financial intermediation grows from 2% in 1870 to almost 9% in 2010. Furthermore, Kneer (2012) finds that financial deregulation disproportionately reduces labour productivity in more high-skill intensive industries. Referring to the results of Philippon and Reshef (2012), that financial deregulation is associated with high-skilled labour in the financial sector, the author tests whether the financial sector absorbs talent at the cost of productivity in the real sector of the economy. At the same time, however, the real sector benefits from financial deregulation through improved intermediation services. The overall effect of reallocation of talent on labour productivity in the real sector depends on a combination of a sector's reliance on skilled labour and external funds.

To the best of our knowledge, no research has been done investigating the effect of increasing relative wages in the financial industry on the allocation of labour across economic sectors and, as a consequence, on economic growth. In this paper we aim to fill this gap in the literature. First, we find a significant negative correlation between an increase in relative wage in the financial sector compared to the manufacturing sector and subsequent economic growth using the U.S. panel data at the state level from 1977 to 2012. Furthermore, we conjecture that the main driving force behind the observed negative correlation is an inefficient reallocation of talented employees from the productive manufacturing sector to the financial sector due to the relatively higher wages in the financial industry. In the theoretical part of the current study we develop a tractable equilibrium model of financial intermediation, manufacturing, entrepreneurship, relative wage and output that helps to understand the empirical findings.

3 Theory

In this section we present a tractable equilibrium model of financial intermediation, entrepreneurship and final good production, where labour is the only input and in a fixed supply. There are two sectors: manufacturing and finance. A person can work in manufacturing, finance or become an entrepreneur. A fraction of the population is endowed with talent, which allows them to successfully manage an innovation project, if they get funding from the financial intermediaries. The financial sector requires labour to scan the economy for successful projects of the entrepreneurs. In the manufacturing sector the stock of current ideas is processed into a final good production using labour. Both sectors are competitive within, i.e. labour is paid its marginal product, but there is limited competition between the sectors, such that the law of one price does not apply. We can show that such a model may predict key empirical facts, such as increasing relative wages, increasing relative sector shares and decreasing production. The source of inefficiency is that, by competition between financial intermediaries, the financial sector fails to account for an absorption-of-labour effect. Our model suggests both the likelihood of inventing a new set of blueprints, which might become more difficult over time, and the rewards of a new idea, which might increase over time, to be important determinants of relative wages, labour allocation and ultimately economic growth. These channels are different from previous arguments concerning labour misallocation, such as rent-seeking or cream-skimming.

3.1 A Two-Sector Model

We consider a static two-sector model, consisting of a real (production) sector (hereinafter R-sector) and a financial sector (hereinafter F-sector). The final output Y is produced in the R-sector using knowledge (technology) state of the economy and labour as inputs. The total labour force of the economy L is fixed. Individuals in the R-sector are either employed in the final good production (L_R) or become entrepreneurs (e). Individuals not employed in the R-sector and neither entrepreneurs are employed in the F-sector (L_F). Successful entrepreneurs are capable of innovating new technologies, which increase labour productivity in the final good sector, but need external financing to cover their costs. Any labour allocation over the economy must satisfy the aggregate labour constraint:

$$L_R + e + L_F = L. \tag{1}$$

Manufacturing

There is a single final output of the economy (numeraire) produced in the real (production) sector by a unit mass of firms with L_R units of labour and technology level A, according to the aggregate production function:

$$Y = AL_R^{\alpha}, \qquad \alpha \in (0, 1). \tag{2}$$

The parameter α quantifies the elasticity of production with respect to labour, and in equilibrium also the share of total income earned in the R-sector.[1] For any given measure of workers L_R the labour market within the R-sector is perfectly competitive, and real sector firms take the wage w_R as well as the technology level A as given. The profit maximization in the R-sector then solves

$$\max_{L_R} \ \Pi_R = AL_R^{\alpha} - w_R L_R$$

which implicitly defines aggregate R-labour demand

$$\alpha AL_R^{\alpha} = w_R L_R \tag{3}$$

and R-sector profits

$$\Pi_R = (1 - \alpha)Y \tag{4}$$

Optimization and price-taking behaviour equates labour elasticity (α) with the income share of labour in the R-sector by (3), and implies that the remaining income, $(1 - \alpha)Y$, is earned as industry profits.

[1]This follows from equation (3) below. The fact that this share is fixed with a constant production elasticity greatly simplifies the analysis.

Technology

From equation (2), we see that technological knowledge increases labour productivity for a given level of employment in the R-sector. As in many endogenous growth models, technology is endogenous, too in our model and depends on the degree of innovation in the economy. Innovation is driven by successful entrepreneurs. Consider a measure e of entrepreneurs who are engaged in innovation activity to create new technologies. Assuming a complementary nature of the innovations, we let $A = \int_0^e a(i)di$, where $a(i)$ is each entrepreneur's expected knowledge contribution to the technology stock of the economy. For simplicity, we require the knowledge contribution to be of a binary nature, that is $a(i) \in \{0, q\}$, with $q > 0$. A *successful* entrepreneur contributes with a knowledge variety worth q to the current stock, whereas a unsuccessful one will have no contribution. It follows that, if $\hat{e} \leq e$ is the measure of successful innovators, then the available technology in the economy is

$$A = \hat{e}q \tag{5}$$

Financial intermediation

We consider a financial sector, where its prime economic role is to provide services of financial intermediation. The financial sector specifically provides the services of screening and evaluation of innovation projects, the financing of potential and promising entrepreneurs and the provision of risk sharing. Specifically, we assume that a unit measure of financial firms provide external financing to potential entrepreneurs.[2] Financial firms screen the real economy for innovators, and provide those with the required funds to accomplish their innovation activities. Without these funds there are no innovation activities and hence no innovations.[3] The main challenge to the F-sector is to provide funding for the most successful business proposals. In the model, we suppose that "talent" is of a binary nature, and only entrepreneurs "with talent" can become successful entrepreneurs, while untalented individuals always fail. If an individual is deemed to be talented, she receives entrepreneurial funding which covers her innovation expenses and opportunity costs. Each funded entrepreneur signs a contract with the financial firm that

[2] One could ask if the number of financial institutes might be related to subsequent economic activity. In general, we found only weak evidence for a correlation between the relative number of establishments in the financial sector compared to the manufacturing sector and subsequent economic growth. Moreover, we found that the relative size of the financial sector as measured by the number of employees (also compared to the manufacturing) correlates negatively with the subsequent growth, which follows the general intuition about misallocation in this paper.

[3] It can be shown that our main insights are not driven by this assumption.

it receives funding from. The contract specifies the financial firm's claims on the innovation rents earned by a successful entrepreneur, which will be a share γ of the profits made by the entrepreneur. In addition to that, the contract specifies the funding, w_e, that the entrepreneur receives. In our simple model, the funding amounts to the entrepreneurial wage w_e, which essentially reflects an entrepreneur's opportunity costs of not being employed in either sector. Further, we assume that the F-sector at least partly, that is $\gamma \in (0, 1]$, owns the business (e.g. the entrepreneur is its CEO). Financial firms believe that each successful innovation is worth V and, once funded, talented entrepreneurs develop a successful business, producing final output Y.[4]

Talent screening

Suppose that talent is distributed over the population according to the binary random variable X, where $P(X = T) \equiv \tau$ is the fraction of the population equipped with talent. Individuals requesting entrepreneurial funding send their business proposals (innovation project) to the F-sector for evaluation. For tractability reasons we assume that an individual can send its proposal only to one financial firm at random.[5] Let G denote the total measure of proposals sent out to the F-sector for evaluation. When considering an individual proposal, a financial firm must decide whether to fund or reject the business proposal. If the firm believes a proposal to be successful, its applicant receives entrepreneurial funding. Let $P(\hat{X} = T)$ denote the probability with which the firm believes the current proposal to be successful. Hence

$$P(\hat{X} = T) = P(\hat{X} = T|X = T)\tau + P(\hat{X} = T|X \neq T)(1 - \tau)$$

A rational firm wishes to maximize its probability of correctly awarding a grant, $P(\hat{X} = T|X = T)$, and to minimize its type I error of judgement, $P(\hat{X} = T|X \neq T)$. Specifically, let $s \in [0, \bar{s}]$ denote a firm's screening depth, and suppose that $p(s) \equiv P(\hat{X} = T|X = T, s)$ depends positively on s, while $\bar{p}(s) \equiv P(\hat{X} = T|X \neq T, s)$ depends negatively on s.[6] Finally, we assume that the overall screening cost of the F-sector is $c + k(s)$, where $c \geq 0$ is a fixed cost and $k(s)$ is a variable

[4]We abstract away from additional possible inefficiencies coming from imperfect monitoring.

[5]This avoids the complications arising from multiple screening of an entrepreneur. In reality, it occurs that several financial institutes examine the same business proposals, which may be a source of additional inefficiency effects.

[6]It should be remarked that any determination of $p(s)$ does not jointly pin down $\bar{p}(s)$ and $P(\hat{X} = T)$, which requires us to make a modeling assumption also about $\bar{p}(s)$.

part.[7] With the above specifications, profits in the F-sector are

$$\Pi_F = p(s)\tau GV - P(\hat{X} = T, s)Gw_e - c - k(s) \tag{6}$$

To keep the model simple, we assume a linear relation between the screening depth and a talent detection rate, and normalize $p(0) = \tau$, $p(\bar{s}) = 1$ and $\bar{p}(0) = \tau$, $\bar{p}(\bar{s}) = 0$. Then:

$$p(s) = \tau + \frac{s}{\bar{s}}(1 - \tau), \qquad \bar{p}(s) = \tau - \frac{s}{\bar{s}}\tau \tag{7}$$

Formulation (7) is intuitive. Without any screening, the F-sector has no way of telling apart talented and untalented applicants other than the prior statistics ($p(0) = \bar{p}(0) = \tau$), whereas perfect screening (if feasible) would imply a perfect talent recognition. How effective an additional unit of screening depth is depends on the screening efficiency $1/\bar{s}$ as well as on how scarce a resource talent is. If talent is very scarce (τ small), then it is most important to not miss the business opportunity in the rare event one actually receives a promising proposal.[8]

A convenient feature of equation (7) is that $P(\hat{X} = T) = \tau$, and hence, the overall fraction of awarded projects corresponds to the fraction of talents independently of s, i.e.

$$e = \tau G. \tag{8}$$

That is, more screening depth tilts the funding distribution towards its profitable usage. In our simple model screening depth depends on the measure of employees in the F-sector, where we set $s = L_f$. Then, the measure of successful entrepreneurs is

$$\hat{e} = \left(\tau + (1 - \tau)\frac{L_F}{\bar{s}}\right)\tau G \tag{9}$$

In the baseline model we assume that talent is irrelevant for the screening ability of a financial

[7]Having in mind potential learning and coordination effects, we assume that the variable part of the screening costs, $k(s)$, is independent of the overall screening size G. In the another version of the model screening costs become $cG + k(s)G$, which leads to a slightly more complicated equilibrium system, but yields the same insights as the simpler version of the main text.

[8]The ability of financial firms to recognize talents as a function of screening depth will affect how effective screening is. We could assume that individuals have no way of communicating their talent to the firm or cannot fully self-assess their potential as entrepreneurs. This is similar to King and Levine (1993), where the authors assume that entrepreneurs cannot evaluate themselves. It seems conceivable that financial professionals have more market knowledge and routine in judging the overall potential of a business plan than a single applicant.

firm.[9] Then, using (7) and $s = L_f$, equation (6) becomes

$$\Pi_F = \left(\tau + (1-\tau)\frac{L_F}{\bar{s}}\right)\tau G V - \tau G w_e - c - w_F L_F, \qquad L_F \leq \bar{s} \tag{10}$$

Competition between financial firms makes each individual firm behave as a wage-taker within the F-sector and requires the financial industry to make zero rents. The behaviour of the F-sector then is described by two equations: optimal screening depth and zero-profits.[10] This yields two equilibrium conditions of the F-sector:

$$\frac{1}{\bar{s}}(1-\tau)\tau V G = w_F \tag{11}$$

and

$$\tau V - w_e = \frac{c}{\tau G} \tag{12}$$

The central feature here is that when financial firms make their individual profit-maximizing screening (hiring) decisions, they do not take into account the externality that the aggregate hiring decisions of the F-sector imposes on the economy's potential to expand. Specifically, they take G and V as given characteristics of the economy. This ignorance is rational since an individual firm's hiring decision has no critical impact on the entire labour allocation of the economy nor on the earnings of a successful entrepreneur, while the aggregate sector activity is a crucial determinant of G and V. If profit expectations V increase, this yields a higher expected revenue of labour in the F-sector, which reinforces hiring activities. Competition among financial firms in the labour market then puts upward pressure on wages in the F-sector (as can be seen in equation (11)).

Innovation rents

The F-sector finances entrepreneurship because of the possible innovations rents earned by a successful company. We suppose that the overall value of innovation to the F-sector is deter-

[9] We modify this assumption in the extended version of the model, and show that the main predictions remain unchanged.

[10] We assume that the F-sector considers all proposals G.

mined by

$$V\hat{e} = \gamma \Pi_R \tag{13}$$

The parameter γ has at least two meaningful interpretations. First, it can be viewed as capturing the share of claims on profits that is acquired by the F-sector for its intermediation activity. In this case $\gamma \in (0, 1]$. We then think of the remaining claims absorbed by the governmental or legal institutions required to keep the economy running, but not otherwise used in a productive way.[11] Second, we can think of γ as expressing average profitability expectations in the F-sector. In this case $\gamma > 1$ is conceivable. For example, a very optimistic F-sector could expect the per-innovation profits to be much larger than justified by their fundamental value $\Pi_R/\hat{e}$.

What will be important for our later result is that the parameter γ co-determines the F-sectors expected rewards from funding successful projects and influences its hiring decisions, but is not otherwise relevant to the production process.

Labour Indifference Condition

We have assumed labour markets within each sector to be competitive, and firms behave as wage takers. In our simple baseline model an individual has two main career paths, either in the F-sector or in the R-sector. The labour indifference condition below then states that, from an ex-ante perspective, an individual must be indifferent between the two sectors in equilibrium. If an individual ends up working in the F-sector, he is employed at a wage w_F. People in the R-sector either remain workers or advance to entrepreneurs.[12] As argued above, we assume that individuals do not know their own talent *ex ante*, and thus their proposals are only useful to learn their talent in conjunction with a professional judgement obtained from the F-sector. For simplicity, we suppose that writing and sending a proposal to the F-sector is a free of cost activity[13], hence everybody in the R-sector writes one and

$$G = L - L_F. \tag{14}$$

[11] An alternative interpretation is that the remaining claims are randomly dispersed over the population, such that the labour indifference condition (15) is not altered.

[12] Hence, people in the F-sector do not write proposals. Loosely spoken, this reflects the idea that only people with some experience in the productive sector can become entrepreneurs. Our main results remain unchanged if we set $G = L$ instead.

[13] A more elaborate model might explicitly encompass the education system with its signalling power. However, a similar argument in that case would state that all people with a higher education might send out their applications, leaving the F-sector essentially with the same selection problem, whereas people with a lower education would simply become employed in the R-sector.

If the business plan of an individual in the R-sector gets rejected, which happens with an ex ante probability $(1-\tau)$, he becomes employed as a production worker and earns wage w_R. Otherwise, the individual becomes an entrepreneur, and earns a wage w_e with probability τ. This leads to the following labour indifference condition:

$$\tau w_e + (1-\tau) w_R = \theta w_F. \tag{15}$$

The parameter θ can be interpreted, for example, as a preference parameter, and captures the average willingness to substitute between the F-sector and the R-sector. A lower value of θ, for example, means that people are willing to forfeit some salary in order not to work in the F-sector. It should be noted that, by its ex-ante nature, condition (15) implies no systematic bias of talents towards the F-sector.[14]

3.2 Market Equilibrium

In this section, we show the competitive market equilibrium. The model is parametrized by $\{L, \alpha, q, \tau, \bar{s}, c, \gamma, \theta\}$. Our model encompasses 12 endogenous variables, which are

$$\{Y, A, L_R, L_F, e, \hat{e}, w_R, w_F, w_e, \Pi_R, G, V\},$$

described by a system of 12 equations: the labour conditions (1) and (15), the R-sector conditions (2) - (4), the F-sector conditions (11) - (13) and the entrepreneurial conditions (5), (8), (9) and (14).

To solve the model, we make the following simplifying assumptions on the screening costs of the F-sector: $c = 0$, $k(L_F) = w_R L_F$, i.e. the variable part of the costs is independent of G. Furthermore, we assume that the theoretical upper level of the screening depth in the F-sector is equal to the total supply of labour in the economy, i.e. $\bar{s} = L$.[15] We then obtain the following solutions to the equilibrium conditions: [16]

$$L_R = BL \tag{16}$$

$$L_F = (1 - \frac{1}{1-\tau} B) L \tag{17}$$

[14] This is a difference to the cream-skimming or rent-seeking literature. If a talent is also rewarded in the F-sector this might lead to additional biases of talent selection into the financial sector.

[15] If $s = \bar{s} = L$, everybody works in the F-sector and there is no production in the R-sector. Obviously, this cannot be an equilibrium outcome.

[16] For the derivation of the solution see Appendix A.

$$e = \frac{\tau}{1-\tau} BL \tag{18}$$

$$\hat{e} = \frac{\tau}{1-\tau}(1-B)BL \tag{19}$$

$$G = \frac{1}{1-\tau} BL \tag{20}$$

$$w_R = \alpha q \frac{\tau}{1-\tau}(1-B)B^{\alpha}L^{\alpha} \tag{21}$$

$$w_F = (1-\alpha)\gamma q \tau B^{1+\alpha}L^{\alpha} \tag{22}$$

$$w_e = (1-\alpha)\gamma q \tau B^{\alpha}L^{\alpha} \tag{23}$$

$$A = q\frac{\tau}{1-\tau}(1-B)BL \tag{24}$$

$$Y = q\frac{\tau}{1-\tau}(1-B)B^{1+\alpha}L^{1+\alpha} \tag{25}$$

$$\Pi_R = (1-\alpha)q\frac{\tau}{1-\tau}(1-B)B^{1+\alpha}L^{1+\alpha} \tag{26}$$

$$V = (1-\alpha)\gamma q B^{\alpha}L^{\alpha} \tag{27}$$

where $B = \frac{\alpha+(1-\alpha)\gamma\tau}{\alpha+(1-\alpha)\gamma\theta}$.

Illustration of the equilibrium

In this paragraph, we want to examine the evolution of the central variables of interest in equilibrium, namely the wage of financial sector workers relative to the wage of real sector workers, the employment in the financial sector relative to the real sector and the production of output in the real sector. For this purpose, we assume the following benchmark values for the parameters of the model:

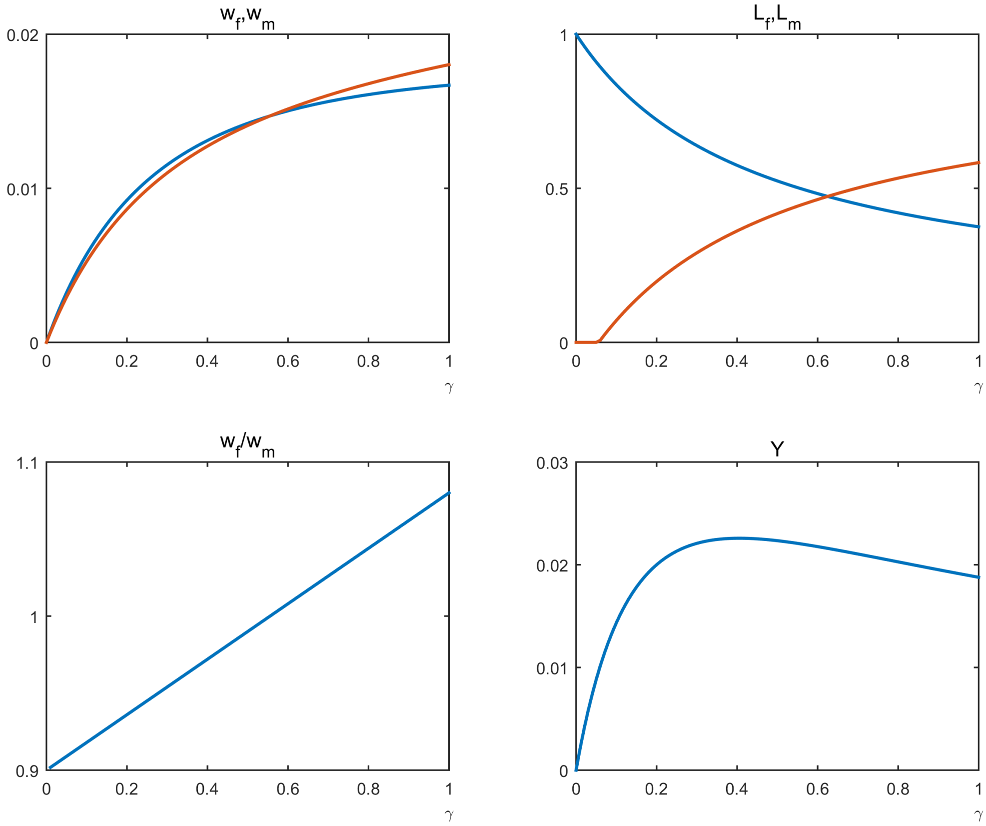
$$\alpha = 1/3, \tau = 0.1, q = 1, \bar{s} = L = 1, c = 0, \theta = 1.1$$

Figure 4 depicts the simulation results for the wages and labour in the financial and real sectors in the upper panel, and the relative wage and the final output in the lower panel as a function of the parameter γ.[17] The model predicts that the relative wage and the labour share in the financial sector are increasing functions of the parameter γ, whereas the final output is a hump-shaped function of γ in equilibrium. In other words, the aggregate output correlates non-monotonically with the growing financial sector as measured by the relative wage or the relative

[17] We have simulated the model for other parameters of the model, α and τ, as well. However, the simulation results for the parameter γ seem to be the best fitting the data and therefore, the most interesting for our study.

employment, which fits very well the evolution of the wages and labour shares in the financial and real sectors in the U.S. from 1977 to 2012 (see Figure 1 and 2). We want to leave a more detailed analysis of the parameter γ (i.e. the share of claims on profits of the F-sector in our model) and its evolution over time (which is supposed to be increasing) for future research.[18]

Figure 3: Wages, labour, Relative Wage and Output as Functions of γ



Note: this figure depicts wages (top left panel) and labour force (top right panel) in F-sector (red line) and R-sector (blue line), the ratio of the wage in F-sector to the wage in R-sector (bottom left panel) and the final good output (bottom right panel) as the functions of the parameter γ of the model.

3.3 Social Planner Equilibrium

In this section we define and calculate the Social Planner equilibrium and compare it with the competitive market equilibrium. It should be noted that the Social Planner solution here is a constraint first best choice, since the Social Planner himself doesn't know each individuals type, i.e. whether he has or hasn't the talent to run a successful innovation project. The

[18] An alternative possible interpretation of the parameter γ could be a belief in the financial sector about the profitability of entrepreneurship. Higher γ gives incentives to the F-sector for better screening and therefore to hire more labour at higher wages than the R-sector does. Another possible interpretations of γ could be an economy's leverage ratio or a level of financial markets regulation.

Social Planner maximizes real sector output. He thereby considers the constraints into its optimization.

$$\max_{L_R} \quad Y(L_R) = AL_R^{\alpha}$$
$$s.t.\ L = L_R + e + L_F$$
$$A = \hat{e} * q = p(s) * e * q$$
$$G = L - L_F$$
$$V = \gamma * (1-\alpha) * q * L_R^{\alpha}$$
$$p(s) = \tau + (1-\tau) * \frac{L_F}{L}$$

Therefore, the Social Planner problem reduces to the maximization of the following equation.

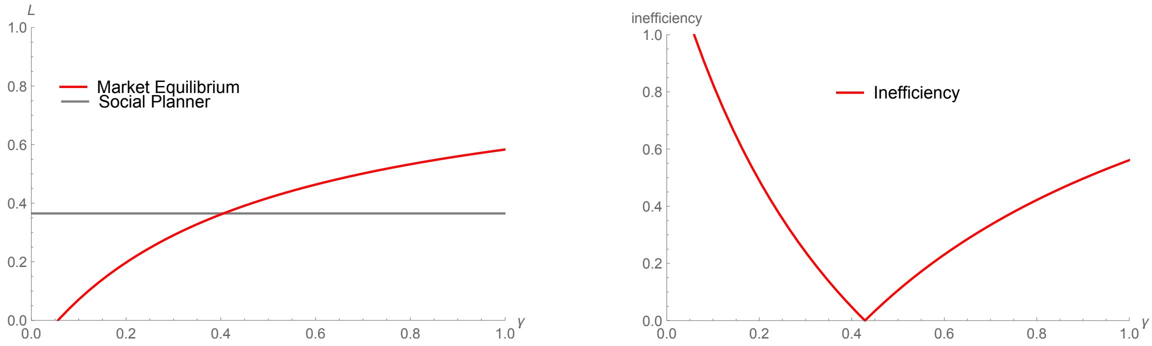
$$\max_{L_F} \quad Y(L_F) = \left[\tau + (1-\tau) * \frac{L_F}{\bar{L}}\right] * q * \tau(1-\tau)^{\alpha} * (L - L_F)^{1+\alpha} \tag{28}$$

Maximizing equation (28) with respect to L_F, yields the following optimal choice of worker in the financial sector by the Social Planner. In our baseline model, with $\sigma = 1$, we get the following choice of L_F:

$$L_F^{SP} = \left[\frac{(1-\tau) - (1+\alpha)\tau}{(1-\tau) * (2+\alpha)}\right] * L \tag{29}$$

In Figure 6, we compare graphically the to equilibria. As can be seen, for low levels of γ, the market evaluates the screening less then it would be socially optimal. Hence, the financial sector will funds less innovation activities and therefore there is low level of technological progress. With the increase in γ, the claims of the innovation rents going to the financial sector increase, and hence it is more profitable to engage more in screening and evaluation of proposals and subsequently finance more entrepreneurial activities. At some points, i.e. for high enough values of γ, the market overestimates the value of screening and evaluation of proposals, and hence the financial sector hires too many workers, relative to the Social Planner. The right panel of Figure (6) show the deviation of the market equilibrium from the optimal choice of the Social Planner.

Figure 4: Social Planner, Market Equilibrium and Inefficiency



3.4 Financial Market Regulator

In this section, we want to investigate, whether we can restore the constraint first best choice of a Social Planner and how his could be done. As mentioned above, each financial firm doesn't take into account that its hiring decision will have a negative effect on the aggregate economy. Furthermore, as the claims on profits that each financial firms receives (γ) from funded entrepreneurs, the inefficiency first decrease, but then the financial markets private returns from screening and evaluation and funding entrepreneurs are higher then the social return. Therefore, at some points the market equilibrium becomes again inefficiently large. In this section, we highlight that a financial regulator, taking these externalities into account, will lead us back to the social optimal choice.

The financial regulator takes the takes of optimizing the size of the financial sector, by maximizing total financial sector profits, taking into account all market informations.

$$\max_{L_F} \ \pi_F = \hat{e} * V - \tau * G * w_e - w_F * L_F \tag{30}$$

$$\begin{aligned} s.t. \quad G &= L - L_F \\ L_R &= (1-\tau)(L - L_F) \\ V &= \gamma(1-\alpha)qL_R^{\alpha} \\ w_R &= \alpha A q L_R^{\alpha-1} \\ \hat{e} &= p(s)\tau G \\ \theta w_F &= \tau w_e + (1-\tau) * w_R \\ p(s) &= \tau + (1-\tau) * \frac{L_F}{L} \end{aligned} \tag{31}$$

Plugging in the constraint we can rewrite the financial regulator's problem as

$$\max_{L_F} \ \pi_F = \left[\tau + (1-\tau) * \frac{L_f^{\sigma}}{L}\right] * (L - L_F)^{1+\alpha} \tau * q * (1-\tau)^{\alpha} [\gamma(1-\alpha) + \alpha]$$
$$- w_F(1-\theta) * L_F - w * L \tag{32}$$

Taking the derivative with respect to L_F, we can show that the optimal choice of the financial regulator is exactly the same as the choice of the Social Planner. It has to be note that for this to hold we need to set the parameter θ equal to one. Otherwise we would need to rewrite the Social Planner problem, too. The Social Planner doesn't care about workers preferences working in specific sectors, but care mainly about optimizing total production in the real sector, which is the consumption possibilities of all workers.

$$L_F^{FR} = \frac{(1-\tau) - (1+\alpha)\tau}{(1-\tau)(2+\alpha)} L \tag{33}$$

As can been seen, equation (33) and (29) are exactly the same, and hence, for all values of γ, the social optimum is restored by the financial regulator.

Summarizing, we presented a two-sector model of financial intermediation and manufacturing, where labour is a scarce resource, that is perfectly mobile within a sector but not between them, so that the law of one price (wage) does not hold. The baseline model incorporates several possible channels, which could explain the new stylized facts found by this study, namely the increasing relative wage and relative employment in the financial industry and the stagnating economic growth in the U.S. during the last three decades. It turns out that a change in the parameter γ can explain all empirical patterns over time. The model suggests that the main source of a negative effect of an expansion of the financial intermediation on an economy's productivity growth is that individual firms in the F-sector do not internalize the negative externality of their own hiring decision on the aggregate pool of labour force, and thereby their increasing size for the rest of the economy. With regard to the hypothesis stated at the beginning of the paper, in the present model there is no systematic flow of talent into the financial sector, because of the simplifying assumption that talent is not useful in the F-sector. However, already this simple static version of our model has succeeded well in fitting the real data on the relative wage and the relative employment in the financial industry in the U.S. observed during the last three decades. We conjecture, that in the generalized version of our model (which is currently in progress), where talented individuals have a higher marginal productivity also in finance and are paid accordingly, the inefficiencies associated with misallocation and the wage differentials become even worse.

4 Empirical Evidence

In this section we firstly introduce the data and the variables used in our study. Then we specify the model and econometric methods applied for the analysis. Finally, we perform the estimation results in the last subsection, where we first show empirical evidence for the hypothesis that an increase in relative wage in the financial sector compared to the manufacturing industry might have a negative impact on subsequent economic growth, and second, we provide various robustness tests of the obtained results.

4.1 Data and Variables

Our main data come from the County Business Patterns (CBP) provided by the U.S. Census Bureau. The CBP provides substantial economic statistics on U.S. business establishments at the state and industry levels. The data are arranged by the Standard Industrial Classification (SIC) System from 1977 to 1997 and the North American Industry Classification System (NAICS) from 1998 to 2012, and aggregated both at the Division level (4-digit codes) and at the Major Group level (6-digit codes), which hereinafter we call sectors and subsectors respectively.[19] Information is available on the number of establishments, employment, and annual payroll both at the sectoral and the subsectoral level. For our purposes, we first use the data set at the sectoral level and generate the following variables:

$$Annual\ Payroll_{s,t,i},\ Number\ of\ Employees_{s,t,i},\ Number\ of\ Establishments_{s,t,i},$$

$$Average\ Wage_{s,t,i} = \frac{Annual\ Payroll_{s,t,i}}{Number\ of\ Employees_{s,t,i}},$$

where s stands for state, t for year, and i for sector.[20]

Further, we generate a central variable of interest, the *Relative Wage*, which is a ratio

[19] The SIC is a United States government system for classifying industries, which was replaced by the NAICS starting in 1998. We applied the transition bridges between the both systems published on the same source to make the data consistent over the whole time period under consideration. For more information about the SIC and the NAICS see: http://www.census.gov/eos/www/naics/

[20] We are aware of the shortcoming of the variable *Average Wage*: there might be a lack of precision in the measurement of the actual average wage, because the variable Number of Employees consists of full-time and part-time employees. Ideally, we would use an hourly average wage for our analysis, however these statistics are not available in the provided data source. Our future research should overcome this measurement problem by using more comprehensive statistics.

of the average wage in the Finance, Insurance, and Real Estate Division (hereinafter the financial sector) to the average wage in the Manufacturing Division (hereinafter the manufacturing sector), i.e.:

$$Relative\ Wage_{s,t} = \frac{Average\ Wage_{s,t,f}}{Average\ Wage_{s,t,m}},$$

where f and m represent the financial sector and the manufacturing sector respectively.

The data on Gross Domestic Product, population size, government consumption and price indexes at the state and national levels come from the Regional Economic Accounts provided by the U.S. Bureau of Economic Analysis (BEA). We calculate the growth rate of real GDP per capita and the government share, which is the ratio of government consumption to GDP, for each state in each year. As the price indexes we use the GDP deflator to deflate GDP per capita, and the Consumer Price Index (CPI) to deflate the variable $Average\ Wage$ with a base year of 2009. Figure B1 in the appendix shows the time series of the growth rates of real GDP per capita for eight U.S. states over the time period from 1977 to 2012. There are significant differences between the growth rates in these states and their business cycle frequencies. However, in the long run the growth rates seem to move in a correlated fashion. The national recessions in 1980-1982, 1990-1991 and 2007-2009 are also remarkable on the graph.

To control for the size effects of the states, in addition to the real GDP per capita and the government share, we generate the next two control variables:

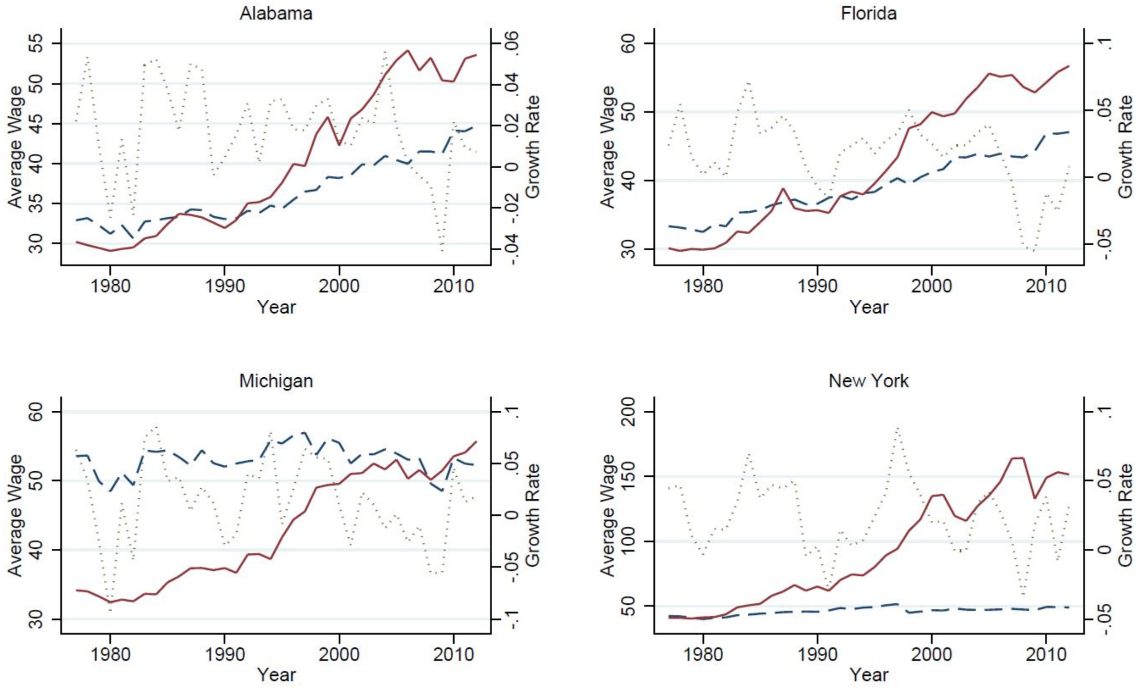
$$Total\ Number\ of\ Employees_{s,t} = \sum_{i=1}^{N} Number\ of\ Employees_{s,t,i},$$

$$Total\ Number\ of\ Establishments_{s,t} = \sum_{i=1}^{N} Number\ of\ Establishments_{s,t,i},$$

where N is a total number of sectors in state s.

We then select a sample of sectors and sub-sectors for which we have consistent data on both annual payroll and number of employees for the same time period. For this reason, we impose the following sample restrictions. We first exclude observations for which there is clear evidence of measurement error. In particular, we exclude observations with a negative annual payroll, and negative or zero number of employees. Further, to avoid outliers in the data we truncate the sample by excluding observations with an average wage lower than 5th percentile and greater than 95th percentile of the average wage distribution across sub-sectors in each state in each

Figure 5: Wage Dispersion and Growth Rates in U.S. states



Note: This figure depicts average wage in the financial sector (solid line) and manufacturing sector (dash line) on the left axis (thousands of U.S. dollars, base year 2009) and real GDP per capita growth rate (dot line) on the right axis for four U.S. states. Data sources: U.S. Census Bureau and U.S. Bureau of Economic Analysis.

year.

Figure 3 shows the dispersion of the average wages in the financial and the manufacturing sectors for four U.S. states over the period of 1977-2012. It is obvious from the figure that the growth rate of the real average wage in the financial sector was on average higher than in the manufacturing sector. The growth rate of real GDP per capita in these states is measured on the right axis of the graphs. We can show that there is a significant negative correlation between the relative wage in finance and economic growth rate in the U.S. states.

4.2 Model Specification and Estimation Methods

Having constructed the panel data set for fifty U.S. states for the time period of 1977-2012 as discussed above, we now investigate the following research question: what impact does a change in the relative wage in the financial sector compared to the manufacturing sector have on the subsequent economic growth within a given state on average? The growth model to be tested takes the following specification:

$$Growth_{s,t} = \beta_1 Relative\ Wage_{s,t-1} + \beta_2' CV_{s,t-1} + \beta_3 t\alpha_s + \alpha_s + \epsilon_{s,t}, \tag{34}$$

where s represents each state and t represents each time period (with $t = 1, 2 \ldots T$); $Growth_{s,t}$ is an average growth rate of real GDP per capita for state s during period t, $Relative\ Wage_{s,t-1}$ is a ratio of the average wage in the financial sector to the average wage in the manufacturing sector for state s in period $t-1$; $CV_{s,t-1}$ is a vector of control variables, which includes log of real GDP per capita, government share, log of total number of employees and log of total number of establishments for state s in period $t-1$; α_s are state dummies; and $\epsilon_{s,t}$ is the error term.

The empirical results and their interpretation strongly depend on an econometric method used for estimation. In this study investigating the empirical relationship between relative wage and economic growth, we use panel data estimation techniques. There are two methods commonly used to analyze panel data: Fixed Effects estimation (FE) and Random Effects estimation (RE). The key distinction between the FE and the RE estimations is that a RE estimator assumes that an unobserved, time constant, state specific effect is uncorrelated with all the explanatory variables in all time periods. This is quite a strong assumption and to verify this, there is a formal test called Hausman test, which specifies whether there are statistically significant differences between the FE and the RE estimates (Wooldridge, 2009, pp. 481-505). The Hausman test was applied to each regression in this study and in all cases it has rejected the RE estimation in favor of the FE estimation suggesting the presence of state specific effects, which supports the regression model stated above. Therefore, only the results of the fixed effects estimation will be performed.

The first problem, which can arise from estimating the equation (34) by the FE estimation, is endogeneity, since it contains a lagged endogenous variable (log of real GDP per capita) and therefore can lead to inconsistent and biased fixed effects estimators (Forbes, 2000, p. 876; Wooldridge, 2009, p. 503). To correct for this bias the Generalized Method of Moments (GMM) of Arellano-Bond dynamic panel technique (AB), which uses lagged values of each variable as instruments, and hence allows for some endogeneity in the regressions, is applied to the growth model (34). The estimation results by the AB method are discussed in the robustness section.

The second problem is that for both estimation methods, the FE and the GMM, a strong underlying assumption has to be satisfied, namely that the idiosyncratic errors are serially uncorrelated (Wooldridge, 2009, p. 504). Therefore, all estimations were carried out using robust standard errors clustered at the state level to control for the presence of heteroskedasticity in the error terms.[21] Moreover, as we have seen in Figure B1, there are large short-run fluctuations in the yearly growth rates of real GDP per capita. In order to eliminate large variation in the data we average all variables over non-overlapping four-year periods.[22] This provides several advantages: first it reduces serial correlation from the business cycles (Forbes, 2000, p. 873); second more relevant economic policy issue of medium-run response of economic growth to a change in the relative wage can be examined.[23] Further, the time variable, which indicates each period, interacted with the state dummies is included into the regression model to control for a state-specific linear trend.

The third problem in (34) is an implied state-specific linear trend in the growth process. To ease this restriction, additionally to the FE and the AB methods, the State and Time Fixed Effects with a state-specific linear trend (TFE), which includes state and period dummies, and hence allows for both state and time specific effects, and an individual linear trend within a state, is applied to the regression model (34). The estimation results of the TFE method are also performed in the robustness section.

4.3 Estimation Results

4.3.1 Relative Wage and Growth

The estimation results of the model (34) are reported in column (1) of Table 1. The estimated coefficients on the control variables have expected signs and are statistically significant in most cases. The growth rate depends negatively on the initial level of real GDP per capita, which implies conditional convergence in the U.S. states. For a given value of GDP, growth is negatively related to the government share in the previous period, which includes government consumption expenditures for civilian, military, the state and local sectors. The growth rate is positively related to the number of employees and negatively related to the number of establishments in the previous period. Quite possibly, the former suggests a positive size effect of labour

[21]The formal test for the second-order serial correlation was applied to each regression by the AB estimation method, and the null hypothesis of no autocorrelation could not be rejected at least at the 5% level.

[22]We also average the data over non-overlapping five-year periods. The estimation results are similar to those with the four-year averages, which provides an additional robustness test for our findings, i.e. the estimation results do not depend on the arbitrary chosen time period. The estimation results with the data averaged over five-year periods are available from the author.

[23]Generally, estimation using data averaged over certain periods of time is a common practice in the empirical growth literature (see e.g. Persson and Tabellini (1994), Barro (2000), Forbes (2000)).

Table 1: Estimation Results by State Fixed Effects with State-Specific Linear Trend

Dependent variable:	$Growth_{s,t}$			
Independent variables	(1)	(2)	(3)	(4)
$Relative\ Wage_{s,t-1}$	-0.0691***	-0.0577**	-0.0640**	-0.0729***
	(0.0237)	(0.0248)	(0.0241)	(0.0265)
$\log(real\ GDP\ per\ capita)_{s,t-1}$	-0.2799***	-0.2863***	-0.2589***	-0.2323***
	(0.0295)	(0.0289)	(0.0339)	(0.0329)
$Government\ Share_{s,t-1}$	-0.2460*	-0.3199**	-0.2754*	-0.2617*
	(0.1381)	(0.1413)	(0.1583)	(0.1390)
$\log(Total\ Number\ of\ Employees)_{s,t-1}$	0.1368***	0.1203***	0.1018***	0.0988***
	(0.0309)	(0.0334)	(0.0353)	(0.0303)
$\log(Total\ Number\ of\ Establishments)_{s,t-1}$	-0.0610***	-0.0587***	-0.0524***	-0.0856***
	(0.0153)	(0.0166)	(0.0151)	(0.0191)
$Gini\ (Average\ Wage)_{s,t-1}$		-0.2602*		
		(0.1385)		
$Relative\ Employment_{s,t-1}$			-0.0377***	
			(0.0124)	
$Relative\ Establishment_{s,t-1}$				-0.0266***
				(0.0070)
Observations	400	400	400	400
Within R-sq	0.68	0.68	0.69	0.73

Notes: This table reports estimation results with the data averaged over four-year periods from 1977 to 2012. The clustered robust standard errors are in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% level respectively. Estimation method: State Fixed Effects with state-specific linear trend. Data sources: County Business Patterns from U.S. Census Bureau, Regional Economic Accounts from U.S. Bureau of Economic Analysis.

on economic performance of a state and the later result suggests the inefficiency of fix costs replications of firms in that state. There is an upward state-specific linear trend in the growth process, i.e. the estimates on the interaction terms of the time variable and the state dummies are in most cases positive and statistically significant (not shown in the table). The within R-square in the FE estimation can be interpreted as the amount of time variation in the growth rate that is explained by the time variation in the explanatory variables within a given state (Wooldridge, 2009, p. 484).

The estimated coefficient on the central variable of interest, the relative wage in the financial sector, is negative and statistically significant at the 1% level. The FE estimate suggests that a ceteris paribus increase in the relative wage by 10 percentage points in a given state would have resulted in a 0.69 percentage point lower growth rate in that state during the next four-year period on average. Thus, the relative wage in the financial sector compared to the manufacturing sector correlates negatively with the subsequent growth rate of real GDP per capita within a state across time. Since this result challenges previous econometric work on the finance-growth nexus, and also since the model specification and the estimation method may influence the coefficient estimates, in the next section we perform several robustness tests of the obtained result.

4.3.2 Robustness Analysis

First, we want to examine whether the estimation results change if we add further control variables to the regression model (34). For instance, we want to test whether the estimated negative coefficient on the relative wage stays significant if we control for the wage inequality across all sectors of the economy. As in the major literature examining the relationship between inequality and growth we use a Gini coefficient as our measure of intersectoral wage inequality. We have calculated Gini coefficients using the distribution of the variable $Average\ Wage$ at the subsectoral level for each state in each year.[24] Figure B2 in the appendix shows the evolution of the Gini coefficients for eight U.S. states over the time period from 1977 to 2015. There are significant differences between the states: for example Florida always has a lower Gini coefficient than Alabama. From the figure it is apparent that the level of inter-sectoral wage inequality as measured by the Gini coefficients has risen over time on average in all states, and that there is an increasing dispersion of inter-sectoral wage inequality among the states after the end of the 90's.

We average the Gini coefficient over four-year periods as well, and add it to the previous regression model. Column (2) of Table 1 reports the estimation results. The estimated coefficients on the control variables do not substantially change from column (1). The estimated coefficient on the Gini coefficient is negative and statistically significant at the 10% level. The result suggests that if inter-sectoral wage inequality as measured by the Gini coefficient would have increased by 10 percentage points given all other variables remain the same, the real GDP per capita had grown by 2.6 percentage point slower in the next period. However, the estimated coefficient on the variable of interest, the relative wage in the financial sector, is still negative and statistically

[24] We use data at the subsectoral level to calculate the Gini coefficients, since it provides a finer classification of industries. The estimation results do not substantially change if we use data at the sectoral level instead.

significant at the 5% level. Moreover, the magnitude of the coefficient remains roughly the same. A 10 percentage points increase in the relative wage is correlated with 0.58 percentage point decrease in average growth rate over the next four-years period. Thus, controlling for the level of inter-sectoral wage inequality within a given state does not alter the negative coefficient on the relative wage in the financial sector in our growth regression model.

Next, we want to verify whether the results change if we control for the relative size of the financial and the manufacturing sectors. For this purpose we generate the following two variables:

$$Relative\ Employment_{s,t} = \frac{Number\ of\ Employees_{s,t,f}}{Number\ of\ Employees_{s,t,m}},$$

$$Relative\ Establishment_{s,t} = \frac{Number\ of\ Establishments_{s,t,f}}{Number\ of\ Establishments_{s,t,m}},$$

where s stands for state, t for year, f and m for the financial and the manufacturing sectors respectively.

Again we average the new variables over non-overlapping four-year periods and add them to the regression model (34). The estimation results are reported in columns (3) and (4) of Table 1 respectively. The estimates of the relative wage are still negative and statistically significant at least at the 5% level in both columns. The estimated coefficients on the relative employment and the relative establishment are also negative and statistically significant at the 1% level. Overall, the last results indicate that there is an evidence for a significant negative correlation between the growing financial sector, as measured by the relative wage and the relative size of the sector, and the subsequent economic growth in the U.S. states during the time period from 1977 to 2015.

As discussed above, we apply alternative estimation methods to the regression model (34), namely the TFE and the AB. The estimation results are reported in Table B1 and B2 respectively in the appendix, where the estimation results with the additional control variables (i.e. Gini coefficient, relative employment, and relative establishment) are also performed. The estimated coefficients on the control variables do not substantially change from Table 1. However, their significance level worsens once we control for time fixed effects or apply the dynamic panel estimation method. For example, the estimated coefficient on the government share is still negative, but becomes statistically insignificant. The positive coefficient on the total number of employees becomes statistically insignificant as well. The estimate of the Gini coefficient is still

Table 2: Estimation Results for the Major Groups of the Financial Sector

Dependent variable:			$Growth_{s,t}$		
Independent variables	(1)	(2)	(3)	(4)	(5)
$Relative\ Wage\ 1_{s,t-1}$	-0.0824***				-0.0138
	(0.0172)				(0.0201)
$Relative\ Wage\ 2_{s,t-1}$		-0.0156***			-0.0098*
		(0.0048)			(0.0050)
$Relative\ Wage\ 3_{s,t-1}$			-0.1003***		-0.0419*
			(0.0145)		(0.0212)
$Relative\ Wage\ 4_{s,t-1}$				-0.1405***	-0.0908***
				(0.0155)	(0.0207)
$\log(real\ GDP\ per\ capita)_{s,t-1}$	-0.2628***	-0.2899***	-0.2802***	-0.2180***	-0.2521***
	(0.0304)	(0.0356)	(0.0275)	(0.0262)	(0.0314)
$Government\ Share_{s,t-1}$	-0.1946	-0.3250**	-0.1268	-0.0246	-0.0696
	(0.1419)	(0.1329)	(0.1296)	(0.1353)	(0.1216)
$\log(Total\ Number\ of\ Employees)_{s,t-1}$	0.1261***	0.1169***	0.1536***	0.1353***	0.1506***
	(0.0302)	(0.0318)	(0.0285)	(0.0228)	(0.0309)
$\log(Total\ Number\ of\ Establishments)_{s,t-1}$	-0.0623***	-0.0289*	-0.0827***	-0.0616***	-0.0866***
	(0.0146)	(0.0172)	(0.0138)	(0.0153)	(0.0170)
Observations	400	391	400	399	391
Within R-sq	0.68	0.66	0.71	0.72	0.74

Notes: This table reports estimation results with the data averaged over four-year periods from 1977 to 2012. The clustered robust standard errors are in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% level respectively. Estimation method: State Fixed Effects with state-specific linear trend. Data sources: County Business Patterns from U.S. Census Bureau, Regional Economic Accounts from U.S. Bureau of Economic Analysis.

negative, but it is statistically significant only by the AB estimation method (see column (2) of Table B2). The negative estimates of the variables measuring the relative size of the financial sector, namely the relative employment and the relative establishment, remain statistically significant at least at the 10% level. Nevertheless, the central result of our study, i.e. the negative coefficient on the relative wage in the financial sector, stays highly statistically significant no matter which additional control variables are included into the regression or which estimation method is used.

As a next interesting side result of our study we examine how the estimation results change if we split the relative wage into the major subsectors within the financial sector. For this purpose we use the data at the subsectoral level and calculate the relative wages for the following four major subgroups of the Finance, Insurance, and Real Estate Division: (1) Banking, Credit Intermediation, and Related Activities; (2) Securities, Commodity Contracts, and other Financial Investments and Related Activities; (3) Insurance Carriers, and Related Activities; (4) Real Estate.[25] Then we run the same regression as in (1) but with the variable $Relative\ Wage$ calculated for each major group of the financial sector, which we call $Relative\ Wage$ 1, $Relative\ Wage$ 2, $Relative\ Wage$ 3, $Relative\ Wage$ 4 respectively. Table 2 shows the estimation results for each major group separately in columns (1) to (4) and for all major groups combined in one regression in column (5). Interesting result is that, when estimating coefficients on the relative wage in each major group separately, the estimates are both negative and statistically significant at the 1% level. However, when the relative wages of all groups are included into one regression, the estimates on the relative wages in groups 1, 2, and 3 become less significant and only the estimate on the relative wage in the fourth group stays significant at the 1% level. Also the magnitude of the negative effect of the relative wage on growth increases compared to the result of Table 1. That is, a 10 percentage points increase in the relative wage of the Real Estate sector, which includes among others real estate brokers, lessors, and property managers, would have resulted in a 0.9 percentage point lower growth rate in the next period within a given state on average (see column (5) of Table 2).

To summarize this section, the estimated negative correlation between the relative wage in the financial sector compared to the manufacturing sector and the subsequent growth rate of real GDP per capita within a state across time is robust to various model specifications and estimation methods.

4.3.3 Reverse Causality

So far, the effect of the relative wage in the financial sector on the subsequent growth rate was estimated. However, since any estimation method yields a correlation between variables, which does not imply causality, the results should be interpreted with caution. The estimated causal effect may be distorted by reverse causation leading to simultaneity bias (Persson and Tabellini, 1994, pp. 608-609). In particular, a systematic relation between the relative wage in the financial sector and the growth rate of real GDP per capita gives rise to a simultaneity problem. First note that direct reverse causation is ruled out, because the relative wage is

[25] The complete list of the subsectors of each major group can be found here: http://www.census.gov/eos/www/naics/

lagged by one period in our regression model and so is statistically predetermined relative to the growth rate. However, a systematic relation between the relative wage and growth would make the relative wage correlated with lagged growth. To explore this possibility, we look at the reverse direction of causation and estimate the following model:

$$Relative\ Wage_{s,t} = \beta_1 Growth_{s,t-1} + \beta_2' CV_{s,t-1} + \beta_3 t\alpha_s + \alpha_s + \epsilon_{s,t} \tag{35}$$

Table B3 in the appendix reports the estimated coefficients by the FE, the TFE, and the AB methods in columns (1), (2), and (3) respectively. The coefficient estimates on the lagged value of the growth rate suggest that there is no systematic relation between the relative wage and growth, but quite the contrary: a higher growth rate predicts higher relative wage in the next period, which is significant only by the AB estimation.

Although we did not find evidence for a systematic relation between the relative wage and growth, there are might be other sources of reverse causation, e.g. the financial sector or the manufacturing sector might rise their wages in expectation of higher growth in the future. However, a test of such direction of causation is beyond the scope of the present study.[26] In the future research we intend to use Instrumental Variables (IV) as a method in estimating model (1). But firstly we must identify appropriate instruments for the relative wage in the financial sector. For that reason, in the next section we develop a theory that helps to find out possible channels, through which an increase in the relative wage in the financial sector might have a negative impact on economic growth.

5 Conclusion

The present study is set out with the aim of assessing the empirical relationship between inter-industrial wage inequality and economic growth in the U.S. states during the time period of 1977-2012. The following conclusions can be drawn. The econometric results have shown that generally there is a significant negative correlation between inter-sectoral wage inequality and subsequent economic growth within a state over time. The most robust finding is a negative effect of the relative wage in the financial sector compared to the manufacturing sector on the subsequent growth rate of real GDP per capita. A similar while somewhat less robust result

[26]Certainly, we are aware of other possible econometric problems such as omitted variables bias and measurement error. We leave a more detailed discussion on these issues for future work.

applies to the case of the relative sector size as measured by the number of employees or by the number of establishments in both sectors.

In the theoretical part of the present study we developed a static version of the two-sector equilibrium model of financial intermediation, entrepreneurship, relative wage and output in an attempt to explain the observed empirical patterns. The model generates two important insights about the financial sector. First, the size of the financial sector as measured by the size of the labour force might be inefficiently large in the decentralized equilibrium. Intuitively, competition in the financial sector makes this sector blind for its aggregate absorption of its underlying source of profits, namely potential entrepreneurs with significant abilities to advance the real economy by their innovations. Second, an increase in the financial claims on the revenues earned by successful entrepreneurs yields increasing relative wages in the financial sector despite an overall diminishing productivity. While it is rational for individual banks to hire more employees as profitability prospects increase, competition in the market does not mediate the aggregate externality of depleting the innovative potential of the economy since individual firms have only a small impact. As a consequence, equilibrium output depends in a hump-shape fashion on the financial involvement in the economy.

This research also highlights the need for further investigation. First, further econometric analysis is necessary to understand the relationship between the relative wage in the financial sector and economic growth by applying the instrumental variables estimation techniques. Second, considerably more research needs to be carried out on the hypothesis proposed within this thesis to understand what mechanism can explain the negative impact of an increase in the relative wage in finance on economic growth most accurately. In particular, it would be interesting to investigate empirically the impact of the banking sector regulations on wages in this sector, and their consequences for aggregate productivity growth. Third, further work should be undertaken on developing a generalized dynamic version of our theoretical model. We strongly believe that future research on the mentioned issues is very promising and encouraging.

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A Appendix

A.1 Derivation of the solution to the equilibrium conditions

We have a system of 12 equations in 12 unknowns:

$$w_F = (1-\tau)\tau\frac{GV}{L}$$

$$w_e = \tau V$$

$$w_R = \alpha A L_R^{\alpha-1}$$

$$\tau w_e + (1-\tau)w_R = \theta w_F$$

$$L_F = L - L_R - e = L - \frac{1}{1-\tau}L_R$$

$$G = L - L_F = L_R + e = \frac{1}{1-\tau}L_R$$

$$e = \tau G = \frac{\tau}{1-\tau}L_R$$

$$\hat{e} = (\tau + (1-\tau)\frac{L_F}{L})e = \frac{\tau}{1-\tau}(1-\frac{L_R}{L})L_R$$

$$A = \hat{e}q = q\frac{\tau}{1-\tau}(1-\frac{L_R}{L})L_R$$

$$Y = AL_R^{\alpha} = q\frac{\tau}{1-\tau}(1-\frac{L_R}{L})L_R^{1+\alpha}$$

$$\Pi_R = (1-\alpha)Y = (1-\alpha)q\frac{\tau}{1-\tau}(1-\frac{L_R}{L})L_R^{1+\alpha}$$

$$V = \frac{\gamma\Pi_R}{\hat{e}} = \gamma(1-\alpha)qL_R^{\alpha}$$

We can reduce this system to the system of 4 equations in 4 unknowns as follows:

$$w_F = (1-\alpha)\gamma q\tau\frac{L_R^{1+\alpha}}{L}$$

$$w_e = (1-\alpha)\gamma q\tau L_R^{\alpha}$$

$$w_R = \alpha q\frac{\tau}{1-\tau}(1-\frac{L_R}{L})L_R^{\alpha}$$

$$\tau w_e + (1-\tau)w_R = \theta w_f$$

Plugging the first three equations into the fourth one and solving for L_m yields the following expression:

$$L_R = \frac{\alpha + (1-\tau)\gamma\tau}{\alpha + (1-\alpha)\gamma\theta} L$$

The solutions for other variables follow directly from this result.

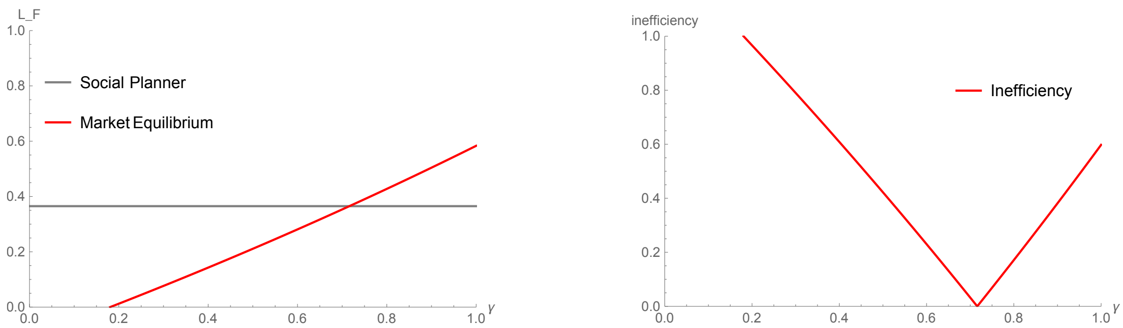
A.2 Alternative Labor Indifference Condition

In this section, we would like to check the model for robustness. That is, using instead of equation (15), we use the alternative labour indifference condition, where the entrepreneurs can keep some fraction of the innovation rents. That is, the new labour indifference condition becomes:

$$\tau(w_e + p(s)W) + (1-\tau)w_R = \theta w_F, \tag{36}$$

where $W = (1-\gamma)\pi_R/\hat{e}$. Hence, instead of, as assumed in the main text, that the share $(1-\gamma)$ is captured by the government, this share of the innovation rents are captured by the entrepreneur, either in a way of a bonus, granted by the financial sector firm, as a bonus for the entrepreneurs good CEO accomplishments, or indirectly, in the way that the entrepreneur can hide some of the innovation rents to the financial firm (e.g. by wrongly reporting the firms business results, etc.). All results mentioned in the main text hold with this alternative labour indifference condition, too. The only difference is that the point where the financial sector starts to become too large is higher then compare to the first specification of the labour indifference condition.

Figure 6: Social Planner, Market Equilibrium and Inefficiency II



A.3 Alternative Screening Technology

$$p(s) = \tau + \frac{s}{\bar{s}}(1-\tau), \qquad \bar{p}(s) = \tau - \frac{s}{\bar{s}}\tau \tag{37}$$

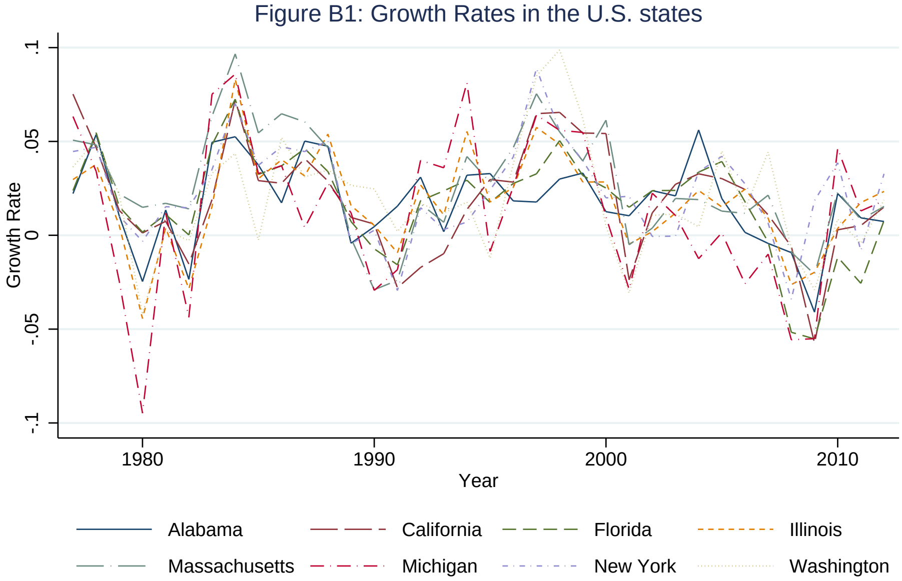
In the main text, we assumed in equation (7) that $s = L_F$, and $\bar{s} = L$. Here instead we would like to check, whether results depend on the way we defined the screening technology. Let us for therefore assume that there are decreasing marginal gains from additional workers in screening. That is, we assume $s = L_F^\sigma$ instead, where $\sigma \in (0, 1]$. The screening technology then becomes:

$$p(s) = \tau + (1-\tau)\frac{L_F^\sigma}{L} \tag{38}$$

We can show that all results mentioned above, do hold with this alternative specification of the screening technology.

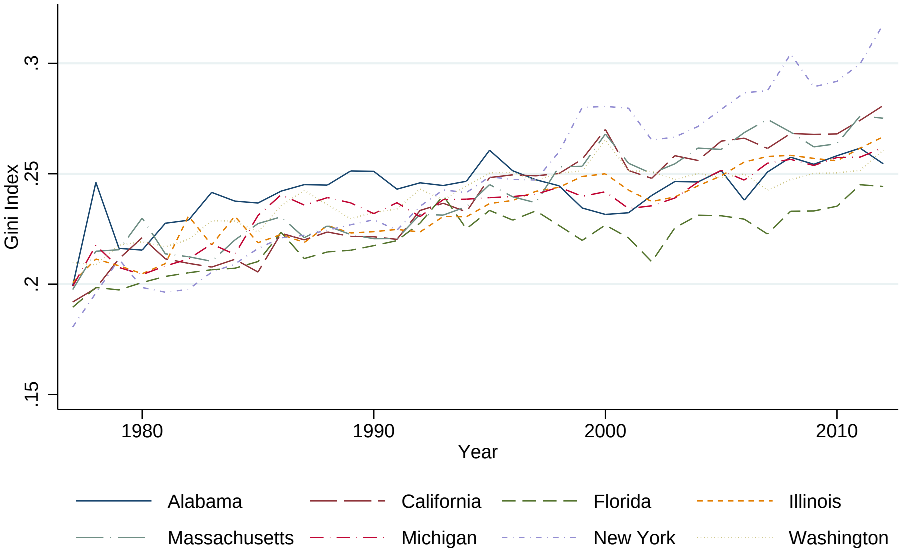
B. Figures and Tables

Figure B1: Growth Rates in the U.S. states



Notes: this figure depicts the time series of real GDP per capita growth rates for eight U.S. states.
Data source: Regional Economic Accounts from U.S. Bureau of Economic Analysis.

Figure B2: Increasing Intersectoral Wage Inequality in the U.S. states



Notes: this figure depicts Gini coefficients of the Average Wage distribution over all sectors for eight states.
Data source: County Business Patterns from U.S. Census Bureau.

Table B1: Estimation Results by Time and State Fixed Effects with State-Specific Linear Trend

Dependent variable:	$Growth_{s,t}$			
Independent variables	(1)	(2)	(3)	(4)
$Relative\ Wage_{s,t-1}$	-0.0563***	-0.0507***	-0.0562***	-0.0841***
	(0.0149)	(0.0145)	(0.0153)	(0.0222)
$\log(real\ GDP\ per\ capita)_{s,t-1}$	-0.1795***	-0.1810***	-0.1778***	-0.1797***
	(0.0279)	(0.0280)	(0.0281)	(0.0247)
$Government\ Share_{s,t-1}$	-0.0283	-0.0443	-0.0772	-0.0665
	(0.1441)	(0.1433)	(0.1531)	(0.1371)
$\log(Total\ Number\ of\ Employees)_{s,t-1}$	0.0199	0.0156	0.0091	0.0064
	(0.0331)	(0.0319)	(0.0369)	(0.0285)
$\log(Total\ Number\ of\ Establishments)_{s,t-1}$	-0.0694**	-0.0720**	-0.0631*	-0.0335
	(0.0324)	(0.0326)	(0.0337)	(0.0348)
$Gini\ (Average\ Wage)_{s,t-1}$		-0.1585		
		(0.1269)		
$Relative\ Employment_{s,t-1}$			-0.0188*	
			(0.0107)	
$Relative\ Establishment_{s,t-1}$				-0.0203**
				(0.0096)
Observations	400	400	400	400
Within R-sq	0.76	0.76	0.76	0.77

Notes: This table reports estimation results with the data averaged over four-year periods from 1977 to 2012. The clustered robust standard errors are in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% level respectively. Estimation method: State and Time Fixed Effects with state-specific linear trend. Data sources: County Business Patterns from U.S. Census Bureau, Regional Economic Accounts from U.S. Bureau of Economic Analysis.

Table B2: Estimation Results by the GMM of Arellano-Bond

Dependent variable:	$Growth_{s,t}$			
Independent variables	(1)	(2)	(3)	(4)
$Growth_{s,t-1}$	-0.0686***	-0.0664***	-0.1381***	-0.1712***
	(0.0246)	(0.0243)	(0.0295)	(0.0290)
$Relative\ Wage_{s,t-1}$	-0.0692***	-0.0520***	-0.0557***	-0.0714***
	(0.0171)	(0.0169)	(0.0171)	(0.0154)
$\log(real\ GDP\ per\ capita)_{s,t-1}$	-0.1857***	-0.2075***	-0.1725***	-0.1674***
	(0.0272)	(0.0297)	(0.0357)	(0.0319)
$Government\ Share_{s,t-1}$	-0.0882	-0.2579*	-0.2119	-0.1996
	(0.1507)	(0.1507)	(0.1620)	(0.1640)
$\log(Total\ Number\ of\ Employees)_{s,t-1}$	0.0247	0.0100	-0.0035	0.0336
	(0.0217)	(0.0225)	(0.0218)	(0.0221)
$\log(Total\ Number\ of\ Establishments)_{s,t-1}$	-0.0509***	-0.0556***	-0.0324**	-0.0715***
	(0.0181)	(0.0187)	(0.0162)	(0.0225)
$Gini\ (Average\ Wage)_{s,t-1}$		-0.5411***		
		(0.1226)		
$Relative\ Employment_{s,t-1}$			-0.0555***	
			(0.0122)	
$Relative\ Establishment_{s,t-1}$				-0.0300***
				(0.0062)
Observations	350	350	350	350

Notes: This table reports estimation results with the data averaged over four-year periods from 1977 to 2012. The robust standard errors are in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% level respectively. Estimation method: Generalized Method of Moments (GMM) of Arellano-Bond. Data sources: County Business Patterns from U.S. Census Bureau, Regional Economic Accounts from U.S. Bureau of Economic Analysis.

Table B3: Reverse Causality

Dependent variable:		$Relative\ Wage_{s,t}$	
Estimation method:	FE	TFE	AB
Independent variables	(1)	(2)	(3)
$Growth_{s,t-1}$	0.3492	-0.0131	0.5748***
	(0.2270)	(0.1864)	(0.1366)
$\log(real\ GDP\ per\ capita)_{s,t-1}$	-0.7526***	-0.2303	-0.3463***
	(0.1517)	(0.1720)	(0.0938)
$Government\ Share_{s,t-1}$	-3.8032***	-0.8846	-4.0464***
	(0.9822)	(1.0765)	(1.2358)
$\log(Total\ Number\ of$	0.2707**	-0.3037	-0.5012***
$Employees)_{s,t-1}$	(0.1239)	(0.2674)	(0.1546)
$\log(Total\ Number\ of$	-0.2373**	0.0905	0.2294***
$Establishments)_{s,t-1}$	(0.1070)	(0.3335)	(0.0691)
$Relative\ Wage_{s,t-1}$			0.6800***
			(0.0365)
Observations	400	400	350
Within R-sq	0.96	0.97	

Notes: This table reports estimation results with the data averaged over four-year periods from 1977 to 2012. The clustered robust standard errors are in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, 1% level respectively. Estimation methods: State Fixed Effects with state-specific linear trend (FE), State and Time Fixed Effects with state-specific linear trend (TFE), GMM of Arellano-Bond (AB). Data sources: County Business Patterns from U.S. Census Bureau, Regional Economic Accounts from U.S. Bureau of Economic Analysis.