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Credit Supply, Firms, and Earnings Inequality[*]

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Abstract

We study the distributional consequences of monetary policy-induced credit supply in the labor market. To this end, we construct a novel dataset that links worker employment histories to firm financials and banking relationships in Germany. Firms in relationships with banks that are more exposed to the introduction of negative interest rates in 2014 experience a relative contraction in credit supply, associated with lower average wages and employment. These effects are heterogeneous within and between firms. Within firms, initially lower-paid workers are more likely to leave employment, while initially higher-paid workers see a relative decline in wages. Between firms, wages fall by more at initially higher-paying employers. In this way, credit affects the distribution of pay and employment in line with predictions of an equilibrium model with both credit and search frictions.

Keywords: Wages, Employment, Worker and Firm Heterogeneity, Monetary Policy, Negative Interest Rates

JEL Classification: J31, E24, J23, G21, E51

1 Introduction

The credit channel of monetary policy is traditionally viewed as a macroeconomic stabilization tool. Yet the possibility that monetary policy-induced credit can also have distributional consequences is relevant not just to those concerned with inequality. Rather, monetary policy's effectiveness itself depends on whom it affects and how much. At the same time, there is scant empirical evidence on the individual-level ramifications of monetary policy-induced credit, especially in the context of labor market outcomes like employment and wages. This is perhaps surprising in light of labor income making up the lion's share of total income for the average person.[1]

Our contribution is to empirically quantify the distributional consequences of the credit channel of monetary policy in the labor market. To this end, we build a novel dataset, which for the first time links worker employment histories to firm financials and banking relationships in Germany. We exploit as a particular monetary policy episode the introduction of negative interest rates by the European Central Bank (ECB) in 2014. We show that firms in preexisting relationships with banks that were more exposed to negative rates see a relative reduction in credit supply. In turn, the relative reduction in credit is associated with lower firm-level average wages and employment. Our main result concerns the heterogeneous effects of this relative reduction in credit on workers within and between firms. Within firms, initially lower-paid workers are more likely to leave employment, while higher-paid workers see relative wage declines. Between firms, wages fall by more at initially higher-paying employers. Altogether, we find that a monetary policy-induced reduction in credit leads to lower wage inequality within and between firms.

To guide our empirical investigation, we develop a simple equilibrium model with both credit and search frictions. Because they finance their labor expenses using debt, firms with more binding borrowing constraints face a higher shadow cost of resources, which leads to lower effective productivity and, thus, lower firm-level wages and employment. If wages are relatively rigid for low-skill workers, then a credit tightening causes wages to decline by more among high-skill workers and more so at firms with higher effective productivity. Consequently, a reduction in credit leads to lower within- and between-firm wage inequality.

We test these predictions by studying the ECB's introduction of negative deposit facility rates in 2014. This episode constitutes a credit supply shock since banks are reluctant or unable to pass on negative rates to their depositors. As a result, more deposit-reliant banks see higher funding

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[1]Estimates based on income tax data by the Internal Revenue Service (2020) in the U.S. show that 83 percent of all tax returns and 67 percent of tax filing amounts pertain to salary and wage income.

costs and lower net worth, which leads them to cut lending to their preexisting borrowers. Thus, our empirical strategy exploits heterogeneity in preexisting bank-firm relationships around the introduction of negative rates as a source of variation in firm-level credit supply.

While restricting attention to a particular monetary policy episode necessarily comes at some loss of generality, our focus on negative rates has three advantages. First, it enables us to identify the credit channel of monetary policy at the micro level. As negative rates squeeze deposit spreads (Heider et al., 2019; Eggertsson et al., 2020) and banking relationships are sticky (Chodorow-Reich, 2014; Darmouni, 2020), deposit-reliant banks cut lending to their preexisting borrowers. This allows us to identify variation in firms' credit access using information on their relationship banks, akin to Huber (2018). Second, it allows us to abstract from confounding channels. During normal times, changes in monetary policy rates are transmitted through several components of bank balance sheets (Kashyap and Stein, 2000), which are not directly relevant for the transmission of negative deposit facility rates. Third, it helps address the endogeneity of monetary policy and banks' balance sheets. The introduction of negative rates in the euro area was an unprecedented step, which came as a surprise to financial institutions and firms (Hirst, 2014). While negative rates were intended to stimulate aggregate credit supply, the network of preexisting bank-firm relationships is more plausibly exogenous to the introduction of negative rates at the time.

To study the distributional effects of credit supply in the labor market, we proceed in two stages. In the first stage, we show that negative rates lead firms in relationships with more deposit-reliant banks to experience a relative contraction in credit from any bank, along both the extensive margin (i.e., the probability of receiving any loan) and the intensive margin (i.e., loan volume). These results are robust to controlling for bank-firm match-specific and time-varying bank-specific unobserved heterogeneity, which subsumes variation in aggregate economic conditions and banks' financial health. To show that the reduction in firm borrowing is driven by credit supply, and not just demand, we exploit between-bank variation in exposure to negative rates while controlling for time-varying unobserved firm heterogeneity (Khwaja and Mian, 2008). We also find suggestive evidence that firms imperfectly substitute credit, with more affected firms reducing their leverage and building cash reserves. At the same time, we find no significant changes in firms' fixed assets, consistent with the presence of significant capital adjustment costs.

In the second stage, we study the effects of credit supply on worker-level labor market outcomes. Consistent with the predictions of our theoretical model, a reduction in credit leads to lower firm-level wages and employment. In terms of magnitudes, a one standard deviation in-

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crease in exposure to negative rates is associated with a reduction in mean wages of around 1.3 percent, and an increase in the probability of leaving employment of around 0.2 percentage points. These estimates control for state time trends and worker-firm match heterogeneity, which would be confounded with changes in worker composition absent individual-level microdata.

These effects mask important heterogeneity across workers *within* firms. To shed light on this, we estimate individual wage equations with controls for worker-firm match-specific and time-varying firm pay components (Lachowska et al., 2019; Engbom and Moser, 2020). We find that initially lower-paid workers are more likely to leave employment, while initially higher-paid workers see relative wage declines. A one standard deviation increase in exposure to the negative credit supply shock is associated with a reduction in top-quintile wages of around 0.8 percent relative to workers in the bottom quintile. At the same time, the probability of leaving employment increases by around 0.2 percentage points per standard deviation of exposure among workers in the bottom relative to the top quintile. Consequently, within-firm wage inequality decreases.

We show that credit supply also affects the distribution of wages and employment *between* firms. To this end, we estimate specifications that include an interaction term with firms' initial pay rank while controlling for worker-firm match heterogeneity and state time trends. We find that among firms equally exposed to negative rates, wages decline by more at initially higher-paying firms. Over four years, wages at top-ranked firms fall by 11 percent relative to bottom-ranked firms, while the probability of leaving employment is 2 percentage points higher at bottom-ranked compared to top-ranked firms. Consequently, between-firm inequality decreases.

In summary, we show that monetary policy-induced credit supply affects the distribution of pay and employment within and between firms. Therefore, our findings suggest that credit supply, firms, and earnings inequality are interlinked.

Related literature. We contribute to an emerging literature on the distributional consequences of monetary policy and credit. Specifically, we study the effects of a credit supply shock on workers within and between firms by building on insights from related research on pass-through of other firm-level shocks.[2] The link between credit supply and earnings inequality is directly relevant for a holistic understanding of monetary policy. In addition, our analysis puts a spotlight on the role of firms in the labor market (Card et al., 2013; Song et al., 2019). Studying firms' heterogeneous

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[2]Previous work has studied the pass-through of shocks to revenue productivity (Guiso et al., 2005; Fagereng et al., 2018; Garin and Silvério, 2018; Friedrich et al., 2019; Lamadon et al., 2019; Bagger et al., 2020; Chan et al., 2021), innovation (Van Reenen, 1996; Kline et al., 2019; Aghion et al., 2019; Kogan et al., 2021), cash (Howell and Brown, 2020), and taxes (Arulampalam et al., 2012; Suárez Serrato and Zidar, 2016; Fuest et al., 2018).

responses to credit is important because firms are the natural unit of analysis when it comes to wage setting and employment decisions, among other margins of adjustment. In related work, Michelacci and Quadrini (2009) and Guiso et al. (2013) show that firm credit affects starting wages and the wage growth of new hires. Our work complements theirs by demonstrating that credit has different effects on wages and employment throughout the within- and between-firm distribution.

The credit channel has been the focus of traditional work on the aggregate effects of monetary policy (Bernanke and Gertler, 1995).[3] We study the credit channel at a more granular level by tracing its effects on the distribution of workers' wages and employment within and between firms. To make this possible, we build a novel dataset that tracks the complete credit chain—from monetary policy to banks to firms to workers—in Germany. This allows us to shed light on distributional consequences of monetary policy and credit that would remain hidden in more aggregate data when there are changes in the underlying composition of worker.

Numerous policymakers have expressed interest in the distributional effects of monetary policy (Romer and Romer, 1999; Bullard, 2014; Yellen, 2014; Bernanke, 2015; Lagarde, 2020). Existing research by Doepke and Schneider (2006), Wong (2019), and Holm et al. (2020) has linked monetary policy to *household* balance sheets and inequality. In contrast, our paper identifies monetary policy-induced *firm* credit as a source of inequality. This complements more aggregate studies of the effects of credit on employment at the firm level (Chodorow-Reich, 2014; Jiménez et al., 2017; Benmelech et al., 2019), across worker groups within firms (Berton et al., 2018; Caggese et al., 2019; Barbosa et al., 2020), and across demographic groups (Bergman et al., 2021). While we find significant employment responses to credit supply, the effect of credit on wages matters for the vast majority of workers who remain employed. Other recent work has measured the response of average wages to firm-level credit shocks (Fonseca and Van Doornik, 2020; Adamopoulou et al., 2020; Arabzadeh et al., 2020). Relatedly, Broer et al. (2021) quantify the effects of monetary policy shocks on job-finding and separation rates across income levels in Germany. A distinguishing feature of our work is its focus on the distributional effects of monetary policy-induced credit within and between firms.

While our contribution is primarily empirical, our results are of broader interest to a new generation of macroeconomic models concerned with the interplay between monetary policy and

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[3]In other settings, credit supply has been shown to affect productivity (Gilchrist et al., 2013), employment (Chodorow-Reich, 2014), product pricing (Gilchrist et al., 2017), investment (Amiti and Weinstein, 2018), innovation (Huber, 2018), household demand (Mian et al., 2020), firm dynamics (Acabbi et al., 2020), organizational structure (Sforza, 2020), and aggregate output (Herreño, 2020).

household heterogeneity.[4] Kaplan et al. (2018) build a Heterogeneous Agent New Keynesian (HANK) model in which wages are determined competitively and workers' productivity follows an exogenous Markov process. They show that the dominant driver of the consumption response to monetary policy pertains to its effect on workers' earnings. Yet empirical evidence on this effect remains scant. Ravn and Sterk (2020) embed search and matching frictions into a tractable HANK model in which all firms offer the same pay. In contrast, our empirical results point toward pay differences for identical workers between firms and heterogeneous responses of firm pay to monetary policy-induced credit. Auclert (2019) allows for a reduced-form elasticity of agents' relative income to aggregate income. With a negative elasticity chosen to match the empirical findings of Coibion et al. (2017), this channel amplifies the aggregate consumption response to monetary policy. Our empirical findings instead suggest that monetary easing increases earnings inequality through the credit channel in Germany, which has important policy implications.

Outline. The remainder of the paper is structured as follows. Section 2 develops an equilibrium model with frictions in credit and labor markets. Section 3 outlines our empirical strategy. Section 4 introduces the data. Section 5 presents our empirical results. Finally, Section 6 concludes.

2 Equilibrium Model

The purpose of this model is to provide a conceptual framework that links credit supply to the distribution of wages and employment within and between firms. To this end, we model multi-worker firms subject to frictions in both credit and labor markets. Credit frictions imply that firms finance working capital, including their wage bill and recruiting costs, subject to idiosyncratic borrowing constraints (Neumeyer and Perri, 2005; Jermann and Quadrini, 2012). We model the bank lending channel of monetary policy as affecting firms' idiosyncratic credit constraints, while—for simplicity—abstracting from other channels through which monetary policy affects the real economy. Labor market frictions imply that identical workers receive different pay across employers (Card et al., 2013; Song et al., 2019). Unlike existing models of match heterogeneity subject to credit and labor market frictions (Wasmer and Weil, 2004; Kehoe et al., 2019, 2020), we allow for multi-worker firms as in the seminal Burdett and Mortensen (1998) framework. We tractably extend this framework to include worker heterogeneity in skills and firm heterogeneity in credit constraints.

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[4]See, for example, Gornemann et al. (2016), McKay and Reis (2016), Auclert et al. (2018), Bilbiie (2019), Hagedorn et al. (2019), Acharya et al. (2020), Auclert et al. (2020), Kekre and Lenel (2020), and Ottonello and Winberry (2020).

2.1 Workers

Workers are infinitely lived, risk neutral, and discount time at rate ρ. They differ ex ante in skill $a \in \{a_L, a_H\}$. We assume $0 < a_L < a_H$ and refer to worker types as low-skill and high-skill, with population shares μ_a. Ex post, workers are either employed at some wage w or unemployed.

Job search. Unemployed workers enjoy flow utility b_a, where $b_{a_L} \leq b_{a_H}$, engage in random job search within labor markets segmented by skill a, and receive job offers at rate λ_a^u. Employed workers enjoy flow utility equal to their wage w and also receive job offers at rate $\lambda_a^e = s_a^e \lambda_a^u$, with relative on-the-job search intensity satisfying $s_{a_L}^e = 0 < s_{a_H}^e \leq 1$. A job offer entails a wage w drawn from the endogenous offer distribution $F_a(w)$. Jobs end exogenously at rate δ_a.

Value functions. The value of an employed worker of skill a in a job with wage w is

$$\rho S_a(w) = w + \lambda_a^e \int_{w'>w} \left[S_a(w') - S_a(w) \right] dF_a(w') + \delta_a \left[W_a - S_a(w) \right], \quad \forall a. \tag{1}$$

The value of an unemployed worker of skill a is

$$\rho W_a = b_a + \lambda_a^u \int_{w'} \max \left\{ S_a(w') - W_a, 0 \right\} dF_a(w'), \quad \forall a. \tag{2}$$

Policy functions. Employed workers accept any higher wage. Unemployed workers have a reservation wage ϕ_a, which we assume is low enough so that all firms hire both skill types.

2.2 Firms

Firms differ ex ante in their productivity $p > 0$ and credit limit $\xi > 0$, with $j = (p, \xi) \overset{c}{\sim} \Gamma(j)$.

Wages and job vacancies. Firms post for each worker skill a a market-specific wage w_a and vacancies v_a subject to strictly convex increasing recruiting costs $c_a(v_a)$: $c_a'(\cdot) > 0, c_a''(\cdot) > 0$.

Production. A firm with productivity p_j employing $\{l_a\}_{a \in \{a_L, a_H\}}$ workers of each skill level produces output according to the linear production function $y(p_j, \{l_a\}_{a \in \{a_L, a_H\}}) = p_j \sum_{a \in \{a_L, a_H\}} a l_a$.

Credit constraint. Before production occurs, firms take up debt $D \geq 0$ to finance their working capital, defined as the sum of their wage bill $\sum_a w_a l_a(w_a, v_a)$ and recruiting costs $\sum_a c_a(v_a)$. Given interest rate $r > 0$, firms face idiosyncratic credit limits given by $rD \leq \xi_j$.

Value function. The value of a firm of type (p_j, ξ_j) is the net present value of revenues minus the wage bill minus recruiting costs minus the cost of servicing debt, which can be written as

$$r\Pi(p_j, \xi_j) = \max_{\{w_a, v_a\}_a} \left\{ \sum_a \left[(p_j a - (1+r)w_a) \, l_a(w_a, v_a) - (1+r)c_a(v_a) \right] \right\} \tag{3}$$

$$\text{s.t.} \quad r \sum_a \left[w_a l_a(w_a, v_a) + c_a(v_a) \right] \leq \xi_j. \tag{4}$$

2.3 Matching and Firm Sizes

A Cobb-Douglas matching function with constant returns to scale combines the effective job searchers $U_a = \mu_a \left[u_a + s_a^e(1 - u_a) \right]$ with the aggregate vacancies $V_a = E \int_j v_a(j) \, d\Gamma(j)$ to produce, for each a, matches $m_a = \chi_a V_a^\alpha U_a^{1-\alpha}$ with matching efficiency $\chi_a > 0$ and elasticity $\alpha \in (0,1)$.

2.4 Equilibrium Pay and Employment Decisions under Credit Constraints

We define a *stationary equilibrium* of the economy in Appendix A.1. A firm's optimal wage and vacancy policies depend on both its productivity and its credit constraint, as characterized by the following first-order conditions (FOCs):

$$[\partial w_a]: \quad p_j a \frac{\partial l_a(w_a, v_a)}{\partial w_a} - (1 + (1 + \psi_j)r) \left[l_a(w_a, v_a) + w_a \frac{\partial l_a(w_a, v_a)}{\partial w_a} \right] = 0, \quad \forall a, \tag{5}$$

$$[\partial v_a]: \quad p_j a \frac{\partial l_a(w_a, v_a)}{\partial v_a} - (1 + (1 + \psi_j)r) \left[w_a \frac{\partial l_a(w_a, v_a)}{\partial v_a} + \frac{\partial c_a(v_a)}{\partial v_a} \right] = 0, \quad \forall a, \tag{6}$$

where $\psi_j \geq 0$ is the Lagrange multiplier on firm j's credit constraint (4). For unconstrained firms, $\psi_j = 0$, while $\psi_j > 0$ for constrained firms. Firms are more credit constrained if, all else equal, they have higher productivity p_j, which leads to higher labor demand, or a lower credit limit ξ_j.

The FOCs in equations (5) and (6) are identical to those of a firm with *effective productivity*

$$\tilde{p}_j = p_j \frac{1+r}{1 + (1 + \psi_j)r}. \tag{7}$$

Note that $\tilde{p}_j = p_j$ for unconstrained firms with $\psi_j = 0$, while $\tilde{p}_j < p_j$ for credit constrained firms

with $\psi_j > 0$. Firms facing a tighter credit constraint, as measured by a higher ψ_j, have lower effective productivity due to their higher shadow cost of resources.

2.5   The Effect of Credit Supply on the Distribution of Wages and Employment

The following proposition characterizes the effect of credit supply on the distribution of wages and employment within and between firms across steady states of the economy.

Proposition 1 (Effects of credit on distribution of wages and employment)**.** *Suppose that credit constraints bind across firms. For any firm j, a decrease in the idiosyncratic credit limit ξ_j leads to*

  (i) *lower firm-level wages for identical workers,*

 (ii) *lower firm-level employment,*

(iii) *lower within-firm wage inequality through a relatively greater reduction in wages among initially high-paid workers, and*

(iv) *lower between-firm wage inequality through a relatively greater reduction in wages at initially high-paying firms.*

Proof. See Appendix A.2.   □

Intuitively, Proposition 1 states that a tighter credit constraint lowers a firm's effective productivity, leading to a reduction in relative wages of high-paid workers. Thus, our simple equilibrium model has sharp predictions for the effect of credit supply on the distribution of wages and employment within and between firms. The timing and magnitude of the predicted effects of credit supply on the distribution of wages and employment are ultimately an empirical question.[5] Therefore, we test these predictions using an identified credit supply shock in the data.

3   Empirical Strategy

Guided by the model predictions, our goal is to estimate the effect of monetary policy-induced credit supply on the distribution of wages and employment within and between firms. Before

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[5]Our comparative statics results pertain to steady states and are silent on the speed of the transition. Real wages may either adjust immediately through nominal wage cuts or adjust slowly over time by staying constant in nominal terms in the wake of inflation. Analogously, employment may either adjust immediately through existing workers being fired or adjust slowly over time by new hires being reduced following worker separations.

going into details of the specific empirical setting based on which we identify variation in credit supply, it will be useful to spell out the general methodology that allows us to achieve our goal.

3.1 Measuring the Effects of Credit Supply within and between Firms

Consider a panel of workers indexed by i across firms indexed by j and years indexed by t. We want to track wages and employment of workers in the years around a firm-level credit supply shock. Let us denote such a shock to credit supply at the level of the firm-year jt by $Credit_{jt}$.

Mean effects. While the credit supply shock is at the firm-year level, we study individual wages and employment at the level of the worker-firm-year ijt. Our simplest specification will be:

$$y_{ijt} = \beta Credit_{jt} + \theta_{ij} + \zeta_{s(j)t} + \varepsilon_{ijt}, \tag{8}$$

where y_{ijt} is an outcome for worker i at firm j in year t, $Credit_{jt}$ is the credit supply shock described above, and θ_{ij} and $\zeta_{s(j)t}$ denote, respectively, worker-firm and state-year fixed effects corresponding to state $s(j)$ that firm j is located in. The coefficient of interest in equation (8) is β, which measures the average response of y_{ijt} to variation in $Credit_{jt}$. The inclusion of worker-firm match fixed effects means that we identify this coefficient off the effect on workers that were already employed at the same firm prior to the credit supply shock. By first excluding and then including controls for worker-firm match heterogeneity, our estimates shed light on the different margins of labor market adjustments, specifically changes in worker composition through employment transitions. By additionally controlling for state-year fixed effects, we absorb aggregate trends and regional business cycle fluctuations that equally affect all workers in a given state each year.

Aside from the credit supply shock's mean effect on workers, we are also interested in its distributional effects. Specifically, we study the effect of credit on the distribution of worker-level outcomes within and between firms.

Within-firm heterogeneity. To estimate within-firm heterogeneity in the effect of credit, we interact the credit supply shock with a worker's pay rank within the firm:

$$y_{ijt} = \beta_1 Credit_{jt} \times RankWithin_i + \beta_2 Credit_{jt} + \beta_3 RankWithin_i + \theta_{ij} + \eta_{jt} + \varepsilon_{ijt}, \tag{9}$$

where *RankWithin$_i$* is worker i's pay rank within firm j during a preperiod prior to the credit supply shock, and θ_{ij} and η_{jt} denote worker-firm and firm-year fixed effects, respectively. The coefficient of interest in equation (9) is β_1, which measures the differential response of y_{ijt} to variation in *Credit$_{jt}$* throughout the within-firm wage distribution. As before, by controlling for worker-firm match fixed effects, we identify this coefficient off the effect on workers that were already employed at the same firm prior to the credit supply shock. In addition to the set of previous controls, we also add a set of firm-year fixed effects that control for time-varying unobserved heterogeneity at the firm level that may govern firm-level movements in wages or employment. This powerful control absorbs, for instance, aggregate trends and idiosyncratic firm innovations, including productivity shocks and other factors that affect all workers within a given firm equally.

Between-firm heterogeneity. To estimate between-firm heterogeneity in the effect of credit, we interact the credit supply shock with a firm's mean pay rank:

$$y_{ijt} = \beta_1 Credit_{jt} \times RankBetween_j + \beta_2 Credit_{jt} + \beta_3 RankBetween_j + \theta_{ij} + \zeta_{s(j)t} + \varepsilon_{ijt}, \quad (10)$$

where *RankBetween$_j$* is firm j's mean pay rank during a preperiod prior to the credit supply shock, and θ_{ij} and $\zeta_{s(j)t}$ denote, respectively, worker-firm and state-year fixed effects corresponding to state $s(j)$ that firm j is located in. The coefficient of interest in equation (10) is β_1, which measures the differential response of y_{ijt} to variation in *Credit$_{jt}$* throughout the firm pay distribution.

Firm-level aggregation. In addition to our worker-level analysis of the effects of credit, we are also interested in outcomes aggregated to the firm level. To study such outcomes, we explicitly allow for changes in worker composition due to separations and hires, which we previously held constant when including worker- or worker-firm match-specific controls. To ascertain the effect of credit supply on firm-level outcomes, we estimate the following specification:

$$y_{jt} = \beta Credit_{jt} + \psi_j + \zeta_{s(j)t} + \varepsilon_{jt}, \quad (11)$$

where y_{jt} is an outcome for firm j in year t, ψ_j denotes firm fixed effects, and $\zeta_{s(j)t}$ are state-year fixed effects corresponding to state $s(j)$ that firm j is located in.

3.2 Identification

To study the distributional effects of credit in the labor market, the ideal experiment would involve manipulating the credit supply to a known subset of firms but not others in a "macroeconomic laboratory." Absent such variation, we exploit a quasi-natural experiment that involves firm-level variation in credit supply. Specifically, we study the heterogeneous transmission of monetary policy to bank lending following the implementation of negative *deposit facility rates* in the euro area. We show that, depending on firms' preexisting banking relationships and banks' balance sheet exposure to negative rates, this episode resulted in firm-level variation in credit supply.

The deposit facility rate is the rate at which banks may make overnight deposits with the Eurosystem, i.e., the ECB and national central banks of countries that have adopted the euro currency. It is one of three main policy rates set by the Governing Council of the ECB.[6] By affecting the return on bank deposits, the deposit facility rate is a key determinant of deposit-reliant banks' funding costs and hence their lending activity.

In June 2014, for the first time in the history of the euro, the deposit facility rate was set to negative. There is broad consensus that this unprecedented step came as a surprise to financial institutions and firms, as evidenced by the sharp market reaction and ensuing devaluation of the euro currency (Hirst, 2014). Since then, the deposit facility rate has remained negative. Figure 1 shows the deposit facility rate over our period of study between January 1, 2010 and December 31, 2017. Our identification strategy exploits heterogeneous effects of this negative rate episode.

During normal times, the deposit facility rate has little bite when banks can pass on *positive* rates to their clients. As such, lower monetary policy rates decrease banks' funding costs independent of their financing structure, which induces them to increase lending to firms, in line with classical monetary theory (Gertler and Kiyotaki, 2010). Exploiting fluctuations in the level of credit supply due to changes in positive rates would be fruitful in theory. However, due to their aggregate nature, monetary policy-induced credit supply shocks of this type are difficult to empirically disentangle from other factors, such as credit demand (Nakamura and Steinsson, 2018).

Instead, our identification strategy exploits cross-sectional variation in banks' exposure to *negative* rates. Negative rates have been shown to affect bank lending through two channels. The first channel is due to the imperfect pass-through of negative monetary policy rates to deposit

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[6]The other two policy rates are the *main refinancing operations rate*, which determines the cost at which banks can engage in one-week borrowing, and the *marginal lending facility rate*, which determines the cost at which banks can engage in overnight borrowing from the Eurosystem.

rates, since banks are reluctant—or unable—to charge negative rates to their depositors.[7] As a result, deposit spreads are squeezed, so banks with greater reliance on deposit funding experience increased funding costs (Eggertsson et al., 2020; Ulate, 2021). The second channel is due to the effect of negative rates on banks' net worth or equity value, which falls in line with the decline in profitability of banks that are more reliant on deposit funding (Ampudia and Van den Heuvel, 2018; Hong and Kandrac, 2018). The decline in their net worth leads banks to reach for yield by channeling credit away from existing borrowers and toward new, and potentially riskier, projects (Heider et al., 2019).

Both of these channels lead to a relative reduction in credit supply to existing borrowers from banks that are more exposed to negative rates because of their deposit reliance. Therefore, to the extent that banking relationships are sticky (Chodorow-Reich, 2014; Darmouni, 2020), firms in preexisting relationships with more deposit-reliant banks should experience a relative contraction in credit supply. We confirm this differential response of bank lending to negative rates in our data for Germany.

Given that negative monetary policy rates have a differential *financial* effect across banks and their preexisting borrower firms, we explore to what degree this also resulted in a differential *real* shock across firms and their employees. On this front, we extend existing work along four important dimensions. First, we study a large subpopulation of private and public firms in Germany without the restriction to large corporations in the syndicated loans market. Second, we aggregate the financial effects of exposure to negative rates to the firm level, which is important since firms may be able to substitute across different financing sources. Third, we examine the effects of credit supply on real variables, some of which (e.g., capital) may be more sluggish to adjust than others (e.g., wages or employment). Fourth, we link variation in monetary policy-induced credit supply to worker-level outcomes, including individual wages and employment.

We use this credit supply shock in a difference-in-differences setting as follows. As a firm's exposure to negative rates depends on its banking relationships, we categorize firms according to their relations on deposit-reliant banks. For this purpose, we combine data on firms' self-reported banking relationships with bank-level balance sheet information. Specifically, let *Deposit ratio$_j$* denote the average deposit ratio, that is the ratio of deposits to assets, across all (typically German) euro-area banks that firm j reports to be in a banking relationship with during the preperiod from 2010 to 2013. Let *After*(2014)$_t$ denote a dummy variable for the years 2014–2017. Then, following

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[7]In this sense, our work is related to Drechsler et al. (2017) who study market power in deposit markets.

the argument above, we define as our credit supply shock proxy the following:

$$Credit_{jt} \equiv Deposit\ ratio_j \times After(2014)_t. \tag{12}$$

The credit proxy in equation (12) captures the difference-in-differences idea that firms in relationships with banks that are more exposed to negative rates through greater reliance on deposit funding experience a negative credit supply shock after June 2014. Identification of the effects of credit supply relies on the assumption that firms in relationships with banks of different deposit reliance would experience parallel trends in all outcomes of interest absent this shock.

3.3 Specification Details

We consider individual wages and employment as outcome variables associated with specifications (8)–(10), which are concerned with the worker-level effects of credit supply. Specifically, we consider for each individual their log wage and an indicator for whether they are no longer employed next year. For the firm-level aggregate specification (11), we consider as outcome variables various inequality measures, such as the log P90-P10 wage percentile ratio, and employment counts, such as the log number of employees.

In the within-firm specification (9), we replace *RankWithin$_i$* by an indicator for the position in the wage distribution at firm j where worker i was in the last available year during the preperiod 2010–2013. Specifically, we split the within-firm wage distribution into three parts. We include indicators for the bottom wage quintile *Bottom 20% within firm$_i$* and the three center quintiles *Middle 60% within firm$_i$*, leaving the top quintile *Top 20% within firm$_i$* as the omitted category.

In the between-firm specification (10), we replace *RankBetween$_j$* by a continuous variable *Firm pay rank$_j$* that lies between 0 and 1, where 0 represents the lowest and 1 represents the highest firm-level mean wage in 2013, which is the last year prior to the introduction of negative rates.

Finally, we cluster standard errors at the firm level throughout since we exploit variation in firm-level exposure to a bank-specific lending shock.

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4 Data

4.1 Data Sources

For the first time, this paper combines multiple datasets spanning the complete credit chain in Germany: starting from banks' balance sheet exposure to negative interest rates, to bank-firm relationships and loan transactions, to firm financials, and finally to worker-level outcomes. Building this data infrastructure requires us to combine microdata from several different data providers, including private and restricted public data sources.

Employment histories (IAB). At the heart of our analysis lie the administrative linked employer-employee data hosted at Germany's Institute for Employment Research (IAB). These restricted public data contain employment histories based on social security records for essentially the universe of workers and establishments in Germany, excluding civil servants and the self-employed. The linked employer-employee nature of the data means that we observe all workers within each establishment and that we can track both workers and over establishments time.

Firm financials (Amadeus). We use firm financials data that comprises private and public firms' balance sheet information based on data from *Amadeus*. These private data can be purchased from Bureau van Dijk (BvD) and are distributed as part of the Orbis Historical data product. The merge between the IAB linked employer-employee data and the Amadeus firm financials data forms part of the IAB-internal data product *Orbis-ADIAB* (Schild, 2016; Antoni et al., 2018). We extend the pre-existing record linkages beyond 2013 to cover our complete sample period from 2010–2017.[8] This merge allows us to link individual establishments in the IAB data at the firm level.

Board compensation (BoardEx). We supplement the IAB worker earnings records with small-sample information on compensation—including salary and bonus components—of board members at companies listed on the German stock market index (DAX) from 2010 to 2016. We source this information from *BoardEx*, which we access via Wharton Research Data Services (WRDS) and merge with the other datasets via consistent BvD identifiers.

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[8]At the time of writing, this data product is available to researchers affiliated with IAB and will be made available to the broader research community along with other IAB data products in the future.

Bank-firm relationships (Creditreform). To capture firms' bank credit relationships, we primarily use firms' self-reported bank relationships collected by *Creditreform*, akin to Huber (2018). These data identify private and public firms' principal and other bank affiliations, which we merge as before using BvD identifiers.

Loan transactions (DealScan). As an additional source of information on firms' bank credit relationships, we use data from Thomson Reuters *DealScan* on (typically large, public) firms' transactions in the syndicated loans market based on public filings, company statements, and media reports. We hand-match data from DealScan to firms in the other datasets using a combination of firm name, industry, and address, similar to Acharya et al. (2019) and Heider et al. (2019).

Bank balance sheets (SNL Financial). To measure banks' exposure to negative rates, we take balance sheet data from *SNL Financial* (now S&P Global Market Intelligence), a financial news and data services provider, for all banks that appear in the other datasets.

4.2 Description of Variables

The main variables of interest for our analysis are the deposit ratios of firms' relationship banks as well as workers' wages and employment status. We measure a firm's exposure to negative rates through the mean ratio of deposits to assets across all (typically German) euro-area banks that a firm reports to be in a banking relationship with during the preperiod from 2010 to 2013.[9] Wages are defined as the mean (log) daily earnings of full-time employees as reported in the IAB linked employer-employee data. Since these data are based on social security records and reporting is subject to statutory contribution limits, earnings are winsorized around the 90th percentile of the population.[10] Finally, unemployment is defined as a worker leaving our sample of employment records in a given year, excluding temporary leaves and recalls.

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[9]We construct the unweighted mean ratio of deposits to assets across all euro-area banks since the Creditreform data do not quantify the intensities of bank-firm relationships.

[10]The winsorized share varies between 10.0 and 11.3 percent for our sample covering 2010–2017. This data constraint means that we are unable to study top-earnings inequality, which motivates our use of broader within-firm earnings groups (e.g., top 20 percent). Importantly, this winsorizing structure mechanically works *against* our empirical results, as we argue in the next section.

4.3 Sample Selection

We use data from years 2010 to 2017 (the latest year of available data) to maximize our sample period subject to a balanced number of years before and after the introduction of negative monetary policy rates in 2014. Exploiting the matched employer-employee dimension of the merged data, we build a panel of workers indexed by i across firms indexed by j and years indexed by t. Within a given worker-year it, we keep the main job j, which we define as the highest-paid full-time job held by worker i in year t. We then limit the sample to firms with information on bank relationships from Creditreform, which we use to construct the credit supply shock exposure variable $Credit_{jt} \equiv Deposit\ ratio_j \times After(2014)_t$ as part of our empirical strategy.

4.4 Summary Statistics

Our final sample covers approximately 36 percent of all full-time workers in Germany, which constitutes a large subset of the German labor force. Table 1 presents summary statistics for this sample and key variables from the merged dataset. In Panel A, we start out with German firms' activities in the syndicated loans market. As will be the case in Table 3, we build a panel at the firm-bank-half-year level for syndicated loans granted to German firms in DealScan. Interestingly, the average $Deposit\ ratio_j$ in this dataset is lower than in the merged administrative linked employer-employee data (see Panel C), as typically only large, public firms in Germany access the syndicated loans market. Large firms are, in turn, more likely to contract with financial institutions that rely less on deposit funding and more on market funding, such as investment banks.

Panel B shows summary statistics at the worker-year level based on the merged data. Altogether, our sample covers over 72 million worker-year observations, or an average of 9 million observations per year. The average worker earns 37,294 euros (around 44,000 US dollars) per year, with a standard deviation of 18,541 euros (around 22,000 US dollars). Approximately 9.6 percent of observations in a balanced panel based on our data are classified as unemployment spells.

Finally, Panel C summarizes key variables at the firm-year level based on the merged data. The average deposit ratio is around 0.65. The mean P90/P10 wage percentile ratio is around 4.4 for all firms and around 2.6 for the subset of publicly listed firms. Using small-sample evidence on compensation of board members at public firms, we find a large pay gap between board members and regular workers. While the average firm in our sample has 47.8 full-time employees, the firm size distribution is positively skewed and fat-tailed. The mean number of nonmanagerial

employees that work full-time is 44.8, while the mean number of part-time employees is 16.4.

Table 2 presents firm-level summary statistics separately for firms in the top and bottom quartiles of the distribution of deposit ratios. Firms in relationships with high-deposit banks (Panel A), which have greater exposure to negative rates, and firms in relationships with low-deposit banks (Panel B) are similar along several observable characteristics (e.g., proportion female workers, proportion foreign workers, return on assets, volatility of return on assets, cash/assets, and investment/assets).

There are, however, some notable differences between the two groups. The average firm in relationships with high-deposit banks has a mean of 27.6 employees, compared to 74.7 employees at firms in relationships with low-deposit banks. Mean pay at firms in relationships with high-deposit banks is 27,530 euros, or around 20 percent less compared to that at firms in relationships with low-deposit banks, which is 33,116 euros. Similarly, while the average firm in relationships with high-deposit banks has an asset value of 3.4 million euros, the average asset value of firms in relationships with low-deposit banks is 31.6 million euros. This difference is relatively smaller when comparing median asset values of 0.73 million versus 1.17 million euros.

It is important to note that baseline differences between firms in relationships with high- versus low-deposit banks are not a threat to our identification. By including firm fixed effects in all worker-level regression specifications, we control for permanent (unobserved) firm heterogeneity. We also explicitly address nonrandom matching between firms and banks by including bank-firm match fixed effects in all credit-related specifications. In our analysis of within-firm inequality, we also include firm-year fixed effects, which account for permanent as well as time-varying (unobserved) employer differences, subsuming any firm-specific trends.

5 Results

We present our results in two steps. In the first step, we measure the firm-level credit supply shock due to the introduction of negative rates. In the second step, we quantify the effect of firms' exposure to this credit supply shock on the distribution of wages and employment.

5.1 Effect of Negative Monetary Policy Rates on Credit Supply

The goal of this section is to estimate the extent to which German firms in relationships with high-deposit, rather than low-deposit, banks see a relative reduction in credit supply following

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the introduction of negative monetary policy rates in June 2014. To conform as closely as possible with the Orbis-ADIAB sample that we use for identifying heterogeneous worker effects, we limit our analysis to German firms in Amadeus with data coverage throughout 2010–2017 and at least ten employees. Furthermore, we drop a small number of firms that, according to the Amadeus data, have ratios of the sum of long-term debt and short-term loans over assets of 0.05 and less, as those firms are unlikely to be affected by financial shocks.

We start by using transaction-level data on German firms' syndicated loans based on DealScan. While only a subset of German firms in our sample are active in the syndicated loans market, the granularity of these data allows us to control for a rich set of codeterminants of firms' credit access.

We focus on banks that act as lead arrangers in the syndication process. Lead arrangers are those members of a syndicate that are typically responsible for traditional bank duties including due diligence, payment management, and monitoring of the loan (Ivashina and Scharfstein, 2010). Based on all lead banks' shares of completed syndicated loans of German corporations between January 1, 2010 and December 31, 2017, we extend the sample to a balanced panel of borrowers j and banks k over time t at semi-annual frequency.

To measure a firm's exposure to the introduction of negative rates, we first compute the mean deposit ratio in 2013 of its relationship banks in the preperiod from 2010 to 2013, which we denote *Deposit ratio$_j$*. We then estimate the following difference-in-differences specification at the firm-bank-time level *jkt*, where time therefore refers to the semi-annual level:

$$y_{jkt} = \beta Deposit\ ratio_j \times After(06/2014)_t + \kappa_{jk} + \lambda_{kt} + \varepsilon_{jkt}, \tag{13}$$

where y_{jkt} is an outcome associated with lending by bank k to firm j at time t, *Deposit ratio$_j$* is the mean deposits-to-assets ratio, measured in 2013, across all (typically German) banks that firm j reports to be in a banking relationship with anytime from 2010 to 2013, $After(06/2014)_t$ is an indicator for whether the date falls on or after June 2014, and κ_{jk} and λ_{kt} denote firm-bank and bank-time fixed effects, respectively. Our interest lies in estimates of the coefficient β in equation (13), which we interpret as the effect of greater exposure to negative rates on outcome y_{jkt}. We cluster standard errors at the bank level.

Table 3 presents the results of estimating (13). In columns 1–2, the dependent variable is an indicator for any non-zero share of firm j's syndicated loans retained by bank k in t. In the first column, we include only bank-firm and time fixed effects, and find that a one standard deviation

increase in *Deposit ratio$_j$* (see Panel A in Table 1) is associated with a $0.126 \times 0.084 = 1.1$ percentage points lower likelihood of attaining any loan. The mean level of *Deposit ratio$_j$* is 0.374, which implies that the mean effect is a reduction in said likelihood by 3.1 percentage points.

This estimate becomes even larger in the second column, which adds bank-time fixed effects to control for bank-wide shocks such as regulatory changes that affect bank lending across all clients. In this case, the coefficient of interest, β, is estimated off firms in relationships with the same bank in a given year. Among these firms, β captures the effect of differential exposure to high- versus low-deposit banks in the preperiod on current lending by preexisting or new bank relationships.

All of these results also hold when we replace the dependent variable by the natural logarithm of one plus the total loan volume granted to firm j by bank k in t, as shown in columns 3–4. For each syndicated loan, we use information on each lead bank's share from DealScan, which we use to compute each lead bank's total loan amount granted to a firm in a given time period.[11]

Together, these findings imply that firms in relationships with high-deposit banks receive less credit from any bank, including those outside of the euro area, following the introduction of negative rates. These results are consistent with both bank-firm-level and bank-level evidence in Heider et al. (2019) and Eggertsson et al. (2020), suggesting that firms in existing relationships with affected high-deposit banks receive less credit and cannot perfectly substitute for the drop in credit by switching to new banks.

In the next step, we establish that this reduction in borrowing is due to a reduction in credit supply by high-deposit banks rather than a reduction in firms' credit demand. Following Heider et al. (2019), we use bank k's deposit ratio as the exposure variable and limit the sample to lead banks in negative-rate currency areas from which firm j borrowed anytime in the preperiod. By controlling for firm-year fixed effects, we test for changes in bank k's credit supply to its existing borrowers as a result of greater exposure to negative rates.

The results in Table 4 show a significant reduction in credit supply for different time windows around the introduction of negative rates. In the first column, we include firm-time fixed effects that absorb time-varying unobserved heterogeneity at the firm level, including loan demand (Khwaja and Mian, 2008). We find that high-deposit banks reduce their credit supply after the introduction of negative rates. Using these estimates, a one standard deviation increase in banks' deposit ratios implies a lower likelihood of granting any loans through syndication by

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[11]Whenever available, we use loan shares as reported in DealScan. Otherwise, similar to Chodorow-Reich (2014), we set the total loan share retained by lead arrangers in the syndicate equal to the sample mean, and divide it equally among all lead arrangers in the syndicate.

$0.176 \times 0.085 = 1.5$ percentage points.

Our identification rests on the assumption that negative rates are special.[12] To corroborate this assumption, in column 2 we interact the deposit ratio with an indicator for the period starting in July 2012, which is when the ECB reduced the deposit facility rate from 0.25 percent to 0 percent, the lowest nonnegative monetary policy rate. We find that high-deposit and low-deposit banks do not respond differently to this cut in positive rates. Instead, we continue to find that high-deposit banks start reducing their credit supply after the introduction of negative policy rates in June 2014. Our interpretation of this finding is that banks' funding structure matters for bank lending only if the pass-through of monetary policy to deposit rates breaks down. This is the case when rates go below zero as banks are reluctant, or unable, to pass on negative rates to their depositors.

In column 3, we estimate the same specification as in column 1 but use a short time window, from 2013–2015, around the introduction of negative rates in June 2014. This reduces the likelihood of other bank-level events, including concurrent monetary policy decisions, interfering with our identification. The difference-in-differences estimate becomes somewhat larger and is significant at the 5 percent level. As before, all of these results hold when we replace the dependent variable by the actual loan amounts granted by lead banks through syndication in columns 4–6.

Our results indicate that high-deposit banks reduce credit supply in response to the introduction of negative rates. As Table 3 shows, firms are unable to compensate for this credit reduction by switching to other banks, e.g., those outside negative-rate currency areas. In our model in Section 2, a firm's credit limit can be interpreted as the sum of all sources of external debt financing. To map this into the data, we confirm, using the firm-level panel in Amadeus, that German firms in relationships with high-deposit banks see a reduction in overall debt financing following the introduction of negative rates. To this end, we run the following firm-year-level regression:

$$y_{jt} = \sum_{\tau=2010}^{2017} \beta_\tau Deposit\ ratio_j \times \mathbf{1}[t = \tau] + \psi_j + \delta_t + \varepsilon_{jt}, \tag{14}$$

where y_{jt} is the dependent variable of interest at the firm-year level, where t represents the respective year-end, $Deposit\ ratio_j$ is the mean deposits-to-assets ratio, measured in 2013 across all (typically German) banks that firm j reports to be in a banking relationship with anytime from 2010 to 2013, $\mathbf{1}[t = \tau]$ is a dummy variable for the year t being equal to τ, and ψ_j and δ_t denote firm and year fixed effects, respectively. Standard errors are clustered at the firm level.

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[12]In this sense, our analysis complements related work on the reversal interest rate (Brunnermeier and Koby, 2018).

Figure 2 plots estimates of β_τ from equation (14) alongside 90 percent confidence intervals, relative to the year 2013 and using as dependent variable $Leverage_{jt}$, which we define as the ratio of the sum of long-term debt and short-term loans (in Amadeus) to firm j's assets in year-end t. Firm leverage has been shown to be relevant for the transmission of other macroeconomic shocks (Giroud and Mueller, 2017) and is associated with both credit risk and labor compensation (Favilukis et al., 2020). The coefficient is statistically insignificantly different from zero for the preperiod from 2010–2013 and becomes negative and marginally significant at the 10 percent level starting with the first full year of negative rates in 2015. In terms of point estimates, an increase by one standard deviation of $Deposit\ ratio_j$ (0.153, see Panel C in Table 1) translates into a reduction in leverage by up to $0.04 \times 0.153 = 0.6$ percentage points. This suggests that firms in relationships with high-deposit banks can only imperfectly substitute credit with other sources of debt financing. As a result, firms experience what corresponds to a tightening of their idiosyncratic credit constraint ξ_j in our theoretical model in Section 2.

Supporting our interpretation of the introduction of negative rates as a credit supply shock, Figure 3 shows that firms in relationships with high-deposit banks hoard significantly more cash following the introduction of negative rates. This is in line with theoretical predictions that credit constrained firms engage in precautionary savings (Almeida et al., 2004).

In theory, a credit shock may lead firms to respond along several margins. For example, tighter financial constraints may lead firms to adjust their assets (Campello et al., 2011; Berg, 2018), wages (Popov and Rocholl, 2018), and employment (Bacchetta et al., 2019). We now explore these sequentially, starting with the asset response. In Figure 4, we plot estimates from the same regression, using the natural logarithm of fixed assets (i.e., capital) as dependent variable. Interestingly, we find no significant effect on fixed assets, which suggests that the size of the shock to financial constraints of firms in relationships with higher-deposit banks does not lead to notable adjustments in capital following the introduction of negative rates.[13] This finding is consistent with the presence of adjustment costs or irreversibility preventing significant movements in capital in response to a credit shock of the observed magnitude, in line with related mechanisms explored in the literature (Ramey and Shapiro, 2001; Cooper and Haltiwanger, 2006; Lanteri, 2018; Winberry, 2020). As we find no effect on fixed assets, consistent with the presence of capital adjustment costs, we next turn to the adjustments in the distribution of wages and employment.

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[13]We find similar results when looking at either total assets, tangible fixed assets, or intangible fixed assets.

5.2 Effects on the Distribution of Wages and Employment

So far, we have established that firms in relationships with higher-deposit banks experience receive less credit, both within preexisting relationships and also from other banks and external financing sources. Our next goal is to estimate the effect of firms' exposure to negative rates on the distribution of wages and employment in our worker-level data.

Mean effects. We start by looking at effects on mean wages and unemployment, corresponding to specification (8) of our empirical strategy at the worker-year level:

$$y_{ijt} = \beta Deposit\ ratio_j \times After(2014)_t + \theta_{ij} + \zeta_{s(j)t} + \varepsilon_{ijt}, \tag{15}$$

where y_{ijt} is an outcome for worker i at firm j in year t, *Deposit ratio$_j$* is the mean deposits-to-assets ratio, measured in 2013, across all (typically German) banks that firm j reports to be in a banking relationship with anytime from 2010 to 2013, *After*(2014)$_t$ is a dummy variable for the years 2014–2017, and θ_{ij} and $\zeta_{s(j)t}$ denote, respectively, worker-firm and state-year fixed effects corresponding to state $s(j)$ that firm j is located in.

Table 5 shows results from estimating a variant of equation (15) that uses as dependent variable either worker i's log wage at firm j or her employment status in the following year. When including worker, firm, and year fixed effects, we find that workers at more exposed firms experience, on average, a relative reduction in wages (column 1) and higher unemployment risk (column 4). These findings are consistent with the predictions of our model that a tightening of the credit constraint reduces labor demand, leading firms to cut wages and reduce employment.

Columns 2 and 5 show that the effects on wages and unemployment become stronger when including worker-firm match fixed effects, which means the coefficient of interest, β, is estimated off workers that were either employed at the same firm before and after 2014, or no longer employed only after 2014. Based on these estimates, a one standard deviation increase in firms' exposure, captured by *Deposit ratio$_j$*, translates into $0.153 \times 0.077 = 1.2$ percent lower wages and a $0.153 \times 0.011 = 0.2$ percentage points increase in the probability of becoming unemployed. These estimates become somewhat larger when we include state-year fixed effects in columns 3 and 6, which additionally controls for time-varying unobserved regional heterogeneity.

At face value, these are significant—albeit not enormous—effects. To assess the economic significance of these effects, recall that a one standard deviation increase in firms' exposure is

associated with a reduction in leverage by up to 0.6 percentage points (see Section 5.1). Evaluated at the mean leverage for high- and low-deposit exposure firms (0.201 and 0.158, see Panels A and B of Table 2), this implies an elasticity of firms' mean wages with respect to leverage of $0.012/(0.006/0.201) = 0.4$ and $0.012/(0.006/0.158) = 0.3$, respectively. Similarly, the mean for workers' unemployment probability (0.096, see Panel B of Table 1) implies an elasticity of the unemployment probability with respect to leverage of $(0.002/0.096)/(0.006/0.201) = 0.7$ and $(0.002/0.096)/(0.006/0.158) = 0.5$, respectively.

To summarize, we find that a reduction in credit is associated with significant declines in firm-level mean wages and the probability of remaining employed, in line with parts (i)–(ii) of Proposition 1 of our theoretical model.

Within-firm heterogeneity. These estimated mean effects on wages and employment may mask important heterogeneity across worker groups within firms. To investigate this, we estimate the following variant of specification (9) of our empirical strategy, which adds an interaction term indicating a worker's position in the within-firm wage distribution:

$$
\begin{aligned}
y_{ijt} = {} & \beta_1 Deposit\ ratio_j \times After(2014)_t \times Bottom\ 20\%\ within\ firm_i \\
& + \beta_2 Deposit\ ratio_j \times After(2014)_t \times Middle\ 60\%\ within\ firm_i \\
& + \beta_3 Deposit\ ratio_j \times Bottom\ 20\%\ within\ firm_i + \beta_4 Deposit\ ratio_j \times Middle\ 60\%\ within\ firm_i \\
& + \beta_5 After(2014)_t \times Bottom\ 20\%\ within\ firm_i + \beta_6 After(2014)_t \times Middle\ 60\%\ within\ firm_i \\
& + \theta_{ij} + \eta_{jt} + \varepsilon_{ijt},
\end{aligned}
\tag{16}
$$

where y_{ijt} is either the natural logarithm of the wage or an indicator for unemployment next period for worker i employed at firm j in year t, *Bottom* 20% *within firm$_i$* (*Middle* 60% *within firm$_i$*) is an indicator variable for whether worker i's wage is in the bottom 20 percent (middle 60 percent) of the wage distribution of the firm where worker i was employed in the last available year during the preperiod from 2010 to 2013, and θ_{ij} and η_{jt} denote worker-firm and firm-year fixed effects, respectively. The coefficients of interest in equation (16) are β_1 and β_2, which capture the extent to which firms' exposure to negative rates differentially affects workers within the bottom 20 percent and middle 60 percent of the wage distribution relative to workers in the top 20 percent.

Table 6 presents the results from estimating specification (16) on the data. We always include worker fixed effects, controlling for time-invariant heterogeneity at the worker level. In column 1,

we include also firm and year fixed effects, which we replace by firm-year fixed effects in column 2. Firm-year fixed effects control for time-varying heterogeneity at the firm level, e.g., firm-wide developments that may be correlated with firms' heterogenous exposure to negative rates through their banking relationships. As such, they subsume state-year fixed effects, which we included in our investigation of mean effects. By including firm-year fixed effects, we also address a potential weakness of our identification strategy, namely that confounding firm characteristics could affect their wage setting and employment behavior around the introduction of negative rates, including firm-specific pretrends.

In this manner, we find that individuals that used to earn a wage in the bottom 20 percent of their respective firms' wage distributions see their wages grow more at more exposed firms after the introduction of negative rates than the top 20 percent (the omitted category). This result remains robust after adding worker-firm fixed effects in column 3. A one standard deviation increase in firms' exposure as captured by *Deposit ratio$_j$* translates into a $0.153 \times 0.051 = 0.8$ percent reduction in wages of workers in the top 20 percent versus those in the bottom 20 percent of the within-firm wage distribution. Since the coefficient of interest for the wage regression is now estimated off workers who stay at the same employer before and after the introduction of negative rates, these results are driven by wage effects on incumbents rather than new hires.

In columns 4–6, we estimate specification (16) with the dependent variable replaced by an indicator for whether worker i is unemployed in year $t + 1$. We find significant unemployment effects for workers in the middle 60 percent of the within-firm wage distribution across all three specifications. In column 4 and column 6, when including worker-firm match fixed effects, we find that all workers outside of the top 20 percent of the within-firm wage distribution face higher risk of being laid off following the negative credit supply shock. Quantitatively, the additional risk of leaving employment for workers below the top 20 percent of the within-firm wage distribution amounts to between $0.153 \times 0.013 = 0.2$ and $0.153 \times 0.019 = 0.3$ percentage points based on our preferred specification in column 6. Note that the inclusion of worker-firm match fixed effects implies that we identify the effect in column 6 off workers that did not switch to another firm, neither from employment nor through unemployment, after 2014.

The empirical observation that wages are more rigid for lower-paid workers may partly reflect that, coinciding with our postperiod, Germany introduced a federal minimum wage of 8.50 euros on January 1, 2015. To the extent that workers near the bottom of the within-firm wage distribution find themselves at or near this threshold, their wages are downwardly rigid. On the

flipside, stronger downward wage rigidity of low-paid workers could also rationalize our finding that these workers are relatively more likely to become unemployed following the credit supply shock. This finding is consistent with the prediction from our theoretical model that larger firms initially pay a relative premium for high-skill workers, which is subsequently reduced due to the tightening of their credit constraint.

Some discussion of an important data issue is in order. As alluded to earlier, the German administrative data on earnings are winsorized around the 90th percentile of the population. We argue here that this is not a major concern for our identification, since it actually works *against* our empirical results. A comparison of Panels A and B of Table 2 reveals that firms in relationships with low-deposit (high-deposit) banks have relatively higher (lower) average wages, which is also reflected in the fact that their winsorized share of worker-years is 15.5 (5.0) percent. This means that firms in relationships with low-deposit banks are relatively more likely to have high earnings winsorized. It is useful to think of our empirical setting as a combination of aggregate wage growth plus differential firm-level wage growth due to firms' differential exposure to the credit supply shock. The aggregate wage growth component by itself pushes more employees at firms in relationships with low-deposit banks into the winsorizing range, leading to a mechanical decrease in relative within-firm inequality at these firms. This is the exact opposite of what we find, namely that within-firm inequality declines by more at firms in relationships with high-deposit banks. The relative wage growth component—which can be normalized to be zero at firms in relationships with low-deposit banks—means that wages grow by relatively less at firms in relationships with high-deposit banks, but this is itself not a problem since a small share of their workers are in the winsorized range.

To summarize, we find that initially higher-paid workers see relative wage declines, while initially lower-paid workers are more likely to become unemployed. As a consequence and in line with part (iii) of Proposition 1 of our theoretical model, within-firm wage inequality decreases.

Between-firm heterogeneity. While we have shown that the credit supply shock due to negative rates led to lower wages on average, we now address the extent to which different firms adjusted wages differentially. To explore this, we estimate the following variant of specification (10) of our

empirical strategy, which adds an interaction term indicating a firm's mean wage rank:

$$y_{ijt} = \beta_1 Deposit\ ratio_j \times After(2014)_t \times Firm\ pay\ rank_j$$

$$+ \beta_2 Deposit\ ratio_j \times After(2014)_t + \beta_3 After(2014)_t \times Firm\ pay\ rank_j$$

$$+ \theta_{ij} + \zeta_{s(j)t} + \varepsilon_{ijt}, \tag{17}$$

where y_{ijt} is either the natural logarithm of the wage or an indicator for unemployment next period for worker i employed at firm j in year t, *Firm pay rank$_j$* is firm j's mean wage rank among all firms in 2013, with 0 being the lowest rank and 1 being the highest rank, and θ_{ij} and $\zeta_{s(j)t}$ denote, respectively, worker-firm and state-year fixed effects corresponding to state $s(j)$ that firm j is located in. The coefficient of interest in equation (17) is β_1, which captures the extent to which initially higher-paying firms respond differentially to the credit supply shock induced by the introduction of negative monetary policy rates.

Table 7 presents the results from estimating variants of specification (17). Column 1, which includes worker, firm, and year fixed effects, shows that initially higher-paying firms respond to the negative credit supply shock with a relative reduction in wages, but the estimated coefficient falls short of being statistically significant at conventional levels. After including worker-firm fixed effects and therefore focusing on incumbent workers in column 2, the coefficient almost triples and becomes significant, suggesting that changes in worker composition are an important margin of adjustment. This continues to hold true in column 3 after replacing year fixed effects by more granular state-year fixed effects of the respective firms.

Columns 4–6 test for differential unemployment effects across firm pay ranks. To this end, we replace the dependent variable by an indicator for whether a worker will be unemployed next period. Column 4 shows a negative and significant estimate of the interaction coefficient of -0.028 (standard error of 0.009). In our preferred specification with worker-firm and state-year fixed effects in column 6, the coefficient is still negative and statistically significant, but it is insignificant in column 5 when using year fixed effects instead of state-year fixed effects.

Our interpretation of these findings is that higher-paying firms are plausibly less constrained by a binding minimum wage and other wage floors. As a consequence of lower wage rigidity at initially higher-paying firms, a tightening of credit supply leads initially higher-paying firms to decrease their pay by relatively more. Since they can reduce their labor cost by lowering wages, these firms are less inclined to lay off workers following the negative credit supply shock.

As argued above, the winsorizing inherent to the German administrative data is not a major concern in this context. In particular, the mechanical effect of winsorization goes *against* our finding that between-firm inequality declines due to the credit supply shock. This is because initially higher-paying firms have, all else equal, a larger share of their workers in the winsorized range, which mechanically dampens the measured wage response at those firms. This is the exact opposite of what we find, namely a greater reduction in wages at initially higher-paying firms.

To summarize, we find that initially higher-paying firms administer relative wage cuts while at the same time retaining (weakly) more of their workforce. As a consequence and in line with part (iv) of Proposition 1 of our theoretical model, between-firm wage inequality decreases.

Firm-level aggregation. In our worker-level analysis above, we have studied the effect of a negative credit supply shock on the distribution of wages within and between firms. Throughout this analysis, we have been holding constant worker composition by including worker fixed effects or worker-firm match fixed effects. Of independent interest are outcomes aggregated to the firm level, which we now turn to. In doing so, we explicitly take account of changes in worker composition due to hiring and separations.

To this end, we construct measures of within-firm wage inequality for all firms in each year. We then estimate variants of specification (11) of our empirical strategy at the firm-year level:

$$y_{jt} = \beta Deposit\ ratio_j \times After(2014)_t + \psi_j + \zeta_{s(j)t} + \varepsilon_{jt}, \tag{18}$$

where y_{jt} is a measure of within-firm pay inequality for firm j in year t, ψ_j denotes firm fixed effects, and $\zeta_{s(j)t}$ are state-year fixed effects corresponding to state $s(j)$ that firm j is located in.

Table 8 presents the results from estimating specification (18) for different inequality measures and different samples in our data. Columns 1–3 take as dependent variable y_{jt} the log P90-P10 wage percentile ratio. All three specifications include firm and state-year fixed effects, thereby controlling for time-invariant firm-specific and time-varying regional heterogeneity. Column 1, which includes all firms in our sample, indicates a modest reduction in within-firm wage inequality at more affected firms, with a coefficient estimate of -0.013 (standard error of 0.006). This is consistent with our worker-level finding of relative wage declines among higher pay ranks within firms, as in Table 6.

Motivated by evidence that larger, publicly listed firms may exhibit greater within-firm wage

inequality (Mueller et al., 2017), we estimate the same regression specification separately for public firms in column 2. In doing so, we find that the reduction in within-firm inequality due to the negative credit shock is even more emphasized for firms in this small subsample.

One advantage of using this subsample is that it comprises firms that are large and covered also in our syndicated loans data from DealScan, which we have used in Tables 3 and 4. Those firms are likely to receive syndicated loans not only from German and other euro-area banks, but also from non-euro area banks whose supply of credit should not be affected by monetary policy in the euro area. This enables us to conduct a falsification test in column 3 by adding an interaction term between *After*(2014)$_t$ and *Non-euro deposit ratio*$_j \in [0, 1]$, which is the mean deposit ratio across all non-euro area lead arrangers (and other banks not based in negative-rate currency areas) that firm j received a syndicated loan from in the preperiod from 2010 to 2013. Reassuringly, we find that the coefficient on the placebo term is close to zero and statistically insignificant.

While rich in many dimensions, the IAB linked employer-employee data do not allow us to measure top-wage inequality due to the data being winsorized at the social security contribution threshold, which falls around the 90th percentile of the earnings distribution in our sample. This winsorizing may be particularly relevant for the pay structure at public firms, which tend to offer high variable compensation to their top management (Bertrand and Schoar, 2003; Gabaix and Landier, 2008). A plausible way for firms to reduce pay at the top of the distribution is by adjusting variable compensation.

To test for this adjustment mechanism, we use information on compensation for executive board members of 26 of the DAX-listed firms from BoardEx.[14] Although large firms with capital market access tend to be more sheltered from credit supply shocks (Chodorow-Reich, 2014), we still find an effect on larger German firms that are active in the syndicated loan market. In columns 4–6 of Table 8, we provide small-sample evidence that a negative credit supply shock is associated with a reduction of top-to-bottom wage inequality within said listed firms. Column 4 shows a point estimate that is large and negative but noisily estimated and barely significant at the 10 percent level. Splitting board pay further into salary and bonus pay, we find a significant negative reduction in bonus (column 6), but not in salary (column 5). This suggests that firms take into account the availability of credit, with associated future growth prospects, when reducing top-earners' variable compensation due to tighter financial constraints.

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[14]Since German some company board positions are allocated to worker representatives and other nonexecutives (Jäger et al., forthcoming), we drop these from our data. For nonexecutive board members, who typically do not receive substantial variable compensation, we find no significant response in their relative pay—see Table B.1 in Appendix B.1.

We also consider the effects of the negative credit supply shock on firm-level employment. The key difference between this analysis and our previous worker-level analysis is that we now take into account both new hires and separations. Table 9 presents the results from estimating specification (18) for different employment counts. All specifications in this table control for firm and state-year fixed effects. Column 1 shows that firms more exposed to negative rates see a significant reduction in overall employment, consistent with our theoretical model. We estimate a coefficient of -0.015 (standard error of 0.005), suggesting that a one standard deviation increase in firm-level exposure is associated with a $0.153 \times 0.015 = 0.2$ percent reduction in total employment. Column 2 shows that this effect is 40 percent larger for nonmanagerial employees. Column 3 shows that, as a result, more exposed firms see a significant reduction in their share of nonmanagerial workers. Finally, column 4 shows that the negative credit supply shock is also associated with a reduction of part-time work, suggesting that those workers are more likely to leave employment or else are asked to work extra hours.

6   Conclusion

Using a theory-guided empirical approach, we study the effects of monetary policy-induced credit supply on the distribution of wages and employment within and between firms. To this end, we build a novel dataset that spans the complete credit chain—from banks to firms to workers—in Germany. We find that firms in relationships with more deposit-reliant banks see a relative reduction in credit supply following the introduction of negative rates by the ECB in June 2014. Lower credit in turn leads to a negative effect on firm-level wages and employment. Within firms, initially lower-paid workers are more likely to leave employment, while initially higher-paid workers receive lower relative wages. Between firms, wages decline by more at initially high-paying firms. In this way, credit affects the distribution of pay and employment within and between firms in line with predictions of our equilibrium model with frictions in both credit and labor markets.

These findings point in several interesting directions for future work. First, while our analysis focuses exclusively on workers' wages and employment, a natural extension of our analysis could explore other margins of adjustment to credit supply, including firms' technology choices and workers' investment in human capital. Second, while we restrict attention to a particular episode of negative interest rates in Germany, it would be valuable to study other instances of conventional and unconventional monetary policy. Third and finally, the effects of credit in our study are

estimated off a relatively short time window since June 2014. Understanding the medium- and long-term effects of monetary policy and credit supply through the channels highlighted in our work is deserving of further investigation.

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Figures

Figure 1: Deposit Facility Rate by Eurosystem, January 2010 – December 2017
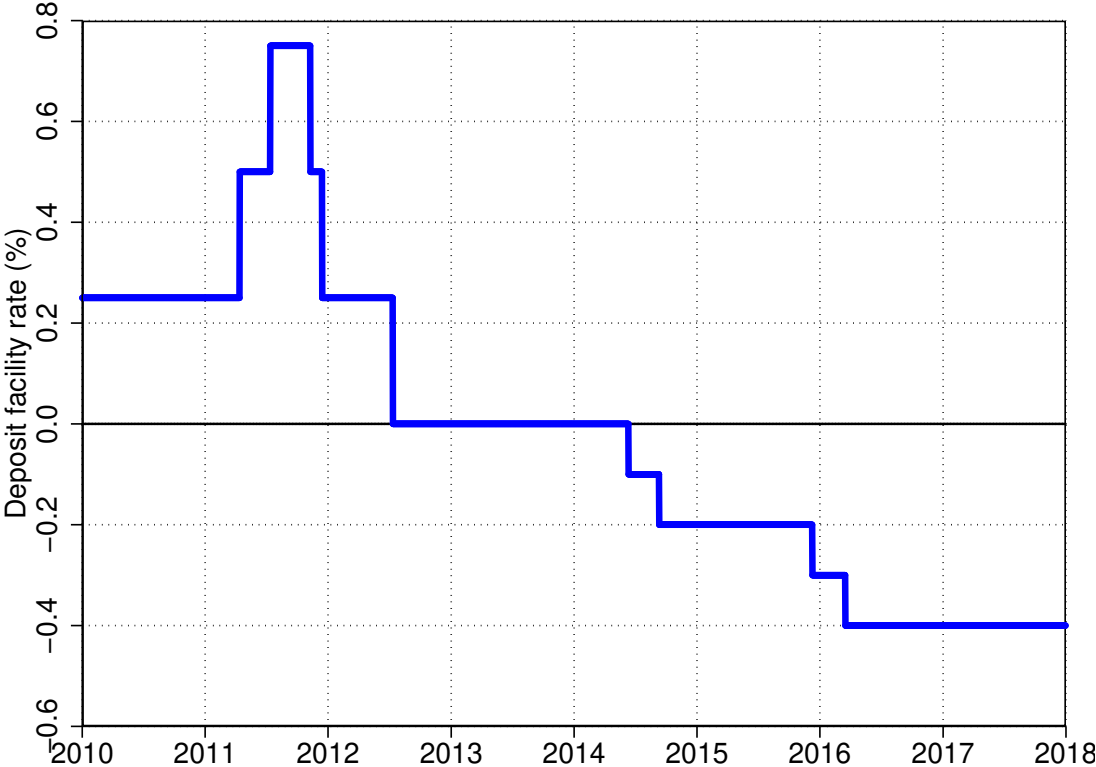
Notes: This figure plots the deposit facility rate on overnight deposits with the Eurosystem set by the European Central Bank between January 1, 2010 and December 31, 2017. *Source:* ECB.

Figure 2: Impact of Negative Policy Rates on Firms' Leverage
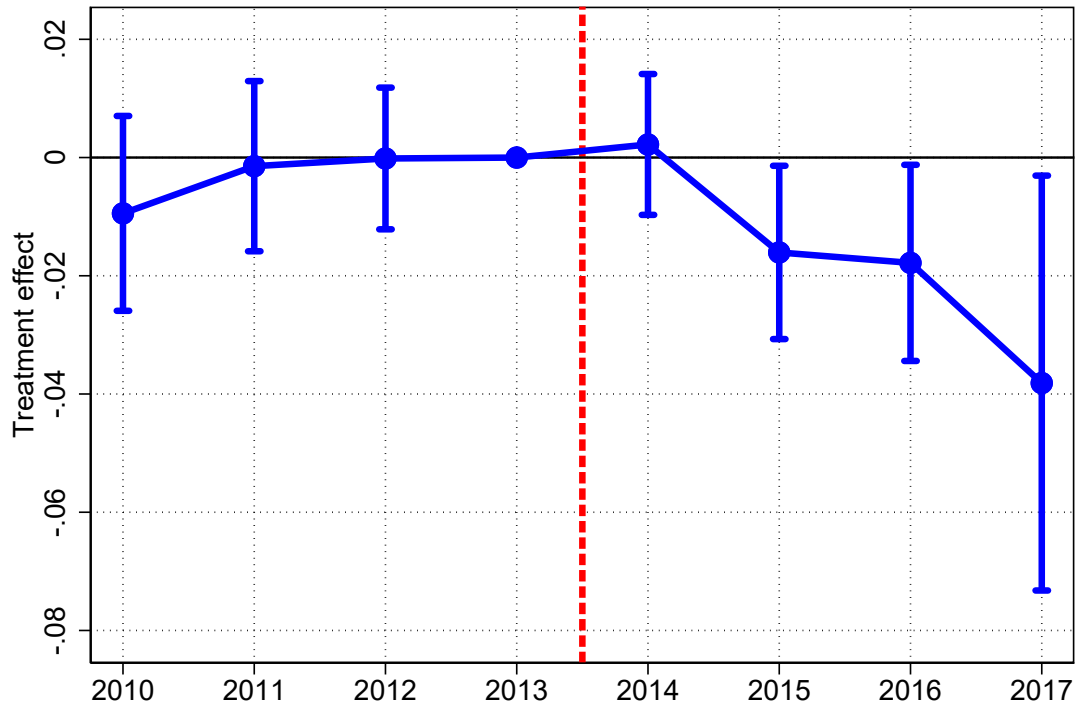
Notes: This figure plots estimates of β_τ, alongside 90 percent confidence bands, over time (each year represents the respective year-end) based on the event study specification in (14), using as dependent variable firm j's leverage ratio, estimated on the sample of German firms in the administrative linked employer-employee data merged with Amadeus from 2010 to 2017.

Figure 3: Impact of Negative Policy Rates on Firms' Cash Position
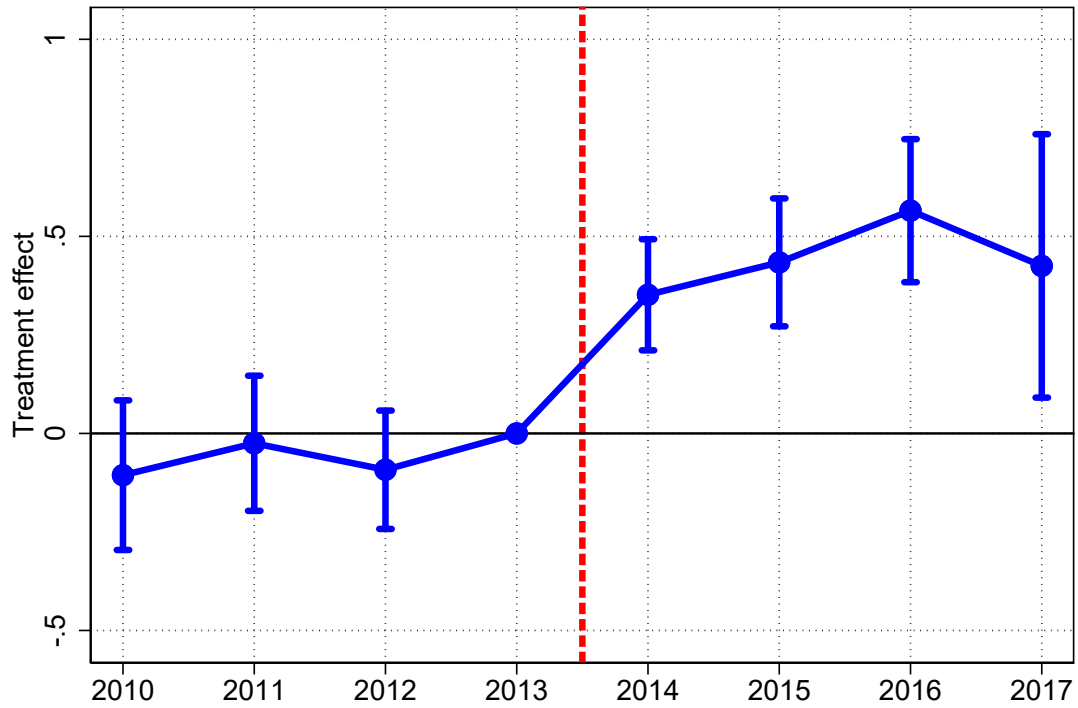
Notes: This figure plots estimates of β_τ, alongside 90 percent confidence bands, over time (each year represents the respective year-end) based on the event study specification in (14), using as dependent variable the natural logarithm of firm j's total cash and cash equivalents, estimated on the sample of German firms in the administrative linked employer-employee data merged with Amadeus from 2010 to 2017.

Figure 4: Impact of Negative Policy Rates on Firms' Fixed Assets
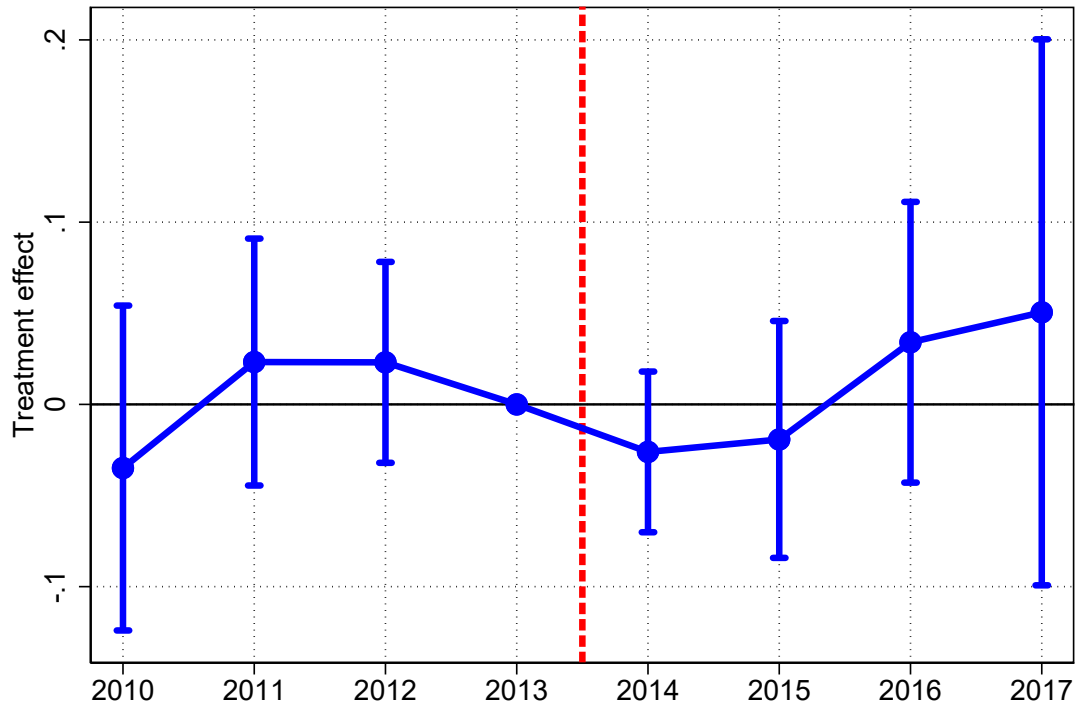
Notes: This figure plots estimates of β_τ, alongside 90 percent confidence bands, over time (each year represents the respective year-end) based on the event study specification in (14), using as dependent variable the natural logarithm of firm j's fixed assets, estimated on the sample of German firms in the administrative linked employer-employee data merged with Amadeus from 2010 to 2017.

Tables

Table 1: Summary Statistics

| Variable	Mean	Std. dev.	P5	P50	P95	No. of observations
Panel A: Firm-bank-half-year level						
Deposit ratio	0.374	0.126	0.235	0.337	0.552	22,016
Any loan share	0.141	0.348	0	0	1	22,016
Total loan amount (bn euros)	0.069	0.194	0.008	0.035	0.152	3,068
Panel B: Worker-year level						
Annualized wage (euros)	37,294	18,541	8,317	35,249	70,949	72,130,131
Unemployed next year	0.096	0.294	0	0	1	66,250,135
Panel C: Firm-year level						
Deposit ratio	0.654	0.153	0.257	0.693	0.837	2,810,558
Wage P90/P10	4.374	216.636	1.000	2.093	9.529	2,779,570
Wage P90/P10 at public firms	2.589	3.267	1.171	2.006	4.352	1,340
Board total P50/Wage P5	189.077	852.580	28.666	60.360	298.299	266
Board salary P50/Wage P5	64.158	294.934	12.883	25.318	85.895	266
Board bonus P50/Wage P5	126.299	580.321	11.868	35.884	213.693	263
No. of employees	47.793	752.164	1.500	11	135	2,810,558
No. of nonmanagerial employees	44.812	692.138	1	10	127	2,810,558
No. of part-time employees	16.442	277.181	0	3	44	2,810,558

Notes: The summary statistics in Panel A refer to the firm-bank-half-year level for syndicated loans granted to German firms in DealScan, and correspond to the respective descriptions and the sample in Table 3. Total loan amount is conditional on having any loan. The summary statistics in Panel B refer to the dependent variables at the worker-year level, and correspond to the respective descriptions in Tables 5 to 7. The variables in Panel C correspond to the respective descriptions in Tables 8 and 9.

Table 2: Summary Statistics for Firms with High versus Low Exposure to Negative Rates

Variable	Mean	Std. dev.	P5	P50	P95	No. of firms
Panel A: German firms related to banks in the highest quartile of the deposit ratio distribution						
No. of employees	27.634	497.686	1.5	9	78	88,899
Average annualized wage (euros)	27,530	11,290	11,728	26,118	48,483	88,899
Proportion female	0.252	0.320	0.000	0.111	1	88,899
Proportion foreigner	0.070	0.183	0.000	0.000	0.500	88,899
Proportion university	0.110	0.236	0.000	0.000	0.700	88,899
Assets (mm euros)	3.417	65.291	0.079	0.725	8.764	62,117
Leverage	0.201	0.244	0.000	0.098	0.730	34,224
ROA	0.113	0.127	0.005	0.071	0.368	8,191
ROA volatility	0.062	0.064	0.006	0.041	0.188	4,379
Cash/Assets	0.192	0.207	0.001	0.117	0.635	59,711
Investment/Assets	0.070	0.101	0.000	0.033	0.272	25,585
Panel B: German firms related to banks in the lowest quartile of the deposit ratio distribution						
No. of employees	74.729	990.003	1	12	219	87,150
Average annualized wage (euros)	33,116	13,989	12,642	31,490	58,499	87,150
Proportion female	0.297	0.317	0.000	0.200	1	87,150
Proportion foreigner	0.080	0.185	0.000	0.000	0.500	87,150
Proportion university	0.191	0.287	0.000	0.035	1	87,150
Assets (mm euros)	31.612	1,529	0.096	1.172	44.720	61,893
Leverage	0.158	0.228	0.000	0.031	0.675	37,468
ROA	0.125	0.131	0.007	0.085	0.388	13,557
ROA volatility	0.071	0.066	0.009	0.052	0.200	9,636
Cash/Assets	0.194	0.214	0.001	0.113	0.650	59,007
Investment/Assets	0.065	0.105	0.000	0.025	0.271	25,173

Notes: This table shows firm-level summary statistics for 2013, the last year before the introduction of negative rates, for German corporations in the top (Panel A) and bottom (Panel B) quartile of the distribution of *Deposit ratio$_j$*, which is the average deposit ratio, measured in 2013, across all (typically German) banks that firm *j* reports to be in a banking relationship with anytime from 2010 to 2013.

Table 3: Impact of Negative Policy Rates on Lending to German Firms

Variable	Any loan share $\in \{0,1\}$		ln(1 + total loan volume)	
	(1)	(2)	(3)	(4)
Deposit ratio$_j$ × After(06/2014)	-0.084***	-0.101***	-1.254**	-1.559***
	(0.030)	(0.030)	(0.511)	(0.514)
Bank-firm FE	Y	Y	Y	Y
Time FE	Y	N	Y	N
Bank-time FE	N	Y	N	Y
N	21,274	21,158	21,274	21,158

Notes: Based on all lead banks' shares of completed syndicated loans of German corporations *j* anytime from January 2010 to December 2017, the sample is extended so as to represent a balanced panel of all borrower-bank pairs at the semi-annual frequency. Time therefore refers to the semi-annual level. All singletons are dropped from the total number of observations N. In the first two columns, the dependent variable is an indicator for any nonzero share of firm *j*'s loans retained by bank *k* in *t*. In the last two columns, the dependent variable is the natural logarithm of one plus the total loan volume granted to firm *j* by bank *k* in *t*. *Deposit ratio$_j$* $\in [0,1]$ is the average deposits-to-assets ratio, measured in 2013, across all (typically German) banks that firm *j* reports to be in a banking relationship with anytime from 2010 to 2013. *After*(06/2014)$_t$ is a dummy variable for the period from June 2014 onwards. Energy and financial-services borrower firms are dropped. Robust standard errors (clustered at the bank level) are in parentheses. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 4: Impact of Negative Policy Rates on German Firms' Preexisting Banking Relationships

	Any loan share $\in \{0,1\}$			ln(1 + total loan volume)		
Sample	2010–2017		2013–2015	2010–2017		2013–2015
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Deposit ratio$_k$ × After(06/2014)	-0.085*	-0.122**	-0.158**	-1.475*	-2.099*	-2.630*
	(0.048)	(0.061)	(0.076)	(0.852)	(1.108)	(1.382)
Deposit ratio$_k$ × After(07/2012)		0.066			1.113	
		(0.089)			(1.611)	
Bank-firm FE	Y	Y	Y	Y	Y	Y
Firm-time FE	Y	Y	Y	Y	Y	Y
N	15,554	15,554	6,508	15,554	15,554	6,508

Notes: Based on all lead banks' shares of completed syndicated loans of German corporations j anytime from January 2010 to June 2014, the sample is extended so as to represent a balanced panel of all borrower-bank pairs at the semi-annual frequency from 2010 to 2017. Time therefore refers to the semi-annual level. Furthermore, the sample is limited to banks in currency areas with negative monetary policy rates (that lend to German firms at any point in the preperiod from January 2010 to June 2014). In columns 3 and 6, the sample runs from the first half of 2013 to the second half of 2015. All singletons are dropped from the total number of observations N. In the first three columns, the dependent variable is an indicator for any nonzero share of firm j's loans retained by bank k in t. In the last three columns, the dependent variable is the natural logarithm of one plus the total loan volume granted to firm j by bank k in t. *Deposit ratio$_k$* $\in [0,1]$ is bank k's ratio of deposits over total assets in 2013. *After*(06/2014)$_t$ is a dummy variable for the period from June 2014 onwards. *After*(07/2012)$_t$ is a dummy variable for the period from July 2012 onwards. Energy and financial-services borrower firms are dropped. Robust standard errors (clustered at the bank level) are in parentheses. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 5: Effects of Monetary Policy-Induced Credit Supply on Wages and Employment

Variable	ln(wage)			Unemployed next year $\in \{0,1\}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Deposit ratio × After(2014)	-0.019**	-0.077***	-0.083***	0.007**	0.011***	0.013***
	(0.009)	(0.010)	(0.009)	(0.003)	(0.004)	(0.004)
Worker FE	Y	N	N	Y	N	N
Firm FE	Y	N	N	Y	N	N
Worker-firm FE	N	Y	Y	N	Y	Y
Year FE	Y	Y	N	Y	Y	N
State-year FE	N	N	Y	N	N	Y
N	70,137,681	67,731,621	67,722,380	65,253,153	63,505,552	63,495,556

Notes: The sample consists of full-time employees i at German corporations j in year t from 2010 to 2017. The dependent variable in the first three columns is the natural logarithm of the wage of individual i at firm j in year t. The dependent variable in the last three columns is an indicator variable for whether individual i is unemployed in year $t+1$. *Deposit ratio$_j \in [0,1]$* is the average deposits-to-assets ratio, measured in 2013, across all (typically German) banks that firm j reports to be in a banking relationship with anytime from 2010 to 2013. *After(2014)$_t$* is a dummy variable for the years 2014–2017. State-year fixed effects are based on the modal location (state) of firm j's establishments. Robust standard errors (clustered at the firm level) are in parentheses. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 6: Effects of Monetary Policy-Induced Credit Supply on Wages and Employment, by Workers' Within-Firm Pay Rank

Variable	ln(wage)			Unemployed next year $\in \{0,1\}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Deposit ratio × After(2014) × Bottom 20% within firm	0.034*	0.069***	0.051***	0.009**	0.004	0.013***
	(0.018)	(0.019)	(0.017)	(0.004)	(0.004)	(0.004)
Deposit ratio × After(2014) × Middle 60% within firm	-0.017**	-0.012*	-0.014**	0.018***	0.016***	0.019***
	(0.007)	(0.007)	(0.007)	(0.002)	(0.002)	(0.002)
Deposit ratio × After(2014)	-0.008			-0.008**		
	(0.007)			(0.003)		
Deposit ratio × Bottom 20% within firm	-0.136***	-0.142***		0.004	0.009**	
	(0.021)	(0.018)		(0.004)	(0.004)	
Deposit ratio × Middle 60% within firm	-0.112***	-0.106***		0.001	0.003	
	(0.015)	(0.013)		(0.003)	(0.003)	
After(2014) × Bottom 20% within firm	0.154***	0.141***	0.071***	0.029***	0.032***	0.050***
	(0.013)	(0.013)	(0.011)	(0.002)	(0.002)	(0.003)
After(2014) × Middle 60% within firm	0.010**	0.007	-0.011**	-0.005***	-0.001	0.000
	(0.004)	(0.005)	(0.005)	(0.002)	(0.001)	(0.002)
Worker FE	Y	Y	N	Y	Y	N
Firm FE	Y	N	N	Y	N	N
Worker-firm FE	N	N	Y	N	N	Y
Year FE	Y	N	N	Y	N	N
Firm-year FE	N	Y	Y	N	Y	Y
N	61,987,235	61,519,347	59,839,079	58,204,386	57,773,587	56,308,377

Notes: The sample consists of full-time employees i at German corporations j in year t from 2010 to 2017. The dependent variable in the first three columns is the natural logarithm of the wage of individual i at firm j in year t. The dependent variable in the last three columns is an indicator variable for whether individual i is unemployed in year $t + 1$. *Deposit ratio$_j$* $\in [0, 1]$ is the average deposits-to-assets ratio, measured in 2013, across all (typically German) banks that firm j reports to be in a banking relationship with anytime from 2010 to 2013. *After*(2014)$_t$ is a dummy variable for the years 2014–2017. *Bottom* 20% (*Middle* 60%) *within firm$_i$* is an indicator variable for whether worker i's wage is in the bottom 20 percent (middle 60 percent) of the wage distribution of the firm where i was employed in the last available year during the preperiod from 2010 to 2013. Robust standard errors (clustered at the firm level) are in parentheses. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 7: Effects of Monetary Policy-Induced Credit Supply on Wages and Employment, by Firms' Pay Rank

	ln(wage)			Unemployed next year $\in \{0,1\}$		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Deposit ratio × After(2014) × Firm pay rank	-0.050	-0.137***	-0.113***	-0.028***	-0.009	-0.020**
	(0.037)	(0.031)	(0.029)	(0.009)	(0.010)	(0.010)
Deposit ratio × After(2014)	-0.017	0.060***	0.045**	0.002	-0.017***	-0.010*
	(0.024)	(0.019)	(0.019)	(0.005)	(0.006)	(0.006)
After(2014) × Firm pay rank	-0.034	0.173***	0.177***	-0.033***	-0.065***	-0.066***
	(0.028)	(0.023)	(0.021)	(0.006)	(0.007)	(0.007)
Worker FE	Y	N	N	Y	N	N
Firm FE	Y	N	N	Y	N	N
Worker-firm FE	N	Y	Y	N	Y	Y
Year FE	Y	Y	N	Y	Y	N
State-year FE	N	N	Y	N	N	Y
N	69,627,349	67,372,241	67,363,297	64,700,521	63,076,967	63,067,608

Notes: The sample consists of full-time employees i at German corporations j in year t from 2010 to 2017. The dependent variable in the first three columns is the natural logarithm of the wage of individual i at firm j in year t. The dependent variable in the last three columns is an indicator variable for whether individual i is unemployed in year $t+1$. *Deposit ratio*$_j \in [0,1]$ is the average deposits-to-assets ratio, measured in 2013, across all (typically German) banks that firm j reports to be in a banking relationship with anytime from 2010 to 2013. *After*(2014)$_t$ is a dummy variable for the years 2014–2017. *Firm pay rank*$_j$ is the rank (from 0 = lowest to 1 = highest) of firm j in terms of its average pay in 2013. State-year fixed effects are based on the modal location (state) of firm j's establishments. Robust standard errors (clustered at the firm level) are in parentheses. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 8: Firm-Level Effects of Monetary Policy-Induced Credit Supply on Within-Firm Inequality

	ln(P90/P10)	ln(P90/P10)	ln(P90/P10)	ln(P50 board total/P5)	ln(P50 board salary/P5)	ln(P50 board bonus/p5)
Sample	All	Public firms	Public firms	DAX firms	DAX firms	DAX firms
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Deposit ratio × After(2014)	-0.013**	-0.373**	-0.510***	-0.877*	-0.696	-0.888*
	(0.006)	(0.160)	(0.183)	(0.485)	(0.456)	(0.532)
Non-euro deposit ratio × After(2014)			-0.029			
			(0.117)			
Firm FE	Y	Y	Y	Y	Y	Y
State-year FE	Y	Y	Y	N	N	N
Year FE	N	N	N	Y	Y	Y
N	2,771,902	1,324	1,149	266	266	263

Notes: The unit of observation is the firm-year level jt. In column 1, the sample consists of all German corporations j in year t from 2010 to 2017. In columns 2 and 3, the sample is limited to all publicly listed German corporations j that are active in the syndicated loans market in year t from 2010 to 2017. In the last three columns, the sample consists of DAX-listed German corporations j in year t from 2010 to 2016 for which we have board-compensation data from BoardEx. In the first three columns, the dependent variable is the delta log of the wage at the 90th versus 10th percentile of firm j's wage distribution in year t. The dependent variable in column 4 is the delta log of the median total compensation, consisting of a salary and a potential bonus, of executive board members at firm j in year t versus the wage at the 5th percentile of firm j's wage distribution in year t. The dependent variable in column 5 is the delta log of the median salary of executive board members at firm j in year t versus the wage at the 5th percentile of firm j's wage distribution in year t. The dependent variable in column 6 is the delta log of the median bonus (conditional on being nonzero) of executive board members at firm j in year t versus the wage at the 5th percentile of firm j's wage distribution in year t. *Deposit ratio$_j$* $\in [0,1]$ is the average deposits-to-assets ratio, measured in 2013, across all (typically German) banks that firm j reports to be in a banking relationship with anytime from 2010 to 2013. *Non-euro deposit ratio$_j$* $\in [0,1]$ is the average deposits-to-assets ratio, measured in 2013, across all non-euro area banks (and other banks not based in negative-rate currency areas) from which firm j received syndicated loans anytime from 2010 to 2013. *After*(2014)$_t$ is an indicator variable for the years 2014–2017 in the first three columns (2014–2016 in all remaining columns). State-year fixed effects are based on the modal location (state) of firm j's establishments. Robust standard errors (clustered at the firm level) are in parentheses. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Table 9: Firm-Level Effects of Monetary Policy-Induced Credit Supply on Employment

Variable	ln(no. of all employees) (1)	ln(no. of nonmanagerial employees) (2)	Share nonmanagerial (3)	Share part-time (4)
Deposit ratio × After(2014)	-0.015***	-0.021***	-0.006***	-0.011***
	(0.005)	(0.005)	(0.001)	(0.001)
Firm FE	Y	Y	Y	Y
State-year FE	Y	Y	Y	Y
N	2,803,152	2,803,152	2,803,152	2,803,152

Notes: The unit of observation is the firm-year level jt. In the first four columns, the sample consists of all German corporations j in year t from 2010 to 2017. The dependent variable in column 1 is the natural logarithm of the total number of employees at firm j in year t. The dependent variable in column 2 is the natural logarithm of the number of nonmanagerial employees at firm j in year t. The dependent variable in column 3 is the ratio, between 0 and 1, of nonmanagerial staff over all employees at firm j in year t. The dependent variable in column 4 is the ratio, between 0 and 1, of part-time staff over all employees at firm j in year t. *Deposit ratio*$_j \in [0, 1]$ is the average deposits-to-assets ratio, measured in 2013, across all (typically German) banks that firm j reports to be in a banking relationship with anytime from 2010 to 2013. *After*(2014)$_t$ is an indicator variable for the years 2014–2017. State-year fixed effects are based on the modal location (state) of firm j's establishments. Robust standard errors (clustered at the firm level) are in parentheses. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Online Appendix—Not for Publication

A   Model Appendix

A.1   Equilibrium Definition

Definition 1. *A stationary search equilibrium is a set of worker value functions $\{S_a, W_a\}_a$ and policy functions $\{\phi_a\}_a$; a firm value function Π and policy functions $\{w_a, v_a\}_a$; wage offer distributions $\{F_a(w)\}_a$; measures of unemployed workers $\{u_a\}_a$, aggregate job searchers $\{U_a\}_a$, aggregate vacancies $\{V_a\}_a$, and labor market tightnesses $\{\theta_a\}_a$; job offer arrival rates $\{\lambda_a^u, \lambda_a^e\}_a$; and firm sizes $\{l_a\}_a$ such that for all a:*

- *Given $F_a(w)$ and $\{\lambda_a^u, \lambda_a^e\}$, the value functions S_a and W_a satisfy equations (1) and (2);*

- *Unemployed workers' job acceptance policy follows a threshold rule with reservation wage*

$$\phi_a = b_a + (\lambda_a^u - \lambda_a^e) \int\limits_{w' \geq \phi_a} \frac{1 - F_a(w')}{\rho + \delta_a + \lambda_a^e [1 - F_a(w')]} \, dw', \quad \forall a,$$

  and employed workers with wage w accept any job w' such that $w' > w$;

- *Given $l_a(\cdot)$, firms' value function Π and optimal policy functions $\{w_a, v_a\}$ are consistent with the problem in equations (3)–(4);*

- *Measures of unemployed workers are given by*

$$u_a = \frac{\delta_a}{\delta_a + \lambda_a^u}, \quad \forall a,$$

  aggregate job searchers are given by

$$U_a = \mu_a \left[u_a + s_a^e (1 - u_a) \right], \quad \forall a,$$

  aggregate vacancies are given by

$$V_a = E \int\limits_j v_a(j) \, d\Gamma(j), \quad \forall a,$$

  and labor market tightness θ_a is given by

$$\theta_a = \frac{V_a}{U_a}, \quad \forall a.$$

- *Given θ_a, the job offer arrival rates satisfy*

$$\lambda_a^u = \chi_a \theta_a^\alpha,$$
$$\lambda_a^e = s_a \lambda_a^u.$$

- *Given $F_a(w)$, $\{\lambda_a^u, \lambda_a^e\}_a$, and V_a, steady-state firm sizes satisfy*

$$l_a(w, v) = \left(\frac{1}{\delta_a + \lambda_a^e \left[1 - F_a(w) \right]} \right)^2 \frac{1}{V_a} \mu_a u_a \lambda_a^u \left(\delta_a + \lambda_a^e \right) v, \quad \forall a.$$

- *The offer distribution satisfies $F_a(w) = \int_j v_a(j) \mathbf{1}[w_a(j) \leq w] \, d\Gamma(j) / V_a$.*

A.2 Proof of Proposition 1

As in equation (7) of the main text, we first reformulate the firm's problem by defining

$$\tilde{p} = p \frac{1 + r}{1 + (1 + \psi)r}, \tag{19}$$

where ψ is the Lagrange multiplier on a firm's credit constraint. From here, the proof follows closely that in Morchio and Moser (2020), which we adapt to our setting.

A.2.1 Part (a)

Proof. To prove this part, we proceed in two steps.

Step 1. In the first step, we prove monotonicity of w_a^* in the composite productivity $\tilde{p}$. We can rewrite the firm's FOCs as

$$[\partial w_a]: \quad 1 = (\tilde{p} - w_a) \frac{2\lambda_a^e f_a(w_a)}{\delta_a + \lambda_a^G + \lambda_a^e(1 - F_a(w_a))} \tag{20}$$

$$[\partial v_a]: \quad c_a^{v,0} \frac{\partial \tilde{c}^v(v_a)}{\partial v_a} = T_a (\tilde{p} - w_a) \left(\frac{1}{\delta_a + \lambda_a^G + \lambda_a^e(1 - F_a(w_a))} \right)^2, \tag{21}$$

where $T_a = \mu_a[(u_a + s_a^G)\lambda_a^u(\delta_a + \lambda_a^G + \lambda_a^e)] / V_a$. Equation (20) already shows that the optimal wage w_a is independent of the cost of posting vacancies, proving the first statement. Now consider equation (21); because the term on the right-hand side is always positive for $\tilde{p} > \phi_a$, it follows that optimal vacancies $v_a^*(\tilde{p}, c_a^{v,0})$ are always strictly positive.
We now show that the derivative of wages with respect to $\tilde{p}$ is always positive. Define $h_a(\tilde{p}) = F_a(w_a^*(\tilde{p}))$. Thus:

$$h_a(\tilde{p}) = \frac{\int_{\tilde{p}' \geq \phi_a}^{\tilde{p}} \bar{v}_a^*(\tilde{p}) \gamma_a(\tilde{p})}{V_a} \, d\tilde{p}' \tag{22}$$

$$h_a'(\tilde{p}) = f_a(w_a^*(\tilde{p})) \, w_a^{*\prime}(\tilde{p}) \tag{23}$$

$$f_a(w_a^*(\tilde{p})) = h_a'(\tilde{p}) / w_a^{*\prime}(\tilde{p}), \tag{24}$$

where $\bar{v}_a^*(\tilde{p}) = \int v_a^*(\tilde{p}, c') \gamma_a^c(c'|\tilde{p}) \, dc'$ is the integral of optimal vacancies conditional on $\tilde{p}$ and $\gamma_a^c(c|\tilde{p})$ is the density of vacancy posting costs $c_a^{v,0}$ conditional on $\tilde{p}$, $\gamma_a(\tilde{p})$ is the marginal density of composite productivity $\tilde{p}$ and $\partial w_a^*(\tilde{p})/\partial \tilde{p} = w_a^{*\prime}(\tilde{p})$ is the derivative of equilibrium wage with respect to $\tilde{p}$. Thus, we can rewrite $h_a'(\tilde{p}) = \frac{\bar{v}_a^*(\tilde{p})}{V_a} \gamma(\tilde{p})$ by differentiating equation (22) using Leibniz's integral rule.

Using these identities, we can write $f_a(w_a^*(\tilde{p})) = \frac{\overline{v}_a^*(\tilde{p})}{V_a}\gamma_a(\tilde{p})\partial\tilde{p}/\partial w_a^*(\tilde{p})$. Thus, we can rewrite equation (20) as

$$\frac{\partial w_a^*(\tilde{p})}{\partial \tilde{p}} = (\tilde{p} - w_a^*)\frac{2\lambda_a^e}{\delta_a + \lambda_a^G + \lambda_a^e(1 - h_a(\tilde{p}))}\frac{\overline{v}_a^*(\tilde{p})}{V_a}\gamma_a(\tilde{p}). \tag{25}$$

Because the right-hand side of this expression is always positive for $\tilde{p} > \phi_a$, it follows that $\partial w_a^*(\tilde{p})/\partial\tilde{p} > 0$, thus proving that equilibrium wage is increasing in $\tilde{p}$.

Step 2. That optimal wages w_a^* are strictly increasing in productivity p and strictly decreasing (constant) in the Lagrange multiplier on the credit limit ψ for workers of high (low) ability follows from the definition of $\tilde{p}$ in equation (19) above. $\qquad\square$

A.2.2 Part (b)

Proof. Expected profits per worker contacted by a firm is

$$\pi_a(\tilde{p}, w) = h_a(w)J_a(\tilde{p}, w),$$

where $h_a(w)$ is the acceptance probability and $J_a(\tilde{p}, w)$ is the value of employing a worker to a firm with composite productivity $\tilde{p}$ providing wage w. Under the assumption that firms maximize long-run profits, the value of employing a worker is simply

$$\begin{aligned}J_a(\tilde{p}, w) &= \frac{\tilde{p} - w}{\delta_a + \lambda_a^e(1 - F_a(w))}\\&= \frac{(\tilde{p} - w)/(\delta_a)}{1 + \kappa_a^e(1 - F_a(w))},\end{aligned}$$

The acceptance probability for a firm offering w is

$$\begin{aligned}h_a(w) &= \frac{u_a + s_a^e(1 - u_a)G_a(w)}{u_a + s_a^e(1 - u_a)}\\&= \frac{\delta_a + s_a^e(\lambda_a^u)G_a(w)(\delta_a + \lambda_a^u)}{\delta_a + s_a^e(\lambda_a^u)(\delta_a + \lambda_a^u)}\\&= \frac{1 + s_a^e\kappa_a^uG_a(w)(1 + \kappa_a^u)}{1 + s_a^e\kappa_a^u(1 + \kappa_a^u)}\\&= \frac{1 + s_a^e\kappa_a^u\left[\frac{F_a(w)}{1 + \kappa_a^e[1 - F_a(w)]}\right](1 + \kappa_a^u)}{1 + s_a^e\kappa_a^u(1 + \kappa_a^u)}\\&= \frac{1 + \kappa_a^e[1 - F_a(w)] + s_a^e\kappa_a^uF_a(w)(1 + \kappa_a^u)[1 + \kappa_a^e[1 - F_a(w)]]}{[1 + s_a^e\kappa_a^u(1 + \kappa_a^u)][1 + \kappa_a^e[1 - F_a(w)]]},\end{aligned}$$

where $\kappa_a^u = \lambda_a^u/\delta_a$. Combining expressions, expected profits per contacted worker are

$$\begin{aligned}\pi(\tilde{p}, w) &= h(w)J(\tilde{p}, w)\\&= \frac{\{1 + \kappa_a^e[1 - F_a(w)] + s_a^e\kappa_a^uF_a(w)(1 + \kappa_a^u)[1 + \kappa_a^e[1 - F_a(w)]]\}(\tilde{p} - w)}{[1 + s_a^e\kappa_a^u(1 + \kappa_a^u)][1 + \kappa_a^e(1 - F_a(w))]^2(\delta_a)}.\end{aligned} \tag{26}$$

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Then the firm's problem becomes

$$\max_{w,v} \left\{ \pi_a \left(\tilde{p}, w \right) v q_a - c_a \left(v \right) \right\}.$$

Therefore, the optimal wage and vacancy policy functions satisfy

$$w_a^* \left(\tilde{p}, \cdot \right) = \arg\max_w \pi_a \left(\tilde{p}, w \right)$$

$$\frac{\partial c_a \left(v^* \left(\tilde{p}, \cdot \right) \right)}{\partial v} = \max_w \pi_a \left(\tilde{p}, w \right). \tag{27}$$

Since the vacancy cost function $c \left(\cdot \right)$ is convex, and $\pi \left(\tilde{p}, w \right)$ in equation (26) is strictly increasing in $\tilde{p}$, then it follows from an application of the envelope theorem to equation (27) that $v^* \left(\tilde{p}, \cdot \right)$ is strictly increasing in $\tilde{p}$. Therefore, $v_a^* (\cdot)$ is strictly increasing in productivity p and strictly increasing (constant) in the Lagrange multiplier on the credit constraint ψ for credit contsrained (unconstrained) firms. □

A.2.3 Part (c)

Proof. The proof follows by combining the result in part (a) of Proposition 1 with the fact that wages for low-ability workers are equal to the constant flow value of unemployment. Specifically, by part (a), at constrained firms, wages of high-skill workers, w_{a_H}, are strictly increasing in ξ_j but wages of low-skill workers, w_{a_L}, are invariant to the credit limit ξ_j. Therefore, a reduction in the credit limit ξ_j that increases the Lagrange multiplier ψ_j strictly reduces the top-to-bottom wage difference,

$$\frac{\partial (w_{a_H} - w_{a_L})}{\partial \psi_j} = \frac{\partial w_{a_H}}{\partial \psi_j} < 0 \tag{28}$$

for credit constrained firms with $\psi_j > 0$. While equation (28) proves the result for one particular measure of within-firm wage inequality, an analogous result applies more generally due to the fact that

$$w_{a_L} = b_{a_L} \leq b_{a_H} < w_{a_H} \tag{29}$$

and

$$\frac{\partial w_{a_H}}{\partial \psi_j} < 0 = \frac{\partial w_{a_L}}{\partial \psi_j}. \tag{30}$$

□

A.2.4 Part (d)

Proof. First, we have $\phi_{a_L} < \phi_{a_H}$ since the reservation wage ϕ_a satisfies

$$\phi_a = b_a + \left(\lambda_a^u - \lambda_a^e \right) \int_{w=\phi_a}^{\infty} \frac{1 - F_a(w)}{\rho + \delta_a + \lambda_a^e (1 - F_a(w))} dw, \tag{31}$$

combined with the fact that $b_{a_L} \leq b_{a_H}$ and $\lambda_{a_L}^e = 0 < \lambda_{a_H}^e$. Next, we have that the firm with the lowest composite productivity $\underline{\tilde{p}}$ pays exactly workers' reservation wages, $w_{a_L} (\underline{\tilde{p}}) = \phi_{a_L} = b_{a_L}$

and $w_{a_H}(\underline{\tilde{p}}) = \phi_{a_H} > b_{a_L}$. Note that the latter statement is independent of the bindingness of credit constraints. Finally, we have that any firm with higher compositive productivity $\tilde{p}_j$ pay low-ability workers their reservation wage, $w_{a_L}(\tilde{p}_j) = \phi_{a_L}$, but high-ability workers some wage strictly above their reservation wage, $w_{a_H}(\tilde{p}_j) > \phi_{a_H}$.

Now consider the impact of a decrease in the credit limit ξ_j for some firm j. At the lowest-paying firm, $\tilde{p}_j = \underline{\tilde{p}}$ and wages are invariant to the credit limit. At any higher-paying firm, $\tilde{p}_j > \underline{\tilde{p}}$ and wages of high-ability workers are strictly decreasing in the Lagrange multiplier on the credit constraint ψ_j, while wages of low-ability workers are invariant, by part (a) of Proposition 1. Therefore,

$$\frac{\partial(w_a(\tilde{p}_j) - w_a(\underline{\tilde{p}}))}{\partial \psi_j} = \frac{\partial w_a(\tilde{p}_j)}{\partial \psi_j} \geq 0, \tag{32}$$

for workers of any ability level a, with strict inequality for workers with high ability $a = a_H$. $\qquad\square$

B Empirical Appendix

B.1 Additional Tables

Table B.1: Effects of Monetary Policy-Induced Credit Supply Shock on Within-Firm Inequality: Nonexecutive Board Members

	ln(p50 board total/p5)	ln(p50 board salary/p5)	ln(p50 board bonus/p5)
Sample	DAX firms	DAX firms	DAX firms
Variable	(1)	(2)	(3)
Deposit ratio × After(2014)	-0.311	0.097	-0.295
	(0.548)	(0.577)	(1.450)
Firm FE	Y	Y	Y
Year FE	Y	Y	Y
N	266	266	105

Notes: The unit of observation is the firm-year level jt. In column 1, the sample consists of all German corporations j in year t from 2010 to 2017. The sample consists of DAX-listed German corporations j in year t from 2010 to 2016 for which we have board-compensation data from BoardEx. The dependent variable in column 1 is the delta log of the median total compensation of nonexecutive board members at firm j in year t versus the annualized wage at the 5th percentile of firm j's wage distribution in year t. The dependent variable in column 2 is the delta log of the median salary of nonexecutive board members at firm j in year t versus the annualized wage at the 5th percentile of firm j's wage distribution in year t. The dependent variable in column 3 is the delta log of the median bonus (conditional on being nonzero) of nonexecutive board members at firm j in year t versus the annualized wage at the 5th percentile of firm j's wage distribution in year t. *Deposit ratio$_j$* $\in [0, 1]$ is the average deposits-to-assets ratio, measured in 2013, across all (typically German) banks that firm j reports to be in a banking relationship with anytime from 2010 to 2013. *After*(2014)$_t$ is an indicator variable for the years 2014–2016. Robust standard errors (clustered at the firm level) are in parentheses. ***, **, and * denote significance at the 1 percent, 5 percent, and 10 percent level, respectively.