Essays on Credit Constraints, International Trade and Local Government Budgets

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Introduction

The development of financial markets and the global integration of goods markets together have shaped the world economy in recent decades. For example, the trade-to-GDP ratio for the US has increased by 39 percent between 1980 and 2008, while private capital relative to GDP more than doubled. The numbers are 45 percent and 116 percent for high-income countries, respectively.[1] There is a fairly large body of literature on financial constraints in the context of international trade. That literature hypothesizes and provides evidence for effects of financial constraints and financial market development on the structure of trade through comparative advantage, on trade volume, and on international capital flows. Yet, the implications of financial constraints for product market competition and distributional aspects in the open economy have received inadequate attention.

In this thesis, I analyze the consequences of financial frictions due to asymmetric information in the open economy. In a collection of three essays, I examine the effects of credit constraints on (i) firms' markups, (ii) inter-group inequality of profit–wage income, and (iii) intra-group inequality of wage income. The fourth essay, in contrast, is not concerned with credit constraints in open economies but empirically analyzes the trade exposure effects on income and spending of German municipalities.

The first essay is a joint work with Peter Egger and Tobias Seidel, and has been published in Economica Vol. 85 (340) in October 2018. We model credit constraints due to asymmetric information, that exclude some firms from external finance and thus from market entry. Therefore, credit constraints affect prices and markups by altering the degree of competition. Lower credit constraints allow less productive firms to enter with the following consequences. On the one hand, more competition tends to reduce average prices, but on the other hand, less productive firms charge above-average prices. The overall effect is thus ambiguous. We formulate and structurally estimate a quantitative multi-country version of the model to gauge the direction and magnitude of the effects of credit constraints. We find that an abolishment of credit constraints reduces markups by about 6.1 percent on average while average prices are predicted to increase by 1.6 percent in the European manufacturing sector.

The second paper develops the thesis that credit market frictions might contribute to profit–wage inequality. I analyze the role of credit constraints for profit–wage inequality in closed and open economies. A general finding is that workers' wages are negatively affected by financial constraints, whereas the effect on profits is less clear-cut. However, in the simple benchmark model, profit–wage inequality increases in financial intermediation costs as well as in the degree of moral hazard.

The role of credit constraints for union and competitive wages in closed and open economies is examined in the third essay. The credit friction in this model also stems from a moral hazard framework. It is shown that union and competitive wages decrease in agency costs as well as in financial intermediation costs. Tighter credit frictions impact union wages stronger than competitive wages, reducing inequality within the group of workers. Profits decrease in financial intermediation costs in union and non-union sectors under free trade as well as in autarky, because intermediation costs increase the unit costs in this model. By contrast, tighter credit frictions caused by higher agency costs increase profits due to the fall

[1] World Bank's World Development Indicators and Global Financial Development Database.

of workers' wages irrespective of the trade regime. Therefore, higher agency costs relocate income from workers to entrepreneurs in general equilibrium.

The fourth essay analyzes the causal effect of rising German trade with China and Eastern Europe on local government budgets in Germany during the period 1992–2006. The variation of the local industry structure is used to identify regional differences in the exposure to international trade with the East employing an instrumental variables approach. I find at least mild evidence of "winners" and "loser" in terms of municipal budget revenues and expenditures. Further, I identify certain revenue sources and expenditure categories, which are significantly affected by being exposed to trade. In particular, per capita business tax income is lower in districts with high import exposure, as is spending for community streets and sports. In general, effects are small but more pronounced in spending categories where local governments have substantial leeway in budgeting and execution of their duties.

Chapter 1

The competitive effects of credit constraints in the global economy

This chapter is based on the article "The competitive effects of credit constraints in the global economy" as published in Economica **85**(340), October 2018, pp. 771–792 and is joint work with Peter Egger and Tobias Seidel.

Abstract

As credit constraints exclude some firms from external finance and thus from market entry, they affect prices and markups by altering the degree of competition. Lower credit constraints allow less productive firms to enter with the following consequences. On the one hand, more competition tends to reduce average prices, but on the other hand, less productive firms charge above-average prices. The overall effect is thus ambiguous. We therefore formulate and structurally estimate a quantitative multi-country version of the model to gauge the direction and magnitude of the effects of credit constraints in a model with variable firm-specific markups over marginal costs. In a sample of 11 European countries' manufacturing sectors between 2000-2005, we find that an abolishment of credit constraints reduces markups by about 6.1 percent on average while average prices are predicted to increase by 1.6 percent. The latter indicates that the effect of credit constraints on productivity dominates the one on competition.

1.1 Introduction

If firms have market power, they exploit it by setting higher price–cost markups and prices relative to a competitive market. While this behavior raises firm profits, it reduces consumption possibilities for households and reduces welfare. Accordingly, a lot of countries have installed antitrust authorities to prevent excessive market power.[1] While there is a large literature on competition policy (e.g., Jaquemin and Slade, 1989, or Motta, 2004) that has improved our understanding of regulation and market efficiency, less focus has been laid on the role of credit constraints for product market competition, especially in the global economy. If there are frictions in the credit market, some firms might be excluded from external finance despite positive net present values and cannot enter the market. This reduces the degree of competition and potentially affects markups and prices in an industry.

Financial markets are particularly interesting to consider as they have deepened enormously over the last decades, in particular, among developed countries. According to the World Bank's Global Financial Development Database, the ratio of private capital to GDP more than doubled for high-income countries between 1980 and 2010 and recently reached values of two in the cases of the United Kingdom and the United States. During the same period, cross-country linkages through international commodity trade deepened substantially. Considering the World Bank's World Development Indicators, the increase in trade-to-GDP ratios between 1980 and 2010 amounted to around 40 percent for high-income countries.

To understand the link between financial development and product market competition in the well-integrated developed part of the world and to learn about the direction and the magnitude of the effects, we develop and structurally estimate a multi-country model of international trade, financial market frictions, and endogenous price–cost markups. This allows us to study the relative importance of trade liberalization and a reduction in credit constraints in a unified framework. We extend the model by Melitz and Ottaviano (2008) by adding incomplete credit markets. In particular, asymmetric information between lenders and borrowers gives rise to a moral-hazard problem à la Holmstrom and Tirole (1997). Lenders are neither able to observe the effort of entrepreneurs who need to secure external finance to run their operations, nor is it possible to write a contract contingent on outcome because all borrowers face a nonzero probability of being hit by a bad shock that forces them to exit with zero profits. Lenders thus need to ensure that entrepreneurs provide effort to raise the probability of surviving and earning profits to repay the loan such that the lender avoids losses in expectation. As effort provision is associated with opportunity costs, entrepreneurs need to earn a certain minimum income to make shirking unattractive. However, a side effect of this information asymmetry is that lenders deny firms with a too low productivity (i.e., too low expected entrepreneurial income) the requested loans, even if they have a positive net present value. This mechanism exerts direct implications for aggregate outcomes through firm entry and exit (selection) and, with variable markups, the degree of competition in the market. Thereby, our model relates changes in macroeconomic variables (like productivity) to firm-level selection effects that are driven by both trade and credit frictions.

As in models of monopolistic competition among heterogeneous firms, an increase in credit constraints precludes the least productive firms from securing external finance and from entering the market. This mechanism is in line with Aghion, Fally, and Scarpetta (2007) showing that financial development is particularly beneficial for small firms.[2] In models of monopolistically competitive firms where markups are fixed, credit constraints have been shown to induce effects at extensive and intensive margins of exporting (Manova, 2013): a reduction in credit constraints allows some firms to become exporters and incumbent exporting firms raise their foreign sales; in the aggregate, exports expand. In a model with

[1] Examples include the Federal Trade Commission's Bureau of Competition in the United States, the Competition and Markets Authority in the United Kingdom, or the Directorate-General for Competition of the European Commission.

[2] Bertrand, Schoar and Thesmar (2007) and Krishna, Nandy and Puri (2014) provide additional evidence that banking reforms affect firm entry.

variable markups, aggregate effects are less clear cut, though, as we will demonstrate. This ambiguity is owed to two mechanisms that may work in opposite directions. A reduction in credit constraints (which we dub financial development) generates (i) a *productivity effect* as less productive firms get access to external funds; and (ii) a *competition effect* as firm entry raises the degree of competition in the market. While the competition effect tends to reduce prices (when credit constraints decline), the productivity effect counteracts it because small firms charge above-average prices. Which of these two channels dominates in the global economy with bilateral trade flows between countries is ex ante unclear. Average markups, however, unambiguously decline in financial development because low-productive firms charge *below-average* markups.

To learn about comparative static effects and their magnitude, we structurally estimate the model for the manufacturing sector in 11 European countries. It turns out that the abolishment of financial frictions raises average industry prices by about 1.6 percent across all countries. Depending on the level of credit constraints, the effects range from 0.41 percent (Netherlands) to 3.1 percent (France). These results indicate that the productivity effect due to the selection of low-productive firms into the market dominates the competition effect. Markups decline between 1.6 percent in the Netherlands and about 11 percent in France, all in response to an abolishment of financial frictions. We further show the response of markups and prices to trade liberalization is more sensitive compared to changes in credit constraints.

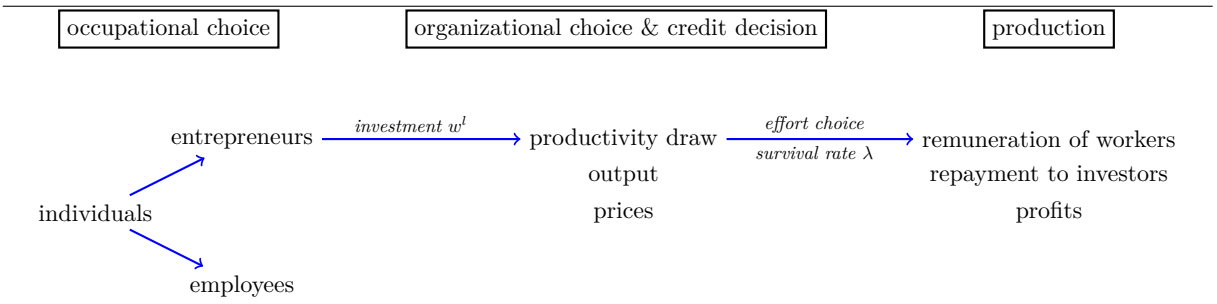
The present paper is related to the empirical literature on markups and international trade. In his review article, Tybout (2003) documents that the exposure to international markets is associated with lower markups.[3] For the United States, Feenstra and Weinstein (2010) show that increases in import shares led to lower price–cost margins between 1992 and 2005. More recently, de Loecker, Goldberg, Khandelwal, and Pavcnik (2016) confirm pro-competitive effects of trade liberalization for India. Edmond, Midrigan, and Xu (2015) study the Taiwanese case finding a strong decline of markups after opening up to trade. Corcos, del Gatto, Mion and Ottaviano (2012) assess the effects of trade liberalization in a model with endogenous markups. While such effects emerge also in the present paper, we highlight the quantitative role of financial frictions for product market competition in open economies rather than the role of trade barriers.

The paper also contributes to the recent literature on credit constraints and international trade that hypothesizes and provides evidence on effects of financial constraints on the structure of trade through comparative advantage (Kletzer and Bardhan, 1987; Ju and Wei, 2011; Egger and Keuschnigg, 2015), on trade volume (Beck, 2002; Chaney, 2016; Manova, 2008, 2013), on international capital flows (Matsuyama, 2005; Antràs and Caballero, 2009), and on technology adoption (Peters and Schnitzer, 2015). To some extent, the focus of this literature is on trade finance (see, e.g., Schmidt-Eisenlohr, 2013; Antràs and Foley, 2015; Amiti and Weinstein, 2011), while we understand financial development more broadly, affecting *all* firms. Most importantly, this strand of literature remains silent about the competitive effects of credit constraints.

The remainder of the paper is organized as follows. The next section introduces the model. Section 1.3 discusses the data and lays out the identification strategy of key parameters of the model. Section 1.4 presents the counterfactual analysis, and Section 1.5 offers concluding remarks.

[3]Earlier contributions include Levinsohn (1993), Harrison (1994), and Krishna and Mitra (1998).

Figure 1.1: Sequence of decisions



1.2 Model

The starting point of our analysis is the multi-country version of the model of Melitz and Ottaviano (2008). This model is well suited to study the competitive effects of credit constraints as it features endogenous price–cost markups. Before proceeding with a formal description of the model, let us provide a brief non-technical overview of the set-up and introduce some of the basic notation.

1.2.1 Overview

Assume that a generic country l is endowed with L^l individuals and produces one homogeneous good as well as a mass of differentiated products. Individuals choose between alternative careers: they choose to become entrepreneurs if expected profits exceed the opportunity cost, that is the prevailing wage rate w^l they would earn when choosing to become employees.

Figure 1.1 illustrates the sequencing of decisions made by economic agents. In the first stage, entrepreneurs need to invest their labor endowment to develop a project. This sunk investment is necessary to find out the productivity of the firm. Second, and based on this knowledge, entrepreneurs choose which of the available markets (domestic and foreign) to serve. Third, as firms are assumed to be inherently credit constrained along the lines of Holmstrom and Tirole (1997), they need to finance a share of production costs externally as some cash flow occurs too late to cover expenses (see Rajan and Zingales, 1998). The financial friction stems from the fact that entrepreneurial effort is unobservable and cannot be inferred from observable firm performance measures. The reason is that even firms with motivated entrepreneurs face the risk of a bad shock. In case of shirking, however, the firm fails with certainty. In essence, it is impossible to write a credit contract contingent on firm performance. The solution is that lenders have to ensure that borrowers have no incentive to shirk as their expected return from running the firm diligently exceeds the private benefit of shirking. This condition is referred to as the incentive compatibility constraint. As the moral hazard problem imposes a minimum level of income to prevent shirking, some of the lesser productive firms (with low operating profits) are unable to obtain funding and cannot enter the market. These firms are credit rationed and, due to lacking funding, cannot produce although their net present value of producing would be positive. Finally, those firms that receive external funding and are not hit by the bad shock hire workers, produce, and remunerate workers and investors using their revenues. Profits as the residual income fall to the entrepreneur. In the next sections, we proceed with a detailed description of the model and solve it by backward induction.

1.2.2 Preferences and demand

Individuals in country l derive utility from consuming a numéraire good, $q_0^{c,l}$, and differentiated varieties v. Consumers' preferences in country l are described by a quasi-linear utility function as in Melitz and Ottaviano (2008),

$$U^l = q_0^{c,l} + \alpha \int_{v \in V} q^{c,l}(v)dv - \frac{1}{2}\gamma \int_{v \in V} q^{c,l}(v)^2 dv - \frac{1}{2}\eta \left(\int_{v \in V} q^{c,l}(v)dv \right)^2, \tag{1.1}$$

delivering the following inverse demand function for a differentiated good v in country l,

$$p^l(v) = \alpha - \gamma q^{c,l}(v) - \eta Q^{c,l}. \tag{1.2}$$

Notice that $Q^{c,l} \equiv \int_0^{N^l} q^{c,l}(v)dv$ represents the individual consumption level over all varieties with N^l denoting the number of available varieties. The utility function features love of variety as long as $\gamma > 0$. A higher level of α and a lower level of η imply a stronger preference for the composite good compared to the numéraire. Assuming that the numéraire good is always consumed, (1.1) delivers the demand function for variety v

$$q^l(v) \equiv L^l q^{c,l}(v) = \frac{\alpha L^l}{\eta N^l + \gamma} - \frac{L^l}{\gamma} p^l(v) + \frac{\eta N^l}{\eta N^l + \gamma} \frac{L^l}{\gamma} \bar{p}^l \quad \forall \ v \in V^*, \tag{1.3}$$

where $\bar{p}^l = (1/N^l) \int_{v \in V^*} p^l(v)dv$ is the average price of varieties in l and L^l denotes the number of consumers. The set of varieties V^* is the largest subset of V that satisfies

$$p^l(v) \leq \frac{\gamma\alpha + \eta N^l \bar{p}^l}{\eta N^l + \gamma} \equiv p^l_{max}, \tag{1.4}$$

where the right-hand side is the upper price bound at which demand for a variety is equal to zero. Equation (1.4) shows that a larger number of varieties reduces the maximum willingness to pay and increases the price elasticity of demand $\varepsilon(v) = [(p_{max}/p(v)) - 1]^{-1}$. Hence, the preference specification implies pro-competitive effects that are absent from a Dixit-Stiglitz framework with a large number of firms and constant elasticity of demand.

1.2.3 Firms and technology

Turning to the production side of the economy, we assume perfectly-competitive labor markets. There are no frictions in the production of the homogeneous good and we assume ζ^l units of labor are needed to produce one unit of q_0^l. In the absence of fixed costs, this establishes a perfectly competitive environment where firms make zero profits. Setting the price of the homogeneous good to unity and assuming diversification of production so that there is always positive demand for that commodity, wages are pinned down to $w^l = 1/\zeta^l$.[4]

To found a firm in the differentiated goods sector, individuals have to invest their labor endowment to learn about the firm-specific productivity level $1/c$. Entry costs are thus determined by the foregone wage income w^l. The parameter c denotes the unit labor input requirement (UIR) that companies draw from a common, known distribution function $G^l(c)$. There are no per-period fixed production costs. To simplify the analysis and to obtain closed-form solutions, we follow the empirical literature on heterogeneous firms in assuming productivity draws to follow a Pareto distribution $G^l(c) = \left(c/c^l_{max}\right)^k$ where c^l_{max} denotes the highest possible cost draw in country l and shape parameter $k \geq 1$. If $k = 1$, c is uniformly distributed.

[4] While constant nominal wages keep the analysis simple, we acknowledge that this affects the quantitative responses of the model.

At higher levels of k, it becomes more likely to draw a high value of c. As labor is the only input in our model, the unit input costs are simply $m^l = cw^l$. As a direct consequence of fixing w^l, unit input costs $m(c)$ follow the same distribution as unit input requirements c.

To ship products from the factory gate to final consumers, firms need to incur transport costs of the iceberg type. This implies that $\tau^{lh} > 1$ units of output have to be shipped from country l to country h to ensure that one unit arrives at the destination. Assuming no trade frictions within markets, we have $\tau^{lh} > \tau^{ll} = 1$ for all countries l, h.

1.2.4 Credit decision

Companies are liquidity constrained and need to finance a share σ of their variable costs externally through a perfectly-competitive financial sector.[5] The parameter σ serves as a compact measure of financial dependence. Let the amount to be borrowed be $C^l(c) = \sigma m^l(c) \sum_{h=1}^{M} \tau^{lh}\, q^{lh}(c)$ where we sum output over M countries. Investors fund the borrower's project only if she behaves diligently because the entrepreneur's project would fail with certainty otherwise. In the case of shirking, the entrepreneur obtains a private benefit of $B^l(c) = b^l C^l(c) = b^l \sigma m^l(c) \sum_{h=1}^{M} \tau^{lh} q^{lh}(c)$, which is proportional to the amount borrowed, with $0 < b^l < 1$. This assumption follows the notion that larger projects offer more scope to divert funds for private use. Under diligence, the probability of success is $0 < \lambda^l < 1$, which implies that inference from the outcome on the entrepreneur's effort level is impossible and a contract contingent on effort is infeasible. Thus, the entrepreneur needs a sufficiently large stake in her project, $R_E^l(c)$, that incentivizes her to behave diligently in order to obtain funding. This requirement is formally expressed by the entrepreneur's incentive constraint

$$\lambda^l R_E^l(c) \geq B^l(c). \tag{IC}$$

The entrepreneur behaves diligently if her expected income (expected profits) is at least as large as the opportunity cost of doing so, that is the private benefit of shirking $B^l(c)$. The expected pledgeable income of an entrepreneur with UIR c in country l,

$$\lambda^l \left(\sum_{h=1}^{M} p^{lh}(c) q^{lh}(c) - \tau^{lh}(1-\sigma) m^l(c) q^{lh}(c) \right) - B^l, \tag{1.5}$$

is required to cover the investor's initial outlay to avoid losses.[6] This is formally given by the investor's participation constraint,

$$\lambda^l R_I^l(c) \geq C^l(c), \tag{PC}$$

where $R_I^l(c)$ denotes the repayment to the investor. As the financial sector is assumed to be perfectly competitive, (PC) holds with equality and the entrepreneur offers the minimum amount that satisfies the incentive compatibility constraint, that is the value of the loan including the default premium, $R_I^l(c) = C^l(c)/\lambda^l$. The entrepreneur thus keeps the entire surplus of the project.

Both (IC) and (PC) impose a link between prices, unit costs and credit constraints,

$$p^{lh}(c) \geq \tau^{lh} \theta^l \tilde{m}^l(c). \tag{1.6}$$

This equation holds with equality for the marginal firm. The measure of financial friction corresponds

[5] As the Melitz-Ottaviano model does not contain fixed costs, we tie the financial constraint to variable costs. This is an innocent assumption as the Holmstrom-Tirole mechanism simply imposes a minimum income threshold for borrowers to ensure diligent behavior. This can be achieved either by imposing agency costs on the fixed or the variable part of production costs.

[6] For the sake of simplicity, we normalize the investor's outside option to zero.

to $\theta^l = 1 + \beta^l/\delta^l \geq 1$. The parameter $\delta^l \equiv 1 + \sigma(1-\lambda^l)/\lambda^l$ is a multiplier on unit costs m^l capturing the costs of external finance. It is increasing in external financial dependence σ and decreasing in the exogenous survival rate λ^l. For the rest of the paper we therefore combine this parameter with unit costs to get $\tilde{m}^l(c) = \delta^l m^l(c)$. Lastly, $\beta^l \equiv b^l\sigma/\lambda^l$ captures the financial friction by imposing a higher revenue per unit sold to ensure a sufficiently high income of the entrepreneur and thus to avoid shirking.[7]

1.2.5 Organizational and occupational choice

Entrepreneurs serve market l if profits from this activity are non-negative and the pricing constraint (1.6) is satisfied. Total profits of firm c in market l are given by

$$\max_{q^{lh}} \lambda^l \sum_{h=1}^{M} \left[p^{lh}(c)q^{lh}(c) - \tau^{lh}\tilde{m}(c)q^{lh}(c)\right]. \tag{1.7}$$

Finally, individuals make a choice between a career as an entrepreneur or an employee by comparing the entrepreneur's expected profits to the outside option of becoming a production worker, which generates income w^l. This is formalized by the free-entry condition

$$\lambda^l \left\{ \int_0^{\tilde{m}_d^l} \pi_d^l dG^l(c) + \sum_{h=1,h\neq l}^{M} \left(\int_0^{\tilde{m}_x^{lh}} \pi_x^{lh} dG^l(c) \right) \right\} = w^l, \tag{FEC}$$

where the upper limits $\tilde{m}_d^l$ and $\tilde{m}_x^{lh}$ denote the marginal costs of the least productive firms which serve the domestic market l and the export market h, respectively. We call $\tilde{m}_d^l$ the domestic cost cutoff of country l and $\tilde{m}_x^{lh}$ the export cost cutoff of country l for export market h. The left-hand side of the equation describes expected profits from domestic and export sales, respectively. Individuals choose to pursue an entrepreneurial career as long as expected profits exceed their opportunity cost, that is the expected wage from working as an employee w^l. This opportunity cost is also the market entry cost.

1.2.6 Equilibrium

From the maximization problem of a firm operating in an open economy as stated in (1.7), we can derive profit-maximizing prices $p^{lh}(c)$ and quantities $q^{lh}(c)$, which have to meet the first-order condition

$$q^{lh}(c) = \frac{L^h}{\gamma}\left[p^{lh}(c) - \tau^{lh}\tilde{m}^l(c)\right]. \tag{1.8}$$

Every firm whose profit-maximizing price is above the threshold level p_{max}^h of market h makes losses and exits that market. Starting with the domestic market, the cutoff firm with a unit input requirement of $\tilde{m}_d^l$ satisfies $p(\tilde{m}_d^l) = p_{max}^l = \theta^l\tilde{m}_d^l$. Exporting firms need to take into account the cost cutoffs in the destination market. Using (1.6) for the marginal exporting firm, we have $p^{lh}(\tilde{m}_x^{lh}) = \theta^l\tilde{m}_x^{lh}\tau^{lh} = p_{max}^h$. Substituting for the domestic price threshold in h allows us to write $\theta^l\tilde{m}_x^{lh} = (\theta^h\tilde{m}_d^h)/\tau^{lh}$. With these insights at hand, we are able to express firm-level prices $p^{lh}(c)$, quantities $q^{lh}(c)$, markups $\mu^{lh}(c)$, revenues $r^{lh}(c)$, and profits $\pi^{lh}(c)$ as functions of the cutoff $\tilde{m}_d^l$, the firm-specific cost level $\tilde{m}(c)$, and the financial

[7] Notice that we have abstracted from collateral and assumed that lenders have unlimited access to funds at zero cost. These assumption keep the model simple without implications for qualitative insights.

constraints parameter θ^l:

$$p^{ll}(c) = \frac{1}{2}\left[\theta^l \tilde{m}_d^l + \tilde{m}^l(c)\right] \qquad p^{lh}(c) = \frac{\tau^{lh}}{2}\left[\theta^l \tilde{m}_x^{lh} + \tilde{m}^l(c)\right]$$

$$\mu^{ll}(c) = \frac{1}{2}\left[\theta^l \tilde{m}_d^l - \tilde{m}^l(c)\right] \qquad \mu^{lh}(c) = \frac{\tau^{lh}}{2}\left[\theta^l \tilde{m}_x^{lh} - \tilde{m}^l(c)\right] \tag{1.9}$$

To understand the role of credit constraints for these firm-level variables, we need to solve the free-entry condition for the domestic cost cutoffs $\tilde{m}_d^l$ (see Appendix 1.D for details). Plugging profits from domestic sales, $\pi^{ll}(c) = (L^l/4\gamma)(\theta^l \tilde{m}_d^l - \tilde{m}^l(c))^2$, and exports, $\pi^{lh}(c) = (L^h/4\gamma)(\tau^{lh})^2(\theta^l \tilde{m}_x^{lh} - \tilde{m}^l(c))^2$, into (FEC) delivers

$$\tilde{m}_d^l = \left(\frac{4\gamma}{|P|}\frac{\sum_{h=1}^M |C^{hl}|\psi^h \Theta^h}{L^l(\theta^l)^{k+2}}\right)^{\frac{1}{k+2}}, \tag{1.10}$$

where $|P|$ is the determinant of the trade freeness matrix, $|C^{hl}|$ is the co-factor of the $\rho^{hl} \equiv (\tau^{lh})^{-k}$ element, $\Theta^h \equiv \frac{(\theta^h)^{k+2}}{(\theta^h)^2 - \frac{2k}{k+1}\theta^h + \frac{k}{k+2}}$, and $\psi^h \equiv w^h(\tilde{m}_{max}^h)^k/\lambda^h$. Notice that credit rationing only applies to the marginal firm, for both domestic and exporting operations, as profits are increasing in productivity $1/c$. The industry-level number of firms that operate in country l is given by

$$N^l = \frac{2(k+1)\gamma}{\eta}\frac{\alpha - \theta^l \tilde{m}_d^l}{\tilde{m}_d^l\left[\theta^l(k+1) - k\right]}. \tag{1.11}$$

Further, as price distributions of domestic firms in market l and of exporters to country l are identical, the average price in a market is given by

$$\bar{p}^l = \frac{\theta^l(k+1) + k}{2(k+1)}\tilde{m}_d^l. \tag{1.12}$$

For firms from a given country, markups are consumer-market-specific due to market segmentation so that we obtain

$$\bar{\mu}^{ll} = \frac{\theta^l(k+1) - k}{2(k+1)}\tilde{m}_d^l \qquad \bar{\mu}^{lh} = \frac{\theta^l(k+1) - k}{2(k+1)}\tau^{lh}\tilde{m}_x^{lh}. \tag{1.13}$$

1.2.7 The role of credit constraints

We are now ready to explore the economic channels through which credit constraints operate in the model. To build intuition, let us start with the simple case of autarky. As we show formally in Appendix 1.A, reducing credit constraints (that is reducing θ) raises the cost cutoff $\tilde{m}_d$ so that also less productive firms will survive in the market. Incumbent firms respond by charging lower prices and markups in response, because entry of new firms raises the degree of competition in the market and the choke price $p(\tilde{m}_d) = p_{max} = \theta\tilde{m}_d$.

To understand the response of average prices and markups, we need to consider two effects. First, a change in θ affects the average productivity in the market due to entry (*productivity effect*). In autarky, the productivity of the marginal (and average) firm increases in the degree of financial frictions. As less productive firms charge higher prices and lower markups, improving access to external finance raises average prices and reduces average markups according to this channel. Second, the entry of less productive firms induces a *competition effect* due to which firms respond by reducing prices and markups. Hence, this channel contributes to lower average prices and lower markups in response to a reduction of financial frictions. In sum, financial development exerts an ambiguous effect on average prices but unambiguously reduces markups in the model.

In the global economy, the effects are less clear-cut. Improving access to external finance in one country does neither necessarily increase the cutoff in this economy nor does it reduce the choke price unambiguously. As countries are dependent on each other through bilateral international trade with different trade frictions, third-country effects could lead to a reduction in firm entry in that country. In other words, both the *productivity effect* and the *competition effect* are changed relative to autarky. To learn about comparative static results and the direction and magnitude of responses, we proceed to structurally estimating and quantifying the model and the comparative static effects of financial frictions.

1.3 Quantification of the model

We start this section with a brief overview of the data we use before laying out in detail how we identify the required parameters of the theoretical model. These parameters will then be utilized to derive empirically-informed insights about the comparative static effects of credit constraints in multi-country equilibrium. Specifically, we assess how average prices and domestic markups respond to an abolishment of *all* financial frictions ($\theta^l = 1$). To put the relevance of financial development in perspective, we finally ask by how much trade costs or market size would have to change to obtain similar responses in average prices and markups as with the respective change in financial constraints relative to the benchmark situation. The final part addresses the sensitivity of our findings.

1.3.1 Data

We utilize data on the manufacturing sector in 11 European countries for the average year in 2000-2005 (see Table 1.1). The exercise builds on country level data for manufacturing from the OECD Structural Analysis database (STAN), and the Groningen Growth and Development Centre (GGDC) productivity level database. From Eurostat's Structural Business Statistics (SBS), we use production values at the sector level. Data on firm-level sales, costs, and export revenues are obtained from Bureau van Dijk's AMADEUS database. We use information on total population from Eurostat, and data on purchasing power parities (PPP) from the GGDC productivity level database. In order to measure the degree of international trade freeness, we use bilateral trade flows from the OECD's STAN database (see Appendix 1.C for further details).

Data coverage in AMADEUS is known to be heterogeneous across countries. To make this transparent, we relate total aggregated firm-level output from AMADEUS to aggregate output from OECD's STAN database. Table 1.1 reveals AMADEUS covers about 90 percent of total output in the Netherlands while Portugal reaches only 3 percent.

Table 1.1: Data coverage of AMADEUS

Austria	13.83%	Netherlands	90.02%
Belgium	48.45%	Poland	3.44%
Finland	22.31%	Portugal	3.01%
France	39.26%	Spain	7.12%
Germany	16.75%	Sweden	4.12%
Italy	6.24%		

Notes: The figures show the share of total firm-level output obtained from AMADEUS in aggregate manufacturing output obtained from OECD's STAN database.

1.3.2 Identification strategy

To quantify the model, we need to uncover the following structural parameters: the common Pareto shape parameter k, the country-specific credit constraint parameter θ^l, the country-specific domestic cost cutoff $\tilde{m}_d^l$, the common love-of-variety parameter γ, country-pair-specific trade freeness $\rho^{lh} \equiv (\tau^{lh})^{-k}$, and the country-specific measure of exogenous competitiveness $\psi^l \equiv (m_{max}^l)^k w^l/\lambda^l$. We obtain these parameters by matching the model to trade flows, cross-country differences in average prices, revenue-cost-ratios as well as domestic sales of French firms.

Pareto shape parameter k

We use the industry shape parameters estimated by Corcos et al. (2012) for a similar set of European economies. As their study is executed for 18 manufacturing industries, we aggregate their sector-specific estimates using French sector output in 2000 for these 18 sectors, as their estimation is based on French firm data. The French production value is obtained from Eurostat's SBS. This delivers an average shape parameter value of $k = 1.55$.

Credit constraint parameters θ^l

In order to estimate the credit constraint parameters θ^l, we take advantage of (1.6) that delivers a link between profit-maximizing prices of the marginal firm, that firm's marginal costs, and the credit constraint parameter. Multiplying both prices and costs with quantities and solving for θ^l allows us to write

$$\theta^l = \frac{r^l(\tilde{m}_d^l(c))}{\tilde{m}_d^l(c)\sum_h^M \tau^{lh} q^{lh}}. \tag{1.14}$$

Noting that the marginal domestic firm only serves its home market, we can back out θ^l by taking the ratio of revenues over costs. To do this, we build on firm level data on sales, costs of employees, and material costs from the AMADEUS database for all countries for the average year in 2000-2005. Taking the average value of the first percentile of the sales-over-cost distribution delivers θ^l. As shown in Table 1.4, the respective values in the data range from 1.011 (the Netherlands) to 1.086 (France). One concern with these estimates is that countries with higher data coverage are associated with lower values of θ. While this seems to hold true for the Netherlands (high data coverage, low θ), the AMADEUS data for France show a decent coverage of about 40 percent of total output according to the OECD STAN database, but imply the highest level of θ in our sample of countries (see Tables 1.4 and 1.1).

To check the plausibility of the obtained values of the compact measure θ^l, we correlate it with observable measures of financial frictions. As credit constraints are difficult to measure, previous work has relied on various proxy variables. We relate θ^l to an index of access to credit (*Getting credit*), the *Recovery rate* capturing the percentage of investment that creditors are able to recover from an insolvent firm, the share of private credit provided by banks relative to GDP (*Private credit/GDP*) and the *share of high cash flow firms*. The idea of the latter variable is that a large share of firms with high cash flows implies low dependence on external finance and should therefore be negatively correlated with θ^l.

The first two variables are provided by the World Bank's Doing Business Database while the third one is obtained from the World Bank's Global Financial Development Database. We have computed the fourth variable from firm-level data (AMADEUS) by identifying firms with a cash flow to capital stock ratio above the 75th percentile in the distribution of all firms in our sample of countries. Table 1.2 reports

Table 1.2: Correlations of credit constraint measures

	θ	Getting credit	Recovery rate	Private credit/ GDP	Share of high cash flow firms
θ	1				
Getting credit	-0.3491	1			
Recovery rate	-0.5041	0.2407	1		
Private credit/ GDP	-0.3595	-0.11	0.5482	1	
Share of high cash flow firms	-0.8694	0.6671	0.6868	0.5511	1

Notes: Getting credit and *Recovery rate* are taken from the World Bank's Doing Business database. *Private credit/ GDP* measures the value of private credit granted by banks relative to that country's gross domestic product and is provided by the World Bank's Global Financial Development Database (GFDD). *Share of high cash flow firms* is based on own calculations using AMADEUS database. Following Guariglia (2008) we classify a firm as a high cash flow company if its ratio of cash flow to capital stock ratio exceeds the 75th percentile in the distribution covering all firms in our sample of countries. Table content is based on own calculations.

pairwise correlations between these variables. Most importantly, the signs of the correlations between θ^l and the alternative measures point in the right direction: higher values of *Getting credit*, *Recovery rate*, *Private credit/ GDP*, and *share of firms with high cash flows* all indicate better access to external funds which is reflected in a lower value of θ^l in the model. With regard to magnitude, it is evident that correlations in some cases are rather low indicating that these variables measure different aspects of financial frictions. Moreover, *Private credit/ GDP* and *Getting credit* are even negatively correlated with each other. Overall, the model-driven measure of financial frictions, θ^l, compares well with alternative observable measures of financial frictions.

Domestic cost cutoffs m_d^l

To obtain the domestic cost cutoffs, we combine data on average prices with parameter estimates for k and θ^l from above. Rearranging (1.12) and using hats to indicate estimates gives

$$\hat{\tilde{m}}_d^l = \frac{2(\hat{k}+1)}{\hat{\theta}^l(\hat{k}+1)+\hat{k}}\bar{p}^l \tag{1.15}$$

which allows us to retrieve an estimate for $\tilde{m}_d^l$. We use data on relative producer prices in manufacturing at the country level that are comparable across countries. The data are available for 2005 from the GGDC productivity level database (Inklaar and Timmer, 2014) and summarized in Table 1.3. Average prices in an economy are informative about the endogenous competitiveness of a market, that is lower prices indicate a higher degree of competition (for given productivity distributions $G(c)$). We observe that Poland has the lowest producer prices (0.84) in the sample, while France, Finland, and Sweden have the highest at around 12 percent above the level of the United States. Clearly, these numbers are driven by a combination of average productivity and wages. Table 1.4 shows that cost cutoffs associated with equation (1.15) cluster around a value of 1.3 for most countries. Lower values for Portugal and Poland are rationalized by lower wage levels in these countries and associated lower average prices. If we relate our estimates to average unit labor costs in the manufacturing sector in the period 2001-2005, we obtain

a positive correlation parameter of 0.63.[8] Given that we have not used these data for identification, our estimates are able to capture these out-of-sample characteristics quite reasonably.

Table 1.3: Relative producer prices, US=1

Austria	1.05	Netherlands	1.04
Belgium	1.07	Poland	0.84
Finland	1.12	Portugal	0.96
France	1.13	Spain	1.04
Germany	1.09	Sweden	1.12
Italy	1.08		

Source: Inklaar and Timmer (2014), GGDC productivity level database, own calculations.

Love-of-variety parameter γ

The preference parameter γ can be derived from a formal expression of average domestic revenues given by

$$\bar{r}^{ll} = \frac{L^l}{4\gamma}\left((\theta^l)^2 - \frac{k}{k+2}\right)(\tilde{m}_d^l)^2.$$

Solving for the love-of-variety parameter and using information obtained in the previous steps delivers an estimate of γ,

$$\hat{\gamma} = \frac{L^l}{4\bar{r}^{ll}}\left((\hat{\theta}^l)^2 - \frac{\hat{k}}{\hat{k}+2}\right)(\hat{\tilde{m}}_d^l)^2. \tag{1.16}$$

In the AMADEUS database and among the countries in our sample, separate information on revenues from domestic sales and exports is only available for France. We thus build our estimation on French data which implies a value of $\hat{\gamma} = 1.16$ with a standard error of $SE = 0.005$. Our estimate is higher than those obtained for several industries in Ottaviano, Taglioni and di Mauro (2009). However, γ is innocent in the quantification exercise as it only scales cutoffs (1.10) without affecting responses of cutoffs to changes in θ^l.

Gravity

Our multi-country model also enables us to derive a gravity equation for aggregate bilateral trade flows X^{lh} of manufactures that accounts for country-specific credit constraints (see Appendix 1.B for further details). It can be expressed as

$$X^{lh} = \frac{(k+2)(\theta^l)^2 - k}{4\gamma(k+2)} N_E^l \left(\theta^l\right)^{-(k+2)} L^h (\tilde{m}_{max}^l)^{-k} (\theta^h \tilde{m}_d^h)^{k+2} \rho^{lh} \tag{1.17}$$

where $\rho^{lh} = (\tau^{lh})^{-k} \in [0,1]$ is a measure of trade freeness and N_E^l denotes the number of entrants in country l. Note that ρ^{lh} is the only country-pair specific term in this equation, so we can estimate trade freeness as the residual of a regression with exporter and importer country-specific fixed effects.

[8] Unit labor costs are available from www.oecd.org.

Exogenous competitiveness $1/\psi^l = [(\tilde{m}^l_{max})^k w^l/\lambda^l]^{-1}$

In a final step, we compute ψ^l which can be interpreted as the inverse of countries' exogenous competitiveness or the ability to generate low-cost firms. Higher values of the upper cost bound $\tilde{m}^l_{max}$ or higher wages w^l reduce this ability. We take advantage of the system of free-entry conditions (see appendix 1.D for details) to get estimates

$$\hat{\psi}^l = \frac{1}{4\hat{\Theta}^l\hat{\gamma}} \sum_{h=1}^{M} \hat{\rho}^{lh} L^h (\hat{\theta}^h \hat{\tilde{m}}^h_d)^{\hat{k}+2} \tag{1.18}$$

where $\Theta^l \equiv \frac{(\theta^l)^{k+2}}{(\theta^l)^2 - \frac{2k}{k+1}\theta^l + \frac{k}{k+2}}$. As reported in Table 1.4, Germany has the lowest ability among this group of countries to generate low-cost firms ($\psi = 13.07$), while Finland ($\psi = 1.82$), Portugal ($\psi = 2.14$), or Sweden ($\psi = 2.37$) are characterized by comparably high levels of exogenous competitiveness. Although we follow a different procedure in identifying the parameters of the model than Corcos et al. (2012), it is reassuring that the country ranking of exogenous competitiveness delivers a similar picture.

Table 1.4: Parameter estimates

	$\hat{\theta}^l$	$\hat{\tilde{m}}^l_d$	$\hat{\psi}^l$
Austria	1.043	1.283	2.506
	(0.006)	(0.005)	(0.016)
Belgium	1.023	1.313	2.759
	(0.004)	(0.004)	(0.015)
Finland	1.057	1.341	1.815
	(0.005)	(0.004)	(0.011)
France	1.086	1.334	12.017
	(0.003)	(0.002)	(0.023)
Germany	1.038	1.330	13.068
	(0.003)	(0.002)	(0.076)
Italy	1.051	1.307	10.631
	(0.001)	(0.001)	(0.049)
Netherlands	1.011	1.289	3.031
	(0.006)	(0.004)	(0.021)
Poland	1.042	1.023	3.239
	(0.004)	(0.002)	(0.019)
Portugal	1.037	1.165	2.144
	(0.003)	(0.002)	(0.010)
Spain	1.037	1.261	6.230
	(0.001)	(0.001)	(0.025)
Sweden	1.064	1.339	2.367
	(0.003)	(0.003)	(0.014)

Notes: The table shows parameter estimates of the credit constraint parameter $\hat{\theta}^l$, domestic cutoff cost $\hat{\tilde{m}}^l_d$, and exogenous competitiveness $\hat{\psi}^l$ at the country level. Bootstrapped standard errors are stated in parentheses and obtained from 100 replications of the estimation procedure.

1.4 Counterfactual analysis

As all endogenous variables of interest are functions of domestic cost cutoffs, it is essential to compute counterfactual values of $\tilde{m}_d^l$. Defining the scalars $a^{lh} \equiv \rho^{lh} L^h \left(\theta^h\right)^{k+2}$ and $b^l \equiv \phi(\theta^l)^k \psi^l$, the 11×11-matrix $\mathbf{A} = (a^{lh})$ and the 11×1-vectors $\mathbf{b} = (b^l)$ and $\tilde{\mathbf{m}} = ((\tilde{m}_d^l)^{k+2})$, the system of equations can be expressed in matrix notation as $\mathbf{A}\tilde{\mathbf{m}} = \mathbf{b}$. Pre-multiplying by the inverse of $\mathbf{A}$ on both sides of the equation delivers a closed-form solution for the domestic cost cutoff for each country according to

$$\tilde{\mathbf{m}} = \mathbf{A}^{-1}\mathbf{b}. \tag{1.19}$$

Abolishing credit constraints

To evaluate the role of credit constraints, we set $\theta^l = 1$ for each $l \in M$. This gives rise to counterfactual values that allow us to compute percentage changes of key endogenous variables of interest. As documented in Table 1.5, we study changes in cutoffs, choke prices, average prices, markups and the price elasticity of demand that we evaluate at average prices, $\epsilon^l(\bar{p}^l) = [p_{max}^l/\bar{p}^l - 1]^{-1}$.

A first glance at the results reveals that the abolishment of credit constraints leads to higher average prices and lower markups in all countries. The former outcome indicates that the *productivity effect* dominates the *competition effect*. However, the magnitude of price changes is modest given that credit constraints were reduced by 100 percent. In the Netherlands (where credit constraints were low), prices are predicted to rise by only 0.41 percent in response. France, with a comparably high value of $\theta^l = 1.086$ would experience an increase in average prices of 3.05 percent, according to the model. Across the sample, the average effect amounts to 1.6 percent.

As both the *productivity effect* and the *competition effect* reduce markups in our counterfactual exercise, the overall effects are naturally more pronounced than those on average prices. According to the fourth column in the table, the Netherlands (-1.6 percent) and Belgium (-3.3 percent) are characterized by relatively low changes while markups are predicted to decline by as much as 8.5 percent in Sweden and 11 percent in France in response to the considered change in financial frictions. The average response is -6.1 percent.

The insight that the *productivity effect* dominates can also be seen from the inspection of column 1 of Table 1.5, reflecting percentage changes of the domestic cutoff cost. As the average unit input cost is a constant fraction of the cutoff value, we can also make statements about the effects on average unit input requirements. There, the responses range between 1.1 percent (Netherlands) and 8.6 percent (France) with an average value of 4.5 percent.

Column 2 of Table 1.5 provides information about the responses of choke prices p_{max}^l in each country. In contrast to other variables in this table, results are mixed. While the choke price declines in some countries such as France (-0.04 percent) or Finland (-0.01 percent), it rises in others such as Belgium (0.01 percent) or the Netherlands (0.003 percent). It is evident that these changes are small and not all are statistically different from zero. Combining this information with responses of average prices allows us to evaluate the change of the price elasticity of demand at $\bar{p}^l$. As documented in column 5 of Table 1.5, credit constraints exert a sizeable impact on the price elasticity. In France or Sweden, for example, $\varepsilon(\bar{p})$ rises by 15.8 percent and 11.8 percent, respectively. At the lower end of the distribution, we find countries such as the Netherlands (2.1 percent) or Belgium (4.3 percent).

Table 1.5: Abolishing credit constraints

	Change of $\hat{m}_d^l$	Change of p_{max}^l	Change of $\bar{p}^l$	Change of $\bar{\mu}^{ll}$	Change of $\epsilon^l(\bar{p}^l)$
Austria	4.335	-0.004	1.592	-6.046	8.139
	(0.615)	(0.005)	(0.217)	(0.775)	(1.130)
Belgium	2.261	0.009	0.848	-3.284	4.277
	(0.434)	(0.001)	(0.159)	(0.606)	(0.816)
Finland	5.732	-0.012	2.084	-7.767	10.687
	(0.510)	(0.006)	(0.176)	(0.611)	(0.927)
France	8.569	-0.035	3.052	-10.965	15.745
	(0.256)	(0.003)	(0.085)	(0.273)	(0.450)
Germany	3.822	-0.003	1.409	-5.401	7.201
	(0.285)	(0.001)	(0.102)	(0.367)	(0.525)
Italy	5.127	-0.007	1.874	-7.041	9.590
	(0.142)	(0.001)	(0.050)	(0.174)	(0.259)
Netherlands	1.075	0.003	0.405	-1.603	2.049
	(0.564)	(0.001)	(0.208)	(0.803)	(1.065)
Poland	4.236	-0.003	1.558	-5.926	7.958
	(0.380)	(0.002)	(0.135)	(0.484)	(0.699)
Portugal	3.695	0.002	1.366	-5.225	6.957
	(0.335)	(0.002)	(0.120)	(0.436)	(0.620)
Spain	3.731	-0.001	1.378	-5.281	7.030
	(0.097)	(0.000)	(0.035)	(0.126)	(0.179)
Sweden	6.334	-0.018	2.292	-8.485	11.779
	(0.345)	(0.003)	(0.119)	(0.405)	(0.622)

Notes: The table shows parameter changes of the cutoff cost $\hat{m}_d^l$, threshold price $p_{max}^l = \theta^l \tilde{m}_d^l$, average domestic prices $\bar{p}^l$, average domestic markups of domestic firms $\bar{\mu}^{ll}$, and average price elasticity $\epsilon^l(\bar{p})$ due to a decrease in credit frictions. Bootstrapped standard errors are stated in parentheses. Numbers above are given in percent.

Financial development versus trade liberalization

As we have examined financial frictions in the global economy, it is interesting to compare financial development to trade liberalization. To obtain the same average quantitative response of markups (-6.1 percent) as with the above changes in financial constraints, we compute that trade costs would need to *decrease* by about 20 percent for all country pairs. To induce the same average price effect (+1.6 percent) as in our counterfactual credit constraints experiment, we would have to *increase* bilateral trade costs by 8.5 percent. These results indicate that credit constraints act both qualitatively and quantitatively very differently from trade costs in this model. Changes in trade costs need to be much lower than changes in credit frictions (-20 percent and 8.5 percent as compared to 100 percent) to obtain the same responses of markups and prices on average. Intuitively, changes in agency costs affect prices and markups indirectly via the selection of firms while trade costs affect the cost structure directly. This explains the more pronounced responses of markups and prices to changes in trade costs.

Financial development versus market size

It is well understood that larger markets are characterized by stronger product market competition in the Melitz-Ottaviano (2008) framework, implying lower markups and average prices. We thus ask by how much we would have to change market size to obtain the same average quantitative responses of markups (-6.1 percent) and prices (+1.6 percent) as with the considered changes in financial constraints. To obtain identical reductions in average markups, we would have to increase market size (population) by 25 percent across all economies. With respect to average prices, a decrease in the population of 5.5 percent delivers the same response as the abolishment of financial frictions.

Table 1.6: Alternative identification of credit constraints

	Outlier cleaning method	$\hat{\theta}^l$	Change of $\bar{p}^l$	Change of $\bar{\mu}^{ll}$
First percentile	none (benchmark)	1.0487	0.167	-0.631
	median ± 1.5 std.dev.	1.0492	0.168	-0.637
	1% trimmed mean	1.0738	0.242	-0.894
Second percentile	none	1.0719	0.236	-0.874
	median ± 1.5 std.dev.	1.0731	0.240	-0.887
	1% trimmed mean	1.0860	0.286	-1.045
Fifth percentile	none	1.1220	0.362	-1.305
	median ± 1.5 std.dev.	1.1154	0.347	-1.254
	1% trimmed mean	1.1257	0.370	-1.331

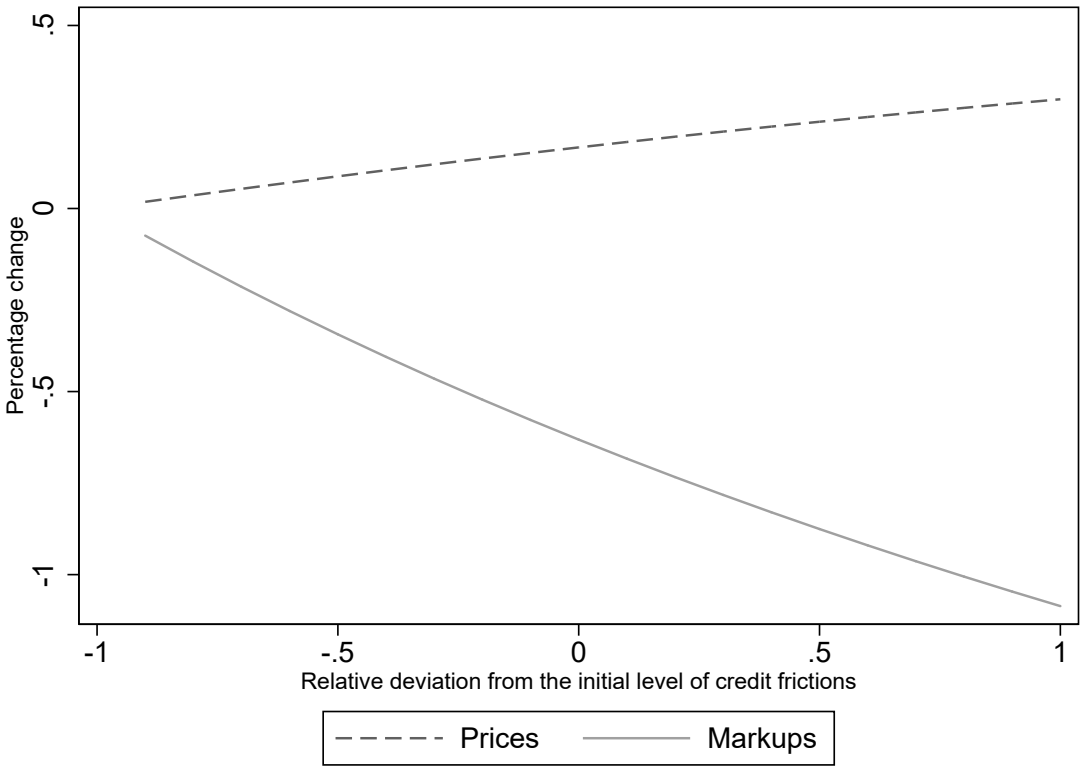
Notes: All variables are weighted by country size. Changes of average prices and markups are given in percent and calculated from a counterfactual scenario where credit constraints are decreased by 10 percent. Two methods are employed in order to clean for outliers in the AMADEUS dataset. The first method drops all sales-over-cost ratios which lie outside a band of 1.5 standard deviations around the median. The second method drops all observations below the first and above the 99th percentile.

1.4.1 Robustness

Finally, we explore the sensitivity of our results. A first concern relates to the identification of the credit constraint parameter. Against the background of heterogeneous data coverage across countries and the fact that θ^l relies on the first percentile in the sales-to-cost distribution, we alternatively use the second and fifth percentile. Further, we control for outliers by dropping all observations that are more distant to the median by 1.5 standard deviations or in the top and bottom percentile of the selected observations. We report the results in Table 1.6 by averaging θ^l and changes in average prices and markups across all countries in our sample. The first line reports the benchmark result as a point of reference. Considering only observations within 1.5 standard deviations to the median does not change results in a significant way. Deleting observations in the top and bottom percentiles, however, leads to an increase in both the average θ^l and the responses of average prices and markups. Including all observations within the second or within the fifth percentile raises average sales-to-cost ratios and thereby θ^l, whereas controlling for outliers is less sensitive. In all cases, the ranking of countries with respect to θ^l is robust.

As Table 1.6 indicates that the response of prices and markups seems to depend on the level of θ^l, we explore this issue further by artificially modifying the values of the credit constraint parameter. We reduce θ^l by up to 90 percent and increase it by up to 100 percent and rerun both the quantification and the counterfactual exercise to obtain changes in average prices and markups. Notice that different levels of θ^l imply different estimates of all subsequently estimated parameters according to the identification strategy in subsection 1.3.2. Nevertheless, this procedure allows insights in the sensitivity of the model to different levels of credit frictions. We compute weighted average responses across countries for prices and markups and summarize them in Figure 1.2. Reducing the respective credit constraints by 10 percent reflects non-constant responses of prices and markups. Higher values of credit constraints are associated with stronger responses of both variables to an identical percentage change in θ^l. This effect is more pronounced for price–cost markups. Most importantly, the key insight that the productivity effect dominates the competition effect remains valid for the entire domain of starting values.

Figure 1.2: Changes of prices and markups with alternative levels of credit constraints



Notes: The figure shows how average prices and average markups across all countries in our sample respond to a 10-percent reduction of the credit constraint parameter θ^l when we scale its initial level upwards or downwards. On the horizontal axis, 0 corresponds to the baseline scenario. Moving to the right means raising θ^l by up to 100 percent. The domain to the left of 0 represents lower values up to 10 percent of the initial level.

As a final aspect, we examine whether credit constraints capture differences in country-specific policies that affect the sales-to-cost ratio underlying the identification of θ^l. For example, better product market regulation allows entering firms to challenge incumbent companies or lower entry barriers and less rigid employment protection stimulate entry and thus competition. Hence, sales-to-cost ratios should be negatively correlated with product market regulation and positively associated with higher barriers to entry or stricter employment protection regulation. While it is difficult to control for these policies' effects of sales-to-cost ratios, it would be reassuring if our measure of credit constraints showed a low correlation with measures of such institutions. We use indicators from the OECD to show that the correlations with product market regulation (0.002), barriers to entrepreneurship (-0.155) and employment protection (-0.117) are low and even have the wrong sign. Further, our estimates of θ^l do not seem to be driven by differences in corporate tax schedules as the correlation between θ^l and tax rates are low (-0.09).

1.5 Conclusion

In this paper, we have examined the role of credit constraints for product market competition in an open economy. The theoretical model revealed that credit constraints due to asymmetric information between borrowers and lenders preclude low-productive firms from entering the market. When financial markets develop, that is frictions decline, more entry raises competition and the price elasticity of demand. This generates both a *competition effect* due to market entry and a *productivity effect* as less productive firms enter. As these channels work in opposite directions with respect to average prices, the effect of financial development is ambiguous.

To shed light on comparative static effects and quantify their magnitude, we have structurally estimated the model based on information on manufacturing industries in 11 European countries. Credit constraints are estimated to range between 1.1 to 8.6 percent, that is profits of the marginal firm have to be higher by that amount compared to a situation without moral hazard to receive external funding. Abolishing credit constraints in a counterfactual experiment reduces average markups by 6.1 percent on average, while average prices are predicted to increase by 1.6 percent. The latter indicates that the productivity effect dominates the competition effect. Relating these magnitudes to changes in trade costs and market size, our model requires that trade costs would have to decline by about 20 percent and population to increase by about 25 percent to obtain the same average effect on markups. With respect to average prices, trade costs would have to increase and population to decrease by 8.5 percent and 5.5 percent, respectively.

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Appendix

1.A Comparative statics

Autarky

In autarky, the domestic cost cutoff is given by

$$\tilde{m}_d = \left(\frac{4\gamma\Theta\psi}{\theta^{k+2}L}\right)^{\frac{1}{k+2}},$$

where, recall, $\Theta \equiv \frac{\theta^{k+2}}{\theta^2 - \frac{2k}{k+1}\theta + \frac{k}{k+2}}$. Deriving $\tilde{m}_d$ with respect to θ yields

$$\frac{\partial \tilde{m}_d}{\partial \theta} = -\frac{1}{\theta^2 - \frac{2k}{k+1}\theta + \frac{k}{k+2}} \frac{2\theta(k+1) - 2k}{(k+1)(k+2)} \tilde{m}_d < 0.$$

The derivative of the choke price $p_{max} = \theta\tilde{m}_d$ with respect to θ is given by

$$\frac{\partial \theta\tilde{m}_d}{\partial \theta} = \frac{1}{\theta^2 - \frac{2k}{k+1}\theta + \frac{k}{k+2}} \frac{k(\theta-1)^2}{\theta(k+2)} \tilde{m}_d > 0.$$

With these insights at hand, we can directly infer that profit-maximizing prices and markups of individual firms are increasing in θ according to (1.9). It is also immediate that average markups are increasing in credit constraints. However, the response of average prices is generally ambiguous:

$$\frac{\partial \bar{p}}{\partial \theta} = \frac{1}{2(k+2)} \left\{ (k+1)\frac{\partial \theta\tilde{m}_d}{\partial \theta} + k\frac{\partial \tilde{m}_d}{\partial \theta} \right\} \gtreqless 0.$$

Finally, inspection of (1.11) shows that the number of operating firms is decreasing in financial frictions.

General case with $M \geq 2$

In the general case, both the derivatives of the domestic cost cutoff and the choke price are ambiguous:

$$\frac{\partial \tilde{m}_d^l}{\partial \theta^l} = \frac{1}{k+2} \left(\frac{4\gamma}{|P|} \frac{\sum_{h=1}^M |C_{hl}|\Theta^h\psi^h}{L^l} \right)^{\frac{1}{k+2}-1} \frac{4\gamma}{|P|L^l}$$
$$\frac{|C_{ll}|\frac{\partial \Theta^l}{\partial \theta^l}\psi^l(\theta^l)^{k+2} - \left(\sum_{h=1}^M |C_{hl}|\Theta^h\psi^h\right)(k+2)(\theta^l)^{k+1}}{(\theta^l)^{2(k+2)}} \gtreqless 0$$

and

$$\frac{\partial \theta^l\tilde{m}_d^l}{\partial \theta^l} = \frac{1}{k+2} \left(\frac{4\gamma}{|P|} \frac{\sum_{h=1}^M |C_{hl}|\Theta^h\psi^h}{L^l} \right)^{\frac{1}{k+2}-1} \frac{4\gamma}{|P|} \frac{|C_{ll}|\frac{\partial \Theta^l}{\partial \theta^l}\psi^l}{L^l} \gtreqless 0.$$

Hence, firm-level variables, country averages as well as the number of firms might be increasing or decreasing in the severeness of the financial friction.

1.B Derivation of the gravity equation

An exporting firm from country l sells $r_x^{lh}(c) = p_x^{lh}(c)q_x^{lh}(c)$ with

$$p_x^{lh} = \tau^{lh}\frac{1}{2}\left(\theta^l\tilde{m}_x^l + \tilde{m}(c)\right) = \frac{1}{2}\left(\theta^h\tilde{m}_d^h + \tau^{lh}\tilde{m}(c)\right)$$

$$q_x^{lh} = \tau^{lh}\frac{L^h}{2\gamma}\left(\theta^l\tilde{m}_x^l - \tilde{m}(c)\right) = \frac{L^h}{2\gamma}\left(\theta^h\tilde{m}_d^h - \tau^{lh}\tilde{m}(c)\right)$$

Note: $\theta^l\tilde{m}_x^l = sup\left\{\tilde{m}(c) : \pi_x^l(c) > 0\right\} = \frac{p_{max}^h}{\tau^{lh}} = \frac{\theta^h m_d^h}{\tau^{lh}}$ and thus $\tilde{m}_x^l = \frac{\theta^h\tilde{m}_d^h}{\theta^l\tau^{lh}}$

$$\begin{aligned} r_x^{lh}(c) &= \frac{1}{2}\left(\theta^h\tilde{m}_d^h + \tau^{lh}\tilde{m}(c)\right)\frac{L^h}{2\gamma}\left(\theta^h\tilde{m}_d^h - \tau^{lh}\tilde{m}(c)\right) \\ &= \frac{L^h}{4\gamma}\left(\left(\theta^h\tilde{m}_d^h\right)^2 - \left(\tau^{lh}\tilde{m}(c)\right)^2\right) \end{aligned}$$

Aggregated export sales over all exporters from country l to h (with cost $\tilde{m}(c) \leq \tilde{m}_x^{lh}$) are given by

$$X^{lh} = N_E^l\int_0^{m_x^{lh}} r_x^{lh}(c)dG^l(c).$$

$$\begin{aligned} X^{lh} &= N_E^l\frac{L^h}{4\gamma}\int_0^{\frac{\theta^h\tilde{m}_d^h}{\theta^l\tau^{lh}}}\left(\left(\theta^h\tilde{m}_d^h\right)^2 - \left(\tau^{lh}\tilde{m}(c)\right)^2\right)dG^l(c) \\ &= N_E^l\frac{L^h}{4\gamma}\left(\tilde{m}_{max}\right)^{-k}k\int_0^{\frac{\theta^h\tilde{m}_d^h}{\theta^l\tau^{lh}}}\left(\left(\theta^h\tilde{m}_d^h\right)^2\tilde{m}(c)^{k-1} - \left(\tau^{lh}\right)^2\tilde{m}(c)^{k+1}\right)dc \\ &= N_E^l\frac{L^h}{4\gamma}k\left(\tilde{m}_{max}\right)^{-k}\left[\left(\theta^h\tilde{m}_d^h\right)^2\frac{1}{k}\tilde{m}(c)^k - \left(\tau^{lh}\right)^2\frac{1}{k+2}\tilde{m}(c)^{k+2}\right]_0^{\frac{\theta^h\tilde{m}_d^h}{\theta^l\tau^{lh}}} \\ &= N_E^l\frac{L^h}{4\gamma}k\left(\tilde{m}_{max}\right)^{-k}\left[\left(\theta^h\tilde{m}_d^h\right)^{k+2}\frac{1}{k}\left(\theta^l\tau^{lh}\right)^{-k} - \left(\theta^h\tilde{m}_d^h\right)^{k+2}\frac{1}{k+2}(\tau^{lh})^{-k}(\theta^l)^{-(k+2)}\right] \\ &= N_E^l\frac{L^h}{4\gamma}k\left(\tilde{m}_{max}\right)^{-k}\left(\theta^h\tilde{m}_d^h\right)^{k+2}\left(\theta^l\right)^{-k}\left(\tau^{lh}\right)^{-k}\left[\frac{1}{k} - \frac{1}{(k+2)(\theta^l)^2}\right] \\ &= N_E^l\frac{L^h}{4\gamma}\left(\tilde{m}_{max}\right)^{-k}\left(\theta^h\tilde{m}_d^h\right)^{k+2}\left(\theta^l\right)^{-(k+2)}\left(\tau^{lh}\right)^{-k}\frac{(k+2)(\theta^l)^2 - k}{k+2} \end{aligned}$$

$$X^{lh} = \frac{(k+2)(\theta^l)^2 - k}{4\gamma(k+2)}N_E^l\left(\theta^l\right)^{-(k+2)}L^h(\tilde{m}_{max}^l)^{-k}(\theta^h\tilde{m}_d^h)^{k+2}\rho^{lh}$$

where $\rho^{lh} = (\tau^{lh})^{-k}$.

1.C Data sources

Table 1.7: Overview of variables

Sales (firm level)	AMADEUS database
Material costs (firm level)	AMADEUS database
Costs of employees (firm level)	AMADEUS database
Export revenues (firm level)	AMADEUS database
Industry output	Eurostat SBS
Bilateral trade flows	OECD STAN database
Relative producer prices	GGDC productivity level database
Population	Eurostat

1.D Cutoff in the multiple countries framework

The free entry condition in country l is given by

$$\sum_{h=1}^{M} \rho^{lh} L^h \left(\theta^h \tilde{m}_d^h\right)^{k+2} = 4\gamma\Theta^l\psi^l$$

where $\psi^l \equiv w^l(\tilde{m}_{max}^l)^k/\lambda^l$, $\Theta^l = \frac{\left(\theta^l\right)^{k+2}}{(\theta^l)^2 - \frac{2k}{k+1}\theta^l + \frac{k}{k+2}}$ and $\tilde{m}_d^l$ denotes the domestic cutoff cost in country l. Note that ψ^l may vary across countries and depends on w^l, the wage in country l, λ, the survival rate, and $\tilde{m}_{max}^l$, which is the upper bound of the pareto distribution's support in country l, i.e. the maximum cost or the minimum productivity of firms in country l.

From equation (1) we have a system of M linear equations with M unknowns:

$$\begin{array}{ccccccccc}
\rho^{11}L^1\left(\theta^1\tilde{m}_d^1\right)^{k+2} & + & \rho^{12}L^2\left(\theta^2\tilde{m}_d^2\right)^{k+2} & + & \dots & + & \rho^{1M}L^M\left(\theta^M\tilde{m}_d^M\right)^{k+2} & = & 4\gamma\Theta^l\psi^1 \\
\vdots & & \vdots & & \ddots & & \vdots & & \vdots \\
\rho^{M1}L^1\left(\theta^1\tilde{m}_d^1\right)^{k+2} & + & \rho^{M2}L^2\left(\theta^2\tilde{m}_d^2\right)^{k+2} & + & \dots & + & \rho^{MM}L^M\left(\theta^M\tilde{m}_d^M\right)^{k+2} & = & 4\gamma\Theta^M\psi^M
\end{array}$$

Define $x_l = L^l(\theta^l\tilde{m}_d^l)^{k+2}$ which yields

$$\begin{array}{ccccccccc}
\rho^{11}x_1 & + & \rho^{12}x_2 & + & \dots & + & \rho^{1M}x_M & = & 4\gamma\Theta^l\psi^1 \\
\vdots & & \vdots & & \ddots & & \vdots & & \vdots \\
\rho^{M1}x_1 & + & \rho^{M2}x_2 & + & \dots & + & \rho^{MM}x_M & = & 4\gamma\Theta^M\psi^M
\end{array}$$

The linear equation system can be solved for x_l using matrix inversion $P \cdot x = d \Leftrightarrow x = P^{-1} \cdot d$, where P is the trade freeness matrix.

$$P = \begin{pmatrix} (\tau^{11})^{-k} & (\tau^{12})^{-k} & \dots & (\tau^{1M})^{-k} \\ \vdots & \vdots & \ddots & \vdots \\ (\tau^{M1})^{-k} & (\tau^{M2})^{-k} & \dots & (\tau^{MM})^{-k} \end{pmatrix} = \begin{pmatrix} \rho^{11} & \rho^{12} & \dots & \rho^{1M} \\ \vdots & \vdots & \ddots & \vdots \\ \rho^{M1} & \rho^{M2} & \dots & \rho^{MM} \end{pmatrix}$$

Inverting matrix P gives $P^{-1} = \frac{1}{|P|}\ adjP$ with P's adjugate or adjoint matrix :

$$adjP = \begin{pmatrix} |C_{11}| & |C_{21}| & \dots & |C_{M1}| \\ \vdots & \vdots & \ddots & \vdots \\ |C_{1M}| & |C_{2M}| & \dots & |C_{MM}| \end{pmatrix}$$

which is the matrix of cofactors corresponding to P (see Chiang, p.96), and solving for x yields:

$$x = \frac{1}{|P|} \begin{pmatrix} \sum_{h=1}^{M} |C_{h1}| d_h \\ \vdots \\ \sum_{h=1}^{M} |C_{hM}| d_h \end{pmatrix} = \frac{1}{|P|} \begin{pmatrix} 4\gamma \ \ \sum_{h=1}^{M} |C_{h1}| \Theta^h \psi^h \\ \vdots \\ 4\gamma \ \ \sum_{h=1}^{M} |C_{hM}| \Theta^h \psi^h \end{pmatrix}$$

According to Cramer's rule the result for x_l is thus $x_l = \frac{1}{|P|} \sum_{h=1}^{M} |C_{hl}| d_h$. If we now plug in $x_l = L^l(\theta^l \tilde{m}_d^l)^{k+2}$, we can solve for country l's cutoff level, $\tilde{m}_d^l$:

$$\tilde{m}_d^l = \left(\frac{4\gamma}{|P|} \ \frac{\sum_{h=1}^{M} |C_{hl}| \Theta^h \psi^h}{L^l(\theta^l)^{k+2}} \right)^{\frac{1}{k+2}}$$

Chapter 2

The impact of credit constraints on wages, inequality, and welfare in general oligopolistic equilibrium

Abstract

This paper develops the thesis that credit market frictions might contribute to profit–wage inequality. The role of credit constraints for profit–wage inequality is analyzed theoretically in closed and open economies. The simple benchmark model is also extended allowing for financial development in a subset of sectors and heterogeneous financial dependence. A general finding is that workers' wages are negatively affected by financial constraints, whereas the effect on profits is less clear cut. However, in the simple benchmark model, profit–wage inequality increases in financial intermediation costs as well as in the degree of moral hazard.

2.1 Introduction

Income inequality has always been a hot topic of discussion not only in developing countries but in recent years also among OECD countries. The OECD states that during "the 1980s, the average disposable income of the richest 10% was around seven times larger than that of the poorest 10%; today, it's around $9\frac{1}{2}$ times higher" (Keeley, 2015, p.3). Additionally, Goebel, Grabka, and Schröder (2015) find increasing income inequality as the income of the richest 10% rose by 15% whereas the income stagnated or fell for lower income groups in Germany. They find that income from business operations and capital rose higher during the period 2000-2014 than labor income.

The literature provides several explanations for these observations including trade, globalization, technological progress, migration, and different trends in society such as an increasing number of single households or changing marriage behavior. Another reason for the increase in inequality, which has been proposed by Cournède, Denk, and Hoeller (2015), is the enhanced economic role of the financial sector. This in turn has multiple dimensions such as credit and stock market financing, increased borrowing capacities of high-income people, coupled with the fact that people working in the financial sector earn more than people with similar profiles in other industries (Cournède et al., 2015). At the aggregate level, the quality of financial institutions may also affect inequality. The idea is that developed countries have better financial institutions, which facilitate higher diversification (Acemoglu and Zillibotti, 1997; Martin and Rey, 2004). This can lead to higher investment levels in developed countries, amplifying inequality between rich and poor countries.

As the core competency of the financial sector is to provide credit to the production side of the economy, this paper exclusively focuses on this dimension. A moral-hazard framework is added to a general equilibrium model with an oligopolistic market structure. All the projects of the entrepreneurs present in the market have a positive net present value (NPV) but will be funded only if the entrepreneurs have a sufficiently high stake in their project, which induces them to run their business operations diligently. This paper addresses the question whether credit frictions affect profit–wage inequality in an oligopolistic market setup. In particular, it analyzes the effects of intermediation costs and the degree of moral hazard on firm profits and workers' wages. I closely follow Holmström and Tirole (1997) in modelling the credit friction, which stems from the presence of moral hazard in the creditor-debtor relationship.

I show that in the closed economy general equilibrium with identical external financial dependence across industry sectors, profit–wage inequality is driven by credit constraints. Additionally, I find that firm entry lowers inequality, but this effect is mitigated for higher levels of credit constraints. In general, workers' wages are negatively affected by financial constraints, whereas the effect on profits is less clear cut. The model is extended in several dimensions. If for financial development is allowed in a subset of sectors, this leads to unambiguously increasing wages and decreasing profit–wage inequality. With heterogeneous external financial dependence of sectors, I find that lower intermediation costs and a lower degree of moral hazard are associated with higher levels of welfare. In an open economy, welfare is independent of trade costs. But opening the economy for trade strictly increases welfare as the degree of competition among firms increases in an open economy.

This paper is closely related to the strand of literature analyzing wage effects in oligopolistic industries using Peter Neary's (2016) generalized oligopolistic equilibrium (GOLE) model. These papers mainly focus on wage inequality and the effects of international trade on this by introducing different wage setting mechanisms (see Bastos and Kreickemeier, 2009; Kreickemeier and Meland, 2013; Egger and Etzel, 2012, 2014; Egger, Meland and Schmerer, 2015). In contrast, I focus mainly on profit–wage inequality, i.e. inter-group inequality.

Other related research connects credit constraints with the labor market. Dromel, Kolakez, and

Lehmann (2010) introduce credit constraints into the labor market matching model of Mortensen and Pissarides (1999) and Pissarides (2000). In this model, credit constraints increase steady-state unemployment and slow down the transitional dynamics, which leads to more persistence of unemployment. They also examine the effects of credit constraints on unemployment empirically using a panel of 20 OECD countries (1982-2003). They find that more severe credit constraints are associated with higher unemployment and a significantly negative effect of credit constraints on lagged unemployment, indicating that credit constraints affect not only the level but also the persistence of unemployment. Acemoglu (2001) develops a model in which credit market frictions harm the economy's transition to a new steady state after having experienced a technological shock. This may result in persistent unemployment rates. In his model, credit frictions can result in delayed investment activities as agents need time to accumulate sufficient capital to launch new enterprises. The delayed market entry of new firms is associated with lower labor demand and higher unemployment rates while converging to a new steady state. However, these papers focus on unemployment and intertemporal transition to new steady states. In contrast, I abstract from unemployment and the time dimension, as I am solely interested in wage effects and inter-group inequality in a static model framework.

Naturally, the vast empirical literature on income distribution is related to this paper as well. To mention just a few of these, Piketty (2003) and Piketty and Saez (2003), who have analyzed data spanning almost a whole century (1901-1998 for France and 1913-1998 for the USA), find that income inequality is rather stable in the long run but saw a decline during the World War I & II periods. The authors attribute this finding to large shocks capital owners experienced during this period, which have affected top capital income with persistent effects until today. Nevertheless, Atkinson, Piketty and Saez (2011) find a substantial rise in top income shares in Western English-speaking countries as well as in China and India. They also find an increase with a lower magnitude in Nordic and Southern European countries, whereas Continental European countries and Japan experienced only a modest or no increase in top income shares in recent decades.

Finally, this paper is also related to the recent literature on credit constraints and international trade that claims credit frictions to affect trade patterns. Studies documented that credit constraints may influence trade volumes (Beck, 2002; Chaney, 2016; Manova, 2008, 2013), international capital flows (Matsuyama, 2005; Antràs and Caballero, 2009), and comparative advantage (Kletzer and Bardhan, 1987; Ju and Wei, 2011; Egger and Keuschnigg, 2015).[1] Egger et al. (2018) find that credit constraints influence the competitive environment firms are facing and that an counterfactual abolishment of credit constraints reduces markups by about 6.1 percent while prices increase by 1.6 percent on average. However, these papers totally overlook distributional aspects, which is the main focus of this paper.

So far, there has been little or no theory on how credit constraints affect profits and wages in general equilibrium. This paper seeks to fill this gap by adding a new channel of credit frictions to Peter Neary's (2016) GOLE model. I analyze how a change in the credit environment of the economy influences firm profits, workers' wages, and in particular profit–wage inequality.

The remainder of the paper is organized as follows: In Section 2.2, a closed economy version of the model is introduced, where firms have to finance a constant share of their variable costs externally. The model is solved in partial and in general equilibrium. Section 2.3 extends the model in several dimensions. The rather strong assumption of identical credit frictions for the whole economy is relaxed and the economy is opened for international trade. Section 2.4 concludes the paper.

[1] This selection of literature is based on Egger et al. (2018).

2.2 Model setup

The starting point of my analysis is the GOLE model of Neary (2016). This model enables me to analyse profit–wage inequality as it features endogenous wages and price–cost markups. The unique characteristic of the GOLE model is that it assumes firms to be relatively large in the markets where they compete, but that they are relatively small in the economy as a whole (Neary, 2016). This means that on the one hand firms have market power in their own market, which they can exploit strategically, but on the other hand they take income, prices in other sectors, and factor prices as given.

2.2.1 Preferences and demand

Consumers have quadratic preferences over a continuum of goods produced by different sectors z defined on the unit interval, so $x(z)$ denotes the quantity of goods produced by industry z. These so-called continuum-quadratic preferences are given by:

$$U[x(z)] = \int_0^1 u[x(z)]dz \quad \text{, where} \quad u[x(z)] = ax(z) - \frac{1}{2}bx(z)^2, \tag{2.1}$$

which can also be expressed by

$$U[x(z)] = a\mu_1 - \frac{1}{2}b\mu_2, \tag{2.2}$$

where μ_1 and μ_2 denote first and second moments of the consumption levels, respectively. A single representative consumer in each country is assumed, who maximizes utility subject to the budget constraint:

$$\int_0^1 p(z)x(z)dz \leq I, \tag{2.3}$$

where I is aggregate income and $p(z)$ is the price of good z. From the consumer's utility maximization problem, inverse and direct demand functions can be derived for each good:

$$p(z) = \frac{1}{\lambda}\left[a - bx(z)\right] \quad , \quad x(z) = \frac{1}{b}\left[a - \lambda p(z)\right], \tag{2.4}$$

where λ is the marginal utility of income, the Lagrange multiplier from consumers budget constraint, given by

$$\lambda\left\{p(z), I\right\} = \frac{a\mu_1^p - bI}{\mu_2^p}, \tag{2.5}$$

where μ_1^p and μ_2^p denote the first and the second moment of the price distribution respectively. Welfare changes can be evaluated using the indirect utility function $\tilde{U}$, which is given by

$$\tilde{U} = -\lambda^2\mu_2^p. \tag{2.6}$$

2.2.2 Credit friction

Credit constraints arise from moral hazard in the tradition of Holmström and Tirole (1997). Companies are liquidity-constrained and need to finance a share δ of their unit costs $c(z)$ through an external capital market. Thus, the parameter δ serves as a measure of external financial dependence. The amount to be borrowed is given by $C(z) = \delta c(z)y(z)$, where $y(z)$ denotes firm level output. Investors fund the project only if the entrepreneur behaves diligently because the project would fail with certainty in case of shirking. If the entrepreneur shirks, he obtains a private benefit of $B(z) = \beta C(z) = \beta\delta c(z)x(z)$ with $\beta \in [0, 1]$, which is proportional to the amount to be borrowed as it is easier to divert resources for private use when the project is larger. Under diligent behavior of the entrepreneur, the probability of success

is $0 < \gamma < 1$. This implies that inference from the outcome on the borrower's effort level is impossible and a contract contingent on the effort level is infeasible. Therefore, investors require the entrepreneur to have a sufficiently large stake in his project, $R_E(z)$, in order to insure a high effort level and to obtain funding. This requirement is expressed by the entrepreneur's incentive constraint

$$\gamma R_E(z) \geq B(z) \tag{IC}$$

The expected pledgeable income of a diligent entrepreneur with marginal costs $c(z)$ is given by

$$\gamma \left[p(z)x(z) - (1-\delta)c(z)x(z)\right] - B \tag{2.7}$$

and has to exceed the investor's initial outlay. This is formally given by the investor's participation constraint,

$$\gamma R_I(z) \geq gC(z), \tag{PC}$$

where $R_I(z)$ denotes the repayment to the investor and g indicates financial intermediation costs of iceberg type, $g > 1$. The financial market is assumed to be perfectly competitive. This implies that the entrepreneur offers the minimum amount that satisfies the investor's participation constraint and therefore keeps the entire surplus of the project. The repayment to the investor is thus the borrowed amount including intermediation costs and a default premium, $R_I(z) = gC(z)/\gamma$. Both (IC) and (PC) impose a link between prices, unit costs and credit constraints,

$$\Theta \equiv 1 + \delta \left(\frac{g + \beta - \gamma}{\gamma} \right) \tag{2.8}$$

Further, I define $\Theta = 1 + \theta^g + \theta^\beta$ with

$$\theta^g \equiv \delta \frac{g - \gamma}{\gamma} \tag{2.9}$$

and

$$\theta^\beta \equiv \delta \frac{\beta}{\gamma}, \tag{2.10}$$

where θ^g captures the cost effect of external finance and θ^β measures agency costs. In the remainder of the paper, tighter credit frictions are meant to be solely due to a rise in β.

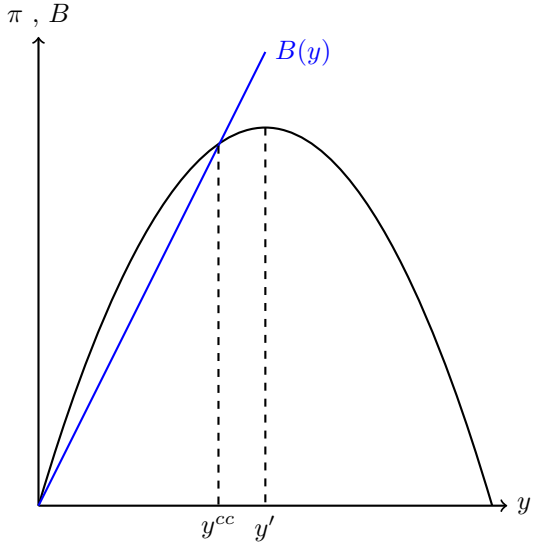
In the following sections, I first solve the model in partial equilibrium and analyze the effects of credit constraints on markups and inequality for given wages. After that the model is solved general equilibrium, which is the main focus of this paper. In general equilibrium, workers' wages are endogenous and adjust to changes in the economic environment. Especially the distributional aspects of credit frictions form the center of attention.

2.2.3 Solving the model in partial equilibrium

Before turning to general equilibrium, wages are fixed in partial equilibrium. Outcomes of a single oligopolistic industry z are determined; firms engage in Cournot competition and choose their output on the assumption that competitors keep theirs fixed. Further, a fixed number of active firms, n, in industry z is assumed, corresponding to the assumption of entry barriers preventing new firms from market entry. Consequently, oligopoly rents are not eroded by entry and firms make strictly positive profits.

Firms produce a single output good, which is homogeneous in industry z. Industry output is denoted by $x(z) = ny(z)$. Productivity is homogeneous within and across sectors with unit input requirement of

Figure 2.1: Binding incentive constraint in partial equilibrium



one. Hence, firms maximize their expected profits according to:

$$\pi(z) = \gamma \left[p(z)y(z) - (1-\delta)c(z)y(z) - R_l(z) \right] \tag{2.11}$$

subject to inverse demand (2.4), entrepreneur's incentive constraint (IC), and investor's participation constraint (PC). Optimal firm output and prices are given by

$$y(z) = \frac{a - \lambda\Theta c(z)}{b(n+1)} \quad , \quad p(z) = \frac{a + n\Theta c(z)}{n+1}. \tag{2.12}$$

It is clear that credit frictions affect output negatively and prices positively.

Furthermore, the deviation of prices from marginal costs can be determined. Note that β does not exhibit actual costs but g and γ do, so the marginal costs of production increase due to these parameters scaled by our measure of external financial dependence δ.

$$D^{PE}(z) = p(z) - (1+\theta^g)\, c(z) = \frac{a - c(z)\left[1 + \theta^g - n\theta^\beta\right]}{n+1} \tag{2.13}$$

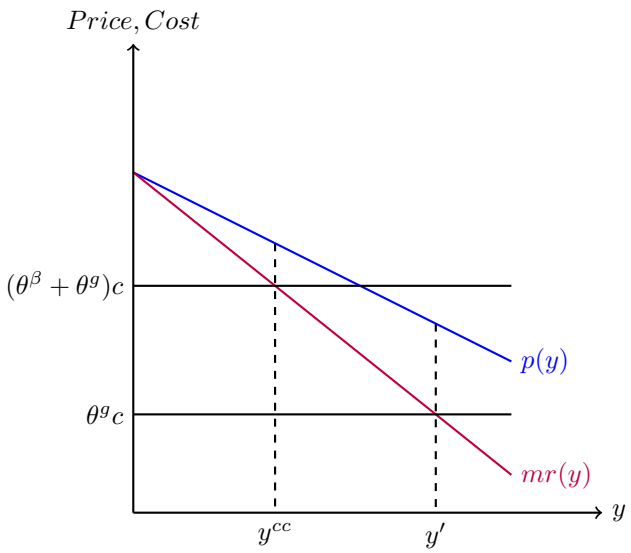
The equation above shows that the price–marginal-cost gap decreases in financial intermediation costs g and increases in the private benefit parameter β. This is quite intuitive as intermediation costs obviously increase firms' costs of production and thus lowering markups and profits. As higher values of β mean that entrepreneurs need a higher stake in their project, it is also natural that β increases markups.

How do credit frictions work in partial equilibrium? The way the credit friction is modelled basically means that firms cannot borrow as much as they would like. There is in fact a borrowing constraint. This is illustrated by Figures 2.1 and 2.2 which show that optimal output in a frictionless world, y', is larger than the credit constrained equilibrium output, y^{cc}. As is evident from Figure 2.1, profits are lower if there is a binding credit friction. A higher degree of moral hazard, i.e. higher values of β, is associated with a higher slope of $B(y)$. Thus, increasing β reduces profits in partial equilibrium.

With respect to inequality it is obvious that it is purely driven by the behavior of profits as wages are constant in partial equilibrium. Thus, the profit–wage inequality decreases in β and g.

From now on, marginal costs of production $c(z)$ are constant across sectors. Firms face a wage w,

Figure 2.2: Optimal output in partial equilibrium



which characterizes the labor market equilibrium, and is derived and discussed in the next section.

2.2.4 Solving the model in general equilibrium

In order to take the model from partial to general equilibrium, a labor market clearing condition has to be imposed, which equates aggregate labor demand to the total supply of labor, L. This is formally expressed by

$$L = \int_0^1 ny(z)dz. \tag{2.14}$$

Substituting for optimal firm output yields the following:

$$L = \frac{n}{b(n+1)} \int_0^1 [a - \lambda\Theta w]\, dz \tag{2.15}$$

which can be solved for the product λw, the consumer's real wage at the margin. This is given by

$$w_a \equiv (\lambda w)_a = \frac{a - L\frac{b(n+1)}{n}}{\Theta}. \tag{2.16}$$

As is evident from (2.16) wages decrease in Θ, i.e. they decrease in the credit friction parameters g and β, as well as in the degree of external financial dependence. Further, there are the typical demand-supply forces at work, which means that wages decrease in labor supply L and increase in n as labor demand increases due to firm entry. If the cross-derivative with respect to Θ and n is examined, one finds that the positive wage effect of firm entry decreases in the level of credit frictions. From partial equilibrium we know that tighter credit conditions lead to lower output levels and thus lower labor demand. This, combined with the full employment condition, leads to the result that the wage effect of firm entry is mitigated by credit constraints as additional firms have a small labor demand if credit constraints are high. However, output is constant in general equilibrium (see Appendix 2.B).

To continue the analysis, aggregate profits are derived, which are given by

$$\Pi = \frac{n}{b(n+1)^2}\left[a^2 - \left(a - \frac{b(n+1)}{n}L\right)\left(\frac{1+\theta^g}{\Theta}\frac{b(n+1)^2}{n}L - a + b(n+1)L\right)\right]. \tag{2.17}$$

Taking the derivative with respect to g it can be found that in general equilibrium aggregate profits are affected in the same way as in partial equilibrium, i.e. they decrease in financial intermediation costs (see equation 2.38). The degree of moral hazard has a different impact on profits in general than in partial equilibrium. While in partial equilibrium profits are negatively affected by higher levels of β, they increase in β in general equilibrium (see equation 2.39). This is due to the fact that β is a non-monetary parameter. It solely limits the amount to be borrowed but does not exhibit actual costs. As we have seen before, β decreases workers' wages and, thus, firms' unit costs just enough to offset firms' restricted labor demand. As a result, firms produce the same quantity of output at lower factor prices. Thus, β shifts income from workers to entrepreneurs. With respect to the price–marginal-cost gap, the same dynamics in general as in partial equilibrium are found. The gap widens in β as entrepreneurs need a higher stake in their project and it narrows due to the cost effect of g (see Appendix 2.E).

Proposition: *In the equal financially dependent economy,*
(i) profits fall in intermediation costs g and rise in the moral hazard parameter β
(ii) price–marginal-cost gaps narrow in g and widen in β.

To analyze the distributional aspects of credit constraints I calculate the ratio of aggregate profits and aggregate wages:

$$\frac{\Pi}{Lw} = \Theta \frac{a - bL}{a - \frac{b(n+1)}{n} L} - (1 + \theta^g). \tag{2.18}$$

In contrast to partial equilibrium, comparative statics show that inter-group inequality increases in β and g. We already know that firm profits decline due to rising intermediation costs both in partial and in general equilibrium, so one might think that this mitigates profit–wage inequality. But we have also seen that wages decrease in g. This, combined with the result that inequality increases in intermediation costs, enables me to conclude that wages drop more heavily due to higher financing costs than profits do. A higher β leads to lower labor demand for given wages. In general equilibrium, this puts downward pressure on wages as the full employment condition has to be fulfilled and results in higher inequality. Further, a negative impact of firm entry on inequality can be detected, which is smaller in magnitude for higher levels of credit constraints.

Proposition: *In the equal financially dependent economy,*
(i) inequality increases in intermediation costs g and the degree of moral hazard β
(ii) the higher the level of credit frictions, the lower is the effect of firm entry in reducing profit–wage inequality.

One reason to conduct a rigorous general equilibrium analysis of credit constraints is to measure welfare effects. However, there are none of those as the only source of welfare in this model is a reallocation of resources toward more efficient sectors (Neary, 2016). But to date, industries are assumed to be homogeneous in all respects, and thus, the relative sector resource allocation remains unaffected. This assumption will be relaxed in the next section, which enables me to derive potential welfare effects of credit constraints, as well as to gain further insights into the model dynamics.

2.3 Extensions

2.3.1 Asymmetric credit friction between two sector types

In this section, the assumption that sectors are homogeneous in their credit frictions is relaxed. To this end, two types of sectors are assumed that differ in their moral-hazard parameter β with

$$\beta(z) = \begin{cases} \beta^L & if \quad z \leq \tilde{z} \\ \beta^H & if \quad z > \tilde{z} \end{cases} \tag{2.19}$$

where $\beta^H > \beta^L$ which translates into $\Theta^H > \Theta^L$. There are many available interpretations for different sizes of β. One possible explanation might be the presence of specialized investors in a subset of sectors, who monitor the entrepreneur more closely at the same intermediation costs as the rest of the financial sector. This closer monitoring process in turn reduces the rent the manager can extract in case of shirking, which is expressed by a lower β. I further assume that intermediation costs do not differ between sectors, and define

$$\theta^g(z) = \theta^g = \delta \frac{g-\gamma}{\gamma} \quad \forall z. \tag{2.20}$$

Now consider a process of financial market development taking place, which is in this setup modelled as an increase in the threshold sector $\tilde{z}$, i.e. specialized investors operate in a bigger subset of the economy than before. Of course, this will reduce the average degree of moral hazard in the economy, but what are the implications for profits, wages, and inequality?

Solving the corresponding labor market clearing condition for wages documented in Appendix 2.F yields

$$w_a \equiv (\lambda w)_a = \frac{a - \frac{b(n+1)}{n} L}{\tilde{z}\Theta^L + (1-\tilde{z})\Theta^H}, \tag{2.21}$$

which leaves us with the insight that

Proposition: *Financial development leads to unambiguously increasing wages.*

Aggregate profits unambiguously decrease in $\tilde{z}$ if the threshold sector lies below a certain level $z\prime = \left((\Theta^H)^2 - \Theta^L\Theta^H\right) / \left((\Theta^H)^2 - (\Theta^L)^2\right)$, i.e. if the share of financially developed sectors is sufficiently small (see equation 2.55). The simple rationale for this is that profits decline due to rising wages. At some point, a rise in wages due to additional low constrained sectors might be dominated by the rising profit in the marginal sectors, which take advantage of lower credit frictions.

Calculating the profit–wage ratio and taking the derivative with respect to $\tilde{z}$ shows that inequality unambiguously decreases in financial development (see equation 2.56). Of course, this result is not surprising as we already know that wages are increasing in financial development. However, it clearly points out the central result that a reduction in financing constraints reduces inequality also under asymmetric credit frictions.

Proposition: *Financial development unambiguously decreases profit–wage inequality.*

Now statements on welfare can be made as heterogeneity between the two types of sectors opens the channel for potential welfare effects. At this point, it is important to recall that the representative consumer is characterized by quadratic subutility functions, meaning that he dislikes variance in prices. This is noteworthy as it highlights the source of welfare, i.e. lower price variance. In this model, output

is constant, so welfare is purely driven by the second moment of prices. Utility is given by

$$\begin{aligned}\tilde{U}_a &= -\left(\lambda p\right)^2 \\ &= -\frac{1}{(n+1)^2}\left[a^2 + 2anw_a\left(\tilde{z}\Theta^L + (1-\tilde{z})\Theta^H\right) + n^2 w_a^2\left(\tilde{z}(\Theta^L)^2 + (1-\tilde{z})(\Theta^H)^2\right)\right].\end{aligned} \tag{2.22}$$

Plugging in for wages and differentiating with respect to $\tilde{z}$ shows that utility is U-shaped in $\tilde{z}$ as

$$\begin{aligned}\frac{\partial \tilde{U}_a}{\partial \tilde{z}} &< 0 \quad \text{if} \quad \tilde{z} < z\prime \\ \frac{\partial \tilde{U}_a}{\partial \tilde{z}} &= 0 \quad \text{if} \quad \tilde{z} = z\prime \\ \frac{\partial \tilde{U}_a}{\partial \tilde{z}} &> 0 \quad \text{if} \quad \tilde{z} > z\prime.\end{aligned} \tag{2.23}$$

The increase in $\tilde{z}$ leads to an increase in price variability as we move from a homogeneous Θ^H-economy to a Θ^L-economy, where local minimum price variability can be found at the limits of the unit interval, $\tilde{z} = 0$ and $\tilde{z} = 1$.

2.3.2 Heterogeneity in sectoral external financial dependence

The assumption of constant external financial dependence across industries is now released, allowing instead for a sector specific $\delta(z) \in (0, 1]$. The parameter $\delta(z)$ is comparable to the measure for external financial dependence of industry sector of Rajan and Zingales (1998). From now on, the first or benchmark setup is called the "featureless" economy, while this section's setup is named the "general" or "heterogeneous" case. I assume that sectors z are ranked in ascending order according to their financial dependence. Thus, there is now a sector-specific $\Theta(z)$ with

$$\Theta(z) = 1 + \delta(z)\frac{\beta + g - \gamma}{\gamma}. \tag{2.24}$$

which results in sector specific output and prices:

$$y(z) = \frac{a - \lambda\Theta(z)c(z)}{b(n+1)} \quad , \quad p(z) = \frac{a + n\Theta(z)c(z)}{n+1} \tag{2.25}$$

Due to perfect labor mobility between sectors, there is one price of labor in the economy given by

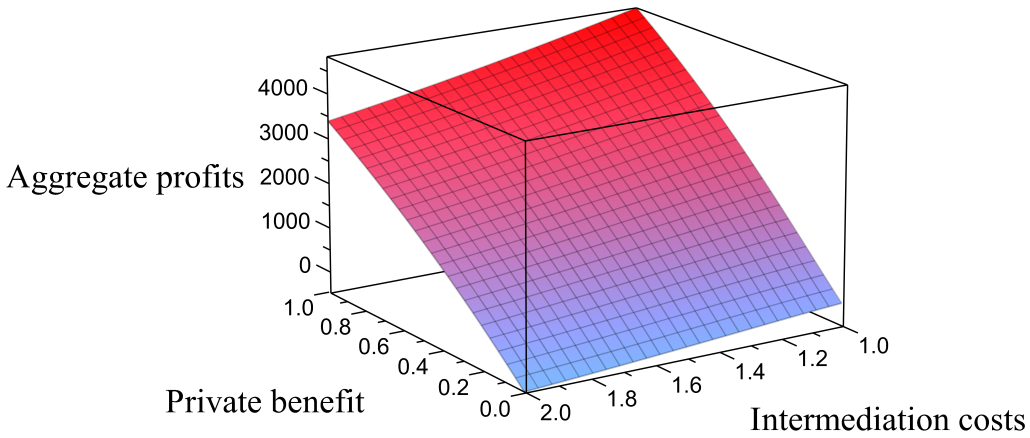
$$w_a \equiv (\lambda w)_a = \frac{a - L\frac{b(n+1)}{n}}{\mu_1^{\Theta}} \tag{2.26}$$

where

$$\mu_1^{\Theta} = \int_0^1 \Theta(z)dz. \tag{2.27}$$

It is immediate from (2.26) that the wage equation corresponds to (2.16) in the case of constant external financial dependence. The only difference is that we have the integral in the denominator. Thus, comparative statics of wages are similar as well, i.e. wages decrease in β, g, $\delta(z)$, and L and they increase in n and γ. However, profits are ambiguously affected by a change in β and g, making it complicated to make statements on inequality in this setting. Therefore, I run simulations using MATLAB, which indicate that the effect of β on profits and inequality is comparable to that in the featureless economy. In contrast to the featureless economy, profits and inequality tend to decrease in g in the general setup as shown by Figures 2.3 and 2.4, but contrary examples can be found as well.

Figure 2.3: Simulation of profits (autarky)



Additionally, a formal expression for welfare can be obtained:

$$\tilde{U}_a = -\frac{1}{(n+1)^2}\left[a^2 + 2an\left(a - \frac{n+1}{n}bL\right) + n^2\frac{\mu_2^\Theta}{\left(\mu_1^\Theta\right)^2}\left(a - \frac{n+1}{n}bL\right)^2\right] \tag{2.28}$$

where

$$\mu_2^\Theta = \int_0^1 \left(\Theta(z)\right)^2 dz. \tag{2.29}$$

Welfare unambiguously decreases in credit friction parameters β and g (see equation 2.67) and higher credit frictions are associated with smaller positive welfare effects of marginal firm entry ($\frac{\partial \tilde{U}_a}{\partial\beta\partial n} < 0$).

Proposition: *Lower financial intermediation costs as well as lower moral-hazard parameters lead to a rise in welfare in an economy with heterogeneous external financial dependence.*

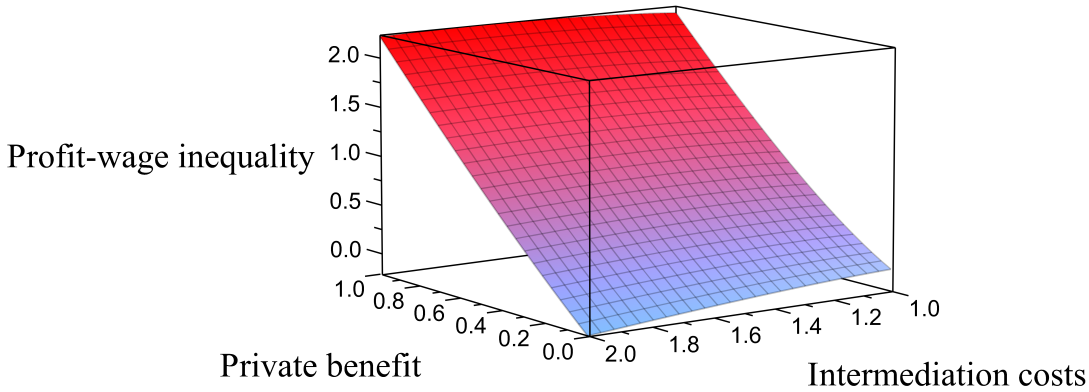
As in the case of two sector types, this welfare effect stems from the fact that labor is reallocated from high to low financially dependent industries in case of stronger credit frictions. This can be seen by examining the sector-level comparative statics of output in general equilibrium. It is formally shown in the following that output decreases in above-average financially dependent sectors whereas it increases in below-average financially dependent industries.

$$\frac{\partial ny(z)}{\partial\beta} = \frac{\partial ny(z)}{\partial g} = -\frac{n}{b(n+1)}\left(a - \frac{b(n+1)}{n}L\right)\frac{\delta(z) - \mu_1^\delta}{\gamma\left(1 + \frac{g+\beta-\gamma}{\gamma}\mu_1^\delta\right)^2} \tag{2.30}$$

where μ_1^δ denotes average external financial dependence in the economy.

Continuing the analysis of the profit–wage inequality using simulations Figure 2.5 shows that a higher degree of competition as well as a larger workforce is associated with less inequality. The first result is

Figure 2.4: Simulation of credit constraint effects on the profit–wage ratio (autarky)



rather standard as in Cournot competition profits decline in the number of competitors (Tirole, 1988) and it is also in line with Lloyd-Ellis and Bernhardt (2000), who built a business cycle model with credit constraints and occupational choice. They find that under certain conditions "competition amongst entrepreneurs for workers bids up the equilibrium wage, so that profits eventually fall, and income and wealth inequality start to decline" (Lloyd-Ellis and Bernhardt, 2000, p. 148). The second finding is that the size of the labor force and inequality are inversely related is because L not only denotes the number of workers but the mass of consumers as well. Thus, higher levels of L lead to a bigger supply of input factors on the one hand, which might result in lower factor prices. On the other hand, firms face higher demand as well. My graphical analysis indicates that the latter effect dominates in terms of inequality, i.e. higher goods market demand leads to increasing labor demand, which increases wages and reduces income inequality. This mechanism can also be found in Lloyd-Ellis and Bernhardt (2000), but the size of the workforce is endogenous in their model as it features occupational choice.

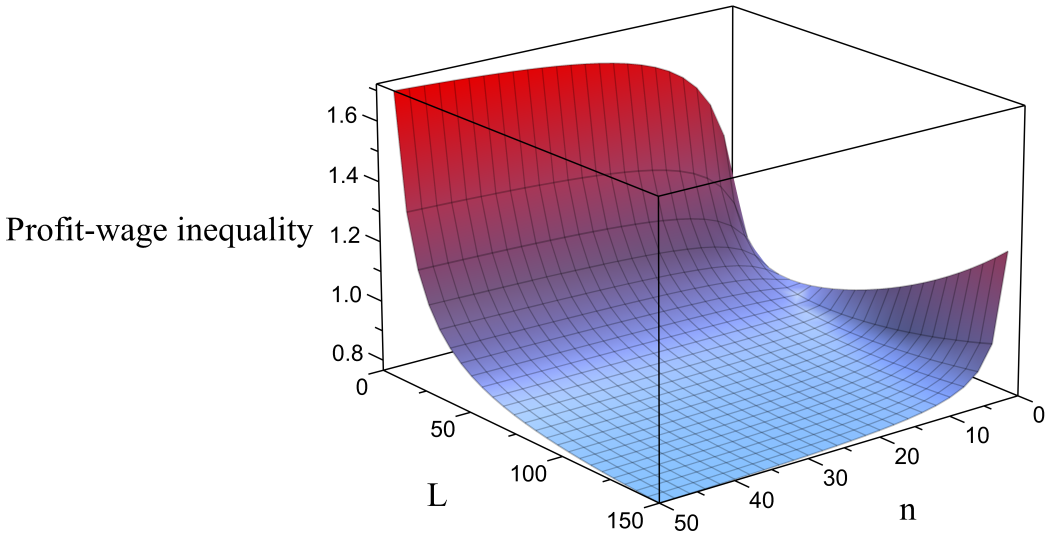
2.3.3 Open economy with heterogeneous external financial dependence

The model in this section is now extended by opening the economy to trade with a fully symmetric trading partner. In general, effects of credit constraints have points of comparison with the autarky case. Therefore, the focus of this section is on the role of trade costs and marginal trade liberalization.

$$w_t \equiv (\lambda w)_t = \frac{2a - L\frac{b(2n+1)}{n}}{(1+\tau)\mu_1^{\Theta}} \tag{2.31}$$

The formal expression of the open economy wage given by (2.31) shows that workers' wages fall in trade costs, i.e. they increase due to marginal trade liberalization. This positive effect of trade liberalization on wages becomes smaller for higher levels of credit constraints ($\frac{\partial w_t}{\partial \beta \partial \tau} < 0$).

Figure 2.5: Simulation of the profit–wage ratio (autarky)



Profits react ambiguously to a reduction in trade costs (see Appendix 2.H), but simulations show that profits increase in τ, which is specific to the symmetric country setup and also drives inequality. Figure 2.7 shows that in the given simulation inequality increases in trade costs. The rationale for this is as follows: wages strictly decrease in τ, partly reducing variable costs of firms. Further, a rise in τ means that exporting becomes costlier relative to domestic sales, and consequently, firms decrease their exports. The symmetric country setup now implies that exports are substituted by domestic sales, which are traded without any additional costs. As a result, profits (see figure 2.6) and inequality (see figure 2.7) rise in τ. This also means that international integration reduces profit–wage inequality under this model setup.

Welfare is given by

$$\tilde{U}_t = -\frac{1}{(2n+1)^2}\left((2n+1)a^2 - 2(2n+1)abL + n^2\frac{\mu_2^{\Theta}}{\left(\mu_1^{\Theta}\right)^2}\left(a - \frac{b(2n+1)}{n}L\right)^2\right), \tag{2.32}$$

which shows that marginal trade liberalization does not affect welfare as the expression is independent of τ. This is because trade costs do not hit sectors differently, and thus, there will be no reallocation of labor across sectors and no change in the variation of prices. However, there are still gains from trade as welfare increases when moving from autarky to trade due to the competition effect (see equation 2.94). As there are more firms in the market, prices are bid down and price variability is reduced, which is also observed by Neary (2016) in a comparable setup, with heterogeneous productivities across sectors and

Figure 2.6: Simulation of trade cost effects on profits

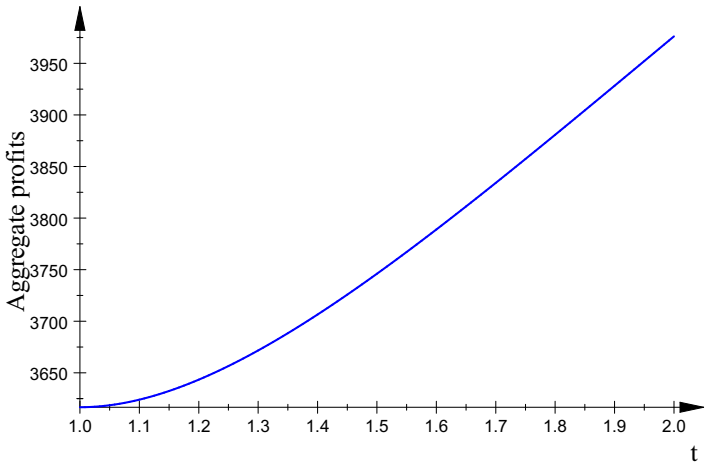
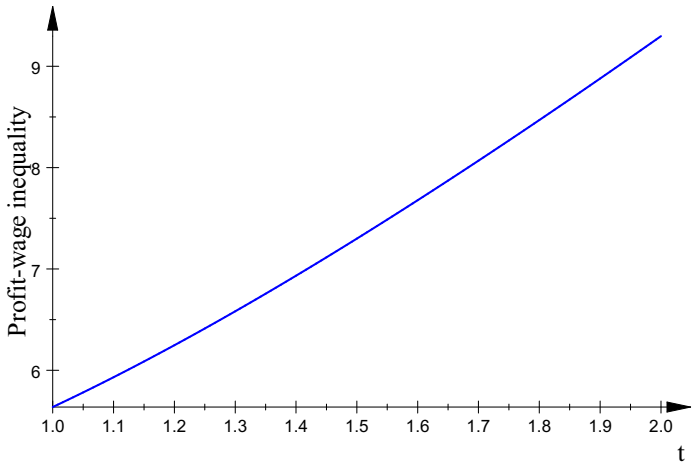


Figure 2.7: Simulation of trade cost effects on the profit–wage ratio



two identical countries.

Proposition: *(i) Welfare in the open economy is strictly higher than in autarky due to the competition effect if the demand intercept, a, is sufficiently large, but (ii) marginal trade liberalization does not affect welfare in the open economy.*

2.4 Conclusion

I extend Peter Neary's (2016) GOLE-model with credit constraints, which stem from a moral-hazard framework in the tradition of Holmström and Tirole (1997). This framework enables me to analyze the effects of credit constraints on profits, wages, and inter-group inequality.

In the closed economy general equilibrium with identical external financial dependence across industry sectors, profit–wage inequality increases in financial intermediation costs as well as in the degree of moral hazard. Additionally, I find that firm entry lowers inequality, which is mitigated for higher levels of credit constraints. In general, workers' wages are negatively affected by financial constraints, whereas the effect on profits is less clear-cut. The model is extended in several dimensions. If for financial development is allowed in a subset of sectors in the economy, this unambiguously leads to increasing wages and decreasing profit–wage inequality. With heterogeneous external financial dependence of sectors, I find that lower intermediation costs, as well as a lower degree of moral hazard, are associated with higher levels of welfare. In the open economy, welfare is independent of trade costs, but opening the economy for trade strictly increases welfare.

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Appendix

2.A Solving for wages in general oligopolistic equilibrium

The labor market clearing condition is given by:

$$L = \int_0^1 nydz \tag{2.33}$$

we then need to plug in for the autarky output $y = \frac{a-\lambda\Theta w}{b(n+1)}$ and solve for w:

$$w_a \equiv (\lambda w)_a = \frac{a - L\frac{b(n+1)}{n}}{\mu_1^{\Theta}} \tag{2.34}$$

where

$$\mu_1^{\theta} = \int_0^1 \Theta dz \tag{2.35}$$

$$\frac{\partial w_a}{\partial\beta\partial n} = -\frac{\mu_1^{\delta}}{\gamma}\frac{bL}{n^2\left(\int_0^1 \Theta dz\right)^2} < 0 \tag{2.36}$$

2.B Output in general oligopolistic equilibrium

$$\begin{aligned}
Y_a &= \int_0^1 ny(z)dz \\
&= \int_0^1 n\frac{a-\Theta w}{b(n+1)}dz \\
&= \frac{n}{b(n+1)}\left(a - w\Theta\right) \\
&= \frac{n}{b(n+1)}\left(a - \frac{a - L\frac{b(n+1)}{n}}{\Theta}\Theta\right) \\
&= L
\end{aligned}$$

2.C Derivation of aggregate profits in general equilibrium

$$\begin{aligned}\Pi &= \int_0^1 n\pi(z)dz \\ &= \frac{n}{b(n+1)^2}\left[a^2 + \left(\left(1 - \frac{1+\theta^g}{\Theta}\frac{n+1}{n}\right)b(n+1)L - a\right)\left(a - \frac{b(n+1)}{n}L\right)\right]\end{aligned} \tag{2.37}$$

$$\frac{\partial \Pi}{\partial g} = -\left(a - \frac{b(n+1)}{n}L\right)\frac{\beta\delta^2}{\gamma^2\left(1+\delta\frac{g+\beta-\gamma}{\gamma}\right)^2}L < 0 \tag{2.38}$$

$$\frac{\partial \Pi}{\partial \beta} = \left(a - \frac{b(n+1)}{n}L\right)\frac{\delta\left(1+\delta\frac{g-\gamma}{\gamma}\right)}{\gamma\left(1+\delta\frac{g+\beta-\gamma}{\gamma}\right)^2}L > 0 \tag{2.39}$$

2.D Comparative statics of the profit–wage ratio

The profit–wage ratio in this ('featureless') case is given by:

$$\frac{\Pi}{Lw} = \Theta\frac{a-bL}{a-\frac{b(n+1)}{n}L} - (1+\theta^g) \tag{2.40}$$

$$\frac{\partial\frac{\Pi}{Lw}}{\partial g} = \frac{\delta}{\gamma}\left(\frac{a-bL}{a-\frac{b(n+1)}{n}L} - 1\right) \geq 0 \tag{2.41}$$

$$\frac{\partial\frac{\Pi}{Lw}}{\partial \beta} = \frac{\delta\left(a-bL\right)}{\gamma\left(a-\frac{b(n+1)}{n}L\right)} \geq 0 \tag{2.42}$$

$$\frac{\partial\frac{\Pi}{Lw}}{\partial n} = -\Theta\frac{a-bL}{\left(a-\frac{b(n+1)}{n}L\right)^2}\frac{bL}{n^2} \leq 0 \tag{2.43}$$

$$\frac{\partial\frac{\Pi}{Lw}}{\partial\beta\partial n} = -\frac{\delta}{\gamma}\frac{a-bL}{\left(a-\frac{b(n+1)}{n}L\right)^2}\frac{bL}{n^2} \leq 0 \tag{2.44}$$

2.E Deviation of prices from marginal costs in general equilibrium

$$D = p - (1+\theta^g)\,w = \frac{1}{n+1}\left[a - \frac{a-\frac{b(n+1)}{n}L}{\Theta}\left(1+\frac{\delta}{\gamma}\left(g-\gamma-n\beta\right)\right)\right] \tag{2.45}$$

$$\frac{\partial D}{\partial \beta} = \frac{\delta}{\gamma}\frac{a-\frac{b(n+1)}{n}L}{(n+1)\Theta^2}\left[g-\gamma+n\left(\Theta-\beta\right)\right] \geq 0 \tag{2.46}$$

$$\frac{\partial D}{\partial g} = \frac{\delta}{\gamma} \frac{a - \frac{b(n+1)}{n} L}{(n+1)\Theta^2} \left[1 + \delta \frac{g - \gamma - n\beta}{\gamma} - \Theta \right] < 0 \tag{2.47}$$

In autarky, a change in credit constraint parameters affects the price–marginal-cost gap in the same direction in general equilibrium as in partial equilibrium.

2.F Financially separated closed economy

Labor market clearing condition

$$\begin{aligned} L &= \int_0^1 n \frac{a - \lambda\Theta(z)w}{b(n+1)} dz \\ \Leftrightarrow L\frac{b(n+1)}{n} &= \int_0^{\tilde{z}} a - \lambda w \Theta^L dz + \int_{\tilde{z}}^1 a - \lambda w \Theta^H dz \\ \Leftrightarrow L\frac{b(n+1)}{n} &= \tilde{z}\left(a - \lambda w \Theta^L\right) + (1-\tilde{z})\left(a - \lambda w \Theta^H\right) \end{aligned}$$

$$w_a \equiv (\lambda w)_a = \frac{a - \frac{b(n+1)}{n} L}{\tilde{z}\Theta^L + (1-\tilde{z})\Theta^H} \tag{2.48}$$

$$\frac{\partial w_a}{\partial \tilde{z}} = \frac{\Theta^H - \Theta^L}{\tilde{z}\Theta^L + (1-\tilde{z})\Theta^H} w_a > 0 \tag{2.49}$$

Aggregate profits

$$\begin{aligned} \Pi &= \int_0^{\tilde{z}} n\pi(z)dz + \int_{\tilde{z}}^1 n\pi(z)dz \\ &= \frac{n}{b(n+1)^2}\left[a^2 + a(n-1)w\left[\tilde{z}\Theta^L + (1-\tilde{z})\Theta^H\right] - a(n+1)\left(1+\theta^g\right)w\right. \\ &+ (n+1)\left(1+\theta^g\right)\left[\tilde{z}\Theta^L + (1-\tilde{z})\Theta^H\right]w^2 - n\left[\tilde{z}(\Theta^L)^2 + (1-\tilde{z})(\Theta^H)^2\right]w^2\Big] \end{aligned} \tag{2.50}$$

Welfare

Welfare

$$\tilde{U}_a = -\lambda^2 p^2 = \int_0^1 p(z)^2 dz = \int_0^{\tilde{z}} p(z)^2 dz + \int_{\tilde{z}}^1 p(z)^2 dz \tag{2.51}$$

$$= -\frac{1}{(n+1)^2}\left[a^2 + 2anw\left(\tilde{z}\Theta^L + (1-\tilde{z})\Theta^H\right) + n^2 w^2\left(\tilde{z}(\Theta^L)^2 + (1-\tilde{z})(\Theta^H)^2\right)\right] \tag{2.52}$$

$$\frac{\partial \tilde{U}_a}{\partial \tilde{z}} = 2(\Theta^H - \Theta^L)\frac{n^2}{(n+1)^2}\frac{\Theta^L\Theta^H - \tilde{z}(\Theta^L)^2 - (1-\tilde{z})(\Theta^H)^2}{\tilde{z}\Theta^L + (1-\tilde{z})\Theta^H} w^2 \tag{2.53}$$

I define $z' = \left((\Theta^H)^2 - \Theta^L\Theta^H\right) / \left((\Theta^H)^2 - (\Theta^L)^2\right)$ and find the following relationship between the welfare change in $\tilde{z}$ and z':

$$\frac{\partial \tilde{U}_a}{\partial \tilde{z}} > 0 \quad \text{if} \quad \tilde{z} > z\prime$$
$$\frac{\partial \tilde{U}_a}{\partial \tilde{z}} = 0 \quad \text{if} \quad \tilde{z} = z\prime$$
$$\frac{\partial \tilde{U}_a}{\partial \tilde{z}} < 0 \quad \text{if} \quad \tilde{z} < z\prime$$

Profit-wage ratio

$$\begin{aligned}\frac{\Pi}{Lw} = \frac{1}{b(n+1)^2} \Bigg[& \frac{a^2(\tilde{z}\Theta^L + (1-\tilde{z})\Theta^H)}{a - \frac{n+1}{n}bL} + a(n-1)\left[\tilde{z}\Theta^L + (1-\tilde{z})\Theta^H\right] \\ & - (1+\theta^g)\frac{(n+1)^2}{n}bL - n\left(a - \frac{n+1}{n}bL\right)\frac{\left[\tilde{z}(\Theta^L)^2 + (1-\tilde{z})(\Theta^H)^2\right]}{\tilde{z}\Theta^L + (1-\tilde{z})\Theta^H}\Bigg]\end{aligned} \tag{2.54}$$

Comparative statics

$$\begin{aligned}\frac{\partial \Pi}{\partial \tilde{z}} = -\frac{n}{b(n+1)^2}\frac{a - \frac{n+1}{n}bL}{(\tilde{z}\Theta^L + (1-\tilde{z})\Theta^H)^2} \Bigg[& (1+\theta^g)\left(\Theta^H - \Theta^L\right)\frac{(n+1)^2}{n}bL \\ & + n\left(a - \frac{n+1}{n}bL\right)\frac{\Theta^H\left[(\Theta^L)^2 + (\Theta^H)^2\right] - \tilde{z}\left[\Theta^H - \Theta^L\right]\left[(\Theta^L)^2 - (\Theta^H)^2\right] - 2(\Theta^H)^2\Theta^L}{\tilde{z}\Theta^L + (1-\tilde{z})\Theta^H}\Bigg]\end{aligned} \tag{2.55}$$

which is unambiguously negative if

$$\tilde{z} < \frac{\Theta^H(\Theta^H - \Theta^L)}{(\Theta^L)^2 - (\Theta^H)^2} \quad \text{with} \quad 0 < \frac{\Theta^H(\Theta^H - \Theta^L)}{(\Theta^L)^2 - (\Theta^H)^2} < 1$$

At the outset, if additional sectors have low credit frictions, aggregate profits fall due to rising wages. At some point, it might be that a rise in wages due to additional low-constrained sectors is dominated by the rising profit in the marginal sectors, which take advantage of lower credit frictions.

$$\begin{aligned}\frac{\partial \frac{\Pi}{Lw}}{\partial \tilde{z}} = & -\left(\Theta^H - \Theta^L\right)\frac{n}{(n+1)^2 bL}\frac{1}{\left[\tilde{z}\Theta^L + (1-\tilde{z})\Theta^H\right]^2} \\ & \left[a\left(\tilde{z}^2(\Theta^L)^2 + (1-\tilde{z})^2\Theta^H(\Theta^H - \Theta^L)\right) + \Theta^H\Theta^L\frac{n+1}{n}bL\right] < 0\end{aligned} \tag{2.56}$$

2.G Heterogeneity in sectoral external financial dependence

Derivation of aggregate output

$$\begin{aligned}
Y_a &= \int_0^1 ny(z)dz \\
&= \int_0^1 n\frac{a-\Theta(z)w}{b(n+1)}dz \\
&= \frac{n}{b(n+1)}\left(a - w\mu_1^{\Theta}\right) \\
&= \frac{n}{b(n+1)}\left(a - \frac{a - L\frac{b(n+1)}{n}}{\mu_1^{\Theta}}\mu_1^{\Theta}\right) \\
&= L
\end{aligned}$$

Sectoral output dynamics and prices in general equilibrium

Sector output is given by

$$ny(z) = \frac{n}{b(n+1)}\left(a - \frac{\Theta(z)}{\mu_1^{\Theta}}\left(a - \frac{b(n+1)}{n}L\right)\right). \tag{2.57}$$

$$\frac{\partial ny(z)}{\partial g} = \frac{\partial ny(z)}{\partial \beta} = -\frac{n}{b(n+1)}\left(a - \frac{b(n+1)}{n}L\right)\frac{\delta(z)-\mu_1^{\delta}}{\gamma\left(1+\frac{g+\beta-\gamma}{\gamma}\mu_1^{\delta}\right)^2} \tag{2.58}$$

$$\frac{\partial ny(z)}{\partial\beta\partial n} = -\frac{1}{b(n+1)}\left[\frac{1}{n+1}\left(a - L\frac{b(n+1)}{n}L\right) + \frac{bL}{n}\right]\frac{\delta(z)-\mu_1^{\delta}}{\gamma\left(1+\frac{\beta+g-\gamma}{\gamma}\mu_1^{\delta}\right)^2} \tag{2.59}$$

$$\begin{aligned}
\frac{\partial\frac{\Theta(z)}{\mu_1^{\Theta}}}{\partial g} &> 0 \quad \text{if} \quad \delta(z) > \mu_1^{\delta} \\
\frac{\partial\frac{\Theta(z)}{\mu_1^{\Theta}}}{\partial g} &= 0 \quad \text{if} \quad \delta(z) = \mu_1^{\delta} \\
\frac{\partial\frac{\Theta(z)}{\mu_1^{\Theta}}}{\partial g} &< 0 \quad \text{if} \quad \delta(z) < \mu_1^{\delta}
\end{aligned} \tag{2.60}$$

Note that μ_1^{δ} denotes average financial dependence in the economy. We can see that sectoral output decreases if the sector is above-average financially dependent in the case of increasing intermediation costs g and vice versa.

The higher the number of firms in the economy, the larger is the extent of reallocation between sectors due to changing credit frictions (positive in below-average and negative in above-average financially dependent sectors).

Sector prices are given by

$$p(z) = \frac{a + n\Theta(z)c(z)}{n+1} = \frac{1}{n+1}\left(a + n\frac{\Theta(z)}{\mu_1^{\Theta}}\left(a - L\frac{b(n+1)}{n}L\right)\right) \tag{2.61}$$

$$\frac{\partial p(z)}{\partial g} = \frac{n}{n+1}\left(a - L\frac{b(n+1)}{n}L\right)\frac{\partial \frac{\Theta(z)}{\mu_1^\Theta}}{\partial g} \tag{2.62}$$

$\frac{\partial \frac{\Theta(z)}{\mu_1^\Theta}}{\partial g} = \frac{\partial \frac{\Theta(z)}{\mu_1^\Theta}}{\partial \beta}$ has been already determined above.

Derivation of welfare

Welfare is given by

$$\tilde{U}_a = -\left(\lambda^2 \mu_2^p\right)_a \tag{2.63}$$

$$= -\frac{1}{(n+1)^2}\left(a^2 + 2anw_a\mu_1^\Theta + n^2 w_a^2 \mu_2^\Theta\right) \tag{2.64}$$

with

$$\mu_2^\Theta = \int_0^1 \Theta(z)^2 dz. \tag{2.65}$$

$$\tilde{U}_a = -\frac{1}{(n+1)^2}\left((2n+1)a^2 - 2(n+1)abL + n^2\frac{\mu_2^\Theta}{\left(\mu_1^\Theta\right)^2}\left(a - \frac{n+1}{n}bL\right)^2\right) \tag{2.66}$$

$$\frac{\partial \tilde{U}_a}{\partial g} = \frac{\partial \tilde{U}_a}{\partial \beta} = -\frac{2n^2}{(n+1)^2}\frac{\left(a - \frac{n+1}{n}bL\right)^2}{\left(1 + \frac{g+\beta-\gamma}{\gamma}\mu_1^\delta\right)^3}\frac{g+\beta-\gamma}{\gamma^2}\left(\mu_2^\delta - \left(\mu_1^\delta\right)^2\right) \leq 0 \tag{2.67}$$

where

$$\mu_1^\delta = \int_0^1 \delta(z)dz \text{ and } \mu_2^\delta = \int_0^1 \delta(z)^2 dz. \tag{2.68}$$

Aggregate Profits

$$\begin{aligned}\Pi_a &= \int_0^1 n\pi(z)dz \\ &= \frac{n}{b(n+1)^2}\left[a^2 - a\left((n+1)\frac{1+\frac{g-\gamma}{\gamma}\mu_1^\delta}{1+\frac{\beta+g-\gamma}{\gamma}\mu_1^\delta} - n + 1\right)\left(a - \frac{b(n+1)}{n}L\right)\right. \\ &\left. + \left(\frac{1+\frac{2g+\beta-2\gamma}{\gamma}\mu_1^\delta + \frac{(g-\gamma)(g+\beta-\gamma)}{\gamma^2}\mu_2^\delta - n\left(\frac{\beta}{\gamma}\mu_1^\delta + \frac{\beta(g+\beta-\gamma)}{\gamma^2}\mu_2^\delta\right)}{1+2\frac{g+\beta-\gamma}{\gamma}\mu_1^\delta + \left(\frac{g+\beta-\gamma}{\gamma}\right)^2\left(\mu_1^\delta\right)^2}\right)\left(a - \frac{b(n+1)}{n}L\right)^2\right]\end{aligned} \tag{2.69}$$

Simulations prove that $\frac{\partial \Pi}{\partial g} \gtreqless 0$ and $\frac{\partial \Pi}{\partial \beta} \gtreqless 0$.

2.H Open economy with heterogeneous external financial dependence

Partial equilibrium

The model is solved by backward induction.

$$E\left[\pi(z)\right] = \gamma\left[(p_1(z) - (1-\delta(z))c_1(z))y_{11}(z) + (p_2(z) - (1-\delta(z))c_1(z)\tau)y_{12}(z) - R_L(z)\right] \tag{2.70}$$

subject to (IC), (PC), and inverse demand. By using (2.8), the maximization problem above can be reformulated

$$E\left[\pi(z)\right] = \gamma\left[(p_1(z) - \Theta_1 c_1(z))y_{11}(z) + (p_2(z) - \Theta_1 c_1(z)\tau)y_{12}(z)\right] \tag{2.71}$$

subject to inverse demand.

First-order condition:

$$p_1(z) - \Theta_1 c_1(z) + \frac{\partial p_1(z)}{\partial y_{11}^l(z)} y_{11}(z) = 0 \tag{2.72}$$

where $\frac{\partial p_1(z)}{\partial y_{11}^l(z)}$ denotes the partial derivative of the inverse demand function with respect to individual firm l's output only (Cournot competition). The reaction functions of firms from Country 1 are given by

$$y_{11}(z) = \frac{a - \lambda_1 \Theta_1 c_1(z)}{b(n+1)} - \frac{n}{n+1} y_{21}(z) \tag{2.73}$$

$$y_{12}(z) = \frac{a^* - \lambda_2 \Theta_1 \tau c_1(z)}{b(n+1)} - \frac{n}{n+1} y_{22}(z) \tag{2.74}$$

Analogously, we obtain reaction functions of firms from Country 2

$$y_{22}(z) = \frac{a^* - \lambda_2 \Theta_2 c_2(z)}{b(n+1)} - \frac{n}{n+1} y_{12}(z) \tag{2.75}$$

$$y_{21}(z) = \frac{a - \lambda_1 \Theta_2 \tau c_2(z)}{b(n+1)} - \frac{n}{n+1} y_{11}(z) \tag{2.76}$$

Based on equations (2.73)–(2.76), I can derive the optimal equilibrium domestic and export output of a firm in sector z:

$$y_{11}(z) = \frac{1}{b(2n+1)} \left[a - (n+1)\lambda_1 \Theta_1 c_1(z) + n\tau \lambda_1 \Theta_2 c_2(z)\right] \tag{2.77}$$

$$y_{12}(z) = \frac{1}{b(2n+1)} \left[a^* - (n+1)\lambda_2 \Theta_1 \tau c_1(z) + n\lambda_2 \Theta_2 c_2(z)\right]. \tag{2.78}$$

In the rest of the section, I assume that countries are identical, i.e. $c_1 = c_2 = c$, $\lambda_1 = \lambda_2 = \lambda$, $\Theta_1(z) = \Theta_2(z) = \Theta(z), \forall z \in [0,1]$, and $a = a^*$. This leads to equilibrium outputs

$$y_{11}(z) = \frac{1}{b(2n+1)} \left[a - \lambda\Theta \left(c + n(1-\tau)c\right)\right] \tag{2.79}$$

$$y_{12}(z) = \frac{1}{b(2n+1)} \left[a - \lambda\Theta \left(\tau c - n(1-\tau)c\right)\right] \tag{2.80}$$

$$p_t(z) = \frac{a + n\Theta(z)(1+\tau)c(z)}{2n+1} \tag{2.81}$$

Deviation of prices from marginal costs:

$$p(z) - (1+\theta^g)\, c(z) = \frac{1}{2n+1} \left[a + \frac{1}{\gamma}\delta(z)c\left[\beta(1+\tau) - (g-\gamma)(2n-\tau)\right] - (n+1)c + n\tau c\right] \tag{2.82}$$

Profits react ambiguously with respect to trade costs in partial equilibrium:

$$\begin{aligned} \frac{\partial \pi(z)}{\partial \tau} = \frac{1}{b(n+1)^2} \big[& -aw\left(2n\left(1+\theta^g - \Theta\right) + 1 + \theta^g + \Theta\right) \\ & -2w^2\Theta\left(n\Theta + n\tau\Theta - (1+\theta^g)\left(2n^2\tau + 3n\tau + \tau - n\right)\right)\big] \gtrless 0 \end{aligned} \tag{2.83}$$

Note that from now on marginal costs of production $c_1(z)$ are constant across sectors. Firms face a wage w_1, which is determined in equilibrium.

$$c_1(z) = w_1 \tag{2.84}$$

General oligopolistic equilibrium

Labor market clearing condition

$$L = \int_0^1 n(y_{11}(z) + y_{12}(z))dz \tag{2.85}$$

Wages under trade are given by

$$w_t \equiv (\lambda w)_t = \frac{2a - L\frac{b(2n+1)}{n}}{(1+\tau)\mu_1^\Theta} \tag{2.86}$$

where

$$\mu_1^\Theta = \int_0^1 \Theta(z)dz. \tag{2.87}$$

$$\frac{\partial w_t}{\partial \tau} = -\left(2a - \frac{2n+1}{n}bL\right)\frac{1}{(1+\tau)^2\mu_1^\Theta} \tag{2.88}$$

$$\frac{\partial w_t}{\partial \tau \partial \mu_1^\Theta} = \left(2a - \frac{2n+1}{n}bL\right)\frac{1}{(1+\tau)^2(\mu_1^\Theta)^2} \tag{2.89}$$

Welfare

$$\begin{aligned}\tilde{U}_t &= -\left(\lambda^2\mu_2^p\right)_t \\ &= - - \frac{1}{(2n+1)^2}\left(a^2 + 2anw_t'\mu_1^\Theta(1+\tau) + (n(1+\tau))^2(w_t')^2\mu_2^\Theta\right)\end{aligned} \tag{2.90}$$

with

$$\mu_2^\Theta = \int_0^1 \Theta(z)^2 dz \tag{2.91}$$

Note that in the open economy a denotes the world demand intercept, which is the sum of the a^{HOME} and $a^{FOREIGN}$. I need to account for this when deriving utility in order to maintain comparability. Therefore, I substitute a for $2a$ in the open economy wage equation before plugging in the open economy utility function. Except for the utility function, we keep the notation of $2a = a^{HOME} + a^{FOREIGN}$ for the world demand intercept throughout the paper.

$$w_t' \equiv (\lambda w)_t = \frac{a - L\frac{b(2n+1)}{n}}{(1+\tau)\mu_1^\Theta} \tag{2.92}$$

$$\tilde{U}_t = -\frac{1}{(2n+1)^2}\left((2n+1)a^2 - 2(2n+1)abL + n^2\frac{\mu_2^\Theta}{\left(\mu_1^\Theta\right)^2}\left(a - \frac{b(2n+1)}{n}L\right)^2\right) \tag{2.93}$$

$$\tilde{U}_t - \tilde{U}_a = \frac{a}{(2n+1)^2(n+1)^2}\left[a(2n+1)^3\left(1 - \left(\frac{n+1}{2n+1}\right)^2\right) + n^2\frac{\mu_2^\Theta}{(\mu_1^\Theta)^2}\left(an(3n+2) - 2(2n+1)(n+1)bL\right)\right], \tag{2.94}$$

which is strictly positive for sufficiently large a. This is typically fulfilled for positive wages in autarky.

$$\frac{\partial \tilde{U}_t}{\partial g} = \frac{\partial \tilde{U}_t}{\partial \beta} = -\frac{2n^2}{(2n+1)^2}\frac{\left(a - \frac{2n+1}{n}bL\right)^2}{\left(1 + \frac{g+\beta-\gamma}{\gamma}\mu_1^\delta\right)^3}\frac{g+\beta-\gamma}{\gamma^2}\left(\mu_2^\delta - \left(\mu_1^\delta\right)^2\right) \leq 0 \tag{2.95}$$

with

$$\mu_1^\delta = \int_0^1 \delta(z)dz \tag{2.96}$$

$$\mu_2^\delta = \int_0^1 \delta(z)^2 dz \tag{2.97}$$

Aggregate profits

Aggregate profits are given by

$$\begin{aligned}\Pi_t &= \int_0^1 n\pi(z)dz \\ &= \frac{1}{b(2n+1)^2}\left[2a^2 + \left(2a - \frac{b(2n+1)}{n}L\right)\left[a(2n-1) - a(2n+1)\frac{\mu_1^{\theta^g}}{\mu_1^\Theta}\right.\right. \\ &\left.\left. - \left(2a - \frac{b(2n+1)}{n}L\right)\left(n\frac{\mu_2^\Theta}{\left(\mu_1^\Theta\right)^2} - (2n+1)(n+1-2n\tau+(n+1)\tau^2)\frac{\int_0^1 (1+\theta^g(z))\,\Theta(z)dz}{(1+\tau)^2\left(\mu_1^\Theta\right)^2}\right)\right]\right]\end{aligned} \tag{2.98}$$

where

$$\mu_1^{\theta^g} = \int_0^1 1 + \theta^g(z)dz. \tag{2.99}$$

As in the autarky case, with heterogeneous external financial dependence, simulations prove that profits react ambiguously to a change in the credit environment $\left(\frac{\partial\Pi}{\partial g} \gtreqless 0, \frac{\partial\Pi}{\partial\beta} \gtreqless 0\right)$. Aggregate profits generally react ambiguously to a change in trade costs. This can be easily seen by inspecting the following equation for the case of open economy with constant external financial dependence across sectors.

$$\begin{aligned}\frac{\partial\Pi}{\partial\tau} = &-\frac{1+\theta^\delta}{\Theta}\frac{n}{b(2n+1)(1+\tau)^2}\left(2a - \frac{b(2n+1)}{n}L\right)\left[2a\left(n\tau^2 - (3n+2)\tau + 2n + 1\right)\right. \\ &\left. -\frac{b(2n+1)}{n}\left((n+1)\tau^2 - 2(2n+1)\tau + 3n + 1\right)\right] \gtreqless 0\end{aligned}$$

However, it is instructive to check for which parameter constellations the above derivative is negative. We know that $2a > \frac{b(2n+1)}{n}L$ as wages need to be positive. Thus, the remaining question is whether the term in the square brackets is of positive sign. If the multiplicative factor of $2a$ is greater than that of $\frac{b(2n+1)}{n}$, the term is negative and we can rest assured that the derivative w.r.t. τ is negative under the following condition:

$$\begin{aligned}n\tau^2 - (3n+2)\tau + 2n + 1 &> (n+1)\tau^2 - 2(2n+1)\tau + 3n + 1 \\ &\Leftrightarrow \tau^2 - n\tau + n < 0\end{aligned}$$

The inequality above holds for $n > 4$ and

$$\frac{1}{2}\left[n - \sqrt{n(n-4)}\right] < \tau < \frac{1}{2}\left[n + \sqrt{n(n-4)}\right]$$

Numerical example for $n = 5$ and $n = 6$:

$$n = 5: \qquad 1.38197 < \tau < 3.61803$$
$$n = 6: \qquad 1.26795 < \tau < 4.73205$$

However, please note that there are other possible parameter constellations, where the relationship explained above is of different sign.

Chapter 3

The impact of credit constraints on wages in general equilibrium

Abstract

This paper analyzes the role of credit constraints for union and competitive wages in closed and open economies. The credit friction stems from a moral hazard framework. It is shown that union and competitive wages decrease in agency costs as well as in financial intermediation costs. Tighter credit frictions impact union wages stronger than competitive wages, reducing inequality within the group of workers. Profits decrease due to higher financial intermediation costs in union and non-union sectors under free trade as well as in autarky, because intermediation costs increase the unit costs in this model. By contrast, tighter credit frictions caused by higher agency costs increase profits due to the fall of workers' wages irrespective of the trade regime. Therefore, higher agency costs relocate income from workers to entrepreneurs in general equilibrium.

3.1 Introduction

Inequality has various dimensions. When it comes to power, education, wealth and income, inequality could be one of the driving factors for social unrest. Socrates early considered unequal income and wealth as a major source for this in the society stating that '*any city, however small, is in fact divided into two, one the city of the poor, the other of the rich; these are at war with one another[...]*' (Plato, The Republic, 360 BC). However, not all scholars were concerned about inequality of wealth and income. In particular, the opinion that labor income should be – at least to some extent – equally distributed is a rather modern view.

Coming to the present, OECD statistics indicate that income inequality has increased since the 1980s (Keeley, 2015). It is interesting to note that, according to the OECD (2016), the average share of workers covered by collective bargaining agreements across OECD countries decreased from 54.2 % in 2008 to 50.4 % in 2013. Further regarding collective bargaining agreements, there is large heterogeneity across OECD countries ranging from 6.5 % in Turkey to 98 % in France and Austria.[1] Obviously, countries differ significantly in their wage-finding process. Therefore, it can be inferred that this might affect both wage levels and wage inequality. If there is an interaction with the financial environment, the impact of potential credit frictions on wages might also depend on the degree of collective bargaining in the economy.

This paper develops the hypothesis that credit frictions may affect income inequality in terms of workers' wages. I add credit frictions arising from a moral hazard framework in the tradition of Holmström and Tirole (1997) to a general equilibrium model with oligopolistic markets. In this model, entrepreneurs have to finance a share of their project externally. Due to the oligopolistic market structure, all projects have positive net present value, but entrepreneurs are able to obtain funding only if they have a sufficiently high stake in their project, which prevents them from diverting resources for their private benefit.

This paper investigates whether credit frictions affect the gap between union and competitive wages. Following Bastos and Kreickemeier (2009) unions demand a wage premium on the competitive wage of the economy. This setting enables me to analyze the wage effects of agency costs. I find that union and competitive wages decline due to tighter credit constraints. A higher level of credit frictions affects union wages stronger than competitive wages, thereby reducing inequality within the group of workers. A further result is that profits decrease in financial intermediation costs in union and non-union sectors under free trade as well as in autarky, because intermediation costs increase unit costs in the model. In contrast to this, tighter credit frictions due to higher agency costs increase profits irrespective of the trade regime due to the fall in workers' wages. Therefore, higher agency costs relocate income from workers to entrepreneurs in general equilibrium.

This paper is closely related to the strand of literature analyzing wage effects within the framework of the generalized oligopolistic equilibrium (GOLE) model proposed by Peter Neary (2016). Similar to my paper, this literature mainly focuses on wage inequality and the effects of international trade on this, by introducing different wage setting mechanisms (see Bastos and Kreickemeier, 2009; Kreickemeier and Meland, 2013; Egger and Etzel, 2012, 2014; Egger, Meland and Schmerer, 2015). I closely follow Bastos and Kreickemeier (2009), who introduce a mechanism of union wage setting in a sector-subset of the economy.

Further related studies focus on the wage and employment effects of collective bargaining. Theoretical literature suggests that under certain model assumptions, i.e. the "monopoly union" and the "efficient bargaining" model, unions increase their members' relative wages while employment effects are ambiguous

[1] Note that coverage of collective bargaining agreements may not be interchanged with union membership. However, in many countries with collective bargaining agreements, unions are part of the wage-finding process or union wage structures are also applied to non-union workers. See Nickell and Layard (1999) and Blaun and Kahn (1999) for an overview of labor market institutions.

(Blau and Kahn, 1999; Farber, 1986). Many empirical studies documented that unions raise wages of measured low-skilled workers stronger than other skill-groups' wages (Freeman, 1980, 1982; Blanchflower and Freeman, 1992; Blau and Kahn, 1996; Kahn, 2000). According to Kahn (2000) "most studies have found that unions compress the wage distribution across a variety of countries" (Kahn, 2000, p. 567). It is noteworthy that unions might influence income inequality within sectors or occupations, as well as between them. Freeman (1980) finds that unions compress the wage structure in manufacturing industries and thereby reducing inequality by standardizing wages across firms. This gives rise to the view that equalizing within-sector effects more than offset the deviating between-sector effects, which is confirmed by Freeman (1993), who finds that declining unionization had contributed to the rise in wage inequality in the US over the 1980s. In my model, however, I am not primarily interested in the wage effects of unionization itself but in the implications of credit constraints for wage inequality. The source of wage inequality is union presence in a subset of sectors of the economy, which interacts with the credit friction affecting all sectors.

Also related to this paper is the large empirical literature on income distribution. I mention a non-comprehensive selection of recent insights only. Atkinson, Piketty and Saez (2011) find an increase in top income shares in Western English-speaking countries as well as in China and India. Additionally, they find an increase with a lower magnitude in Nordic and Southern European countries, whereas Continental European countries and Japan experienced only a modest or no increase in top income shares in the recent decades. Alvaredo et al. (2017) find rising top income shares with large heterogeneity across countries and suggest that these differences might be due to country-specific institutions and policies.

Other related research includes the recent literature on credit constraints and international trade. Egger et al. (2018) find that credit constraints affect the degree of competition in the open economy and therefore influence all firms in the market at least indirectly. Additionally, this literature also postulates that credit frictions affect trade patterns. Studies show that credit constraints may affect comparative advantage (Kletzer and Bardhan, 1987; Ju and Wei, 2011; Egger and Keuschnigg, 2015), trade volumes (Beck, 2002; Chaney, 2016; Manova, 2008, 2013), and international capital flows (Matsuyama, 2005; Antràs and Caballero, 2009) [2]. However, none of these authors deal with the potential effects of financial frictions on the distribution of income.

So far, there is little or no theory on how credit constraints affect wage inequality in general equilibrium. This paper seeks to fill this gap by adding a new channel of credit frictions to Bastos and Kreickemeier (2009) and Neary (2016). I analyze how a change in the credit environment of the economy influences firm profits, union and competitive wages.

The remainder of the paper is organized as follows. In Section 3.2, I introduce an open economy model with oligopolistic markets and union wage setting, where firms have to finance a constant share of their variable costs externally. The model is solved in partial and in general equilibrium in Sections 3.3 and 3.4, respectively. Section 3.5 discusses comparative statics of the model and Section 3.6 concludes the paper.

3.2 Model setup

In this section, Peter Neary's (2016) model of oligopoly in general equilibrium with labor market unionization, as introduced by Bastos and Kreickemeier (2009), is presented. I extend this model by adding credit frictions due to asymmetric information following Holmström and Tirole (1997). The model operates in a two-country world where countries are assumed to be perfectly identical. The economy of country 1 is described solely, as all insights hold for country 2 as well.

[2] This selection of literature is based on Egger et al. (2018).

3.2.1 Preferences and demand

The representative consumer has an additive utility function over a continuum of goods defined on the unit interval:

$$U[x_1(z)] = \int_0^1 \left[ax_1(z) - \frac{1}{2}bx_1(z)^2\right] dz \tag{3.1}$$

where $x_1(z)$ denotes consumption of good z in country 1. Consumer's budget constraint is given by

$$\int_0^1 p_1(z)x_1(z)dz \leq I_1. \tag{3.2}$$

The inverse and direct demand functions can be calculated in a straightforward way:

$$p_1(z) = \frac{1}{\lambda_1}(a - bx_1(z)) \tag{3.3}$$

$$x_1(z) = \frac{1}{b}(a - \lambda_1 p_1(z)) \tag{3.4}$$

with

$$\lambda_1 \left[\{p_1(z)\}, I_1\right] = \frac{a\mu_1 - bI_1}{\sigma_1^2}, \tag{3.5}$$

where λ_1 is the marginal utility of income, which is the Lagrange multiplier attached to the budget constraint. The first and second moments of prices, μ_1 and σ_1^2 respectively, are given by

$$\mu_1 = \int_0^1 p_1(z)dz \quad \text{and} \quad \sigma_1^2 = \int_0^1 p_1^2(z)dz. \tag{3.6}$$

Firms treat economy-wide variables parametrically as they are assumed to have market power in goods markets but not in factor markets. This parametrical treatment also holds for λ_1 as it is determined in general equilibrium.

The indirect utility function can be obtained by substituting the demand function given by (3.4) into equation (3.1):

$$\tilde{U} = \frac{a^2 - \sigma_1^2}{2b} \tag{3.7}$$

Equation (3.7) shows that indirect utility is strictly decreasing in the second moment of prices.

3.2.2 Credit friction

Firms are liquidity-constrained and have to finance a share ρ of their input costs in advance. The share of external finance is likely to differ across sectors for various reasons such as technological ones [3]. As labor is the only input factor in the model, the idea is that workers have to be paid during the process of production, which takes place before the firm generates any revenues from sales.

In modeling credit constraints, I closely follow the continuous investment model of Holmström and Tirole (1997). I assume that the financial sector is perfectly competitive and firms make a take-it-or-leave-it offer to investors, specifying the amount to be borrowed, $C(z) = \rho c(z)y(z)$, and the repayment to investors, $R_L(z)$. The variable investment captures the stylized fact that larger firms in terms of output (and those that have to finance a larger total cost of inputs) usually request a larger volume of credit. The following participation constraint formally shows that investors' expected revenue has at least to be equal to their initial outlay:

$$\gamma R_L(z) \geq C(z) \tag{PC}$$

[3] See Rajan and Zingales (1998) for further information on differences in external financial dependence of industries

where γ is the probability of repayment or the survival rate of firms and $R_L(z)$ denotes the repayment to investors. The participation constraint holds with equality due to the assumption of perfectly competitive investors.

Further, investors will fund the borrower's project only if he behaves diligently, otherwise the entrepreneur's project will fail with certainty. If the entrepreneur shirks, he obtains a private benefit denoted by $B(z) = \phi C(z) = \phi \rho c(z)$, which is proportional to the total amount of credit with $\phi \in [0, 1]$. Under diligence, the probability of success is $0 < \gamma < 1$, implying that inference from the outcome on the entrepreneur's effort level is impossible and a contract contingent on effort is infeasible. Thus, the entrepreneur needs a sufficient stake in his project, $R_B(z)$, which incentivizes him to behave. This requirement is formally expressed by the entrepreneur's incentive constraint

$$\gamma R_B(z) \geq B(z) \tag{IC}$$

where $R_B(z)$ denotes the borrower's stake, which is defined as the entrepreneur's operating profit. The expected pledgeable income is then given by

$$\gamma R_B(z) - B(z), \tag{3.8}$$

which has to exceed investors' initial outlay to enable firms to obtain external funding. Combining (3.8) and (PC) and manipulating yields the following relationship between prices and unit costs (see Appendix 3.A for details):

$$p(z) \geq (\beta + \delta)\, c_1(z) \tag{3.9}$$

Notably, β is a non-monetary component of the incentive constraint, which ensures that an entrepreneur's stake is large enough to induce a high effort level. It can be interpreted as a measure of agency costs. In contrast, δ creates actual costs for the firm due to the repayment to investors.

3.2.3 Labor market

Country 1 is endowed with L workers, who are identical ex ante. However, their wage depends on whether there are unions present in their sector. Closely following Bastos and Kreickemeier (2009), I assume sector-level unions, which are active in a subset of industries. There is a threshold sector $\tilde{z} \in [0, 1]$ that separates union from non-union sectors. Unions set wages in all sectors $z \leq \tilde{z}$. In all other industries, the labor market is perfectly competitive.

There is a single active union in each industry $z \in [0, \tilde{z}]$, representing all workers employed in this sector. Each union maximizes rents, i.e. the wage gap between union and competitive wages, weighted by the marginal utility of income λ_1. Union's preferences are characterized by a Stone–Geary utility function:

$$\Omega_1(z) = \lambda_1 \left[w_1(z) - w_1^c\right] l_1(z) \tag{3.10}$$

where $w_1(z)$ is the nominal union wage in sector z; w_1^c is the nominal competitive wage in the non-union sectors; and $l_1(z)$ is total labor demand in industry z in country 1. Assuming constant wages within sector z can be justified by the finding of Freeman (1980)—that unions reduce wage inequality within sectors as they tend to standardize wages within and across firms.

3.2.4 Technology and credit constrained firms

The economy comprises a continuum $[0, 1]$ of imperfectly competitive industries, each producing a differentiated product. Each industry consists of n symmetric firms. I assume n to be small, which induces

imperfect competition within industries due to unspecified barriers to market entry. Competition within sectors is of Cournot type. Hence, firms are relatively large in their own sector but small in the economy. This leads to market power of firms within industries, but they treat factor prices as given. Labor is the only factor of production with constant marginal product. Marginal labor productivity is normalized to unity. As firms are aware of the credit constraints they will face when applying for the loan at the next stage, they already take (IC) and (PC) into account as well as consumers' demand when maximizing their profits. In contrast to Bastos and Kreickemeier (2009), I am especially interested in analyzing an economy in which equation (3.9) is binding. Using the combined constraint of equation (3.9) leads to the following maximization problem:

$$E\left[\pi(z)\right] = \gamma\left[(p_1(z) - (\beta_1 + \delta_1)c_1(z))y_{11}(z) + (p_2(z) - (\beta_1 + \delta_1)(c_1(z) + t))y_{12}(z)\right] \tag{3.11}$$

subject to inverse demand. Subscripts indicate origin and destination country, i.e. $y_{12}(z)$ is the output produced by a firm of sector z in country 1 to be sold in country 2 at price $p_2(z)$. Ad valorem trade costs are denoted by t. A typical firm from country 1 in sector z faces marginal costs, $c_1(z)$, with

$$c_1(z) = \begin{cases} w_1^c & if \quad z > \tilde{z} \\ w_1 & if \quad z \leq \tilde{z}. \end{cases} \tag{3.12}$$

3.3 Partial equilibrium

3.3.1 Production

First, each union sets its wage, w_1, taking as given the competitive wage, w^c. Second, each firm chooses its quantity, taking as given the output of competitors and wages, and making a take-it-or-leave-it offer to investors. As the model is solved by backward induction, firms account for the credit constraints they face when choosing their output. Thus, the choice of output and the credit decision can be seen as taking place concurrently. Maximization of equation (3.11) leads to the following reaction functions:

$$y_{11}(z) = \frac{a - \lambda_1(\beta_1 + \delta_1)c_1(z)}{b(n+1)} - \frac{n}{n+1}y_{21}(z) \tag{3.13}$$

$$y_{12}(z) = \frac{a^* - \lambda_2(\beta_1 + \delta_1)(c_1(z) + t)}{b(n+1)} - \frac{n}{n+1}y_{22}(z) \tag{3.14}$$

Solving these leaves us with the equilibrium output of each firm in autarky

$$y_{11}(z) = \frac{a - \lambda_1(\beta + \delta)c_1(z)}{b(n+1)} \tag{3.15}$$

and under two-way trade

$$y_{11}(z) = \frac{1}{b(2n+1)}\left[a - (n+1)\lambda_1(\beta_1 + \delta_1)c_1(z) + n\lambda_1(\beta_2 + \delta_2)(c_2(z) + t)\right] \tag{3.16}$$

$$y_{12}(z) = \frac{1}{b(2n+1)}\left[a^* - (n+1)\lambda_2(\beta_1 + \delta_1)(c_1(z) + t) + n\lambda_2(\beta_2 + \delta_2)c_2(z)\right] \tag{3.17}$$

I assume countries to be identical in all respects, i.e. competitive, and union wages as well as marginal utility and credit constraints are the same for both countries. Hence, country indices are omitted hereinafter. Following Neary (2003), marginal utility of income is chosen as the numeraire with $\lambda = 1$. Thus, wages are to be interpreted as real wages at the margin (Neary, 2016). Under these assumptions, the

equations for optimal output collapse to

$$y_{11}(z) = \frac{1}{b(2n+1)}\left[a - (\beta+\delta)(c(z) - nt)\right] \tag{3.18}$$

$$y_{12}(z) = \frac{1}{b(2n+1)}\left[a^* - (\beta+\delta)(c(z) + nt)\right] \tag{3.19}$$

3.3.2 Union wage setting

Maximizing union's utility function (3.10) under different trade regimes leads to union wages in autarky

$$w_1(z) = \frac{a + (\beta+\delta)w_1^c}{2(\beta+\delta)} \tag{3.20}$$

and under two-way trade

$$w(z) = \frac{2a - (\beta+\delta)t + 2(n+1)(\beta+\delta)w^c}{2(n+2)(\beta+\delta)}. \tag{3.21}$$

Once again, countries are assumed to be identical. Hence, the union wage $w(z)$ under two-way trade is identical for both countries. It is immediate from (3.21) that the union wage decreases in t, meaning that trade liberalization raises union wages. As noted by Bastos and Kreickemeier (2009), this is also a key result of Naylor (1998, 1999), who finds this in a duopoly model with union wage setting. However, union wages are lower under free trade ($t = 0$) than in autarky in partial equilibrium as shown by (3.22).

$$D = w_t(z) - w_a(z) = -\frac{n(a - (\beta+\delta)w^c) + (\beta+\delta)t}{2(n+2)(\beta+\delta)} < 0 \tag{3.22}$$

3.4 General equilibrium

In contrast to the partial equilibrium case where w^c is treated parametrically, the competitive wage is determined by the labor market equilibrium. The last section has shown that the union wage is higher than the competitive wage, which induces an incentive for workers to join unionized industries. In order to abstract from the incentive problem, and because the number of jobs in unionized sectors is limited, workers are assumed to be allocated to industries by chance.

3.4.1 Union and non-union sector wages in general equilibrium

The labor market clearing condition in Country 1 is given by

$$L = n\int_0^1 y_{11}(z) + y_{12}(z)dz \tag{3.23}$$

Using equations (3.15), (3.20), and the fact that in autarky $y_{12}(z) = 0$ gives the competitive autarky wage:

$$w_1^c = \frac{1}{(\beta_1+\delta_1)}\left(a - \frac{2(n+1)}{n(2-\tilde{z})}bL\right). \tag{3.24}$$

The autarky union wage is then determined by substituting w^c back into the partial equilibrium wage (3.20):

$$w_1 = \frac{1}{(\beta_1+\delta_1)}\left(a - \frac{(n+1)}{n(2-\tilde{z})}bL\right). \tag{3.25}$$

In order to determine wages under two-way trade, one needs to follow the same steps as in autarky. The competitive wage is determined by solving the full-employment condition for w^c, where equations

(3.16), (3.17), and (3.21) are used:

$$w^c = \frac{a}{(\beta+\delta)} - \frac{t}{2} - \frac{(2n+1)(n+2)}{2n(n+2-\tilde{z})(\beta+\delta)}bL. \tag{3.26}$$

Substituting w^c back into (3.21) yields the union sector wage in an open economy:

$$w = \frac{a}{(\beta+\delta)} - \frac{t}{2} - \frac{(2n+1)(n+1)}{2n(n+2-\tilde{z})(\beta+\delta)}bL. \tag{3.27}$$

Thus, the union wage premia in the autarky, P_a, and open economy case, P_t, are given by

$$P_a = w_1 - w_1^c = \frac{1}{(\beta_1+\delta_1)}\frac{n+1}{n(2-\tilde{z})}bL \tag{3.28}$$

$$P_t = w - w^c = \frac{2n+1}{2n(n+2-\tilde{z})(\beta+\delta)}bL. \tag{3.29}$$

Comparing the derived equations with the corresponding expressions in Bastos and Kreickemeier (2009) reveals that the only difference is the presence of parameters β and δ. The equations coincide if $\beta+\delta=1$, i.e. in the absence of credit constraints. It is immediate from equations (3.24) - (3.27) that the presence of credit constraints has a negative impact on wages across sectors and that it is independent from the trade regime. The impact of credit constraints on wages, especially with regard to inequality, is analyzed in detail in the following section.

3.4.2 Output, prices, profits, and welfare

Using the industry general equilibrium wages, one can derive the formal expressions for output, prices, and profits for union and non-union sectors reported in table 3.1.

Table 3.1: Industry output, prices, and profits

	Sector	Output	Prices	Profits
Autarky	U	$\frac{1}{2-\tilde{z}}L$	$a - \frac{1}{2-\tilde{z}}bL$	$\left[a\beta + \frac{\delta-n\beta}{(2-\tilde{z})n}bL\right]\frac{1}{(\beta+\delta)(2-\tilde{z})}L$
	NU	$\frac{2}{2-\tilde{z}}L$	$a - \frac{2}{2-\tilde{z}}bL$	$\left[a\beta + \frac{2(\delta-n\beta)}{(2-\tilde{z})n}bL\right]\frac{2}{(\beta+\delta)(2-\tilde{z})}L$
Trade	U	$\frac{n+1}{n+2-\tilde{z}}L$	$a - \frac{n+1}{n+2-\tilde{z}}bL$	$\frac{(n+1)\beta}{(n+2-\tilde{z})(\beta+\delta)}aL + \frac{(n+1)^2(\delta-2n\beta)}{2n(n+2-\tilde{z})^2(\beta+\delta)}bL^2 + \frac{n(n+\frac{1}{2})(\beta+\delta)\delta}{b(2n+1)}t^2$
	NU	$\frac{n+2}{n+2-\tilde{z}}L$	$a - \frac{n+2}{n+2-\tilde{z}}bL$	$\frac{(n+2)\beta}{(n+2-\tilde{z})(\beta+\delta)}aL + \frac{(n+2)^2(\delta-2n\beta)}{2n(n+2-\tilde{z})^2(\beta+\delta)}bL^2 + \frac{n(n+\frac{1}{2})(\beta+\delta)\delta}{b(2n+1)}t^2$

Notes: The table shows aggregate output $n(y_{11}+y_{12})$, prices p_1, and aggregate profits $n(\pi_{11}+\pi_{12})$ in Country 1 for union and non-union sectors.

It is noticeable that the general equilibrium expressions for industry output and prices are independent of the credit constraints as they do not contain β and δ and match those in Bastos and Kreickemeier (2009). Hence, welfare is unaffected by the credit friction as well. This is formally expressed by equations (3.30) and (3.31), which also coincide with the corresponding second moments of prices in Bastos and

Kreickemeier (2009). The second moment of prices in autarky is formally given by

$$\sigma^2 = a(a - 2bL) + \frac{4 - 3\tilde{z}}{(2 - \tilde{z})^2}(bL)^2 \tag{3.30}$$

and for the case of an open economy it can be expressed as

$$\sigma^2 = a(a - 2bL) + \frac{(n+2)^2 - (2n+3)\tilde{z}}{(n + 2 - \tilde{z})^2}(bL)^2. \tag{3.31}$$

3.5 Comparative statics

I proceed with comparative static exercises focusing on the credit constraint parameters β and δ. Other comparative static results such as trade liberalization, deunionization, and firm entry are discussed for the sake of completeness. However, the last three exercises are extensively discussed in Bastos and Kreickemeier (2009), and their results remain valid for this modified version of the model.

3.5.1 The effect of credit constraints on union and non-union wages

Under both trade regimes, credit constraints affect wages negatively. The credit constraint elasticity of wages is constant and identical for union and non-union wages:

$$\frac{\partial w_1}{\partial(\beta+\delta)}\frac{\beta+\delta}{w_1} = \frac{\partial w_1^c}{\partial(\beta+\delta)}\frac{\beta+\delta}{w_1^c} = -1. \tag{3.32}$$

This result is not surprising since credit constraints are modeled as a multiplicative factor shifting input costs upward. However, β is a non-monetary factor, that ensures that entrepreneurs have a sufficiently high stake in their project. Another interesting fact is that credit constraints decrease the union wage premium since $\partial P/\partial(\beta+\delta) < 0$ in both closed and open economies (see Appendices 3.B and 3.C). As union wages are higher than competitive wages and the credit constraint elasticity of wages is constant, union wages decrease stronger in response to more severe credit frictions than non-union wages. The reason for this can be found in the wage setting mechanism. Unions maximize their wage premium but also account for the employment level of their sector. Therefore, they internalize a part of the credit friction, which is the partial equilibrium effect. This can be better understood by disentangling the partial and the general equilibrium effect of credit constraints:

$$\frac{dw}{d(\beta+\delta)} = \frac{\partial w}{\partial(\beta+\delta)} + \frac{\partial w}{\partial w^c}\frac{\partial w^c}{\partial(\beta+\delta)} = -\left(\frac{a}{(n+2)(\beta+\delta)^2} + \frac{n+1}{(n+2)(\beta+\delta)}w^c\right). \tag{3.33}$$

The first term within brackets is the partial equilibrium effect; the second is the general equilibrium effect. The partial equilibrium effect has been described above and works in the same direction as the general equilibrium effect. This illustrates why union wages decrease more strongly in terms of absolute values than competitive wages and clearly shows the different degree of impact credits constraints have within the group of workers.

3.5.2 The effect of credit constraints on industry profits

Another interesting open question concerns the response of inequality between wages and profits to a change in credit constraints. As the general equilibrium wage effects have already been analyzed in the last section, the effects of credit constraints on profits remain to be examined. The crucial point is that there is a difference between parameters β and δ. While δ is an actual cost shifter, β does not shift any costs of the entrepreneur upward but ensures that the entrepreneur has a sufficiently high stake in the

revenues of the firm. Thus, it is necessary to analyze the response of firm profits to changes in β and δ separately.

Consider first the input cost shifter δ. It is intuitive that a higher δ reduces profits, and indeed this can be formally shown for both sectors in autarky as $dn\pi/d\delta < 0$. In case of trade, the result is less clear-cut because the sign of the derivative depends on the level of trade costs (see Appendix 3.C). However, in the absence of trade costs, the response of aggregate profits to an increase in δ is unambiguously negative.

Continuing the analysis with respect to β,I have already shown that profits decline in β in partial equilibrium as β limits the borrowing capacity and thus entrepreneurs' profit opportunities. However, given that wages decrease in credit constraints and that they increase the stake entrepreneurs have in their project, one would expect profits to increase in this variable. This is indeed the case: independent from the trade regime and sector, profits unambiguously increase in β, resulting in a rise in inequality between wages and firm profits. Thus, β reallocates income from workers to firm owners. However, please note that I did not make any statements on welfare, which is unaffected by credit constraints as already discussed in the preceding sections.

Further, union sector profits respond stronger to a change in δ than non-union sector profits if $w^c < (1/2)w$ holds in autarky and $w^c < (n+1)/(n+2)w$ holds under free trade. This means that profits of union sectors fall stronger in δ than for non-union sector if the wage premium is sufficiently high. Similarly, union sector profits respond stronger than non-union sector profits to a change in β if the conditions above hold in autarky and under free trade, respectively.

3.5.3 Trade liberalization

Similar to Bastos and Kreickemeier (2009), I find that the union wage is higher under free trade (t=0) than in autarky if $\tilde{z} > \tilde{z}^* = 1 - \frac{1}{2n-1}$:

$$D_{GE}^{Union} = w_t - w_a = \left(\frac{(n+1)\left[2(n+2-\tilde{z}) - (2n+1)(2-\tilde{z})\right]}{2n(2-\tilde{z})(n+2-\tilde{z})} \right) \frac{bL}{(\beta+\delta)}. \tag{3.34}$$

The competitive wage unambiguously increases if an economy shifts from autarky to free trade:

$$D_{GE}^{c} = w_t^c - w_a^c = \left(\frac{\tilde{z}(2n^2+n-2)+2n+4}{2n(2-\tilde{z})(n+2-\tilde{z})} \right) \frac{bL}{(\beta+\delta)} > 0. \tag{3.35}$$

The union wage premium decreases when an economy opens up for free trade:

$$P_t - P_a = w_t - w_t^c - (w_a - w_a^c) = \frac{1}{\beta+\delta} \frac{(2n+1)(2-\tilde{z}) - (2n+2)(n+2-\tilde{z})}{2n(2-\tilde{z})(n+2-\tilde{z})} bL < 0. \tag{3.36}$$

These three equations are closely linked. When the economy is opened for trade, direct positive labor demand effects are created as shown by equations (3.16), (3.18), and (3.19), which puts upward pressure on all wages, in both union and non-union industries. As Bastos and Kreickemeier (2009) note, there is a first-order and a second-order effect on union wages. The first-order effect is that in partial equilibrium union wages are lower under two-way trade than in autarky, holding the competitive wage constant. The second-order effect is the general equilibrium effect of changing competitive wages. As competitive wages increase, this puts upward pressure on union wages. So first- and second-order effects operate in opposite directions. Now, if $\tilde{z}$ exceeds a critical level $\tilde{z}^*$, the second-order effect dominates the first-order effect, as with a larger $\tilde{z}$ the first-order effect "occurs in a larger proportion of sectors, which implies a larger effect on aggregate labour demand, and therefore a larger (positive) second-round effect on the competitive wage" (Bastos and Kreickemeier, 2009, p. 242).

The equations above also reveal that credit constraints affect wage differences with the same magnitude. This implies a purely redistributive effect of credit constraints but leaves welfare unaffected, as already mentioned in the previous section. Since the only source of welfare gain in this model is the

reallocation of workers to more efficient sectors, a shift from autarky to trade is welfare increasing due to the decline in the union wage premium, which results in a reallocation of workers from non-union to union sectors (Bastos and Kreickemeier, 2009). Parameters β and δ do not change relative input prices and thus do not lead to a change in welfare.

Next, I consider a reduction in trade costs with $t > 0$ in the case of two-way trade. Equations (3.26) and (3.27) show that a reduction in trade barriers increases competitive and union wages as

$$\frac{dw}{dt} = \frac{dw^c}{dt} = -\frac{1}{2} \tag{3.37}$$

leaving the union wage premium constant

$$P_t = w - w^c = \frac{2n+1}{2n(n+2-\tilde{z})(\beta+\delta)} bL. \tag{3.38}$$

The result that gradual trade liberalization increases wages is also found by Naylor (1998, 1999). Since the tariff reduction does not affect the union wage premium, it has no effect on welfare. Further, Bastos and Kreickemeier (2009) find that the general equilibrium effect of a reduction in trade costs ($\partial w \partial w^c / \partial w^c \partial t$) dominates the partial equilibrium effect ($\partial w / \partial t$), where the relative importance of the first effect is increasing in the number of firms n:

$$\frac{dw}{dt} = \frac{\partial w}{\partial t} + \frac{\partial w}{\partial w^c}\frac{\partial w^c}{\partial t} = -\left(\frac{1}{2(n+2)} + \frac{n+1}{2(n+2)}\right) = -\frac{1}{2}. \tag{3.39}$$

As is evident from Table 1, industry profits fall due to marginal trade liberalization. This surprising result can be explained by the fact that there is full employment in general equilibrium. Thus, higher labor demand due to lower trade costs leads to rising equilibrium wages, and the effect of increased factor prices dominates the lower trade costs with respect to profits. This result is also found by Bastos and Kreickemeier (2009).

3.5.4 Deunionization

Next, the effects of marginal deunionization are analyzed, i.e. a marginal reduction in the threshold sector $\tilde{z}$. As is evident from equations (3.24) - (3.27), union as well as competitive wages increase due to deunionization. Equations (3.28) and (3.29) show that the union wage premium falls. This result is also found by Bastos and Kreickemeier (2009), who provide the intuition that aggregate labor demand increases if union sectors are replaced by competitive wage sectors due to lower labor costs. This in turn increases the competitive wage and, via the general equilibrium effect, has a positive effect on the union wage. They also find that welfare is maximal if the economy is fully unionized or deunionized, i.e. if $\tilde{z} = 1$ or $\tilde{z} = 0$. Further, welfare is minimized when the second moment of prices is maximized, which is the case for intermediate levels of unionization $\tilde{z}^U = 2/3$ and $\tilde{z}^U = (2+n)/(3+2n)$ in the closed and open economy, respectively. Therefore, "deunionisation increases welfare once the proportion of sectors that are unionised falls below a threshold level" (Bastos and Kreickemeier, 2009, p. 243).

In this extended version of the model, credit frictions affect union and competitive wages in the way that the upward pressure of deunionization is mitigated by higher levels of credit frictions. The intuition for this is as follows. In partial equilibrium, credit frictions have a negative impact on labor demand. This puts downward pressure on wages as we have already seen. Hence, deunionization and the degree of credit constraints affect wages in opposite directions. In contrast, the fall in the union wage premium through deunionization is amplified by the degree of credit constraints. The premium falls in the degree of credit frictions and in deunionization, and hence the cross derivative is negative as well (see Appendices

3.B and 3.C).

3.5.5 Firm entry

In autarky, firm entry increases the general equilibrium union and competitive wage

$$\frac{\partial w}{\partial n} = \frac{1}{n^2(2-\tilde{z})}\frac{bL}{(\beta+\delta)} > 0 \tag{3.40}$$

$$\frac{\partial w^c}{\partial n} = \frac{2}{n^2(2-\tilde{z})}\frac{bL}{(\beta+\delta)} > 0 \tag{3.41}$$

As Bastos and Kreickemeier (2009) note, this result is different from firm entry in partial equilibrium as equation (3.20) is independent of the number of firms in the unionized sectors. Another interesting point is that firm entry reduces the union wage premium (Bastos and Kreickemeier, 2009) and therefore reduces wage inequality within the group of workers.

$$\frac{\partial P_a}{\partial n} = -\frac{1}{n^2(2-\tilde{z})}\frac{bL}{(\beta+\delta)} < 0 \tag{3.42}$$

However, this effect is mitigated by higher levels of credit constraints ($\frac{\partial P_a}{\partial n \partial(\beta+\delta)} > 0$). Welfare remains constant in this case because relative goods prices and sectoral output do not change (Bastos and Kreickemeier, 2009).

In an open economy, firm entry increases the competitive wage and reduces the union wage premium but has an ambiguous effect on the union wage. The impact on union wages depends on the degree of unionization of the economy $\tilde{z}$ (see Appendix 3.C for details). Welfare increases as firm entry decreases the union wage premium in the open economy, and now relative goods prices as well as sectoral output are affected.

3.6 Conclusion

Based on the Peter Neary's (2016) GOLE model with union wage setting as introduced by Bastos and Kreickemeier (2009), I analyze the role of credit constraints for union and competitive wages. The credit friction stems from a moral hazard framework closely following Holmström and Tirole (1997).

I show that union and competitive wages decrease in the degree of the credit friction. For this result, it does not matter whether intermediation costs or agency costs are regarded as a measure of credit constraints. Tighter credit frictions affect union wages stronger than competitive wages, thereby reducing inequality within the group of workers.

Profits decrease due to higher financial intermediation costs in union and non-union sectors under free trade as well as in autarky, because intermediation costs increase unit costs in the model. In contrast, tighter credit frictions due to higher agency costs increase profits irrespective of the trade regime or industry due to the decrease in workers' wages. Therefore, higher agency costs relocate income from workers to entrepreneurs in general equilibrium. This result cannot be obtained in partial equilibrium.

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Appendix

3.A Deriving the relationship between prices and unit costs

$$\begin{aligned}
\gamma R_B(z) - B(z) &\geq C(z) \\
\Leftrightarrow \gamma(p_1(z) - (1-\rho)c_1(z))y_{11}(z) - \phi\rho c_1(z)y_{11}(z) &\geq \rho c_1(z)y_{11}(z) \\
\Leftrightarrow p(z) &\geq \underbrace{\frac{\phi\rho}{\gamma}}_{\beta} c_1(z) + \underbrace{\left(1 + \rho\left(\frac{1-\gamma}{\gamma}\right)\right)}_{\delta} c_1(z) \\
\Leftrightarrow p(z) &\geq (\beta + \delta)\, c_1(z)
\end{aligned}$$

3.B Comparative statics in the closed economy

Comparative statics of union vs. non-union wages with respect to the credit constraint parameters $\beta + \delta$

$$\frac{\partial w_1^c}{\partial(\beta+\delta)} = -\frac{1}{(\beta+\delta)^2}\left(a - \frac{2(n+1)}{n(2-\tilde{z})}bL\right) < 0 \tag{3.43}$$

which is smaller than zero if the initial non-union wage is strictly positive.

$$\frac{\partial w_1^c/\partial(\beta+\delta)}{w_1^c} = -\frac{1}{(\beta+\delta)} < 0 \tag{3.44}$$

$$\frac{\partial w_1}{\partial(\beta+\delta)} = -\frac{1}{(\beta+\delta)^2}\left(a - \frac{(n+1)}{n(2-\tilde{z})}bL\right) < 0 \tag{3.45}$$

which is smaller than zero if the initial union wage is strictly positive.

$$\frac{\partial w_1}{\partial(\beta+\delta)\partial\tilde{z}} = \frac{1}{(\beta+\delta)^2}\frac{(n+1)}{n(2-\tilde{z})^2}bL > 0 \tag{3.46}$$

$$\frac{\partial w_1/\partial(\beta+\delta)}{w_1} = -\frac{1}{(\beta+\delta)} < 0 \tag{3.47}$$

$$\frac{\partial P_a}{\partial(\beta+\delta)} = -\frac{1}{((\beta+\delta))^2}\frac{n+1}{n(2-\tilde{z})}bL < 0 \tag{3.48}$$

$$\frac{\partial P_a/\partial(\beta+\delta)}{P_a} = -\frac{1}{(\beta+\delta)} \tag{3.49}$$

$$\frac{\partial P_a}{\partial(\beta+\delta)\partial\tilde{z}} = -\frac{1}{((\beta+\delta))^2}\frac{n+1}{n(2-\tilde{z})^2}bL < 0 \tag{3.50}$$

Comparative statics of union vs. non-union wages with respect to the number of firms n (firm entry)

Competitive wage w^c:

$$\frac{\partial w^c}{\partial n} = \frac{2}{n^2(2-\tilde{z})}\frac{bL}{(\beta+\delta)} > 0 \tag{3.51}$$

Union wage w:

$$\frac{\partial w}{\partial n} = \frac{1}{n^2(2-\tilde{z})}\frac{bL}{(\beta+\delta)} > 0 \tag{3.52}$$

Union wage premium P_a:

$$\frac{\partial P_a}{\partial n} = -\frac{1}{n^2(2-\tilde{z})}\frac{bL}{(\beta+\delta)} < 0 \tag{3.53}$$

Comparative statics of profits with respect to the credit friction parameter β

Non-union sector profits:

$$\frac{\partial n\pi^c}{\partial \beta} = \underbrace{\left[a - \frac{2(n+1)}{(2-\tilde{z})n}bL\right]}_{>0 \text{ if } w_c>0}\frac{2\delta}{(\beta+\delta)^2(2-\tilde{z})}L > 0 \tag{3.54}$$

Union sector profits:

$$\frac{\partial n\pi}{\partial \beta} = \underbrace{\left[a - \frac{n+1}{(2-\tilde{z})n}bL\right]}_{>0 \text{ if } w>0}\frac{\delta}{(\beta+\delta)^2(2-\tilde{z})}L > 0 \tag{3.55}$$

Comparative statics of profits with respect to the credit friction parameter δ

Non-union sector profits:

$$\frac{\partial n\pi^c}{\partial \delta} = -\frac{2\beta}{(2-\tilde{z})(\beta+\delta)^2}\left[a - \frac{2(n+1)}{(2-\tilde{z})n}bL\right]L < 0 \tag{3.56}$$

which is strictly negative if the initial competitive wage is strictly positive.

union sector profits

$$\frac{\partial n\pi}{\partial \delta} = -\frac{\beta}{(2-\tilde{z})(\beta+\delta)^2}\left[a - \frac{n+1}{(2-\tilde{z})n}bL\right]L < 0 \tag{3.57}$$

which is strictly negative if the initial union wage is strictly positive.

3.C Comparative statics in the open economy

Comparative statics of union vs. non-union wages with respect to the credit constraint parameters $\beta+\delta$

$$\frac{\partial w^c}{\partial(\beta+\delta)} = -\frac{1}{(\beta+\delta)^2}\left(a - \frac{(2n+1)(n+2)}{2n(n+2-\tilde{z})}bL\right) < 0 \tag{3.58}$$

which is smaller than zero if the initial non-union wage is strictly positive.

$$\frac{\partial w}{\partial(\beta+\delta)} = -\frac{1}{(\beta+\delta)^2}\left(a - \frac{(2n+1)(n+1)}{2n(n+2-\tilde{z})}bL\right) < 0 \tag{3.59}$$

which is smaller than zero if the initial union wage is strictly positive.

$$\frac{\partial w}{\partial(\beta+\delta)\partial\tilde{z}} = \frac{1}{(\beta+\delta)^2}\frac{(2n+1)(n+1)}{2n(n+2-\tilde{z})^2}bL > 0 \tag{3.60}$$

$$\frac{\partial P_t}{\partial(\beta+\delta)} = -\frac{1}{(\beta+\delta)^2}\frac{(2n+1)}{2n(n+2-\tilde{z})}bL < 0 \tag{3.61}$$

$$\frac{\partial P_t}{\partial(\beta+\delta)\partial\tilde{z}} = -\frac{1}{(\beta+\delta)^2}\frac{(2n+1)}{2n(n+2-\tilde{z})^2}bL < 0 \tag{3.62}$$

Comparative statics of union vs. non-union wages with respect to trade costs τ (trade liberalization)

Competitive wage w^c:

$$\frac{dw^c}{dt} = -\frac{1}{2} < 0 \tag{3.63}$$

Union wage w:

$$\frac{dw}{dt} = \frac{\partial w}{\partial t} + \frac{\partial w}{\partial w^c}\frac{\partial w^c}{\partial t} = -\left(\frac{1}{2(n+2)} + \frac{n+1}{2(n+2)}\right) = -\frac{1}{2} \tag{3.64}$$

$$\frac{\partial G_t}{\partial t} = 0 \tag{3.65}$$

Comparative statics of union vs. non-union wages with respect to the number of firms n (firm entry)

Competitive wage w^c:

$$\frac{\partial w^c}{\partial n} = \frac{(2n^2+n)(n+2)-(2n^2-2)(n+2-\tilde{z})}{2n^2(n+2-\tilde{z})^2}\frac{bL}{(\beta+\delta)} > 0 \tag{3.66}$$

Union wage w:

$$\frac{\partial w}{\partial n} = \frac{(2n^2+n)(n+1)-(2n^2-1)(n+2-\tilde{z})}{2n^2(n+2-\tilde{z})^2}\frac{bL}{(\beta+\delta)} \tag{3.67}$$

which can be less or greater than zero. Hence, I find an ambiguous effect of competition on union wages. Positive impact if:

$$\begin{aligned}(2n^2+n)(n+1)-(2n^2-1)(n+2-\tilde{z}) &> 0\\ \Leftrightarrow -n^2+2n+2+\tilde{z}(2n^2-1) &> 0\\ \Leftrightarrow \tilde{z} &> \frac{n^2-2n-2}{2n^2-1}\end{aligned} \tag{3.68}$$

which is a monotonously increasing function in n ($\frac{dz}{dn} > 0$) and strictly concave ($\frac{d^2z}{dn^2} < 0$) with upper limit

$$\lim_{n\to\infty}\frac{n^2-2n-2}{2n^2-1} = \frac{1}{2} \tag{3.69}$$

Thus, for all n the union wage increases with firm entry if $\tilde{z} > \frac{1}{2}$.

Union wage premium P_t

$$\frac{\partial P_t}{\partial n} = -\frac{2n^2 + 2n + 2 - \tilde{z}}{2n^2(n + 2 - \tilde{z})} < 0 \tag{3.70}$$

Comparative statics of profits with respect to the credit friction parameter β

Non-union sector profits:

$$\frac{\partial n\pi^c}{\partial \beta} = \frac{(n+2)\delta}{(n+2-\tilde{z})(\beta+\delta)^2}\left[a - \frac{(n+2)(2n+1)}{2n(n+2-\tilde{z})}bL\right]L + \frac{n(n+\frac{1}{2})\delta t^2}{b(2n+1)} > 0 \tag{3.71}$$

which is strictly positive if the initial competitive wage is strictly positive.

Union sector profits:

$$\frac{\partial n\pi}{\partial \beta} = \frac{(n+1)\delta}{(n+2-\tilde{z})(\beta+\delta)^2}\left[a - \frac{(n+1)(2n+1)}{2n(n+2-\tilde{z})}bL\right]L + \frac{n(n+\frac{1}{2})\delta t^2}{b(2n+1)} > 0 \tag{3.72}$$

which is strictly positive if the initial union wage is strictly positive.

Comparative statics of profits with respect to credit friction parameter δ

Non-union sector profits:

$$\frac{\partial n\pi^c}{\partial \delta} = -\frac{(n+2)\beta}{(n+2-\tilde{z})(\beta+\delta)^2}L\left[a - \frac{(2n+1)(n+2)}{2n(n+2-\tilde{z})}bL\right] + \frac{n(n+\frac{1}{2})(\beta+2\delta)t^2}{b(2n+1)} \tag{3.73}$$

The sign of the derivative now depends on the level of trade costs t. However, for $t = 0$ profits unambiguously decrease in δ if the initial competitive wage is strictly positive.

Union sector profits:

$$\frac{\partial n\pi}{\partial \delta} = -\frac{(n+1)\beta}{(n+2-\tilde{z})(\beta+\delta)^2}L\left[a - \frac{(2n+1)(n+1)}{2n(n+2-\tilde{z})}bL\right] + \frac{n(n+\frac{1}{2})(\beta+2\delta)t^2}{b(2n+1)} \tag{3.74}$$

The sign of the derivative now depends on the level of trade costs t. However, for $t = 0$ profits unambiguously decrease in δ if the initial union wage is strictly positive.

Chapter 4

The effects of rising trade with China and Eastern Europe on local government budgets in Germany

Abstract

This paper analyzes the causal effects of rising German trade with China and Eastern Europe on local government budgets in Germany during the period 1992–2006. The variation in the local industry structure is used to identify regional differences in the exposure to international trade with China and Eastern Europe, both referred to as the East. Various income and expenditure categories of German municipalities at the district level are analyzed employing an instrumental variables approach. I find at least mild evidence of "winners" and "losers" in terms of budget revenues and expenditures. While the effects are absent or weak for municipalities' operational income and spending, I do identify certain revenue sources and expenditure categories of local governments, which are significantly affected by being exposed to trade with the East. In particular, business tax income is lower in districts with high import exposure, as is spending for community streets and sports. In general, the effects are small and more clear-cut in spending categories where local governments have substantial leeway in budgeting and the execution of their duties.

4.1 Introduction

Governments collect taxes and use the revenue to provide public goods or redistribute wealth through transfers among citizens. This mechanism is not limited to national or state governments but also includes local governments. According to Glaeser (2013), in the United States "local governments differ from state and national governments because there are vastly more of them and because they specialize in delivering quite tangible services, like public safety and education, to taxpayers who generally pay for them." (p.196) This holds true for German municipalities, the country's lowest layer of government, whose responsibilities include traffic, education, public transit, sports facilities, cultural programming, housing infrastructure and social security services. Because local governments provide "quite tangible services," the local fiscal health directly affects the living conditions they offer. This view is supported by Gyourko and Tracy (1991), who find that intercity fiscal differentials as well as amenity differentials in the United States influence the quality of life across urban areas. Therefore, an analysis of the revenues and expenditures of German local governments is motivated by the fact that they are beneficial to the well-being of their citizens.

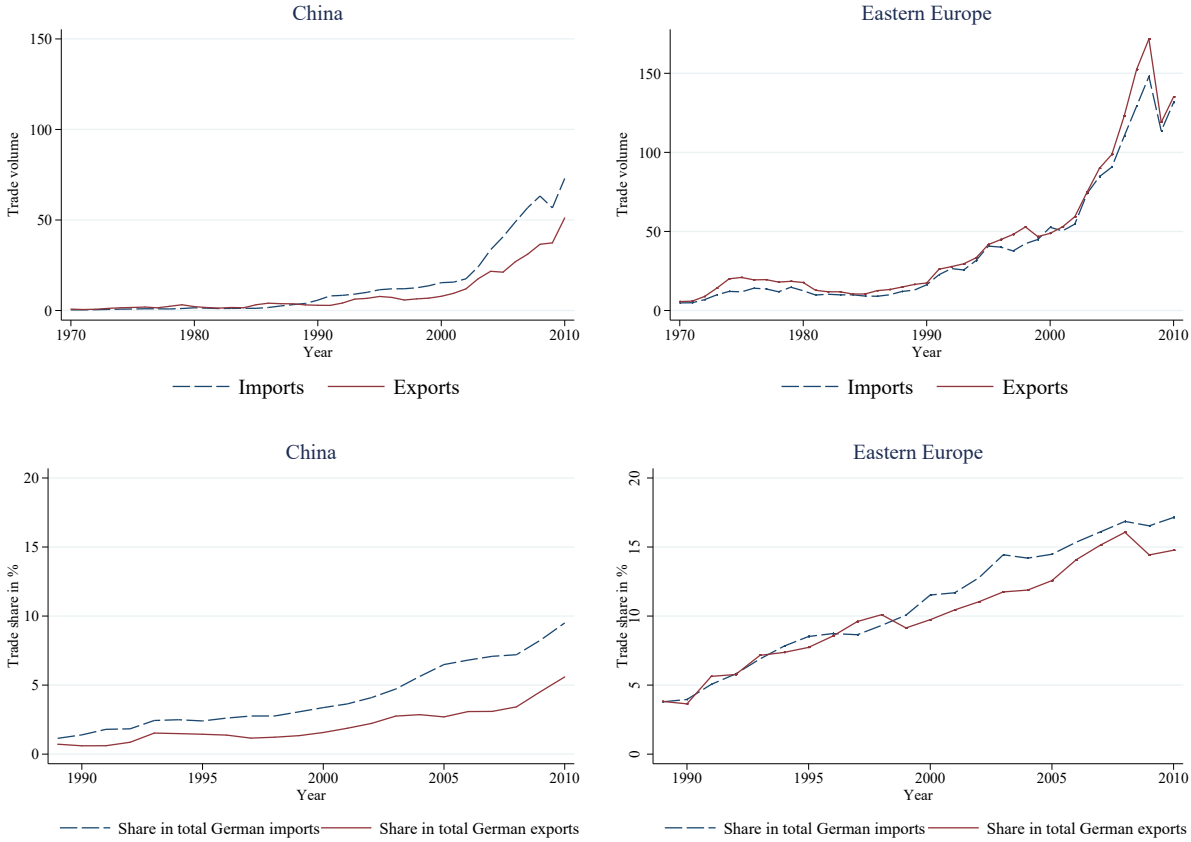
In this paper, I analyze the effects of rising international trade between Germany and China and Eastern Europe on the income and spending of German local governments. I construct measures of local import and export exposure using employment data from the Institute for Employment Research (IAB) and product-level trade flows from United Nations Comtrade Database to estimate the effects on various municipal income and spending components during the period 1992–2006. The data on municipal budgets is provided by the German Research Data Center (RDC). I aggregate and examine the municipal variables at the district level.

The analysis of the trade effects is restricted to trade with the China and Eastern Europe for reasons of identification. When China and Eastern Europe entered international markets, big, new players appeared suddenly. These players were not only a competitive source but they also offered great export opportunities for German firms. As Figure 4.1 highlights trade volumes rose steeply after 1990. Further, the relative importance of trade with these regions to Germany increased during this period. I refer to both regions China and Eastern Europe as *the East*. In order to identify a causal relationship between international trade flows and local government budgets, I employ a two-stage least squares (2SLS) approach instrumenting the German trade flows with the East with a basket of other high-income countries' trade flows with China and Eastern Europe.

I quantify how regional exposure to international trade becomes apparent in German municipality budgets. I show that there is a regional relationship between high import exposure and decreased municipal revenues. Specifically, per capita business tax income is lower in districts with high import exposure, as is spending for community streets and sports. I argue that these effects are more clear in spending categories where local governments have substantial leeway in budgeting and the execution of their duties. Furthermore, I find that the institutional setting (i.e. the fact that German municipalities rely heavily on funding by state transfers) mitigated the effects of trade exposure on per capita revenues of municipal governments.

This paper is structured as follows: Section 4.2 provides a brief review of related literature; section 4.3 gives an overview of the institutional background; section 4.4 proposes hypotheses based on this institutional background; section 4.5 presents the econometric specification and data; section 4.6 presents and discusses the statistical results; and section 4.7 presents my conclusion.

Figure 4.1: German trade with China and Eastern Europe



Notes: The figure shows German trade volumes with China and Eastern Europe in billion EUR of 2005 and trade shares of China and Eastern Europe in total German imports and exports.
Source: UN Comtrade database, own calculations.

4.2 Related literature

This section reviews the related literature, which analyzes the effects of international trade on regional labor markets. A well-known study by Autor et al. (2013) finds negative employment effects on the United States' manufacturing setcor, after it was exposed to competition from imports. Similarly, Dauth et al. (2014) examine regional employment effects of rising German trade with China and Eastern Europe in the manufacturing industry. Specifically, they find that manufacturing employment increased in regions with export-oriented industries but decreased in regions exposed to competition from imports. However, the positive employment effects outweigh the negative. Additionally, Dauth and Südekum (2016) show that local differences in exposure to international trade explain regional employment growth rates in Germany, while Dauth et al. (2018) analyze the distributional effects of international trade exposure among manufacturing workers, finding that high-skilled workers benefit from increased exposure to exports, whereas exposure to imports mostly hits low-skilled workers. In contrast, Felbermayr et al. (2018) employ and estimate a structural model to explore the effects of trade, product and labor market reforms. According to the authors, the increase in German wage dispersion cannot be explained by the increase in international or labor market reforms but by increased product market competition. Apart from the regional effects of trade, there is the related question of how globalization's losers should be compensated at the national level. The welfare implications of redistribution via tax-transfers to mitigate increasing income inequality arising from international trade are studied by Antràs et al. (2017), who find that, in the United States, "trade-induced increases in dispersion of disposable income reduce the gains from trade by about 20 %." (p. 407)

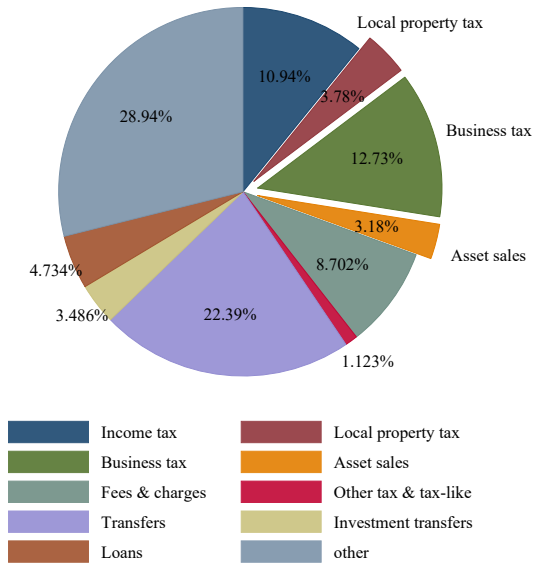
Many other studies have contributed to recent literature that empirically examines the budgets of local governments in Germany. Christofzik and Kessing (2018) find that a temporary withdrawal of fiscal oversight, due to an accounting reform, led to a significant increase in per capita debt in the German state of North Rhine-Westphalia. They conclude that fiscal oversight and the enforcement of fiscal rules are important to restrain debt levels. Egger and Köthenbürger (2010) find a positive causal impact of council size on municipal spending in Bavaria. They also discover only weak empirical evidence of partisan effects on municipal spending. Similarly, Riedel et al. (2016) find only mild partisan effects on per capita spending, as right-wing councils spent more on recreation and sports and less on social services. In contrast, Rösel (2017b) does not find that partisan alignment of supervisors and local councils affects deficits. However, he does find that left-wing supervisors tolerate higher budget deficits than right-wing supervisors. Recent studies searching for empirical evidence on the efficiency of municipal mergers in terms of expenditure reductions obtain mixed results. Baskaran and Blesse (2016) study municipal mergers in the German state of Brandenburg and find significant reductions in administrative costs in the case of compulsory mergers but no cost effects in the municipalities, which merged voluntarily. Rösel (2017a) examines municipal mergers in the German state of Saxony but does not find any significant expenditure reductions after those mergers. Baskaran (2014) studies potential tax mimicking of municipalities in Lower Saxony in response to tax increases in North Rhine-Westphalia; he finds mixed effects depending on the employed estimation framework.

To my knowledge, the effects of trade exposure on local government budgets have not been addressed so far. Therefore, it remains an open question whether differential effects of regional import and export exposure can be found.

4.3 Institutional background

Municipalities form the lowest level of government in Germany. Article 28, paragraph 2, of the German constitution awards them jurisdiction to govern their own affairs within federal and state laws. This includes the right of budgetary autonomy. However, as municipalities execute many duties delegated from higher governmental levels they rely heavily on transfer funding. Further, municipalities also participate in a redistribution scheme between the state government and communities within a state, the embodiments of which are heterogeneous across states (Zimmermann, 2009).[1] Figure 4.2 shows that transfers add up to a share of 22.39 % of total revenues in municipalities in Western Germany between 1992–2006. In general, these income flows cannot be directly influenced by decisions of the municipal councils but are the result of collective negotiations between municipalities and higher governments. Another main income source for municipalities is personal income tax, which accounts for almost 11 % of the total revenue. Municipalities receive 15 % of personnel income tax revenues within a state but have no power to decide on tax rates (Zimmermann, 2009). Besides minor income sources, municipal councils have the power to affect the following income sources: (i) property taxes, (ii) taxes on local business income, and (iii) asset sales such as land, real estate, etc. (Bogumil and Holtkamp, 2006). These income shares are highlighted in Figure 4.2 and form a total share of approximately 22 % of total revenues. This means that German communities can, in fact, autonomously influence only less than a quarter of their total income.

Figure 4.2: Local government income components 1992–2006



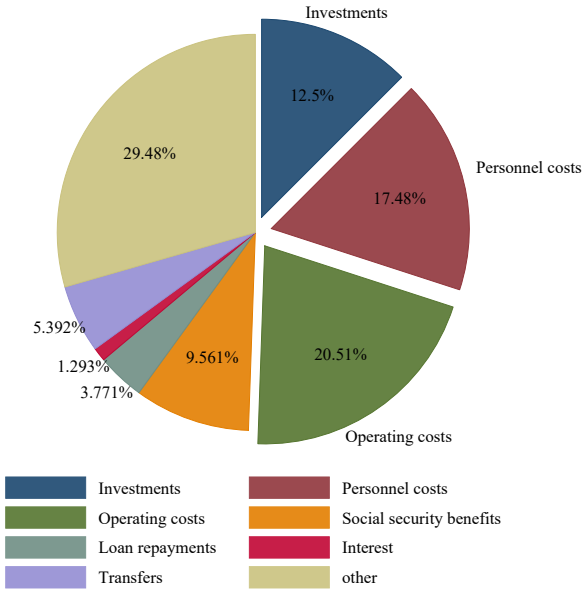
Notes: The figure shows income component shares of municipalities at the district level in West German federal states, excluding city states, between 1992 - 2006.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, Jahresrechnungsstatistik der Gemeinden und Gemeindverbände, own calculations.

Regarding the expenditure side of municipal budgets, Figure 4.3 shows that (i) investments, (ii) personnel and (iii) operating costs add up to a share of 50 % of total expenditures. According to Bogumil and Holtkamp (2006), municipalities can influence these expenditure types directly.[2] However, as noted earlier, municipalities are constrained in their budgeting decisions as they must also execute duties

[1] Zimmermann (2009) provides a detailed overview of the community redistribution scheme in Germany.
[2] Note that Figure 4.3 shows expenditure types by cost, whereas Figure 4.4 shows expenditure shares by area of municipal responsibility.

delegated from the state or federal government. These duties can be separated into duties with autonomy over spending levels and duties that have to be executed according to instructions by higher governments (Bogumil and Holtkamp, 2006). In the first case, municipalities are free to decide how to perform these duties; in the latter, they are not. In addition, there are responsibility areas in which municipalities have significant leeway in their budgeting and execution, such as general public administration; science, culture and education; health, sports and recreation; construction, housing and traffic infrastructure (Riedel et al, 2016; Christofzik and Kessing, 2018). Figure 4.4 shows expenditure-shares by these and other responsibility areas and highlights those areas with considerable discretionary budgeting, which add up to a share of 22 % of total expenditures. This qualifies the previously mentioned share of 50 % of total expenditures, which according to Bogumil and Holtkamp (2006), can be directly influenced by municipal councils and shows that the financial autonomy of German local governments is, in fact, limited.

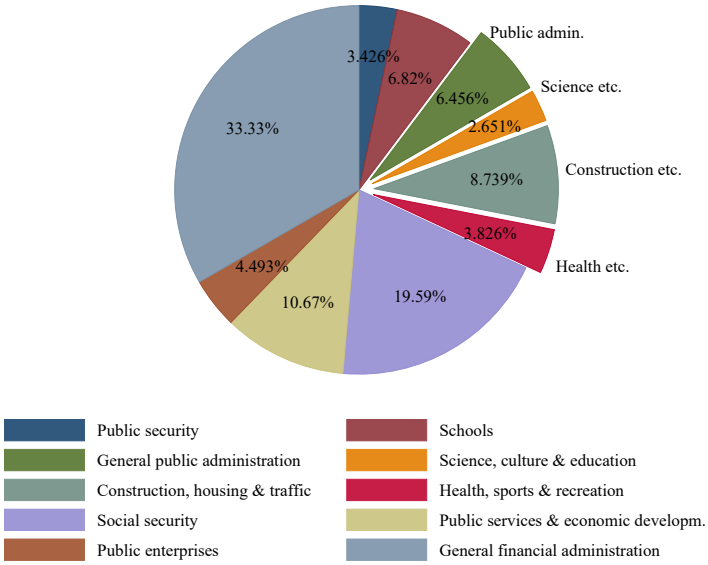
Figure 4.3: Local government expenditure components 1992–2006



Notes: The figure shows expenditure component shares of municipalities at the district level in West German federal states, excluding city states, between 1992 - 2006.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, Jahresrechnungsstatistik der Gemeinden und Gemeindverbände, own calculations.

As is common in federally organized countries, there might be huge differences across regions when it comes to spending levels on various responsibility areas. The governments of Germany's federal states play a central role in this context, as they can decide which duties are delegated to municipalities (Bogumil and Holtkamp, 2006). When duties are delegated, state governments will have to compensate municipalities at least partly. Thus, municipal differences in spending and income between states are very likely. This is illustrated by Figures 4.6 and 4.7 in Appendix 4.A, which show average revenues and expenditures per capita across districts by state. Municipal differences in spending and income between states do not necessarily reflect that municipalities in these countries are rich or poor. Further, one can see a timely correlation in these figures. This is also true for detailed expenditure areas as depicted by Figure 4.9. These issues have to be kept in mind and addressed by state and year fixed effects when analyzing income and spending variables among municipalities.

Figure 4.4: Local government expenditures by responsibility area 1992–2006



Notes: The figure shows expenditure component shares by responsibility area of municipalities at the district level in West German federal states excluding city states between 1992 - 2006. The responsibility area groups are constructed according to the federal structure (*Bundesgliederungsnummern*).
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, Jahresrechnungsstatistik der Gemeinden und Gemeindverbände, own calculations.

4.4 Hypotheses on international trade exposure and local government budgets in Germany

As exposure to international trade with the East increases both risk and opportunity at the regional level, trade might have positive effects in regions with export-oriented industries, as they will have access to larger markets. On the other hand, some industries are exposed to higher import competition in their home markets. Based on the insights from section 4.3 the following hypotheses on municipal spending and income can be formulated:

> ***Hypothesis (H1):*** *High export exposure to trade with the East has a positive effect on the operational per capita (a) revenues and (b) expenditures of municipalities at the district level.*

> ***Hypothesis (H2):*** *High import exposure to trade with the East has a negative effect on the operational per capita (a) revenues and (b) expenditures of municipalities at the district level.*

The revenue side of a municipal budget is expected to be affected by trade shocks through various channels, for instance business or income tax revenues. I claim that the expenditure side is driven by constraints on the income side because common wisdom tells us that politicians are likely to spend the resources they receive. Further, local governments are not allowed to make operational deficits (Bogumil and Holtkamp, 2006), although these deficits frequently occur nevertheless.

We also know from section 4.3 that municipalities carry out duties delegated from higher governments. Spending on these duties might dominate other responsibility area expenditures, which could mitigate the potential effects of trade exposure on the municipality's overall spending. It is likely that resources are shifted from responsibility areas where they have substantial leeway in the execution of their duties and budgeting to other, necessary spending categories. Inspired by Riedel et al. (2016), hypotheses $H1$ and $H2$ are modified to expenditures separated by municipalities' responsibility areas:

Hypothesis (H3): *High export exposure to trade with the East has a positive effect on expenditure areas where local governments have substantial discretionary leeway in budgeting and execution.*

Hypothesis (H4): *High import exposure to trade with the East has a negative effect on expenditure areas where local governments have substantial discretionary leeway in budgeting and execution.*

4.5 Empirical approach

I construct regional measures of average per worker import and export exposure in order to analyse their effects on municipal income and spending components. My identification strategy is closely related to the studies of Autor et al. (2013) and Dauth et al. (2014). Dauth et al. (2014) modify the Autor et al.'s (2013) approach and estimate the effect of German trade with China and Eastern Europe[3] on manufacturing employment in Germany. Consider first the measure of import exposure to trade with China and Eastern Europe of a German district i at time t.[4] The import exposure, ImE_{it}, is a weighted average of an industry j's imports from the East divided by regional employment L_{it}. The expression $Im_{jt}^{GER-East}$ denotes an industry j's national imports, which are weighted by the employment share a region i has in the national employment of this particular industry, denoted by L_{ijt}/L_{jt}. This is formally expressed by:

$$ImE_{it}^{GER-East} = \sum_j \frac{L_{ijt}}{L_{jt}} \frac{Im_{jt}^{GER-East}}{L_{it}}. \tag{4.1}$$

Analogously, the measure of the regional export exposure can be expressed as:

$$ExE_{it}^{GER-East} = \sum_j \frac{L_{ijt}}{L_{jt}} \frac{Ex_{jt}^{GER-East}}{L_{it}}. \tag{4.2}$$

These measures can be interpreted as regional average trade exposure per worker but please note that the used weights do not add up to one, as L_{ijt}/L_{it} would have only added up to one when adding up all industry sectors j present in region i, but I additionally divide international trade flows of a given industry j by the overall (national) employment in that industry L_{jt}. Furthermore, the term L_{ijt}/L_{it} does not provide a complete partition of a region $i's$ employment structure since I consider manufacturing employment in the L_{ijt} term only. Of course, L_{it} is total regional employment, including not only manufacturing but all other sectors in order to measure the relative importance of manufacturing trade flows in the region i.

The measures of regional trade exposure exploit the variation of industry employment across regions in Germany. However, this variable (industry employment) might already be affected by international competition between Germany and the East. To address this concern, I follow a 2SLS strategy and use employment shares lagged by 10 years starting in 1982 to construct the instruments. Further, I want to identify the supply shock exerted by the rising competitiveness of the East. As this supply shock didn't hit only Germany but also all the other trading partners of the East, I use imports of a basket of other countries from the East, as did Dauth et al. (2014). As the authors note, these countries have a comparable income to Germany but are not direct neighbors and are not members of the European

[3]The former and current trading partners from Eastern Europe examined are: Azerbaijan, Bulgaria, Belarus, Czechoslovakia, Czechia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Rep. Of Moldova, Poland, Romania, Russian Federation, Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, the USSR and Uzbekistan.

[4]Index i denotes German districts. Therefore, I need to aggregate municipal variables at the district level.

Monetary Union.[5] To identify the exogenous component of the rising competitiveness of the East, the following instrument is constructed:

$$ImE_{it}^{Instr} = \sum_j \frac{L_{ijt-1}}{L_{jt-1}} \frac{Im_{jt}^{IG-East}}{L_{it-1}}. \tag{4.3}$$

Similarly, the instrument for rising export exposure of German regions is given by:

$$ExE_{it}^{Instr} = \sum_j \frac{L_{ijt-1}}{L_{jt-1}} \frac{Ex_{jt}^{IG-East}}{L_{it-1}}. \tag{4.4}$$

The particular demand effect of China and Eastern Europe has to be captured, as opposed the rising competitiveness of German enterprises. Because the East exerted a demand shock on all countries including the instrument group, the export exposure instrument captures the demand-driven effect of rising export opportunities in the East (Dauth et al., 2014). The instrument extracts the demand-driven part of the variation of the German trade flows with the East, since this is what the German and instrument group trade flows should have in common.

The econometric baseline specification takes the following form:

$$ln(\ Y_{it}\ ) = \beta_0 + \beta_1\ ln(\ ImE_{it}\ ) + \beta_2\ ln(\ ExE_{it}\ ) + X'_{it}\beta_3 + \epsilon_{it}, \tag{4.5}$$

where X_{it} is a set of control variables (see Table 4.4) and Y_{it} are various categories of per capita revenues and expenditures of German municipalities aggregated at the district level (*Kreise & kreisfreie Städte*) (see Table 4.5). The equation (4.5) is estimated by 2SLS employing instruments (4.3) and (4.4) as described above. In order to account for regional differences across German states and potential business cycle effects, I add state and year fixed effects and a state-year interaction term. In contrast to my approach, Dauth et al. (2014) employ a two-period first difference specification, which is equivalent to an individual fixed effects estimation.

4.5.1 Data

Data on the budget variables of local governments is obtained from RDC of the Federal Statistical Office and Statistical Offices of the Länder. This dataset contains highly disaggregated information on revenue and expenditure types of the public budgets of Germany's lowest governmental level (*Gemeinden*) from 1992-2006. The data on municipal revenues and expenditures of core operating and capital budgets is aggregated at the district level (*Kreise*) in order to merge it with the employment dataset. Data on municipality associations (*Gemeindeverbände*) is included only if it can be unambiguously attributed to districts. The data is of administrative origin and, thus, highly reliable.

Regional sectoral employment data is provided by the IAB-Establishment History Panel (*Betriebs-Historik-Panel*, BHP; Eberle and Schmucker, 2017). The German industry classification (Wirtschaftszweige 1993 three-digit codes) is equivalent to NACE rev. 1 three-digit codes and is available from 1978 onwards. I use this information from 1982-2006. As the BHP is of administrative origin as well, the data quality can be viewed as very high. It builds on social security data and contains a representative 50 % sample of all German establishments, that employ at least one socially secured employee.

I use data on trade flows from the UN Comtrade Database at the four-digit SITC rev. 3 product level. Industry and product classifications are harmonized using correspondence tables provided by Eurostat RAMON, and 73% of all the classified products can be unambiguously matched to their industries. As

[5] The instrument group (IG) consists of Australia, Canada, Japan, Norway, New Zealand, Sweden, Singapore, and the United Kingdom.

the analysis is restricted to manufacturing industries, even 79% of the products can be unambiguously matched to their industries. Trade flows of ambiguous cases are partitioned into equal shares.

Further, data on unemployment, population and area at the district level is collected from the German Federal Employment Agency (*Bundesagentur für Arbeit*, BA), the Federal Statistical Office (*Destatis*) and the Federal Institute for Research on Building, Urban Affairs and Spatial Development (*Bundesinstitut für Bau-, Stadt- und Raumforschung*, BBSR).

As the district territorial status in all datasets except for the BHP is corresponding to the actual district status at the time of observation, I generate a territorial status which is comparable throughout the whole observation period. Fortunately, the complete BHP dataset is based on the 2014 territorial status and the regions of the remaining datasets are manipulated such that they agree. For Western German districts, only a few changes were necessary, and it is possible to almost perfectly match all variables to the new district status. In contrast, Eastern German federal states conducted major district territory reforms after the German reunification in 1990 (Brandenburg 1993; Saxony 1994, 1996, 2008; Saxony-Anhalt 1994, 2007; Thuringia 1994). As these reforms might have affected the budget variables of merging local governments, Eastern Germany is excluded from the analysis. Furthermore, Eastern Germany experienced a de-industrialization after the German reunification (Dauth et al., 2014). This might cause an additional lack of comparability of Eastern and Western German municipalities at the district level.

4.5.2 Descriptive statistics

Having already described the increasing relevance of China and Eastern Europe as trading partners (highlighted by Figure 4.1), it is also important to describe which of Germany's industry sectors were exposed to trade with these countries. Table 4.1 shows that motor vehicles, related products and special machinery are Germany's most important exports. The same is true for both destinations China and Eastern Europe.[6] The most important products imported from China and Eastern Europe are rather different, with electronic products and children's toys from China and cars, car parts and furniture from Eastern Europe (Dauth et al., 2014).

In general, manufacturing products are the most important product category in terms of value in the German trade balance with China and Eastern Europe. The share of German manufacturing exports in total exports to the East is 98 % and the respective import share is 83 % between 1992–2006.

Further, the regional distribution of potentially affected manufacturing industries and workers across Germany is of interest. Figure 4.5 illustrates graphically the trade exposures calculated according to equations 4.1 and 4.2, which are averaged over the observation period. A large heterogeneity of import and export exposures across space is apparent, and these measures seem to be correlated (correlation = 0.8691). Additional differences appear when comparing trade exposures between the two regions of origin and destination, respectively.[7] Trade exposure to China is less important than to Eastern Europe.

Additionally, I provide descriptive statistics for all employed dependent, control and trade exposure variables in Appendix 4.A. These numbers indicate a large heterogeneity of German districts in various dimensions, e.g. populatios range from 34,842 in Zweibrücken, Germany's smallest urban district, to Munich with 1,294,608 inhabitants; the standard deviation is 149,425.5. Also the variation of employment structure variables is noteworthy, as, for instance, the employment share of routine occupations ranges from 26.5% to 64.7%, with an average of 42.6% and a standard deviation of 5.2 percentage points.

[6] See Tables 4.6 and 4.7 in Appendix 4.A for further details.
[7] See Figures 4.11 and 4.12 in Appendix 4.A for further details.

Table 4.1: Top-5 German manufacturing product trade flows with China and Eastern Europe

Exports to Eastern Europe and China

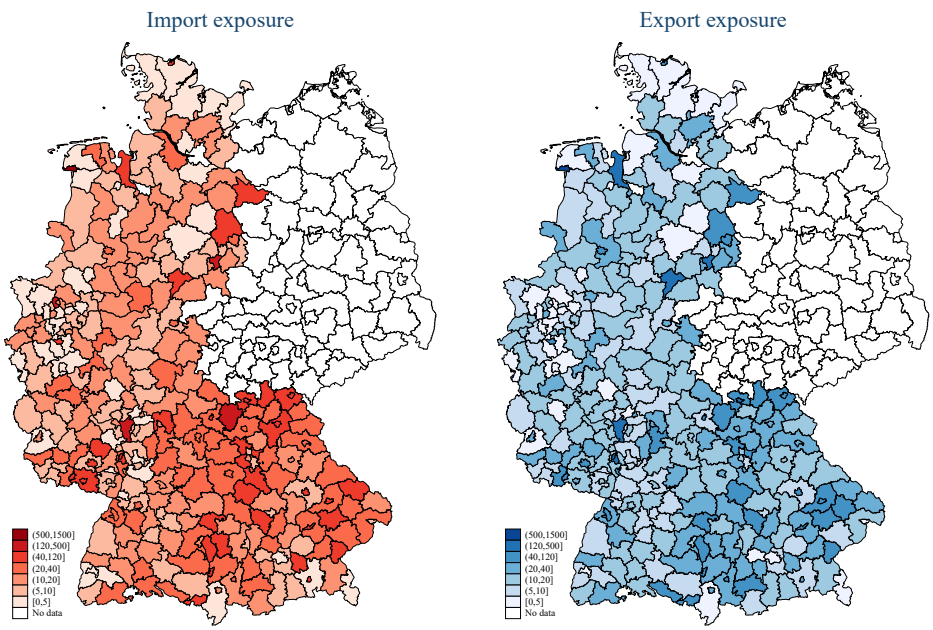
SITC	Product	1992–2006	1992–1999	1999–2006
7812	Motor vehicles for the transport of persons, n.e.s.	48.50	13.00	35.50
7843	Other parts and accessories of the motor vehicles	42.00	7.55	34.50
9310	Special transactions and commodities not classified according to kind	27.00	9.08	17.90
7284	Machinery and mechanical appliances specialized for particular industries, n.e.s.	20.70	7.19	13.50
7139	Parts, n.e.s, for the internal combustion piston engines	17.30	2.40	14.90

Imports from Eastern Europe and China

SITC	Product	1992–2006	1992–1999	1999–2006
7812	Motor vehicles for the transport of persons, n.e.s.	33.80	5.36	28.40
7843	Other parts and accessories of the motor vehicles	32.30	4.30	28.00
7132	Internal combustion piston engines for propelling vehicles	26.30	3.51	22.80
8211	Seats, whether or not convertible into beds, and parts thereof	22.30	6.07	16.30
7731	Insulated wires, etc. and electric conductors	21.70	5.30	16.40

Notes: The table shows product level trade flows in billion EUR of 2005 cumulated over the respective time periods. The SITC 4-Digit product classes are ranked according to their cumulated values over the period 1992–2006.
Source: UN Comtrade database, own calculations.

Figure 4.5: Average manufacturing trade exposure to the East 1992–2006



Notes: The figure shows average yearly per worker import and export exposures to trade of manufacturing products with China and Eastern Europe in EUR of 2005 between 1992 and 2006.
Source: UN comtrade, IAB BHP, own calculations.

4.6 Regional exposure to international trade with the East and the effects on municipality budgets

I analyse various dependent variables of German municipalities at the district level, ranging from aggregate per capita revenues and expenditures to very specific income and spending components, such as business tax revenues or expenditures for community streets.[8] All subsequent regressions employ the same set of control variables, which are described in detail in the Appendix 4.A. The starting point is an analysis of trade effects with the East on operational per capita revenues and expenditures. More detailed budget components will be examined thereafter.

I find at least weak statistical evidence of the effect of increasing import competition from China and Eastern Europe on the financial conditions of local governments in Germany. The institutional setting in Germany mitigates the effects of trade exposure on municipality budgets, but significant trade exposure effects remain even after transfers.

4.6.1 Benchmark specification: municipal revenues and expenditures

The analysis of municipal budgets focuses on the administrative or operational budges as those contain ongoing revenues and expenditures of a local government.[9] In contrast, capital budgets contain income and spending components which affect a municipality's assets.[10]

Table 4.2 reports the results of regressions where per capita revenues in the administrative budget of districts is the dependent variable. The regressions provide weak statistical evidence that increasing import competition of China and Eastern Europe affected the financial conditions of local governments in Germany. The results of the first three regression models in Table 4.2 seem to confirm hypotheses $H1a$) and $H2a$), as coefficients of the import and export exposure measure are statistically significant, with the expected negative sign for import and positive sign for export exposure. However, the export exposure coefficient becomes insignificant when adding control variables, state and year fixed effects to the regression model. Further, the import exposure coefficient shrinks in absolute value in this specification and is weakly significant at a 10 % significance level only. According to the model in column 5 a 1 % increase of regional per worker import exposure from the East decreases a municipality's per capita revenues by an average of approximately 0.03 %, *ceteris paribus*. Thus, a district of average income and population size would have lowered administrative budget revenue by 118,677 EUR, additional redistributional effects not taken into account. The corresponding first-stage results of the regressions in Table 4.2 are provided by Table 4.3. It can be concluded that the instruments using other high-income countries' trade flows are relevant.

When subtracting general transfers (e.g. key transfers from the state, equalization payments from the redistribution scheme, etc.), one can expect trade exposure effects to be more pronounced. This is, indeed, confirmed by comparing the respective coefficients of Table 4.12 in Appendix 4.B, where general transfers are subtracted from the dependent variable, with the respective coefficients from Table 4.2. I find that the import and export exposure coefficients are of greater absolute size. Therefore, the institutional setting in Germany, that is the significant share of transfer funding, mitigates the trade exposure effects on municipality budgets; though relatively small - statistically significant trade exposure effects remain even after transfers. Additionally, Table 4.13 shows that no statistically significant coefficients can be obtained for the expenditure side of municipal budgets.

[8] An overview of dependent variables is presented in Table 4.5 in Appendix 4.A.

[9] See Bogumil & Holtkamp 2006, Table 6, p. 55.

[10] Table 4.11 in the Appendix reports additional results for the capital and total budget, but coefficients remain insignificant in contrast to revenues in the administrative budget.

As German municipalities rely heavily on funding from higher governments, especially state transfers, I argue that potential trade exposure effects are less clear in terms of overall per capita income and spending but are more likely to be present in the detailed revenue and expenditure categories analyzed in the following sections.

4.6.2 Further insights: municipal revenue and expenditure types

In order to gain further insights into the potential channels and effects of trade exposure on the incomes and spending of municipalities, the analysis continues with specific expenditure and income types. According to hypotheses $H3$ and $H4$, there might be a differential effect on expenditure categories with and without leeway in budgeting and execution. I argue that potential trade exposure effects are likely to be present in these expenditure types. In a last step, specific income components are analyzed to get an idea of which ones might drive the results obtained above.

Specific municipal expenditure types

The analysis of expenditures by municipal responsibility area reported in Table 4.14 in the Appendix shows that a negative relation between import exposure and expenditures for the categories "public security", "social security" and "construction, housing & traffic". Further, there is a positive relationship between export exposure and expenditures for "public security", "culture & science", "health, sports & recreation" and "construction, housing & traffic". But many of the coefficients are only significant at the 10 % significance level. Caution is required when one concludes that these results reflect the quality of local services and goods within these categories. Not only is per capita spending nothing more than a potential proxy for quality, it also includes administration costs attributed to these spending categories. It is also important to consider that these spending categories include expenditures for delegated duties from higher governments and, thus, the results might not be exclusively driven by the autonomous decisions of municipalities. However, comparing the results so far does invite the conclusion that there are negative and positive budgetary effects of import and export exposure, and that there might be some spending categories where these effects are more clear, since local governments are likely to have more budgetary leeway in those categories than in others.

In order to shed more light on this, Table 4.15 reports regression results of expenditures for local sports (e.g. local sporting fields and swimming pools) and community streets. These spending categories have a clear discretionary scope, as they are non-delegated duties. In the case of sports, engagement by municipalities in this category is voluntary. Moreover, public streets and sports yards are, indeed, "quite tangible services" as Glaeser (2013) would call them. An increase of import exposure by 1% is on average associated with a decrease of per capita spending for community sports by approximately 0.1 %, *ceteris paribus*. In the case of community streets, municipalities are obliged to maintain these but have clear discretionary scope here as well; by law municipalities have to build and maintain community streets according to their "capacity."[11] This obviously leaves some room for interpretation. Column 2 shows a statistically negative significant import exposure coefficient and an at least weakly significant positive coefficient of average per worker export exposure to trade with the East, providing some evidence in favor of hypotheses $H3$ and $H4$.

[11] See §9 StrWG NRW, Straßenbaulast, accessed March 13, 2019, `https://recht.nrw.de/lmi/owa/br_text_anzeigen?v_id=2320100122085732243`.

Table 4.2: International trade effects on revenues of the administrative budget

	Dependent variable: logarithmic revenues of the administrative/core budget per capita					
	(1)	(2)	(3)	(4)	(5)	(6)
	2SLS	2SLS	2SLS	2SLS	2SLS	OLS
ln(import exposure(GER-East))	-0.0960^{***}	-0.0421^{**}	-0.0932^{***}	-0.0287^{*}	-0.0297^{*}	-0.0189^{*}
	(0.0223)	(0.0192)	(0.0199)	(0.0173)	(0.0172)	(0.0110)
ln(export exposure(GER-East))	0.0890^{***}	0.0428^{**}	0.0732^{***}	0.0101	0.0116	0.00657
	(0.0227)	(0.0218)	(0.0186)	(0.0203)	(0.0204)	(0.0128)
area		0.0000824^{***}		-0.00000111	0.00000171	0.00000497
		(0.0000173)		(0.0000182)	(0.0000182)	(0.0000162)
population density		0.0000449^{**}		0.0000356^{*}	0.0000334	0.0000362^{*}
		(0.0000194)		(0.0000210)	(0.0000213)	(0.0000215)
unemployment %		0.0356^{***}		0.0146^{**}	0.0179^{**}	0.0171^{**}
		(0.00562)		(0.00664)	(0.00703)	(0.00709)
routine occupations %		-0.0263^{***}		-0.0170^{***}	-0.0168^{***}	-0.0174^{***}
		(0.00439)		(0.00387)	(0.00386)	(0.00384)
qualified occupations %		-0.0314^{***}		-0.0168^{***}	-0.0168^{***}	-0.0168^{***}
		(0.00428)		(0.00412)	(0.00411)	(0.00422)
semiprof. & technical occupations %		-0.0284^{***}		-0.0168^{***}	-0.0169^{***}	-0.0173^{***}
		(0.00640)		(0.00569)	(0.00569)	(0.00570)
foreigners empl. %		0.00733^{***}		0.0000757	0.00113	0.00119
		(0.00222)		(0.00232)	(0.00236)	(0.00242)
female empl. %		0.00488^{***}		-0.00157	-0.00109	-0.000542
		(0.00125)		(0.00201)	(0.00203)	(0.00172)
constant	7.615^{***}	9.803^{***}	7.747^{***}	9.342^{***}	9.258^{***}	9.270^{***}
	(0.0284)	(0.452)	(0.0570)	(0.372)	(0.374)	(0.385)
State dummy	–	–	*Yes*	*Yes*	*Yes*	*Yes*
Time dummy	–	–	*Yes*	*Yes*	*Yes*	*Yes*
State x time inter.	–	–	–	–	*Yes*	*Yes*
Observations	4830	4830	4830	4830	4830	4830

Notes: N = 4830 with 322 districts. All regression models include a constant. Both first stage as well as the second stage include the same set of control variables. Standard errors clustered at the district level are given in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.3: First stage results: international trade effects on revenues of the administrative budget

	(1) 2SLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) OLS
First stage, dependent variable: ln(import exposure (GER-East))						
ln(import exposure (Intsr.))	0.6494***	0.6478***	0.6407***	0.5860***	.5879***	–
	(0.0357)	(0.0322)	(0.0378)	(0.0318)	(0.0325)	–
ln(export exposure (Instr.))	0.2077***	0.1062***	0.2044***	0.0756**	0.0802**	–
	(0.0380)	(0.0334)	(0.0369)	(0.0330)	(0.0335)	–
R-Squared	0.7220	0.7717	0.7651	0.8089	0.8126	–
F-test of excl. inst.	543.74	537.59	379.22	317.38	316.70	–
First stage, dependent variable: ln(export exposure (GER-East))						
ln(import exposure (Instr.))	0.2083***	0.2040***	0.1909***	0.1410***	0.1397***	–
	(0.0328)	(0.0316)	(0.0336)	(0.0316)	(0.0324)	–
ln(export exposure (Instr.))	0.5921***	0.4965***	0.5896***	.4531***	0.4566***	–
	(0.0367)	(0.0358)	(0.0348)	(0.0356)	(0.0361)	–
R-Squared	0.6881	0.7420	0.7420	0.7948	0.7969	–
F-test of excl. inst.	461.11	395.16	378.12	227.29	224.92	–
Cragg-Donald Wald F stat.	1646.33	1324.985	1714.23	1270.22	1252.68	–

Notes: N = 4830 with 322 districts. All regression models include a constant. Both first stage as well as the second stage include the same set of control variables. The critical value for the Cragg-Donald Wald F statistic with two endogenous regressors, two excluded instruments and 10% maximal IV size at the 5% significance level is 7.03 (see Stock and Yogo, 2005, Table 5.2, p. 101).
Standard errors clustered at the district level are given in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Revenue types of municipalities

Turning to the analysis of the income components of German municipalities, a negative relationship between regional import exposure and the categories "property tax B", "business tax" and "other tax" income can be found (see Tables 4.16 and 4.17). The term "basic amount" for business and property taxes means that those tax revenues were corrected by the local assessment rate. Municipalities can set these assessment rates, which raise the effective tax rates. In order to make those tax-income categories comparable across municipalities, the basic amount is calculated according to: $basic\,amount = 100 \cdot \frac{tax\ rev.}{assessment\ rate}$. The import exposure coefficient is of higher significance and higher absolute value when I perform a regression with actual business tax revenue compared to the basic amount of the business tax as a dependent variable. Based on the results in Table 4.17, an increase in import exposure by 1% is associated with approximately 0.12 % lower average per capita business tax revenues, *ceteris paribus*.

4.6.3 Robustness and discussion

Relevance and exclusion restriction of the IV approach

Table 4.3 provides the first-stage results of the benchmark regressions, with total per capita revenues in the administrative budget of municipalities as a dependent variable. It proves that the instruments constructed using other high-income countries' trade flows to instrument for the German regional import and export exposure are relevant. Dauth et al. (2014) "expect correlations in demand and supply shocks between Germany and those countries, and possible independent effects of shocks in those countries on German local labor markets, to be relatively modest." (p.1649) I agree with this viewpoint and additionally expect potential independent effects of shocks in the instrument group countries on German local government budgets to be even smaller. Therefore, I claim that the exclusion restriction in this paper's specification is more likely to be met than in Dauth et al. (2014). However, it can still be argued that the exclusion restriction is not fulfilled because lagged regional and industry employment shares are used to construct the instruments. As regional industry employment might be very persistent and correlated with factors other than trade exposure affecting municipal budgets, a violation of the exclusion restriction cannot be completely ruled out. To mitigate this potential problem, the regressions include variables that explicitly control for the regional employment structure based on Blossfeld's 12-scale classification of occupations. Including these variables strongly decreases significance levels of the trade exposure measures, but the analysis, nevertheless, shows still some (at least weak) statistically significant results.

Robustness

The results obtained using 2SLS are robust compared to a standard OLS specification, as Table 4.2 shows. Further, as my main interest in carrying out the econometric analysis is the sign of the regional trade exposure coefficients and not the actual coefficient size, the results are robust against including several control variables that weaken significance levels (see Table 4.18). Even controlling explicitly for the regional employment structure leaves some significant results. The employment structure control variables might potentially measure the same trade effects as the trade exposure measures. Additionally, I control explicitly for sector employment in the manufacturing, services and financial industries, and this process delivers similar results (see Table 4.19).

However, the robustness of the obtained results is weakened by the inclusion of district and year fixed effects, rendering the trade exposure coefficients insignificant (see Table 4.20). This might be an indication of unobserved heterogeneity across districts. But it is more likely that this is simply the result of little variation within the district level over the observation period. A glance at the point estimates in

column 1 reveals that the size of the export exposure coefficient is twice as large as the import exposure coefficient; this is at least roughly in line with the idea that export-exposed municipalities perform better than import-exposed counterparts. In the specifications without district fixed effects, including state and year fixed effects, as well as a state-year interaction term, decreases significance levels but leaves me with at least weakly significant results. This enables me to identify the regional pattern and provide at least some weak statistical evidence for the relation between regional exposure to international trade with the East and the budget conditions of local governments in Germany.

4.7 Conclusion

This paper analyzes the causal effect of Germany's rising trade with China and Eastern Europe on local government budgets during the period 1992–2006. I use the variation of the local industry structure to identify regional differences in exposure to international trade with the East, which rose steeply in the 1990s and gained also in importance relative to Germany's other trading partners.

The analysis of various municipal income and spending variables at the district level reveals heterogeneous effects across Germany. I find at least mild evidence of "winner" and "loser" municipalities in terms of per capita budget revenues and expenditures. While the effects are absent or only weak for per capita operational income and spending, I do identify certain revenue sources and expenditure categories significantly affected by exposure to trade with the East. In particular, per capita business tax income is lower in districts with high import exposure, as is spending for community streets and sports. I argue that these effects are more clear-cut in spending categories where local governments have substantial leeway in budgeting and the execution of their duties. However, overall effects are small. Furthermore, I find that the institutional setting, especially the fact that German municipalities rely heavily on funding from state transfers, mitigates the trade exposure effects on the per capita revenues of municipal budgets.

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Appendix

4.A Descriptive statistics

Tables

Table 4.4: Control variables

Variable name	Description	Source / Dataset
area	district area in square km	Federal Institute for Research on Building, Urban Affairs and Spatial Development
population	population of districts, used to transform variables in per capita values	Federal statistical office and the statistical offices of the Länder / Regionalstatistik
population density	Population per square km	Federal statistical office and the statistical offices of the Länder Federal Institute for Research on Building, Urban Affairs and Spatial Development
unemployment %	share of unemployment in total population	Federal Employment Agency and Federal statistical office and the statistical offices of the Länder
routine occupations %	share of routine occupations in total employment, routine occupations contains the following occupational groups classified by Blossfeld (1987): agricultural, unskilled manual, unskilled services, unskilled commercial and administrational occupations	Research Data Centre of the Federal Employment Agency / BHP
qualified occupations %	share of qualified occupations in total employment, qualified occupations contains the following occupational groups classified by Blossfeld (1987): skilled manual, skilled service and skilled commercial and administrational occupations	Research Data Centre of the Federal Employment Agency / BHP
semiprof & technical occupations %	share of semiprofessions and technicians as classified by Blossfeld (1987) in total employment	Research Data Centre of the Federal Employment Agency / BHP
highskill occupations %	share of engineers, professions and managers as classified by Blossfeld (1987) in total employment (left out to prevent perfect multicollinearity)	Research Data Centre of the Federal Employment Agency / BHP
foreigners employed %	share of employed foreigners in total employment	Research Data Centre of the Federal Employment Agency / BHP
female employment %	share of female employment in total employment	Research Data Centre of the Federal Employment Agency / BHP
financial employment %	share of financial sector employment in total employment	Research Data Centre of the Federal Employment Agency / BHP
service employment %	share of service sector employment in total employment	Research Data Centre of the Federal Employment Agency / BHP
manufacturing employment %	share of manufacturing sector employment in total employment	Research Data Centre of the Federal Employment Agency / BHP

Notes: Variables are based on own calculations.

Table 4.5: Dependent variables

Variable name	Description	Source / Dataset
revenues of the administrative budget	the administrative budget contains revenues which do not affect a municipality's assets, e.g. taxes, fees, general transfers, etc.	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
revenues of the capital budget	the capital budget contains revenues which affect a municipality's assets, e.g. asset sales	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
revenues of the total budget	sum of revenues of the admin. and capital budget	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
expenditures of the administrative budget	the administrative budget contains expenditures which do not affect a municipality's assets, e.g. wages, maintenance of buildings, interest rates etc.	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
expenditures of the capital budget	the capital budget contains expenditures which affect a municipality's assets, e.g. investment in companies and property	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
expenditures of the total budget	sum of expenditures of the admin. and capital budget	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
expenditures for public security	expenditures for public security in the administrative budget	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
expenditures for schools	expenditures for schools in the administrative budget	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
expenditures for culture & science	expenditures for culture & science in the administrative budget	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
expenditures for health, sports & recreation	expenditures for health, sports & recreation in the administrative budget	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
expenditures for social security	expenditures for social security in the administrative budget	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
expenditures for construction, housing & traffic	expenditures for construction, housing & traffic in the administrative budget	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
expenditures for community sports	expenditures for support of sports, community owned sports yards and swimming pools in the administrative budget (note that this is a sub-category of health, sports & recreation above)	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
expenditures for community streets	expenditures for community streets, street cleaning, lighting and parking areas in the administrative budget (note that this is a sub-category of construction, housing & traffic above)	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
property tax A (basic amount)	basic amount of property tax A, $basic\ amount = 100 \cdot \frac{tax\ rev.}{assessment\ rate}$	Realsteuervergleich
property tax B (basic amount)	basic amount of property tax B, $basic\ amount = 100 \cdot \frac{tax\ rev.}{assessment\ rate}$	Realsteuervergleich
income tax revenues	amount of income tax revenues kept by municipalities	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
key transfers	general key transfers paid by the state	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
value added tax	amount of VAT revenues kept by municipalities	Realsteuervergleich
other tax revenues	other taxes, e.g. dog tax, beverage tax, hunting & fishing tax, etc.	Jahresrechnungsstatistik der Gemeinden und Gemeindverbände
business tax (basic amount)	basic amount of business tax, $basic\ amount = 100 \cdot \frac{tax\ rev.}{assessment\ rate}$	Realsteuervergleich
business tax income	actual business tax income kept by municipalities	Realsteuervergleich

Notes: All dependent variables are transformed into per capita values. Variables are based on own calculations.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder

Table 4.6: Top-5 German manufacturing product trade flows with China

Exports to China

SITC	Product	1992–2006	1992–1999	1999–2006
7843	Other parts and accessories of the motor vehicles	9.92	2.11	7.82
7284	Machinery and mechanical appliances specialized for particular industries, n.e.s.	9.53	3.31	6.22
7812	Motor vehicles for the transport of persons, n.e.s.	9.15	1.77	7.38
9310	Special transactions and commodities not classified according to kind	5.92	2.61	3.31
7924	Aeroplanes and other aircraft, mechanically propelled (other than helicopters), of an unladen weight exceeding 15000 kg	4.33	0.07	4.27

Imports from China

SITC	Product	1992–2006	1992–1999	1999–2006
7643	Transmission apparatus for radio-telephony, radio-telegraphy, radio-broadcasting or television, whether or not incorporating reception apparatus or sound recording or reproducing apparatus	11.80	0.06	11.70
7522	Digital automatic data processing machines containing in the same housing at least a central processing unit and an input and output unit whether or not combined	8.98	0.02	8.97
7526	Input or output units, whether or not presented with the rest of a system and whether or not containing storage units in the same housing	8.86	0.91	7.95
7599	Parts and accessories (other than covers, carrying cases and the like) suitable for use solely	7.04	1.16	5.88
8942	Children's toys	5.65	2.39	3.26

Notes: The table shows product level trade flows in billion EUR of 2005 cumulated over the respective time periods. The SITC 4-Digit product classes are ranked according to their cumulated values over the period 1992–2006.
Source: UN Comtrade database, own calculations.

Table 4.7: Top-5 German manufacturing product trade flows with Eastern Europe

Exports to Eastern Europe

SITC	Product	1992–2006	1992–1999	1999–2006
7812	Motor vehicles for the transport of persons, n.e.s.	39.30	11.20	28.10
7843	Other parts and accessories of the motor vehicles	32.10	5.45	26.70
9310	Special transactions and commodities not classified according to kind	21.10	6.47	14.60
7139	Parts, n.e.s, for the internal combustion piston engines	15.40	2.16	13.30
5429	Medicaments, n.e.s.	12.80	3.76	9.08

Imports from Eastern Europe

SITC	Product	1992–2006	1992–1999	1999–2006
7812	Motor vehicles for the transport of persons, n.e.s.	33.70	5.36	28.30
7843	Other parts and accessories of the motor vehicles	31.60	4.27	27.30
7132	Internal combustion piston engines for propelling vehicles	26.30	3.48	22.80
8211	Seats, whether or not convertible into beds, and parts thereof	21.30	5.96	15.30
7731	Insulated wires, etc. and electric conductors	21.04	5.04	15.40

Notes: The table shows product level trade flows in billion EUR of 2005 cumulated over the respective time periods. The SITC 4-Digit product classes are ranked according to their cumulated values over the period 1992–2006.
Source: UN Comtrade database, own calculations.

Table 4.8: Descriptive statistics of dependent variables

	obs	mean	sd	min	max
revenues administrative budget	4830	2041.696	379.6321	1205.123	4960.337
revenues admin. budget excl. general transfers	4830	1543.256	421.3661	710.6935	4626.106
revenues capital budget	4830	606.1237	255.3221	78.01409	4222.542
revenues total budget	4830	2647.742	463.4176	1484.577	9182.879
expenditures admin. budget	4830	2144.591	468.0829	1218.543	5116.275
expenditures capital budget	4830	585.819	223.9241	67.52648	4922.238
expenditures total budget	4830	2730.41	508.5849	1588.894	9859.2
expenditures public security (admin.)	4830	75.65472	37.20805	17.62038	249.6554
expenditures schools (admin.)	4830	145.8762	45.14101	31.54428	530.2904
expenditures culture, science (admin.)	4830	56.84495	48.49074	4.690616	452.3525
expenditures social security (admin.)	4830	492.1512	237.0312	105.7652	1714.358
expenditures health, sports & recreation (admin.)	4830	74.21868	27.97373	14.77185	275.2285
expenditures construction, traffic & housing (admin.)	4830	140.949	46.83907	58.59833	711.1391
expenditures community sports (admin.)	4827	38.07702	18.0102	.0649374	158.5831
expenditures community streets (admin.)	4830	108.1576	40.7874	18.48814	825.4348
property tax A (basic amount)	3861	1.87506	1.503694	.0309217	7.93655
property tax B (basic amount)	3864	30.42377	5.937776	16.667	58.71261
business tax (basic amount)	3864	90.70721	52.38502	12.16225	906.6154
income tax (basic amount)	3864	300.1214	68.70111	3.901898	577.4688
value added tax (basic amount)	2883	32.65562	17.16483	9.900114	227.7794
business tax revenue	3863	255.3001	167.9983	44.06359	2048.964
key transfers (state)	4776	242.5554	102.1416	8.18e-06	643.2186
other tax revenues	4830	29.24885	23.20598	.4200173	242.4868

Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, own calculations.

Table 4.9: Descriptive statistics of control variables

	obs	mean	sd	min	max
area	4830	767.9702	534.2463	35.7	2882.05
population	4830	193756.1	149425.5	34842	1294608
density	4830	552.5818	683.2669	41.15343	4166.746
unemployment %	4830	3.901877	1.220801	1.237287	9.607164
routine occupations %	4830	42.62477	5.22791	26.46797	64.70524
qualified occupations %	4830	40.60967	3.776946	24.60053	52.8031
semiprof & technical occupations %	4830	10.86957	2.303857	4.688362	22.37481
highskill occupations %	4830	5.274674	2.396209	1.698864	20.06273
foreigners employed %	4830	7.097568	3.725243	.8707483	20.589
female employment %	4830	45.5045	5.532925	19.10032	59.84658
financial sector employment %	4601	3.0712	2.083778	.3352292	19.28301
service sector employment %	4830	8.373817	4.510419	1.031347	29.70496
manufacturing sector employment %	4830	29.8963	11.08918	5.792446	73.7337

Source: IAB BHP, BBSR, RDC of the Federal Statistical Office and Statistical Offices of the Länder, own calculations.

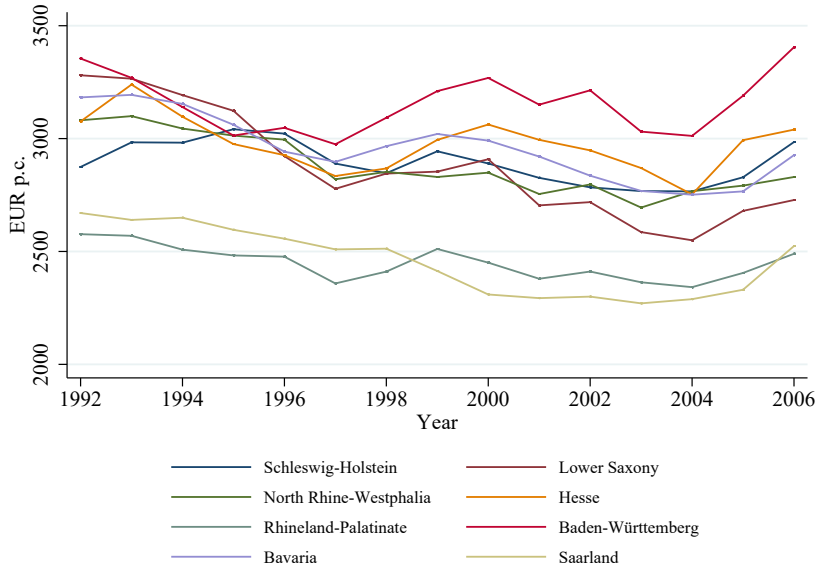
Table 4.10: Descriptive statistics of trade exposure variables

	obs	mean	sd	min	max
Import exposure: Germany - China	4830	5.290187	11.99335	.0448274	316.166
Import exposure: Germany - Eastern Europe	4830	19.62479	68.44516	.2125526	1820.828
Import exposure: Germany - China & Eastern Europe	4830	24.83445	72.41551	.2573799	1825.075
Export exposure: Germany - China	4830	4.125775	14.81141	.0438982	474.6941
Export exposure: Germany - Eastern Europe	4830	22.68101	72.6352	.3511944	2126.531
Export exposure: Germany - China & Eastern Europe	4830	26.79824	85.70259	.4369888	2601.225
Import exposure: instrument group - China	4830	32.9238	54.86958	.1867175	810.2915
Import exposure: instrument group - Eastern Europe	4830	9.326868	28.51793	.056193	1008.39
Import exposure: instrument group - China & Eastern Europe	4830	42.24285	68.16544	.2938764	1255.877
Export exposure: instrument group - China	4830	27.47749	60.02199	.201423	1075.104
Export exposure: instrument group - Eastern Europe	4830	13.20727	78.54001	.1427877	3316.748
Export exposure: instrument group - China & Eastern Europe	4830	40.68476	125.5168	.3442106	4226.708

Source: UN comtrade, IAB BHP, own calculations.

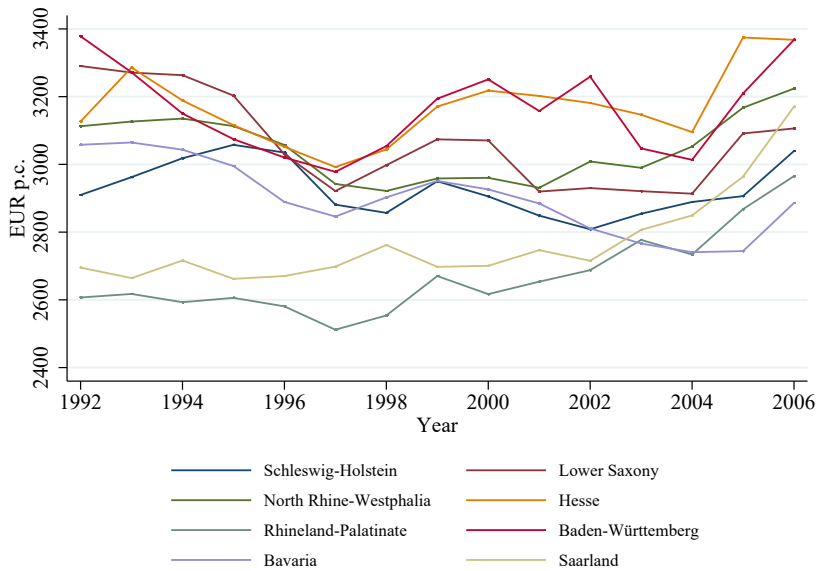
Figures

Figure 4.6: Average revenues per capita



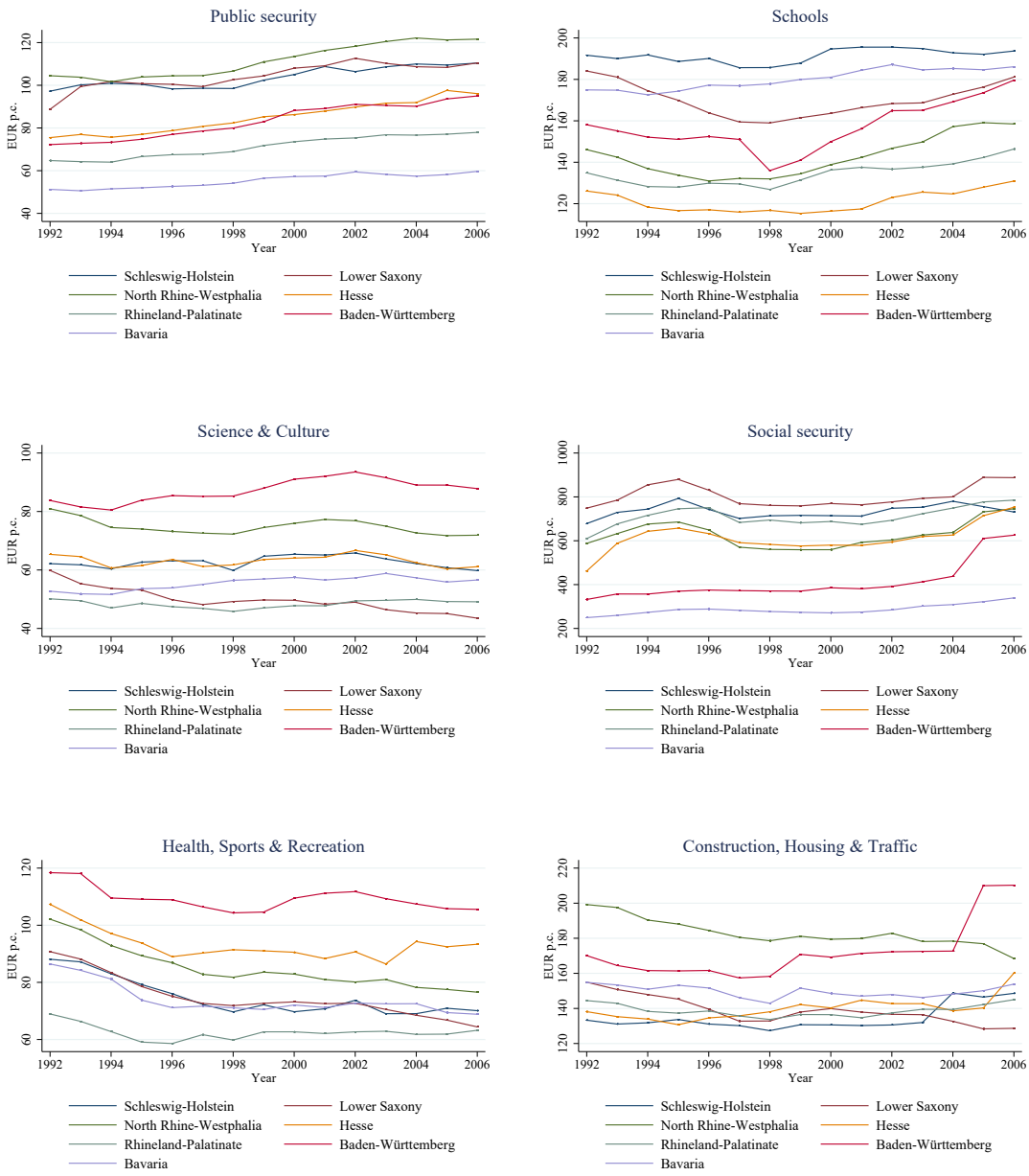
Notes: The figure shows average revenues per capita of municipalities at the federal state level in EUR of 2005 between 1992 and 2006.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, Jahresrechnungsstatistik der Gemeinden und Gemeindverbände, own calculations.

Figure 4.7: Average expenditures per capita



Notes: The figure shows average expenditures per capita of municipalities at the federal state level in EUR of 2005 between 1992 and 2006.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, Jahresrechnungsstatistik der Gemeinden und Gemeindverbände, own calculations.

Figure 4.8: Average expenditures per capita by responsibility area

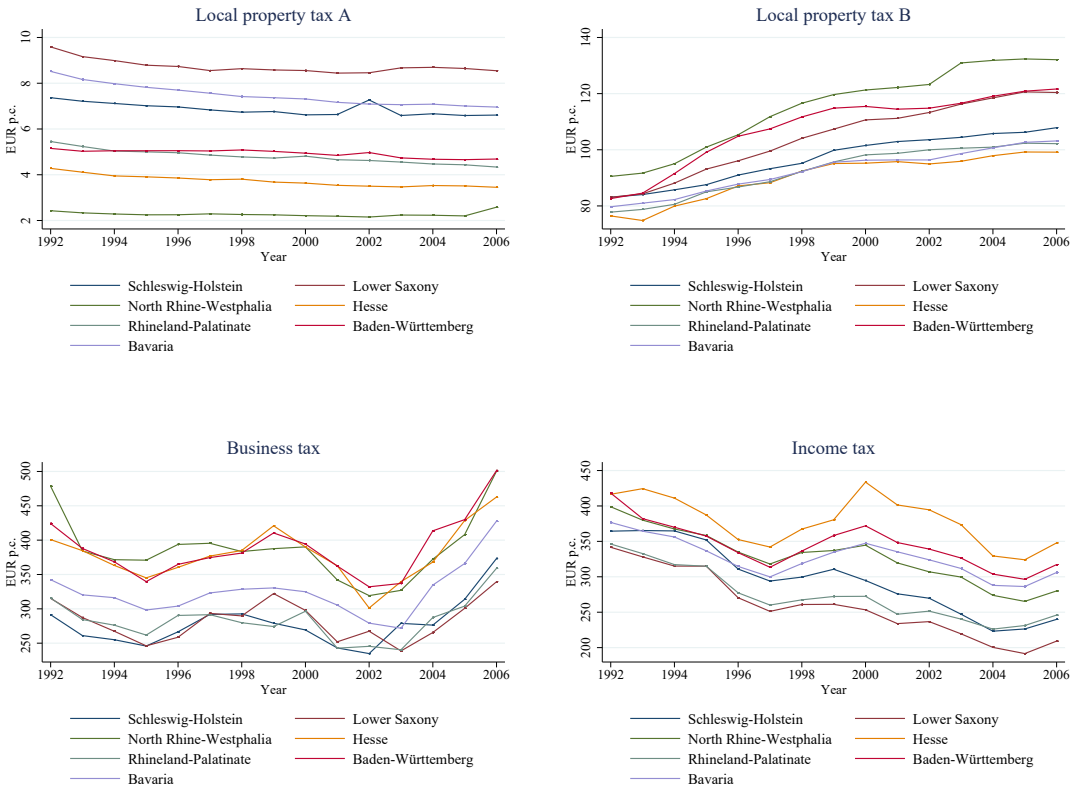


Notes: The figure shows average expenditures per capita in the administrative budget of municipalities at the federal state level by responsibility area in EUR of 2005 between 1992 and 2006.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, Jahresrechnungsstatistik der Gemeinden und Gemeindverbände, own calculations.

Figure 4.9: Average expenditures per capita with discretionary budgeting

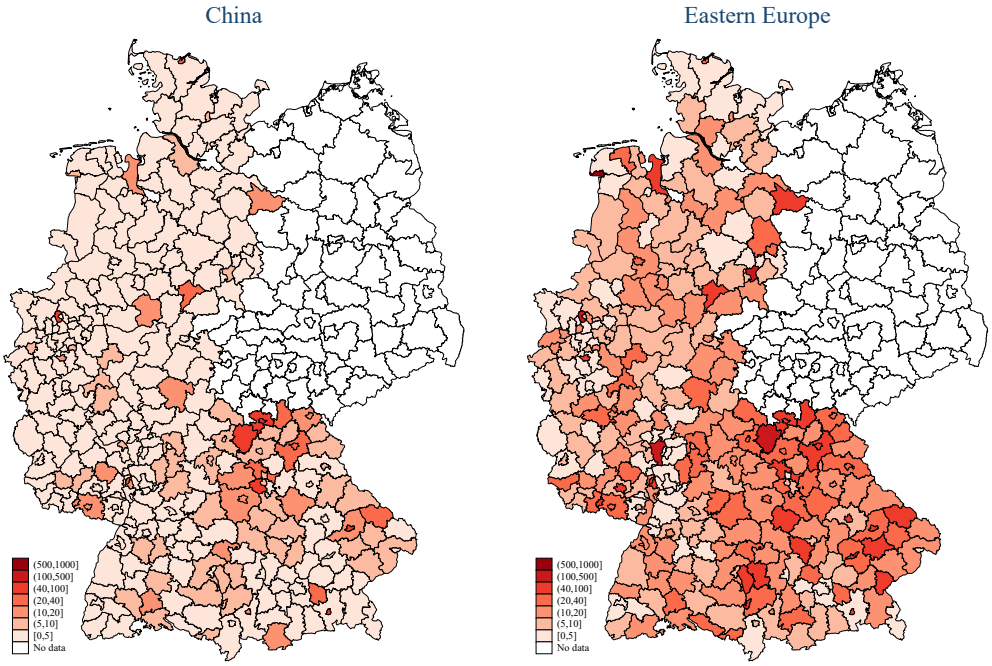
Notes: The figure shows average expenditures per capita in the administrative budget of municipalities at the federal state level by sub-responsibility area in EUR of 2005 between 1992 and 2006. Note that "community sports" and "community streets" are subcategories of "health, sports & recreation" and "construction, housing & traffic" respectively.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, Jahresrechnungsstatistik der Gemeinden und Gemeindverbände, own calculations.

Figure 4.10: Average tax revenues per capita by tax type



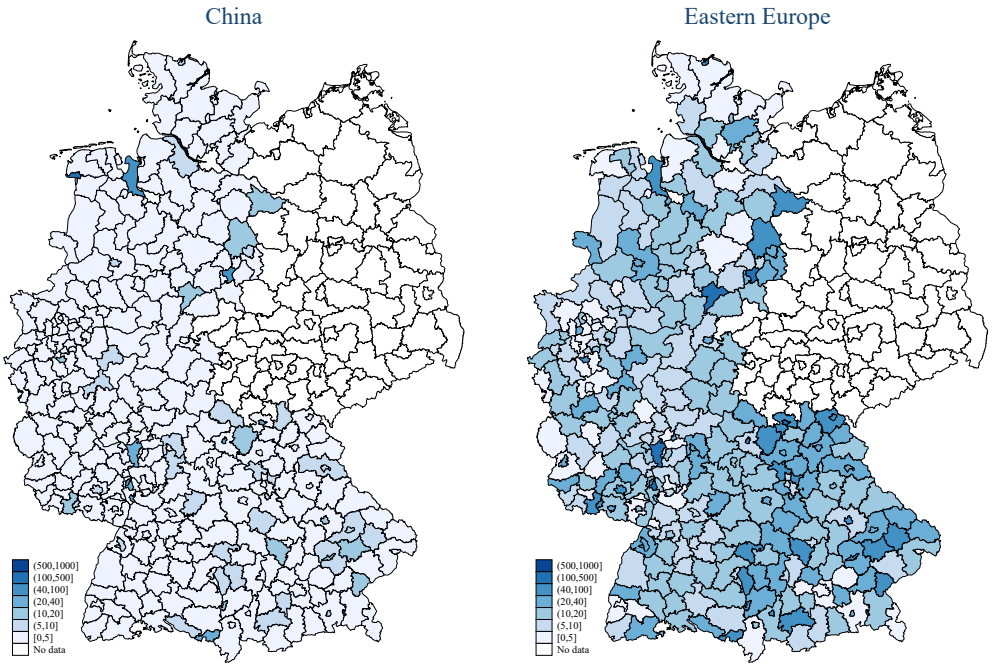
Notes: The figure shows average revenues per capita of communities at the federal state level by income type in EUR of 2005 between 1992 and 2006.
Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, Jahresrechnungsstatistik der Gemeinden und Gemeindverbände, own calculations.

Figure 4.11: Average manufacturing import exposure 1992–2006



Notes: The figure shows average yearly per worker import exposures to trade of manufacturing products with China and Eastern Europe in EUR of 2005 between 1992 and 2006.
Source: UN comtrade, IAB BHP, own calculations.

Figure 4.12: Average manufacturing export exposure 1992–2006



Notes: The figure shows average yearly per worker export exposures to trade of manufacturing products with China and Eastern Europe in EUR of 2005 between 1992 and 2006.
Source: UN comtrade, IAB BHP, own calculations.

4.B Regression analysis

Table 4.11: Effects on revenues of the administrative, capital and total budget

	Dependent variable: ln(revenues per capita)		
	administrative budget	capital budget	total budget
	(1)	(2)	(3)
ln(import exposure(GER-East))	-0.0297^{*}	0.0205	-0.0149
	(0.0172)	(0.0295)	(0.0175)
ln(export exposure(GER-East))	0.0116	-0.0354	-0.00306
	(0.0204)	(0.0359)	(0.0203)
area	0.00000171	0.0000689^{*}	0.0000160
	(0.0000182)	(0.0000365)	(0.0000195)
population density	0.0000334	0.0000182	0.0000322
	(0.0000213)	(0.0000344)	(0.0000215)
unemployment %	0.0179^{**}	-0.0396^{***}	0.00467
	(0.00703)	(0.0150)	(0.00723)
routine occupations %	-0.0168^{***}	-0.0137	-0.0155^{***}
	(0.00386)	(0.00939)	(0.00461)
qualified occupations %	-0.0168^{***}	-0.00818	-0.0140^{***}
	(0.00411)	(0.00982)	(0.00474)
semiprof. & technical occupations %	-0.0169^{***}	-0.0277^{**}	-0.0180^{***}
	(0.00569)	(0.0130)	(0.00648)
foreigners empl. %	0.00113	-0.0109^{**}	-0.00159
	(0.00236)	(0.00424)	(0.00231)
female empl. %	-0.00109	-0.00656^{*}	-0.00285
	(0.00203)	(0.00357)	(0.00201)
constant	9.258^{***}	7.777^{***}	9.433^{***}
	(0.374)	(0.895)	(0.439)
State dummy	*Yes*	*Yes*	*Yes*
Time dummy	*Yes*	*Yes*	*Yes*
State x time inter.	*Yes*	*Yes*	*Yes*
Observations	4830	4830	4830

Notes: The table shows second stage results of 2SLS regressions, where the variables ln(import exposure (GER-East)) and ln(export exposure (GER-East)) are instrumented by logarithmic import and export exposures using other countries' trade flows with the East. Both first stage as well as the second stage include the same set of control variables. Standard errors clustered at the district level are given in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.12: Effects on revenues of the administrative budget without general transfers

	Dependent variable: logarithmic per capita revenues of the administrative/core budget minus general transfers					
	(1)	(2)	(3)	(4)	(5)	(6)
	2SLS	2SLS	2SLS	2SLS	2SLS	OLS
ln(import exposure(GER-East))	-0.207^{***}	-0.0709^{***}	-0.208^{***}	-0.0569^{**}	-0.0572^{**}	-0.0315^{**}
	(0.0309)	(0.0250)	(0.0307)	(0.0225)	(0.0224)	(0.0142)
ln(export exposure(GER-East))	0.204^{***}	0.0867^{***}	0.188^{***}	0.0433	0.0446^{*}	0.0321^{*}
	(0.0322)	(0.0288)	(0.0298)	(0.0267)	(0.0268)	(0.0170)
area		0.0000270		-0.0000782^{***}	-0.0000759^{***}	-0.0000686^{***}
		(0.0000244)		(0.0000273)	(0.0000275)	(0.0000252)
population density		0.000115^{***}		0.0000976^{***}	0.0000963^{***}	0.000103^{***}
		(0.0000272)		(0.0000279)	(0.0000282)	(0.0000282)
unemployment %		0.0318^{***}		0.0123	0.0143	0.0125
		(0.00688)		(0.00850)	(0.00901)	(0.00906)
routine occupations %		-0.0320^{***}		-0.0221^{***}	-0.0220^{***}	-0.0234^{***}
		(0.00495)		(0.00473)	(0.00476)	(0.00486)
qualified occupations %		-0.0339^{***}		-0.0199^{***}	-0.0197^{***}	-0.0198^{***}
		(0.00509)		(0.00542)	(0.00545)	(0.00562)
semiprof. & technical occupations %		-0.0313^{***}		-0.0186^{***}	-0.0187^{***}	-0.0194^{***}
		(0.00724)		(0.00715)	(0.00722)	(0.00732)
foreigners empl. %		0.00915^{***}		0.00000540	0.000839	0.000961
		(0.00300)		(0.00318)	(0.00325)	(0.00332)
female empl. %		0.00629^{***}		-0.00179	-0.00131	-0.0000780
		(0.00185)		(0.00276)	(0.00281)	(0.00246)
constant	7.299^{***}	9.786^{***}	7.342^{***}	9.335^{***}	9.239^{***}	9.267^{***}
	(0.0417)	(0.532)	(0.0693)	(0.471)	(0.480)	(0.489)
State dummy	–	–	*Yes*	*Yes*	*Yes*	*Yes*
Time dummy	–	–	*Yes*	*Yes*	*Yes*	*Yes*
State x time inter.	–	–	–	–	*Yes*	*Yes*
Observations	4830	4830	4830	4830	4830	4830

Notes: N = 4830 with 322 districts. All regression models include a constant. Both first stage as well as the second stage include the same set of control variables. Standard errors clustered at the district level are given in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.13: Effects on expenditures of the administrative, capital and total budget

	Dependent variable: ln(expenditures per capita)		
	administrative budget	capital budget	total budget
	(1)	(2)	(3)
ln(import exposure(GER-East))	−0.0212	0.0103	−0.00991
	(0.0180)	(0.0287)	(0.0180)
ln(export exposure(GER-East))	0.0174	−0.0363	0.00202
	(0.0205)	(0.0350)	(0.0207)
area	0.0000253	0.0000772**	0.0000383*
	(0.0000195)	(0.0000357)	(0.0000200)
population density	0.0000533***	0.0000315	0.0000524***
	(0.0000192)	(0.0000334)	(0.0000199)
unemployment %	0.0471***	−0.0292**	0.0325***
	(0.00852)	(0.0135)	(0.00845)
routine occupations %	−0.0144***	−0.0127	−0.0132***
	(0.00365)	(0.00930)	(0.00433)
qualified occupations %	−0.0115***	−0.00850	−0.00961**
	(0.00371)	(0.00986)	(0.00447)
semiprof. & technical occupations %	−0.00759	−0.0304**	−0.0107*
	(0.00541)	(0.0128)	(0.00635)
foreigners empl. %	0.00623***	−0.0126***	0.00252
	(0.00233)	(0.00404)	(0.00231)
female empl. %	−0.00154	−0.00627*	−0.00299
	(0.00202)	(0.00341)	(0.00203)
constant	8.908***	7.769***	9.119***
	(0.347)	(0.889)	(0.415)
State dummy	*Yes*	*Yes*	*Yes*
Time dummy	*Yes*	*Yes*	*Yes*
State x time inter.	*Yes*	*Yes*	*Yes*
Observations	4830	4830	4830

Notes: The table shows second stage results of 2SLS regressions, where the variables ln(import exposure (GER-East)) and ln(export exposure (GER-East)) are instrumented by logarithmic import and export exposures using other countries' trade flows with the East. Both first stage as well as the second stage include the same set of control variables. Standard errors clustered at the district level are given in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.14: Effects on expenditures of the administrative budget by responsibility area

	Dependent variable: ln(expenditures per capita)					
	public security	schools	culture & science	social security	health, recreation etc.	construction, traffic etc.
	(1)	(2)	(3)	(4)	(5)	(6)
ln(import exposure(GER-East))	-0.122^{***}	-0.0199	-0.0823	-0.0657^{**}	-0.0681	-0.0638^{*}
	(0.0365)	(0.0261)	(0.0518)	(0.0277)	(0.0446)	(0.0337)
ln(export exposure(GER-East))	0.106^{**}	0.000224	0.118^{*}	0.0468	0.102^{**}	0.0826^{*}
	(0.0447)	(0.0340)	(0.0655)	(0.0311)	(0.0520)	(0.0459)
area	-0.000129^{***}	0.00000404	-0.000170^{**}	-0.0000577^{*}	-0.0000395	-0.0000132
	(0.0000370)	(0.0000353)	(0.0000735)	(0.0000325)	(0.0000443)	(0.0000341)
population density	0.000209^{***}	0.0000577	0.000362^{***}	0.000162^{***}	0.000209^{***}	0.000113^{***}
	(0.0000392)	(0.0000446)	(0.0000737)	(0.0000289)	(0.0000327)	(0.0000388)
unemployment %	0.0726^{***}	-0.00350	0.0923^{***}	0.0604^{***}	0.0228	0.0693^{***}
	(0.0147)	(0.0138)	(0.0248)	(0.0112)	(0.0173)	(0.0132)
routine occupations %	-0.0262^{***}	-0.0119^{*}	-0.0676^{***}	-0.0172^{***}	-0.00986	-0.0197^{***}
	(0.00663)	(0.00662)	(0.0123)	(0.00516)	(0.00692)	(0.00553)
qualified occupations %	-0.0261^{***}	-0.0141^{*}	-0.0568^{***}	-0.0146^{**}	-0.0131	-0.0148^{**}
	(0.00765)	(0.00775)	(0.0144)	(0.00605)	(0.00868)	(0.00631)
semiprof. & technical occupations %	-0.00652	-0.00243	-0.0467^{**}	-0.00178	-0.0178	-0.0100
	(0.00988)	(0.0122)	(0.0184)	(0.00751)	(0.0119)	(0.00823)
foreigners empl. %	0.00340	-0.0129^{**}	-0.0129	0.00722^{**}	0.00480	-0.00411
	(0.00492)	(0.00526)	(0.00829)	(0.00345)	(0.00563)	(0.00383)
female empl. %	0.00368	-0.00303	0.0109	0.00166	-0.000802	0.00419
	(0.00401)	(0.00356)	(0.00684)	(0.00324)	(0.00489)	(0.00364)
constant	6.206^{***}	6.150^{***}	8.338^{***}	7.368^{***}	5.283^{***}	5.928^{***}
	(0.671)	(0.711)	(1.249)	(0.534)	(0.710)	(0.572)
State dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Time dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
State x time inter.	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	4830	4830	4830	4830	4830	4830

Notes: The table shows second stage results of 2SLS regressions, where the variables ln(import exposure (GER-East)) and ln(export exposure (GER-East)) are instrumented by logarithmic import and export exposures using other countries' trade flows with the East. Both first stage as well as the second stage include the same set of control variables. Standard errors clustered at the district level are given in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.15: Effects on expenditures with discretionary leeway

	Dependent variable: ln(expenditures per capita)	
	community sports	community streets
	(1)	(2)
ln(import exposure(GER-East))	-0.117^{**}	-0.0951^{**}
	(0.0560)	(0.0399)
ln(export exposure(GER-East))	0.0986	0.110^{**}
	(0.0685)	(0.0539)
area	−0.0000231	0.00000892
	(0.0000596)	(0.0000425)
population density	0.0000725	0.000102^{**}
	(0.0000564)	(0.0000416)
unemployment %	-0.0447^{*}	0.0812^{***}
	(0.0270)	(0.0172)
routine occupations %	−0.000181	−0.00771
	(0.0133)	(0.00653)
qualified occupations %	−0.00441	−0.0101
	(0.0152)	(0.00744)
semiprof. & technical occupations %	−0.0143	−0.00540
	(0.0211)	(0.00982)
foreigners empl. %	0.0152^{*}	-0.0107^{**}
	(0.00823)	(0.00483)
female empl. %	−0.00693	0.00874^{**}
	(0.00637)	(0.00425)
constant	4.528^{***}	4.640^{***}
	(1.333)	(0.679)
State dummy	*Yes*	*Yes*
Time dummy	*Yes*	*Yes*
State x time inter.	*Yes*	*Yes*
Observations	4827	4830

Notes: The table shows second stage results of 2SLS regressions, where the variables ln(import exposure(GER-East)) and ln(export exposure(GER-East)) are instrumented by logarithmic import and export exposures using other countries' trade flows with the East. Both first stage as well as the second stage include the same set of control variables. Standard errors clustered at the district level are given in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.16: Effects on revenue types of the administrative budget (Part I)

	Dependent variable: ln(revenues per capita)					
	property tax A (basic amount)	property tax B (basic amount)	income tax	key transfers (state)	value added tax	other tax revenues
	(1)	(2)	(3)	(4)	(5)	(6)
ln(import exposure(GER-East))	0.0719	-0.0708^{***}	-0.0220	0.0967	-0.0849	-0.0887^{**}
	(0.0766)	(0.0253)	(0.0163)	(0.0730)	(0.0595)	(0.0380)
ln(export exposure(GER-East))	-0.00769	0.0454	0.0341^{*}	0.0183	0.0614	0.0785^{*}
	(0.0878)	(0.0297)	(0.0198)	(0.0941)	(0.0710)	(0.0461)
area	0.000559^{***}	-0.0000973^{***}	-0.000102^{***}	0.000471^{*}	-0.000164^{**}	-0.0000277
	(0.0000844)	(0.0000236)	(0.0000192)	(0.000241)	(0.0000646)	(0.0000432)
population density	-0.000840^{***}	-0.00000707	0.00000172	0.000108	0.000168^{***}	0.000109^{***}
	(0.0000704)	(0.0000253)	(0.0000139)	(0.000122)	(0.0000614)	(0.0000359)
unemployment %	-0.215^{***}	0.0111	-0.0490^{***}	0.231^{***}	0.0410^{*}	0.0871^{***}
	(0.0337)	(0.00910)	(0.00761)	(0.0409)	(0.0213)	(0.0158)
routine occupations %	0.0318^{**}	-0.0215^{***}	-0.0194^{***}	0.0378	-0.0312^{***}	-0.0247^{***}
	(0.0139)	(0.00455)	(0.00405)	(0.0312)	(0.00896)	(0.00624)
qualified occupations %	0.0442^{***}	-0.0167^{***}	-0.0137^{***}	0.0438^{*}	-0.0189^{*}	-0.0175^{**}
	(0.0169)	(0.00567)	(0.00491)	(0.0256)	(0.0111)	(0.00884)
semiprof. & technical occupations %	0.0123	-0.0183^{***}	-0.0211^{***}	0.0212	-0.0101	-0.0117
	(0.0230)	(0.00662)	(0.00504)	(0.0420)	(0.0145)	(0.00942)
foreigners empl. %	-0.0325^{***}	0.0140^{***}	0.0180^{***}	-0.0280^{***}	0.000941	0.0149^{***}
	(0.00964)	(0.00326)	(0.00231)	(0.00936)	(0.00720)	(0.00524)
female empl. %	0.000310	-0.00105	0.00540^{***}	0.0194^{*}	-0.0229^{***}	-0.00399
	(0.00844)	(0.00287)	(0.00195)	(0.0103)	(0.00716)	(0.00475)
constant	-2.924^{**}	5.200^{***}	6.747^{***}	-0.424	6.564^{***}	5.508^{***}
	(1.414)	(0.474)	(0.388)	(2.434)	(0.884)	(0.684)
State dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Time dummy	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
State x time inter.	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	3861	3864	3864	4776	2883	4830

Notes: The table shows second stage results of 2SLS regressions, where the variables ln(import exposure (GER-East)) and ln(export exposure (GER-East)) are instrumented by logarithmic import and export exposures using other countries' trade flows with the East. Both first stage as well as the second stage include the same set of control variables. Standard errors clustered at the district level are given in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.17: Effects on revenue types of the administrative budget (Part II)

	Dependent variable: ln(revenues per capita)	
	business tax (basic amount)	business tax revenue
	(1)	(2)
ln(import exposure(GER-East))	-0.106^{*}	-0.120^{**}
	(0.0575)	(0.0579)
ln(export exposure(GER-East)	0.0511	0.0651
	(0.0622)	(0.0625)
area	-0.000175^{***}	-0.000194^{***}
	(0.0000635)	(0.0000666)
population density	0.0000900	0.000196^{***}
	(0.0000609)	(0.0000673)
unemployment %	-0.0662^{***}	-0.0426^{*}
	(0.0215)	(0.0219)
routine occupations %	-0.0330^{***}	-0.0382^{***}
	(0.0106)	(0.0106)
qualified occupations %	-0.0208^{*}	-0.0272^{**}
	(0.0115)	(0.0118)
semiprof. & technical occupations %	-0.0256	-0.0288^{*}
	(0.0159)	(0.0150)
foreigners empl. %	-0.00467	-0.00399
	(0.00645)	(0.00688)
female empl. %	-0.0275^{***}	-0.0256^{***}
	(0.00638)	(0.00641)
constant	8.935^{***}	10.43^{***}
	(1.004)	(1.008)
State dummy	*Yes*	*Yes*
Time dummy	*Yes*	*Yes*
State x time inter.	*Yes*	*Yes*
Observations	3864	3863

Notes: The table shows second stage results of 2SLS regressions, where the variables ln(import exposure(GER-East)) and ln(export exposure(GER-East)) are instrumented by logarithmic import and export exposures using other countries' trade flows with the East. Both first stage as well as the second stage include the same set of control variables. Standard errors clustered at the district level are given in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.18: Robustness regressions: the role of control variables

	Dependent variable: logarithmic revenues of the administrative/core budget per capita						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln(import exposure(GER-East))	-0.0507^{**}	-0.0527^{***}	-0.0480^{**}	-0.0311	-0.0313	-0.0301	-0.0421^{**}
	(0.0200)	(0.0197)	(0.0202)	(0.0195)	(0.0196)	(0.0191)	(0.0192)
ln(export exposure(GER-East))	0.0631^{***}	0.0624^{***}	0.0606^{***}	0.0297	0.0222	0.0197	0.0428^{**}
	(0.0219)	(0.0217)	(0.0219)	(0.0212)	(0.0212)	(0.0209)	(0.0218)
area	0.0000625^{***}	0.0000627^{***}	0.0000652^{***}	0.0000662^{***}	0.0000627^{***}	0.0000672^{***}	0.0000824^{***}
	(0.0000199)	(0.0000199)	(0.0000195)	(0.0000187)	(0.0000170)	(0.0000167)	(0.0000173)
population density	0.000126^{***}	0.000114^{***}	0.000110^{***}	0.0000798^{***}	0.0000488^{**}	0.0000377^{*}	0.0000449^{**}
	(0.0000201)	(0.0000215)	(0.0000219)	(0.0000229)	(0.0000200)	(0.0000200)	(0.0000194)
unemployment %		0.0157^{***}	0.0166^{***}	0.0136^{**}	0.0251^{***}	0.0329^{***}	0.0356^{***}
		(0.00602)	(0.00578)	(0.00578)	(0.00580)	(0.00580)	(0.00562)
routine occupations %			-0.00165	-0.0127^{***}	-0.0286^{***}	-0.0268^{***}	-0.0263^{***}
			(0.00171)	(0.00230)	(0.00443)	(0.00447)	(0.00439)
qualified occupations %				-0.0199^{***}	-0.0359^{***}	-0.0344^{***}	-0.0314^{***}
				(0.00256)	(0.00407)	(0.00407)	(0.00428)
semiprof. & technical occupations %					-0.0305^{***}	-0.0284^{***}	-0.0284^{***}
					(0.00645)	(0.00649)	(0.00640)
foreigners empl. %						0.00539^{***}	0.00733^{***}
						(0.00208)	(0.00222)
female empl. %							0.00488^{***}
							(0.00125)
constant	7.451^{***}	7.404^{***}	7.464^{***}	8.808^{***}	10.46^{***}	10.24^{***}	9.803^{***}
	(0.0412)	(0.0435)	(0.0844)	(0.198)	(0.411)	(0.421)	(0.452)
State dummy	–	–	–	–	–	–	–
Time dummy	–	–	–	–	–	–	–
State x time inter.	–	–	–	–	–	–	–
Observations	4830	4830	4830	4830	4830	4830	4830

Notes: The table shows second stage results of 2SLS regressions, where the variables ln(import exposure(GER-East)) and ln(export exposure(GER-East)) are instrumented by logarithmic import and export exposures using other countries' trade flows with the East. Both first stage as well as the second stage include the same set of control variables. Standard errors clustered at the district level are given in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.19: Robustness regressions: the role of sector employment

	Dependent variable: logarithmic revenues of the administrative/core budget per capita				
	(1)	(2)	(3)	(4)	(5)
ln(import exposure(GER-East))	-0.0507^{**}	-0.0527^{***}	-0.0476^{**}	-0.0430^{**}	-0.0419^{**}
	(0.0200)	(0.0197)	(0.0206)	(0.0194)	(0.0196)
ln(export exposure(GER-East))	0.0631^{***}	0.0624^{***}	0.0683^{***}	0.0628^{***}	0.0558^{**}
	(0.0219)	(0.0217)	(0.0225)	(0.0211)	(0.0232)
area	0.0000625^{***}	0.0000627^{***}	0.0000562^{***}	0.0000699^{***}	0.0000671^{***}
	(0.0000199)	(0.0000199)	(0.0000191)	(0.0000182)	(0.0000182)
population density	0.000126^{***}	0.000114^{***}	0.0000983^{***}	0.0000503^{***}	0.0000446^{**}
	(0.0000201)	(0.0000215)	(0.0000193)	(0.0000172)	(0.0000178)
unemployment %		0.0157^{***}	0.0194^{***}	0.0187^{***}	0.0214^{***}
		(0.00602)	(0.00596)	(0.00555)	(0.00616)
employment financial %			0.0155^{***}	0.0124^{***}	0.0132^{***}
			(0.00492)	(0.00444)	(0.00445)
employment services %				0.0168^{***}	0.0178^{***}
				(0.00140)	(0.00165)
employment manufacturing %					0.00100
					(0.000858)
constant	7.451^{***}	7.404^{***}	7.331^{***}	7.219^{***}	7.189^{***}
	(0.0412)	(0.0435)	(0.0464)	(0.0452)	(0.0522)
State dummy	–	–	–	–	–
Time dummy	–	–	–	–	–
State x time inter.	–	–	–	–	–
Observations	4830	4830	4601	4601	4601

Notes: The table shows second stage results of 2SLS regressions, where the variables ln(import exposure(GER-East)) and ln(export exposure(GER-East)) are instrumented by logarithmic import and export exposures using other countries' trade flows with the East. Both first stage as well as the second stage include the same set of control variables. Standard errors clustered at the district level are given in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.20: Robustness regressions: control variables and district fixed effects

	Dependent variable: logarithmic revenues of the administrative/core budget per capita							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(import exposure(GER-East))	0.0651**	0.0143	0.00882	0.00746	0.00643	0.00508	0.00800	0.00799
	(0.0326)	(0.0198)	(0.0214)	(0.0208)	(0.0206)	(0.0205)	(0.0201)	(0.0201)
ln(export exposure(GER-East))	0.128***	0.0100	0.0304	0.0294	0.0280	0.0305	0.0258	0.0257
	(0.0345)	(0.0349)	(0.0384)	(0.0370)	(0.0372)	(0.0354)	(0.0347)	(0.0369)
unemployment %			−0.0102*	−0.0112**	−0.0112**	−0.0112**	−0.00986*	−0.00986*
			(0.00551)	(0.00556)	(0.00551)	(0.00551)	(0.00546)	(0.00537)
routine occupations %				−0.00314**	−0.00145	−0.00273	−0.00243	−0.00243
				(0.00147)	(0.00274)	(0.00337)	(0.00332)	(0.00319)
qualified occupations %					0.00252	0.00130	0.000425	0.000428
					(0.00354)	(0.00418)	(0.00409)	(0.00399)
semiprof. & technical occupations %						−0.00241	−0.00433	−0.00432
						(0.00453)	(0.00443)	(0.00416)
foreigners empl. %							−0.00906***	−0.00907***
							(0.00276)	(0.00277)
female empl. %								−0.0000136
								(0.00238)
constant	7.111***	7.678***	7.674***	7.826***	7.663***	7.788***	7.889***	7.890***
	(0.0269)	(0.0897)	(0.102)	(0.104)	(0.274)	(0.375)	(0.367)	(0.399)
District FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Time dummy	–	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	4830	4830	4601	4601	4601	4601	4601	4601

Notes: The table shows second stage results of 2SLS regressions, where the variables ln(import exposure(GER-East)) and ln(export exposure(GER-East)) are instrumented by logarithmic import and export exposures using other countries' trade flows with the East. Both first stage as well as the second stage include the same set of control variables. Standard errors clustered at the district level are given in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Conclusion

In this thesis, I analyzed the consequences of financial frictions arising from a moral-hazard framework due to asymmetric information in the open economy. In a collection of three essays, I examined the effects of credit constraints on (i) firms' markups, (ii) inter-group inequality of profit–wage income, and (iii) intra-group inequality of wage income. The fourth essay, in contrast, analyzed the trade exposure effects on income and spending of German municipalities.

In the first essay, credit constraints exclude some firms from external finance and thus from market entry. Therefore, credit constraints affect prices and markups by altering the degree of competition. Lower credit constraints allow less productive firms to enter with two opposing effects on prices. On the one hand, more competition tends to reduce average prices, but on the other hand, less productive firms charge above-average prices. As the overall effect is ambiguous, we structurally estimate a quantitative multi-country version of the model to capture the direction and magnitude of the effects of credit constraints. We find that in the European manufacturing sector an abolishment of credit constraints reduces markups by about 6.1 percent on average while average prices are predicted to increase by 1.6 percent.

The second essay analyzes the role of credit constraints for profit–wage inequality in closed and open economies. A general finding is that workers' wages are negatively affected by financial constraints, whereas the effect on profits is less clear-cut. However, in the simple benchmark model, profit–wage inequality increases in financial intermediation costs as well as in the degree of moral hazard.

The third essay examines the role of credit constraints for union and competitive wages in closed and open economies. It is shown that union and competitive wages decrease in agency costs as well as in financial intermediation costs. Tighter credit frictions impact union wages stronger than competitive wages, reducing inequality within the group of workers. Profits decrease in financial intermediation costs in union and non-union sectors under free trade as well as in autarky, because intermediation costs increase the unit costs in this model. By contrast, tighter credit frictions caused by higher agency costs increase profits due to the fall of workers' wages irrespective of the trade regime. Therefore, higher agency costs relocate income from workers to entrepreneurs in general equilibrium.

The fourth essay analyzes the causal effect of rising German trade with China and Eastern Europe on local government budgets in Germany. I use the variation of the local industry structure to identify regional differences in the exposure to international trade with the East employing an instrumental variables approach. I find at least mild evidence of "winner" and "loser" municipalities in terms of budget revenues and expenditures. In particular, per capita business tax income is lower in districts with high import exposure, as is spending for community streets and sports. In general, effects are small but more pronounced in spending categories where local governments have substantial leeway in budgeting and execution of their duties.

Further research is necessary in order to validate the theoretical findings of chapters two and three, i.e. do we find empirically that countries with weaker financial institutions, and thus probably stronger credit frictions, exhibit higher inequality in profit–wage income and a lower inequality within the wage distribution relative to countries with well developed financial institutions? While there is some empirical

evidence that financial development reduces income inequality[12] to my knowledge there are no studies that particularly analyze the link between financial development and profit–wage inequality. Additionally, it would be interesting to examine both theoretically and empirically whether credit constraints impact not only the wage inequality of unionized versus unorganized workers but also between different worker skill-groups.

With respect to the trade exposure effects on local government budgets it would be interesting to apply my employed empirical strategy to an extended sample period, especially before 1990. Unfortunately, this data was unavailable to me. Additionally, it remains an – at least partly – open question through which exact channels local government budgets are affected. Furthermore, the time dynamics of trade exposure effects need to be examined in the future. The question of whether and how to address the potential trade induced budgetary differences by economic and fiscal policy is also closely related.

[12]See e.g. Beck, T., Demirgüc-Kunt, A. and Levine, R. (2007). Finance, inequality and the poor. *Journal of Economic Growth*, **12**(1), 27–49.

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