FIRM ADJUSTMENTS IN A GLOBAL ECONOMY

INAUGURAL-DISSERTATION

zur Erlangung des Grades Doctor oeconomiae publicae (Dr. oec. publ.)
an der Ludwig-Maximilians-Universität München

2016

vorgelegt von
JAN NICOLAS TSCHEKE

Referentin: Prof. Dr. Dalia Marin
Korreferent: Prof. Dr. Joachim Winter
Promotionsabschlussberatung: 16. November 2016

Datum der mündlichen Prüfung: 25.10.2016
Namen der Berichterstatter:
Prof. Dr. Dalia Marin, Prof. Dr. Joachim Winter, Prof. Dr. Gabriel Felbermayr

Für meine Familie

Danksagung

Eine Dissertation wie die vorliegende erfordert Geduld und Konzentration, aber vor allem Unterstützung. Ich empfinde tiefste Dankbarkeit gegenüber all denen, die es mir ermöglicht haben, diese Arbeit zu beenden. Einige dieser Menschen möchte ich im Folgenden besonders hervorheben. Viele andere werden in dieser Danksagung namentlich keinen Platz finden. Selbst ein Buch könnte sie nicht fassen, all die Freunde, Familienangehörigen, Lehrer und Mitmenschen, die mich geprägt und gefördert, geerdet und gefordert haben. Ohne sie wären die nachfolgenden Seiten nicht entstanden. Vielen Dank.

Besonders bedanken möchte ich mich jedoch bei meiner Erstgutachterin, Koautorin und Mentorin Dalia Marin. Ihr Vertrauen und ihre Geduld waren existentiell für meine Promotion. Von ihr habe ich gelernt, dass Wissenschaft viel mehr sein muss als die Arbeit im stillen Kämmerchen und dass vor allem der Mut den Erfolg bedingt. Ganz herzlich bedanke ich mich auch bei Joachim Winter, der sich sofort bereit erklärt hat, meine Dissertation als Zweitprüfer zu begutachten. Auch bin ich sehr glücklich, dass Gabriel Felbermayr die Drittbetreuung übernommen hat. Meine Dissertation liegt damit in den Händen eines Komitees, über dessen Zusammensetzung ich mich sehr freue.

Meine Dankbarkeit gilt auch Wilhelm Kohler, der mir wissenschaftlich wie auch real den Weg nach München ebnete. Tilman Brück bin ich sehr verbunden, weil er mir ermöglicht hat, über einen ausgedehnten Zeitraum die Arbeit an einem wissenschaftlichen Institut aus der Nähe kennen zu lernen. Bedanken möchte ich mich insbesondere auch bei meinen Koautoren Jan Schymik und Philippe Fromenteau, ohne die meine Dissertation in der vorliegenden Form nicht bestünde.

Ganz besonders freue ich mich darüber, meine Zeit an der LMU mit ausgesprochen netten, hilfsbereiten und klugen Menschen verbracht haben zu dürfen. So stand ich den Herausforderungen einer Dissertation nie alleine gegenüber, sondern hatte Freunde und Kollegen an meiner Seite, die stets zur Diskussion bereit standen und Freude und Leid mit mir teilten. Neben meinen Koautoren gilt meine besondere Dankbarkeit dabei meinen Teamkollegen: meiner langjährigen Bürogenossin Henrike Michaelis, dem lehrenden Norman Loeckel, dem abtrünnigen Andreas Backhaus, dem jungen Padawan Philipp Herkenhoff, dem alten Hasen Michael Seitz, der mutigen Lei Hou, der fleißigen Francesca Fabbri, dem großen Alexander Tarasov und natürlich unserer stellvertretenden Direktorin, Eva Tehua. Darüber hinaus möchte ich mich bei all den MGSEler/innen, Postdocs, Professor/innen und Verwaltungsmitarbeiter/innen bedanken, die mich auf dieser Reise begleitet und die Zeit an der LMU mit Leben gefüllt haben.

Schließlich geht mein tiefster Dank an meine Familie. All die Universitäten der Welt hätten mir in einem ganzen Leben nicht mehr vermitteln können, als es meine Eltern und meine Schwester in den vergangenen Jahrzehnten getan haben. Sie haben den Nährboden für meine Arbeit geschaffen, emotional wie intellektuell. Daneben habe ich von einer sehr großherzigen Familie profitiert, in Deutschland, Mexiko und Südafrika. Bei euch allen möchte ich mich bedanken. Marisol, dir gilt mein herzlichster Dank, weil du mir den Rücken freigehalten hast wenn es eng wurde und mich zurechtgestutzt hast wenn ich drohte aus der Form zu wachsen.

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I. Preface

> *Given what is everywhere the purpose of commerce, the global company will shape the vectors of technology and globalization into its great strategic fecundity. It will systematically push these vectors toward their own convergence, offering everyone simultaneously high-quality, more or less standardized products at optimally low prices, thereby achieving for itself vastly expanded markets and profits. Companies that do not adapt to the new global realities will become victims of those that do.*
>
> Theodore Levitt (1983)

It has long been known that the steady formation of a global economy provides auspicious opportunities and imminent threat to firms around the globe. Still, at the time Theodore Levitt wrote his famous article on the globalization of markets, the focus on individual firms had not yet reached the agenda of mainstream trade economists. But the predominant theories of comparative advantage had already been outgrown by the data, showing that a substantial and increasing share of world trade was happening between similar countries and within industries.[1] The subsequent integration of product differentiation, imperfect competition and economies of scale into formal trade models implicitly began to shift the focus towards the firm level. Yet, it was not until newly available firm-level data provided evidence of significant heterogeneity among trading and non-trading firms that the spotlight fully hit the individual business entity.[2]

By now there is a large literature, both theoretical and empirical, showing how the productivity distribution of firms has important repercussions on the gains from trade.[3] Most notably, periods of trade liberalization have been found to be accompanied by a shift in market shares from low-productivity to high-productivity firms.

[1] See for example Grubel (1967) and compare Krugman (1980).
[2] See for example Bernard and Jensen (1999)
[3] See Melitz (2003) for a seminal theoretical contribution and Bernard et al. (2012a) for a survey of the empirical literature.

Understanding this shift is of inherent economic interest as high-productivity firms, leading the race for technological innovation, determine the productivity frontier and well-being of current and future generations. Yet, the productivity of firms is not given exogenously and firms fight fiercely to avoid exiting the market and to stay ahead of competitors when facing the challenge of globalization. In the end, these adjustments at the micro level shape the firm productivity distribution endogenously. Accordingly, the extent of market share reallocation from low productivity to high productivity firms becomes itself a function of these adjustments, determining the size of trade induced productivity effects at the aggregate level.

The following three chapters provide new insights on the channels of adjustment that firms resort to in order to adapt to the new global realities, including larger markets, foreign competition and increasing uncertainty. Specifically, chapter II examines how internationally active firms are affected by exchange rate volatility and discusses how exports and imports at the firm level can be orchestrated to reduce their exchange rate exposure. Chapter III shows how the reorganization of production across borders and the decentralization of management structures can help firms to reduce costs and improve quality, allowing them to increase their share of the market. Finally, chapter IV analyzes how firms adjust investments across time in response to an increase in foreign competition. Each of the chapters is a self-contained contribution, shortly presented in what follows.

Chapter II deals with exchange rate uncertainty. From the firm perspective, exchange rate movements are largely unpredictable. Accordingly, they imply a constant threat to the price-cost margin of trading firms. This is confirmed by recent firm-level evidence, showing that large swings in exchange rates are often not reflected in foreign price adjustments because firms adjust markups in order to hold foreign demand constant.[4] As I am going to argue in the first chapter of the dissertation, instead of adjusting markups, firms can in principal hold demand *and* profits constant if they properly align intermediate imports and final good exports in terms of exchange rates. An appreciation of the domestic currency with respect to the export market, threatening foreign demand, then at the same time leads to an increase in purchasing power with respect to intermediates sourced from abroad. Accordingly, firms can reduce the cost component of foreign prices, keeping the final price expressed in the foreign currency constant despite an appreciation of the domestic currency. Exchange rate induced price shocks at the output level are then offset by

[4] See for example Berman et al. (2012).

corresponding adjustments at the input cost level.

The chapter empirically addresses two questions related to this mechanism. In the first part, I determine the degree to which exporting firms can expect intermediate imports to offset the effect of exchange rates on total firm sales. Related to the approach of Amiti et al. (2014), I propose a stylized theoretical framework that allows me to structurally estimate the exchange rate effect on total firm sales conditional on exports and intermediate imports at the firm level. I use manufacturing firm-level panel data from seven European countries to estimate the model. Taking the regional pattern of firm trade as given, my results suggest that controlling for the alignment, i.e. co-movement, of the export and intermediate import related exchange rates is crucial.

I determine the relevant exchange rates for exports and intermediate imports as the trade weighted geometric average of bilateral exchange rates, where weights are chosen according to either final good export or intermediate good import flows at the industry level. The co-movement of the two resulting effective exchange rates is then measured by the elasticity of the intermediate import with respect to the export weighted exchange rate. Surprisingly, my results suggest that sourcing intermediates from abroad reinforces the export related exchange rate effects on average. The reason is that export destination markets and input sourcing regions are not well aligned for the average firm. This differentiates my results from Amiti et al. (2014), who find international sourcing on average to offset some of the export related exchange rate effects on prices for Belgian firms. Yet, in line with the theoretical predictions, the offsetting effect is confirmed in my data provided that the co-movement between export and intermediate import weighted exchange rates is high. Then even a moderate amount of offshoring can completely offset the exchange rate effect on sales that is working through exports.

Given that I find the offsetting effect of international sourcing to be contingent on the alignment of exchange rates, the question arises whether firms are taking the exchange rate co-movement into account when deciding on sourcing regions. Anecdotal evidence suggests that firms are indeed trying to reduce exchange rate exposure via offsetting international activities, an attempt that has been termed operational hedging. Consequently, the second part of the paper looks at the regional sourcing pattern of firms and relates it to regional export decisions and the co-movement of exchange rates. To my knowledge, this is the first systematical analysis addressing this question. In line with the operational hedging mechanism, I find the probability of a firm importing from a specific region to increase in regional exporter status if and only if the elasticity of the intermediate import with respect to the export weighted exchange rate is high. I further find that the role of regional exporter status as a predictor of regional sourcing is reversed in highly volatile regions if the elasticity is low. Exporters are then less likely to source from the region because imports would reinforce exchange rate uncertainty. These results hold after controlling for alternative area characteristics that determine the probability of regional sourcing. I take these results as evidence for operational hedging.

Chapter III is joint work with Dalia Marin and Jan Schymik. We analyze the effect of organizational choice on the international competitiveness of firms within their export market. Specifically, we link the organization of firms to their export success, using the same firm-level data that was used in chapter one. Because information on exporting is only available for 2008, chapter III constitutes a cross-sectional analysis.[5] Two margins of organizational adjustment are considered: offshoring and the decentralization of decision making. We propose that firms that reorganize production internationally can reduce costs and increase price competitiveness while firms with decentralized hierarchies empower their knowledge workers and can compete on global markets with innovativeness and quality.

The paper thus aims at the overlap between the literature on heterogeneous firms in a global environment and the role of organizational choice for firm productivity. Accordingly, we shift the focus away from exogenously given productivity distributions and towards specific firm-level decisions that determine the relative market position. We motivate the empirical analysis with a stylized model, linking organizational decisions to export market shares and product quality. First, following Grossman and Rossi-Hansberg (2008), we show how firms can import intermediates to reduce production costs. Second, we propose a mechanism where shifting decision rights to lower levels of the management hierarchy incentivizes knowledge workers to increase their creative effort. This fosters the implementation of new ideas and ultimately translates into higher product quality.

We test the following predictions that we derive from the theoretical framework: First, offshoring and better product quality increase the competitive position of a firm within its specific export market. Second, decentralization of decision authority leads to improvements in perceived product quality and innovation. And third, the effect of decentralization on quality and innovation is particularly strong if the

[5] In chapter II the focus lies on total firm sales for which panel data is available.

conflict of interest within the board of managers is large.

In order to measure the competitive position of a firm in its specific export market, we construct a world export market share, using data on firm exports as well as trade flow information from the set of firm specific industries. We exploit variation in wages paid by intermediate good producers in typical sourcing regions and variation in the skill intensity of input production to identify how offshoring affects export competitiveness. We exploit regional variation in religious beliefs and trust across Europe in order to identify the effects of a decentralized management on product quality. In line with the predictions, we find offshoring to increase the global market share of firms and a strong positive association between a decentralized management and product quality. Furthermore, we find this effect to be less pronounced if the share of family board members is large, indicating a low conflict of interest within the board of managers.

In chapter IV, which is joint work with Philippe Fromenteau and Jan Schymik, we empirically assess how exposure to foreign competition affects firm investments into durable and nondurable assets. If firms determine investments into different types of assets according to profit expectations, a foreseeable reduction of future price-cost margins can discourage long-term investments. Accordingly, we would expect a relative shift of investment expenditures towards assets that pay off early.

In order to guide the empirical analysis, we formalize the implied trade-off in marginal investment returns in a stylized model. We consider firms in a two-period economy, choosing between short- and long-term investments. Short-term investments reduce marginal costs today and thus yield an immediate benefit. Investments into more durable assets reduce future production costs and thus pay off according to the future market environment. Because an increase in competition reduces profits in period two, the marginal return on short-term investment increases relative to the marginal return on long-term investment. Our model predicts the resulting compositional effect in investments to be less pronounced for larger firms, because their market power shields them from competitive pressure.

In order to test these predictions, we use panel data for all available manufacturing firms that are stock listed in the US. Specifically, we derive a within-firm difference-in-differences estimator that resembles the theoretical framework. Similar to Garicano and Steinwender (2016), we exploit variation in durability across asset groups to distinguish between short- and long-term investments. Investments are measured by expenditures into different asset categories. We then estimate how changes in the sectoral degree of foreign competition affect the within-firm composition of investments. In accordance with the theoretical framework, we find that tougher competition leads to a relative shift towards short-term investments and that this effect is more pronounced for smaller firms. We argue that this effect is causal, controlling for alternative channels such as uncertainty, export market size effects or financial constraints. Furthermore, we exploit the Chinese WTO accession in 2001 as an alternative source of exogenous variation.

II. Operational Hedging of Exchange Rate Risks

II.1. Introduction

Internationally active firms represent only a small fraction of all firms. Nevertheless, above average performance implies that their impact on aggregate economic activity is much larger than their number suggests. Using US data for the year 2000, Bernard et al. (2009) find that trading firms, a mere 4.1% of all firms, accounted for as much as 41.9% of employment outside government and education.[1] In the light of these findings, and spurred by the increasing availability of firm-level data, a major puzzle from macroeconomics has recently reemerged and come under the scrutiny of microdata analysis: why have exchange rates so little effect on the real economy?[2]

A large body of literature, dealing with the exchange rate disconnect, has revealed that much of the puzzle can be traced back to incomplete pass-through of exchange rates into prices.[3] Thus, a devaluation of the dollar does not necessarily imply cheaper US imports for the rest of the world and accordingly no expenditure adjustments. The focus on firms' sourcing behavior can be seen as the latest addition to this literature. It is driven by the insight that internationally active firms are often exporting final goods and importing intermediate goods at the same time.[4] If

I have benefited from the access to the EU-EFIGE/Bruegel-UniCredit database, managed by Bruegel and funded by the EU 7th Framework Programme ([FP7/2007-2013] under grant agreement no. 225551), as well as by UniCredit.

[1] Bernard et al. (2009), tables 14.1 and 14.3.

[2] See Obstfeld and Rogoff (2001) for an explicit formulation of that puzzle.

[3] See Goldberg and Knetter (1997) and Burstein and Gopinath (2014) for reviews of the literature. Classical explanations for this inelasticity of prices include price rigidities in the local currency (e.g. Gopinath and Rigobon (2008)), firms adjusting the profit margin (e.g. Atkeson and Burstein (2008)) and local-currency distribution costs (e.g. Goldberg and Campa (2010)).

[4] Bernard et al. (2009) find that of the 41.9% of US workers employed in trading firms, about 73% are employed in firms that are both exporters and importers (compare Bernard et al. (2009), table

both flows are denominated in the same currency, an appreciation, usually increasing the price tag on foreign sales, also implies higher purchasing power with respect to intermediate inputs. This reduction in costs helps firms to counter the increase in prices of goods sold in the foreign market, effectively preventing changes in foreign sales.

Adding to this branch of literature, this paper provides new firm-level evidence from European manufacturing firms, supporting the hypothesis that the missing link between exchange rates and the real economy is partly due to imports of intermediate goods. Yet, in difference to earlier results, I find the mechanism of offsetting exchange rate effects to hold for a subset of firms only. Specifically, I analyze to what extent export and intermediate import flows are denominated in the same currency and find that for many firms the alignment appears to be rather weak or even negative. This has important implications: if the exchange rate with respect to exporting regions moves independently from the exchange rate with respect to sourcing regions, the offsetting effect described above disappears. If exchange rates are negatively related, the effect of exchange rates on export sales is reinforced through intermediate imports. This is what I find for the average exporting firm in my sample.

From the macro perspective, this is an important finding because it implies that the link between intermediate imports and the exchange rate disconnect puzzle is specific to only a subset of importing firms, namely those with a positive alignment of export and intermediate import related exchange rates. Amiti et al. (2014) conceptually acknowledge this limitation, but, because they do not consider the full distribution of the measure of co-movement, their approach does not bring to light its empirical significance. To my knowledge, the present paper is the first to put the co-movement of exchange rates in the foreground.

The following analysis addresses two questions related to the effects of intermediate imports on the rate of exchange rate pass-through. The first part of the paper determines the offsetting effect of intermediate imports on the exchange rate pass-through into total sales, contingent on the co-movement of exchange rates. Technically, this part is closely related to the exchange rate disconnect literature. The second part of the paper asks whether exporters take into account the co-movement of exchange rates when deciding on sourcing regions. It connects to the hedging lit-

14.1). As a study by the OECD for 2006 confirms, intermediate imports are thereby the dominant trade flows in OECD countries, representing 56% of the total trade in goods and 73% of the total trade in services. (compare Miroudot et al. (2009)).

erature and, to my knowledge, is the first approach of addressing this question in a systematical manner.

In order to guide the empirical specification for the first part, I propose a stylized theoretical framework where demand is derived from standard CES preferences and firms set prices with a fixed markup over marginal cost. Marginal costs are determined by the composition of domestic and foreign inputs and firms can sell their output at home and abroad.[5] Partially differentiating the expression for sales with respect to the export weighted exchange rate leads to a simple structural estimation equation. For exporting firms, the structure predicts a positive association between sales and the foreign currency value. A potentially countervailing association is established when the firm is offshoring, i.e. purchasing inputs from abroad. A devaluation of the export related exchange rate then implies increasing input costs, *provided that* the co-movement between export and intermediate import related exchange rates is positive.

I estimate the equation for log-changes in sales over the years 2004 to 2013, using a large sample of manufacturing firms from seven European countries, including France, Germany, Italy, Spain and the UK.[6] The dependent variable is regressed on log-changes in the real effective exchange rate as well as interactions with the share of exports in total sales and the share of imported intermediates in total intermediates, i.e. offshoring. Following the literature, the effective exchange rate is constructed as a trade weighted geometric average of bilateral exchange rates, where weights are chosen according to export flows at the industry level. Because I expect the coefficient on the offshoring interaction to be contingent on the co-movement between the export and intermediate import weighted exchange rates, I add a triple interaction with a corresponding measure.[7]

I find the results to be in line with the theoretical predictions. Specifically, exporting firms on average face higher demand after a devaluation of the domestic currency. The effect is countered by imported intermediates if the co-movement be-

[5] As my data does not provide information on the evolution of exports and imported inputs over time, I assume the optimal import and export decision to be sunk at the time of observation.

[6] Different from earlier studies that relied on price-level or export data, the structure I propose is built upon firm-level variables that are easily available. This enhances the applicability to different data sources considerably.

[7] Note that the industry weights used in the construction of the intermediate import weighted exchange rate are chosen according to imports at the *input* industry level, using Input-Output (IO) coefficients to determine the importance of each input industry in the firm's output industry. For simplicity, I will use the terms import weighted exchange rate and intermediate import weighted exchange rates interchangeably.

tween export and import weighted exchange rates is high enough. The coefficients of interest have the expected sign and are statistically significant. This implies that, for exporters, offshoring can in principle have a dampening effect on the exchange rate elasticity of sales. My data thus confirms earlier findings, showing that multiple foreign operations have the potential to provide an operational hedge against the exchange rate uncertainty facing exporters. Yet, different from earlier studies, I find the co-movement of exchange rates to be too low for the average firm in my sample. As pointed out earlier, importing intermediates then reinforces the exchange rate effects due to exporting.

In terms of economic significance, my findings suggest that doubling the average sample rate of exchange rate devaluation from 0.3% to 0.6% increases the growth rate of sales by about 8.8% for the average non-offshoring exporter. For the average offshoring exporter, the corresponding increase more than doubles to 18.5%. Thus, instead of offsetting the effect of exchange rates on sales working through exports, offshoring appears to reinforce it on average. I find offshoring to work as a hedging device only for firms that, by purpose or luck, choose an offshoring region with high hedging potential, i.e. a high co-movement between export weighted and intermediate import weighted exchange rate. Thus, the best possible hedging region, with a co-movement indicator at the 99th percentile, completely offsets the export effect on sales with an import share of only 7%, while the same amount of offhoring can increase the export effects by more than 73% if the co-movement indicator is very low, i.e. at the 1st percentile.

In the hedging literature, it has long been recognized that the exchange rate exposure of firms is effectively reduced when the firm engages in multiple international activities. The underlying mechanism has often been referred to as natural hedging.[8] As the term *natural* suggests, the hedging effect is implicitly assumed to work through random diversification. For existing empirical studies, this assumption was usually sensible, given that most of them are dealing with data on large multinationals. But in the light of the results described above, the assumption needs to be qualified when small and medium-sized firms with limited international activity are concerned. For the average exporting firm in my sample intermediate imports tend to reinforce the effects of exchange rates, thereby increasing exchange rate exposure. This implies that most firms willing to engage in *operational hedging*[9] activities will

[8] See Clark (1973) for an early formulation of the natural hedging hypothesis.

[9] Because my findings suggest that hedging requires a non-random choice of sourcing regions for most firms, I will refer to *operational* hedging instead of *natural* hedging from now on.

have to carefully consider the exchange rate characteristics of export and sourcing regions.

This consequently provokes a question that has been barely addressed in the literature: do firms take into account the hedging potential when choosing an offshoring region?[10] Anecdotal evidence strongly suggests that they do.[11]

In order to address this question more formally, in the second part of this paper I regress regional offshoring choices on regional exports and their interaction with exchange rate characteristics. Regional exports are included as an indicator of exchange rate exposure and because, keeping constant regional characteristics, sunk cost of regional entry and network effects would predict that firms should be relatively more willing to import from a region that they already know. Nevertheless, if the region is highly volatile in terms of exchange rates and if firms dislike exchange rate volatility, then even regional exporters might not like to source from that region. Again, these results are contingent on the co-movement between import and export weighted exchange rates. If this co-movement is low for a given region, sourcing would reinforce the volatility effect of exports and, controlling for other area specific effects, firms would be wise to import from other regions. But once the co-movement exceeds a certain level, the high volatility of exchange rates can be effectively hedged through intermediate imports. Because higher volatility implies a higher risk level, I would then expect firms to be relatively eager to match exports with intermediate imports from a given region.

The analysis delivers results that are in line with these predictions. As expected,

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[10] Amiti et al. (2014) indirectly approach the issue by determining whether the co-movement between export and import weighted exchange rates at the firm level is increasing in import intensity. Finding no significant relationship, they conclude that hedging is not systematic. Yet they do not address the choice of sourcing countries explicitly.

[11] In its annual report 2007, German car manufacturer BMW explicitly proclaims that "[f]rom a strategic point of view, i.e. in the medium and long term, the BMW Group endeavors to manage foreign exchange risks by 'natural hedging', in other words by increasing the volume of purchases denominated in foreign currency or increasing the volume of local production." (BMW Group Annual Report 2007, p. 63). Similar intentions are expressed in the annual reports of Toyota (2007, p.77) and Volkswagen (2009, p.188). While these very large multinationals are not representative of the manufacturing sector, a survey conducted by the Canadian export credit agency EDC among 260 exporters suggests that operational hedging might actually be relevant to a large number of exporters. The authors of the report note that "[a]lthough, natural hedging is an important tactic for firms of all sizes, [...] small firms are particularly drawn to the use of natural hedging strategies." Overall, the report finds almost 60% of the respondents to engage in operational hedging activities (EDC (2009), p.6.). The report defines natural hedging as the attempt "to match revenues in a foreign currency with payments in that same foreign currency." Note also that Friberg and Huse (2014) derive counterfactual profit distributions for BMW and Porsche and find that operational hedging reduces exchange rate exposure.

the data suggests that the probability of importing from a region is, on average, higher for regional exporters. Thus, ignoring any exchange rate risks, exporting increases the probability of importing by 15.9 percentage points. Factoring in the average level of exchange rate volatility significantly reduces this effect to 4.3 percentage points for an average level of co-movement between the export and the intermediate import weighted exchange rate. Thus, firms tend to avoid exchange rate risks. But additionally, the sourcing decision depends critically on the indicator of exchange rate co-movement. Accordingly, the positive effect of regional exports on regional imports increases to 7 percentage points in regions with high co-movement of exchange rates (90th percentile) but decreases to 2 percentage points for regions with low co-movement (10th percentile). The effects are more pronounced in high volatility regions (75th percentile of the volatility distribution), where an exporters facing high co-movement of exchange rates tends to be 4.2 percentage points more likely than a non-exporter to source from that region, whereas firms facing low co-movement tend to be on average 3.5 percentage points less likely. These findings represent a clear pattern in the choice of importing regions that is in line with the mechanisms explained above. I interpret them as evidence for *directed* operational hedging.

The rest of the paper is structured as follows: Section II.2 summarizes the related literature. Section II.3 presents the theoretical framework. Section II.4 introduces data sources, key variables and discusses the empirical identification. Section II.5 presents estimation results for the theoretical framework. Section II.6 introduces the estimation equation for local sourcing and discusses the results. Section II.7 concludes.

II.2. Related Literature

The paper connects two strands of the literature that have so far been developed apart from each other. On the one hand, there is a recent literature that focuses on imports and global value chains in order to explain the exchange rate disconnect puzzle. On the other hand, there is a branch of the finance literature that deals with the exchange rate exposure of multinationals and discusses reasons and means to deal with it.[12] Both strands have provided evidence suggesting that international

[12] Note that this paper also relates to a literature that examines the relation between exchange rate volatility and trade flows. It is surveyed in McKenzie (1999) and Clark et al. (2004) and I will

sourcing is effectively hedging the exchange rate risk of exporters. Accordingly, the question arises whether firms might be actively directing their international activities towards hedging opportunities. This paper adds to both strands of the literature, providing new evidence for effective and directed operational hedging in the European manufacturing sector.

The first part of the paper relates to the pass-through literature with its recent focus on imported intermediates. This literature is looking at price adjustments in response to exchange rate variations and usually requires highly detailed data on prices or volumes. The analysis then follows from a structural decomposition of prices into markups and marginal costs. Proceeding this way, Athukorala and Menon (1994) use Japanese industry-level data and find evidence for an indirect effect of exchange rates on export prices that is operating through the cost of imported inputs. Goldberg and Hellerstein (2008) review empirical work and find that after accounting for the variation in markups, structural models of pass-through tend to produce substantial residual variation that could be due to movements in marginal costs. Fauceglia et al. (2012) use Swiss industry-level data and find high pass-through rates of exchange rates into import prices, concluding that importing intermediates potentially allows exporters to benefit from operational hedges.

But while these studies have confirmed the role of imported intermediates for pass-through at the sectoral level, evidence at the firm level remains relatively sparse. Using French firm-level data, Berman et al. (2012) estimate a pass-through regression at the firm level and find that importing firms increase their prices more than others in response to a devaluation. While they attribute this effect to a rise in input costs, the underlying mechanisms are not formally addressed and their analysis remains silent about the relationship between export and import weighted exchange rates. Amiti et al. (2014) develop and test a structural model of variable markups at the firm level that explicitly accounts for the role of imported intermediates and the co-movement between export and import weighted exchange rates. They find imported intermediates to significantly reduce pass-through rates in their sample of Belgian firms.

My work is closely related to the approach of Amiti et al. (2014), given that they explicitly consider the role of exchange rate co-movement for pass-through rates at the firm level. Yet, different from these authors I measure pass-through into total sales instead of prices. This allows me to extend the analysis to several countries

briefly return to it in section II.6.

but implies that price and volume adjustments remain closely entangled. Accordingly, I abstract from markup heterogeneity in the structural model.[13] Instead, I give more weight to the structural co-movement between import and export weighted exchange rates and allow the measure to vary continuously in the empirical application.

The paper is also closely related to Greenaway et al. (2010). Similar to the approach presented here, they focus on (export) sales rather than prices. Using data on UK manufacturing firms, they find an appreciation to reduce exports. Furthermore, they find an offsetting effect through imported intermediates. They also distinguish export and import weighted measures of the exchange rate but do not account for exchange rate co-movements. Furthermore, their measure of offshoring is not firm specific.[14]

The second part of the paper shifts the focus towards the notion of exchange rate exposure. This concept originates from the business and finance literature and provides the basis for most of the hedging analysis. Authors like Heckerman (1972) and Shapiro (1975) define exposure as the sensitivity of the firm value to changes in the exchange rate. Among others, Jorion (1990) and Bodnar and Gentry (1993) have therefore used stock market values to assess the exchange rate exposure of multinational firms. Because these studies struggle to find significant effects, Bartov and Bodnar (1994) propose that the net exposure of multinationals depends on the relative size of foreign costs and revenues and that failure to measure exposure might be the result of offsetting cash flows. Using data on 409 US multinationals, Choi and Prasad (1995) provide evidence consistent with the idea.[15]

Accordingly, some authors have acknowledged the role of internationalization as a hedging device.[16] That firms actively determine their international activities accord-

[13] Note that this in theory implies a complete pass-through for firms that source domestically only. Empirically, I will add markup controls in order to allow for heterogeneous pricing-to-market.

[14] The role of imported inputs for pass-through is also confirmed in recent findings at the macro-level. Thus, Ahmed et al. (2015) and Ollivaud et al. (2015) document a significant drop in the elasticity of aggregate manufacturing exports to the real effective exchange rate over the last two decades. They propose the expansion of global value chains as one of the major reasons for that change over time. Note that while the literature has proposed various determinants of low *levels* of pass-through, global value chains are especially suitable when it comes to explaining a *change* in recent years. Note also that Leigh et al. (2015) do not share the view of an increasing disconnect at the macro level but acknowledge the role of international production fragmentation in explaining a low pass-through of exchange rates into export prices.

[15] See Muller and Verschoor (2006) and Bartram et al. (2010) for more recent results on the determinants of exchange rate exposure.

[16] The question of whether and why firms hedge against exchange rate risks is not the focus of the

ing to operational hedging potential has, to my knowledge, only been addressed in theoretical contributions. Thus, Broll (1992) derives a model of risk averse multinationals and finds that, in the absence of forward markets, profit maximization leads to active operational hedging. Chowdhry and Howe (1999) show that operational hedging can be efficient even in a world with fixed quantity forward contracts, as the alignment of revenues and costs allows for flexible exchange rate hedges that are contingent upon sales in the foreign country. Empirically, most of the literature has focused on the relation between financial and operational hedges. Operational hedges are mostly treated as the result of predetermined geographic diversification rather than a specific match of import and export weighted exchange rates.[17] Thus, none of these papers provides evidence for firms actually choosing locations according to hedging potential. Additionally, because exposure is measured through changes in stock values, most of the literature has focused on large multinationals and fails to acknowledge the role of operational hedging for a broader set of firms.

present analysis but has been covered in several papers. Dumas (1978) introduces market imperfections such as capital market segmentation or bankruptcy costs in order to restore the relevancy of the financial hedging decision. Rodriguez (1981) presents results from interviews with financial officers of US multinationals and suggests that risk aversion might play an important role when it comes to exchange rate hedging. Mayers and Smith (1982) provide a more general discussion of corporate demand for insurance. A short overview of alternative theoretical assumptions that justify hedging activities is given Mian (1996).

[17] Examples include Houston and Mueller (1988) who note that more geographical diversification should tend to reduce the need for hedging but find no evidence for that effect in data on US multinationals. Makar et al. (1999) and Allayannis et al. (2001) also use measures of geographic diversification as a proxy for operational hedges and assess the effect of dispersion on the financial hedging decisions of firms. While the former find operational hedging to substitute for financial hedges, the latter find both types of hedges to be complementary. Pantzalis et al. (2001) show that operational hedging in terms of breadth and depth of the multinational network lowers exchange rate exposure after controlling for the presence of financial hedges. Ito et al. (2015) focus on the relationship between the choice of invoicing currencies and both, the need and effectiveness of financial and operational hedges. A summary of the hedging literature with a focus on Europe can be found in Döhring (2008), who points out that operational hedges, involving high sunk costs, are typically used to reduce longer-term exposure to economic risk, while transaction risk can be easily hedged using standard financial products. In general, the literature distinguishes transaction risk, economic risk and translation risk. While transaction risk refers to the impact of exchange rates on committed cash flows, economic risk refers to uncertain future cash flows. Translation risk refers to the impact of exchange rates on the valuation of assets and liabilities denominated in a foreign currency. Compare e.g. Döhring (2008). Recent survey evidence regarding hedging from a sample of 804 Swedish firms is presented in Amberg and Friberg (2015).

II.3. Theoretical Framework

In order to guide the empirical specification, I propose a stylized Dixit-Stiglitz framework of internationally active firms. Using CES preferences keeps the structural equations tractable, but still flexible enough to provide useful predictions on the relation between exports, offshoring and exchange rate exposure.[18]

I define marginal costs to be a simple weighted average of domestic and foreign wages, with i representing the firm specific but exogenous physical imported input share and E_i representing the import weighted exchange rate in price notation ($E_{€/\$}$):[19]

$$MC \equiv (1-i)w_{€} + iw_{\$}E_i \tag{II.1}$$

Given marginal costs, we can write domestic and foreign prices in the usual markup formulation:

$$p_{€} = \mu \cdot MC \tag{II.2}$$

$$p_{\$} = \mu \cdot \tau \cdot MC \cdot \frac{1}{E_x} \tag{II.3}$$

where μ is the markup, τ represents iceberg trade costs and E_x is the export weighted exchange rate. Note that the markup is determined by the fixed elasticity of substitution σ.

The total sales equation can be written in the standard Dixit-Stiglitz notation:

$$r_{tot} = r_{€} + E_x \cdot r_{\$} = R_{€}\left[\frac{p_{€}}{P_{€}}\right]^{1-\sigma} + E_x \cdot R_{\$}\left[\frac{p_{\$}}{P_{\$}}\right]^{1-\sigma} \tag{II.4}$$

where r_j and R_j resemble firm revenues and GDP respectively in country j and P_j

[18] Note that in this framework the costs of imported intermediates remain the sole determinant of the exchange rate pass-through into exporter prices, because a constant elasticity of demand effectively fixes the markup, muting any pricing-to-market effects. Compare e.g. Goldberg and Hellerstein (2008).

[19] All values are measured in local currency and multiplied with the corresponding exchange rate where necessary. Thus, foreign labor costs $w_{\$}$ are expressed in Dollars and need to be multiplied by the intermediate import-weighted exchange rate in order to enter the domestic marginal cost formula which is expressed in Euros.

is the country specific price aggregator, all measured in local currency.

Partially differentiating equation (II.4) with respect to the export weighted exchange rate (E_x) and multiplying with the total change in the exchange rate yields the following results:

$$\frac{\partial r_{tot}}{\partial E_x} \cdot \Delta E_x \quad = \quad \sigma \cdot E_x r_{\$} \cdot \frac{\Delta E_x}{E_x} - (\sigma - 1) \cdot r_{tot} \cdot IS \cdot \frac{dE_i}{dE_x} \frac{E_x}{E_i} \cdot \frac{\Delta E_x}{E_x} + \epsilon_r \qquad \text{(II.5)}$$

where the ϵ_r captures general equilibrium adjustments in domestic and foreign aggregate demand and IS is the share of imported intermediates in value terms.[20]

This equation has an intuitive interpretation and could, in principal, be directly estimated. Specifically, equation (II.5) shows that the change in total revenues due to a devaluation of the domestic currency is composed of two effects.[21] The first term on the right hand side is the direct effect. It is positive and implies that total sales increase after a devaluation when the firm is exporting ($r_{\$} > 0$). This term captures both, the positive effect on foreign sales that is due to the lower conversion of domestic prices into foreign currency, and a second effect that is due to the higher conversion of foreign revenues into domestic currency. The second term captures the indirect effect of importing. It is indirect, because here we are looking at changes in the export weighted exchange rate. Thus, the indirect effect crucially depends on the elasticity of the import with respect to the export weighted exchange rate, as only the former has an effect on the cost of imported intermediates. Furthermore, it depends on the absolute importance of inputs denominated in foreign currency, measured by the import intensity times the total value of sales. The effect is negative given that the elasticity of substitution is larger than one and captures the effect of higher material cost on foreign and domestic sales. Note further that the absolute size of both effects is increasing in σ, because a higher price elasticity of demand implies that the decrease in prices caused by the conversion effect and the increase in prices due to higher marginal cost both result in larger demand and therefore sales adjustments.[22]

[20] Specifically, ϵ_r resembles a firm specific average of changes in the foreign and domestic demand shifter ($Q_€ P_€^{\sigma}$ and $Q_{\$} P_{\$}^{\sigma}$). This is going to be the error term in the empirical specification and is explicitly formulated in section A.1.1 of the appendix. The share of imported intermediates in value terms is defined as: $IS \equiv \frac{iw_{\$}E_i}{(1-i)w_€ + iw_{\$}E_i}$.

[21] Note that a devaluation of the domestic currency corresponds to an increase in E_x. A more detailed decomposition of the effects is provided in section A.1.1 of the appendix.

[22] Defining equation (II.5), I implicitly assumed σ to be the same across countries for the sake of

Equation (II.5) requires data on *export* sales over time. Unfortunately, my dataset contains information on *total* sales only. In principle, I could easily construct the time varying equivalent for exports, assuming that the export share, that relates only to 2008 in the data, remains valid over the full period. Instead, I propose a small transformation that, while still depending on the same assumption, allows me to express the equation directly in terms of the export share. This provides for a better fit with my data and reduces the dimension of the interaction term on the import related effect by one:

$$\frac{\Delta r_{tot}}{r_{tot}} = \sigma \cdot XS \cdot \frac{\Delta E_x}{E_x} - (\sigma - 1) \cdot IS \cdot \frac{dE_i}{dE_x} \frac{E_x}{E_i} \cdot \frac{\Delta E_x}{E_x} + \widehat{\epsilon}_r \tag{II.6}$$

where XS is the export share.[23]

Finally, I am going to reformulate equation (II.6) in terms of *real* exchange rates, acknowledging that a change in the foreign price index relative to the domestic price index should have effects that work through the same channels as a change in the nominal exchange rate. While the derivation for the nominal exchange rate provides a helpful conceptional starting point, from the firm perspective it should not matter whether sales deteriorate due to a nominal appreciation or worsening terms of trade, induced for example by diverging rates of productivity growth across countries. Note that in difference to most financial hedging devices, operational hedging delivers a unique opportunity for firms to hedge against movements in real exchange rates. Thus, in order to determine the hedging potential of offshoring, it is worthwhile to consider the full range of macro-economic risks that the typical exporting firm is facing. Adjusting the equation for movements in real exchange rates is straightforward and leads to the following equation:[24]

$$\frac{\Delta r_{tot}}{r_{tot}} = \sigma \cdot XS \cdot \frac{\Delta R_x}{R_x} - (\sigma - 1) \cdot IS \cdot \frac{dR_i}{dR_x} \frac{R_x}{R_i} \cdot \frac{\Delta R_x}{R_x} + \overline{\epsilon}_r \tag{II.7}$$

simplicity. It is straightforward to allow different sigmas at home ($\sigma_€$) and abroad ($\sigma_\$$). In this case, the sigma of the the first term on the right hand side of equation (II.5) would be the foreign price elasticity ($\sigma_\$$), while the σ of the second term would be a trade weighted average of the domestic and the foreign elasticity. The basic intuition would remain the same.

[23] The export share is defined as: $XS \equiv \frac{E_x r_\$}{r_{tot}}$.

[24] The equation follows from (II.6) by replacing E_i with $R_i * (P_€/P_\$)$, acknowledging that the relative price $\widehat{P} \equiv P_€/P_\$$ is itself a function of the real exchange rate and partially differentiating with respect to R_x.

The error term $\overline{\epsilon}$ now contains additional elements capturing the general equilibrium adjustments in the sectoral terms of trade. As with the demand shifters, these effects are firm specific because the exposure to the sectoral terms of trade effects with respect to exporting or importing countries depends on the export and the import intensity of the firm.[25]

Equation (II.7) can be directly estimated, assuming that the export and import decisions are fixed over time. This is a major simplification but necessary due to the restrictions of my data.

II.4. Data Description, Key Variables and Identification

II.4.1. Data Sources and Construction of Key Variables

Firm-level data stems from two data sources: the *EU-EFIGE/Bruegel-UniCredit* (EFIGE) survey and Bureau van Dijk's *Amadeus* database. The EFIGE survey is at the core of the analysis as it defines the firm sample. Coordinated by the European think tank Bruegel and supported by the Directorate General Research of the European Commission, the full EFIGE sample encompasses almost 15.000 firms of the manufacturing sector in seven European countries: Germany, France, Italy, Spain, United Kingdom, Austria and Hungary.[26] The survey focus lies on the international activity of firms. Data was collected in 2010 and covers the years from 2007 to 2009. However, most information is cross-sectional and only available for the year 2008. From EFIGE I obtain the share of imported intermediates in total intermediates, the share of turnover exported as well as information on the regional structure of firms' international activities as of 2008. The EFIGE survey restricts regional information to the area level.[27] The destination area specific information will become important for the empirical exercise in section II.6.

I match the firms from the EFIGE survey with Bureau van Dijk's Amadeus database. This allows me to add balance sheet data for the years 2005 to 2013 as

[25] See equation (A.2) in the appendix for an explicit formulation.

[26] The survey is representative in terms of the firm-size distribution at the country level for firms with more than 10 employees in the manufacturing industry. See Altomonte and Aquilante (2012) and Altomonte et al. (2012) for more details.

[27] EFIGE splits the world into eight areas: EU15, other EU, other Europe not EU, China & India, other Asia, USA & Canada, Central & South America and other areas. See Altomonte and Aquilante (2012) for a full list of countries and table A.1 in the appendix for a list of the countries used in the empirical analysis.

well as detailed information on a firm's industry class. Especially, I obtain total sales in every year, as well as a range of other balance sheet variables that I use as controls or alternative dependent variables.[28] The sectoral details enable me to add industry specific exchange rates to the firm panel.

Industry, country and area specific real effective exchange rates for the years 2005 to 2013 are constructed from four additional data sources: Average monthly nominal exchange rates of the Euro against a range of other currencies are obtained from Eurostat. From these I derive bilateral exchange rates also with respect to the Forint and the Pound Sterling. I index all bilateral exchange rates with respect to the rate of January 2004. I use seasonally adjusted nominal CPI data from World Bank's Global Economic Monitor, again indexed with respect to January 2004, in order to transform nominal into real exchange rates. The effective exchange rates are obtained by geometrically weighting the bilateral exchange rates according to the trade flow structure in a given industry with respect to a specific region of international activity.[29] The trade flow data is obtained from the WITS/Comtrade database and averaged over the years 2005 to 2007. I construct the export weighted and an intermediate import weighted real exchange rate at the two digit level (ISIC Rev.3). Intermediate import trade flows are linked to the firms' output industry using the two-digit Input-Output coefficients from the OECD Stan database as weights and arithmetically averaging over all input industries.[30]

Equations II.8 and II.9 formalize how the export weighted real effective exchange rate (R^x) and the intermediate import weighted real effective exchange rate (R^i) are constructed with respect to some region κ of international activity:[31]

[28] A list of all variables used is provided in table A.2 in the appendix. The appendix also provides summary statistics for most variables in tables A.3 and A.4.

[29] Geometric weighting is the usual approach for the construction of effective exchange rates. Different from arithmetic averages, percentage movements in a geometrically averaged index will not depend on whether the bilateral rates are expressed in price or quantity notation. They are also more robust to changes in the base period. Compare e.g. Ellis (2001). See table A.1 in the appendix for details on the final currency basket.

[30] I apply the German IO-coefficients for the year 2005 to all countries for simplicity.

[31] For the specification that results from the theoretical framework presented in section II.3, I will define the relevant currency basket with respect to the world. In section II.6 I will use effective exchange rates that are specific to a certain area of international activity, i.e. that contain only those currencies used in a specific EFIGE export destination or import sourcing area.

$$R^x_{cs\kappa t} \;=\; \prod_{k\in\kappa}\left(E_{ckt}\cdot\frac{cpi_{kt}}{cpi_{ct}}\right)^{\frac{EX_{cks}}{\sum_{k\in\kappa}EX_{cks}}} \tag{II.8}$$

$$R^i_{cs\kappa t} \;=\; \prod_{k\in\kappa}\left(E_{ckt}\cdot\frac{cpi_{kt}}{cpi_{ct}}\right)^{\frac{\sum_{z\in IO(s)}\varsigma_{zs}\cdot IM_{ckz}}{\sum_{k\in\kappa}\sum_{z\in IO(s)}\varsigma_{zs}\cdot IM_{ckz}}} \tag{II.9}$$

where $k \in \kappa$ is the set of trading partners of country c in region κ, E_{ckt} is the price of country k's currency in terms of country c's currency at time t (i.e. the nominal exchange rate in price notation), cpi_{ct} is the consumer price index in country c, EX_{cks} are average industry s exports from country c to country k in industry s, IM_{ckz} are average sector z imports from country c to country k, where $z \in IO(s)$ is the set of input industries z related to industry s via IO-coefficients ς_{zs}.

These real effective monthly exchange rates are then used to determine the covariance of exchange rates for a specific region κ and finally (arithmetically) averaged in order to obtain yearly exchange rates that can be matched to the firm-level data. I approximate the theoretical elasticity capturing the co-movement of exchange rates by the following projection coefficient:[32]

$$\frac{dR^i_{cs\kappa t}}{dR^x_{cs\kappa t}}\frac{R^x_{cs\kappa t}}{R^i_{cs\kappa t}} \approx \frac{cov(logR^x_{cs\kappa t}, logR^i_{cs\kappa t})}{var(logR^x_{cs\kappa t})} \equiv Proj^{didx}_{cs\kappa} \tag{II.10}$$

I use this country and sector specific elasticity as a proxy for the unobserved firm specific elasticity. Looking at the summary statistics for the implied correlation between export and import weighted exchange rates yields a mean coefficient of 0.90, with the minimum around 0.59. While this might be reasonable at the sector level, at the firm level one would expect the correlation to be much lower or even negative for some firms. I therefore demean the projection coefficient defined in equation (II.10) and use $\widehat{Proj}^{didx}_{cs\kappa}$ instead, which is centered around zero.[33] This has the additional advantage of substantially diminishing the amount of collinearity in the model. Thus, when regressing the triple interaction with offshoring and the projection coefficient

[32] In order to obtain the variance and covariance of the exchange rates, I use variation over 120 different points in time (12 month in each of the 10 years). Note that $Proj^{didx}_{cs\kappa}$ has no time dimension. Note also that an alternative time-varying approximation of $\frac{dR^i_{cs\kappa t}}{dR^x_{cs\kappa t}}\frac{R^x_{cs\kappa t}}{R^i_{cs\kappa t}} \approx \frac{cov(R^x_{cs\kappa t}, R^i_{cs\kappa t})}{var(R^x_{cs\kappa t})}\frac{R^x_{cs\kappa t}}{R^i_{cs\kappa t}}$ delivers identical results.

[33] Note that the proxy variable assumptions actually require a proxy variable to be mean zero in the population when it is used in an interaction term. Compare Wooldridge (2010), pp. 74-76.

on all other explanatory variables in the baseline specification, using the demeaned version of $Proj^{didx}_{cs\kappa t}$ reduces the variance inflation factor (VIF) from 60 to 1.9.

II.4.2. Discussion of the Empirical Strategy

The theoretical structure represented by equation (II.7) can be directly translated into the following empirical specification:

$$\frac{\Delta r_{csit}}{r_{csit}} = \left[\alpha + \beta_1 \cdot XS_{csi} + \beta_2 \cdot (IS_{csi} \times \widehat{Proj}^{didx}_{cs})\right] \frac{\Delta R^x_{cst}}{R^x_{cst}} + \epsilon_{csit} \tag{II.11}$$

The main variation in regression equation (II.11) stems from log-changes in the country, sector and year specific real exchange rate. As Goldberg and Hellerstein (2008) point out, the advantage of using exchange rate data is that they provide a source of large and plausibly exogenous price variation. Additionally, note that the estimation in changes eliminates some of the endogeneity that usually arises in the context of firm-level survey data. On the downside, identification is restricted to variation in log-changes which arguably represents only a small fraction of the total variation. This makes it harder to establish statistically significant results and implies that the results can only account for a part of the economic significance. Yet, I would argue that the complexity of the effects involved would render it almost impossible to derive useful conclusions from a level regression that, though capturing more of the variation, would impede a structural interpretation.

Note that while the proposed theoretical structure is very simple, the resulting empirical specification requires higher-dimensional interaction terms, on top of all the level effects, in order to identify the underlying mechanisms. As much of this identification depends on the proper translation of the theoretical into the empirical model, it is important to point out assumptions and simplifications implied by equation (II.11) and to discuss the potential problems arising from each. Most notably, note that I assume the export and import decisions to be firm specific but fixed parameters of the model and that I treat the markup that firms set over marginal costs to be the same for all firms and constant over time.

The assumption of fixed export and import decisions is due to data limitations. As pointed out before, variables of international activity are time invariant snapshots from the 2008 EFIGE survey and thus the assumption is necessary. At least the assumption of fixed import shares might not be too restrictive, as Amiti et al. (2014) find the import share to be empirically very persistent over time. Thus, they treat the offshoring decision as fixed in most specifications. Yet the assumption is a critical one and I will address potential endogeneity arising from it through the inclusion of sector- and country-specific year dummies. Inasmuch as the potential adjustments of export and import shares over time follow a sector specific trend, the fixed effects should account for a substantial part of the confounding effects.

The assumption of fixed markups is simplifying the theoretical framework considerably. Because I do not have price-level data, the structural equations are derived for aggregate variables, implying that the markup and marginal cost channels are blurred by mixing up price and quantity adjustments as well as domestic and foreign demand components.[34] Including variable markups into the structural model would therefore substantially increase the complexity of the empirical model and render the distinction and identification of the hedging effects of offshoring less viable. As this is the channel least studied in the pass-through literature, I decided to keep the structure as focused on the import channel as possible. Still, because firm size, markups and international activity tend to be highly correlated, it is important to acknowledge the potential endogeneity arising from markup adjustments and to think about the impact it might have on my estimates.

A good starting point is the paper by Berman et al. (2012). The authors find that in models of heterogeneous pricing-to-market the high productivity firms usually adjust their markups more in response to exchange rate movements than low productivity firms, because the perceived demand elasticity is higher for the latter. Accordingly, when faced with a real devaluation, exporters will increase the markup and this effect will be stronger for more productive firms. For offshoring firms the opposite should hold. For them, a real devaluation implies higher marginal costs and therefore higher prices. Because this reduces demand, these firms will lower their markup in order to sustain sales. Again, the decrease in markups will be larger for more productive firms, perceiving demand to be less elastic.

In my framework, the positive effect on sales and the negative effect on sales are captured in separate interactions, including the export share and the import share respectively. As more productive firms on average tend to be internationally more active, I expect both the export and the import share to be larger for more productive firms and thus, to be positively correlated with the size of the unobserved markup adjustment. Because the export share interaction captures a positive effect on sales, it

[34] Note that Amiti et al. (2014) use export price data, which allows them to conceptually split price variation into markup and marginal cost variation and reliefs them from accounting for export intensity.

will induce firms to increase the markup, where the increase is going to be larger for firms with a larger market share. Not controlling for the markup variation should therefore bias the coefficient on the export interaction downward, as the increase in markups would tend to lower the positive effect on sales for large exporters. By the same token, an increase in material cost would force firms to lower the markup, effectively diminishing the increase in prices and the decrease in sales. Therefore, I further expect the coefficient on the offshoring interaction to be downward biased. Overall, omitting to control for markup adjustments should make it more difficult for me to find significant effects on the interactions of interest.

I add markup and size controls to control for other potential confounding effects due to markup heterogeneity. Specifically, I use the log-change in total assets to control for changes in size and add alternative time-varying measures of the markup in levels. Additionally, I include firm fixed effects to control for the firm specific average of the sales reaction.

Because this paper is concerned with hedging potential, one obvious omitted factor in specification (II.11) is the hedging activity of firms. Effectively insured firms should be less affected by exchange rate changes and this would tend to diminish the absolute size of my estimates given that hedging would be relatively more frequent among exporting and offshoring firms. Again, this makes it more difficult to encounter significant results. Accordingly, the inclusion of firm fixed effects, controlling for the average hedging activity, should result in larger coefficients. Additionally, I provide a specification where I interact my measure of exchange rate movement with a dummy indicating whether a firm was using foreign exchange rate protection in 2008.

A related potential problem arises because the projection coefficient is derived at the sectoral level. Effectively, the proxy resembles the average hedging effectiveness in the firm's industry. Yet, the fact that it is sector specific implies that there remains a firm specific residual component of the projection coefficient in the error term. Following the directed hedging argument, one could argue that this unobserved component should be positively correlated with the import and the export share, as internationally more active firms face higher exposure and would thus tend to adjust sourcing regions in order to increase the co-movement of exchange rates above the sector average.[35] The sector specific projection coefficient would then underestimate

[35] Note that one argument against this potential endogeneity issue could be derived from the findings of Amiti et al. (2014). They explicitly test for a systematic relationship between the import intensity and the extent to which firms align import and export regions in their data and fail to find any

the actual projection coefficient for firms with high import and export shares and the residual component in the error term would be positive. In the error term, this component would show up, among others, in a triple interaction analogous to the one in the model, inflicting a negative impact on the dependent variable. Because the firm specific component of the projection coefficient is, presumably, positively correlated with exporting and offshoring, I would tend to underestimate the coefficient on the export interaction, but overestimate the effect on the offshoring interaction. But then the danger of falsely obtaining significant results would only be present for the offshoring interaction where the problem is minor, because identification ultimately tries to assess the whole effect of offshoring, including the part in the error term. Again, I try to mitigate these effects altogether by including firm fixed effects that should account for the firm specific projection coefficient, assuming that it is constant over time. Sector-country-year fixed effects will account for any mismeasurement of the projection coefficient over time, that is specific to a certain sector.

This leaves the structural error term $\overline{\epsilon_r}$. Note again that this error term resembles changes in the dependent variables induced by changes in aggregate variables such as the domestic and foreign price index and the domestic and foreign demand shifter. It is firm specific because the weighting of domestic and foreign aggregate changes depends on firms' specific composition of domestic and foreign activity. Note that corresponding terms also form part of the error term in Amiti et al. (2014). Yet, these are residual effects that remain after controlling for the export and import related interactions that are present in equation (II.11). Amiti et al. (2014) therefore assume these factors to be idiosyncratic and mean zero.[36] I will follow their assumption but propose that controlling for firm and sector-country-year fixed effects should eliminate a large part of any remaining endogeneity.

supportive evidence. The error component would therefore be random with respect to the share of imported intermediates and not interfere with my results.

[36] Compare Amiti et al. (2014), Assumption A3.

II.5. Estimation Results

II.5.1. Baseline Results

Table IV.1 shows the results from different empirical specifications implementing equation (II.7).[37] Column one ignores the additional interaction with the measure of co-movement and thus estimates the differential impact of offshoring for the sample-average co-movement. The negative sign indicates that, if anything, an increase in the rate of devaluation is slowing down sales growth if the firm is importing intermediates. This is in line with the theoretical predictions, though statistically the effect is indistinguishable from zero. The coefficient on the interaction with the export share on the other hand is positive and statistically highly significant. Thus, as the theory predicts, devaluation is positively associated with total sales if the firm is exporting, because domestic goods become cheaper for foreign consumers. Note further that, different from the theoretical model, there appears to be an effect from changes in the exchange rate on total sales growth that is working neither through exports nor offshoring. The effect is highly significant and probably captures alternative channels through which exchange rates have an impact on firms. Country-sector fixed effects are included as I don't want my results to hinge on certain countries or sectors in the sample. Thus, if a certain sector faces more volatile demand than another, these fixed effect would eliminate part of the difference by effectively equalizing average sales growth across sectors. Additionally, I add year fixed effects in order to control for shocks in time that equally affected firm sales in all countries and industries.

In specification (2) I add log-changes in total firm assets as a further control. Note that specification (1) only contains interactions of time-constant firm variables with the log change in the real effective exchange rate on the right hand side. Any time-varying firm characteristic that might have an impact on total sales growth is therefore captured in the error term. This becomes an issue if such a factor is correlated with exchange rates or the variables of international activity, because then the coefficients of interest might pick up variation that is not causally related to the import cost or the export sales channel described by the model. Most notably, total assets are directly related to what has been called the translation risk of exchange rates. Following Döhring (2008), this refers to the impact of exchange rate changes on the valuation of foreign assets. Foreign assets often result from foreign subsidiaries and

[37] If not indicated otherwise, the specifications are cluster robust at the firm level and contain the full set of sub-interaction terms and level effects.

Table II.1.: Baseline

	$Sales_{csit}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\Delta log R^x_{cst}$	-0.464***	-0.154*	-0.114	-0.113	-0.161*	-0.161	
	(0.0870)	(0.0803)	(0.0933)	(0.0931)	(0.0962)	(0.291)	
$\Delta log R^x_{cst} \times XS_{csi}$	0.766***	0.747***	0.752***	0.744***	0.859***	0.859***	0.760***
	(0.176)	(0.157)	(0.157)	(0.156)	(0.165)	(0.233)	(0.217)
$\Delta log R^x_{cst} \times IS_{csi}$	-0.0521	-0.117	0.0677	0.0742	0.160	0.160	0.551**
	(0.189)	(0.168)	(0.180)	(0.180)	(0.189)	(0.237)	(0.211)
$\Delta log R^x_{cst} \times IS_{csi} \times \widehat{Proj}^{didx}_{cs}$			-2.518**	-2.543**	-2.939***	-2.939**	-2.432*
			(1.051)	(1.054)	(1.121)	(1.365)	(1.283)
$\Delta log(Assets_{csit})$	no	yes	yes	yes	yes	yes	yes
μ_{csit}	no	no	no	yes	yes	yes	yes
Fixed Effects	$\gamma_{cs} + \gamma_t$	$\gamma_{cs} + \gamma_t$	$\gamma_{cs} + \gamma_t$	$\gamma_{cs} + \gamma_t$	$\gamma_i + \gamma_t$	$\gamma_i + \gamma_t$	$\gamma_i + \gamma_{cst}$
Cluster (Firm)	yes	yes	yes	yes	yes	no	no
Cluster (Sector#Country)	no	no	no	no	no	yes	yes
Nr. of Clusters	9063	9063	9063	9063	8641	177	153
Adj. R2	0.162	0.331	0.331	0.332	0.314	0.314	0.343
Observations	60,169	60,169	60,169	60,169	59,747	59,747	59,491

Notes: Observations relate to firm i in year t, where firms are based in country c and active in sector s. The dependent variable $Sales_{csit}$ represents total sales of firm i in year t. $\Delta log R^x_{cst}$ are annual log-changes of the country and sector specific export weighted real effective exchange rate. XS_{csi} and IS_{csi} denote the firm specific export and import share respectively. $\widehat{Proj}^{didx}_{cs}$ is the elasticity of the import weighted with respect to the export weighted real effective exchange rate. μ_{csit} is a markup control defined in the appendix. $\Delta log(Assets_{csit})$ is the log-change in total assets. γ_{cs} are country-sector fixed effects, γ_t are year fixed effects, γ_i are firm fixed effects and γ_{cst} are country-sector-year fixed effects. The sector level is defined at the 2-digit US SIC level. All specifications contain the full set of relevant sub-interaction terms and level effects. Standard errors are clustered either at the firm level or at the country-sector level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

are therefore, at least potentially, directly related to the exporting and offshoring decisions of firms. A devaluation of foreign assets also reduces the financial collateral of firms and might therefore reduce their capability to invest in an extension of the sales network. Potentially then, total assets might be confounding the effects observed in specification (1). Yet, adding log-changes in total assets does not alter the coefficients of interest substantially. The offshoring coefficient increases somewhat in size but remains insignificant. Note though that the level effect of log-changes in exchange rate is significantly reduced, both economically and statistically. This indicates that the asset control is picking up a substantial part of exchange rate effects other than those related to exports and imports.

Specification (3) introduces the triple interaction with the measure of co-movement between the export and the intermediate import weighted exchange rate. While the simple interaction remains insignificant, the coefficient on the triple interaction is negative as expected and statistically significant at the 5% level. Because the measure of co-movement is demeaned in the sample, this implies that offshoring has a negligible effect on the (export weighted) exchange rate pass-through into sales in sectors with an average level of exchange rate alignment, but counters the positive export effect when the co-movement between exchange rates in export and import regions is sufficiently high. Thus, the joint location of export and import regions matters for the hedging potential of imported intermediates.[38]

In specification (4) I add a time varying markup control defined as total sales over total cost.[39] Though the markup control is highly statistically significant (with a positive sign), the results do not change much, indicating that the markup control is either not picking up the relevant variation or markup effects are simply not too important. I therefore include firm fixed effects in specification (5) to see whether

[38] While Amiti et al. (2014) also find the marginal cost channel to depend on the correlation of exchange rates, their offshoring coefficient is always significant and does not change signs even for a low correlation. Different from their result, my findings suggest that the offshoring effect might actually enhance the exchange rate effects caused by exporting. One potential reason for the discrepancy is that they define a low correlation to be everything below 0.7, which is still a relatively high correlation. I will discuss the heterogeneity of the offshoring effects in more detail below, together with a discussion of the marginal effects.

[39] The markup measure is winsorized at 1% due to some very low (zero) and some very high (above a billion) values. The winsorized measure varies from from 1 to 3.55. There is no significant change in the results when I completely drop observations where the original markup measure is below 1 or above 5. Alternative measures for the markup, such as total profits over turnover, the log of total assets or the constant export market share from 2008 (defined in Marin et al. (2014b)) deliver similar results. I also tried adding the markup interacted with the log-change in exchange rates but the interaction is not significant and other results are practically the same.

controlling for unobserved heterogeneity in time constant firm characteristics alters my results.[40] Controlling for heterogeneity increases both, the coefficient on the export interaction and the coefficient on the triple interaction, which is now significant at the 1%-level. As explained earlier, both unobserved market power (not captured by the markup control) and hedging activities could have biased the previous results towards zero. Including firm fixed effects eliminates the constant component of these confounding factors, which would explain the increase of the estimates.

Specification (6) accounts for a slightly more technical problem. Because the exchange rate measures are country and industry specific but not firm specific, error terms are potentially correlated for the firm within a certain country and industry cluster. I therefore explicitly allow for arbitrary clustering at the country-industry level in specification (6). Note that this allows error terms to be serially correlated across years and therefore subsumes the firm clusters used so far. The use of clustered standard errors results in slightly higher standard errors but the coefficients of interest remain statistically significant.

In specification (7) I retain firm fixed effects and the smaller number of clusters but replace year fixed effects by country-sector-year fixed effects. Among other things, these control for any sector specific changes in offshoring, exporting and market structure and eliminate the level effects of the real effective exchange rate and the measure of co-movement as well as their interaction. Thus, systematical errors through aggregation and approximation of exchange rates and their co-movement are better accounted for. Additionally, the set of fixed effects now controls for the sector and country specific general equilibrium effects feeding into the structural error term. Note that the results in specification (7) are now driven exclusively by deviations over time in the differential effect of exchange rates on sales growth resulting from offshoring and exporting within a certain country and industry cluster while accounting for the average characteristics of firms. Nevertheless, both the export and the offshoring interaction remain statistically different from zero, though the size of the coefficients and their significance is slightly reduced.

II.5.2. Marginal Effects

It is instructive to discuss the meaning of the coefficients in table II.1 in terms of the marginal effects involved. I will refer to specifications (5) and (7) as my baseline

[40] I loose some firms due to singleton observations but the change in the estimates is driven by the firm fixed effects rather than the change in the number of observations.

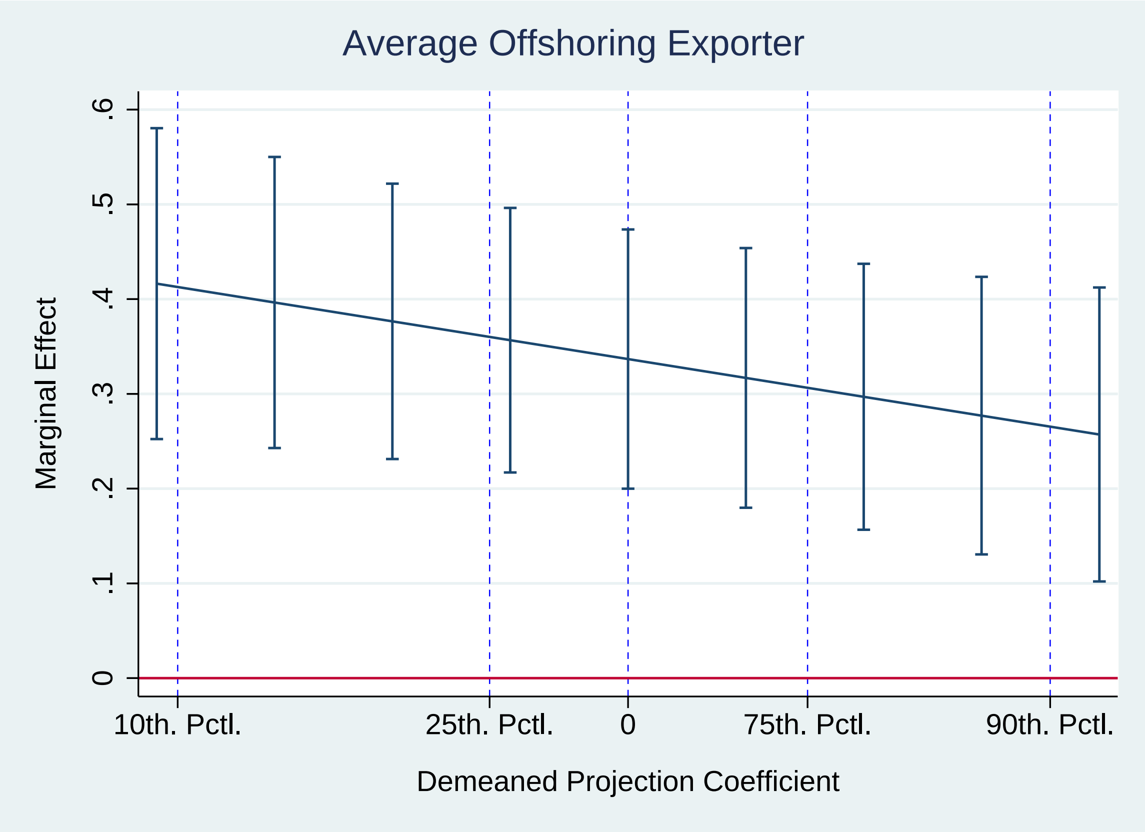
and my fixed effects specification respectively and present marginal effects for these two specifications only. Specification (5) contains firm fixed effects, controlling effectively for unobserved firm level characteristics such as time-invariant productivity or financial hedging activity. Variation at the level of exchange rates is retained and can be used for identification. Specification (7) is much stricter in that it eliminates potential biases arising from the imperfect approximation of the exchange rate measures. On the downside, some precision of the estimates is lost. In analogy to the fixed effects, specification (5) adjusts standard errors for clustering at the firm level only, while specification (7) allows for arbitrary error co-variation within a certain country and sector. Again, there is a potential trade-off involved. While the larger size of clusters in specification (7) accounts much better for error correlation, the reduced number of clusters potentially leads to biased estimates of the variance-covariance matrix.[41] Taken together, these two regressions provide for a good compromise between precision and bias and I propose that the true effect is in the neighborhood of these estimates.

As noted earlier, the structural equations presented here describe log-changes in total sales as a function of log-changes in the exchange rate interacted with firm variables. Thus effectively, I can only explain changes in growth rates of sales.[42] For example, looking at the average exporting firm, and evaluating marginal effects for the average non-offshorer with an average projection coefficient, I find that doubling the sample average of the annual log-change of devaluation from 0.3% to 0.6% increases the rate of sales growth by 8.8% in the baseline and 10.9% in the fixed effects specification respectively. For the average offshoring firm, the increase in the rate of sales growth is 18.5% in the baseline and 25.3% in the fixed effects regression. Therefore, offshoring actually increases the rate of sales growth given an increase in the rate of devaluation at the average level of co-movement between export and import weighted exchange rates. This is not in line with the predictions of the model, because the mean projection coefficient in the sample is positive. But with a positive projection coefficient, the offshoring effect should counter the export effect and not reinforce it. Technically, this is due to the sign of the coefficient on the single interaction between the rate of devaluation and offshoring. The fact that the sign of

[41] Some authors have proposed 50 or more as a rule of thumb for a sufficient number of clusters. According to this rule, 152 cluster groups appear to be more than enough. Nevertheless, the underlying analysis is based on state-year panel data and the required number of clusters might be much higher for unbalanced firm-level data. See Colin Cameron and Miller (2015) for a discussion.

[42] I would argue that the finding of evidence for hedging effects of offshoring at the level of growth rates is an important indicator of potentially much larger level effects.

Figure II.1.: Marginal Effects for Different Levels of the Projection Coefficient



Notes: The figure depicts marginal effects at different levels of $\widehat{Proj_{cs}^{didx}}$, i.e. the measure of co-movement between export and import weighted real effective exchange rates. Marginal effects are evaluated for the average exporting firm ($TS = 0.32$), with the average exporters' share of imported intermediates ($IS = 0.16$). All remaining variables are evaluated at the mean. The confidence level, depicted by vertical bars along the margins-line, is set to 95%. The marginal effects relate to specification (7) of table II.1.

this effect is positive potentially indicates that the sectoral proxy of the projection coefficient might overestimate the true, firm specific co-movement of exchange rates. If this unobserved true elasticity was negative for the average firm in the sample, then the coefficient on the interaction between the rate of devaluation and offshoring should have a positive sign indeed.

The possibility of the true elasticity being negative on average automatically brings the question of hedging effects to the foreground again. Apparently, the balancing effect of offshoring on exchange rate pass-through into sales might not be as obvious as previous findings suggest. The statistical significance of the triple interaction in table II.1 provides evidence for that. It is then easy to see that hedging through offshoring requires a co-movement between import and export weighted exchange rate that is sufficiently high. Figure II.1 shows how the marginal effect of a change in the rate of devaluation varies with the projection coefficient for the average offshoring exporter.[43] It is based on specification (7). At the mid-point of the x-axis, the demeaned projection coefficient is zero, indicating that this measure is at its sample mean. As noted above, the marginal effect at this point (0.34) therefore corresponds to an increase in the rate of sales growth of 25.3%, given a 100% increase in the growth rate of devaluation. The other points on the x-axis represent different percentiles from the distribution of the projection coefficient. Going from the midpoint to the right, the marginal effects depicted in the figure imply that the increase in the rate of sales growth for the average offshoring exporter is reduced to 23.02% at the 75th. percentile and to 19.9% at the 90th. percentile. Going to the left, i.e. diminishing the projection coefficient, the increase in the rate of sales growth becomes 27.1% at the 25th percentile and 31% at the 10th percentile.

Because in these examples offshoring always reinforces the exchange rate risks of exporting (up from 8.8%), it is instructive to examine whether it is principally possible for firms to use offshoring as a hedging instrument after all. In figure A.1 I therefore depict the marginal effects for various levels of offshoring. I thereby consider the best and the worst pairing of export and import regions in terms of exchange rate co-movement in my sample. Specifically, I examine the marginal effects at the 1st and the 99th percentile from the distribution of projection coefficients. This allows me to consider how large hedging effects can become if firms try to avoid the exchange rate risks attached to exporting by choosing the origin and share of imported intermediates according to hedging objectives. Furthermore, it shows how offshoring can dramatically increase exchange rate exposure if import regions are chosen badly in terms of hedging potential.

Panel A of figure A.1 presents the effects from the baseline specification for the average exporter. The intercept with the y-axis represents the marginal effect for a non-offshoring exporter. Using the same hypothetical doubling of the rate of devaluation, the marginal effect at this point implies that sales growth is increasing by 7% for a firm with a projection coefficient at the 99th percentile and 10.3% for a firm at the 1st percentile.[44] Increasing the share of imported intermediates shows

[43] I evaluate at the average export share (32.4%) and import share (16.4%) among all exporting firms in the sample.

[44] While the effects from the exchange rate interaction with the export share is identical for both firms, the difference here is explained by the sub-interactions, specifically the level effect of the exchange rate and the interaction of the exchange rate with the projection coefficient. This difference is absent from the fixed effects regression (panel B) because the sub-interactions are absorbed by the

how the level of the projection coefficient determines whether offshoring is working as a hedging device: for the high-elasticity firm, the exchange rate effect through exporting is completely offset for an import share of only 7%. Instead, if the low elasticity firm offshores the same amount of intermediates, it increases the effect on sales growth by more than 73%, with the new effect now representing a 17.9% increase in total sales growth.

In Panel B, the intercept of both sub-graphs implies that doubling the rate of devaluation increases sales growth by 18.5%. The high elasticity firm can completely offset the devaluation effect through exports with an import share of 29%. But if the low elasticity firm would source the same share of intermediates from abroad, the increase in sales growth would substantially increase from 18.5% to 53.5%.

From this I conclude that if firms want to make use of operational hedges, they seriously need to consider how exporting and importing regions jointly behave in terms of exchange rate movements. As the analysis so far has shown, offshoring can significantly reinforce the exchange rate effects of exporting if firms just follow the average offshoring pattern in the industry. That average offshoring patterns typically reinforce the exchange rate risks of exporting is easily reconcilable with optimizing firm behavior if other criteria (such as lower prices) are relatively more important determinants for the choice of sourcing regions. But given the anecdotal evidence cited in the introduction, the potential for operational hedges might still play a role in the choice of import regions, once other characteristics such as wages and institutional factors have been accounted for. Section II.6 addresses this question empirically.

II.5.3. Robustness

In table A.5 I address the robustness of the baseline and the fixed effects regression from table II.1. Specifications (1) in table A.5 repeats the baseline regression for better comparability. In specification (2) I replace the projection coefficient with a dummy variable equal to one if the projection coefficient is positive and thus above the sample mean. This turns the measure of co-movement into an ordinal variable which is less dependent on the cardinal properties of the original proxy variable. The simple offshoring interaction now increases in size and becomes statistically significant, confirming that the positive export effect is reinforced through offshoring if the

fixed effects.

co-movement between export and import weighted exchange rates is below the average. Plotting the marginal effects (not shown) confirms that offshoring serves as a hedging device if the dummy is equal to one. An offshoring share of about 20% then completely offsets the export related effects. In specification (3) I add an additional interaction between the log change in the real effective exchange rates and a dummy variable indicating whether a specific firm is using financial hedges. The result remain basically unchanged. Specification (4) uses the non-demeaned, raw projection coefficients. Now again, the positive coefficient on the simple interaction between exchange rates and offshoring becomes highly significant, indicating that for a projection coefficient of zero the effect of offshoring reinforces the effect of exporting on exchange rate pass-through into sales growth. Note though that this time a zero projection coefficient does not relate to the sample average but to zero co-movement between export and the import weighted exchange rates. For the sector-level proxy this never actually occurs in the sample. Taking the model seriously, the fact that the effect is still positive again implies that the unobserved firm-level co-movement is probably negative at this point. Specification (5) repeats the fixed effects specification from table II.1. Specifications (6) to (8) apply the same robustness tests to the fixed effects specification that I applied to the baseline. Specifications (6) and (7) are further robust to sector-country-year fixed effects when using 4-digit instead of 2-digit industry codes. In specifications (9) and (10) I use nominal effective exchange rates instead of real effective exchange rates. These are constructed as in equation (II.8) and (II.9) but omit the CPI terms. Accordingly, specifications (9) and (10) correspond to a test of the theoretical equation (II.6). The coefficients are robust to the change but are slightly less significant in statistical terms. The results are also very similar in terms of marginal effects. Specifically, using the projection coefficient of nominal exchange rates at the 99th percentile and applying it to specification (9) implies that 9% offshoring is enough to balance out the effects of exporting. For real exchange rates, the corresponding share of offshored intermediates was 7%.

II.5.4. Extension

One further way to test the robustness of my results is to see whether the framework presented in section II.3 is flexible enough to lend itself to other dependent variables. If the empirical results really capture the theoretical channels suggested above, then this should allow me to consider theoretically related effects and still find the empirical results to be in line with the predictions. Specifically, if sales are affected by exchange rates through the exporting and importing channel in the way that the theoretical structure suggests, than I should find analogous effects for material costs and profits. Clearly, total material costs should be related to the costs of intermediates and and the price of exports analogously to total sales. But if both sales and costs are affected then also profits should depend on exchange rates via exports and imports.

Adjusting the theoretical framework in order to obtain estimable equations analogous to equation (II.7) is straightforward, once I determine the theoretical counterparts of total costs and total profits. Abstracting from fixed costs, which should not depend to much on exchange rates, these are given as:[45]

$$c_{tot} = MC \cdot (q_{€} + q_{\$}) = MC \cdot Q_{€} \left[\frac{p_{€}}{P_{€}}\right]^{-\sigma} + MC \cdot Q_{\$} \left[\frac{p_{\$}}{P_{\$}}\right]^{-\sigma} \tag{II.12}$$

$$\pi_{tot} = r_{tot} - c_{tot} \tag{II.13}$$

where q_j and Q_j resemble firm and total quantities sold in the corresponding country. As before, I take the partial derivative with respect to the real effective exchange rate and obtain the following equations, that closely resemble the effects described in equation (II.7).

$$\frac{\Delta c_{tot}}{c_{tot}} = \sigma \cdot A \cdot XS \cdot \frac{\Delta R_x}{R_x} - (\sigma - 1) \cdot IS \cdot \frac{dR_i}{dR_x} \frac{R_x}{R_i} \cdot \frac{\Delta R_x}{R_x} + \bar{\epsilon}_c \tag{II.14}$$

$$\frac{\Delta \pi_{tot}}{\pi_{tot}} = \sigma \cdot B \cdot XS \cdot \frac{\Delta R_x}{R_x} - (\sigma - 1) \cdot IS \cdot \frac{dR_i}{dR_x} \frac{R_x}{R_i} \cdot \frac{\Delta R_x}{R_x} + \bar{\epsilon}_\pi \tag{II.15}$$

where $\quad A \in [0,1]$ and $B \in [1, \infty]$

The terms A and B are wedge factors indicating that, relative to total sales, the export related effects are smaller for total costs and larger for total profits. As shown in the appendix, the export related effects are the same for all three measures, and thus $A = B = 1$, if trade costs are zero ($\tau = 1$). Intuitively, positive trade costs create a wedge between foreign and domestic prices because exporters transfer the pro-

[45] Details on the derivations and on the error terms are provided in section A.1.4 of the appendix.

duction cost for units lost during transportation onto foreign consumers. Given this wedge, a devaluation that increases foreign sales relative to domestic sales implies that the average producer currency price charged by the affected firm is increasing. This increase in prices adds to the increase in revenues but not to the increase in quantities. Accordingly, the percentage increase in revenues is going to be higher than the percentage increase in total costs. With revenues increasing more than costs in percentage terms, the percentage increase in profits is going to be higher than the increase in revenues and costs.[46]

In analogy to equation (II.7), equation (II.14) shows that the change in total costs can be decomposed into a positive effect that results from the increase in quantities produced for the export market and a negative effect mainly working through the reduction in quantities produced due to higher costs and prices. Note that different from the revenue case, the export related effect now only resembles the lower conversion of domestic prices into foreign currency, as total material costs are already denominated in domestic currency. On the other hand, the import related effect now explicitly contains the higher conversion of imported input prices into domestic currency, given quantities produced. The effect on operating profits resembles the net of the effects on total revenues and total costs.

Table A.6 in the appendix shows the results from estimating equations (II.14) and (II.15). Specification (1) repeats the baseline regression for material costs. The effects are principally in line with the theoretical predictions though I fail to find a significant effect for offshoring. Note however, that the absolute size of the coefficient on the triple interaction is relatively close to the coefficients I obtained for total sales, which is exactly what theory would predict. Furthermore, the coefficient on the export interaction is smaller than in the sales regression, which is in line with the wedge factor $0 < A < 1$. In specification (2) I replace the continuous projection coefficient by a dummy variable indicating that the projection coefficient is above the sample mean. Thus, specification (2) in table A.6 correspond to specification (2) in the robustness table for total sales. Now the triple interaction becomes significant at the 5% level. Again, note how close the estimate on the interaction is to the one obtained in table A.5. Specification (3) and (4) repeat the exercise with the full set of fixed effects and the more aggregate cluster level. Qualitatively, the results do not change significantly.

[46] Note that B is also decreasing in μ, because the function that relates the percentage change in π_{tot} to the percentage changes in r_{tot} and c_{tot} puts higher weight on r_{tot} for higher markups.

Specification (5) to (8) do the same regressions for total profits. Here I do not find significant effects on the offshoring interactions. Yet, the export interaction is highly significant and shows the expected sign. More importantly, the coefficient is larger than both the coefficients for total sales and total material cost, providing further evidence for the theoretical structure, as the predicted wedge factor B is larger than 1.[47]

Summing up, the regressions for total material costs in general confirm all of my findings for total sales. The theoretical prediction of wedge factors A and B is confirmed by the data, adding to the credibility of the theoretical framework. While I find highly significant effects on the export interaction for total profits, the import interactions are not significant. Note however that observed profits, to a much greater extent than sales and material costs, contain many elements that are not contained in the theoretical definition of profits. Most notably, the simple structure presented here does not account for fixed costs and the costs of employees. Additionally, firms usually shift profits strategically from one period to another in order to save on taxes. These omitted factors imply that the empirical profit term is measuring the simple theoretical equivalent with a lot of noise, probably much more than the other dependent variables. It is therefore not surprising that I find the estimates to be less precise in the profit specification.

II.6. Regional Choice of Importing Regions

The results from section II.5 suggest that operational hedging requires firms to deliberately take exchange rate characteristics into account when deciding on sourcing regions. Specifically, in order to operate as a hedging device, offshoring needs to offset some of the exchange rate risk that is due to other international activities. As the previous analysis has shown, for exporters this requires the co-movement between export and intermediate import weighted exchange rates to be sufficiently high. Yet, to my knowledge, no empirical study to date has taken the co-movement of exchange rates into account in explaining exporters' choice of sourcing regions. In this section, I will therefore provide first empirical evidence relating firms' sourcing

[47] Note that taking the coefficients from the export interactions seriously actually allows me to determine the average trade costs and markups implied by the structural model. Using the estimates from the baseline regressions implies wedge factors $A = 0.85$ and $B = 1.55$. Evaluating the theoretical terms of factors A and B at the average export share in the sample (19%) implies trade costs of $\tau = 1.22$ and a markup of $\mu = 1.23$.

decisions to the co-movement of exchange rates.

I am going to capture sourcing decisions with a dummy variable indicating whether a firm was sourcing from a specific area in 2008. As noted earlier, EFIGE provides information on the regional distribution of international firm activities as of 2008, where the world is split into eight distinct areas. For each of these areas, respondents where asked to indicate whether raw material or intermediate goods were purchased from or whether products were sold to that specific area. I use this information in order to expand my data along the geographic dimension. Again, I match the data with monthly real effective exchange rates. These are now constructed as a trade weighted average of all available exchange rates *within* a certain EFIGE area.[48]

I use the monthly data to construct time invariant measures of exchange rate volatility and the projection coefficient, using the full range of years in my data. Specifically, I determine the standard deviation of all measures of the effective exchange rate as well as the covariance between the intermediate import and the export weighted effective exchange rates, both in logs and in levels. Note that from these I can easily recover the regional projection coefficients defined in equation (II.10). I then drop the time dimension for the empirical analysis. Because EFIGE provides information on regional exports and imports for 2008 only, I am not able to make use of the time-dimension when analyzing the sourcing decision of firms. Thus, regression and identification in this section will be based on a firm-area panel, where one observation represents firm activity in a specific area of the world.

On this data, I run the following regression:

[48] I use the same method as detailed in equations (II.8) and (II.9), only that this time region κ corresponds to a specific EFIGE area rather than the world as a whole. I will also construct a third real effective exchange rate that represents total trade, and thus both intermediate imports and exports. It is going to provide a measure of the overall regional volatility. I am using the overall trade weighted volatility rather than the export or intermediate import weighted volatility because those two measures are highly correlated and a separate identification of effects related to one or the other is therefore empirically not feasible. The trade weighted volatility is constructed as follows: $R^{xi}_{cs\kappa t} = \prod_{k\in\kappa}\left(E_{ckt}\cdot\frac{cpi_{kt}}{cpi_{ct}}\right)^{\frac{EX_{cks}+\sum_{z\in IO(s)}\varsigma_{zs}\cdot IM_{ckz}}{\sum_{k\in\kappa}\left[EX_{cks}+\sum_{z\in IO(s)}\varsigma_{zs}\cdot IM_{ckz}\right]}}$.

$$\begin{aligned} importer_{csi\kappa} = \gamma \quad &+ \quad \delta_1 \cdot exporter_{csi\kappa} \\ &+ \quad \delta_2 \cdot \left[exporter_{csi\kappa} \times sd(R^{xi}_{cs\kappa t})_{cs\kappa} \right] \qquad \text{(II.16)} \\ &+ \quad \delta_3 \cdot \left[exporter_{csi\kappa} \times sd(R^{xi}_{cs\kappa t})_{cs\kappa} \times \widehat{Proj}^{didx}_{cs\kappa} \right] \ldots \end{aligned}$$

where $importer_{csi\kappa}$ is a dummy variable indicating whether firm i, active in country c and sector s, was importing intermediates from area κ in 2008 and $exporter_{csi\kappa}$ is the corresponding dummy for exports. $sd(R^{xi}_{cs\kappa t})_{cs\kappa}$ is the standard deviation over all months in the sample period of the home country c specific trade weighted real effective exchange rate in region κ. $\widehat{Proj}^{didx}_{cs\kappa}$ is the area κ specific elasticity of the import weighted with respect to the export weighted real effective exchange rate. Additionally, I am going to add all relevant sub-interaction terms as well as a number of control variables and fixed effects to the model. Because standard errors are potentially clustered across areas for a given firm and because all firms in a given country-sector-area combination obtain the same measures of exchange rate volatility and co-movement, I allow for two-way clustering at the firm and the country-sector-area level.

My expectations with respect to the sign of the coefficients in equation (II.17) are explained in what follows. I expect the probability of firm i sourcing intermediates from region k to be higher if the firm is exporting to that very same region. The reason is that entering a new geographic region usually implies fixed costs, such as finding a translator, establishing business networks or getting to know the legal system. As a firm that already exports to a region will probably be able to save on some of these expenses, I expect δ_1 to be positive.[49] I expect δ_2 to be negative if the key assumption of this paper, that firms dislike exchange rate risk, holds in the data.[50] If

[49] The reason for taking export status into the model in the first place, is that offshoring decisions are only related to operational hedging activities for firms that are actually exposed to exchange rate risks. The export status is clearly a good indicator for that.

[50] A large literature has shown that firms' international activities are related to the volatility of exchange rates. Thus, Cheung and Sengupta (2013) and Héricourt and Poncet (2015) show that firm-level exports to a specific destination are decreasing in the volatility of bilateral exchange rates. Earlier aggregate and sector-level evidence on the effects of exchange rate volatility on exports is surveyed in McKenzie (1999). Literature focusing on volatility and FDI flows is reviewed in Blonigen (2005). Note that in a recent paper Héricourt and Nedoncelle (2016) regress regional export performance on volatility measures and explicitly control for operational hedging by adding a re-

firms are considering hedging activities because they want profits and sales to be less responsive to exchange rate shocks, then, *ceteris paribus*, they should be less inclined to source from highly volatile regions. This is true even if a firm is exporting to that region because, as has been shown in the previous sections, offshoring might actually add to the exchange rate risk of exporting for the average firm. Only if importing helps the firm to offset some of the exchange rate shocks to the export value, I would expect the probability of offshoring to be rising in exchange rate volatility for exporting firms. This is the case when the shock to the export weighted exchange rate translates into a corresponding movement in the import weighted exchange rate. Theoretically, the degree to which the import weighted exchange rate responds to the export weighted exchange rate is given by the elasticity of the import weighted with respect to the export weighed exchange rate. Empirically, this elasticity is approximated by $Proj^{didx}_{cs\kappa}$ and accordingly I expect δ_3 to be positive.

Table II.2 presents the results from estimating a linear probability model of equation (II.17). Note that all specifications include at least area and firm fixed effects, which control for the average level of sourcing in certain areas, industries or for specific firms. Other than that, specification (1) only contains the explanatory variables detailed in equation (II.17) and the relevant sub-interaction terms. As expected, the probability of firm i sourcing from area κ is on average higher for firms that exported to the given area in 2008. But note that the regional exporter status is becoming, *ceteris paribus*, a worse predictor of offshoring when the sourcing region is highly volatile in terms of the real effective exchange rate. As noted earlier, the reason for that is that the import weighted exchange rate is not trailing the export weighted exchange rate close enough for the average firm. Abstracting from other reasons of offshoring, foreign sourcing then simply adds to the already higher exchange rate risks of exporters. Thus, while the model predicts the probability of regional offshoring to be 15.9 percentage points higher for regional exporters than for non-exporters when abstracting from exchange rate volatility, the exporter effect is reduced to 4.3 percentage points when factoring in the average level of exchange rate volatility. As the highly significant coefficient on the triple interaction indicates, the effect of volatility on the sourcing decision of exporters significantly changes with the elasticity of the

gional import dummy interaction. They find imports to diminish the negative effect of exchange rate volatility on exports. While their approach is closely related to the one presented here, they focus on the intensive margin of exports rather than the extensive margin of intermediate imports. They also treat the importer status merely as a control variable and do not further discuss the implications of their results with respect to operational hedging.

import weighted with respect to the export weighted real effective exchange rate. Thus, evaluating at the 10th percentile of the elasticity distribution, exporting increases the probability of regional sourcing by merely 2 percentage points, whereas the effect is 7 percentage points for an elasticity at the 90th percentile.

The contrast becomes more pronounced when considering regions with above average volatility. Thus, setting the volatility to the 75th percentile of the distribution implies that the probability of regional sourcing actually *decreases* by 3.5 percentage points for a regional exporter that faces a low co-movement of exchange rates, while it *increases* by 4.2 percentage points for exporters facing a high co-movement.

The fact that the probability of importing responds not only to area characteristics, exporter status and the level of exchange rate volatility, but crucially depends on the co-movement between intermediate import and export weighted exchange rates is what I count as evidence for operational hedging. Note that the coefficient on the triple interaction can be read in two ways. On the one hand, it implies that for a given level of exchange rate volatility, the probability of regional sourcing for an exporter relative to a non-exporter is increasing in the co-movement of exchange rates. This is in line with operational hedging, because the co-movement of exchange rates implies that a shock to the export weighted exchange rate is offset partly by a change in marginal cost, keeping profits and sales of the exporter relatively stable. On the other hand, the triple interaction implies that exporters will attribute more importance to a given level of exchange-rate co-movement when the volatility of the potential sourcing region increases. Because then shocks to the value of exports due to exchange rate movements are relatively severe, exporting firms should have a higher interest in considering offsetting effects through adjustments in the marginal cost, i.e. operational hedging.

In specifications (2) to (6) I add various controls at the sectoral level that are potentially correlated with the sectoral exchange rate measures and are known to have an impact on the sourcing decision of firms. In specification (2) I add area κ's share in total intermediate imports of country c to the model, as well as the regional share in final good exports from country c. Both measures are country, industry and area specific and are indicative of the differential importance of area κ for sector-level trade. Not surprisingly, the estimates suggest that firms tend to source more frequently from areas that provide inputs to other firms in the sector. Furthermore, the probability of sourcing from a given region is increasing in the sectoral importance of that region as an export market. This is in line with an access cost story at the sec-

Table II.2.: Area Baseline

	$importer_{csi\kappa}$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$exporter_{csi\kappa}$	0.159***	0.153***	0.147***	0.180***	0.0691***	0.0570***	0.0755***	0.0528***
	(0.0132)	(0.0139)	(0.0173)	(0.0157)	(0.0147)	(0.0182)	(0.0168)	(0.0172)
$exporter_{csi\kappa} \times sd(R^{xi}_{cs\kappa t})_{cs\kappa}$	-1.147***	-1.124***	-1.084***	-1.249***	-0.939***	-0.880***	-0.890***	-0.655***
	(0.119)	(0.123)	(0.133)	(0.128)	(0.114)	(0.121)	(0.110)	(0.143)
$exporter_{csi\kappa} \times sd(R^{xi}_{cs\kappa t})_{cs\kappa} \times \widehat{Proj}^{didx}_{cs\kappa}$	1.927***	2.376***	1.934***	1.786***	1.979***	2.046***	1.886***	3.014***
	(0.434)	(0.455)	(0.434)	(0.434)	(0.459)	(0.457)	(0.414)	(0.588)
$exporter_{csi\kappa} \times \widehat{Proj}^{didx}_{cs\kappa}$	-0.0629	-0.108*	-0.0700	-0.0300	-0.0349	-0.0458	-0.0630	-0.0710
	(0.0616)	(0.0641)	(0.0616)	(0.0633)	(0.0619)	(0.0632)	(0.0587)	(0.0687)
$sd(R^{xi}_{cs\kappa t})_{cs\kappa} \times \widehat{Proj}^{didx}_{cs\kappa}$	0.161	0.131	0.172	0.177	0.299	0.275		
	(0.242)	(0.249)	(0.242)	(0.243)	(0.271)	(0.244)		
$sd(R^{xi}_{cs\kappa t})_{cs\kappa}$	-0.0959	-0.135	-0.121	-0.0855	-0.146	-0.236*		
	(0.128)	(0.122)	(0.129)	(0.128)	(0.137)	(0.122)		
$\widehat{Proj}^{didx}_{cs\kappa}$	0.0453	0.0485	0.0455	0.0403	0.0237	0.0218		
	(0.0397)	(0.0441)	(0.0398)	(0.0399)	(0.0434)	(0.0427)		
$reg.\ io\text{-}import\ share_{cs\kappa}$		0.515***				0.501***		
		(0.0743)				(0.0732)		
$reg.\ final\text{-}export\ share_{cs\kappa}$		0.145***				0.145***	0.0747*	0.0634
		(0.0409)				(0.0408)	(0.0387)	(0.0402)
$exporter_{csi\kappa} \times rel.\ io\text{-}wage\ (p.C.)_{cs\kappa}$			0.00966			0.0410***	0.0455***	0.0718***
			(0.00898)			(0.0109)	(0.0113)	(0.0149)
$rel.\ io\text{-}wage\ (p.C.)_{cs\kappa}$			0.00211			0.00474		
			(0.00561)			(0.00618)		
$exporter_{csi\kappa} \times rel.\ io\text{-}lab.prod._{cs\kappa}$				-0.0111***		-0.0214***	-0.0233***	-0.0208***
				(0.00331)		(0.00597)	(0.00646)	(0.00594)
$rel.\ io\text{-}lab.prod._{cs\kappa}$				0.000529		0.00258		
				(0.00193)		(0.00257)		
$exporter_{csi\kappa} \times Grubel\text{-}Lloyd_{cs\kappa}$					0.129***	0.121***	0.0811***	0.0477***
					(0.0147)	(0.0150)	(0.0133)	(0.0137)
$Grubel\text{-}Lloyd_{cs\kappa}$					-0.0122**	-0.0180***	-0.0174***	-0.0203**
					(0.00613)	(0.00582)	(0.00632)	(0.00793)
Fixed Effects	$\gamma_\kappa + \gamma_i$	$\gamma_\kappa + \gamma_i$	$\gamma_\kappa + \gamma_i$	$\gamma_\kappa + \gamma_i$	$\gamma_\kappa + \gamma_i$	$\gamma_\kappa + \gamma_i$	$\gamma_{cs\kappa} + \gamma_i$	$\gamma_{cs\kappa} + \gamma_i$
Area	κ	κ	κ	κ	κ	κ	κ	$\widehat{\kappa}$
Cluster (Firm)	12311	11229	12311	12311	11474	11228	11225	11080
Cluster (Sector#Country#Area)	1450	1026	1450	1450	1039	1026	1008	756
Adj. R2	0.303	0.313	0.304	0.304	0.307	0.315	0.335	0.363
Observations	95,490	86,988	95,490	95,490	88,567	86,952	86,934	65,003

Notes: Observations relate to firm i in area κ, where firms are based in country c and active in sector s. The dependent variable $importer_{csi\kappa}$ is an indicator equal to one if the firm is sourcing intermediates from region κ. $exporter_{csi\kappa}$ is an indicator equal to one if the firm is exporting to region κ. $sd(R^{xi}_{cs\kappa t})_{cs\kappa}$ is the standard deviation of the monthly export and import weighted, area κ specific real effective exchange rate, measured over the full sample period. $\widehat{Proj}^{didx}_{cs\kappa}$ is the demeaned elasticity of the import weighted with respect to the export weighted area κ specific real effective exchange rate. $reg.\ io\text{-}import\ share_{cs\kappa}$ is share of intermediate imports from area κ in all intermediate imports (2-digit). $reg.\ final\text{-}export\ share_{cs\kappa}$ is the share of final good exports to area κ in all final good exports (4-digit). $rel.\ io\text{-}wage\ (p.C.)_{cs\kappa}$ is the wage per employee in intermediate input industries in area κ relative to country c (2-digit). $rel.\ io\text{-}lab.prod._{cs\kappa}$ is the value added per employee in intermediate input industries in area κ relative to country c (2-digit). $Grubel\text{-}Lloyd_{cs\kappa}$ is the Grubel-Lloyed Index of industry s for trade with area κ (4-digit). γ_κ are area fixed effects, γ_i are firm fixed effects and $\gamma_{cs\kappa}$ are country-sector-area fixed effects. The sector level is defined at the 2-digit US SIC level. Specification (7) regroups small areas into larger areas. Specifically, Central & South America are grouped together with USA & Canada, and China & India are grouped together with Other Countries. Standard errors are clustered at the firm level and at the sector-country-area level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

toral level. Controlling for the differential importance of region κ at the sectoral level does not alter the main results significantly, though the effect on the triple interaction increases in terms of absolute size.

While specification (2) controls for the overall importance of the different areas in terms of trade, specifications (3) to (6) consider specific industry characteristics of those regions. Specification (3) looks at the per-capita wage in region κ for all input industries of sector s and relates it to the corresponding wage in firm i's home country c. Note that I add the relative wage in levels and further allow it to interact with the exporter dummy. While the reason to enter the level control is quite obvious, the reason to add the interacted control is of a more technical nature: as the effects under examination happen at the interaction level, controls, supposed to disentangle the exchange rate effects from alternative channels, should also enter at the interaction level.[51] From table II.2 it can be seen that the relative wage control is not affecting my estimates significantly. The coefficients on the controls are statistically close to zero, which is somewhat surprising, given that offshoring is often attributed to low foreign wages. Note however that the specification already controls for area fixed effects and that the relative wage control therefore measures wage effects only as long as they deviate at the sectoral level from the area average.

Specification (4) controls for the relative labor productivity in region κ's input industries. Again the level control is insignificant but now the effect is significant at the interaction level. Nevertheless, all interactions of interest remain significant at the 1% level. In specification (5) I add the Grubel-Lloyd index as a measure of intra-industry trade. This is supposed to control for the type of final good trade between area κ and home country c in firm i's output industry. A rise in the measure implies that comparative advantages are becoming less important in shaping trade patterns. The fact that the level effect on the control is negative is in line with offshoring being less relevant for regions that are similar to country c in terms of the trade structure. Not surprisingly, the control seems to be important for the correlation between export and import status and therefore reduces the exporter dummy effect substantially. In specification (6) I add all sector-level controls at the same time but the results

[51] For the controls of specification (2), the inclusion of an interaction term yields insignificant results for the main effects under consideration. This is not surprising, given that the sectoral controls of specification (2) capture the full industry sourcing patterns and thus will also contain the average effects of operational hedging at the sectoral level. The remaining variation of the *sectoral* exchange rate measure is then simply not enough to identify additional firm specific effects. Different from the controls in specification (2), the controls in specifications (3) to (6) are focused exclusively on alternative channels, leaving the full variation related to exchange rates for identification.

remain stable.

In specification (7), I replace area dummies by country-sector-area fixed effects. Accordingly, all level effects relating to the exchange rate measures and some of the controls are dropped from the model.[52] Specification (7) is my preferred specification. Astonishingly, the marginal effects implied by specification (7) are very close to the effects discussed earlier. Thus, for a high volatility region (75th percentile of the distribution), specification (7) implies that exporting decreases the probability of regional sourcing by 3.4 percentage points if the projection coefficient is at the 10th percentile but increases the probability by 4.2 percentage points for a projection coefficient at the 90th percentile of the distribution. The earlier results were -3.5 and 4.2 respectively.

Specification (8) repeats specification (7), but is based on a different area grouping. Specifically, I group the smallest regions together, i.e. Central & South America together with USA & Canada and China & India together with Other Countries. As shown in table A.1 in the appendix, exchange rate data is available for a limited set of countries only. Matching the different data sets implies an additional loss of countries, such that in my data Central & South America consists of Brazil and Mexico only. Furthermore, the complete set of Other Areas is represented by South Africa alone. Naturally, if the number of countries in a given region becomes too small, the co-movement of exchange rates increases. Thus effectively, the correlation coefficient is equal to one for Other Areas and potentially gets close to one if the number of countries per area is small.[53] This effect was of no consequence in the first part of the paper, as all effective exchange rates were constructed over the same set of available countries. For the current specification, the number of countries that feed into the area-specific effective exchange rates is different across areas. Note though, that this is partly controlled for by area or country-sector-area fixed effects. Still, because I am identifying at the interaction level, some of the constructional bias in projection coefficients might still be present in my results. Regrouping countries into broader areas increases the minimum number of countries in a given area to four.[54] As shown in

[52] Note that controls determined at the final good industry level remain in the model because they are constructed at the 4-digit industry level, whereas sectoral dummies relate to the 2-digit level. See the variable description in the appendix for details.

[53] See table A.4 in the appendix.

[54] Except for EU15 (14) and Other Asian (8), the groups are now relatively homogenous in size, with four or five countries in each regional cluster. In the robustness section I will re-run the regression omitting the two larger areas and show that my results do not exclusively hinge on these two country clusters.

table II.2, the results remain qualitatively the same for the new grouping. Quantitatively, the effects are slightly smaller, with the probability of regional imports from a high volatility region increasing in exporter status by 3.5 percentage points for a high projection coefficient but virtually independent of exporting for firms facing a low projection coefficient. Note though, that by reducing the number of areas from 8 to 6, a quarter of the observations yields no additional information and accordingly is lost for the empirical analysis. Because my focus lies on the qualitative results, I will stick to the full data set in what follows.

In table A.7 I present further robustness results, built upon specification (7) from the baseline table. Specification (1) to (5) consider real exchange rates and specification (6) to (10) nominal exchange rates. I will mention differences between the real and the nominal exchange rate specifications only if relevant. Specifications (1) and (6) repeat the baseline. Note that my baseline results are robust to using the nominal instead of the real exchange rate. The marginal effects are slightly larger, with the probability of regional sourcing 5 percentage points higher for a firm with projection coefficient at the 90th percentile and 4.3 percentage points lower for a firm at the 10th percentile (evaluated for regions with exchange rate volatility at the 75th percentile). In specifications (2) and (7), I use the non-demeaned projection coefficient which delivers identical results for the triple interaction. Specifications (3) and (8) use an indicator equal to one if the demeaned projection coefficient is larger than zero. The results remain qualitatively the same. The marginal effects implied are +3.6 and -1.6 percentage points for the real exchange rate (+4.3 and +1.6 for the nominal exchange rate) where these now refer to a firm with above and below average projection coefficient. Specification (4) and (9) use the demeaned correlation coefficient rather than the projection coefficient. This renders the coefficient on the triple interaction negative and insignificant. While this might be due to high collinearity of the triple interaction term,[55] I would argue that to some extent it also reflects the limited information content of the correlation coefficient. While the projection coefficient contains information regarding the actual size of the response in the intermediate import weighted exchange rate to a change in the export weighted exchange rate, the correlation just measures their unit-free association. Because hedging requires the response in the costs of intermediates to be *sizable*, the projection coefficient is the preferable measure.

[55] The variance inflation factor (VIF) of the triple interaction, for real exchange rates, is 16.9 for the correlation coefficient - up from 5.5 for the projection coefficient.

Specification (5) and (10) finally omit EU15 and Other Asian Countries from the set of regions. As discussed earlier, these areas are especially large in terms of the number of distinct countries involved and thus the projection coefficient might be biased due to constructional reasons. Furthermore, EU15 is by far the most important area in terms of export and import activity (see table A.4), with about 48% of the firms exporting to and 35% of the firms sourcing from EU15. Additionally, note that 12 out of 15 countries in EU15 use the Euro as currency. For many of the firms in my data, the exchange rate risk for the EU15 activities is therefore relatively small and relates to changes in the relative price levels. Accordingly, it is important to check whether my results hinge on the EU15 alone. As shown in specification (5) and (10), the effect on the triple interaction turns insignificant after dropping EU15 and Other Asian Countries for real exchange rates but remains significant close to the 5% level for the nominal exchange rate (p-value = 0.051).[56] The marginal effects for the high and low projection coefficient implied by these estimates are +4.5 and -0.093% respectively.

II.7. Conclusion

This paper confirms earlier results, suggesting that imported intermediates are important determinants for the pass-through of exchange rates into prices and sales of an exporter. If marginal costs and export prices are denominated in currencies that are closely related, then shocks to the exchange rate will trigger offsetting effects on foreign demand. Specifically, a devaluation will lower foreign prices through a conversion effect and increase foreign prices due to higher marginal costs. The reverse effects hold for an appreciation. This is an important finding, given that the apparent disconnect between exchange rates and trade flows has been considered one of the major puzzles in macroeconomics. Yet, the shift of focus away from the macroeconomic country perspective towards decisions taken at the firm level has brought to light a second question: do internationally active firms synchronize international activities and *purposely* produce a disconnect between exchange rates and prices in order to reduce their exposure to exchange rates?

The findings presented in this paper shed new light on this question that has only been addressed for large multinationals in the previous literature. They suggest that a qualified yes might be the answer. Offshoring provides for a means to operational

[56] The p-value is 0.029 when only omitting the EU15 and keeping Other Asian Countries in the model.

hedging if and only if sourcing regions are closely related to the firm's export market in terms of exchange rate co-movement. Note that the conditionality of the statement as well as the focus on small and medium-sized firms are two sides of a medal. Large multinationals are active in many countries and many dimensions, whereas the diversity of international activities decreases rapidly when considering smaller firms. Thus, while the diversification effect might provide a *natural* hedge for large multinationals, as earlier studies have confirmed, my findings suggest that smaller firms will have to actively match international activities in order to benefit from operational hedges.

Viewed from a different perspective, my results send a clear warning to small and medium-sized firms considering a mix of different international activities: because export and sourcing decisions are often taken for reasons other than exchange rate considerations, such as cheap foreign inputs or promising foreign markets, firms are potentially underestimating the exchange rate risks involved. The tempting idea of natural hedges just doesn't appear to hold for the average firm.

A. Appendix

A.1. Theoretical Appendix

A.1.1. Decomposition of Effects for Total Sales

$$
\begin{aligned}
\frac{\partial r_{tot}}{\partial E_x} &= \frac{\partial r_{€}}{\partial E_x} + \frac{\partial E_x r_{\$}}{\partial E_x} = \frac{\partial p_{€} q_{€}}{\partial E_x} + \frac{\partial E_x p_{\$} q_{\$}}{\partial E_x} \\
&= \underbrace{\frac{\partial p_{€}}{\partial E_x} q_{€}}_{a} + \underbrace{\frac{\partial q_{€}}{\partial E_x} p_{€}}_{b+\epsilon_1} + \underbrace{\frac{\partial E_x}{\partial E_x} p_{\$} q_{\$}}_{c} + \underbrace{\frac{\partial p_{\$}}{\partial E_x} E_x q_{\$}}_{d} + \underbrace{\frac{\partial q_{\$}}{\partial E_x} E_x p_{\$}}_{e+\epsilon_2}
\end{aligned}
$$

Where in case of a devaluation total revenues change due to:

- the change in domestic revenues
  - a) higher prices due to higher import cost (given quantities)
  - b) lower demand due to higher prices
  - ϵ_1) sectoral effect that resembles general equilibrium adjustments in the domestic demand shifter
- and the change in foreign revenues
  - c) higher conversion of foreign revenues into domestic currency (given revenues in foreign currency)
  - d) change in foreign prices due to d_1) higher import cost and d_2) lower conversion of domestic prices into foreign currency (given quantities)
  - e) change in foreign demand due to the price changes induced by e_1) higher import cost and e_2) lower conversion of domestic prices into foreign currency (given quantities)
  - ϵ_2) sectoral effect that resembles general equilibrium adjustments in the foreign demand shifter

Using Dixit-Stiglitz definitions of prices, quantities and the price elasticity of demand, as well as my definitions of marginal cost and the share imported intermediates (IS), reordering, multiplying with the absolute change in E_x and keeping track of the effects we obtain equation (II.5):

$$\begin{aligned}\frac{\partial r_{tot}}{\partial E_x}\cdot\Delta E_x &= \underbrace{\sigma\cdot E_x r_\$ \cdot\frac{\Delta E_x}{E_x}}_{c+d_2+e_2}\underbrace{-(\sigma-1)\cdot r_{tot}\cdot IS\cdot\frac{dE_i}{dE_x}\frac{E_x}{E_i}\cdot\frac{\Delta E_x}{E_x}}_{a+b+d_1+e_1}\\ &\quad \underbrace{+\,r_€\cdot\frac{\Delta Q_€ P_€^\sigma}{Q_€ P_€^\sigma}}_{\epsilon_1}+\underbrace{E_x r_\$\cdot\frac{\Delta Q_\$ P_\$^\sigma}{Q_\$ P_\$^\sigma}}_{\epsilon_2}\end{aligned}$$

The effects are now ordered in the following way:[57]

- A positive effect on foreign revenues due to a higher conversion of foreign revenues into domestic currency (c)
- A positive effect on foreign revenues due to a lower conversion of domestic prices into foreign currency (d_2+e_2)
- A negative effect on domestic revenues due to higher material cost $(a+b)$,
- A negative effect on foreign revenues due to higher material cost (d_1+e_1)
- Sectoral effects that resemble general equilibrium adjustments in the domestic and foreign demand shifter, weighted by firm activity at home and abroad $(\epsilon_1+\epsilon_2)$

A.1.2. The Structural Error for Nominal Exchange Rates

$$\widehat{\epsilon}_r = (1-XS)\cdot\frac{\Delta Q_€ P_€^\sigma}{Q_€ P_€^\sigma}+XS\cdot\frac{\Delta Q_\$ P_\$^\sigma}{Q_\$ P_\$^\sigma} \tag{A.1}$$

A.1.3. The Structural Error for Real Exchange Rates

$$\begin{aligned}\overline{\epsilon}_r &= (1-XS)\cdot\frac{\Delta Q_€ P_€^\sigma}{Q_€ P_€^\sigma}+XS\cdot\frac{\Delta Q_\$ P_\$^\sigma}{Q_\$ P_\$^\sigma}\\ &\quad +\sigma\cdot 1\cdot XS\cdot\frac{\Delta\widehat{P}}{\widehat{P}}-(\sigma-1)\cdot IS\cdot\frac{\Delta\widehat{P}}{\widehat{P}}\end{aligned} \tag{A.2}$$

where $\widehat{P}\equiv P_€/P_\$$ resembles the relative price levels abroad and at home.

[57] Note that the quantity effect always dominates the price effect for $\sigma>1$

A.1.4. Extension for Costs and Profits

Costs

$$\frac{\partial c_{tot}}{\partial E_x} = \underbrace{\frac{\partial q_{tot}}{\partial E_x} \cdot MC}_{\text{A: change in demand}} + \underbrace{q_{tot} \cdot \frac{\partial MC}{\partial E_x}}_{\text{B: change in marginal cost}}$$

Where the change in quantities produced (A) is determined by:

$$\begin{aligned}\frac{\partial (q_{€} + q_{\$})}{\partial E_x} &= Q_{€} P_{€}^{\sigma} \cdot \frac{\partial p_{€}^{-\sigma}}{\partial E_x} + Q_{\$} P_{\$}^{\sigma} \cdot \frac{\partial p_{\$}^{-\sigma}}{\partial E_x} + p_{€}^{-\sigma} \cdot \frac{\partial Q_{€} P_{€}^{\sigma}}{\partial E_x} + p_{\$}^{-\sigma} \cdot \frac{\partial Q_{\$} P_{\$}^{\sigma}}{\partial E_x} \\ &= \underbrace{-\sigma \cdot \frac{q_{€}}{p_{€}} \cdot \frac{\partial p_{€}}{\partial E_x}}_{a_1} + \underbrace{(-\sigma) \cdot \frac{q_{\$}}{p_{\$}} \cdot \frac{\partial p_{\$}}{\partial E_x}}_{a_2 + a_3} + \underbrace{p_{€}^{-\sigma} \cdot \frac{\partial Q_{€} P_{€}^{\sigma}}{\partial E_x} + p_{\$}^{-\sigma} \cdot \frac{\partial Q_{\$} P_{\$}^{\sigma}}{\partial E_x}}_{\epsilon_c'}\end{aligned}$$

Thus, a devaluation:

a_1) decreases domestic demand due to higher domestic prices (higher input costs)

a_2) decreases foreign demand due to higher foreign prices (higher input costs)

a_3) increases foreign demand due to lower conversion of domestic prices into foreign prices

B) increases total cost due to higher conversion of imported input prices into domestic currency (given quantities)

ϵ_c') Sectoral effects that resemble general equilibrium adjustments in the domestic and foreign demand shifter, weighted by firm activity at home and abroad

Multiplying with the absolute change in exchange rates, using Dixit-Stiglitz definitions of prices, quantities and the price elasticity of demand, as well as my definitions of marginal cost and the share imported intermediates (IS), reordering and keeping track of the effects we obtain:

$$\frac{\partial c_{tot}}{\partial E_x} \cdot \Delta E_x = \underbrace{\sigma \cdot E_x c_{\$} \cdot \frac{\Delta E_x}{E_x}}_{a_3} \underbrace{-(\sigma - 1) \cdot IS \cdot c_{tot} \cdot \frac{dE_i}{dE_x} \frac{E_x}{E_i} \cdot \frac{\Delta E_x}{E_x}}_{a_1 + a_2 + B}$$
$$+ \underbrace{c_{€} \cdot \frac{\Delta Q_{€} P_{€}^{\sigma}}{Q_{€} P_{€}^{\sigma}} + E_x c_{\$} \cdot \frac{\Delta Q_{\$} P_{\$}^{\sigma}}{Q_{\$} P_{\$}^{\sigma}}}_{\epsilon_c}$$

Profits The equivalent of equation (II.15) in nominal terms results by using equations (II.6) and (A.3) and noting that:

$$\frac{\partial \pi}{\partial E_x} \cdot \Delta E_x = \frac{\partial r_{tot}}{\partial E_x} \cdot \Delta E_x - \frac{\partial c_{tot}}{\partial E_x} \cdot \Delta E_x$$

Wedge Factor for Costs

$$\frac{\Delta c_{tot}}{c_{tot}} = \sigma \cdot \frac{E_x c_{\$}}{c_{tot}} \cdot \frac{\Delta E_x}{E_x} - (\sigma - 1) \cdot IS \cdot \frac{dE_i}{dE_x} \frac{E_x}{E_i} \cdot \frac{\Delta E_x}{E_x}$$
$$+ \underbrace{\frac{c_{€}}{c_{tot}} \cdot \frac{\Delta Q_{€} P_{€}^{\sigma}}{Q_{€} P_{€}^{\sigma}} + \frac{E_x c_{\$}}{c_{tot}} \cdot \frac{\Delta Q_{\$} P_{\$}^{\sigma}}{Q_{\$} P_{\$}^{\sigma}}}_{\widehat{\epsilon}_c}$$

Using:

$$E_x c_{\$} = [(1-i) w_{€} + i w_{\$} E_i] \cdot q_{\$} = E_x r_{\$} \cdot \frac{1}{\mu \tau}$$

$$c_{tot} = [(1-i) w_{€} + i w_{\$} E_i] \cdot (q_{€} + q_{\$}) = r_{€} \cdot \frac{1}{\mu} + E_x r_{\$} \cdot \frac{1}{\mu \tau}$$

$$\Rightarrow \frac{E_x c_\$}{c_{tot}} = \frac{E_x r_\$ \cdot \frac{1}{\tau}}{r_€ + E_x r_\$ \cdot \frac{1}{\tau}} = \frac{E_x r_\$}{r_{tot}} \cdot \frac{r_{tot}}{r_€ \tau + E_x r_\$}$$

$$= \frac{E_x r_\$}{r_{tot}} \cdot \underbrace{\left[\frac{r_€}{r_{tot}} \cdot \tau + \frac{E_x r_\$}{r_{tot}} \cdot 1\right]^{-1}}_{A \in [0,1]} = XS \cdot A$$

where: $A \to 1$ if $\tau \to 1$ and $A \to 0$ if $\tau \to \infty$

Wedge Factor for Profits

$$\frac{\Delta \pi}{\pi} = \sigma \cdot \frac{E_x \pi_\$}{\pi_{tot}} \cdot \frac{\Delta E_x}{E_x} - (\sigma - 1) \cdot IS \cdot \frac{dE_i}{dE_x} \frac{E_x}{E_i} \cdot \frac{\Delta E_x}{E_x}$$

$$+ \underbrace{\frac{\pi_€}{\pi_{tot}} \cdot \frac{\Delta Q_€ P_€^\sigma}{Q_€ P_€^\sigma} + \frac{E_x \pi_\$}{\pi_{tot}} \cdot \frac{\Delta Q_\$ P_\$^\sigma}{Q_\$ P_\$^\sigma}}_{\widehat{\epsilon}_\pi}$$

Using:

$$E_x c_\$ = E_x r_\$ \cdot \frac{1}{\mu \tau}$$

$$c_{tot} = r_€ \cdot \frac{1}{\mu} + E_x r_\$ \cdot \frac{1}{\mu \tau}$$

$$\Rightarrow \frac{E_x \pi_\$}{\pi_{tot}} = \frac{E_x r_\$ - E_x c_\$}{r_{tot} - c_{tot}} = \frac{E_x r_\$ \left(1 - \frac{1}{\mu \tau}\right)}{r_{tot} - \left(E_x r_\$ \frac{1}{\mu \tau} + r_€ \frac{1}{\mu}\right)}$$

$$= \frac{E_x r_\$}{r_{tot}} \cdot \underbrace{\frac{\mu \tau - 1}{\mu \tau - \left(\frac{E_x r_\$}{r_{tot}} \cdot 1 + \frac{r_€}{r_{tot}} \cdot \tau\right)}}_{B \in [1,\infty]} = XS \cdot B$$

where: $B \to 1$ if $\tau \to 1$ and $B \to \left[1 - \frac{r_€}{r_{tot}} \frac{1}{\mu}\right]^{-1} > 1$ if $\tau \to \infty$

The Structural Error for Real Exchange Rates - Costs

$$\bar{\epsilon}_c = (1 - XS \cdot A) \cdot \frac{\Delta Q_€ P_€^\sigma}{Q_€ P_€^\sigma} + XS \cdot A \cdot \frac{\Delta Q_\$ P_\$^\sigma}{Q_\$ P_\$^\sigma} + \sigma \cdot A \cdot XS \cdot \frac{\Delta \widehat{P}}{\widehat{P}} - (\sigma - 1) \cdot IS \cdot \frac{\Delta \widehat{P}}{\widehat{P}} \tag{A.3}$$

The Structural Error for Real Exchange Rates - Profits

$$\bar{\epsilon}_\pi = (1 - XS \cdot B) \cdot \frac{\Delta Q_€ P_€^\sigma}{Q_€ P_€^\sigma} + XS \cdot B \cdot \frac{\Delta Q_\$ P_\$^\sigma}{Q_\$ P_\$^\sigma} + \sigma \cdot B \cdot XS \cdot \frac{\Delta \widehat{P}}{\widehat{P}} - (\sigma - 1) \cdot IS \cdot \frac{\Delta \widehat{P}}{\widehat{P}} \tag{A.4}$$

A.2. Data Appendix

Table A.1.: The Currency Basket

EFIGE Area	Partner Country	Currency
EU15	Austria	Euro
EU15	Belgium	Euro
EU15	Denmark	Danish krone
EU15	Finland	Euro
EU15	France	Euro
EU15	Germany	Euro
EU15	Greece	Euro
EU15	Ireland	Euro
EU15	Italy	Euro
EU15	Luxembourg	Euro
EU15	Netherlands	Euro
EU15	Portugal	Euro
EU15	Spain	Euro
EU15	Sweden	Swedish krona
EU15	United Kingdom	Pound sterling
OTHER EU COUNTRIES	Bulgaria	Bulgarian lev
OTHER EU COUNTRIES	Czech Republic	Czech koruna
OTHER EU COUNTRIES	Hungary	Hungarian forint
OTHER EU COUNTRIES	Poland	Polish zloty
OTHER EU COUNTRIES	Romania	Romanian leu
OTHER EUROPEAN COUNTRIES NOT EU	Croatia	Croatian kuna
OTHER EUROPEAN COUNTRIES NOT EU	Norway	Norwegian krone
OTHER EUROPEAN COUNTRIES NOT EU	Russian Federation	Russian rouble
OTHER EUROPEAN COUNTRIES NOT EU	Switzerland	Swiss franc
OTHER EUROPEAN COUNTRIES NOT EU	Turkey	Turkish lira
CHINA AND INDIA	China	Renminbi-yuan
CHINA AND INDIA	Hong Kong, China	Hong Kong dollar
CHINA AND INDIA	India	Indian rupee
OTHER ASIAN COUNTRIES	Indonesia	Indonesian rupiah
OTHER ASIAN COUNTRIES	Israel	Israeli shekel
OTHER ASIAN COUNTRIES	Japan	Japanese yen
OTHER ASIAN COUNTRIES	Korea, Rep.	South Korean won
OTHER ASIAN COUNTRIES	Malaysia	Malaysian ringgit
OTHER ASIAN COUNTRIES	Philippines	Philippine peso
OTHER ASIAN COUNTRIES	Singapore	Singapore dollar
OTHER ASIAN COUNTRIES	Thailand	Thai baht
USA AND CANADA	Canada	Canadian dollar
USA AND CANADA	United States	US dollar
CENTRAL AND SOUTH AMERICA	Brazil	Brazilian real
CENTRAL AND SOUTH AMERICA	Mexico	Mexican peso
OTHER AREAS	South Africa	South African rand
dropped due to missing price data	Australia	Australian dollar
dropped due to missing price data	New Zealand	New Zealand dollar
dropped due to missing price data	Serbia	Serbian dinar
dropped due to missing price data	Argentina	Argentine peso
dropped due to missing trade data	Iceland	Icelandic krona
dropped due to missing trade data	Macedonia	Denar (of the former Yugoslav Republic of Macedonia)
dropped due to missing trade data	Taiwan	New Taiwan dollar

Notes: I use bilateral nominal exchange rates with respect to the Euro from Eurostat [ert_bil_eur_m]. These are matched with seasonally adjusted CPI price data from World Bank's Global Economic Monitor [CPTOTSAXN] in order to construct real exchange rates with respect to the Euro, the Pound Sterling and the Hungarian Forint. Eurostat provides bilateral exchange rates with respect to the EURO for 36 currencies. I can match 32 of these currencies with the CPI data, loosing the Australian Dollar, the New Zealand Dollar, the Serbian Dinar and the Argentine Peso due to missing price data for the base month January 2004. Matching the combined exchange rate and price data with trade data leads to the loss of three additional currencies, the Icelandic Krona, the Macedonian Denar and the New Taiwan Dollar. The reason is that I want to keep the set of countries feeding into the weighting of exchange rates to be relatively constant across all industries and I want them to be the same for both export and import flows. As trade flows are a crucial determinant in the effective exchange rate construction, they also determine the co-movement of effective exchange rates. I therefore need to make sure that it is not missing data that is driving my results. Thus, I drop industries when too many countries are missing for those industries and I drop countries with two many missing industries. This results in a set of 29 currencies other than the Euro, plus 12 distinct real Euro exchange rates.

Table A.2.: Description of Variables

variable	description
XS_{csi}	Percentage of annual turnover represented by exports (2008, *EFIGE*).
IS_{csi}	Percentage of intermediate goods purchased from abroad (2008, *EFIGE*).
$importer_{csi\kappa}$	Indicator equal to 1 if percentage of intermediate goods purchased from area κ larger than zero (2008, *EFIGE*).
$exporter_{csi\kappa}$	Indicator equal to 1 if percentage of exports sold to area κ larger than zero (2008, *EFIGE*).
FH_{csi}	Indicator equal to 1 if firm uses foreign exchange risk protection (2008, *EFIGE*).
$Sales_{csit}$	turnover in th. EUR (*Amadeus*), if missing: costs of goods sold - costs of employees in th. EUR (Amadeus).
$Materialcost_{csit}$	material cost in th. EUR (*Amadeus*)
$Profits_{csit}$	gross profit in th. EUR (*Amadeus*), if missing: turnover - costs of goods sold in th. EUR (Amadeus).
$Assets_{csit}$	total assets in th. EUR (*Amadeus*).
μ_{csit}	turnover / (cost of employees + material cost) in th. EUR (*Amadeus*). Alternative measures used: (turnover - cost of employees - material cost) /turnover in th. EUR (*Amadeus*) , $EMS^{2008}_{cs\kappa}$: $XS_{cs\kappa} * Sales^{2008}_{cs\kappa}$/ (total sectoral imports of the outside world (*WITS/Comtrade), see Marin et al. (2014b) for detailed information*).
$R^{f}_{cs\kappa t}$ with $f \in x, i, xi$	Export weighted (x), intermediate input weighted (i) or export and import weighted (xi) real effective exchange rate specific to country c, sector s and area κ. If the κ is omitted, the weighting is done with respect to the whole world. See section II.4 for detailed information.
$E^{f}_{cs\kappa t}$ with $f \in x, i, xi$	Export weighted (x), intermediate input weighted (i) or export and import weighted (xi) nominal effective exchange rate specific to country c, sector s and area κ. If the κ is omitted, the weighting is done with respect to the whole world. See section II.4 for detailed information.
$Proj^{didx}_{cs\kappa}$	Elasticity of the monthly intermediate import weighted with respect to the export weighted exchange rate, measured over the full sample period. Real or nominal in accordance with the exchange rate measure used and specific to country c, sector s and area κ. If the κ is omitted, the weighting is done with respect to the whole world. $\widehat{Proj}^{didx}_{cs\kappa}$ is the corresponding measure demeaned for the sample. See section II.4 for detailed information.
$\widehat{corr}_{cs\kappa}$	Simple correlation coefficient between the monthly intermediate import weighted and the export weighted exchange rate, demeaned for the regression sample and measured over the full sample period. Real or nominal in accordance with the exchange rate measure used and specific to country c, sector s and area κ.
$sd(R^{xi}_{cs\kappa t})_{cs\kappa}$	Standard deviation of the monthly intermediate import and export weighted real effective exchange rate specific to country c, sector s and area κ and measured over the full sample period.
$sd(E^{xi}_{cs\kappa t})_{cs\kappa}$	Standard deviation of the monthly intermediate import and export weighted nominal effective exchange rate specific to country c, sector s and area κ and measured over the full sample period.
reg. io-import share$_{cs\kappa}$	Share of region κ in all industry s intermediate imports into country c. Import data at the 2-digit level (ISIC Rev. 3) from *WITS/Comtrade*, linked to output industries via the IO-table from *OECD Stan*.
reg. final-export share$_{cs\kappa}$	Share of region κ in all industry s final good exports from country c. Export data at the 4-digit level (ISIC Rev. 3) from *WITS/Comtrade*.
rel. io-wage (p.C.)$_{cs\kappa}$	Wage per Employee (INDSTAT, ISIC Rev. 3, 2-digit) in region κ relative to Wage per Employee in country c. Relative wage is input-industry specific, where input industries have been linked to output industries via the IO-table from *OECD Stan*.
rel. io-lab.prod.$_{cs\kappa}$	Value Added per Employee (INDSTAT, ISIC Rev. 3, 2-digit) in region κ relative to Value Added per Employee in country c. Relative labor productivity is input-industry specific, where input industries have been linked to output industries via the IO-table from *OECD Stan*.
Grubel-Lloyd$_{cs\kappa}$	$1 - \frac{\lvert EX_{cs\kappa} - IM_{cs\kappa} \rvert}{EX_{cs\kappa} + IM_{cs\kappa}}$, where $EX_{cs\kappa}$ are final good export flows from country c to area κ in industry s (*WITS/Comtrade*) at the 4-digit level (ISIC Rev. 3) and $IM_{cs\kappa}$ are corresponding final good import flows from region κ into country c.

Table A.3.: Summary Statistics

	Obs	Mean	Std. Dev.	Min	Max
	Summary Statistics for Section II.5				
$\Delta log(Sales_{csit})$	60174	0.00	0.22	-0.75	0.66
$\Delta log(Materialcosts_{csit})$	60174	0.00	0.34	-1.15	1.04
$\Delta log(Profits_{csit})$	60174	-0.01	0.38	-1.51	1.20
			real		
$\Delta log R^x_{cst}$	60174	0.00	0.02	-0.10	0.14
$\widehat{Proj}^{didx}_{cs}$	60174	0.00	0.16	-0.51	0.67
$\widehat{Proj}^{didx}_{cs} > 0$	60174	0.43	0.50	0.00	1.00
$Proj^{didx}_{cs}$	60174	0.86	0.16	0.35	1.53
			nominal		
$\Delta log E^x_{cst}$	60174	0.00	0.02	-0.06	0.14
$\widehat{Proj}^{didx}_{cs}$	60174	0.00	0.14	-0.37	0.61
$\widehat{Proj}^{didx}_{cs} > 0$	60174	0.45	0.50	0.00	1.00
$Proj^{didx}_{cs}$	60174	0.65	0.14	0.28	1.25
IS_{csi}	60174	0.13	0.23	0.00	1.00
XS_{csi}	60174	0.19	0.27	0.00	1.00
μ_{csit}	60174	1.53	0.38	1.00	3.55
$\Delta log(Assets_{csit})$	60174	0.03	0.18	-0.51	0.61
FH_{csi}	60174	0.10	0.30	0.00	1.00
	Summary Statistics for Section II.6				
$importer_{csi\kappa}$	86934	0.10	0.30	0.00	1.00
$exporter_{csi\kappa}$	86934	0.21	0.41	0.00	1.00
			real		
$sd(X^{xi}_{cs\kappa t})_{cs\kappa}$	86934	0.10	0.05	0.01	0.35
$\widehat{Proj}^{didx}_{cs\kappa}$	86934	0.00	0.16	-0.82	0.79
$Proj^{didx}_{cs\kappa}$	86934	0.98	0.16	0.16	1.77
$\widehat{Proj}^{didx}_{cs\kappa} > 0$	86934	0.46	0.50	0.00	1.00
$\widehat{corr}_{cs\kappa}$	86934	0.00	0.08	-0.86	0.05
			nominal		
$sd(X^{xi}_{cs\kappa t})_{cs\kappa}$	86934	0.09	0.05	0.00	0.25
$\widehat{Proj}^{didx}_{cs\kappa}$	86934	0.00	0.20	-1.18	0.87
$Proj^{didx}_{cs\kappa}$	86934	0.93	0.20	-0.25	1.81
$\widehat{Proj}^{didx}_{cs\kappa} > 0$	86934	0.41	0.49	0.00	1.00
$\widehat{corr}_{cs\kappa}$	86934	0.00	0.16	-1.08	0.11
$reg.\ io\text{-}import\ share_{cs\kappa}$	86934	0.12	0.20	0.00	0.75
$reg.\ final\text{-}export\ share_{cs\kappa}$	86934	0.13	0.19	0.00	0.94
$rel.\ io\text{-}wage\ (p.C.)_{cs\kappa}$	86934	0.59	0.56	0.04	5.86
$rel.\ io\text{-}lab.prod._{cs\kappa}$	86934	0.88	0.95	0.12	12.54
$Grubel\text{-}Lloyd_{cs\kappa}$	86934	0.52	0.29	0.00	1.00

Notes: Table provides selected summary statistics for the variables used in sections II.5 and II.6. For a definition of variables, see table A.2. $\Delta log(Sales_{csit})$, $\Delta log(Materialcosts_{csit})$, $\Delta log(Profits_{csit})$, $\Delta log(Assets_{csit})$ and μ_{csit} are winsorized at the 1%-level in order to normalize the error distribution. The results presented are robust to using the non-winsorized variables.

Table A.4.: Summary Statistics - Key Variables (by Area)

Area	#c	Obs	Mean	Std. Dev.	Mean	Std. Dev.	
			$importer_{csi\kappa}$		$exporter_{csi\kappa}$		
EU15	14	11078	0.35	0.48	0.48	0.50	
OTHER EU COUNTRIES	5	10799	0.09	0.29	0.23	0.42	
OTHER EUROPEAN COUNTRIES NOT EU	5	10913	0.07	0.26	0.25	0.43	
CHINA AND INDIA	3	10755	0.11	0.31	0.12	0.33	
OTHER ASIAN COUNTRIES	8	10789	0.05	0.22	0.14	0.35	
USA AND CANADA	2	10812	0.07	0.25	0.19	0.39	
CENTRAL AND SOUTH AMERICA	2	10927	0.02	0.13	0.12	0.32	
OTHER AREAS	1	10861	0.02	0.14	0.15	0.36	
CHINA, INDIA + OTHER	4	10755	0.12	0.32	0.21	0.41	
AMERICA	4	10812	0.08	0.27	0.22	0.42	
Area	**#c**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	
				$sd(R^{xi}_{cs\kappa t})_{cs\kappa}$			
EU15	14	11078	0.02	0.02	0.01	0.09	
OTHER EU COUNTRIES	5	10799	0.08	0.02	0.05	0.14	
OTHER EUROPEAN COUNTRIES NOT EU	5	10913	0.08	0.02	0.05	0.14	
CHINA AND INDIA	3	10755	0.13	0.02	0.11	0.18	
OTHER ASIAN COUNTRIES	8	10789	0.09	0.02	0.07	0.15	
USA AND CANADA	2	10812	0.06	0.01	0.05	0.10	
CENTRAL AND SOUTH AMERICA	2	10927	0.13	0.03	0.06	0.23	
OTHER AREAS	1	10861	0.12	0.00	0.12	0.13	
CHINA, INDIA + OTHER	4	10755	0.12	0.02	0.09	0.17	
AMERICA	4	10812	0.06	0.01	0.05	0.12	
Area	**#c**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Corr**
					$\widehat{Proj}^{didx}_{cs\kappa}$		
EU15	14	11078	-0.13	0.11	-0.49	0.12	0.96
OTHER EU COUNTRIES	5	10799	0.00	0.04	-0.23	0.08	0.98
OTHER EUROPEAN COUNTRIES NOT EU	5	10913	-0.14	0.06	-0.36	0.04	0.93
CHINA AND INDIA	3	10755	0.19	0.07	-0.06	0.45	0.96
OTHER ASIAN COUNTRIES	8	10789	-0.12	0.10	-0.34	0.12	0.86
USA AND CANADA	2	10812	0.01	0.02	-0.09	0.07	0.99
CENTRAL AND SOUTH AMERICA	2	10927	0.17	0.23	-0.82	0.79	0.86
OTHER AREAS	1	10861	0.01	0.00	0.01	0.01	1.00
CHINA, INDIA + OTHER	4	10755	0.23	0.09	-0.36	0.49	0.93
AMERICA	4	10812	-0.05	0.12	-0.43	0.42	0.87

Notes: Table provides selected summary statistics for the key variables used in section II.6 by area. Areas are either the original EFIGE area groups or regrouped in order to increase the number of countries (#c) per area group. Specifically, China & India are grouped together with Other Areas, and USA & Canada are grouped together with Central & South America. *Corr* is the correlation coefficient that relates to each projection coefficient. For a definition of the variables, see table A.2. For the countries in each area, see table A.1.

Table A.5.: Robustness

	$Sales_{csit}$								$\Delta logE^x_{cst}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\Delta logR^x_{cst}$	-0.161*	0.0456	-0.150	-0.123					-0.167	
	(0.0962)	(0.126)	(0.160)	(0.368)					(0.149)	
$\Delta logR^x_{cst} \times XS_{csi}$	0.859***	0.872***	0.856***	0.859***	0.760***	0.758***	0.731***	0.760***	0.894***	0.737***
	(0.165)	(0.165)	(0.172)	(0.165)	(0.217)	(0.217)	(0.215)	(0.217)	(0.162)	(0.210)
$\Delta logR^x_{cst} \times IS_{csi}$	0.160	0.662**	0.158	2.683**	0.551**	1.083***	0.537**	2.639**	0.178	0.540**
	(0.189)	(0.290)	(0.189)	(1.045)	(0.211)	(0.318)	(0.210)	(1.218)	(0.192)	(0.218)
$\Delta logR^x_{cst} \times IS_{csi} \times f(Proj^{didx}_{cs})$	-2.939***	-1.028***	-2.934***	-2.939***	-2.432*	-1.077***	-2.400*	-2.432*	-1.424*	-1.435**
	(1.121)	(0.359)	(1.124)	(1.121)	(1.283)	(0.369)	(1.280)	(1.283)	(0.738)	(0.708)
$\Delta logR^x_{cst} \times FH_{csi}$			-0.0113				-0.117			
			(0.137)				(0.108)			
Measure of Co-movement	$\widehat{Proj}^{didx}_{cs}$	$\widehat{Proj}^{didx}_{cs} > 0$	$\widehat{Proj}^{didx}_{cs}$	$Proj^{didx}_{cs}$	$\widehat{Proj}^{didx}_{cs}$	$\widehat{Proj}^{didx}_{cs} > 0$	$\widehat{Proj}^{didx}_{cs}$	$Proj^{didx}_{cs}$	$\widehat{Proj}^{didx}_{cs}$	$\widehat{Proj}^{didx}_{cs}$
μ_{csit}	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
$\Delta log(Assets_{csit})$	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Fixed Effects	$\gamma_i + \gamma_t$	$\gamma_i + \gamma_t$	$\gamma_i + \gamma_t$	$\gamma_i + \gamma_t$	$\gamma_i + \gamma_{cst}$	$\gamma_i + \gamma_{cst}$	$\gamma_i + \gamma_{cst}$	$\gamma_i + \gamma_{cst}$	$\gamma_i + \gamma_t$	$\gamma_i + \gamma_{cst}$
Cluster (Firm)	yes	yes	yes	yes	no	no	no	no	yes	no
Cluster (Sector#Country)	no	no	no	no	yes	yes	yes	yes	no	yes
Nr. of Clusters	8641	8641	8641	8641	153	153	153	153	8641	153
Adj. R2	0.314	0.314	0.314	0.314	0.343	0.343	0.343	0.343	0.314	0.343
Observations	59,747	59,747	59,747	59,747	59,491	59,491	59,491	59,491	59,747	59,491

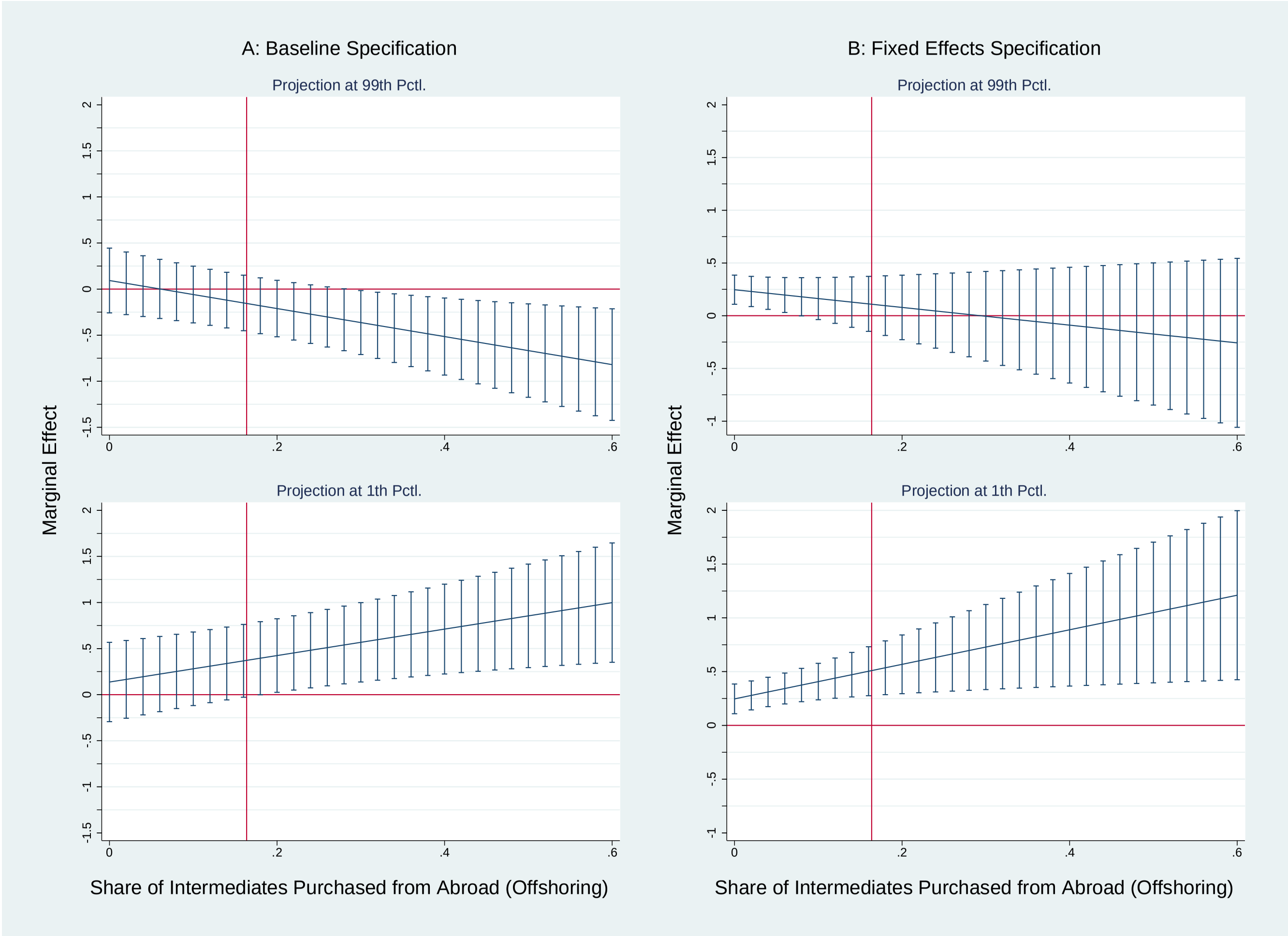
Notes: Observations relate to firm i in year t, where firms are based in country c and active in sector s. The dependent variable $Sales_{csit}$ represents total sales of firm i in year t. $\Delta logR^x_{cst}$ are annual log-changes of the country and sector specific export weighted real effective exchange rate. XS_{csi} and IS_{csi} denote the firm specific export and import share respectively. $\widehat{Proj}^{didx}_{cs}$ is a demeaned version of $Proj^{didx}_{cs}$, the elasticity of the import weighted with respect to the export weighted real effective exchange rate. In specifications (9) and (10), the real effective exchange rate is replaced by the nominal effective exchange rate E^x_{cst}, and the measure of co-movement is constructed accordingly. FH_{csi} is a dummy variable indicating whether firm i is using financial hedges. μ_{csit} is a markup control defined in the appendix. $\Delta log(Assets_{csit})$ is the log-change in total assets. γ_{cs} are country-sector fixed effects, γ_t are year fixed effects, γ_i are firm fixed effects and γ_{cst} are country-sector-year fixed effects. The sector level is defined at the 2-digit US SIC level. All specifications contain the full set of relevant sub-interaction terms and level effects. Standard errors are clustered either at the firm level or at the country-sector level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A.6.: Extension

	$Materialcost_{csit}$				$Profits_{csit}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta log R^x_{cst}$	0.248*	0.625***			-0.0407	0.422**		
	(0.147)	(0.200)			(0.153)	(0.213)		
$\Delta log R^x_{cst} \times XS_{csi}$	0.729***	0.748***	0.593*	0.589*	1.327***	1.336***	1.368***	1.369***
	(0.242)	(0.242)	(0.317)	(0.318)	(0.287)	(0.286)	(0.363)	(0.363)
$\Delta log R^x_{cst} \times IS_{csi}$	-0.0275	0.576	0.685**	1.296***	-0.0717	-0.257	0.0892	-0.0699
	(0.305)	(0.464)	(0.304)	(0.413)	(0.327)	(0.496)	(0.337)	(0.584)
$\Delta log R^x_{cst} \times IS_{csi} \times f(Proj^{didx}_{cs})$	-2.605	-1.112*	-2.376	-1.195**	-0.359	0.311	-0.0534	0.243
	(1.679)	(0.580)	(1.861)	(0.540)	(1.825)	(0.617)	(1.702)	(0.666)
Measure of Co-movement	$\widehat{Proj}^{didx}_{cs}$	$\widehat{Proj}^{didx}_{cs} > 0$	$\widehat{Proj}^{didx}_{cs}$	$\widehat{Proj}^{didx}_{cs} > 0$	$\widehat{Proj}^{didx}_{cs}$	$\widehat{Proj}^{didx}_{cs} > 0$	$\widehat{Proj}^{didx}_{cs}$	$\widehat{Proj}^{didx}_{cs} > 0$
μ_{csit}	yes	yes	yes	yes	yes	yes	yes	yes
$\Delta log(Assets_{csit})$	yes	yes	yes	yes	yes	yes	yes	yes
Fixed Effects	$\gamma_i + \gamma_t$	$\gamma_i + \gamma_t$	$\gamma_i + \gamma_{cst}$	$\gamma_i + \gamma_{cst}$	$\gamma_i + \gamma_t$	$\gamma_i + \gamma_t$	$\gamma_i + \gamma_{cst}$	$\gamma_i + \gamma_{cst}$
Cluster (Firm)	yes	yes	no	no	yes	yes	no	no
Cluster (Sector#Country)	no	no	yes	yes	no	no	yes	yes
Nr. of Clusters	8641	8641	153	153	8641	8641	153	153
Adj. R2	0.219	0.219	0.244	0.244	0.218	0.218	0.230	0.230
Observations	59,747	59,747	59,491	59,491	59,747	59,747	59,491	59,491

Notes: Observations relate to firm i in year t, where firms are based in country c and active in sector s. The dependent variables $Materialcost_{csit}$ and $Profits_{csit}$ represent total ma sales of firm i in year t. $\Delta log R^x_{cst}$ are annual log-changes of the country and sector specific real effective exchange rate. XS_{csi} and IS_{csi} denote the firm specific export and import share respectively. $\widehat{Proj}^{didx}_{cs}$ is the elasticity of the import weighted with respect to the export weighted real effective exchange rate. μ_{csit} is a markup control defined in the appendix. $\Delta log(Assets_{csit})$ is the log-change in total assets. γ_{cs} are country-sector fixed effects, γ_t are year fixed effects, γ_i are firm fixed effects and γ_{cst} are country-sector-year fixed effects. The sector level is defined at the 2-digit US SIC level. All specifications contain the full set of relevant sub-interaction terms and level effects. Standard errors are clustered either at the firm level or at the country-sector level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Figure A.1.: Marginal Effects for Different Levels of Offshoring



Notes: The figure depicts marginal effects for different levels of offshoring (IS), evaluated for the average exporting firm ($TS = 0.32$) and, respectively, at the 1st and 99th percentile of the sample distribution of $\widehat{Proj}_{cs}^{didx}$, i.e. the measure of co-movement between export and import weighted real effective exchange rates. All remaining variables are evaluated at the mean. The vertical red line denotes the average share of imported intermediates among all exporting firms in the sample ($IS = 0.16$). The confidence level, depicted by vertical bars along the margins-line, is set to 95%. Panel A represents specification (5) and panel B specification (7) from table II.1.

Table A.7.: Area Robustness

	importer$_{csi\kappa}$									
			Real: $R^{x}_{cs\kappa t}$					Nominal: $E^{x}_{cs\kappa t}$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$exporter_{csi\kappa}$	0.0755***	0.137**	0.0903***	0.0700***	0.0675***	0.0459***	0.171***	0.0596***	0.0638***	0.0575***
	(0.0168)	(0.0536)	(0.0163)	(0.0153)	(0.0173)	(0.0127)	(0.0315)	(0.0130)	(0.0140)	(0.0128)
$exporter_{csi\kappa} \times sd(X^{xi}_{cs\kappa t})_{cs\kappa}$	-0.890***	-2.741***	-1.148***	-0.664***	-0.428***	-0.838***	-3.545***	-0.990***	-0.850***	-0.533***
	(0.110)	(0.412)	(0.128)	(0.0871)	(0.120)	(0.0890)	(0.439)	(0.0902)	(0.101)	(0.0974)
$exporter_{csi\kappa} \times sd(X^{xi}_{cs\kappa t})_{cs\kappa} \times f(Proj_{cs\kappa})$	1.886***	1.886***	1.024***	-2.428	0.0609	2.893***	2.893***	1.055***	0.798	1.191*
	(0.414)	(0.414)	(0.172)	(1.560)	(0.546)	(0.447)	(0.447)	(0.185)	(0.753)	(0.608)
$exporter_{csi\kappa} \times f(Proj_{cs\kappa})$	-0.0630	-0.0630	-0.0893***	0.430***	0.0817	-0.134***	-0.134***	-0.0855***	0.0362	-0.0175
	(0.0587)	(0.0587)	(0.0190)	(0.166)	(0.0768)	(0.0324)	(0.0324)	(0.0172)	(0.0504)	(0.0473)
Measure of Co-movement	$\widehat{Proj}^{didx}_{cs\kappa}$	$Proj^{didx}_{cs\kappa}$	$\widehat{Proj}^{didx}_{cs\kappa} > 0$	$\widehat{corr}_{cs\kappa}$	$\widehat{Proj}^{didx}_{cs\kappa}$	$\widehat{Proj}^{didx}_{cs\kappa}$	$Proj^{didx}_{cs\kappa}$	$\widehat{Proj}^{didx}_{cs\kappa} > 0$	$\widehat{corr}_{cs\kappa}$	$\widehat{Proj}^{didx}_{cs\kappa}$
$exporter_{csi\kappa} \times controls_{cs\kappa}$	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Fixed Effects	$\gamma_{cs\kappa} + \gamma_i$	$\gamma_{cs\kappa} + \gamma_i$	$\gamma_{cs\kappa} + \gamma_i$	$\gamma_{cs\kappa} + \gamma_i$	$\gamma_{cs\kappa} + \gamma_i$	$\gamma_{cs\kappa} + \gamma_i$	$\gamma_{cs\kappa} + \gamma_i$	$\gamma_{cs\kappa} + \gamma_i$	$\gamma_{cs\kappa} + \gamma_i$	$\gamma_{cs\kappa} + \gamma_i$
Cluster (Firm)	11225	11225	11225	11225	10989	11225	11225	11225	11225	10989
Cluster (Sector#Country#Area)	1008	1008	1008	1008	756	1008	1008	1008	1008	756
Adj. R2	0.335	0.335	0.336	0.335	0.244	0.336	0.336	0.336	0.335	0.245
Observations	86,934	86,934	86,934	86,934	64,841	86,934	86,934	86,934	86,934	64,841

Notes: Observations relate to firm i in area κ, where firms are based in country c and active in sector s. The dependent variable $importer_{csi\kappa}$ is an indicator equal to one if the firm is sourcing intermediates from region κ. $exporter_{csi\kappa}$ is an indicator equal to one if the firm is exporting to region κ. $X^{xi}_{cs\kappa t} \in R, E$ is either the real or the nominal real effective exchange rate in area κ at time t. $sd(X^{xi}_{cs\kappa t})_{cs\kappa}$ is the standard deviation of the monthly export and import weighted, area κ specific real or nominal effective exchange rate, measured over the full sample period. $\widehat{Proj}^{didx}_{cs\kappa}$ is the demeaned elasticity of the import weighted with respect to the export weighted area κ specific real or nominal effective exchange rate $Proj^{didx}_{cs\kappa}$. $\widehat{corr}_{cs\kappa}$ is the demeaned correlation coefficient between the import weighted and the export weighted real or nominal effective exchange rate. $controls_{cs\kappa}$ include: 1. $reg.\ final\text{-}export\ share_{cs\kappa}$ is the share of final good exports to area κ in all final good exports (4-digit). 2. $rel.\ io\text{-}wage\ (p.C.)_{cs\kappa}$ is the wage per employee in intermediate input industries in area κ relative to country c (2-digit). 3. $rel.\ io\text{-}lab.prod._{cs\kappa}$ is the value added per employee in intermediate input industries in area κ relative to country c (2-digit). 4. $Grubel\text{-}Lloyd_{cs\kappa}$ is the Grubel-Lloyed Index of industry s for trade with area κ (4-digit). γ_κ are area fixed effects, γ_i are firm fixed effects and $\gamma_{cs\kappa}$ are country-sector-area fixed effects. The sector level is defined at the 2-digit US SIC level. Specification (5) and (10) exclude the EU15 area and Other Asia Countries. Standard errors are clustered at the firm level and at the sector-country-area level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

III. Organizations as Competitive Advantage

III.1. Introduction

Little is known about the effect of organizational choices on the international competitiveness of firms within their market. This paper links the organization of firms to their export activity using representative firm-level data for the European manufacturing sector. Two important margins of organizational adjustment are offshoring and decentralization of decision making. Firms that reorganize production internationally and offshore part of the production to other countries can reduce their costs and compete on prices. Firms with a more decentralized hierarchy can empower their knowledge workers to suggest new ideas and compete on product quality.

During the last decade, much of the literature on international trade has centered around the heterogeneity of firm export activities.[1] More productive firms are more likely to enter export markets, obtain more sales from exports, export more products and sell higher quality goods.[2]

Furthermore, the increasing availability of firm-level data during recent years has pushed research in organizational economics to new empirical grounds. This allowed for a linkage between differences in organizational choices and firm productivity.[3]

This chapter is joint work with Dalia Marin and Jan Schymik. We have benefited from the access to the EU-EFIGE/Bruegel-UniCredit database, managed by Bruegel and funded by the EU 7th Framework Programme ([FP7/2007-2013] under grant agreement no. 225551), as well as by UniCredit.

[1]See Bernard et al. (2012b) for a literature review.

[2]Melitz (2003); Melitz and Ottaviano (2008) show that firms with lower production costs are more likely to become exporters and sell more on international markets. Bernard et al. (2011), Eckel and Neary (2010) and Nocke and Yeaple (2008) show that lower production costs increase the scope of exported products. Hottman et al. (2014) provide evidence on the quality channel in export sales.

[3]See Bloom et al. (2010) for a literature review.

This paper aims at the largely untapped overlap between these two strands of the literature, linking the organization of firms to their export activity. This allows us to shift the focus away from exogenously given productivity distributions towards actual firm-level decisions that determine the competitive position of firms within international markets. Naturally, it is important for policy makers to understand the specific channels linking firm decisions to international competitiveness.

We provide firm-level evidence on the role of firm organization on international competitiveness based on representative data of nearly 15,000 European manufacturing plants with detailed information about their exporting and organizational behavior.[4] We show that both, offshoring and decentralized management, are important determinants of firm competitiveness and thus relevant for European policy makers.

We motivate our empirical analysis with a stylized theoretical framework that links organizational decisions to market shares and the product quality that firms offer. Firm success in foreign markets is based on two determinants: production costs and product quality. We propose two channels of adjustment for these determinants that have been widely discussed in the literature. First, firms in our model can import intermediate inputs which reduces their production costs. Second, firms may switch towards a more decentralized hierarchy where strategic decisions are made at lower levels of the hierarchy. Decentralizing decision rights empowers knowledge workers and raises their creative efforts. Flatter chains of command thus promote creativity and incentivize the creation and implementation of new ideas, which ultimately translates into higher quality competitiveness.

Based on the model, we test the following predictions: First, offshoring and better product quality increase the competitive position of a firm within its specific market. Second, decentralization of decision authority leads to improvements in product quality. And third, the effect of decentralization on quality is particularly strong if the conflict of interest within firms is large.

In order to measure competitiveness, we link our data to balance sheet information and trade flows at the industry level to construct the actual market share of each individual firm in its specific world market. Our data reveal that firms which import a larger share of their intermediates also capture a larger market share on export markets. We exploit variation in wages paid by intermediate good produc-

[4]Our data span information from manufacturing plants in 7 European countries (Austria, France, Germany, Hungary, Italy, Spain, UK) and are representative for the manufacturing sectors in each of those countries.

ers in typical sourcing regions and variation in the skill intensity of input production across different output industries in Europe to identify how offshoring affects export competitiveness. After controlling for firm size, labor productivity, product quality, sector and regional fix effects, we find that an exporter importing 30% of its inputs (the average import intensity in our sample) has a market share in global markets about three times as high as an exporter that sources purely domestically.

We then analyze how more decentralized chains of command can help firms to become more competitive. Our results suggest that the probability of outperforming the national competition in terms of quality is on average about 70 percentage points higher for non-family firms with a decentralized organization than for their centralized competitors. Similar results hold for the probability of product innovations. In order to identify the effects of decentralized management on product quality, we exploit regional variation in religious beliefs and trust across Europe.

This paper relates to several literatures. First, we establish an empirical relationship between the international sourcing of intermediates and the competitive position of European firms in world markets. This relates our paper to the literature on offshoring, plant productivity and exporting. The changing nature of world trade flows from trade in final goods towards vertical specialization and trade in intermediate goods has been documented by Hummels et al. (2001) and Hanson et al. (2005).

Previous empirical studies by Halpern et al. (2015) and Amiti and Konings (2007) have identified a link between intermediate imports and firm-level productivity. Our theoretical framework borrows from Grossman and Rossi-Hansberg (2008) who show theoretically that offshoring can increase firm productivity as it gives firms the opportunity to exploit differences in factor costs across borders. Antràs et al. (2006) show theoretically that offshoring increases firm productivity as globalization improves the matching opportunities for knowledge workers in industrialized countries.

Additionally, various theoretical and empirical studies have investigated the link between offshoring and exporting. Kleinert and Zorell (2012) analyze the export-magnification effect of offshoring in an extended Melitz (2003) framework. Empirically, Bas (2012) finds that reductions in input tariffs also increase the probability of exporting for Argentinean firms. Kasahara and Lapham (2013) structurally estimate the relationship between importing and exporting using Chilean plant-level data and find that importing intermediates increases the probability of exporting.

We add to this literature with a link between intermediate imports and an actual measure of firm export competitiveness. Our empirical findings suggest that better importing opportunities lead to a reallocation of market shares towards offshoring firms.

Second, we show that decentralized management improves product quality. Thus, we relate to the literature that analyzes the productivity effects of firm organization. Several empirical papers on management practices have established a connection between the quality of management and total factor productivity differences between firms (see e.g. Bloom and Van Reenen (2007); Bloom et al. (2012) and Bloom et al. (2014) for a survey). Furthermore, Marin and Verdier (2008) show theoretically that heterogeneity in the organization of decision making gives rise to firm heterogeneity. Marin et al. (2014a) show that offshoring affects the organization of firms and their productivity. Acemoglu et al. (2007) find that firms who compete in innovations are more likely to decentralize.

Third, we argue that product quality and innovativeness are important determinants for firm competitiveness. Related papers are Hallak and Sivadasan (2013) and Antoniades (2015) who develop models of international trade with firm heterogeneity in product quality and find that exporters sell higher quality products. Hottman et al. (2014) estimate a structural model of heterogeneous multiproduct firms and find that variation in quality and product scope explain the majority of variation in firm sales. Eckel et al. (2015) construct a model of endogenous quality choices in multiproduct firms and find that firms in differentiated sectors compete more on quality. Our paper builds on their insights but we argue that firms can compete on quality by choosing a decentralized organization.

The remainder of this paper is organized as follows. Section III.2 introduces the theoretical framework. Section III.3 describes our data sources. The empirical modeling strategy and estimation results are presented in section III.4. Section III.5 concludes.

III.2. Theoretical Framework

In this section, we present a simple theoretical framework that links the organization of the firm to its export competitiveness. Firms have two options to adjust their organization to meet competitive pressures. First, firms can offshore part of their production to low cost countries and reduce costs which increases their price competitiveness. Second, firms can reorganize towards more decentralized hierarchies and empower knowledge workers.[5] The empowerment of knowledge workers stimulates new ideas which increases the quality competitiveness of firms. We use this framework to formulate testable predictions about the competitive advantages of offshoring and decentralized organizations. Since our analysis is focused on the relationship between offshoring, headquarter organization and export competitiveness, we make a number of simplifying assumptions. First, we condition our theoretical analysis on exporting firms in a partial equilibrium and do not explicitly model entry and exit into markets. Furthermore, our model treats export destinations as a single market and all firms are considered single-product.

III.2.1. Demand

Consider a firm i in sector s that supplies its product to destination market k. Consumers in each market have a Cobb-Douglas upper-tier utility function that nests CES sub utility functions for different sectors s. The elasticity of substitution across different varieties within each sector is $\sigma > 1$.[6] Firm i faces the following demand for its product in market k:

$$x_{ksi} = \left(\frac{q_i}{p_i}\right)^{\sigma} I_{ks} P_{ks}^{\sigma-1}, \tag{III.1}$$

where x_{ksi} is the quantity demanded in market k, q_i is a firm specific quality parameter and p_i is the firm's price. The parameter P_{ks} is a quality weighted sectoral price index and I_{ks} the income share spent on sector s in destination k. The quality weighted price index is given by $P_{ks} \equiv \left[\int_{\omega} q_{\omega}^{\sigma} p_{k\omega}^{1-\sigma}\right]^{1/(1-\sigma)}$ and is an inverse measure of the degree of competition in market k and sector s.

Each firm's competitive position in the market is its market share that can be expressed as follows:

$$M_{ksi} \equiv \frac{x_{ksi} p_{ksi}}{I_{ks}} \in [0, 1]. \tag{III.2}$$

[5] In our data, firms are decentralized when *managers* can take autonomous decisions and are centralized when the *CEO/owner* takes most decisions. In line with the theoretical mechanisms we have in mind, we will sometimes refer to the manager as the *knowledge worker* or the *agent*, and to the CEO/owner as the *principal*.

[6] The sub utility functions in destination k are of the form $u_{ks} = \left[\int_{\Omega_{ks}} q_i x_i^{\frac{\sigma-1}{\sigma}} di\right]^{\frac{\sigma}{\sigma-1}}$, where Ω_{ks} is the set of varieties in sector s and market k.

We directly observe M_{ksi} for different markets in our data and will now link it to organizational decisions to formulate testable predictions. In the light of the cost and quality channel that we propose, we can rewrite the market share as a function of marginal costs and quality alone:

$$M_{ksi} = \frac{q_i^{\sigma} c_i^{1-\sigma}}{K_{ks}}, \tag{III.3}$$

where K_{ks} measures the total amount of cost weighted quality in the market, and is defined by:

$$K_{ks} \equiv \int_{\Omega_{ks}} q_i^{\sigma} c_i^{1-\sigma} di. \tag{III.4}$$

It is easy to see from equation (III.3) that the market share is strictly increasing in quality and decreasing in marginal costs. In the following two sections we are going demonstrate how marginal costs and quality at the firm level are determined.

III.2.2. Production and Trade in Tasks

We follow Grossman and Rossi-Hansberg (2008) in modeling the firm's decision to offshore production tasks to low cost countries. The production of one unit of output requires a continuum of intermediate tasks of measure 1 that we index by the difficulty to conduct them abroad $\gamma \in [0, 1]$. The firm can perform each task in the production process either at home or import it from abroad (i.e. offshore the task). Tasks with a relatively high index value γ have higher cost requirements when they are offshored relative to tasks with a lower index γ. This is captured by the function $t(\gamma)$ that is assumed to be increasing and continuously differentiable.

The cost level in sector s of firm i's home country is given by C_s. This determines the marginal cost of a non-importing firm in sector s. Additionally, we suppose that there is an offshoring destination where the cost index is $C_s^* < C_s$. The offshoring potential of firm i is determined by its offshoring technology $\theta_i > 0$. The lower θ_i, the easier a firm can offshore production tasks abroad. When the task with index value γ is offshored abroad, it increases production costs by a factor $\theta_i t(\gamma)$, where $t'(\gamma) > 0$. This implies that it is more costly to offshore difficult tasks. The unit production costs of firm i are then given by:

$$c_i = C_s (1 - O_i) + C_s^* \int_0^{O_i} \theta_i t(\gamma) \, d\gamma. \tag{III.5}$$

It is profitable to offshore task γ if and only if there is a cost advantage when the task is conducted offshore, i.e. if $C_s > \theta_i t(\gamma) C_s^*$. Tasks with an index $\gamma \in [0, O_i]$ are offshored while the other tasks are conducted at home. Here, O_i is the marginal task where the firm is indifferent between offshoring the task or not, hence it solves $C_s = \theta_i t(O_i) C_s^*$. We can rewrite the unit production cost of firm i as:

$$c_i = \frac{C_s}{B_i}, \tag{III.6}$$

where the use of imported intermediates leads to a cost-reduction factor that captures the firm-specific productivity gains from offshoring tasks abroad:[7]

$$B_i \equiv B_i(O_i) = 1 - O_i + \frac{\int_0^{O_i} t(\gamma)\, d\gamma}{t(O_i)} \geq 1. \tag{III.7}$$

This cost-reduction factor increases in the share of tasks offshored O_i and because the market share is decreasing in marginal costs, firm competitiveness is strictly increasing in offshoring.

III.2.3. Decentralization, Ideas and Product Quality

We now endogenize the firm-specific product quality and link it to the organization of decision rights within the firm's headquarter. Firms innovate to improve their quality and the process of innovation is modeled in two stages. In the first stage knowledge workers invest into the creation of quality enhancing innovations. In the second stage promising ideas are implemented. We assume that the principal/CEO decides who implements the innovation before the agent starts looking for new ideas.[8] We call firms *decentralized* when the knowledge workers are responsible for the implementation of ideas. Similarly, *centralized* firms are the ones where the CEO decides about the implementation of ideas.

Because the principal chooses ex-ante who will be responsible for the implementation if an idea is found, we implicitly assume that the authority over the implementation choice is ex-ante contractible. Furthermore, in order to abstract from any aspect regarding performance payment, we assume that knowledge workers are infinitely risk averse with respect to income and receive a fix wage r to satisfy their

[7]We borrow the expression of the cost-reduction factor from Marin et al. (2014a).

[8]Inderst (2009) considers a similar stylized model of the firm to analyze how incentive contracts affect the organization.

participation constraint.

Before the principal makes his choice of organization, he observes a firm specific signal $\phi_i > 1$ about the value of potential ideas.[9] If an idea is found in the first stage and successfully implemented in the second stage, it increases the quality of the firm by the factor ϕ_i. If no innovation occurs, product quality remains at its basic level which is denoted by E_i.

Knowledge workers search for ideas with effort e and face a personal cost of effort $g(e) = \frac{g}{2}e^2$ with a sufficiently large g such that there is an interior solution for $e \in (0, 1)$, the probability of finding an idea.

The principal faces a trade-off between higher agent initiative and the cost-efficient production. We assume that knowledge workers only care about how an idea is implemented and whenever an idea is implemented in their preferred manner, they obtain private benefits b. We model the conflict of interest between principal and agent by simply assuming that, with probability $1 - \delta_i$, the knowledge worker prefers to implement the idea in a way that leads to an increase of production costs by the factor $\varphi_i > 1$. With probability δ_i there is no conflict of interest. The optimal allocation of decision authority can easily be found by solving the model backwards.

Decentralization

Suppose that knowledge workers have found an idea such that the firm's product quality is $q_i = \phi_i E_i$. Since the implementation choice was delegated to the knowledge workers, they will choose to implement the idea in their preferred way and receive the private benefits b. The CEO thus expects the following payoff after an idea is found: $\delta_i \pi(c_i, \phi_i E_i) + (1 - \delta_i)\pi(\varphi_i c_i, \phi_i E_i) - r$.

Next, consider the knowledge workers' incentives to search for an idea during the previous period. They find an idea with probability e_d and then always receive the private benefits b on top of the fix wage r. If knowledge workers do not find an idea they only receive the fixed wage. Optimizing expected outcomes leads to the optimal search effort $e_d = b/g$ for decentralized firms.

Given the search effort e_d, the principal of a decentralized firm expects the following ex-ante payoff:

$$e_d [\delta_i \pi(c_i, \phi_i E_i) + (1 - \delta_i)\pi(\varphi_i c_i, \phi_i E_i)] + (1 - e_d)\pi(c_i, E_i) - r. \qquad \text{(III.8)}$$

[9] e.g. by market research.

Centralization

Next, consider the case when the CEO decides to control the implementation of the idea himself. Suppose the knowledge workers have found an idea. Since the principal may now choose how the idea is implemented, he will always choose the low cost implementation and payoffs are given by $\pi(c_i, \phi_i E_i) - r$.

Note that the agents now have less incentives to search for an idea since the principal may ex-post choose to implement the idea in a way that is not in the agents' interest. Their optimal effort choice is now given by $e_c = (\delta_i b)/g = \delta_i e_d$.

Given the search efforts e_c, the CEO of a centralized firm expects the following ex-ante payoff:

$$\delta_i e_d \pi(c_i, \phi_i E_i) + (1 - \delta_i e_d)\pi(c_i, E_i) - r. \tag{III.9}$$

Choice of Decision Authority

We can now state a condition under which the CEO prefers a decentralized organization in order to foster the initiative of knowledge workers. We simply compare the payoffs under both forms of organization, i.e. (III.8) and (III.9). After plugging in the effort levels $e_d = b/g$ and $e_c = (\delta_i b)/g$ and rearranging terms, the condition for decentralization simplifies to a direct comparison of profit levels. Firms are decentralized if

$$\pi(\varphi_i c_i, \phi_i E_i) > \pi(c_i, E_i). \tag{III.10}$$

Given the residual demand function (III.1) and the constant markup pricing rule, a firm chooses to decentralize if $\phi_i^{\sigma} > \varphi_i^{\sigma-1}$.

III.2.4. Firm Organization and Competitiveness

We are now in a position where we can relate the firm's organizational choices to the market share. The expression for the market share (III.3) can be rewritten as:

$$M_{ksi} = \frac{E_i^{\sigma} c_i^{1-\sigma}}{K_{ks}} \eta_i(D_i), \tag{III.11}$$

where the function $\eta_i(D_i)$ captures the cost and quality effect of the chosen level of hierarchy on the market share:

$$\eta_i = \begin{cases} \left[1 + e_d\left(\delta_i \phi_i^{\sigma} + (1-\delta_i)\,\phi_i^{\sigma}\varphi_i^{1-\sigma} - 1\right)\right] & if\ D_i = decentralized \\ \left[1 + \delta_i e_d\left(\phi_i^{\sigma} - 1\right)\right] & if\ D_i = centralized. \end{cases}$$

Equation (III.11) shows that the market share resembles the competitive position of firm i as a function of cost, quality and the decentralization decision. Here, c_i resembles the marginal cost level after offshoring, but before taking account of the cost-increasing potential of a decentralized management. E_i is the firm specific quality level before taking account of the quality-enhancing effect of a decentralized management. We summarize the model description with the following results:

Prediction 1: *The effect of offshoring on market shares is strictly positive.*

Furthermore, it is straightforward to show that $\eta_i(d) > \eta_i(c) \iff \phi_i^{\sigma} > \varphi_i^{\sigma-1}$. Thus, whether a reorganization of the internal hierarchy leads to an increase or a decrease of the market share depends on the optimality of the organizational decision. If the value of innovations ϕ_i outweighs potential cost inefficiencies φ_i, then decentralization leads to higher competitiveness, but only then.

Prediction 2: *The effect of decentralization or centralization on the market share is a priori ambiguous.*

Comparing the optimal effort level under centralization and decentralization, we obtain $e_d = \frac{b}{g} > e_c = \frac{\delta_i b}{g}$ for the probability of innovation. Note that the actual impact of decentralization on innovativeness depends on δ_i. Remember that δ_i is the probability of agent and principal preferring the same implementation strategy. The incentivizing effect of decentralization is zero if there is no conflict of interest to begin with, because then the knowledge worker will always obtain his private benefit, irrespective of decision authority.

Prediction 3a: *The effect of decentralization on quality and innovation is positive.*

Prediction 3b: *The effect of decentralization on quality and innovation is diminishing in the congruence of interests between CEO and knowledge workers.*

In the empirical section, we will analyze how the discussed organizational choices affect the observed market shares M_{ksi} and observed product quality using information from our firm sample. Furthermore, we analyze whether decentralization is associated with innovativeness and quality q_i at the firm level. We also check if the size of the effect depends on the conflict of interest within firms.

III.3. Data Description and Key Variables

In the following section we describe our data sources and the construction of key variables. We refer to the Appendix for a more detailed description of the variable construction. Our firm-level data stem from two main sources: the *EU-EFIGE/Bruegel-UniCredit* (EFIGE) survey and Bureau van Dijk's *Amadeus* database.

III.3.1. Data Sources

The EFIGE survey dataset is at the core of our analysis. Coordinated by the European think tank Bruegel and supported by the Directorate General Research of the European Commission it is the first pan-European firm-level data that combines information on firms' international activities with detailed information on organizational characteristics. The data consist of a representative sample of almost 15,000 surveyed firms with more than 10 employees in seven European economies: Germany, France, Italy, Spain, United Kingdom, Austria and Hungary.[10] Consequently, the representative nature of the survey sample allows us to make statements that are representative for the manufacturing sector in major European economies. The data were collected in 2010 and cover the years from 2007 to 2009. However, most information is collected as a cross-section for the year 2008. The collection of information has been performed through a survey carried out by a professional contractor that is the fourth largest market research company in the world. See Altomonte et al. (2012) for more details on the survey method.

We match the firms in the EFIGE dataset with Bureau van Dijk's Amadeus database. The match with Amadeus gives us two important types of information. First, we obtain detailed balance sheet data and second, we use information on the set of relevant industries at the 4-digit US SIC level where the firms are active in.

[10] The data are representative in terms of the firm-size distribution at the country level for the manufacturing industry.

Finally, we use the *UN Comtrade* data. Comtrade measures trade flows at the industry level which we can use to construct the firm specific export world market size within the industries where each firm is active in. Given the export information from the EFIGE survey, turnover data from Amadeus and the size of the world export market from Comtrade, we can construct firm specific export world market shares for each firm in the sample. We use these market shares to measure the competitive position of each firm within its respective market. We relate it to the firms' intensities of global sourcing to test how importing cheap intermediates can improve the international competitiveness of a firm.

Furthermore, EFIGE provides information on the innovation activity and product quality that firms offer. We link this information to the internal organization of decision making in firm headquarters to estimate if decentralized management improves the firms' product quality.

III.3.2. Construction of Key Variables

Export Market Share

We propose the export market share as a natural measure of export competitiveness. If firms want to stay ahead of their competitors in global markets, it is not sufficient to look at their export sales alone. What matters is how much they export *relative* to their peers. When constructing the market share, the difficulty is to get the peers right. Specifically, we want to account for the fact that many firms are active in more than one industry. Thus, we define the export market share as the ratio of total firm exports relative to all exports available to the world in the firm specific *set* of industries.

We use detailed industry information from Amadeus in order to assess the specific industry mix of each individual firm. While the average firm in our sample is active in about three distinct 4-digit US SIC industries, some firms provide up to 44 different industry codes. Because supposedly not all industries are equally important to the firm, we need to make assumptions about the relative importance of each industry. Here we use information from Amadeus and EFIGE for guidance. Amadeus divides the set of industries into primary and secondary industries. In the EFIGE survey, firms were asked about the percentage of turnover that their core business/product represented in the year 2008. Relating primary industries to the core area of business, we use this percentage share in order to weight primary industries and secondary industries differently. Thus, primary industries are weighted with the share of turnover attributed to the core business, while secondary industries are weighted with the remainder. Within the primary and secondary category, industries are equally weighted.

The peer exports to the world are constructed by applying this firm specific weighting scheme to total industry exports for an individual firm's set of industries. Total exports by industry are obtained from UN Comtrade WITS by summing up industry imports of all countries, excluding the firm's home country. For the numerator, we use survey information on the percentage of annual turnover exported in 2008 and multiply that by turnover information obtained from Amadeus.[11]

Offshoring

The theoretical mechanism we presented in section III.2 is very simple. Firms become more productive by sourcing cheaper inputs from abroad. We stick to these simplicity in the empirical section by assuming that offshoring is simply the share of intermediates purchased from abroad. This also implies that we do not care whether imported inputs origin from within or outside the boundaries of the firm. To be specific, our measure of offshoring is the response of firms to the following question in the EFIGE survey: *What percentage of the total purchased intermediate goods (from anywhere) did the intermediate goods purchased from abroad represent?*

Decentralization

With respect to the organization of internal hierarchies, we use the following survey question in order to determine whether a firm is decentralized or not: *With reference to strategic decisions which of the following statements better describe your firm situation?* Firms are considered centralized when they choose *centralized: the CEO/owner takes most decisions in every area*. Firms that choose *decentralized: managers can take autonomous decisions in some business areas* are considered to be decentralized. In our stylized model the CEO/owner was represented by the principal while managers were represented by the agents/knowledge workers. As we believe that the implications of our model easily transcend into more general settings, we are not worried with the slightly imperfect matching between managers and knowledge workers.

[11] In the appendix we present the construction of the export market share in more detail.

Product Quality and Innovations

Our theoretical model proposes a one to one matching between innovation and quality. Whenever decentralization leads to innovation, product quality increases. In the empirical section we discard with this simplification and try to assess the effect of decentralization on both characteristics separately. For quality, we use a subjective measure from the EFIGE survey. Firms were asked to *think of the product category your main product belongs to. If we rank the maximum quality available in the market for this product equal to 100, how would you rate the quality of your own product?*. Because this measure is prone to cultural noise, we normalize the survey measure at the country level. For innovation, we use a dummy equal to one when firms *carried out any product innovation in years 2007- 2009*. Alternatively, we use the same dummy for process innovations.

III.4. Estimation Results

Our theoretical model predicts that the export market share of firms is a function of the firm specific cost and quality level, relative to the average costs and quality in the market. In the theoretical framework, we mapped quality and costs to specific organizational decisions to see how organizations determine firm competitiveness. The empirical setup is thereby guided by two insights from our theoretical framework. First, offshoring reduces costs and thereby unambiguously increases market shares. Second, decentralization triggers a trade-off between higher costs and higher quality. Thus, the relationship between market shares and decentralization is ambiguous. Quality itself is the factor that we expect to have an unambiguously positive effect on competitiveness and we expect that decentralized management improves product quality. This gives rise to two empirical models that we will subsequently introduce in more detail.

III.4.1. Offshoring and Market Shares

In this part of the empirical analysis we provide evidence supporting a link between offshoring and export market shares. The core empirical specification looks as follows:

$$m_{Ksi} = \alpha + \beta_1 off_i + \beta_2 qual_i + \beta_3 dec_i + \beta_4 F_i + \beta_5 X_{Ks} + \varepsilon_{Ksi}. \quad \text{(III.12)}$$

Our empirical specification closely resembles the theoretical determinants of the market share. The dependent variable m_{Ksi} is our empirical measure of firm i's export market share in industry s and destination K. The key variable of interest in the empirical model (III.12) is the offshoring intensity off_i at the firm level. We proxy off_i by the ratio of intermediates purchased from abroad relative to all intermediates purchased within each firm i. The theoretical model also predicts export market shares to increase with the degree of product quality $qual_i$ that a firm offers. Our measure of product quality is a subjective survey question that ranks the product quality of each firm i relative to its competitors. As cultural influences usually play an important role in these subjective evaluations, we normalize the measure of product quality at the country level and only employ the variation in quality within the firms' home countries (i.e. within each country the mean is 0 and the standard deviation is 1). Furthermore, we replace our quality measure with product innovation in the robustness section. The evaluation of product quality from the firm perspective might introduce measurement error since we are originally interested in the quality perceived by consumers. Due to the lack of a proper instrument, we will treat quality as a control variable rather than a variable of interest. dec_i is a dummy that indicates if managers can autonomously take strategic decisions in some business areas. This dummy is supposed to capture the potential costs and benefits of a decentralized organization as described in our theoretical framework by the term $\eta_i(D_i)$. The vector F_i contains additional firm-level controls such as firm size and productivity in order to account for remaining firm heterogeneity. Finally, X_{Ks} includes a set of fixed effects at the country, region or sector level to capture different market conditions. We will consider destination K to be simply the world market.[12] The variable ε_{Ksi} is the error term.

We will first show our baseline results from ordinary least squares estimates. Then we proceed by addressing potential biases from endogeneity. Our identification strategy is based on measures of comparative advantage and cost saving potentials of offshoring at the industry level that we will use to instrument for offshoring at the firm level.

[12]Given that we consider the world market as destination, the only way to control for destination fixed effects is by accounting for the fact that the world market is different for German firms than it is for French firms. We therefore include *shipping* country fixed effects rather than destination effects in most specifications. Note that this also controls for all other unobserved differences between the countries in our sample. We use the 11 NACE Clio sectors provided in EFIGE to control for sector conditions because our instrumental strategy does not allow for finer sectoral controls. The results in table III.1 are robust to the inclusion of 3digit-industry controls (US SIC).

III.4.1.1. Baseline Results

Table III.1 shows the ordinary least squares estimates of the empirical model (III.12). Column (1) gives a first impression of the link between offshoring and the export market share of a firm: we ignore the set of firm controls and regress the market share on offshoring, normalized quality and fixed effects only. Both, offshoring and quality appear to be positively correlated with the market share and are highly significant.

The empirical literature on firm heterogeneity in trade has established strong connections between various firm characteristics: importing firms export more frequently, but also tend to be larger and more productive on average (see Bernard et al. (2012b) for an empirical overview or Melitz (2003) for a theoretical framework that shows how in principal all those factors might be driven by a single factor). In principle then, it might be size or productivity rather than imports driving the export competitiveness of firms. In specification (2), we therefore control for size and productivity, using log employment and log labor productivity, in order to account for the most obvious factors that might confound our results.[13] Our coefficient of interest remains statistically significant at the 5% level but diminishes to less than half of its original size. This indicates that the size of the measured effect in specification (1) was driven to a considerable extent by the failure to account for unobserved heterogeneity across firms. As expected, controlling for productivity and size increases the explanatory power of the model considerably, raising the adjusted R^2 from 0.011 to 0.073.

Column (3) includes decentralized management as a further control. As suggested by our simple theory and the literature on firm organization, the type of decision making within a firm can have a big impact on firm performance (see Acemoglu et al. (2007) and Bloom et al. (2012)). However, according to our theory, the optimal organization of firms depends on the relative importance of quality and costs such that *a priori* we would not expect a specific sign for the coefficient on decentralization. Still, we should expect the dummy variable to control for firm specific cost and quality opportunities that are not captured by the measures of offshoring or the subjective quality, respectively. Effectively though, the inclusion of decentralization does not alter our results by much and the coefficient remains statistically insignificant.

Column (4) replaces the country dummies with finer regional controls at the

[13] Our estimation results are robust to using total factor productivity in most specifications, though the number of Observations is significantly higher for labor productivity.

NUTS-1 level.[14] Regional controls can be important as they help to absorb omitted factors at the regional level that are related to market access costs. For example, regions at the border might be especially prone to offshoring as well as exporting. Other differences between regions, such as the degree of industrialization, income or local institutions could also be important determinants of export performance at the firm level and should be controlled for. Table III.1 shows that our results are robust to these regional controls.

Note though, that regional fixed effects do not control for unobservable regional effects when the effects are specific to certain industries. In order to control for this type of unobserved covariance, we interact region and industry controls in column (5). The offshoring coefficient increases slightly.

Column (6) tries to address potential bad control problems.[15] In our case, offshoring is itself a candidate variable to explain labor productivity (the value added per employee). As we measure value added as turnover net of the value of intermediates purchased, the ratio of intermediates obtained as cheap imports clearly will have a direct impact on labor productivity. Once we control for labor productivity, our coefficient of interest supposedly measures the effect of offshoring on market shares *conditional* on a specific level of labor productivity. But as the level of labor productivity itself changes with offshoring, this potentially introduces a sort of selection bias into the model. Therefore we reestimate the model without the inclusion of labor productivity. The qualitative results remain robust and the coefficient on offshoring changes only little. Nevertheless, we prefer to keep labor productivity as a control in our model as we assume that endogeneity from omitted variables outweighs endogeneity from bad controls.

Including both exporters and non-exporters in our sample raises one further concern, namely that the correlation we measure is driven solely by the export status. Thus, *given* entry into exporting, offshoring might not have an impact on export performance at all. To rule that out, columns (7) and (8) repeat specifications (3) and (5) respectively, but only include exporters. This reduces the sample size considerably and much of the precision of our estimates is lost. Note though, that the coefficient on offshoring is still positive and significantly different from zero at the 10 and 5 percent level respectively. The magnitude of the effect slightly increases.

[14] The specification is also robust to region fix effects at the even more disaggregated NUTS-2 level. We obtain the NUTS-region for each firm by combining the regional information provided in EFIGE together with zip codes from Amadeus.

[15] See Angrist and Pischke (2009), p.64 ff for a detailed presentation of the problem.

III.4.1.2. Instrumenting for Offshoring

The specifications of our empirical model are subject to different potential endogeneity problems. One problem could be omitted variable bias from unobservable firm characteristics that are correlated with both international activities, offshoring and exporting. Presumably, the inclusion of size and productivity as control variables does not fully account for all dimensions of firm heterogeneity. Furthermore, reversed causality arises if exporting itself has a positive impact on the firm's propensity to engage in offshoring leading to an upward bias of the offshoring coefficient. While empirical evidence for this channel is rare, the broader body of literature on international trade delivers reasons to be aware of the possibility. One argument that raises concerns about reversed causality is the learning-by-exporting hypothesis.[16] If exporting has a positive effect on the productivity of firms, this might very well help exporters to overcome possible fix costs of importing. A related argument could also be derived from the literature of network economics in trade. Exporters may have an advantage to find suppliers in a foreign market simply because they already possess valuable contacts to local business networks.[17] Finally, some of our explanatory variables could be measured with error. Classical measurement error would bias our coefficients towards zero.[18]

We try to respond to these concerns by employing different instrumental variables. The underlying estimation strategy is to use variation in the comparative advantage or the cost saving potential at the *input industry* level in order to instrument for offshoring at the *firm level* in the output industry. In our main specifications, we use two different instruments for offshoring: The low-skilled labor intensity at the input industry and input industry specific wages in Eastern Europe.

The low-skill intensity of intermediate production is the share of low-skilled labor that is used at the input industry level (low-skilled labor compensation in total labor compensation). The measure is obtained from the WIOD database and measures the skill intensity in input industries.[19] On the one hand, the low-skilled labor in-

[16]See De Loecker (2007, 2013) for empirical evidence.

[17]See Chaney (2014) on the effects of international social networks on exports.

[18]Note that measurement error in the market share is less of a problem in terms of consistency, as long as the error is uncorrelated with any of the explanatory variables. Since our construction of the dependent variable allows for multiple sources of measurement error, we will show results for alternative measures of openness in the robustness section of this chapter.

[19]We make use of the February 2012 release of the WIOD database. For each industry, we use the midpoint between the German and the Austrian value. Our instrumental strategy is robust to using the country specific values as well as values for Eastern European countries instead of the

tensity resembles an endowment-type comparative advantage argument. Assuming that the endowment with skills is relatively high for the countries in our data, traditional Heckscher-Ohlin type arguments would suggest low-skilled labor intensive intermediates to be imported more frequently. On the other hand, the instrument might also proxy the complexity of intermediates. This notion of complexity relates the skill intensity at the task level to the offshoring costs $t(\gamma)$ and θ_i in our theoretical model and we would expect less complex intermediates to be offshored more frequently.

Our second instrument are the input industry specific wages in Eastern Europe. These input wages are supposed to capture the cost saving potential from offshoring. The instrument relates to the cost index C_s^* in the offshoring regions in our model.

We expect a positive correlation between the offshoring intensity at the firm level and the low-skill intensity of the input industries and a negative correlation between the input industry wages in Eastern Europe and offshoring.

We weight input industries according to input coefficients from the OECD STAN data to determine the relevant input industries for each industry where the firm is active in.[20] Again, we use information from Amadeus to determine the firms' relevant primary and secondary industries. Weighting of the industries of activity applies as for the market shares. For each of those industries, we then determine the share of inputs provided by any other industry from the input-output table. Finally, we use these shares in order to construct our instruments as a weighted average of input industry level information.

In order for our instruments to be valid, they need to satisfy the exclusion restriction. For this purpose, they need to be conditionally uncorrelated with the export market shares of firms and other unobserved firm characteristics that determine both, offshoring and export performance.

One concern could arise if low-skill intensive input industries supply inputs with lower quality that translate to lower output quality and thus directly affect firm market shares. We account for this by including our proxy $qual_i$ that absorbs variation in the output quality of a firm. Another problem could arise if the wages in specific input industries in Eastern Europe determine world demand. However, as our de-

German Austrian midpoint (unreported).

[20]We use input coefficients for Germany in 2005 and apply them to all countries for simplicity. The STAN database provides input-output coefficients at the 2-digit ISIC Rev.3 level only. Both, the industries of activity for each firm as well as the information for the input industries, will therefore be restricted to the 2-digit level for the construction of our instruments.

pendent variable is the export market *share* rather than the export value, this does not necessarily violate the exclusion restriction. Additionally, we use wages in input industries in India and China relative to domestic wages as an alternative instrument in the robustness section. Then, the exclusion restriction of our second instrument could be violated. An alternative concern is that firms with large market shares are also monopsonists in factor markets and can enforce low wages in input industries. As we focus on wages in relatively aggregated input industries (2-digit ISIC), the bargaining power of an individual firm on the Eastern European labor market seems rather negligible. Furthermore, we also use input wages in China and India in the robustness section which should be even less determined by individual firms.

The specifications presented in table III.2 are the IV analogs of table III.1. Results from the first stage are shown at the bottom of the table. Both instruments are highly significant and the coefficients have the expected signs. The first stage F-test of excluded instruments are above any of the Stock-Yogo critical values of weak identification in all specifications. As we use both instruments simultaneously, we are able to test for overidentification of our model (the Sargan-Hansen test). Reassuringly, the Hansen J-statistics do not reject the null hypothesis of exogenous instruments in any of the specifications except for the first one where we do not control for firm heterogeneity.[21]

Comparing the outcome of the instrumental variable regression with the results from table III.1 shows that our coefficient of interest has increased significantly in size across all specifications. This indicates that attenuation bias might have been a serious issue in our previous ordinary least squares estimates. Offshoring remains highly significant in explaining the export market share in the full sample. The correlation is weaker for the restricted sample of exporters but still remains significant at the 10% level. The coefficient does not vary too much between the individual specifications. As a benchmark, specifications (3) and (5) both yield a coefficient of around 0.5. Taking that coefficient at face value would imply that the average non-offshoring exporter could increase its market share by almost 230% when the firm purchased the same share of intermediates from abroad as the average offshoring export firm does (about 30%).[22] While tripling the market share appears to be a huge

[21] The specification (1) is very weakly controlled. Adding firm controls already raises the p value of the test to 0.57. Note that the Hansen J-statistic only tests the validity of one instrument against the other. Thus, it will not indicate problems if both instruments turn out to be flawed. On the other hand, if the exclusion restrictions is met for at least one of the instruments, our identification strategy should deliver causal effects.

[22] The less precise estimate for exporters in specification (7) yields an increase in the market share

effect indeed, the underlying increase in the offshoring variable from 0% to 30% is very substantial. In terms of the market share, we are talking about an absolute increase in a range between 0.67 to 2.2 per mille.

III.4.1.3. Robustness

Tables B.4 (OLS), B.5 (IV) and B.6 (IV) present results to evaluate the robustness of our estimations. We choose specification (4), from table III.1 and table III.2 respectively, as our baseline specification. In tables B.4 and B.5 we provide the following robustness checks: we control for more disaggregated industry fix effects, exchange the control variables, use alternative measures of offshoring and alternative dependent variables. In table B.6 we deal with the robustness of instruments and consider how auto-correlation within standard errors affect the significance of our estimates. The robustness checks in tables B.4 and B.5 are symmetric unless otherwise noted.

In specification (2) we begin by adding industry dummies at a finer level of detail. As our instruments varies at the industry level our IV results are not robust to the inclusion of industry dummies at the 2-digit US SIC level. As it can be seen from the first stage F-statistic this is due to the loosened grip of our instruments after absorbing industry variation across very narrow industries. The OLS estimates however are robust to the inclusion of industry fix effects up to the 3-digit US SIC level.

Specifications (3) to (6) successively replace the main control variables of our model with alternative measures. Thus, we use average total factor productivity for the years 2001 to 2007 in order substitute for our constructed measure of labor productivity in specification (3).[23] We then replace log employment by log turnover in specification (4). Subjective quality is replaced by an indicator of product innovation in specification (5). Specification (6) interchanges the full set of control variables. Using turnover as a size control in the OLS regression leads to a coefficient that is indistinguishable from zero. We believe that this might be due to measurement error and the strong connection between turnover and the market share. Other than that, our results hold well and the absolute size and significance of the measured effect does not vary substantially across specifications.

In specifications (7) to (10) we replace our explanatory variable and see whether our results are robust to alternative measures of offshoring. The underlying hypoth-

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of slightly more than 200%, while the smallest coefficient, specification (1), implies an increase of almost 170%.

[23]We are thankful to Bruegel for providing us with this measure.

Table III.1.: Offshoring and World Market Shares

	world export market share (%)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
offshoring	0.196***	0.0777**	0.0780**	0.0760**	0.0859**	0.0905***	0.0808*	0.105**
	(0.0384)	(0.0359)	(0.0356)	(0.0352)	(0.0348)	(0.0348)	(0.0480)	(0.0523)
product quality (normal.)	0.0109**	0.00741*	0.00743*	0.00774*	0.00759	0.00757	0.0163*	0.0175*
	(0.00497)	(0.00445)	(0.00447)	(0.00451)	(0.00483)	(0.00484)	(0.00922)	(0.0101)
ln(employment)		0.131***	0.131***	0.131***	0.133***	0.133***	0.191***	0.197***
		(0.0221)	(0.0227)	(0.0228)	(0.0237)	(0.0239)	(0.0340)	(0.0375)
ln(labor productivity)		0.0706***	0.0708***	0.0707***	0.0705***		0.121***	0.126***
		(0.0142)	(0.0144)	(0.0144)	(0.0150)		(0.0255)	(0.0285)
decentralized			-0.00683	-0.00630	-0.0119	-0.00533	-0.0102	-0.0145
			(0.0152)	(0.0152)	(0.0172)	(0.0165)	(0.0247)	(0.0301)
Industry FE	yes	yes	yes	yes	no	no	yes	no
Country FE	yes	yes	yes	no	no	no	yes	no
Region FE	no	no	no	yes	no	no	no	no
Industry-Region FE	no	no	no	no	yes	yes	no	yes
Sample	full	full	full	full	full	full	exporters	exporters
Observations	9,066	9,066	9,066	9,066	9,066	9,066	4,910	4,910
Adj. R2	0.011	0.073	0.073	0.069	0.047	0.037	0.098	0.046

See table B.1 in the Appendix for a description of the variables. All regressions include different sets of fixed effects: we employ a set of 10 Industry FE from EFIGE, Country FE, 54 Region FE and 543 Industry-Region FE. Heteroscedasticity robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table III.2.: Offshoring and World Market Shares - IV

	world export market share (%)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
offshoring	0.371**	0.500***	0.501***	0.532***	0.501***	0.464***	0.452*	0.487*
	(0.157)	(0.154)	(0.154)	(0.162)	(0.179)	(0.179)	(0.271)	(0.276)
product quality (normal.)	0.0103**	0.00624	0.00627	0.00646	0.00598	0.00613	0.0156*	0.0157*
	(0.00504)	(0.00448)	(0.00449)	(0.00451)	(0.00469)	(0.00471)	(0.00921)	(0.00913)
ln(employment)		0.114***	0.115***	0.114***	0.117***	0.118***	0.179***	0.177***
		(0.0223)	(0.0229)	(0.0227)	(0.0232)	(0.0236)	(0.0346)	(0.0345)
ln(labor productivity)		0.0690***	0.0693***	0.0690***	0.0689***		0.123***	0.123***
		(0.0141)	(0.0143)	(0.0142)	(0.0145)		(0.0258)	(0.0257)
decentralized			-0.0113	-0.0112	-0.0159	-0.00902	-0.0120	-0.0124
			(0.0154)	(0.0156)	(0.0173)	(0.0166)	(0.0248)	(0.0251)
Industry FE	yes	yes	yes	yes	no	no	yes	no
Country FE	yes	yes	yes	no	no	no	yes	no
Region FE	no	no	no	yes	no	no	no	no
Industry-Region FE	no	no	no	no	yes	yes	no	yes
Sample	full	full	full	full	full	full	exporters	exporters
Observations	9,063	9,063	9,063	9,063	9,063	9,063	4,910	4,910
First Stage Results								
IV1: *foreign wage per employee*	-6.85e-05***	-7.45e-05***	-7.42e-05***	-7.31e-05***	-7.27e-05***	-7.21e-05***	-8.75e-05***	-8.88e-05***
IV2: *low skilled labor share in compensation*	2.945***	2.737***	2.752***	2.678***	2.280***	2.312***	2.577*	2.670**
Kleibergen-Paap F-Stat	38.45	40.40	40.36	38.47	29.44	29.41	18.93	19.42
Hansen J-Stat (P-Val)	0.01	0.57	0.60	0.69	0.92	0.44	0.88	0.87

All regressions are second stage results of IV estimations where we use 2 instruments for *offshoring*: (1) the lowest 10th percentile wage in Eastern Europe and (2) the industry share of low-skilled employment in compensation. See table B.1 in the Appendix for a description of the variables. All regressions include different sets of fixed effects: we employ a set of 10 Industry FE from EFIGE, Country FE, 54 Region FE and 543 Industry-Region FE. Heteroscedasticity robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

esis is that the effect we measure should not depend too strongly on the specific type of offshoring. As long as costs can be reduced by sourcing inputs from abroad, we expect a significant effect on our measure of competitiveness. While we use intermediates purchased from abroad as a share of all intermediates as our core measure of offshoring, specification (7) shows the results from using intermediates from abroad as a share of turnover instead. Specifications (8) to (10) proceed by replacing intermediate purchases in terms of turnover by FDI, service offshoring and outsourcing in terms of turnover, respectively. The OLS coefficients remain positive but only partly significant. Using our instruments yields positive and significant estimates across all measures of global sourcing. Naturally, the actual size of the coefficients changes. Nevertheless, the implied effect remains very close to the original effect in the case of intermediates relative to turnover. An analogous thought experiment to the one we invoked earlier implies a 223% increase in market shares. The effects are much larger for FDI, service offshoring and outsourcing, but we will not elaborate on these differences as our instruments are relatively weak for these alternative measures of offshoring.

Specifications (11) and (12) replace the dependent variable by the share of exports in turnover and the export volume, respectively. This reduces the risk of potential measurement error in the dependent variable and loosens the constructional bond between dependent variable and instrument by taking the firm specific industry-mix out of the left-hand side variable. The estimates show that our results are robust to using these alternative measures of export performance. The IV results are less clear cut, with a rejected Hansen test for the export share and huge standard errors for the export volume. Note though, that substituting the East European wage instrument, which is measured in absolute terms, by wages relative to the firm's home country increases the Hansen p-value for both specifications and renders the coefficient of interest significant even for the export volume (not reported).

In table B.6 we elaborate more on the robustness of our instruments and check whether our results hinge on standard errors being robust to heteroskedasticity only. Specification (1) again repeats the baseline regression. In specification (2) we want to check whether our results are still robust when using the mean over Chinese and Indian input industry wages rather than wages in Eastern Europe. As the Chinese and Indian markets are less tied to the countries in our sample, the risk of reversed causality from firm's export performance to labor market conditions in the offshoring region should be reduced by using wages from these regions. The offshoring coefficient reduces in size but remains robust apart from that. In specification (3) we use wages in China and India *relative* to the firm's country of origin, as this might be the relevant characteristic from the firm's point of view.

Specifications (4), (5) and (6) introduce an alternative instrument based on an idea by Hummels et al. (2014). The alternative instrument relates to worldwide export supply in firm *i*'s input industries and is measured as the weighted sum of all intermediate exports from any country in the world to all other countries, excluding the firm's home country on both sides. The first stage has the expected sign and the new instrument works in combination with either of the original instruments. As the Hansen test of overidentifying restrictions is not rejected for any of the combinations of instruments, we conclude that all instruments are valid as long at least one of the instruments we propose is valid.

Specifications (7), (8) and (9) finally experiment with the auto-correlation structure of standard errors. Up to now, we showed results for heteroskedasticity robust standard errors, because to us it is not obvious what type of clustering to expect. As our variable of interest is measured at the firm level and we exploit cross-sectional variation between firms, auto-correlation of standard errors is not obvious. Nevertheless, standard errors could be auto-correlated between firms within one geographical region as firms with high levels of intermediate imports might cluster within border regions. Alternatively, standard errors could also be clustered within industries or at the industry-region level. We allowed for clustered standard errors at the regional level (NUTS-2), at the industry level (3-digit US SIC) and at the industry-region level. Our results are robust to all three types of clusters but standard errors tend to increase whenever we cluster at the industry level.

Overall, the coefficients remain relatively stable across all specifications and our results are robust to most of the alterations we proposed.

III.4.2. Decentralization and Product Quality

Let us now turn to the second prediction of the model. We want to analyze if there is a positive association between firms with a decentralized management and the quality of the products that these firms produce. Theoretically, we consider anything the firm can do in order to increase demand for a given price to be a realization of quality. In the empirical section we will focus on two broad measures of desirability: the quality of products relative to the market average as perceived by the firm and an indicator whether firm i has carried out a product innovation in the years 2007 to 2009.

We will use both, product and process innovations in the regressions. Note though, that the notion of non-price desirability applies mainly to product innovations, while process innovations, though still related to the incentive creating effects of decentralization, are probably more relevant for the reduction of costs.

The measure of perceived quality is an indicator, directly taken from the survey, that varies from 0 (the worst product in the market) to 100 (the best). We will use a transformation of this indicator, which is centered around 0 for each country, with the standard deviation set to 1. This normalization helps us to prevent cultural differences in perception from driving our results.

The core empirical specification looks as follows:

$$q_{csi} = \lambda + \mu_1 dec_i + \mu_2 (dec_i \times coi_i) + \mu_3 F_i + \mu_4 X_{cs} + \omega_{csi}, \qquad \text{(III.13)}$$

where q_{csi} is one of our three measures of firm specific product quality or innovation. The variable dec_i is our dummy indicating decentralized organizations and coi_i is a measure of the conflict of interest within firms. The vector F_i contains firm controls, X_{cs} includes industry and country or regional controls and ω_{csi} is the error term.

Two considerations determine the set of controls in equation (III.13). First, our theoretical model predicts the probability of a quality innovation to be higher for decentralized firms because knowledge workers show more initiative in those organizations (as $e_d = b/g > \delta(b/g) = e_c$). This fact resembles the higher search effort of managers once they know they can choose their preferred implementation after an idea is found and lets us expect a positive coefficient $\mu_1 > 0$ for the regressor dec_i. Note though, that the size of this positive effect depends on δ. In our theoretical model, δ measures the probability of manager and principal choosing the same implementation strategy. From the manager's point of view, a high δ implies that he has good chances of obtaining the private benefit from his preferred implementation, even if the principal chooses the strategy in a centralized organization. Therefore, the advantage of a decentralized organization in terms of higher search effort should be relatively low for high values of δ as knowledge workers expand similar efforts under both types of organizations. We try to capture this with the interaction term $dec_i \times coi_i$, where coi_i is an inverse measure of the conflict of interest. We expect the coefficient μ_2 to be negative.

The choice of a good proxy for the congruence of interests δ is crucial to measure the interaction effect $dec_i \times coi_i$. As the majority of firms in our data are private limited liability corporations who are to a substantial part family owned firms, we exploit the ownership structure of the firms to proxy for coi_i. We proxy coi_i by the share of managers (including top and middle management) that is related to the family who owns the company. The underlying assumption is that the probability of congruent interests between owner and manager should be higher when both share the same family ties. In accordance with our theory, we expect μ_1 to be positive and μ_2 to be negative.

Second, as organizational choices are not assigned randomly, we need to control for relevant factors determining whether firm i is prone to being decentralized or not. At the firm level, we add the share of high and medium skilled workers among all workers in order to proxy for the firm specific level of human capital and thus the value of empowerment due to decentralization. The underlying assumption is that innovative activities are more frequent among skilled workers and that the gains from higher effort should therefore be more important to firms with a skilled labor force. We further add a dummy indicating whether the firm is young (less than 6 years old), assuming that younger firms might be more dependent on innovations.[24] Because we do not want our proxy coi_i to pick up other specifics of family firms, we further add a dummy indicating whether the CEO himself is part of the family. As larger firms naturally tend to be more decentralized, we will also control for the number of employees. Finally, we include our measure of labor productivity in order to control for other dimensions of firm heterogeneity that affect product quality.

In order to control for the sectoral fix effects, X_{cs} contains 11 NACE Clio sector dummies.[25] X_{sc} also contains a set of country or regional fix effects. In some specifications we will use interacted sector and region fixed effects as in the regressions for the export market share. Note though, that we will instrument decentralization by regional characteristics below, preventing us from using regional fix effects. We will use regional control variables instead when it comes to instrumentation.

[24] See Acemoglu et al. (2007) for empirical evidence on the relation between firm age and decentralized management.

[25] The specifications are robust to using 3-digit US SIC industry controls.

III.4.2.1. Baseline Results

Table III.3 shows the results from running ordinary least square variants of equation (III.13). Specifications (1) to (3) use the normalized measure of perceived quality, specifications (4) to (6) show the results for product innovation and specifications (7) to (9) use process innovations as the dependent variable.

Specification (1) shows the results when we omit to control for regional effects. As expected, the coefficient on decentralization is positive and significantly different from zero at the 5% level. We fail to establish significant results for the interaction term but the point estimate delivers the right sign. Firm size appears to be an important covariate in this specification.

Specifications (2) and (3) show whether regional effects are decisive drivers of our results. The estimates in table III.3 indicate that our coefficients are relatively robust when controlling for unobservable characteristics at the regional or sector-regional level. This is an important finding as we will not be able to control for regional unobservables once instrumenting at the regional level. Additionally, it might be counted as a good sign for the exclusion restriction we propose.

The results are very similar but more robust when using product innovation instead of perceived quality as our dependent variable.[26] Product innovations are very close in spirit to the theory we proposed. Product innovations are usually thought to be improving the objective characteristics of the product, potentially leaving production costs unaltered. The utility of costumers then rises without the necessity of a decrease in prices. This is exactly the notion of quality we proposed in the theoretical section.

Note that while their absolute size has not changed by much, the coefficients on the interaction are now significant up to the 1% level, suggesting that an increase in the share of family executives renders the impact of decentralized management less important. Finally, the existence of a family CEO as well as the share of high- and medium skilled employees do now appear to be significant covariates of the model.

In specifications (7) to (9) we replace product by process innovations. Innovations in the production process are often related to the cost of the product rather than to its qualitative characteristics. While this is less in line with the theoretical model we proposed, the effort argument remains valid for any type of innovation and therefore

[26] Here we are showing results for the linear probability model. Running Probit estimations does not alter the results significantly but makes the interpretation of the coefficients much harder, given that we are dealing with an interaction term.

we should in general expect to find similar effects in line with our model.

Nevertheless, the results are slightly different for process innovations. The coefficient on the interaction turns out indifferent from zero in a statistical sense. Furthermore, family firms are not as different from other firms when it comes to process innovation. The coefficient on the share of high and medium skilled workers is now negative. Instead, labor productivity shows up to be an important covariate of innovation for the first time.

It is not quite clear what explains these deviations, especially the missing effect on the interaction. As you will note in the next section, some of the differences in the results for product and process innovations will disappear as soon as we try to identify effects with our instrumentation strategy. The interaction effect for example will show up again significantly and with a negative sign. Others, like the coefficient on the share of high-skilled workers, remain significantly different for process innovations. One explanation would be that process innovations are more important for production intensive firms, where the share of low-skilled rather than high-skilled employees is supportive of innovation.

We will briefly return to the differences for varying dependent variables when we have seen results from the instrumental variable estimations.

III.4.2.2. Instrumenting for Decentralization

Again, the set of control variables we added to equation (III.13) might not suffice to prevent omitted variable bias. Additionally, measurement error appears to be important given the survey nature of our data. Finally, innovation itself potentially has a substantial impact on the organization of firms, leading to reverse causality issues.[27]

The literature on firm organization proposes different determinants for decentralization in firms. For example, Bloom et al. (2012) propose the rule of law, product market competition, hierarchical religion and the level of trust in a region as potential determinants for decentralized management within firms.

Rule of law or the degree of product market competition are probably important determinants of innovation and quality in their own right and thus not exogenous in our empirical model. We focus on the other two determinants: regional variation of religious faith and trust levels across Europe and argue that this variation is better

[27] The survey specifically asks firms to indicate whether product or process innovation implied organizational innovation. Almost a third of the firms gave an affirmative answer.

suited for instrumentation given that a direct impact on product quality is less likely. If the notion of trust and religion were relevant determinants of product quality or innovation, than the effect would rather work via trust levels *within* firms. However we try to account for that by controlling for the conflict of interest within firms.

In our main specifications we use measures of religion rather than trust because we assume that religious beliefs are less likely to be shaped by the professional setting which again could have a direct impact on product quality. We will add trust as an instrument in the robustness section.[28]

Our instruments are constructed at the regional level (NUTS-1) where regional averages are obtained from the 2008 European Values Study (EVS).[29] We will use instruments from the EVS for both endogenous variables, the level of decentralization and its interaction with family managers. As you will see in the robustness section, using religion, our instrument for decentralization, interacted with the share of family members as an instrument for the interaction term has two disadvantages. First, the covariation between the instruments and decentralization is very weak when both instruments contain the same variable from the value survey. And second, testing overidentifying restrictions with a larger set of instruments shows that the simple interaction between religion and the share of family members is not exogenous. Results appear to be less problematic when using two distinct instruments based on religion for both endogenous variables, acknowledging that the relevance of the instruments is then based on decentralization alone.

Our first measure of *religion* is the share of people that mentioned "religious faith" when asked about especially important qualities which children can be encouraged to learn at home. La Porta et al. (1997) and Bloom et al. (2012) also propose the regional influence of "hierarchical religions" as a determinant for decentralization which we will use as our second instrument.[30] We argue that both instruments are relevant by arguing that religious believes might be negatively correlated with a taste for autonomy and positively with the submission to authority.

Figures B.2a, B.2b and B.2c in the appendix show the regional variation in the av-

[28]Our measure of *trust* in a region is the share of people responding "most people can be trusted" when asked whether generally speaking, most people can be trusted or alternatively, "one can't be to careful in dealing with people".

[29] The EVS is a large-scale, cross-national and longitudinal value survey, covering 47 European countries or regions with a number of roughly 70,000 interviewees. We use Version 3.0.0 of the Integrated Dataset (Study No. $ZA4800$). Note that our results are robust to using instruments at the NUTS-2 level, though the instruments become weaker.

[30] We refer to Roman Catholic, Muslim or Orthodox believes when talking about hierarchical religions.

erage values of decentralization and our instruments. Three facts are noteworthy: First, much of the variation can be found between countries. This explains why the inclusion of country fixed effects renders our instruments weak. Second, there is indeed a correlation between decentralization and our instruments. For example, Italy is clearly a country where religion is highly important and the level of decentralization is relatively low. Also the levels of decentralization are much higher for Germany and the UK where hierarchical religions play less of a role. Third, religious faith and hierarchical religions are clearly not the same thing. This is important because we need distinct variation in order to employ both instruments at the same time.

Our exclusion restriction requires that religious beliefs have no direct impact on the product quality that firms offer, other than through their influence on firm organization. Again, our claim is that the exclusion restrictions holds after controlling for the relevant covariates. One concern is that religious beliefs could be associated with economic activity and income. This association was proposed by the sociologist Max Weber who claimed that there is a positive link between *protestant ethic* and economic activity.[31] However, Cantoni (2015) does not find evidence for this effect in German-speaking regions. Furthermore, empirical findings by Becker and Woessmann (2009) suggest that the effect of protestantism on economic growth vanishes once they control for human capital accumulation. This effect should be absorbed by our control for human capital at the firm level. We also control for per capita income to absorb variation in demand that stems from variation in income. A problem with the exclusion restriction would persist if religious beliefs affect the preferences for quality besides through differences in income.

Table III.4 shows the results from the instrumental variable regression. Results from the first stage are shown at the bottom. As expected, the coefficients on both measures of religion are negatively correlated with decentralization and are highly significant. This is true for decentralization in the level as well as in the interaction with the conflict of interest proxy. The Angrist-Pischke F-statistic indicates strong instruments in both first stages and the Kleibergen-Paap F-statistic shows that the instruments are overall not weak.

Specification (1) shows results for the normalized measure of product quality. Neither the level effect nor the interaction effect appear to be significantly different from zero. This is due to the normalization of perceived quality, which virtually forces the

[31] See *"The Protestant Ethic and the Spirit of Capitalism"*.

cross country variation of our measure to zero. Given that our instrumental strategy then can work through within-country variation only, the explanatory power of our variable of interest is largely reduced. Specification (2), where we use the non-normalized version of perceived quality, confirms this interpretation. Now the level effect is positive and highly significant, though the interaction is still insignificant.

The problem with using non-normalized quality as perceived by the firm is that our coefficient might pick up cultural differences in perception between countries rather than differences in actual quality. Country fixed effects would help here, but are not viable given that we use regional variation for identification. In specification (3) we add regional controls to account for at least some of the unobserved heterogeneity across countries and regions. Following Bloom et al. (2012) we control for GDP per capita, population and an index of the rule of law.[32]

In principal, we could include all three measures at the regional level. Unfortunately, too much controls at the regional level restrict the amount of variation left for identification. Consequentially, our instruments are rendered weak when we include all three measures at the regional level. We therefore tried to use either the Eurostat variables or the governance index at the regional (NUTS-2) level and included the remaining control(s) at the country level. When both variants turned out to deliver similar results, we decided to stick with quality of governance at the regional level. Assuming that rule of law is potentially easier to causally connect to the organization of firms, we preferred to rule out the alternative channel that firms are more decentralized and produce higher quality because contracts are better enforceable. As column (3) shows, adding regional controls reduces the size of the coefficient on decentralization slightly but in turn renders the interaction significant at the 10% level.

Though our regional controls might pick up some of the cultural differences between countries it is clear that none of the controls is predestined for that task. We therefore transformed the normalized measure of perceived quality into a dummy that indicates whether the perceived product quality of a firm is above the country mean in specification (4) and (5). The advantage of this transformation is that it amplifies the response of the dependent variable with respect to a given regional variation in instrumented decentralization. As table III.4 shows, both coefficients are now highly significant and have the expected signs. Again, including regional

[32] GDP per capita and population are taken from Eurostat while we take the European Quality of Governance Index (EQI) from 2010 as our measure of the rule of law. See Charron et al. (2014).

controls slightly diminishes the coefficients but does not alter the general finding.

In specifications (6) to (9), we show results for product and process innovations with and without country controls respectively. The expected results are valid for both types of innovation. The coefficients are very similar for product and process innovations but smaller than for product quality. Still, the size of the coefficients increases a lot when compared to the ordinary least squares estimates, indicating that our previous results might have been attenuated by measurement error in the explanatory variable.

To provide an idea about the magnitude of the coefficients, we calculate the effect of decentralization on quality and innovation if our results were to be interpreted literally. This exercise is to be taken with caution because we have included an interaction term and the estimated effects depend a lot on the point of evaluation. Using specification (5) and evaluating the effect at the average number of family members (13.7%) for firms where the CEO is not a family member, decentralized management increases the probability of producing quality above the country mean by 70.1 percentage points.

III.4.2.3. Robustness

In tables B.7 and B.8 of the appendix, we test the robustness of our results for quality and production innovation respectively. We evaluate the robustness of our estimates with respect to different instrumentation, industry fix effects and clustering of standard errors. The point of departure is specification (5) of table III.4 for quality and specification (7) for product innovations. As the results are similar for both dependent variables, the following discussion applies to both dependent variables.

In specifications (2) to (6) in both tables, we try different combinations of instruments. Specification (2) replaces religious faith by trust. The results remain qualitatively similar but now the first stage results indicate that our instruments are slightly weak, predominantly due to the interaction. Using the three instruments jointly in specification (3) improves the strength again and allows us to test overidentifying restrictions. The Hansen J-statistic implies that all three instruments are exogenous, given that at least two of them are valid instruments.

In specification (4) we try to instrument the interaction $dec_i \times coi_i$ with $IV_{dec} \times coi_i$. Remember that we used two instruments for decentralization in order to instrument for both, decentralization and the interaction with the share of family members among executives. Often researchers would interact the exogenous part of the

Table III.3.: Decentralization, Quality and Innovation

	product quality (normal.)			product innovation			process innovation		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
decentralized	0.0734**	0.0662**	0.0639*	0.0939***	0.0878***	0.0836***	0.0942***	0.0693***	0.0658***
	(0.0316)	(0.0323)	(0.0334)	(0.0157)	(0.0160)	(0.0166)	(0.0161)	(0.0163)	(0.0169)
decentralized × *share of family board members*	-0.0831	-0.0757	-0.0677	-0.0774***	-0.0633**	-0.0506*	-0.00822	0.00674	0.0186
	(0.0594)	(0.0599)	(0.0625)	(0.0294)	(0.0297)	(0.0305)	(0.0301)	(0.0300)	(0.0308)
share of family board members	0.0477	0.0433	0.0368	0.0222	0.00707	0.00839	0.0271*	-0.00321	-0.00666
	(0.0333)	(0.0359)	(0.0369)	(0.0162)	(0.0171)	(0.0176)	(0.0162)	(0.0171)	(0.0176)
family CEO	0.0313	0.0305	0.0255	0.0404***	0.0431***	0.0423***	0.0162	0.0218*	0.0257*
	(0.0262)	(0.0270)	(0.0278)	(0.0126)	(0.0129)	(0.0134)	(0.0129)	(0.0131)	(0.0135)
young	-0.0484	-0.0451	-0.0418	-0.00464	-0.00691	-0.0136	0.0173	0.0185	0.0221
	(0.0449)	(0.0455)	(0.0470)	(0.0215)	(0.0215)	(0.0222)	(0.0218)	(0.0218)	(0.0225)
share of high- and med. skilled emp.	0.0548	0.0602*	0.0729*	0.0229	0.0418**	0.0456**	-0.0571***	-0.0119	-0.00794
	(0.0349)	(0.0361)	(0.0376)	(0.0177)	(0.0185)	(0.0191)	(0.0178)	(0.0185)	(0.0190)
ln(employment)	0.0394***	0.0403***	0.0384***	0.0698***	0.0664***	0.0677***	0.0632***	0.0664***	0.0664***
	(0.0104)	(0.0107)	(0.0112)	(0.00522)	(0.00531)	(0.00553)	(0.00540)	(0.00544)	(0.00568)
ln(labor productivity)	-0.00444	-0.00387	-0.00106	0.00947	0.00413	0.00571	0.0138**	0.0122**	0.0129**
	(0.0115)	(0.0119)	(0.0125)	(0.00582)	(0.00612)	(0.00641)	(0.00576)	(0.00598)	(0.00623)
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Region FE	no	yes	no	no	yes	no	no	yes	no
Industry-Region FE	no	no	yes	no	no	yes	no	no	yes
Observations	9,013	9,013	9,013	9,013	9,013	9,013	9,013	9,013	9,013
Adj. R2	0.004	0.003	0.003	0.064	0.067	0.067	0.028	0.042	0.043

See table B.1 in the Appendix for a description of the variables. All regressions include different sets of fixed effects: we employ a set of 10 Industry FE from EFIGE, 54 Region FE and 543 Industry-Region FE. Heteroscedasticity robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table III.4.: Decentralization, Quality and Innovation - IV

	product quality (normal.)	product quality (not normal.)		product quality (normal.) above country mean		product innovation		process innovation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
decentralized	-0.0421	96.72***	71.71***	1.451***	1.220***	0.379*	0.647***	0.335	0.679***
	(0.436)	(17.52)	(11.55)	(0.449)	(0.303)	(0.228)	(0.205)	(0.231)	(0.208)
decentralized × share of family board members	-0.417	-44.02	-51.15*	-5.568***	-3.791***	-1.379***	-1.472***	-1.313**	-1.231**
	(0.935)	(36.66)	(27.08)	(1.042)	(0.745)	(0.517)	(0.501)	(0.517)	(0.498)
share of family board members	0.0872	16.70*	16.17***	1.294***	0.900***	0.299**	0.340***	0.295**	0.305***
	(0.216)	(8.528)	(6.184)	(0.234)	(0.167)	(0.118)	(0.114)	(0.119)	(0.113)
family CEO	0.00272	11.28***	7.876***	0.00331	0.0449	0.0198	0.0493**	-0.00649	0.0453*
	(0.0431)	(1.724)	(1.255)	(0.0472)	(0.0347)	(0.0234)	(0.0230)	(0.0239)	(0.0232)
young	-0.0354	-0.735	-0.515	0.0395	0.0166	0.0126	0.0125	0.0264	0.0242
	(0.0496)	(2.017)	(1.494)	(0.0542)	(0.0404)	(0.0263)	(0.0268)	(0.0267)	(0.0267)
share of high- and med. skilled emp.	0.0400	1.255	0.589	-0.0238	0.00112	0.0199	0.0239	-0.0596***	-0.0438**
	(0.0383)	(1.490)	(1.120)	(0.0449)	(0.0336)	(0.0219)	(0.0224)	(0.0221)	(0.0219)
ln(employment)	0.0469**	-3.143***	-1.972***	0.0170	0.0117	0.0658***	0.0547***	0.0628***	0.0477***
	(0.0189)	(0.767)	(0.545)	(0.0192)	(0.0141)	(0.00978)	(0.00954)	(0.00991)	(0.00963)
ln(labour productivity)	0.00388	-2.314***	-1.672***	-0.00799	0.00132	0.000196	-0.00726	0.00710	0.00496
	(0.0143)	(0.615)	(0.457)	(0.0160)	(0.0120)	(0.00841)	(0.00850)	(0.00831)	(0.00842)
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Regional Controls	no	no	yes	no	yes	no	yes	no	yes
Observations	7,780	7,780	7,780	7,780	7,780	7,780	7,780	7,780	7,780
First Stage Results	**without country controls**					**with country controls**			
	decentralized		*interaction*			*decentralized*		*interaction*	
IV1: *hierarchical religion*	-0.136***		-0.015			-0.184***		-0.031***	
IV2: *religious faith*	-0.163***		-0.181***			-0.198***		-0.232***	
A-P F-Stat	25.98		22.23			33.06		23.12	
Kleibergen-Paap F-Stat (joint)	18.089		18.089			17.07		17.07	

All regressions are second stage results of IV estimations where we use 2 instruments for *decentralized* and *decentralized×share of family board members*: (1) the share of people with a hierarchical religion and (2) the share of people who value religious faith. See table B.1 in the Appendix for a description of the variables. All regressions include a set of 10 Industry FE from EFIGE, some regressions include regional control variables. Heteroscedasticity robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

interaction (family members) with the instrument for the endogenous part in order to obtain an instrument for the interaction. But as the results in tables B.7 and B.8 show, applying this to religious faith renders our instruments weak and the coefficients of interest insignificant.

We therefore add the other instruments in specification (5) and do now obtain satisfying F-statistics and significant coefficients with the right sign. However, the Hansen overidentification test indicates a strong endogeneity problem with this set of instruments. Fortunately, the number of instruments allows us to run statistical tests on subsets of instruments. Doing this indicates that the instrument causing problems is precisely the interaction with the share of family members.

In specification (6) we go one final step further and add the share of family members to the list of endogenous regressors. An additional instrument is obtained by interacting our main instruments, religious faith and hierarchical religion. The results persist in terms of significant coefficients although the instrumentation becomes weak.

Overall, our results are relatively robust with respect to different instrumental approaches. The standard approach for the instrumentation of interactions is problematic in our case, as both components appear to be endogenous. The size of the coefficients varies for different specifications but the qualitative predictions are always met.

Finally, in specifications (7) to (9) we include industry dummies at a finer level of detail, exchange covariates and see whether two-way clustering at the region-industry level has any effect on our results. As it seems, neither of these changes has a big impact on the measured effects, neither in size nor in significance.

III.5. Conclusion

In this paper we analyze how firm organization affects the international competitiveness of firms with representative data on 15,000 European manufacturing plants. We motivate our empirical analyses with a stylized model where firms can source inputs internationally to lower their costs and decentralize decision making to foster ideas and produce higher quality products. In order to identify the effects of offshoring, we exploit variation in foreign input wages and input skill intensity to instrument for offshoring at the firm level. We identify the effects of decentralized management by instrumenting the decentralization choice with regional variation in religious beliefs and trust. We find that the average offshoring firm obtains a world market share that is about three times larger than the average market share of non-offshoring firms. Furthermore, we find that decentralized management increases the probability of producing quality above the country mean by 70.1 percentage points in firms where the CEO is not a family member. However, this effect becomes smaller as firms are managed by a larger fraction of managers with family ties.

B. Appendix

Construction of Export Market Shares

We define the export market share of firm i in country c as the ratio of firm exports to export competition in destination region K:

$$m_{Ki_c} = \frac{exports_{Ki_c}}{comp_{Ki_c}},$$

where $exports_{Ki_c}$ are firm exports from country c to region K and $comp_{Ki_c}$ is the export competition of firm i in region K. We measure export competition as a weighted average of industry imports into region K, where the set of industries considered is firm specific. Note that we only look at competition by other exporters and do not consider domestic supply in destination K. One effect of this simplification is that destination specific effects, such as a strong preference for domestic goods, are partly muted. The ranking we obtain then resembles a ranking within exporters and not within firms in general.

Export competition is constructed as follows:

$$comp_{Ki_c} = w_i \frac{1}{N_{1i}} \sum_{s \in S_{1i}} \sum_{k \in K \setminus \{c\}} imports_{ks} + (1 - w_i) \frac{1}{N_{2i}} \sum_{s \in S_{2i}} \sum_{k \in K \setminus \{c\}} imports_{ks},$$

where w_i is the proportion of turnover related to firm i's core business obtained from EFIGE, serving us as a weight for primary industries. N_{1i} and S_{1i} are the number and set of distinct primary industries respectively and are obtained from Amadeus. k are the individual countries in region K and $imports_{ks}$ are all industry s imports into country k which we obtain from the UN Comtrade WITS database. Secondary industry characteristics are defined analogically.[33]

When summing up the industry imports in destination region K, we have to ac-

[33] Besides the four digit primary and secondary codes, Amadeus provides a three digit core code for each firm. If no information on primary and secondary industries was provided, we use the core code information in order to construct the export competition. To avoid scaling issues, we construct the core code trade flow as an average over all lower-level four digit trade flows. If firms did not provide information on the share of turnover they relate to the core business, we use the sample average (90%) for weighting. Note that about two thirds of the firms in our sample assign all their activity to the core business line. Of those, many still provide information on distinct primary and secondary industries. As this might cast doubt on our weighting scheme, we also tried using only the core code industry or only primary industries for calculations. Our results were robust to such alterations.

count for the fact that the home country c of firm i might be part of that region. Thus, when we define the world to be the region of interest, we subtract imports into country c from the sum of imports over all countries in order to obtain the relevant export market. Naturally, the world export market is different for France than it is for Germany.

Table B.1.: Summary Statistics

Variable	Observations	Mean	Min	Max	Std. Dev.
world export market share	9807	0.0590	0	33.450	0.548
EXPvol	10255	10698.02	0	4827955	105146.4
EXPshare	13988	0.179	0	1	0.263
offshoring (relative to all intermediates purchased)	14031	0.107	0	1	0.214
offshoring (relative to turnover)	13856	0.0397	0	1	0.102
FDI (relative to turnover)	14146	0.014	0	1	0.085
service offshoring (relative to turnover)	14631	0.003	0	1	0.0231
decentralized management	14138	0.291	0	1	0.454
product quality (relative to highest quality in the market 100)	14653	87.38	0	100	15.34
product quality (normalized)	14653	0.00	-8.40	1.37	1.00
product innovation	14654	0.491	0	1	0.50
process innovation	14654	0.441	0	1	0.497
employment	14654	92.80838	10	30000	502.1967
turnover	10781	32012.23	0.0266	2.06×10^7	295586.1
labor productivity	10622	192.9212	0	14524.92	374.312
tfp (avg: 2001 - 2007)	10158	-0.0934	-6.616	2.632	0.454
share of family board members	12522	0.435	0	1	0.418
family CEO	14654	0.623	0	1	0.485
young firm	14654	0.070	0	1	0.256
share of high- and medium skilled employees	12813	0.741	0	1	0.295
EQI 2010 (NUTS-2 level)	13060	0.467	-2.284	1.456	0.654
GDP per capita	14654	27695.83	10500	34000	3890.071
population	14654	59779.06	8322	82120	16964.83
foreign wage per employee (Eastern Europe, abs.)	13761	6244.87	2158.28	7174.23	383.72
foreign wage per employee (China & India, abs.)	13761	2585.32	897.58	3105.86	157.69
foreign wage per employee (China & India, rel.)	13761	0.0668	0.0180	0.251	0.0287
low skilled labor share in total compensation	13761	0.116	0.0350	0.145	0.00722
world export supply of intermediates	13190	412723	136306.6	1311349	165574
hierarchical religion	14556	0.729	0	0.997	0.298
religious faith	14556	0.163	0	0.468	0.102
trust	14556	0.346	0.165	1	0.0871

Table B.2.: Description of Variables

Variable	**Description**
world export market share	share of firm exports to export market competition in the world in %. See B for detailed information
EXPvol	percentage of 2008 annual turnover represented by exports (*EFIGE*) × operating revenue in 2008 in th. USD (*Amadeus*)
EXPshare	percentage of 2008 annual turnover represented by exports (*EFIGE*)
offshoring	share of 2008 total purchased intermediate goods (from anywhere) represented by intermediate goods purchased from abroad (*EFIGE*)
offshoring / intermediates	share of 2008 annual turnover represented by purchased intermediates goods (from anywhere)× offshoring (relative to all intermediates purchased) (*EFIGE*)
FDI	percentage of 2008 annual turnover represented by production activities through direct investment (*EFIGE*)
service offshoring	percentage of 2008 annual turnover represented by purchased services (from anywhere)× percentage of 2008 total purchased services (from anywhere) represented by services purchased from abroad (*EFIGE*)
decentralized management	dummy indicating that with reference to strategic decisions the firm is decentralized, i.e. managers can take autonomous decisions in some business areas (*EFIGE*)
product quality	index indicating how firms would rank their main product in terms of quality, when the maximum quality available in the market equals 100 (*EFIGE*)
product quality (normalized)	index indicating how firms would rank their main product in terms of quality, when the country average in the market is set equal to 0 and the standard deviation of individual firms is set to 1 (based on *EFIGE*)
product innovation	dummy for firms that carried out any product innovation in years 2007-2009 (*EFIGE*)
process innovation	dummy for firms that carried out any process innovation in years 2007-2009 (*EFIGE*)
employment	total number of employees in the firm's home country (*EFIGE*)
turnover	operating revenue in 2008 in th. USD (*Amadeus*)
labor productivity	value added per employee: operating revenue in 2008 in th. USD× (1 - offshoring (relative to turnover)) / employment
tfp	total factor productivity (*EFIGE*)
share of family board members	ratio of entrepreneurs/executives (included middle management) who are related to the family who owns the company to total number of entrepreneurs/executives (*EFIGE*)
family CEO	dummy for firms where the chief executive officer (CEO)/company head is the individual who owns or controls the firm or is a member of the family that owns/controls it (*EFIGE*)
young firm	dummy indicating young innovative companies (year of establishment less than 6 years before survey was taken) (*EFIGE*)
share of high- and medium skilled employees	ratio of white and skilled blue collars to white, skilled blue, unskilled blue collars and apprentices (*EFIGE*)
EQI 2010	European Quality of Government Index 2010, see Charron et al. (2014). Due to data limitations we use the NUTS-2 level for Austria, Spain, France and Italy and the NUTS-1 level for Germany, UK and Hungary
GDP per capita	gross domestic product per capita (in Euro) at the country level 2008, (*Eurostat*, nama_r_e2gdp)
population	population in thousand at the country level (*Eurostat*, nama_r_e3popgdp)

Table B.3.: Description of Variables - Instrumental Variables

Variable	**Description**
foreign wage per employee (Eastern Europe, absolute)	ratio of wage (in USD) to employment from *INDSTAT4 2013* at the industry-country level (average 2005 to 2007). The region East consists of Cyprus, Estonia, Latvia, Lithuania, Malta, Poland, Czech Republic, Romania, Slovakia, Slovenia and Hungary (this resembles the group "other UE countries" in *EFIGE*). We use the value at the 10th percentile of these countries in order to guarantee a low wage value for each industry. We then connect these values at the ISIC input industry level to output industries via input coefficients from the IO table (*OECD Stan*, Germany 2005). This results in IO weighted average values at the output industry level. Using industry correspondence tables from *Eurostat*, we can link these isic output industry values to the primary, secondary and core code industries from *Amadeus* (US SIC). Then the weighting applies as for the market share.
foreign wage per employee (China & India, absolute)	ratio of wage (in USD) to employment from *INDSTAT4 2013* at the industry-country level (average 2005 to 2007). We use the average of the Chinese and the Indian value (China and India also define a country group in *EFIGE*). We then connect these values at the ISIC input industry level to output industries via input coefficients from the IO table (*OECD Stan*, Germany 2005). This results in IO weighted average values at the output industry level. Using industry correspondence tables from *Eurostat*, we can link these ISIC output industry values to the primary, secondary and core code industries from *Amadeus* (US SIC). Then the weighting applies as for the market share.
foreign wage per employee (China & India, relative)	ratio of wage (in USD) to employment from *INDSTAT4 2013* at the industry-country level (average 2005 to 2007). We use the ratio of the average Chinese and Indian value (China and India also define a country group in *EFIGE*) to the value of firm's home country. We then connect these values at the ISIC input industry level to output industries via input coefficients from the IO table (*OECD Stan*, Germany 2005). This results in IO weighted average values at the output industry level. Using industry correspondence tables from *Eurostat*, we can link these ISIC output industry values to the primary, secondary and core code industries from *Amadeus* (US SIC). Then the weighting applies as for the market share.
low skilled labor share in total compensation	low-skilled labor compensation (share in total labour compensation) from *WIOD* database, February 2012 release at the industry-country level (average 2004-2007). We use the median of the Austrian and the German value. We then connect these values at the ISIC input industry level to output industries via input coefficients from the IO table (*OECD Stan*, Germany 2005). This results in IO weighted average values at the output industry level. Using industry correspondence tables from *Eurostat*, we can link these ISIC output industry values to the primary, secondary and core code industries from *Amadeus* (US SIC). Then the weighting applies as for the market share.
world export supply of intermediates	intermediate exports by country pair (in million USD) from *WIOD*, see Timmer (2012). For each country in our sample, we add up exports from any country in the world to all other countries, excluding the firm's home country on both sides. This gives us the world export supply of intermediates in a specific industry for each of the countries in our sample. Weight industry export supply of intermediates with IO coefficients in order to obtain weighted intermediate export supply for a given output industry. Concordance from NACE to US SIC (by hand). Link these output industry values to the primary, secondary and core code industries from Amadeus. Then the weighting applies as for the market share. Compare Hummels et al. (2014).
hierarchical religion	share of people belonging to a hierarchical religion (Roman Catholic, Muslim or Orthodox) in a specific NUTS-1 region (*European Value Survey 2008*)
religious faith	share of people who think that generally speaking most people can be trusted in a specific NUTS-1 region (*European Value Survey 2008*)
trust	share of people who consider it to be especially important that children are encouraged to learn religious faith at home in a specific NUTS-1 region (*European Value Survey 2008*)

Table B.4.: Offshoring and World Market Shares - Robustness I

	world export market share (%)										EXPshare	EXPvol
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
offshoring	0.0757**	0.0693*	0.0682*	0.0179	0.0737**	0.0141					0.207***	12,739***
	(0.0354)	(0.0386)	(0.0391)	(0.0392)	(0.0357)	(0.0464)					(0.0148)	(4,394)
product quality (normalized)	0.00793*	0.00710	0.00731	0.00626			0.00779*	0.0105**	0.00831*	0.00846*	0.00528**	1,014
	(0.00458)	(0.00499)	(0.00538)	(0.00443)			(0.00463)	(0.00415)	(0.00455)	(0.00456)	(0.00247)	(626.3)
ln(employment)	0.132***	0.137***	0.141***		0.132***		0.133***	0.119***	0.134***	0.134***	0.0583***	23,897***
	(0.0231)	(0.0243)	(0.0282)		(0.0230)		(0.0234)	(0.0207)	(0.0229)	(0.0228)	(0.00294)	(3,445)
ln(labor productivity)	0.0714***	0.0698***		-0.0328***	0.0713***		0.0727***	0.0667***	0.0715***	0.0710***	0.0326***	10,893***
	(0.0146)	(0.0160)		(0.00732)	(0.0146)		(0.0143)	(0.0145)	(0.0146)	(0.0146)	(0.00317)	(1,922)
decentralized	-0.00626	-0.00568	-0.00210	-0.00403	-0.00677	-0.00156	-0.00579	-0.000214	-0.00539	-0.00555	0.0173***	-3,105
	(0.0154)	(0.0143)	(0.0170)	(0.0148)	(0.0155)	(0.0169)	(0.0155)	(0.0157)	(0.0155)	(0.0156)	(0.00603)	(2,155)
tfp (avg. 2001 - 2007)			0.0616***			0.00477						
			(0.0186)			(0.0203)						
ln(turnover)				0.123***		0.124***						
				(0.0205)		(0.0250)						
product innovation					0.0126*	0.0172**						
					(0.00676)	(0.00870)						
offshoring (% of turn)							0.133**					
							(0.0672)					
FDI (% of turn)								0.491**				
								(0.235)				
service offshoring (% of turn)									0.676			
									(0.436)			
outsourcing (% of turn)										0.147		
										(0.170)		
Industry FE	yes	*SIC 3dig*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Region FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	8,931	8,928	7,162	8,931	8,931	7,162	8,931	8,648	8,928	8,931	8,931	8,931
Adj. R2	0.069	0.089	0.077	0.069	0.069	0.084	0.069	0.071	0.069	0.069	0.203	0.119

See table B.1 in the Appendix for a description of the variables. See paper for details on each specification. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.5.: Offshoring and World Market Shares - Robustness II

	world export market share (%)										EXPshare	EXPvol
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
offshoring	0.532***	-0.546	0.590***	0.505***	0.537***	0.530**					1.578***	15,354
	(0.162)	(0.631)	(0.210)	(0.161)	(0.171)	(0.222)					(0.203)	(19,228)
product quality (normalized)	0.00646	0.00923*	0.00572	0.00538			0.00404	0.00929**	0.0121*	0.0118**	0.00119	973.2
	(0.00451)	(0.00516)	(0.00538)	(0.00441)			(0.00465)	(0.00450)	(0.00712)	(0.00522)	(0.00379)	(603.4)
ln(employment)	0.114***	0.157***	0.118***		0.114***		0.109***	0.0699**	0.0767**	0.128***	0.00583	23,541***
	(0.0227)	(0.0367)	(0.0283)		(0.0227)		(0.0233)	(0.0322)	(0.0380)	(0.0222)	(0.00883)	(3,460)
ln(labor productivity)	0.0690***	0.0739***		-0.0127	0.0690***		0.0819***	0.0567***	0.0609***	0.0622***	0.0273***	10,727***
	(0.0142)	(0.0154)		(0.0103)	(0.0142)		(0.0152)	(0.0146)	(0.0185)	(0.0140)	(0.00475)	(1,868)
decentralized	-0.0112	0.000293	-0.00777	-0.00619	-0.0110	-0.00519	-0.00933	-0.0185	-0.0111	-0.00747	0.00321	-3,201
	(0.0156)	(0.0165)	(0.0176)	(0.0149)	(0.0156)	(0.0173)	(0.0156)	(0.0202)	(0.0213)	(0.0158)	(0.00940)	(2,141)
tfp (avg. 2001 - 2007)			0.0594***			0.0194						
			(0.0188)			(0.0211)						
ln(turnover)				0.0960***		0.100***						
				(0.0203)		(0.0251)						
product innovation					-0.00295	0.000213						
					(0.00983)	(0.0124)						
offshoring (% of turn)							1.497***					
							(0.455)					
FDI (% of turn)								3.773**				
								(1.868)				
service offshoring (% of turn)									27.47*			
									(14.04)			
outsourcing (% of turn)										1.918**		
										(0.746)		
Industry FE	yes	SIC 2dig	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Region FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	9,063	9,063	7,201	9,063	9,063	7,201	9,063	8,778	9,060	9,063	9,063	9,063
First Stage Results												
IV1: *foreign wage per employee*	×	×	×	×	×	×	×	×	×	×	×	×
IV2: *low skilled labor share in compensation*	×	×	×	×	×	×	×	×	×	×	×	×
Kleibergen-Paap F-Stat	38.47	3.809	27.5	38.947	35.473	23.36	28.818	3.23	4.334	8.049	38.47	38.47
Hansen J-Stat (P-Val)	0.694	0.7198	0.2795	0.9687	0.6515	0.8606	0.714	0.1457	0.3785	0.0642	0.0445	0.1609

See table B.1 in the Appendix for a description of the variables. See paper for details on each specification. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.6.: Offshoring and World Market Shares - Robustness III

	world export market share (%)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
offshoring	0.532***	0.387***	0.626***	0.495***	0.668**	0.538***	0.532*	0.549***	0.549*
	(0.162)	(0.128)	(0.222)	(0.178)	(0.273)	(0.160)	(0.285)	(0.184)	(0.295)
product quality (normalized)	0.00646	0.00687	0.00620	0.00730	0.00690	0.00720	0.00646	0.00657	0.00657
	(0.00451)	(0.00457)	(0.00466)	(0.00466)	(0.00491)	(0.00472)	(0.00467)	(0.00402)	(0.00415)
ln(employment)	0.114***	0.119***	0.110***	0.119***	0.113***	0.117***	0.114***	0.114***	0.114***
	(0.0227)	(0.0234)	(0.0241)	(0.0222)	(0.0264)	(0.0229)	(0.0276)	(0.0222)	(0.0271)
ln(labor productivity)	0.0690***	0.0695***	0.0687***	0.0730***	0.0725***	0.0729***	0.0690***	0.0698***	0.0698***
	(0.0142)	(0.0144)	(0.0144)	(0.0149)	(0.0151)	(0.0150)	(0.0173)	(0.0140)	(0.0171)
decentralized	-0.0112	-0.00966	-0.0122	-0.0124	-0.0144	-0.0129	-0.0112	-0.0115	-0.0115
	(0.0156)	(0.0153)	(0.0154)	(0.0166)	(0.0155)	(0.0162)	(0.0149)	(0.0159)	(0.0152)
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Region FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Cluster Robust	no	no	no	no	no	no	industry	region	twoway
Observations	9,063	9,063	9,063	8,764	8,764	8,764	9,063	8,928	8,928
First Stage Results									
IV1: *foreign wage per employee*	*abs East*	*abs China/India*	*rel China/India*	*abs East*		*abs East*	*abs East*	*abs East*	*abs East*
IV2: *low skilled labor share in compensation*	×	×	×		×	×	×	×	×
IV3: *intermediates supply*				× (+)	×	×			
Kleibergen-Paap F-Stat	38.47	36.65	21.85	25.62	20.37	26.24	15.90	33.56	15.94
Hansen J-Stat (P-Val)	0.69	0.21	0.44	0.64	0.67	0.83	0.80	0.71	0.78

See table B.1 in the Appendix for a description of the variables. See paper for details on each specification. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.7.: Decentralization, Quality and Innovation - Robustness I

	product quality (normal.) above ctry. mean								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
decentralized	1.220***	1.479***	1.402***	-9.865	1.005***	0.789***	1.557***	1.510***	1.333***
	(0.303)	(0.309)	(0.254)	(15.32)	(0.177)	(0.249)	(0.415)	(0.555)	(0.443)
decentralized × *share of family board members*	-3.791***	-5.206***	-4.058***	6.604	-1.999***	-1.665*	-4.513***	-4.382***	-3.908***
	(0.745)	(1.653)	(0.734)	(12.13)	(0.330)	(0.959)	(1.012)	(1.403)	(1.152)
share of family board members	0.900***	1.204***	0.968***	-2.062	0.525***	1.079***	1.070***	1.094***	0.942***
	(0.167)	(0.344)	(0.161)	(3.642)	(0.0762)	(0.121)	(0.227)	(0.331)	(0.235)
family CEO	0.0449	0.0274	0.0569*	-0.879	0.0801***	-0.191**	0.0522	-0.0503	0.0489
	(0.0347)	(0.0549)	(0.0338)	(1.360)	(0.0238)	(0.0826)	(0.0406)	(0.0416)	(0.0460)
young	0.0166	0.0334	0.0178	0.0297	-0.00623	0.000336	0.0337	0.0241	0.0230
	(0.0404)	(0.0549)	(0.0425)	(0.192)	(0.0300)	(0.0304)	(0.0464)	(0.0543)	(0.0516)
share of high- and med. skilled emp.	0.00112	-0.000806	0.00177	-0.0551	0.00442	0.0373	0.0129	0.0201	0.0142
	(0.0336)	(0.0430)	(0.0350)	(0.165)	(0.0244)	(0.0275)	(0.0384)	(0.0433)	(0.0279)
ln(employment)	0.0117	0.0137	0.00579	0.430	0.00383	0.0627***	-0.000837		-0.00371
	(0.0141)	(0.0185)	(0.0134)	(0.603)	(0.00997)	(0.0196)	(0.0171)		(0.0252)
ln(labor productivity)	0.00132	-0.00192	-0.00257	0.251	0.00263	0.0173*	-0.00421		-0.00739
	(0.0120)	(0.0144)	(0.0119)	(0.354)	(0.00847)	(0.0100)	(0.0138)		(0.0162)
foreign group								-0.173**	
								(0.0788)	
ln(turnover)								0.0215	
								(0.0135)	
tfp (avg 01-07								-0.0518	
								(0.0443)	
Industry FE	yes	yes	yes	yes	yes	yes	SIC 3dig	SIC 3dig	SIC 3dig
Regional Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
Cluster Robust	no	no	no	no	no	no	no	no	twoway
Observations	7,780	7,780	7,780	7,780	7,780	7,780	7,772	5,776	7,646
First Stage Results									
IV1: *hierarchical religion*	×	×	×		×	×	×	×	×
IV2: *religious faith*	×		×	×	×	×	×	×	×
IV3: *trust*		×	×		×	×			
IV4: *religious faith* × *share of family board members*				×	×				
IV5: *religious faith* × *hierarchical religion*						×			
A-P F-Stat (*decentralized*)	33.06	47.27	24.39	0.36	19.42	13.29	22.63	10.89	9.58
A-P F-Stat (decentralized × share of family board members)	23.12	7.30	12.38	6.65	13.40	5.55	15.56	8.89	6.25
A-P F-Stat (*share of family board members*)						107.47			
Kleibergen-Paap F-Stat (joint)	17.07	4.55	11.14	0.22	16.56	3.81	12.57	6.03	8.82
Hansen J-Stat (P-Val)			0.32		0.00	0.31			

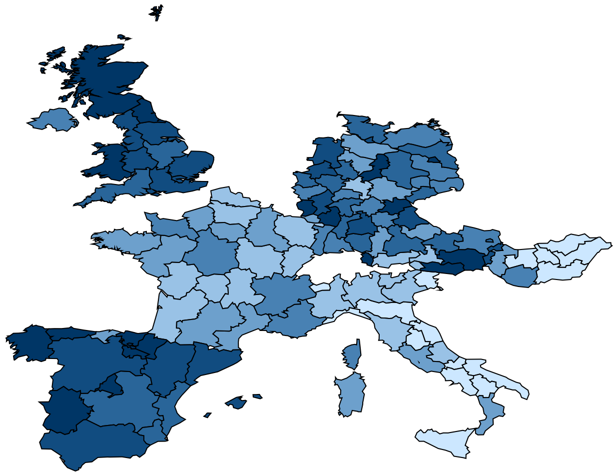
See table B.1 in the Appendix for a description of the variables. See paper for details on each specification. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.8.: Decentralization, Quality and Innovation - Robustness II

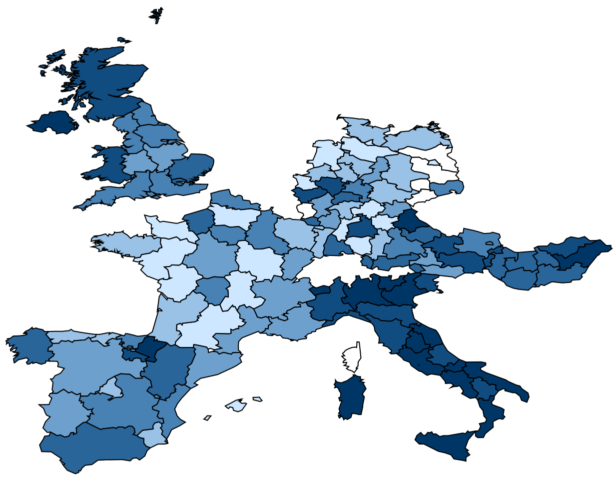
	product quality (normal.) above ctry. mean								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
decentralized	0.647***	0.801***	0.755***	-4.828	0.557***	1.048***	0.940***	0.855**	0.938***
	(0.205)	(0.192)	(0.171)	(7.814)	(0.144)	(0.265)	(0.270)	(0.372)	(0.340)
decentralized × *share of family board members*	-1.472***	-2.317**	-1.631***	3.662	-0.604**	-2.745***	-1.946***	-1.825**	-1.942***
	(0.501)	(0.997)	(0.483)	(6.200)	(0.280)	(1.023)	(0.654)	(0.913)	(0.672)
share of family board members	0.340***	0.521**	0.381***	-1.123	0.159**	0.330**	0.449***	0.438**	0.451***
	(0.114)	(0.209)	(0.108)	(1.861)	(0.0657)	(0.138)	(0.148)	(0.217)	(0.146)
family CEO	0.0493**	0.0388	0.0564**	-0.407	0.0680***	0.173**	0.0724***	0.0334	0.0704***
	(0.0230)	(0.0331)	(0.0221)	(0.693)	(0.0198)	(0.0881)	(0.0259)	(0.0261)	(0.0259)
young	0.0125	0.0224	0.0132	0.0189	0.00117	0.0212	0.0183	-0.0251	0.0134
	(0.0268)	(0.0331)	(0.0276)	(0.0961)	(0.0247)	(0.0345)	(0.0298)	(0.0361)	(0.0335)
share of high- and med. skilled emp.	0.0239	0.0228	0.0243	-0.00385	0.0256	0.00787	0.0229	0.0247	0.0230
	(0.0224)	(0.0259)	(0.0229)	(0.0830)	(0.0207)	(0.0308)	(0.0245)	(0.0276)	(0.0217)
ln(employment)	0.0547***	0.0559***	0.0512***	0.261	0.0502***	0.0244	0.0418***		0.0429***
	(0.00954)	(0.0114)	(0.00899)	(0.308)	(0.00825)	(0.0214)	(0.0112)		(0.0133)
ln(labor productivity)	-0.00726	-0.00919	-0.00958	0.116	-0.00698	-0.0190	-0.00781		-0.00803
	(0.00850)	(0.00933)	(0.00840)	(0.180)	(0.00751)	(0.0120)	(0.00920)		(0.0105)
foreign group								-0.0703	
								(0.0530)	
ln(turnover)								0.0376***	
								(0.00893)	
tfp (avg 01-07)								-0.0761***	
								(0.0291)	
Industry FE	yes	yes	yes	yes	yes	yes	SIC 3dig	SIC 3dig	SIC 3dig
Regional Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
Cluster Robust	no	no	no	no	no	no	no	no	twoway
Observations	7,780	7,780	7,780	7,780	7,780	7,780	7,772	5,776	7,646
First Stage Results									
IV1: *hierarchical religion*	×	×	×		×	×	×	×	×
IV2: *religious faith*	×		×	×	×	×	×	×	×
IV3: *trust*		×	×		×	×			
IV4: *religious faith* × *share of family board members*				×	×				
IV5: *religious faith* × *hierarchical religion*						×			
A-P F-Stat (*decentralized*)	33.06	47.27	24.39	0.36	19.42	13.29	22.63	10.89	9.58
A-P F-Stat (*decentralized* × *share of family*)	23.12	7.30	12.38	6.65	13.40	5.55	15.56	8.89	6.25
A-P F-Stat (*share of family board members*)						107.47			
Kleibergen-Paap F-Stat (joint)	17.07	4.55	11.14	0.22	16.56	3.81	12.57	6.03	8.82
Hansen J-Stat (P-Val)			0.36		0.01	0.36			

See table B.1 in the Appendix for a description of the variables. See paper for details on each specification. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

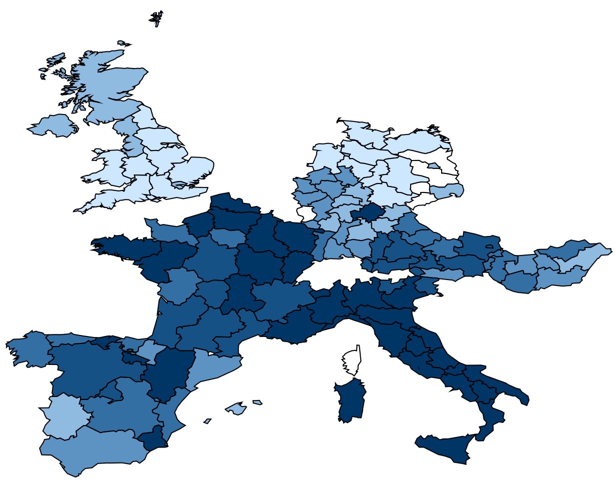
Figure B.1.: Decentralized Organizations and Religious Beliefs Across European Regions



(a) Decentralized Organizations



(b) Religious Faith



(c) Hierarchical Religions

IV. Import Competition and the Composition of Firm Investments

IV.1. Introduction

Firms invest in expectation of some future benefits. A vigorous policy debate is in progress over the origins and consequences of short-term corporate behavior: when firms in the economy face short-term incentives and do not invest sufficiently long-term, into assets that pay off in distant future, this can be impedimental for economic growth. The literature has identified that credit crunches, uncertainty, investor pressures or agency problems can be causal for short-term investment behavior (see Aghion et al. (2010), Garicano and Steinwender (2016), Terry (2015), Garicano and Rayo (2016) and Bénabou and Tirole (2016)). In this paper, we put forward another reason for corporate short-termism: we argue that foreign competition can induce firms to distort investments away from assets that payoff in distant future towards short-term assets.

Falling trade barriers leading to a dramatic rise in international trade flows is a defining feature of the past century. The associated increase in competitive pressure from abroad can threaten domestic firms. When competition lowers future price-cost margins and thereby reduces the quasi-rents from durable investments, import competition might discourage long-term firm investments.

In this paper, we study how trade shocks affect the composition of firm investments with respect to durable and nondurable assets. We think that this investment composition matters due to three reasons. First, when firms do not sufficiently consider the long-term perspective when facing investment decisions but strongly react to short-term pressures, they might not fully exploit their growth potential in the

This chapter is joint work with Philippe Fromenteau and Jan Schymik.

long-run.[1] Second, when the amount of investment into nondurable assets increases, firms need to refinance more frequently as their assets deplete earlier. As a result, financing costs of firms increase. Third, changes in the investment composition due to trade shocks potentially affects the firm-size distribution when investment responses are heterogeneous.

To guide our empirical analysis, we provide a simple model. We consider a firm in a two-period economy which engages in two types of investment: a short-term one and a long-term one. While short-term investments reduce production costs today and yield an immediate payoff, investments into more durable assets reduce future production costs and therefore pay off at a later point in time. When tougher competition from abroad reduces future price-cost margins, firms are incentivized to shift their investment expenditures towards nondurable investments. Furthermore, we show that firm heterogeneity matters for the relative size of this effect. Although tougher foreign competition shifts the composition of investments towards nondurable assets on average, larger firms are expected to respond less to competition shocks since they have more market power.

To estimate the effect of foreign competition on the investment composition inside firms, we use our model to derive a within-firm difference-in-differences estimator. Our model predicts that within a firm in a given year, tougher foreign competition should lead to a *relatively* larger reduction in long-term investments vis-à-vis short-term investments. We use data for the population of stock listed manufacturing firms in the US between 1995 and 2009 to test this prediction. Using data on listed firms has two major advantages for our empirical analysis. First, listed firms disclose investment expenditures across different asset categories which differ in their durability. Similar to Garicano and Steinwender (2016), we exploit variation in durability across asset groups to distinguish between short- and long-term investments.[2]

[1]Hillary Clinton's US presidential election campaign is a prominent example for this policy debate about short-term corporate behavior. Creating stronger incentives for firms to plan for the long-run is part of the program of the Democratic Party for the upcoming legislative period: *"We need an economy where companies plan for the long run [...] - leading to higher productivity, better service, and larger profits."*, Hillary Clinton, 2016. Part of this debate also comes from business experts themselves. For example, Larry Fink, the CEO of the investment firm BlackRock stated: *"Over the past several years, I have written to the CEOs of leading companies urging resistance to the powerful forces of short-termism afflicting corporate behavior. Reducing these pressures and working instead to invest in long-term growth remains an issue of paramount importance for BlackRock's clients, most of whom are saving for retirement and other long-term goals, as well as for the entire global economy."*

[2]Specifically, we consider seven investment categories which we group according to their durability by means of depreciation rates derived from accounting rules: Advertising expenditures, Computer expenditures, expenditures on R&D, expenditures on Transportation Equipment, expendi-

Second, we can use the volatility of each firms' stock returns within a given year to control for variation in the level of uncertainty that firms face.

With the data at hand, we estimate how changes in the sectoral degree of foreign competition lead to a shift of firms' investment composition. We find that between 1995 and 2009, firms became on average more short-term oriented when the level of sectoral import competition increased. Specifically, our estimates suggest that the average increase in import competition by 60% during our sample period has reduced the lifespan of firm assets by 72 days on average, which corresponds to 4.6% of the average asset lifespan. Presuming a refinancing rate of 3%, this would impose an additional cost of 6$ for each 1000$ invested.

We find this result to be robust to controlling for several alternative channels that could counteract our results. First, trade liberalization could be associated with a rise in perceived uncertainty. For firms that face a higher level of uncertainty, the real option value of future investment opportunities increases, leading to a postponement of long-term investments (see Bloom (2009), Handley and Limão (2015) and Novy and Taylor (2014)). We find that a higher level of trade-induced uncertainty cannot fully explain our effects, exploring variation in firm-level stock return volatility across time to control for changes in the level of uncertainty that firms face. Second, the level of import competition could be correlated with developments in the domestic industry. For example, if US industries become more productive over time, this might lead to relatively more long-term investments and a lower level of import competition. When we control for changes in total factor productivity, value added, capital- and skill-intensity of the US manufacturing industries our estimated effect is indeed smaller yet remains significant, both statistically and economically. Third, we find our results to be robust to controlling for financial frictions like credit constraints or the 2007-2009 financial crisis. Fourth, as our estimation is based on the within-firm responses across investment categories, we are able to take account for potential alternative firm-specific demand or technology shocks.

Additionally, we investigate the role of firm heterogeneity on investment responses. Our model suggests that a competition shock has a larger impact on profits of smaller, less productive firms since their residual demand is relatively more elastic than residual demand for larger firms. We find support for that prediction in our data. When comparing investment responses across the size distribution, we find that shifts in investments towards less durable assets as a response to foreign

tures on Machinery, expenditures on Buildings and expenditures on Land.

competition are more vigorous among smaller firms. Comparing a firm at the 10th percentile with a firm at the 90th percentile of the firm-size distribution (in terms of assets), we find that the lifespan of assets decreases by about 15 days more in the small firm.

Lastly, we exploit the WTO accession of China in 2001 as a quasi-natural experiment to study how firms' investment composition changes in response to an exogenous increase in foreign competition. The increase in US imports from China was mainly due to changes in China's internal conditions rather than rising demand in the US. Furthermore, Autor et al. (2016) argue that China's comparative advantage in industrial goods resulted primarily in a large supply shock for manufacturing goods and a large demand shock for raw materials in the US. Since US imports from China vastly exceeded US exports to China, our identification strategy is likely capturing manufacturing import competition rather than export potential. We use the average effectively applied tariffs on imports from China over the years 1995 to 1999 as our treatment variable. Although tariff rates have already been reduced during the 1990s, the change in China's WTO membership status in 2001 led to a reduction in *expected* US imports tariffs on Chinese goods (see Pierce and Schott (2016)). In line with our model, we find that firms in industries with high pre-WTO tariffs shifted their investments towards less durable assets as a response to the rise in import competition from China. Our estimates suggest that between 1999 and 2003, firms with pre-WTO tariffs at the 25th percentile reduced the life span of investments by about 143 days more than a firm with pre-WTO tariffs at the 75th percentile.

This paper relates to studies that analyze how firms adjust their investment expenditures to international trade. Bloom et al. (2016) examine the impact of Chinese import competition on within firm productivity changes and find that the absolute volume of innovation increases within the firms most affected by Chinese imports. Bustos (2011) and Lileeva and Trefler (2010) study how access to foreign markets can induce investments in technology upgrading. Both studies find that firms respond to better exporting opportunities with investments in productivity improvements. While these papers study the *absolute* level of firm investments in response to trade liberalization, our focus is on changes in the *composition* of investments within firms with respect to more or less durable assets.

Furthermore, the paper is also related to a nascent literature that studies the impact of international trade on corporate finance. Fresard (2010) finds that large corporate cash holdings lead to systematic future market share gains at the expense of industry rivals when an industry is hit by an import competition shock. Valta (2012) studies how the costs of bank credit respond to foreign competition and finds that firms face higher loan spreads when import competition toughens. Xu (2012) studies the financing response during periods of higher competition and finds that firms reduce their leverage by issuing equity and selling assets to repay debt when experiencing increases in import competition. While previous studies show that credit constraints determine firms' opportunities to participate in exporting (see e.g. Manova (2013), Foley and Manova (2015)), our paper studies the impact of foreign competition on the composition of firm investments which affects demand for credit itself.

The remainder of the paper is structured as follows. Section IV.2 presents the theoretical framework, section IV.3 describes the data, identification and the empirical results. Finally, section IV.4 concludes.

IV.2. Theoretical Framework

To understand the impact of competition on firms' investment behavior, we lay out a framework which incorporates the inter-temporal investment decision of a firm with respect to short- and long-term investments. The main goal of the section is to guide our empirical work.

IV.2.1. Demand and Industry Structure

We consider an economy that exists for two time periods $t \in \{0, 1\}$. During each period t the economy is composed of L_t consumers which derive their demand from a linear-quadratic utility function following Melitz and Ottaviano (2008). As a result, firms face a linear demand

$$q_{it} = A_t - \frac{L_t}{\gamma} p_{it}, \tag{IV.1}$$

where the intercept is given by $A_t \equiv \frac{\alpha L_t}{\eta N_t + \gamma} + \frac{\eta N_t}{\eta N_t + \gamma} \frac{L_t}{\gamma} \bar{p}_t$. The degree of product differentiation is described by γ, N_t reflects the number of consumed varieties and $\bar{p_{it}} = (1/N_t) \int_{i \in \Omega_t} p_{it} di$ characterizes the average price level in the economy. Linear demand implies an upper price bound $p_t^{max} = \frac{\alpha\gamma}{\eta N_t + \gamma} + \frac{\eta N_t}{\eta N_t + \gamma} \bar{p}_t$ at which demand for a variety is driven to zero. This upper price bound p_t^{max} is an inverse measure of the toughness of competition. A larger degree of differentiation γ, a larger mass of competing varieties N_t or a lower average price level $\bar{p}_t$ all trigger a decline in the price bound p_t^{max} such that firms are forced to charge lower prices in order to generate positive demand for their product.[3] Firms face a larger price elasticity of demand if they set higher prices or if the intensity of competition in the economy increases.[4]

IV.2.2. Production and Investment Decision

Production in the differentiated goods sector occurs at constant returns to scale with marginal costs c^* representing the corresponding unit labor requirement. Most importantly, we assume that profit maximizing firms can opt for two types of investment in order to reduce their marginal costs of production c^*. Short-term investments k reduce the unit costs of production instantaneously to $c_0 = c^* - (c^*)^\theta k^{0.5}$ in period 0. Long-term investments z yield larger productivity gains which however only materialize during the subsequent period 1 and reduce the firm's unit production costs to $c_1 = c^* - \varphi (c^*)^\theta z^{0.5}$ with $\varphi > 1$.[5] Higher levels of investment relate to lower unit costs with decreasing returns to scale.[6] The magnitude of cost reductions however depends on firm productivity c^* and the parameter θ. With $\theta > 0$ a unit of investment reduces marginal costs to a larger extent for less productive firms whereas $\theta < 0$ implies that low cost firms are more efficient in cutting costs. For the sake of simplicity, we assume a unit of short-term investment k and long-term investment z are both equally costly and require r units of labor to finance the investment.

In both periods firms compete on a monopolistically competitive market and take the average price level $\bar{p}_t$ as well as the number of firms N_t as given. This yields

[3] The parameters α and η are both positive and determine the pattern of substitution between a numéraire good and the differentiated varieties. An increase in α and a decrease in η induce an upward shift in the consumption levels of the differentiated varieties relative to the numéraire. If $\gamma = 0$, the varieties are perfect substitutes and consumers only focus on the total level of consumption. A rise in γ however implies that the degree of differentiation augments and consumers care about the distribution of consumption levels across varieties.

[4] The price elasticity of demand is given by $\varepsilon_{it} \equiv |(\partial q_{it}/\partial p_{it})(p_{it}/q_{it})| = [(p_t^{max}/p_{it}) - 1]^{-1}$. This stands in contrast to a CES demand where price elasticity is uniquely determined by the level of product differentiation γ.

[5] The basic set-up of the investment function is akin to Dhingra (2013).

[6] In order for the effective marginal costs c not to become negative, investments k and z are restricted by firm productivity c^*. This however is no critical assumption since our primary interest is in the composition and not in the absolute level of short- and long-term investments.

profits given by

$$\pi\left(c_t\right) = \frac{L_t}{4\gamma}\left(c_t^D - c_t\right)^2. \tag{IV.2}$$

If a firm's unit costs are just as high such that it earns zero profits, it is indifferent about remaining in the industry. This firm is characterized by marginal costs of production c_t^D such that $p\left(c_t^D\right) = c_t^D = p_t^{max}$. Thus, c_t^D reflects the intensity of competition in the economy as the threshold incorporates the impact of both, the average price level and the number of firms. A reduction in c_t^D implies a rise in the toughness of competition, as firms need to exhibit lower costs of production in order to produce profitably. Moreover, c_t^D integrates the impact of competition on firms' prices, demand and profits. Intuitively, firms with lower marginal costs charge lower prices for which reason they generate larger demand and earn higher profits. Beyond that, they face a lower price elasticity of demand which allows them to set higher markups of price over marginal costs. An increase in market size L_t raises profits whereas more intense competition, reflected by a reduction in c_t^D, decreases demand and squeezes markups implying that firms loose earnings.

Having explained the basic organization of production, we now turn towards firm investments and the choice between short- and long-term investments. Taking the size of the market L_t and the level of competition c_t^D as given, the firm optimizes profits discounted with a factor $\delta \in (0,1)$ over time

$$\max_{k,z} \pi\left(c_0\right) + (1-\delta)\,\pi\left(c_1\right) - rk - rz. \tag{IV.3}$$

Determining the first order conditions with respect to short- and long-term investments and solving for the optimal level of k and z yields

$$k^{0.5} = \left[\frac{4\gamma r}{L_0} - \left(c^*\right)^{2\theta}\right]^{-1}\left(c_0^D - c^*\right)\left(c^*\right)^{\theta} \tag{IV.4}$$

$$z^{0.5} = \left[\frac{4\gamma r}{L_1\left(1-\delta\right)\varphi} - \varphi\left(c^*\right)^{2\theta}\right]^{-1}\left(c_1^D - c^*\right)\left(c^*\right)^{\theta} \tag{IV.5}$$

From equations (IV.4) and (IV.5) it becomes clear that stronger competition (smaller c^D) reduces the marginal return of investment and thus diminishes investment volumes. However, we are not interested in the effects on the investment *volume* of firms but want to study the *composition* of investments inside firms. Building ratios of equations (IV.4) and (IV.5) and taking logs finally leaves us with the following expression for the relative composition of short-term and long-term investments k and z:

$$\begin{aligned}\ln(k) - \ln(z) = \quad & 2\left\{\left[\ln\left(c_0^D - c^*\right) - \ln\left(c_1^D - c^*\right)\right]\right. \\ - \quad & \left.\left[\ln\left(\frac{4\gamma r}{L_0} - (c^*)^{2\theta}\right) - \ln\left(\frac{4\gamma r}{L_1(1-\delta)\varphi} - \varphi(c^*)^{2\theta}\right)\right]\right\}\end{aligned} \tag{IV.6}$$

IV.2.3. The Impact of Import Competition on Investment Composition

We now analyze the effect of import competition on the relative composition of short-term and long-term investments. An increase in competition $c_1^D < c_0^D$ reduces firms' profits in period 1 which in turn diminishes the value of long-term investments relative to short-term investments. As such, tougher competition in period 1 incentivizes firms to adjust their investment composition towards short-lived investments. Figure C.1 illustrates the effect. Firms choose the investment composition that equalizes the marginal return of short- and long-term investments.[7] The optimal composition of investments (k^*, z^*) is therefore given by the intersection of the marginal return of short- (MR_k) and long-term investments (MR_z). According to our model, an increase in the intensity of competition reduces the return of long-term investments for any level of z thereby shifting the MR_z-curve downwards (the red, dashed curve). A new intersection of both marginal return curves emerges giving rise to a larger fraction of short-term investments and a smaller fraction of long-term investments.

In order to identify the investment distortion created by international competition, we compare the investment composition of a firm affected by an increase in import competition (*open* economy) with the investment composition of a firm facing no increase in import competition (*closed* economy). If import competition increases between period 0 and period 1, relative investments $[\ln(k) - \ln(z)]^{open}$ are given by

[7] If a firm expected a larger return in one type of investment than in the other, the firm would invest more into that investment type. Since we assumed decreasing marginal returns, the firm would increase investments until marginal returns are equalized.

equation (IV.6). If the economy however remains closed and $c_1^D = c_0^D$ it follows that

$$[\ln(k) - \ln(z)]^{closed} = -2\left\{\ln\left(\frac{4\gamma r}{L_0} - (c^*)^{2\theta}\right) - \ln\left(\frac{4\gamma r}{L_1(1-\delta)\varphi} - \varphi(c^*)^{2\theta}\right)\right\} \quad \text{(IV.7)}$$

Hence, in the closed economy relative investments are exclusively determined by market size in both time periods. Subtracting the investment composition in the closed economy case (IV.7) from the investment composition in the open economy case (IV.6) provides us with the following difference-in-differences equation, identifying the shift in the relative composition of investments induced by import competition

$$[\ln(k) - \ln(z)]^{open} - [\ln(k) - \ln(z)]^{closed} = \ln\left(c_0^D - c^*\right) - \ln\left(c_1^D - c^*\right) \quad \text{(IV.8)}$$

Summing up, international competition from abroad entails tougher competition in period 1. This shrinks the effective market size and lowers firms' market power and profits such that the value of long-term investments relative to short-term investments is reduced. Thus, import competition incentivizes firms to shift their investment expenditure towards investments characterized by a shorter lifespan. Based on these theoretical considerations we derive the following testable result.

Prediction 1 *Import competition increases the amount of short-term relative to long-term investments.*

IV.2.4. Heterogeneous Investment Responses across Firms

From our difference-in-differences equation (IV.8) it becomes obvious that the size of the investment shift depends on a firm's productivity c^*. For less productive firms, the relative loss in profits in period 1 compared to period 0 is more pronounced than for firms with lower unit costs. Hence, while all firms loose profits and market power, the relative change in profits across time decreases with firm productivity. Accordingly, this leads to a smaller reduction in the marginal return of long-term investments MR_z relative to the marginal return of short-term investments MR_k for more productive firms. Thus, high-cost firms shift their composition of investments to a larger extent towards more short-lived investments. In our theoretical framework, more productive firms are characterized by larger sales and employment. Therefore, we employ different measures of firm size as empirical counterpart to firm productivity.[8]

Prediction 2 *Import competition increases the amount of short-term relative to long-term investments less for larger firms.*

IV.2.5. The Impact of Market Size on Investment Composition

Given that trade liberalization is typically associated with both, higher import competition and larger export markets, we also study what an increase in market size would imply for our difference-in-differences estimator. From equations (IV.4) and (IV.5) it becomes clear that a larger market size L_t generates additional demand such that the marginal return of short- and long-term investments increases resulting in a higher level of firm investments for a given level of c_t^D (for both types of investments).[9]

An increase in market size $L_1 > L_0$ in period 1 raises demand and profits and thus the relative value of long-term investments, such that firms become less short-term oriented. Hence, the market size effect works in the opposite direction to the competition effect. In Figure C.2, this is depicted by an upward shift of the MR_z-curve as the marginal return of long-term investments increases for any level of z. As a result, the new intersection of the marginal return of short- and long-term investments shifts to the left implying a reduction in the fraction of short-term investments while the fraction of long-term investments increases.[10] In the empirical analysis, we there-

[8] Based on survey data, Atkin et al. (2015) provide recent evidence for a positive relationship of the level of markups and firm size. They therefore consider firm size to be the best proxy for the productivity parameter in heterogeneous firm models based on Melitz (2003).

[9] These effects of trade liberalization on the investment *volume* of firms have been studied empirically by Lileeva and Trefler (2010) and Bustos (2011).

[10] The magnitude of the effect depends again on firm productivity c^*. However, the role of productivity is ambiguous and depends on the sign of the parameter θ which determines the impact of firm productivity on the efficiency of investments. If $\theta > 0$, less productive firms are more efficient in cutting costs and thus they face relatively larger incentives to engage in long-term investments. If $\theta < 0$, high productive firms are more effective in lowering unit costs such that an increase in market size in period 1 creates larger incentives for high productive firms to shift investment expenditures towards long-term investments. As long as $\theta = 0$, firm productivity has no impact on the magnitude of cost reductions.

fore also take account of this market size effect to control confounding effects.

IV.3. Empirical Analysis

IV.3.1. Identification

Equation (IV.8) serves as our theoretical guideline to set up the econometric estimation strategy in order to identify the effect of import competition on the composition of firm investments. Based on equation (IV.8) we derive the following difference-in-differences specification where I_{isct} denotes investments by firm i in investment category c at time t

$$\ln\left(I_{isct}\right) = \beta_0 + \beta_1 \times \ln\left(ImpComp_{st}\right) \times Short\text{-}Term_c + \mathbf{X'_{isct}}\zeta + \lambda_c + \lambda_{it} + \varepsilon_{isct} \qquad \text{(IV.9)}$$

where $ImpComp_{st}$ is our measure of import competition varying across industries s and years t and $Short\text{-}Term_c$ reflects the duration of an investment category c. In order to distinguish between long- and short-term investments, we rank each firm's investments into different assets according to their time to payoff. We follow here the approach suggested by Garicano and Steinwender (2016) and exploit expenditures on Advertising, Computer Equipment, R&D, Transportation Equipment, Machinery Equipment as well as on Buildings and Land. In our specification, the rate of duration follows an ordering where a higher ranking implies a more short-lived investment category. Alternatively, we also use depreciation rates. $\mathbf{X'_{isct}}$ is a vector of control variables. λ_c and λ_{it} are fixed effects for different investment types as well as for firm-year combinations in order to sweep out unobserved firm-specific factors that vary across time and affect the investment decisions of firms. Notably, this includes demand shocks, credit shocks or technology shocks as long as they do not affect short- and long-term investments differently. Identification is therefore based on variation across investment categories *within* a firm for a given year. Most importantly, in this specification β_1 identifies the distortion in the relative composition of firm investments created by import competition and reflected in our theoretical model in equation (IV.8).[11] Altogether, following *Prediction 1*, if import competition leads firms to adjust their composition of investments towards short-term investment categories, the coefficient of interest is supposed to be positive $\beta_1 > 0$.

[11] $\beta_1 = \left[\ln\left(k\right) - \ln\left(z\right)\right]^{open} - \left[\ln\left(k\right) - \ln\left(z\right)\right]^{closed}$

Transferring this approach to firm size and its impact on the effect of import competition on firm investments, we obtain a triple difference specification of the following form

$$\ln(I_{isct}) = \beta_0 + \beta_2 \times \ln(ImpComp_{st}) \times Short\text{-}Term_c \times Size_i + \mathbf{X}'_{\mathbf{isct}}\zeta + \lambda_c + \lambda_{it} + \varepsilon_{isct} \quad \text{(IV.10)}$$

The coefficient β_2 measures the distortion created by competition and its differential impact across the firm-size distribution.[12] Again, the specification makes use of investment category as well as firm-year fixed effects such that identification rests upon variation across investment types within firm-year combinations. According to *Prediction 2* we expect import competition to have a more negative influence on short-term relative to long-term investments for larger firms. Thus, our coefficient of interest is expected to be negative ($\beta_2 < 0$) in order to be in line with the theoretical prediction.

As an additional step, we use China's accession to the WTO in 2001 in order to identify the effect of foreign competition on the investment composition of firms based on a similar difference-in-differences strategy. China's WTO accession marked an inflection point in the evolution of Chinese exports and gave rise to a dramatic increase in exports to the US. The econometric specification is given by

$$\ln(I_{isct}) = \beta_0 + \beta_3 \times Post2000_t \times Pre\text{-}WTO\text{-}Tariffs_s \times Short\text{-}Term_c + \mathbf{X}'_{\mathbf{isct}}\zeta + \lambda_c + \lambda_{it} + \varepsilon_{isct} \quad \text{(IV.11)}$$

$Post2000_t$ is a dummy variable equal to one for years within the panel which succeed China's WTO entry. $Pre\text{-}WTO\text{-}Tariffs_s$ represents the average US tariff level on Chinese imports by industry during the period preceding the accession. We expect firms in industries with larger average tariffs prior to China's WTO entry to be subject bigger increases in import competition thereafter. Again, we expect the coefficient of interest to be positive. By exploiting the competition effect triggered by China's WTO accession as a quasi-natural experiment, we aim to provide corroborative evidence of capturing a causal and economically significant effect.

In all estimation equations the within-firm identification strategy allows for a clean identification of the effect of competition on investments as potential firm-specific demand and supply shocks that symmetrically affect investment categories are captured by the firm-year fixed effects. Therefore, the specification mainly requires to control for investment determinants that vary at the firm or sector level and differ-

[12] $\beta_2 = \left\{[\ln(k) - \ln(z)]^{open} - [\ln(k) - \ln(z)]^{closed}\right\}_{c^{*\prime}} - \left\{[\ln(k) - \ln(z)]^{open} - [\ln(k) - \ln(z)]^{closed}\right\}_{c^{*}}$, $c^{*\prime} < c^{*}$

entially affect a firm's composition of short- and long-term investments.

IV.3.2. Data Description and Key Variables

We employ data on the population of listed manufacturing firms in the US for the years 1995 - 2009. The firms in our sample are obtained from the CRSP database. We match all CUSIP identifiers in the CRSP database for firms with a primary US SIC industry code between 2000 and 3999 with firm-level information from the Compustat and the Worldscope databases. Overall, we end up with 4,428 stock market listed manufacturing firms in our sample.

Measuring Firm Investment and Size

We follow the approach suggested by Garicano and Steinwender (2016) and exploit expenditures on Advertising, Computer Equipment, R&D, Transportation Equipment, Machinery Equipment as well as on Buildings and Land. Garicano and Steinwender (2016) assign the following depreciation rates to these investments based on a survey of the accounting literature to proxy for $Short\text{-}Term_c$:[13] 60% for Advertising, 30% for Computer Equipment, 20% for R&D, 16% for Transportation Equipment, 12% for Machinery, 3% for Buildings and 0% for Land. Besides using these explicit depreciation rates, we also employ a simple ranking that orders the investments from the most long-term one (Land with a durability rank of 1) to the most short-term one (Advertising with a durability rank of 7). Tables C.1 and C.5 in the Data Appendix provide detailed information on the investment data.

To explore the second empirical prediction, we use three different measures of firm size ($Size_i$): a firm's total assets, employment and sales. Since firm size responds endogenously to the level of investments, we hold firm size constant throughout all our estimations and construct firm-specific averages over the years 1995 - 1999, winsorized at the top 1%.

[13]Note that an investment's depreciation rate is the inverse of its time to payoff in years.

Measuring Foreign Competition and Trade Exposure

We measure import competition at the sector level s for a given year t following Bernard et al. (2006) by

$$ImpComp_{st} = \frac{Imp_{st}}{Prod_{st} + Imp_{st} - Exp_{st}}, \tag{IV.12}$$

where Imp_{st} and Exp_{st} represent the value of total US imports and exports at the 3-digit US SIC level derived from UN Comtrade data. $Prod_{st}$ reflects the value of US domestic shipments at the 3-digit US SIC level taken from the NBER CES manufacturing database. Along the same lines we compute a sector's share of export in domestic consumption

$$ExpMarket_{st} = \frac{Exp_{st}}{Prod_{st} + Imp_{st} - Exp_{st}}. \tag{IV.13}$$

Finally, the sectoral degree of openness is given by the ratio of the sum of total US imports and exports over domestic shipments:

$$Openness_{st} = \frac{Imp_{st} + Exp_{st}}{Prod_{st}}. \tag{IV.14}$$

We implicitly assume that all firms within an industry are subject to the same level of foreign competition as well as export market exposure and openness. In order to measure the level of tariff protection prior to China's WTO entry, we average the effectively applied US tariff on Chinese imports at the 3-digit US SIC level over the years $1995 - 2000$. Data on tariffs are again taken from UN Comtrade.

Firm and Sector Level Controls

Two alternative channels that can have an impact on the investment composition at the firm-level are changes in financial constraints and changes in the degree of uncertainty faced by firms. To control for changes in financial constraints, we use firms' current ratio, external financial dependence as well as capital cost. Table C.1 provides a detailed definition of these variables. Since trade liberalization can also be associated with an increase in the degree of uncertainty perceived by firms, we use the annual standard deviation of daily stock returns to proxy for variation in uncertainty.

Moreover, firms' investment composition as well as the level of foreign competition might be affected by sector specific attributes. If import competition is primarily traced back to low-wage countries such as China, the factor proportions framework predicts firms in capital or skill intensive sectors to be relatively less affected than their counterparts in labor or low-skill intensive industries. Furthermore, trade exposure might be related to trends in technology adoption which alter the demand for skill and capital and determine sector specific productivity. We therefore use the capital stock per worker and the share of non-production worker wages in total compensation in order to control for capital and skill intensity at the sector level. Ultimately, we control for sector specific productivity and size by measures of total factor productivity and value added. The entire set of industry level controls is obtained from the NBER CES manufacturing database.

IV.3.3. Baseline Results

Table IV.1 presents our main results from estimating equation (IV.9). In panel A we use the simple ordering as our measure of duration. The ordering of categories follows the ordering of depreciation rates and ranges from 1 (Land) to 7 (Advertising). Panel B repeats all specifications using absolute depreciation rates from the literature as a measure of duration. By offering two distinct measures we aim to ensure that our results do not hinge on specific assumptions regarding the duration of investments, except for a broad ordering. We will show that our story goes through irrespective of the measure chosen.

In discussing our results, we will focus on the sign of the interaction between import competition and duration in a log-log specification, allowing us to compare how long-term investments react *relative* to short-term investments (both measured in percentage terms), when sector-level import competition is increasing by one percent. According to *Prediction 1*, if import competition induces firms to shift their investments towards less durable categories, we expect our coefficient of interest β_1 to be positive. This implies that higher import competition is associated on average with a *relative* shift of investments towards more short-term categories, i.e. categories with a higher rate of depreciation.

All specifications include our measure of interest, category fixed effects and firm-year fixed effects. We correct for two-way clustered standard errors. We cluster at the firm-level and additionally, we cluster at the industry-year level, as our measure of import competition is the same for all firms in a given industry and in a given year. The level of import competition is sector-year specific and thus absorbed by the fixed effects. Thus, we do not identify the average effect of import competition on investments. Similarly, due to the inclusion of category fixed effects, we do not identify the between-category difference in average investments. We include these fixed effects because they allow us to effectively control for alternative channels that otherwise would potentially be confounding our results.

For example, sectors and firms will be exposed to temporary shocks that, on average, will have an impact on investments. Think about a domestic demand shock that reduces the demand for durable consumer goods. Potentially, this demand shock will be correlated with our sectoral measure of import competition. In response to the shock, firms in the durable goods sector might reduce average investments. Because this decision is due to the demand shock and independent of investment durations, the relative composition of short and long-term investments *within* firms and industries would remain constant. Nevertheless, our coefficient of interest might falsely pick up the variation if the investment composition in the durable goods sector happens to be on average more long-term than in other sectors. The uniform investment reduction in the durable goods sector would then shift the *economy-wide* investment composition towards more short run investments. Consequently, we would find a positive coefficient on the durability interaction and wrongly conclude that import competition was causing firms to invest more short-term. The inclusion of firm-year fixed effects will account for these confounding effects at the firm or sectoral level, as long as the change in investments is uniform across the different types of investment.

The fixed effect specification implies that identification, as well as potential confounding effects, all hinge on factors that vary across firms, years and investment categories. In specification (1), only the interaction of import competition with duration fulfills this requirement. No other controls are included. The coefficient is positive as predicted for both measures of depreciation but significant only for the ordered measure.

The problem with specification (1) is that a lot of systematic variation across the three dimensions is now potentially projected on the import channel. Thus, other sectoral developments with a direct impact on investment composition might interfere with our results provided that they are correlated with import competition. We therefore add interactions of the depreciation measure with various sector-level

Table IV.1.: Baseline Regressions

Dependent Variable: log(Investment)				
	(1)	(2)	(3)	(4)
Panel A: Measure of Depreciation: Ordering				
log(ImpComp) * Depreciation	0.0455***	0.0347***	0.0330***	0.0333***
	(0.00813)	(0.00886)	(0.00906)	(0.00903)
Panel B: Measure of Depreciation: Depreciation rate				
log(ImpComp) * Depreciation	0.143	0.252***	0.237**	0.248**
	(0.0901)	(0.0968)	(0.0994)	(0.0998)
Industry Controls * Depreciation	no	yes	yes	yes
sd(Stock Return) * Depreciation	no	no	yes	yes
Investment FE	yes	yes	yes	yes
Firm-Year FE	yes	yes	yes	yes
Observations	89,735	89,436	81,912	72,064
Firm Clusters	3,308	3,308	3,308	3,308
Industry-Year Clusters	2,163	2,163	2,163	2,163

Notes: Investment categories and assumed depreciation rates: Land (0%), Buildings (3%), Machines (12%), Transportation (16%), R&D (20%) Computer (30%), Advertising (60%). The ordering of categories resembles the ordering of depreciation rates. Investment expenses are either derived from balance sheet data on assets (Land, Buildings, Machines, Transportation and Computer) or taken from the income statement (R&D and Advertising). Import competition (ImpComp) are imports at the sectoral level, relative to domestic production plus imports minus exports. Industry controls contain controls for capital-intensity, skill-intensity, tfp and value added. Sd(stock return) is the standard deviation of daily stock returns in a given year. Standard errors are twoway cluster-robust at the firm and at the industry-year level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

controls in specification (2). Specifically, we interact depreciation with time-varying measures of capital intensity, skill intensity, tfp and value added. The import competition coefficient remains positive and now turns significant for both measures of depreciation.

In specification (3), we add an interaction with firm-level volatility of stock returns. This is supposed to disentangle the import competition effect proposed in the theoretical framework from other effects due to trade induced uncertainty. As our coefficient of interest remains significant, we conclude that import competition must have an impact on investment composition other than through market insecurity.

Specification (3) is our baseline regression. Consider the following example in order to understand the meaning of our coefficients: a higher level of import competition creates a wedge between investments into different investment categories. Suppose for example that the level of import competition increases by 10%. Then our coefficient in panel A implies that this wedge is equal to 0.33%. Thus, if an exemplary firm reduces its land investments (the most long-term category) by 10%, we would expect that firm to reduce its investments in buildings by 9.67%, its machinery investments by 9.34%, its transportation investments by 9.01%, its R&D investments by 8.68%, its computer investments by 8.35% and its advertising investments (the most short-term category) by 8.02%.

To evaluate the economic significance of our estimates, we invoke a simple thought experiment. We consider the average increase in import competition over the sample period 1995-2009, i.e. 60% over the 15-year period. Additionally, we assume that Land investments respond inelastically to an import competition shock.[14] Using the results from Table IV.1, panel B, specification (3), we can then calculate the change in the average depreciation rate that results from the increase in import competition.[15] Our estimates suggest that the average increase in import competition by 60% during our sample period has reduced the lifespan of firm assets by 72 days on average, which corresponds to 4.6% of the average asset lifespan. Presuming a refinancing rate of 3%, this would impose an additional cost of 6$ for each 1000$ invested. Thus, import competition is associated with a significant shift towards relatively short-term investments.

In specification (4), we exclude the years 2008 and 2009 from our sample in order to assure that our effect is not picking up specifics of the financial crisis. Garicano

[14]When regressing import competition on Land investments and adding firm and year fixed effects, we find Land investments to be inelastic with respect to import competition.

[15]See the Data Appendix for details on this calculation.

and Steinwender (2016) show for Spanish manufacturing firms that the credit crisis in 2008 effectively worked like an additional tax rate on long-term investments. If import competition was increasing during the crisis, we would not be able to distinguish the two effects. Dropping the crisis years however does not alter our results significantly. If anything, the estimated effects become stronger, indicating that omitting to control for the crisis actually led us to slightly underestimate the effect of import competition.

IV.3.4. Firm Heterogeneity

In our theoretical framework we show that the import competition effect on investment composition should be less pronounced for larger firms.

In Table IV.2, we confront this prediction (*Prediction 2*) with the data, using a triple interaction with measures of firm size in order to see whether the effect of import competition on investment composition varies along the firm-size distribution. We use total employment, net firm sales and total assets as measures of size. Adding the size interactions increases the coefficient on the original interaction (β_1) compared to the baseline. The interaction remains significant at the 1% level in all specifications. The triple interaction with size has the expected negative sign in all specifications, implying that the shift towards short-term investments is less pronounced for larger firms. Statistically, the effect is significant at the 1% level for total assets, independent of the depreciation measure chosen. The effects are less significant for sales and employment and on average stronger when we use the depreciation rate as our measure of duration. Using assets as a measure of size, the coefficients for the depreciation rank imply that for any two neighboring investment categories, a 10% higher import competition is associated with a 0.4% higher decrease in the long-term investment compared to the neighboring shorter-term investment for the median firm. Using an analogous back-of-the-envelope calculation as in the baseline with respect to the estimates from panel B, we compare a firm at the 10th percentile with a firm at the 90th percentile of the firm-size distribution (in terms of assets). We find that the lifespan of assets decreases by about 15 days more in the small firm.

IV.3.5. Reordering and Omitting Investment Categories

In order to determine whether our results hinge on the assumed ordering of investment categories in terms of depreciation rates, we omit and regroup various cate-

Table IV.2.: Heterogeneous Investment Responses Across Firms

Dependent Variable: log(Investment)				
			Measure of Size	
		Employment	**Sales**	**Assets**
	(1)	(2)	(3)	(4)
Panel A: Measure of Depreciation: Ordering				
log(ImpComp) * Depreciation	0.0330***	0.0396***	0.0403***	0.0401***
	(0.00906)	(0.0101)	(0.00985)	(0.00966)
log(ImpComp) * Depreciation * Size		-0.000599	-3.42e-06*	-3.32e-06***
		(0.000385)	(1.74e-06)	(1.22e-06)
Depreciation * Size		-0.000736	-3.00e-06	-4.83e-06
		(0.000950)	(3.97e-06)	(3.36e-06)
Panel B: Measure of Depreciation: Depreciation rate				
log(ImpComp) * Depreciation	0.237**	0.321***	0.335***	0.326***
	(0.0994)	(0.109)	(0.106)	(0.105)
log(ImpComp) * Depreciation * Size		-0.00647*	-3.86e-05**	-3.58e-05***
		(0.00371)	(1.85e-05)	(1.23e-05)
Depreciation * Sales		0.00421	2.51e-05	-2.82e-06
		(0.0102)	(4.54e-05)	(3.62e-05)
Industry Controls * Depreciation	yes	yes	yes	yes
sd(Stock Return) * Depreciation	yes	yes	yes	yes
Investment FE	yes	yes	yes	yes
Firm-Year FE	yes	yes	yes	yes
Observations	81,912	73,136	75,578	75,660
Firm Clusters	2,866	2,866	2,866	2,866
Industry-Year Clusters	2,381	2,381	2,381	2,381

Notes: Investment categories and assumed depreciation rates: Land (0%), Buildings (3%), Machines (12%), Transportation (16%), R&D (20%) Computer (30%), Advertising (60%). The ordering of categories resembles the ordering of depreciation rates. Investment expenses are either derived from balance sheet data on assets (Land, Buildings, Machines, Transportation and Computer) or taken from the income statement (R&D and Advertising). Import competition (ImpComp) are imports at the sectoral level, relative to domestic production plus imports minus exports. Measures of size are from Compustat and represent firm averages over the years 1995 to 1999. Industry controls contain controls for capital-intensity, skill-intensity, tfp and value added. Sd(stock return) is the standard deviation of daily stock returns in a given year. Standard errors are twoway cluster-robust at the firm and at the industry-year level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

gories for the ordered measure of depreciation in Table C.2.[16] Specification (1) repeats our baseline regression. In specification (2) we omit investments into R&D in order to see whether R&D expenses are driving our result. For example, a rise in import competition might lead firms to foster innovation by investing more heavily in research activities.[17] This decision is independent of the duration of R&D investments, but would still render our coefficient positive because R&D expenditures just happen to be classified as relatively short-term. The inclusion of category fixed effects does not help us against this type of disturbances, as the unobservable effect varies over time. Omitting R&D investments reduces the number of observations by more than a quarter and diminishes the size of our coefficient. But our results remain robust at the 5% level of significance, indicating that R&D is an important, but not the only driver of our results.

In specification (3) we further omit investments in Advertising. Because different from the other categories, both R&D and Advertising expenses are taken from the income statements rather than being derived from asset data, one concern is that our results are due to these constructional differences. The results in specification (3) show that our results go through when restricting the sample to asset data. Specification (4) omits Transportation and Computer investments. Computer investments are reported only for the years 1999 and onwards and Transportation is reported very little over the full range of years. Accordingly, these two categories might not be very representative and specifically prone to be affected by outliers. But again, our results remain robust when estimating the equation for the remaining categories.

Because estimates of depreciation rates vary in the literature, we regroup assets that are close to each other into single categories in specifications (5) to (7). In specification (5), we assign the same rank to Land, Buildings and Machinery. R&D and Computer investments are grouped into another category. The coefficient almost doubles in size and remains highly significant. Adding Transportation to the group of long-term investments in specification (6) further increases the coefficient, confirming that switching from one rank to another now has a higher impact on investment duration. Because the depreciation rate of Transportation is relatively close also to R&D and Computer, specification (7) assigns it into one group with these categories. Again, our results are not significantly altered.

Finally, it could be that firms increase research expenditures in order to remain

[16] Specifications (1) to (4) are robust to using the depreciation rate instead.

[17] Bloom et al. (2016) show that Chinese import competition increases technical change within firms, among other things, by increasing the amount of R&D.

competitive in the future, rendering R&D effectively a long-term investment. Then our ranking of investment categories would be flawed. Specification (8) therefore ranks R&D as the most long-term investment. The effect vanishes and we conclude that our original ordering is more coherent, given that R&D investments are not the sole driver of our results.

IV.3.6. Alternative Financial Channels

In Table C.3 we try to rule out some alternative stories that might affect our results. Garicano and Steinwender (2016) argue that credit shocks reduce the relative value of long-term investments because firms might have to liquidate before the payoff materializes. Since we want to identify a competition shock, we need to make sure that time varying financial characteristics are properly controlled for. In specifications (2) to (5) we therefore add interactions of the depreciation measure with measures of the current ratio, external dependence, capital cost and a financial crisis dummy. While some of these controls appear to have an effect on the investment composition, the results for our measure of import competition are not significantly altered. We therefore conclude that import competition is not just working through changes in firms' financial characteristics and probably better explained by changes in demand.

IV.3.7. Differentiating between Import Competition and Market Access

In subsection IV.2.5 in the theory, we argue that higher market access should have effects exactly opposed to the effects of import competition. Table C.4 addresses this point. Because better market access implies higher demand in the future, we would expect firms to shift investments towards this future market. Accordingly, the results for import competition documented so far are probably biased in the opposite direction.

Specification (2) shows that our assumptions regarding the market access effects are confirmed in the data. When regressing investments on the interaction of depreciation with export market size, our estimates suggest that firms are shifting investments towards long-term categories when faced with better export opportunities. The effects for exports are slightly larger than for imports and highly significant. In specification (3) we add the export market interaction to the baseline specification to see how our original results are affected. Stable signs indicate that the impact of both imports and exports remain as the theory would predict. The increase in size of our coefficient of interest shows that failing to control for export opportunities biases our coefficient on import competition in the opposite direction.[18] Given these findings, we consider our previous results to represent a conservative estimate of the actual effect. Finally, in specification (4) we use an openness measure that incorporates both import competition and export opportunities and find that mixing up the two effects conceals much of the impact trade has on investment composition. Because the coefficient remains positive and marginally significant for the ordering measure, we conclude that import competition might have slightly outweighed the effect of export opportunities for the firms in our sample.

IV.3.8. The Impact of China's WTO Accession on the Composition of Firm Investments in the US

In order to substantiate our claim that it is the surge in imports that induces a reallocation of investments towards long-term investments, we will exploit a quasi-natural experiment based on the large competition effect caused by China's accession to the WTO in 2001. China's WTO accession is a useful experiment for mainly two reasons.

First, China's accession to the WTO, and the dramatic increase of exports to the world that followed thereafter,[19] was driven mostly by the change in China's internal conditions and not by the rising import demand of receiving countries. As Autor et al. (2013) point out, this interpretation is corroborated by the fact that China had an average annual TFP growth in manufacturing of 8% during that time, compared to only 3.9% for the US. Autor et al. (2016) cite several studies indicating that the prospect of formal WTO accession was a major force stimulating the underlying restructuring of the manufacturing industry. The increasing privatization of public enterprises, the extension of trading rights for private firms, greater access to imported intermediates and a solidification of the MFN status, providing security to Chinese exporters, all helped to foster a new level of productivity growth after 2001. Thus, although China had already been granted most-favored nation status (MFN)

[18] The same holds *vice versa* for export opportunities.

[19] Between 2000 and 2007, the low-income country share of US imports almost doubled from 15 to 28%, with China accounting for 89% of this growth. Compare Autor et al. (2013). Additionally, see Figure C.6 in the Data Appendix for the average share of imports from China in total US imports for the industries in our sample.

Table IV.3.: The Impact of China's WTO Accession

Dependent Variable: log(Investment)				
	(1)	(2)	(3)	(4)
Panel A: Measure of Depreciation: Duration rank				
Post2000 * Pre-WTO-Tariff * Depreciation	0.00636**	0.00550*	0.00539*	0.00430
	(0.00290)	(0.00301)	(0.00300)	(0.00313)
Post2000 * Depreciation	-0.0359***	-0.0241*	-0.0219	-0.0123
	(0.0134)	(0.0144)	(0.0139)	(0.0148)
Pre-WTO-Tariff * Depreciation	0.00489	0.00541	0.0181***	0.0184***
	(0.00344)	(0.00352)	(0.00371)	(0.00378)
Panel B: Measure of Depreciation: Depreciation rate				
Post2000 * Pre-WTO-Tariff * Depreciation	0.0642**	0.0548*	0.0549**	0.0447
	(0.0272)	(0.0282)	(0.0270)	(0.0282)
Post2000 * Depreciation	-0.642***	-0.577***	-0.500***	-0.376**
	(0.146)	(0.154)	(0.147)	(0.157)
Pre-WTO-Tariff * Depreciation	0.105***	0.104***	0.134***	0.155***
	(0.0327)	(0.0337)	(0.0351)	(0.0364)
Industry Controls * Depreciation	no	no	yes	yes
sd(Stock Return) * Depreciation	no	yes	no	yes
Investment FE	yes	yes	yes	yes
Firm-Year FE	yes	yes	yes	yes
Observations	30,949	27,804	30,517	27,428
Firm Clusters	2,379	2,379	2,379	2,379

Notes: Investment categories and assumed depreciation rates: Land (0%), Buildings (3%), Machines (12%), Transportation (16%), R&D (20%) Computer (30%), Advertising (60%). The ordering of categories resembles the ordering of depreciation rates. Investment expenses are either derived from balance sheet data on assets (Land, Buildings, Machines, Transportation and Computer) or taken from the income statement (R&D and Advertising). Sample period 1999-2003. Post2000 is an indicator that takes the value 1 if the year is 2001 or later. Pre-WTO-Tariff is the simple industry average (over the years 1995-2000) of the effectively applied tariff on US imports from China as reported in the WITS/Comtrade data base. Industry controls contain controls for capital-intensity, skill-intensity, tfp and value added. Sd(stock return) is the standard deviation of daily stock returns in a given year. Standard errors are twoway cluster-robust at the firm and at the industry-year level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

during the 80s, the surge in exports significantly accelerated after 2001. This surge can be treated as mostly exogenous to dynamics in the US market which is crucial for identification.[20]

Second, Autor et al. (2016) argue that China's comparative advantage in industrial goods implies that China's growth resulted primarily in a large supply shock for manufacturing goods and a large demand shock for raw materials. Given that US imports from China vastly exceeded US exports to China, this suggests that our identification strategy is likely going to capture manufacturing import competition rather than export potential.[21]

While we argue that the results we are going to present in this section represent a causal effect of imports on the investment composition, we are aware that we cannot precisely determine the channel through which imports are affecting the investment choices of firms. Thus, while we claim that import competition is the driving force behind our results, part of the variation we are using might be due to a rise in imported intermediates rather than final goods. Yet, note that cheaper intermediates should have a positive effect on the future market potential of US firms. Thus, if the surge in US imports to China was driven by a surge in intermediate imports, if anything, it would make it more difficult for us to detect a shift towards short-term investments.

Technically, the approach we use is related to Guadalupe and Wulf (2010), as we also use the average pre-trade-agreement level of tariffs to identify the firms most affected by trade liberalization. Specifically, we use the US effectively applied import tariff *vis-à-vis* China, averaged over the years 1995 to 1999 and specific to firms within US SIC three digit industries.[22] As noted by Pierce and Schott (2016), the change in China's WTO membership status in 2001 had two effects: it ended the uncertainty associated with annual renewals of China's MFN status and it led to a substantial reduction in expected US imports tariffs on Chinese goods. It is the latter aspect that we will use for identification.[23] Accordingly, we look at the differential change in investment behavior before and after the Chinese WTO accession in 2001, where

[20] See Iacovone et al. (2013) for a similar argument.

[21] Bloom et al. (2016), Iacovone et al. (2013) and Utar (2014) also use the WTO accession of China as a natural experiment for an increase in import competition.

[22] The effectively applied tariff is defined as the lowest available tariff, given by preferential tariffs if existent and MFN tariffs otherwise.

[23] In fact, the average tariffs remained relatively stable after 2000. Nevertheless, for the years 1999 to 2003, we find that industries with pre-WTO accession tariff levels above the median experienced a 66% larger increase in Chinese import competition than industries with pre-WTO accession tariffs below the median.

we make use of the fact that the threat of tariff reductions is larger in high-tariff industries. The coefficient of interest is the interaction of a post-2000 dummy with the pre-trade-agreement level of tariffs. In all specifications, we focus our sample on a sample period between 1999 and 2003, around China's WTO entry in 2001.

Table IV.3 shows the results for the two measures of depreciation. Again, we allow errors to be clustered at the firm level and include category and firm-year fixed effects in all specifications. In specifications (1) to (4), we subsequently add the time varying sector-level and uncertainty controls interacted with our measure of duration. Adding all controls simultaneously leads to insignificant results, but the triple-interaction of interest is significant at the 5% or 10% level when restricting the controls to one set or the other. The coefficient of interest is positive in all specifications, implying that the WTO accession of China led to a higher decrease (or lower increase) in long-term investments, compared to short-term investments, and that this effect was more pronounced in sectors that had higher average tariffs during the second half of the 1990s.[24] Specifically, using the results from specification (3) in panel B, we find that for a firm at the 25th percentile of our tariff measure, the average investment duration increased in the years after 2001 by roughly 106 days more than for firms at the 75th percentile of the pre-2000 tariff distribution.

IV.4. Conclusion

This paper examines how the exposure to foreign competition affects the composition of short-term relative to long-term investments within firms. In order to guide our empirical strategy, we develop a stylized framework which illustrates the investment decision of a representative firm with respect to short- and long-term investments. An increase in the toughness of competition reduces the relative value of long-term investments and induces firms to shift their investment composition towards short-term investments. The magnitude of this effect varies with firm size. We test these predictions based on the population of listed US manufacturing firms by using data on seven asset classes which we order according to their depreciation rates. Based on our framework, the empirical strategy employs a difference-in-differences estimator. This approach allows using firm-year fixed effects as well

[24] Note that the negative coefficient on the interaction of our measure of depreciation with the post-2000 dummy implies that on average firms with a zero tariff-level invested relatively more long-term after 2000. This is a materialization of the general trend towards more long-term investments over time which can be seen in Figures C.3 and C.5.

as investment category fixed effects in order to identify the effect of trade induced competition on the composition of investments within firms. The empirical results are in line with our predictions. Import competition shifts the composition of investments towards more short-lived categories and the effect depends on firm size. Our results are robust to the inclusion of controls that account for alternative channels at the firm and sector level such as various measures of financial constraints and factor intensities. In order to provide further supportive evidence of a causal effect, we exploit the rise in Chinese imports to the US due to China's accession to the WTO as quasi-natural experiment. Finally, we also explore the impact of exporting on the composition of investments. Our results suggest that exposure to export markets works in the opposite direction, and induces a reallocation towards long-term investments.

We believe that adjustments in the composition of investment have important economic implications. If trade induced competition incentivizes firms to disregard the long-term perspective this implies a loss in sustainability, higher financing costs as well as changes in the firm-size distribution. This suggests new research directions. Future research might for example study how changes in the composition of investment relate to the welfare effects of globalization.

C. Appendix

Figure C.1.: Impact of Tougher Competition on Investment Composition

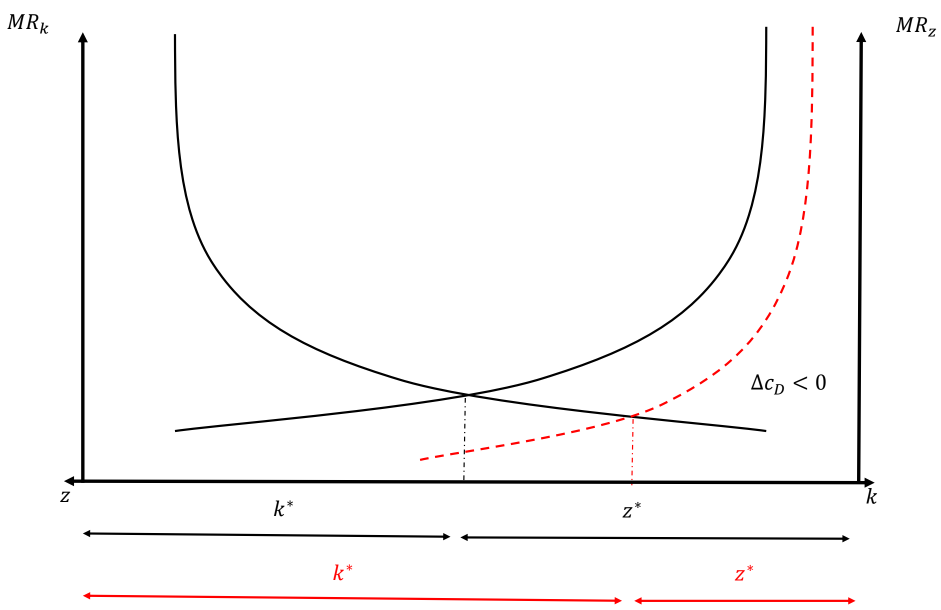


Figure C.2.: Impact of an Increase in Market Size on Investment Composition

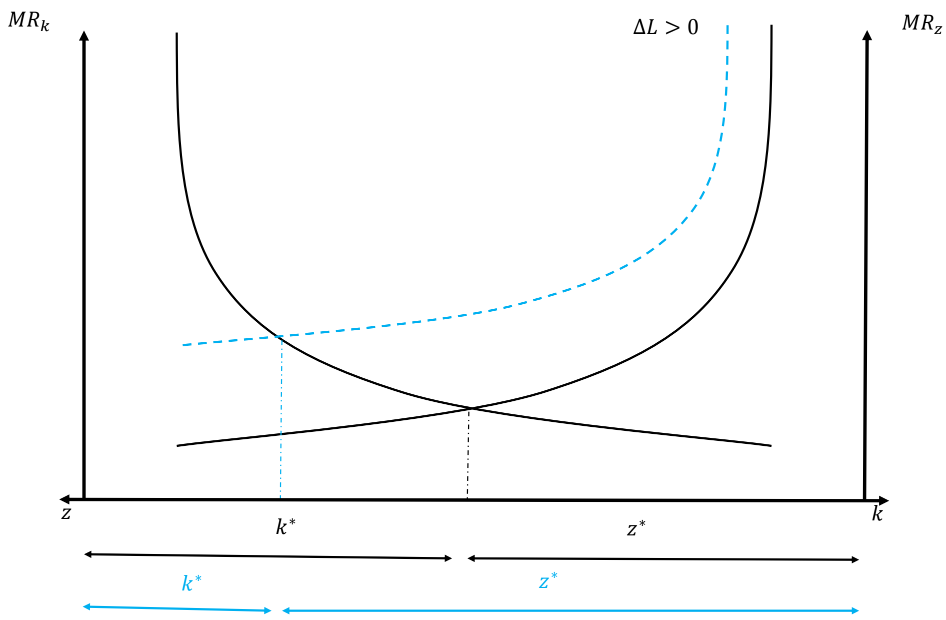


Table C.1.: Description of Variables and Data Sources

Variable	Description	Source
Firm Investments		
advertising$_{it}$	*advertising* represents the cost of advertising media (i.e., radio, television, and periodicals) and promotional expenses in millions USD; Compustat variable name: XAD	Compustat
computer$_{it}$	*computer software & equipment* (period t) - 0.95 $\times$ *computer software & equipment* (period $t-1$); *computer software & equipment* (gross property plant and equipment) represents computer equipment and the information a computer uses to perform tasks in millions USD	Worldscope
R&D$_{it}$	*research & development expenses* (period t) represent all direct and indirect costs related to the creation and development of new processes, techniques, applications and products with commercial possibilities in millions USD	Worldscope
transportation equipment$_{it}$	*transportation equipment* (period t) - 0.95 $\times$ *transportation equipment* (period $t-1$); *transportation equipment* (gross property plant and equipment) represents the cars, ships, planes or any other type of transportation equipment in millions USD	Worldscope
machines$_{it}$	*machinery & equipment* (period t) - 0.95 $\times$ *machinery & equipment* (period $t-1$); *machinery & equipment* (gross property plant and equipment) represent the machines and machine parts needed by the company to produce its products in millions USD	Worldscope
buildings$_{it}$	*buildings* (period t) - 0.95 $\times$ *buildings* (period $t-1$); *buildings* (gross property plant and equipment) represent the architectural structure used in a business such as a factory, office complex or warehouse in millions USD	Worldscope
land$_{it}$	*land* (period t) - 0.95 $\times$ *land* (period $t-1$); *land* (gross property plant and equipment) represents the real estate without buildings held for productive use, is recorded at its purchase price plus any costs related to its purchase such as lawyer's fees, escrow fees, title and recording fees in millions USD	Worldscope
Firm Controls		
employment$_i$	average firm employment in thousands over the years 1995-1999, winsorized at the top 1%; Compustat variable name: EMP	Compustat
sales$_i$	average firm sales in millions USD over the years 1995-1999, winsorized at the top 1%; Compustat variable name: SALE	Compustat
assets$_i$	average firm assets in millions USD over the years 1995-1999, winsorized at the top 1%; Compustat variable name: AT	Compustat
current ratio$_{it}$	*current ratio* is an indication of a firm's market liquidity and ability to meet creditor's demands; defined as current assets divided by current liabilities during a given year t (banker's rule: >2 for creditworthiness); Compustat variable names: ACT/LCT	Compustat
external dependence$_{it}$	*external dependence* is the fraction of capital expenditures that are not financed by internal capital flows during a given year t; Compustat variable names: $(\text{CAPX} - \text{EBIT})/\text{CAPX}$	Compustat
capital cost$_{it}$	*capital cost* is defined as capital expenditures over liabilities during a given year t; Compustat variable names: CAPX/LT	Compustat
sd(stock return)$_{it}$	standard deviation of the daily firm stock returns (P_d/P_{d-1}) during a given year t	CRSP
Trade Variables		
import competition$_{st}$	*ImpComp* is defined as $ImpComp = imports^{World}/\left(domestic\,shipments + imports^{World} - exports^{World}\right)$; at the 3-digit US SIC level during a given year t	NBER CES data for vship, UN Comtrade for exports and imports
export market exposure$_{st}$	*ExpMarket* is defined as $ExpMarket = exports^{World}/\left(domestic\,shipments + imports^{World} - exports^{World}\right)$; at the 3-digit US SIC level during a given year t	NBER CES data for vship, UN Comtrade for exports and imports
openness$_{st}$	*Openness* is defined as $Openness = \left(exports^{World} + imports^{World}\right)/domestic\,shipments$; at the 3-digit US SIC level during a given year t	NBER CES data for vship, UN Comtrade for exports and imports
pre-WTO tariff$_s$	simple industry average tariff over the years 1995-2000 of the effectively applied US tariff on imports from China; at the 3-digit US SIC level	UN Comtrade
Industry Controls		
capital-intensity$_{st}$	total real capital stock in thousands USD per employee; at the 3-digit US SIC level during a given year t; NBER CES variable names: CAP/EMP	NBER CES data
skill-intensity$_{st}$	share of compensation for non-production workers in total compensation; at the 3-digit US SIC level during a given year t; NBER CES variable names: $(\text{PAY} - \text{PRODW})/\text{PAY}$	NBER CES data
tfp$_{st}$	5-factor NBER TFP index with base year 1995; $tfp_{'95}$ = 1	NBER CES data
value added$_{st}$	industry value added in millions USD; at the 3-digit US SIC level during a given year t; NBER CES variable names: VADD	NBER CES data
Other Controls		
economic crisis	is an indicator equal to 1 for the years 2007-2009	
post 2000	is an indicator equal to 1 for the years 2001-2003 and equal to 0 for the years 1999-2000	

Table C.2.: Altering Investment Categories

Dependent Variable:	**log(Investment)**							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Measure of Depreciation: Ordering								
log(ImpComp) * Depreciation	0.0330***	0.0194**	0.0236*	0.0334***	0.0634***	0.104***	0.0896***	-0.0133
	(0.00906)	(0.00918)	(0.0128)	(0.00935)	(0.0166)	(0.0281)	(0.0273)	(0.00870)
Industry Controls * Depreciation	yes	yes	yes	yes	yes	yes	yes	yes
sd(Stock Return) * Depreciation	yes	yes	yes	yes	yes	yes	yes	yes
Investment FE	yes	yes	yes	yes	yes	yes	yes	yes
Firm-Year FE	yes	yes	yes	yes	yes	yes	yes	yes
Excluded categories	none	R&D	R&D/ Advertising	Transportation/ Computer	none	none	none	none
Number of categories	7	6	5	5	4	3	3	7*
Observations	81,912	58,441	49,572	76,822	81,912	81,912	81,912	81,912
Firm Clusters	3,358	3,358	3,358	3,358	3,358	3,358	3,358	3,358
Industry-Year Clusters	2,441	2,441	2,441	2,441	2,441	2,441	2,441	2,441

Notes: Investment categories and assumed depreciation rates: Land (0%), Buildings (3%), Machines (12%), Transportation (16%), R&D (20%) Computer (30%), Advertising (60%). The ordering of categories resembles the ordering of depreciation rates in specification (1)-(4). Specification (5) groups Land, Buildings and Machinery into one category and R&D and Computer into another. Specification (6) additionally takes Transportation into the category with Land, Buildings and Machinery, while specification (7) takes it into the category with R&D and Computer. In specification (8), R&D is ordered as the most long-term investment. Investment expenses are either derived from balance sheet data on assets (Land, Buildings, Machines, Transportation and Computer) or taken from the income statement (R&D and Advertising). Import competition (ImpComp) are imports at the sectoral level, relative to domestic production plus imports minus exports. Industry controls contain controls for capital-intensity, skill-intensity, tfp and value added. Sd(stock return) is the standard deviation of daily stock returns in a given year. Standard errors are twoway cluster-robust at the firm and at the industry-year level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table C.3.: Alternative Financial Channels

Dependent Variable: log(Investment)					
	(1)	(2)	(3)	(4)	(5)
Panel A: Measure of Depreciation: Ordering					
log(ImpComp) * Depreciation	0.0330***	0.0302***	0.0319***	0.0313***	0.0331***
	(0.00906)	(0.00904)	(0.00919)	(0.00912)	(0.00906)
Current Ratio * Depreciation		0.00963***			
		(0.00223)			
External Dependence * Depreciation			0.000198**		
			(9.86e-05)		
Capital Cost * Depreciation				-0.200***	
				(0.0233)	
Crisis * Depreciation					-0.00795
					(0.0187)
Panel B: Measure of Depreciation: Depreciation rate					
log(ImpComp) * Depreciation	0.237**	0.233**	0.229**	0.221**	0.241**
	(0.0994)	(0.0987)	(0.100)	(0.0989)	(0.0993)
Current Ratio * Depreciation		0.00579			
		(0.0247)			
External Dependence * Depreciation			0.00159*		
			(0.000821)		
Capital Cost * Depreciation				-2.116***	
				(0.290)	
Crisis * Depreciation					-0.260
					(0.209)
Industry Controls * Depreciation	yes	yes	yes	yes	yes
sd(Stock Return) * Depreciation	yes	yes	yes	yes	yes
Investment FE	yes	yes	yes	yes	yes
Firm-Year FE	yes	yes	yes	yes	yes
Observations	81,912	79,083	78,956	78,963	81,912
Firm Clusters	3,358	3,358	3,358	3,358	3,358
Industry-Year Clusters	2,441	2,441	2,441	2,441	2,441

Notes: Investment categories and assumed depreciation rates: Land (0%), Buildings (3%), Machines (12%), Transportation (16%), R&D (20%) Computer (30%), Advertising (60%). The ordering of categories resembles the ordering of depreciations rates. Investment expenses are either derived from balance sheet data on assets (Land, Buildings, Machines, Transportation and Computer) or taken from the income statement (R&D and Advertising). Import competition (ImpComp) are imports at the sectoral level, relative to domestic production plus imports minus exports. Financial controls are time varying at the firm level derived from Compustat: Current Ratio is the total of current assets over current liabilities, External Dependence is capital expenditure net of EBIT over total capital expenditure, Capital Cost is capital expenditure over total liabilities. Crisis is an indicator equal to 1 for the years 2007-2009. Industry controls contain controls for capital-intensity, skill-intensity, tfp and value added. Sd(stock return) is the standard deviation of daily stock returns in a given year. Standard errors are twoway cluster-robust at the firm and at the industry-year level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table C.4.: Import Competition and Access to Foreign Markets

Dependent Variable: log(Investment)				
	(1)	(2)	(3)	(4)
Panel A: Measure of Depreciation: Ordering				
log(ImpComp) * Depreciation	0.0330***		0.0767***	
	(0.00906)		(0.0123)	
log(ExpMarket) * Depreciation		-0.0360***	-0.0814***	
		(0.00908)	(0.0118)	
log(Openness) * Depreciation				0.0146*
				(0.00763)
Panel B: Measure of Depreciation: Depreciation rate				
log(ImpComp) * Depreciation	0.237**		0.644***	
	(0.0994)		(0.126)	
log(ExpMarket) * Depreciation		-0.489***	-0.847***	
		(0.0994)	(0.117)	
log(Openness) * Depreciation				0.0894
				(0.0840)
Industry Controls * Depreciation	yes	yes	yes	yes
sd(Stock Return) * Depreciation	yes	yes	yes	yes
Investment FE	yes	yes	yes	yes
Firm-Year FE	yes	yes	yes	yes
Observations	81,912	81,912	81,912	81,912
Firm Clusters	3,358	3,358	3,358	3,358
Industry-Year Clusters	2,441	2,441	2,441	2,441

Notes: Investment categories and assumed depreciation rates: Land (0%), Buildings (3%), Machines (12%), Transportation (16%), R&D (20%) Computer (30%), Advertising (60%). The ordering of categories resembles the ordering of depreciation rates. Investment expenses are either derived from balance sheet data on assets (Land, Buildings, Machines, Transportation and Computer) or taken from the income statement (R&D and Advertising). Import competition (ImpComp) are imports at the sectoral level, relative to domestic production plus imports minus exports. Export market size (ExpMarket) are exports at the sectoral level, relative to domestic production plus imports minus exports. Openness is the sum of exports and imports at the sectoral level, relative to domestic production plus imports minus exports. Industry controls contain controls for capital-intensity, skill-intensity, tfp and value added. Sd(stock return) is the standard deviation of daily stock returns in a given year. Standard errors are twoway cluster-robust at the firm and at the industry-year level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Calculation of the Marginal Effects

For every firm in our sample, we calculate the sum of expenses in each year. Then we express the individual category investment as share of total firm investments for each year. Next, we use these shares to calculate the average investment share of each category across all firms and years in the sample. Because the resulting average shares do not add up to one, we re-weight the shares accordingly.[25] We use the resulting shares to construct an average depreciation rate, where we weight the category specific depreciation rates with the respective average share in investment. This way, we obtain an average sample depreciation rate of 23.1%, which implies that the average firm investment lasts 1579.8 days $[= (1/r) \times 365]$.

Now we consider an increase in import competition of 60%. This corresponds to the increase of the import competition variable in our estimation sample (from 22.4% in 1995 to 35.7% in 2009). We use the regression results to calculate the relative change in each category. Because we do not know the level effect of import competition on investments, we additionally need to assume the investment elasticity in one base category. Here, we use a 0% change in Land investments with respect to a trade shock (when regressing import competition on Land investments and adding firm and year fixed effects, we find Land investments to be inelastic with respect to import competition).

Applying the relative percentage changes in each category, we can then construct new after-trade-shock investment shares. As before, we use these shares to obtain the new average depreciation rate (23.28% for specification (3) in panel B of table IV.1). Investments now fully depreciate after 1507.8 days, implying that import competition has reduced the duration of investments by about 72 days on average.

Note that these results depend on the critical values chosen for the increase in import competition and the elasticity of Land investments with respect to import competition. Thus, letting the percentage change in Land vary from -10% to +10% (holding constant the increase in import competition at 60%) changes the reduction in days from -79 to -66.1.

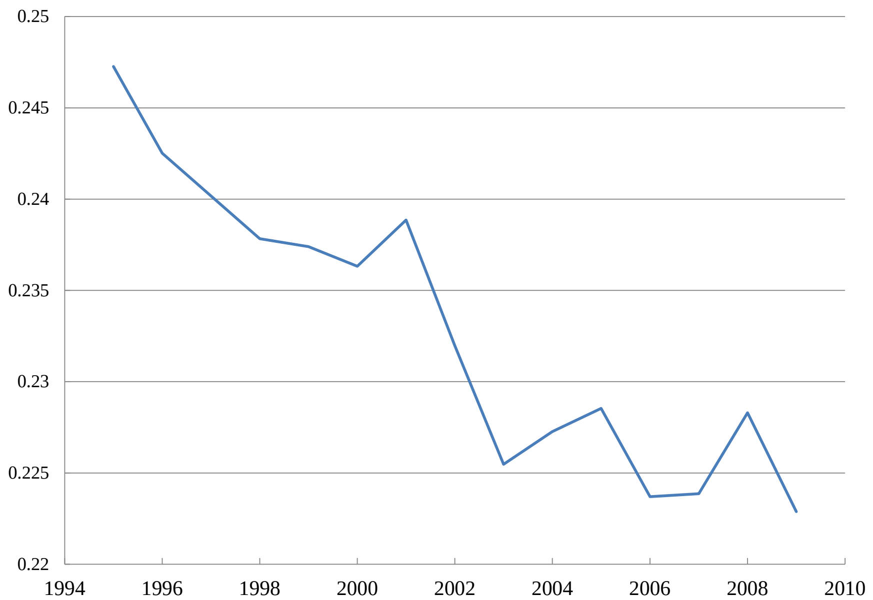
[25] See Figures C.4 and C.5 for the average investment composition in our sample.

Table C.5.: Depreciation Rates of Investments

Firm Investment	Applied Depreciation Rate	Duration Rank
advertising	60%	7
computer	30%	6
R&D	20%	5
transportation equipment	16%	4
machines	12%	3
buildings	3%	2
land	0%	1

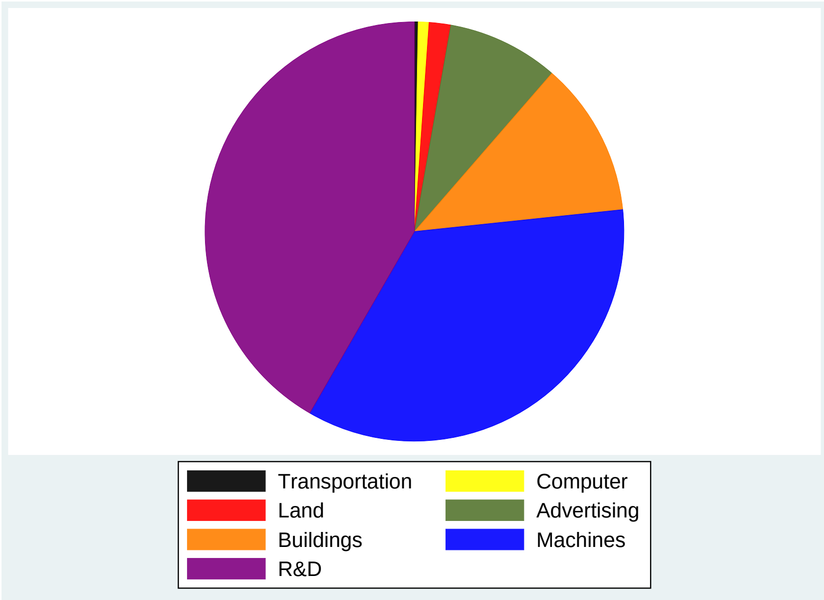
Notes: Applied depreciation rates are obtained from Garicano and Steinwender (2016) who derive the investment-specific depreciation rates from various sources of the accounting literature.

Figure C.3.: Average Rate of Depreciation over Time



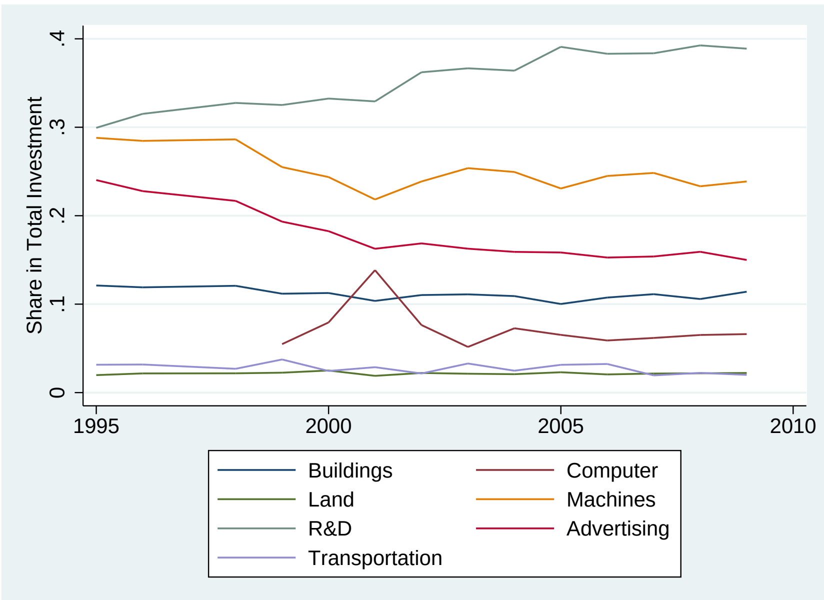
Notes: The figure shows the average depreciation rate over the years for the firms in our sample. The average is constructed by weighting each investment specific depreciation rate with its average investment share across all firms in a specific year. Investment categories and assumed depreciation rates: Land (0%), Buildings (3%), Machines (12%), Transportation (16%), R&D (20%) Computer (30%), Advertising (60%). See section Marginal Effects in this Appendix for a description of how these average depreciation rates are calculated.

Figure C.4.: Shares of Investment Categories in Total Investments



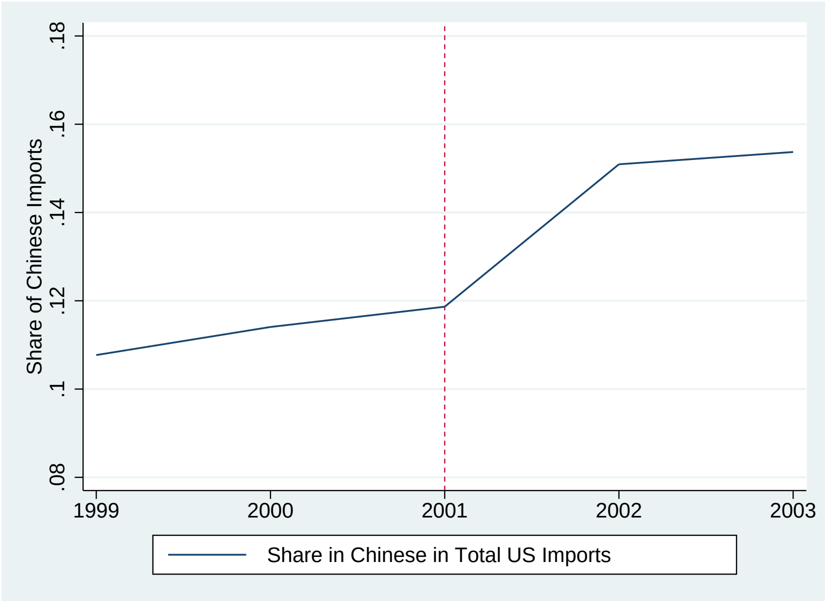
Notes: The figure shows the sample average composition of investment categories.

Figure C.5.: Shares of Investment Categories in Total Investments over Time



Notes: The figure shows the composition of investment categories over time.

Figure C.6.: Share of Chinese in Total US Imports



Notes: The figure shows the average share of imports from China relative to total imports of the US for the US SIC 3-digit industries in our sample.

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