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## Offshoring and Manufacturing Wages in sub-Saharan African Countries

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# 1 Introduction

Opinions on whether developing economies should open up to trade or engage in protectionism differ greatly. The body of theory and evidence on this question offers no straightforward answer. Not only can it be tedious to disentangle effects of technological change and increasing trade openness that at times took place simultaneously and are interconnected, but there are also many aspects to consider. Wages are one dominant aspect which are themselves multifaceted. Trade can affect wages and employment through different channels at the country level, the industry level and at the firm level, and these effects do not always work in the same direction. The relationship of trade and wages at the firm level is one important part of the whole picture. In this work, a sample of 2738 manufacturing companies drawn from UNIDO's Africa Investor Survey 2010 (Organization (2010)) database on 20 sub-Saharan African countries, some of them surveyed for the first time, is used to gain some insight into the firm-level relationship of trade and wages. The analysis considers the impact of direct imports of intermediate inputs and exports on the wages of production and non-production workers as well as on relative wages at the conditional mean using OLS and at different points of the wage distribution using quantile regression.

Furthermore, decomposition methods are employed to test for differences in the wage-setting function between companies that trade and those that do not. To the best of my knowledge, although there are prominent examples of applications of decomposition methods to the wage structure effects of technological change and dispersion of education premia within groups of workers with the same educational characteristics (see Lemieux (2006) and Juhn, Murphy, and Pierce (1993)), there has been no such approach to the effect of trade on wages at the firm level.

Section 2 gives a short review of trade theory and wage theory, and discusses theoretical and empirical works on the relationship of trade and wages with emphasis on studies at the firm-level. Section 3 lays out the research question in detail. Section 4 gives an overview of the methodology applied in this work. Section 5 discusses the data set, descriptive statistics and simple hypothesis tests. Section 6 discusses the regression and decomposition results. Section 7 concludes.

# 2 Theory and empirical evidence

The relationship of trade and wages is rather complex. Neoclassical trade theory draws on the Stolper-Samuelson theorem derived from the Heckscher-Ohlin model. The Heckscher-Ohlin model analyses trade between two countries that differ in endowments. The model predicts that trade will induce a country to export goods the production of which is intensive in the country's abundant factor and import goods the production of which is intensive in the use of the country's scarce factor. The Stolper-Samuelson theorem concludes that this will result in an increase in relative earnings of the abundant factor and a decrease in relative earnings of the scarce factor. Hence, it predicts that trade between industrialised countries and developing countries will increase wages in developing countries whilst increasing the price of capital and decreasing wages in industrialised countries. Trade between countries that differ in skill-endowments is seen to increase the price of low-skilled labour in the low-skilled labour abundant country exporting goods intensive in this factor and to decrease the price of low-skilled labour in the low-skilled labour scarce country. Trade between countries differing in skill-endowments is therefore considered to decrease wage inequality in developing countries and increase wage inequality in industrialised countries.

These theoretical considerations, however, have not been confirmed empirically
(for recent work on the topic see Zhu and Trefler, 2005)[1].
Haskel, Lawrence, Leamer, and Slaughter (2012) criticise that, although two goods — two skill-level models might have been more appropriate in the past, they are not particularly helpful nowadays in explaining trajectories of wage inequality.
Extensions to the Heckscher-Ohlin framework have been proposed to model a more complex interplay of factor prices, goods prices and differences in endowments. The most notable examples are the modelling of love-of-variety, technological change and trade induced innovation. A crucial point is that starting in the 1980's, models that account for firm heterogeneity have become more common and have been able to explain intra-industry trade ((Melitz and Trefler, 2012)) and the fact that some firms in an industry engage in international trade and some do not. These models state that different firms react in a different way to the host country opening up to trade. This argument has been able to explain considerable variation in wages and trade volumes that occur even within very narrowly defined industry sectors. Furthermore, models

[1] They use the Freeman and Oostendorp (2001) occupational wage database that contains data on the relative wages of production and nonproduction workers for the 1990's for 20 developing and newly industrialised countries to demonstrate that trade has not reduced wage inequality in a great part of these countries

that go beyond the static Heckscher-Ohlin framework have been able to solve some major contradictions between theory and empirics.

## 2.1 Wage Theory

Why would trade have an influence on wages other than by changing factor prices at the market level? Theory and empirics point to different reasons for rent-sharing between firms and their employees [2]. If trade is related to productivity levels and profits, rent-sharing would form a link between trade and wage levels. At the firm level, whether a firm engages in trade and its trade volumes would be one determinant of wage levels. If firms heterogeneity is the reason why some firms in the same market engage in trade and some do not, rent-sharing could be a reason for variation in wages between these firms. Major theoretical examples of different forms of rent sharing are efficiency wage theory, contract theory and fair wages theory.

**Efficiency wage theory**

Efficiency wage theory argues that wages above the competitive equilibrium level are paid to increase labour productivity. One reason put forward is that more skilled and more productive employees should be attracted with wages above the equilibrium level (cf. Fehr and Gchter, 1998). Higher wages can also be a way to reduce labour force turnover and to secure that benefits of employee training can be reaped. High wages can be intended to raise the costs of losing a position, and thereby motivate employees to put more effort into their work. At the same time, high wages are seen as a means to prevent them from switching to another company, thus taking firm specific knowledge with them which might benefit a competitor and making it necessary to train a new employee. This is the more costly the higher the employee's position and the more specific her qualifications. This is why productivity and indirectly anything influencing wages over productivity might have a higher ceteris paribus influence on the wages of qualified employees, those with very specific qualifications and those with important knowledge of firm-specific processes and innovations, i.e. a combination of their education, their position and their experience within the firm.

[2] Rent-sharing means that profits made by a firm are shared with its workers to some extent.

### Contract theory

A key feature of an employer-employee relationship is observability and verifiability of the employee's effort. If effort is not verifiable, that is, if evidence on effort is not available, the first best contract of paying according to effort is not feasible. Under uncertainty, the optimal contract with payment according to outcome must both satisfy the constraint that it must be better than the agent's outside option and induce him to exert the desired effort level. The reason is the moral hazard problem involved with this form of asymmetric information. With the agent's marginal costs of effort sufficiently high or the degree of observability of his effort level (how well his actions can be monitored and the probability with which a given effort level yields a certain outcome) sufficiently low, the agent gets an information rent with the optimal piece rate contract. Generally speaking, effort is very hard to verify in high-skilled tasks and less observable the more demanding the task. This is an argument for wage premia to be higher for more skill intensive positions as well.
Another explanation for wages to be higher with firm- and individual employee productivity that also considers observability is given by Shapiro and Stiglitz (1984). They argue that higher wages are used to introduce a higher penalty for shirking and thus to induce employees to be more productive in an environment where there is incomplete control over their behaviour. Hence, the less effort is observable for a certain position, the higher the wage. This hits a similar vein as the general efficiency wages theory implications: the expected cost of shirking is intended to be increased with higher wages when the probability to be laid off on these grounds is very low.

### Fair Wages

Akerlof (1982) proposes a model in which fair wages are considered as a form of partial gift exchange. This view was motivated by anecdotical evidence of wages above the equilibrium level and effort substantially above the level formally required observed in the absence of motivation by promotion and significant wage bargaining power by employees performing rather low-skilled tasks. Hence, in the model, wage premia are paid in exchange for effort above the formally agreed level. This includes less able agents as well because agents stand in for each other and more able agents make up for others failing to meet their targets.

These theories complement rather than contradict each other. As each of them suggests, whether rents are shared and how this happens may vary with the specific requirements of the workplace, the possibility of monitoring and workers' bargaining position, notably unemployment, labour laws and contract enforceability. In empirical analyses, a relationship between productivity and wages has been largely confirmed in various contexts, as well as considerable premia for education and positions that involve more responsibility and are thus more demanding and are up to the agent's discretion to a greater degree. Support for the notion of fair wages is also offered. Individual utility maximization and wage bargaining alone cannot offer a general explanation for bonuses that are well known to be an important feature of many managers' contracts. Fehr and Schmidt (2004b) explore this issue in an experimental setting. Bonus payments cannot be enforced by the agent after the costs of high effort have been incurred, so a principal that only acts out of self-interest will not have an incentive to pay a bonus and the agent knows this. This holds in a one-shot game and in a finitely repeated game by backward induction. In the experiment, principals can design a piece rate or offer a bonus contract and agents decide on an effort level for two different tasks. The tasks are complementary for the principal, but while effort spent on both is perfectly observable, only effort spent on task two is verifiable. This characterises many work situations. The amount of goods produced or services provided may be verifiable, but not so their quality or the presence of a good relationship with a customer. Even in the one-shot game, a bonus contract works much better in making the agent spend equal effort on both tasks although average aggregate effort levels are not significantly different from piece rate contracts, but bonus contracts pareto dominate piece rate contracts. Even though some principals offer high fixed rates with the piece rate contract which also could be seen as an appeal to the agent's fairness, many agents choose minimal effort levels for the second task. Whilst bonuses outperform piece rates, not all agents offered bonuses chose high effort levels for the second task. No principal chose a trust contract with a piece rate of 0 and a generous fixed wage that may also induce reciprocity.[3] Fehr and Schmidt (2004b) explain these observations with their theory of inequity aversion((see Fehr and Schmidt, 1999)) that features heterogenous players with some being very concerned about inequity and some purely self-interested, the interaction of which is crucial for the interpretation. Inequity-averse agents faced with a significant probability of being matched with a selfish principal fear the suffering from inequity additional to the loss of effort costs and expend minimal effort with a bonus

[3] Such a contract performed very poorly in a setting where the alternative was the possibility of a punishment for bad performance (Fehr and Schmidt, 2004a). This could be taken as an argument against fair wages as described by Akerlof (1982), but again, this may depend on the context such as the personal relationship between employer and employee and whether the game can be considered as infinitely repeated.

contract ((Fehr and Schmidt, 2004b)). In real life settings, however, this may be very different with *ex ante* communication and the possibility of screening[4] and signalling [5]. One example of an experimental exploration of the concept of guilt aversion is provided by Charness and Dufwenberg (2006) who assume that decision makers' utility suffers from the feeling that they have let someone down. They find support for the related notion that even without strategic uncertainty, strategies depend on beliefs about the beliefs of others which can be formed and sharpened by communication — finding that in a game with hidden action where reciprocity is no Nash Equilibrium [6] if players are purely self-interested, reciprocity can occur based on beliefs about the partner's credibility, with communication being a way of signalling.

## 2.2 Theory and empirics of trade, productivity and wages

### Trade and factor prices

The impact of trade on factor prices is an issue to be considered when doing analysis at the firm level as more firms that trade are likely to be observed in industries that are more internationally oriented in a randomly drawn sample even though factor prices are not the major identifiable force behind wage differences between traders and non-traders in the same industry. Insufficiently controlling for industry sectors may thus bias results on the firm level. Furthermore, it is worth having a look at the general trade and wages literature (which departs from the simplifying assumption of homogenous firms) because effects that can be made out at the country or industry level may well be able to explain differences between traders and non-traders within the same market segment.

Zhu and Trefler (2005) derive a general equilibrium model building on a combination of the Ricardian model of international technology differences by Dornbusch, Fischer, and Samuelson (1977) with the Heckscher-Ohlin model (Dornbusch, Fischer, and Samuelson, 1980), in which, as industrialising economies catch

[4] The principal offering a contract that is only attractive for agents willing or able to exert a certain level of effort.

[5] A player takes some *ex ante* action tied to some cost that reveals she is incentivised to play the equilibrium the other player favours. This could be for example someone studying for an academic degree and thereby signalling that he is able to exert high effort.

[6] None of the players has an incentive to deviate given the other player's strategy

up in terms of technology, the least skill-intensive goods so far produced in industrialised countries become the most skill-intensive goods so far produced in industrialised countries become the most skill-intensive goods produced in industrialising countries. This predicts rising demand for skills and thus rising wage inequality in both industrialised and developing economies, a mechanism which is empirically confirmed by linear regression analysis using both ordinary least squares and instrumental variable estimation on the Freeman and Oostendorp (2001) data.

At a more general level, Krugman has become well known for his formal analysis of intra-industry trade that builds on increasing returns to scale and monopolistic competition through product differentiation (Krugman, 1979). This model was transformed using less restrictive assumptions in later works (see for example Krugman (1980) and Brander and Krugman (1983)), thus validating the model's predictions for a more general setting. With product differentiation and imperfect substitution, firms compete monopolistically within their market segment. Therefore, with increasing returns to scale, it is profitable to access a bigger market, i.e. to export. Hence, trade and gains from trade can be observed even when the economies between which trade occurs are identical in factor endowments, preferences and technology. It has been pointed out that consumers benefit from a larger variety of goods as do firms from a larger variety of inputs (for an early formal analysis of welfare losses because of reduced variety through tariffs see Romer, 1994).

There has been an intense discussion among labour and trade economists regarding the extent to which the increase in wage inequality in the U.S. and in several other countries can be attributed to trade or technological change. In the ninetees, authors like Katz and Murphy (1992) and Berman, Bound, and Griliches (1994) suggested that technological change is the main driving force behind the increase in inequality on the basis of estimations taking account of both technological change and increase in aggregate trade volumes. Feenstra and Hanson (1999) in their central paper, develop a two-stage regression to isolate effects of trade on factor prices that is based on the approach by Leamer (1996). In the first stage, factor prices and productivity are regressed on structural variables such as trade and technology. In the second stage, the obtained estimates are regressed on factor shares. The resulting estimates yield the change in factor prices explained by the respective structural variable. Using U.S. data for the 1980's, they find that about 25% of the increase in the relative wages of non-production workers is due to offshoring, 30% are through technological change. Their famous article has further heatened the discussion and stimulated various applications and extension to their approach. Hijzen (2007) provides an extension to distinguish between factor and sector bias by making productivity and factor prices endogenous in a two-stage procedure. He finds that, for explaining wage inequality in the UK during the 1990s, the sector bias played a much larger role than the factor bias of international outsourcing, while the factor bias was slightly larger for technological change.

Findings on the sector and country level are important for the present work in the following way: If trade induces technological change, the channels over which this happens may be visible at the market level - imported high-tech intermediates are available to all firms through wholesellers and competition fostered by an increase in trade openness can be felt by all firms. But firms interacting directly with a foreign trade partner or a company that sells its products on a foreign market are likely to be more directly and more intensely exposed to the impact that increased variety and technology level of intermediate inputs and increased competition may have. Feenstra (2010) explains that productivity gains from offshoring acting like low-skilled labour saving technical progress can be expected to have a positive effect on wages for low-skilled labour whilst the price effect of an increase in world output of low-skilled labour intensive is negative. Everything else remaining the same it depends on the size of the country which effect dominates and whether realative wages of non-production workers fall or rise. So again the question is whether it is low-skilled labour that is offshored or high-skilled labour (acting like high-skilled labour saving technological progress) (cf. Feenstra, 2010). The issue is further complicated by specialisation being found to be incomplete (cf. Edwards and Lawrence, 2010). That technological change can occur through trade as well again makes it harder to disentangle effects. Burstein, Cravino, and Vogel (2011) develop a model in which international trade in capital goods increases demand for skill by these capital goods being complementary to skill, hence increasing wage inequality.

Applying the mandated wage approach of Feenstra and Hanson (1999), Edwards and Lawrence (2010) show that the increase in U.S. wage inequality has not been mandated by changes in developing-country import prices. They explain this by the finding that highly disaggregated U.S. manufacturing industries that import high shares of goods from developing economies are more skill-intensive than those that import high shares of goods from developed economies. The authors' explanation is the U.S. and developing economies having specialised in products being highly imperfect substitutes. Another notable example for the impact of trade between countries differing in endowments being not at all straightforward to predict is

Attanasio, Goldberg, and Pavcnik (2004), who find that the impact of tariff reductions in Colombia in the 1980s and 1990s has been threefold: returns to colledge education increased, industry wages chaned in a way that sectors with a higher proportion of low-skilled workers and initially lower wages lost, and a shift of labour towards the informal sector.

When talking about the impact of trade at the firm-level in so-called developing countries, the described ambiguity with respect to skill has to be borne in mind. This review shows as well that it is important to distinguish the overall effect of trade that can be measured by comparing countries or years with different degrees of openness to trade or by comparing industries with different trade volumes from the effect of trade on wages in firms that engage in trade. Assuming that single firms are not responsible for a change in market wages, only the productivity effect but not the price effect can be distinguished in an analysis at the firm-level. If trade is a reason for higher technology levels at the firm-level, trading firms might be willing to pay more for high qualifications if these are complementary to technology. There is no reason for them to pay less for low-skilled labour. Rather, if technology is related to productivity and there is some form of rent-sharing when it comes to production wages, these may well be higher at trading firms. Hence, while the studies discussed in the previous section may allow for the forces at work at the market level being a relevant factor for differences at the firm-level as well, the reasonings on the way these effects work are not generally applicable here.

**Trade at the firm-level**

Several arguments provide support for trade at the firm level being associated with absolute wage differences. Whether it is also associated with higher wage differences between occupations with different skill levels, that is, higher qualification premia, is less clear-cut and depends crucially on the channels over which trade is related to wages and therefore is more closely tied to what is traded and with whom.

It has become common practice to answer the question why, in the same country and industry sector, some firms or plants export and some do not by modeling firm heterogeneity with different productivity levels and different costs of exporting. Recent papers use and extend the framework of Melitz (2003) which was motivated by empirical evidence for self selection of more productive firms into exporting (notably the contributions of Bernard and Bradford Jensen (1999), Aw, Chung, and Roberts (2000), andClerides, Lach, and Tybout (1996)) and the exposure to trade forcing the least productive firms to exit the market (see for example (Aw et al., 2000). The Melitz (2003) model is a general equilibrium model with monopolistic competition. In contrast with earlier models that incorporate trade costs, firms do not only incur a per unit transport and transaction cost (which is as usually modeled as iceberg cost of a fraction lost of each unit sold), but also a fixed sunk cost for accessing a foreign market additionally to the domestic market which are modeled independently of trade volume decisions[7]. Productivity levels are allowed to vary without any distributional restrictions. A transition from autarky to an open economy as well as further trade liberalisation makes market entry more profitable for the more productive firms. More productive firms export and the cutoff productivity level below which a firm does not survive becomes higher as the domestic market share reduces for all firms. Thus, the total number of firms declines and with the reallocation of market shares towards more productive firms, average productivity increases whilst the most productive firms are those that export. This result is particularly important as it is independent of increased competition through imports.

Imports at the firm level have until recently been less extensively studied than exports, even less so the interplay of exports and imports. Kasahara and Lapham (2008) develop a stochastic model with export and import complementarities. They extend the Melitz (2003) model to importing intermediates which increases a firm's productivity because of increasing returns to variety in inputs and leads to a partitioning of the mass of firms into a group of firms that import and a group that does not because of a fixed sunk cost involved with importing [8]. Similar to the prediction of Melitz (2003) for exports, this leads to intra-firm productivity gains for importers and an increase in aggregate productivity. One important insight is that importing intermediates may enable a firm to export as it becomes sufficiently productive to do so. When the returns to importing intermediates are large enough, a firm that exports but does not import may also lose market share through trade liberalisation and vice versa. As a result of market reallocation to more productive firms, labour demand and equilibrium wages rise with trade liberalisation. Kasahara and Lapham (2008) test their model using plant level data on manufacturing plants in Chile from 1990-1996 and find substantial productivity differences between exporters and non-exporters as well as between

[7]This fixed sunk cost may comprise making the product known in the foreign market, getting informed about and adhering to specific rules and regulations, setting up new distribution channels etc.

[8]This sunk cost could include costs such as resources used for establishing relationships with foreign sellers, search costs, transaction costs and transport costs etc.

importers and non-importers. Importers are more productive even after controlling for exports and vice versa. Costs of exporting/importing are modeled with stochastic fixed costs drawn in each period of exporting/importing and if a firm chooses to export or import, it additionally draws choice-dependent cost shocks associated with the export/import decision from the extreme-value distribution. They find compelling evidence for substantial sunk costs associated both with exporting and importing and for a firm being able to save approximately 20 % of its sunk costs associated with the trading decision in each period if it engages in export and import simultaneously (Kasahara and Lapham, 2008, p.20).

Davis and Amiti (2012) combine this framework with the one of Melitz (2003) to model the relationship of exports and imported intermediate inputs and wages at the firm level. The relationship with wages is modelled by incorporating imperfect factor markets in which rent sharing between the firm and its workers occurs. They apply the theory of fair wages proposed by Akerlof (1982) but stress that whilst some form of rent-sharing is essential to their results, its precise form does not play a major role (Davis and Amiti, 2012, p.3). They consider the concept of fair wages more suited than efficiency wages for the setting of developing economies, where a large low-skilled workforce competes for jobs and wage bargaining cannot be a major concern for a large fraction of jobs (Davis and Amiti, 2012, p.9). The impact of increased effort on productivity and the reciprocity of this relationship forms the link between firm characteristics and wages, thereby constituting a channel for trade to influence wages and vice versa. In their model, all workers at zero-profit firms earn the same wage, workers at other firms are paid wages increasing in the profitability of the firm. Bidding down does not occur because workers are identical and any other hired worker will demand the same wage. The two sectors of the economy are the intermediate goods sector with a fixed measure of varieties on the unit interval. Entry is free, returns to scale are constant, and prices equal marginal costs. In order to allow for import and export shares to vary, additional heterogeneity parameters are introduced, that is, after having incurred a sunk fixed cost, firms receive a random draw of three parameters that are distributed with a joint probability density function: the firm's productivity in activities paid according to marginal cost, and idiosyncratic marginal import and export costs. When the idiosyncratic marginal cost of importing is lower for some firm, its productivity threshold for importing intermediates to pay off the sunk fixed cost are lower holding everything else fixed. The setup for exports and its implications are equivalent. Trade liberalisation is captured as the decrease of an iceberg import cost component common to all firms in the market. With the elasticity of substitution between any two varieties of intermediate inputs set to be greater than one, marginal costs are lower for an importing firm and it has access to a larger variety of inputs. Revenues are lower in a foreign market due to iceberg costs, but total revenues of a firm are increasing in export share because it serves a larger market. Hence, total revenue of a firm is thus increasing in export and import shares, with exporting being complementary to importing. By rent-sharing, wages are increasing in revenues with decreasing marginal returns when the trade status is held fixed. This result holds with identical preferences and endowments over countries. They test their model using an unbalanced panel for Indonesia from 1991-2000 with industries classified at the five-digit level and find a significant positive link between trade status and wages, with importer-exporters paying higher wages relative to one way traders. This effect is found to be robust to selection and heterogeneity.

In an unpublished working paper, Helpman, Itskhoki, Muendler, and Redding (2012) explore unobserved differences in workforce composition across firms by extending the theoretical model of Helpman, Itskhoki, and Redding (2010). The latter model considers heterogeneity in productivity as in Melitz (2003), but instead of homogenous workers considers *ex post* match-specific heterogeneity in workers' abilities. By worker ability being complementary to firm productivity and through higher returns to screening for larger firms, multi-lateral bargaining leads to a higher qualified workforce and higher wages for exporters compared to non-exporters. Helpman et al. (2012) add a cost of screening workers as well as heterogeneity in the size of the fixed cost of exporting and predict that wage dispersion between firms is related to trade and size. The model fit is confirmed by matched employer-employee data for Brazil from 1986-1998.

A few theoretical and empirical works point towards an effect of trade on wage inequality when firm and/or worker heterogeneity are the focus of attention. The model by Monte (2011) with heterogeneous technology and heterogeneous workers in which abilities and the qualities of ideas are complementary predicts that changes to trade costs have asymmetric effects on productive vs. less productive firms which leads to higher wages for trading firms. An important feature of the model is that trade integration can lead to increasing wage ratios at the top of the distribution and to constant or decreasing wage ratios at the bottom, which stresses the relevance of considering more than the mean of the wage distribution. Intra-firm wage distribution is predicted not to change with trade integration as the latter is allowed to affect wages over rents reaped by the firm only, so it does not alter rent-sharing itself. This is similar to Yeaple (2005), who shows that firms that are identical in the beginning become heterogeneous due to the scarcity of skilled labour when firms endogenously decide on the employment of different technologies and then hire workers of different types corresponding to the decision on technology. Firms that employ better technology and more skilled labour select into exporting when this is tied to a fixed cost as the better technology allows them to produce at lower unit cost. An export premium is also paid to production workers. This suggests higher wage dispersion at the plant level for exporters as found by Frias, Kaplan, and Verhoogen (2012) for data on Mexico for 1993-2001. They find no effect of exporting on wages at the lower percentiles and an increasing effect at higher percentiles but no increase in the effect from the 75th percentile onwards, which the authors take as evidence for the increase of within-plant wage dispersion not being exclusively caused by higher wages for top-managers. The theoretical model of Davidson, Matusz, and Shevchenko (2008) offers some possible explanations for this finding. Similarly to Yeaple (2005), firms are identical *ex ante*, but there are high-skilled and low skilled non-production workers. Technology can be basic or advanced, the latter can only be managed by high-skilled managers. The model predicts that the globalization decision has no effect on total factor productivity, but that wages of high-skilled managers increase for both high and low technology firms as the surplus is split and their bargaining power increases, whilst net gains of low-skilled managers may be positive or negative as they are paid part of the surplus but lose some bargaining power. High-skilled managers in high technology firms gain more from the firm's decision to export than high-skilled managers in low-tech firms. Their result could be taken the other way around as well: High-skilled managers in an exporting firm gain more from high technology than high-skilled managers in a firm only serving the domestic market. Another potential factor for trade status altering the way in which other structural variables influence wages could be the relationship between global engagement and innovation activities of firms, as found by Criscuolo, Haskel, and Slaughter (2010) for example, that would be complementary to skill and other channels hypothesised by the assumption of learning by exporting [9].

# 3 Research Question

From the literature review, several hypotheses relevant to the analysis of cross section data on the firm level emerge:
Firms that engage in international trade are generally larger in terms of sales than

[9]Learning by exporting or importing could mean that through the interaction with a foreign trade partner, firms could gain access to more advanced technology but also get ideas on how to organise production more efficiently (cf. Clerides et al., 1996).

firms that do not, they are more productive and have a higher qualified workforce than firms that do not. This relationship may be connected to innovation and technology, the latter term being understood in its broadest sense. If some form of rent-sharing occurs, these firms also pay higher wages in general. If innovation and technology are complementary to skill and rents are shared, the wages setting function may be different according to trade status. If exporting and importing at the firm level are complementary, wages should be higher for twoway traders than for those that only either import or export.

Several features of the AIS data impose limitations on the estimation of the hypothesised relationship. A cross-sectional structure and lack of instruments preclude reliable separation of the direction of effects. Worker and occupational characteristics are merely available at a minimum level: Only average monthly wages and working hours were asked for workers in three occupational categories, that is production workers, administrative or clerical employees and managerial or technical staff. The latter two categories have been found to have been inconsistently distinguished by respondents and therefore have to be lumped together. The white to blue collar ratio does provide a measure of skill, but a very crude one. One major shortcoming of this as a measure of skill intensity is that the more white collar workers a firm employs relative to total employment, the more likely it is that some of them would not be very high skilled but medium skilled.

Because of these features, skill-biasedness of trade resulting in disproportionately higher wage inequality between production and nonproduction workers would thus not only show in higher estimated skill premia for firms engaging in international trade, but also in differences in unobservables, that is, residuals would differ for traders and non-traders. Coefficients on the major candidates for forming a connection between trade and wages, notably productivity, size, employment and technology level would also be likely to differ. This would most likely be observed at the higher quantiles of the wage distribution.

The following hypotheses are tested:

1. Wages are generally higher for firms that engage in trade. This effect is stronger for twoway traders because of complementarity of importing and exporting. To a large extent, these differences in wages can be explained with size and productivity effects.

2. The effect of firm trade on wages is stronger for more qualified workers. With qualifications insufficiently controlled for, it is more strongly visible in the higher quantiles of the wage distribution.

3. Therefore, wage ratios of non-production to production workers depend positively on trade status. Skill premia paid by trading firms differing among firms with lower skill premia would mean that the effects of trade on wage ratios differ over quantiles as well. Trade being skill-biased and skill-biasedness mattering more with a low initial skill-level would also show in different estimated effects over the quantiles of the distribution of relative wages.

4. Skill-biasedness of trade and capital-skill as well as trade induced technological change in the widest sense together with technology-skill complementarity and therefore skill becoming more important for a trading firm would show in the wage-setting function differing with respect to trade status. This difference may vary over quantiles as they reflect different skill-levels.

5. If residuals differ systematically for traders and non-traders, that is, if there is a regular pattern over quantiles and one that matches estimated differences in coefficients and endowments, this is an indication for unobserved skill being related to trade.

Mean comparison tests and tests of stochastic dominance are performed to show whether wages, wage ratios and control variables are higher (or lower) for exporters, importers or twoway traders over the whole distribution. An OLS-regression is used to test for a relationship between exporting, importing, twoway trade and wages at the firm level at the conditional mean. Quantile regression is used to explore this relationship and the channels over which it may persist for wages at different quantiles. A Blinder-Oaxaca style decomposition decomposes the estimated differences in wage levels and relative wages between traders and non-traders into into differences arising from different endowments (the composition effect), from different coefficients of the exogenous variables (the structural effect) and the interaction between differences in endowments and differences in coefficients. A wage decomposition as proposed by Juhn et al. (1993) decomposes the observed differences in the dependent variable into composition effects, effects of coefficients and differences arising from different distributions of residuals at different quantiles. The two techniques can be used to test for differences in wage-setting functions according to the globalisation decision of firms. The latter of the two allowing for differences in residuals is particularly useful when qualifications cannot be sufficiently controlled for. To my knowledge, these two decomposition methods have not been used to investigate the relationship of trade and wages before [10].

With OLS and quantile regression, the following linear equation is estimated:

$$w_i = X_i + M_i + T_i + f_i + s_i + a_i + +sr_i + lp_i + kl_i \tag{1}$$

$w_i$ denotes wages. Separate equations are estimated with average wages, blue collar wages, white collar wages and the white collar to blue collar wage ratio respectively as the dependent. $X_i$ is the export status of the firm, taking the value 1 if the firm is a firm that exports only and zero otherwise. $M_i = 1$ denotes that the firm imports part or all of its intermediate inputs but does not export and $T_i = 1$ if the firm both imports and exports. $f_i = 1$ if at least 10 % of the firm is in foreign ownership. $s_i$ is firm size measured by the total number of employees, $a_i$ is firm age, $sr_i$ is the ratio of white collar to blue collar employment, $lp_i$ is labour productivity and $kl_i$ is the capital to labour ratio.

# 4 Methodology

Kolmogorov-Smirnov tests test for stochastic dominance of trading firms and of the firms that import, export or do both respectively. An OLS regression analyses effects of trade and trade volumes at the conditional mean for both production and nonproduction workers. Quantile regressions are performed to give a more complete picture of the relationship at different quantiles of the wage distributions. A decomposition into a composition effect, a wage structure effect and a residual effect is used to test for differences in the wage setting function and in unobserved characteristics.

Results should be interpreted with caution as to the direction of the effect as, from the outset, trade may influence wages and wages may influence trade via the same channels. Given the very limited possibilities to control for worker and job characteristics in the sample, this problem is exacerbated by the wage level itself being a sort of skill measure. If explanatory variables are correlated with skill, i.e. if capital and skill are complements and productivity and skill are correlated, they are thus likely to be correlated with the error term, which leads to biased coefficients. Not too much weight should be given to their absolute magnitude, but rather their relative values should be considered.

[10] Apart from Helpman et al. (2012), there are a couple of other papers in the field that consider residual wage inequality but use a different method. For example, Krishna, Poole, and Senses (2012) find that trade liberalisation increases residual wage inequality more for high-skilled labour by regressing the standard deviation of estimated residuals from a wage regression on education and trade variables.

As there are many large outliers in the sample (about which there is little reason to assume that they are outliers merely because of erroneous recording of data, so deleting them would be wrong), OLS may yield inflated coefficients by giving too much weight to these outliers. The errors may well not be i.i.d. as there are more outliers among very large firms that pay rather high wages and thus not only could estimated coefficients be biased but also could estimated t-statistics be biased upwards and t-tests wrongly reject the null-hypothesis of the coefficients being zero. Comparing the median instead of the mean gives much less weight to outliers and therefore quantile regression can be a way to deal with this problem.

Another advantage is that quantile regression can give a much clearer picture of the effects at work if they vary over the quantiles of the wage distribution. There are only two occupational categories used in this work: production and non-production employment. This is why quantile regression is even more useful here because higher unconditional quantiles of the wage distribution are likely to be associated with worker characteristics which are insufficiently controlled for in the parametric specification.

## 4.1 Quantile Regression

Different from OLS minimising the sum of squared residuals, quantile regression (QR) minimises absolute deviations of conditional quantiles:
Let $\beta$ be a vector of unknown regression parameters from a sample of independent observations on random variables $Y_1, Y_2, ..., Y_T$. They are then distributed according to
$P(Y_t < y) = F(y_t - x_t\beta)$
with $x_t; t = 1, ..., T$ the rows of a known $T \times K$ design matrix. The exact shape of $F$ is not known. The $\theta$th population quantile is
$\theta = Prob[y \leq \mu_\theta], 0 < \theta < 1$
The $\theta$th sample quantile may then be defined as any solution to the minimisation problem:

$$\min_{b\in\mathbb{R}} \left[\sum_{t\in\{t:y_t\geq b\}} \theta|y_t - b| + \sum_{t\in\{t:y_t<b\}} (1-\theta)|y_t - b|\right]$$

Then, the $\theta$th regression quantile is defined as any solution to the minimisation problem:
$$\min_{b\in\mathbb{R}^K} \left[\sum_{t\in\{t:y_t\geq x_tb\}} \theta|y_t - x_tb| + \sum_{t\in\{t:y_t<x_tb\}} (1-\theta)|y_t - x_tb|\right]$$
(Koenker and Bassett, 1978)

The estimation of this equation is not straightforward though as the function is not differenciable in $\beta$. Linear programming is therefore used to solve the minimisation problem. A common method that is used here is the simplex method because it always yields a solution in a finite number of simplex iterations given that a solution exists ((Cameron and Trivedi, 2005)). A linear minimisation problem like the estimation of the regression quantile forms a polytope of the same dimension as the linear model imposed on the parameters $\beta_1, ..., \beta_T$ when the corresponding variables are not multicollinear. The polytope forms the feasible region of the maximisation problem (or minimisation problem by multiplying the maximisation problem by (-1))[11]. With an additional constraint, the simplicial cones formed by the vertices and their neighbourhood become simplices. A simplex algorithm departs then from a starting vertex, moving along the edges in each iteration. Convergence means then that there is no step that could further decrease the sum of absolute weighted deviations (c.f Dantzig and Thapa, 2003). There are several refinements to this basic method and different approaches to finding the starting base. Here, The simplex algorithm by Armstrong, Frome, and Kung (1979) is used

For finding a basis, weighted least squares as in Schlossmacher (1973) is employed [12]. This method is generalised to all quantiles by Hunter and Lange (2000).[13].[14]

[11]A simplex is the simplest form of an n-dimensional polytope. A zero simplex is a point, a one dimensional simplex is a line, a two-dimensional one a triangle and its interior, a three-dimensional one a tetrahedron and its interior. That is, an n-simplex is the convex hull of n+1 vertices and is obtained by connecting all angles that form an n-1 simplex with any affine independent point. The necessity of the point being affine independent of the n-1 simplex means in the 2- respectively 3-dimensional case that a tetrahedron cannot be formed by connecting all angles of a triangle with a point that lies on the same plane, i.e. that is a linear combination of the angular points.

[12]This amounts to solving the least squares problem in k iterations:
$\sum_{i=1}^{N} w_i R_i^2, N = 1, ..., N$
with $R_i^2$ being the squared residuals and $w_i$ the weights. In the first step, the weights are all set to one. In the second step, the residuals are calculated with the generated LS residuals, $R_i(k)$. In the next step, the weighting factors are set to $\frac{1}{|R_i(k)|}$. If any of these is close to zero, the individual weight is set to zero. This is repeated until $|R_i(k+1) - R_i(k)| \cong 0$.

[13]They approximate the minimization problem by a quadratic function that is increasing in residuals and majorises (sorts in a decreasing order) the residuals at each quantile. Summing this function over the residuals and minimising yields the next iteration of the weighted least squares algorithm ((Hunter and Lange, 2000, p.63f)).

[14]This procedure is incorporated for parameter estimation the command *sqreg* for simultaneous bootstrap of several quantiles in *Stata* which is used here.

## 4.2 Heteroscedacity

If the true model is $y = x'\beta + u$ with $u \sim iid[0, \sigma^2]$, that is, if the errors are homoscedastic, $\beta$ does not vary over quantiles. Even more, if the assumptions of weakly exogenous observations $x$ is valid additionally, the OLS-estimator is BLUE [15] by the Gauss-Markov Theorem and thus more precise than quantile regression. That is, quantile regression is not particularly interesting but for its desirable properties for samples with many outliers if there is not some form of heteroscedacity. As with OLS, heteroscedacity does not cause QR coefficients to be biased but leads to inconsistent estimation of standard errors. Hence, t-tests may be more likely to wrongly reject the null hypothesis of no effect of the exogenous variable in question on the dependent variable than otherwise. Several authors suggest that this problem should not be exaggerated though (see for example (Cameron and Trivedi, 2005, p. 275)). Others insist that it should not be neglected, for example (Frolich and Melly, 2010, p. 26), who provide analytical standard errors using the kernel method of Powell (1986) to estimate the asymptotic variance as shown by Koenker (2005)[16] [17].

A more common method to estimate heteroscedacity robust standard errors in a variety of settings is the bootstrap. The sample is treated as the population and multiple random samples are drawn. The mean of the variances of the respective random samples is the estimator for the variance of the complete sample. There are a number of variations of this method. Intuitively, the higher the number of replications, i.e. the number of random draws, the better the approximation of the true variance. The bootstrap is computationally expensive though. Andrews and Buchinsky (2000) propose a three-step method to choose the number of bootstrap replications necessary for a probability $\tau$ that the parameter obtained with this number of replications $\lambda_B$ does not differ by more than a certain percentage value from the parameter obtained with infinitely many replications $\lambda_\infty$. Note that this is not a direct statement about convergence to the true parameter. However, Hahn (1995) shows weak convergence of the bootstrap distribution to the limit distribution. The method by Andrews and Buchinsky

[15] Best linear unbiased estimator, that is, the unbiased linear estimator with the lowest variance

[16] Kernel methods are nonparametric methods to estimate the distribution of a random variable. Similarly to but more sophisticated than the naive estimation by a histogram that counts how many observation fall into a certain bin and uses the binwidth for smoothing, a kernel function determines the shape of bumps that are placed at each observation, and a *bandwidth* (also called *window width* or *smoothing parameter*) is chosen to determine the width of the bumps (compare Silverman, 1986)

[17] These standard errors are built in the version of their command *ivqte* for estimating exogenous conditional quantile treatment effects, that is, the impact of one single dummy in the equation. For a discussion of the appropriateness of the interpretation of a dummy as a treatment effect in the context of quantile regression see e.g. (Koenker, 2005, chapter 2.1). This command can be used to obtain the standard quantile regression estimates as well.

(2000) suggests that for equation 1 run on the AIS data, 1075 replications are needed for $P\left(100\frac{|\lambda_B-\lambda_\infty|}{\lambda_\infty} \leq 0.05\right) = 0.95$ [18]. A Breusch-Pagan test on heteroscedacity for equation 1 gives the following results for the listed dependent variables:

1. Logarithm of average wages: The Breusch-Pagan/Cook-Weisberg test does not reject the Null of constant variance with a p-value of 0.2824. A test on the specification $w_i = x_i + m_i + t_i + f_i$
2. Logarithm of blue collar wages: The Breusch-Pagan/Cook-Weisberg test rejects the Null with a p-value of 0.000.
3. Logarithm of white collar wages: The Breusch-Pagan/Cook-Weisberg test rejects the Null with a p-value of 0.000.
4. White collar to blue collar wage ratios: The Breusch-Pagan/Cook-Weisberg test rejects the Null with a p-value of 0.000.

The Breusch-Pagan/Cook-Weisberg test relies on the assumption of a normal distribution of the errors by restricting $E[u^4 \mid x^4]$ to $3\sigma^4$ (cf. Cameron and Trivedi, 2005, 275) and has therefore little power when the errors are i.i.d. but not normally distributed.

The test suggests heteroscedacity, but the conclusion for average wages is not clear. (Long and Ervin, 2000) use Monte Carlo simulations to evaluate the performance of several estimators of heteroscedacity consistent standard errors and tests on heteroscedacity and conclude that the decision on whether to use robust estimators should not be based on these tests, but they should be used whenever heteroscedacity can be suspected. Especially when skill and education are not controlled for, wages are likely to vary more the higher they are, as more basic tasks are more homogenous than more sophisticated ones. Correcting for heteroscedacity increases standard errors, therefore decreasing the probability of a type I error. Misapplication unduely increases the probability of a type II error. This is less severe than assuming an effect when there is none.

For these reasons, White robust standard errors are used for OLS and the Blinder-Oaxaca-decomposition. The standard errors of the quantile regressions for the 10th, the 25th, the 50th, the 75th and the 90th percentile as well as the decomposition at these quantiles are all estimated with 1075 bootstrap replications. For comparison, quantile regressions at the median for all specifications using the implementation of the kernel method of Powell (1986) by Frolich and Melly (2010) are given in the appendix. Note that these standard errors are increasing in sparcity, that is, they are

[18] The command bssize for *Stata* written by Poi (2004) is used for that.

larger when the number of observations around the quantile of interest is lower, which takes into account that the estimation of these parameters is less precise (Koenker, 2005, p.77).

## 4.3 Wald Tests

Wald tests can be used to test linear hypotheses such as the equality of coefficients wihin an equation. Usually considered a good finite sample approximation is the F-statistic

$F = (\mathbf{R}\hat{\theta} - \mathbf{r})'[\mathbf{R}(N^{-1}\hat{\mathbf{C}})\mathbf{R}']^{-1}(\mathbf{R}\hat{\theta} - \mathbf{r})/h$
with $\mathbf{R}$ being a matrix of constants, $\hat{\theta}$ a vector of parameters, $\mathbf{r}$ a vector of constants. under $H_0$, $\mathbf{R}(N^{-1}\hat{\mathbf{C}})$ is of full rank $h$ (the number of linear restrictions) under the assumption of linearly independent restrictions. $\hat{\theta}$ is a consistent estimator of $\mathbf{C_0}$, which is the asymptotic variance of the consistent estimator $\hat{\theta}$ ((cf. Cameron and Trivedi, 2005, 136)).

$H_0$ is rejected if $F > F_\alpha(h, N - q)$
For OLS, this is straightforward with $\hat{\theta}$ being $\hat{\beta} = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\mathbf{Y}$. In quantile regression, an additional application of the test is testing for equality of coefficients over different quantiles. The test statistic for quantile regression is augmented to $T_N = N(\mathbf{R}\hat{\zeta} - r)'[\mathbf{R}\mathbf{V}^{-1}\mathbf{R}']^{-1}(\mathbf{R}\hat{\zeta} - r)$, with $\hat{\zeta} = (\beta(\tau_1)', ..., \beta(\tau_m)')'$
and
$\mathbf{V}$ a $mp \times mp$ matrix with the $ij$th block being
$\mathbf{V}_N(\tau_i, \tau_j) = [\tau_i \wedge \tau_j - \tau_i\tau_j]H_N(\tau_i)^{-1}J_N(\tau_i, \tau_j)H_N(\tau_j)^{-1}$
to test for equality of coefficients over quantiles, restrictions on individual parameters and restrictions on several covariates, with
$J_N = N^{-1}\sum_{i=1}^{n} x_i x_i'$
and
$H_N = \lim_{n\to\infty} N^{-1}\sum_{i=1}^{n} x_i x_i' f_i(\xi_i(\tau))$,
where
$f_i(\xi_i(\tau))$ is the conditional density of the response $y_i$ evaluated at the $\tau$th conditional quantile. Whithout imposing the restriction that errors are iid, the limiting covariance matrix of $\sqrt{N}(\hat{\beta}(\tau) - \beta(\tau))$ takes the following form:
$\sqrt{N}(\hat{\beta}(\tau) - \beta(\tau)) \rightsquigarrow \mathcal{N}(0, \tau[1 - \tau)H_N^{-1}J_N H_N^{-1})$ .
(cf. Koenker, 2005, p.74f)

This variance can be estimated.

## 4.4 Tests of stochastic dominance and distribution

Consider two cumulative distribution functions $F(y)$ and $G(y)$. First order stochastic dominance of $F(y)$ over $G(y)$ would mean that $F(y) \geq G(y) \forall y \wedge \exists y$ such that $F(y) > G(y)$. A common approach to test for this is the Kolmogorov-Smirnov (KS) test. The two-sided test tests whether the distributions are equal and the one-sided test wether one distribution stochastically dominates the other.
The hypotheses for the two-sided test are

$H_0 : F(y) - G(y) = 0 \forall y$
$H_1 : F(y) - G(y) \neq 0$ for some $y$
and for the one-sided test

$H_0 : F(y) - G(y) \leq 0 \forall y$
$H_1 : F(y) - G(y) > 0$ for some $y$
The test statistic of the two-sided test is

$KS_1 = \sqrt{\frac{n \cdot m}{N}} \max_{1 \leq i \leq N} |F_n(z_i) - G_m(z_i)|$

and of the one-sided test
$KS_2 = \sqrt{\frac{n \cdot m}{N}} \max_{1 \leq i \leq N} \{F_n(z_i) - G_m(z_i)\}$

The asymptotic distribution of the test statistics is

$\lim_{m,n \to +\infty} P \left\{ \sqrt{\frac{mn}{m+n}} D_{m,n} \leq y \right\} = 1 - 2 \sum_{i=1}^{\infty} (-1)^{i-1} e^{(-2i^2 z^2)}$
with $D_{m,n} = max_y(|D_+||D_-|)$ and $D_- = \min_y \{F(y) - G(y)\}$ and $D_+ = \max_y \{F(y) - G(y)\}$
This distribution has to be approximated, so that p-values are not exact. The test's power is low at the tail of the distribution.
In addition to the KS-tests, quantiles of the distributions of log wages are plotted against quantiles of the inverse normal distribution of the rank of sorted log wages to see if they are roughly normal distributed. They would strictly follow a normal distribution if the plotted line was linear. Outliers and granularity are a sign for deviations of the normal. Quantiles of the distributions of traders and non-traders are plotted separately, so are those of importers and non-importers, etc. If the wage distribu-

tion for traders strictly dominates the one for non-traders, each quantile of the wage distribution for traders should lie above the respective quantile for non-traders.[19]

## 4.5 Decomposition

### Decomposition into endowments and coefficients

First, a detailed Blinder-Oaxaca style decomposition with estimated effects of endowments and coefficients for all variables as well as the interaction of differences in coefficients with differences in endowments is performed at the mean[20]. If the assumption of different residuals for trading and non-trading firms holds true, this type of decomposition is likely to give biased results. Furthermore, as the OLS estimator is used, they are likely to suffer from the same shortcomings as the OLS linear regressions. Nonetheless, this type of decomposition is interesting for comparison. Wages and wage differentials between group A and B are decomposed in the following way:

$$\hat{\Delta}_0^{\mu} = \overline{Y}_B - \overline{Y}_A = \underbrace{(\hat{\beta}_{B0} - \hat{\beta}_{A0}) + \sum_{k=1}^{K} \overline{X}_{Bk}(\hat{\beta}_{Bk} - \hat{\beta}_{Ak})}_{\text{Unexplained: } \hat{\Delta}_S^{\mu}} + \underbrace{\sum_{k=1}^{K}(\overline{X}_{Bk} - \overline{X}_{Ak})\hat{\beta}_{Ak}}_{\text{Explained: } \hat{\Delta}_Y^{\mu}}$$
$$+ \underbrace{\sum_{k=1}^{K}(\overline{X}_{Bk} - \overline{X}_{Ak})(\hat{\beta}_{Bk} - \hat{\beta}_{Ak})}_{\text{Interaction}}$$

$\beta$ in this case contains all variables of equation 1. A great advantage of this approach is that estimation is straightforward. The same specification is estimated on each sample that is formed by the two groups. The counterfactual distribution is the distribution that would prevail were workers of group A paid according to the same wage structure as group B.[21]

### Decomposition into endowments, coefficients and residuals

To test the hypothesis of differences in the wage setting function and differences in residuals, differences in the wage distribution are decomposed into differences in differences explained by characteristics, differences explained by coefficients and differences

[19] The approach by Cox (2007) is followed here.

[20] This type of decomposition follows the seminal work by Blinder (1973) and Oaxaca (1973) and is discussed extensively in the version with and without interaction in various textbooks, e.g. Fortin, Lemieux, and Firpo (2011).

[21] For the estimation of this decomposition, the command by Jann (2011) is used.

explained by residuals at the 10th, 25th, 50th, 75th and 90th percentile using the decomposition proposed by Juhn et al. (1993). For the estimation, the approach of Melly (2005) with the amendments proposed in Chernozhukov, Fernndez-Val, and Melly (2012) for inference on the counterfactual distribution [22].

The general approach of the Juhn et al. (1993) decomposition for wages is to decompose the overall wage difference between groups [23] into a composition effect (the difference in wages that would prevail had both groups the same wage setting function but the prevailing distribution of covariates), a wage structure effect (the differences in wages that would be observed if both groups had the same characteristics but the prevailing wage setting functions) and differences in residuals.

$$\hat{\Delta}_0^{\mu} = \overline{Y}_B - \overline{Y}_A = \underbrace{(\hat{\beta}_{B0} - \hat{\beta}_{A0}) + \sum_{k=1}^{K} \overline{X}_{Bk}(\hat{\beta}_{Bk} - \hat{\beta}_{Ak})}_{\text{Unexplained: } \hat{\Delta}_S^{\mu}} + \underbrace{\sum_{k=1}^{K} (\overline{X}_{Bk} - \overline{X}_{Ak})\hat{\beta}_{Ak}}_{\text{Explained: } \hat{\Delta}_Y^{\mu}}$$
$$+ \underbrace{\sum_{k=1}^{K} (\overline{X}_{Bk} - \overline{X}_{Ak})(\hat{\beta}_{Bk} - \hat{\beta}_{Ak})}_{\text{Interaction}} + \underbrace{\sum_{t=1}^{N} (v_B - v_A)}_{\text{Residuals}}$$

For this, one has to estimate the distribution of wages were firm i to be in group trade=1 instead of trade=0. This distribution is not observed and is therefore called the counterfactual.
The estimation of the standard Blinder-Oaxaca style decomposition for the mean is quite straightforward because the unconditional expectation is simply $\mathbb{E}[Y] = \mathbb{E}_X[\mathbb{E}[Y \mid X]] = \mathbb{E}[X]\beta$ by the law of iterated expectations [24] and the assumption of linearity and zero conditional mean [25]. The unconditional expectation is needed for the derivation of the counterfactual distribution as $\beta$ can then be interpreted as the effect of increasing the mean of X on the unconditional mean of Y (see Fortin et al., 2011, p.8). This is not so simple in quantile regression as the law of iterated expectations cannot be applied to quantiles [26]. Inference on counterfactional distributions is therefore more complicated. Different solutions to this problem are proposed, all of which have their strengths and

[22] Built in the command *cdeco_jmp* which is an implementation of several procedures based on Chernozhukov et al. (2012) (see Chernozhukov, Fernandez-Val, and Melly (2008)). It uses the *moremata* package by Jann (2005).
[23] Traders and non-traders, importers and non-importers etc.
[24] Let $X$ be an integrable random variable and Y be any random variable on the same probability space, then $\mathbb{E}[Y] = \mathbb{E}_X[\mathbb{E}[Y \mid X]]$
[25] (see Fortin et al., 2011, p.54)
[26] The law of iterated expectations holds by taking the indefinite integral over the conditional expectations. A quantile is not an integrable random variable though.

drawbacks [27].

The decomposition method as proposed in Melly (2005) and Chernozhukov et al. (2012) is suitable here because it does not assume rank-preservation [28] and it does not invoke the zero conditional mean assumption[29] or its weaker counterpart, ignorability[30] as does the original method by Juhn et al. (1993) which does not give a detailed approach of how to condition the residuals on the covariates. It also does not assume homoscedacity as do the reweighting approaches of DiNardo, Fortin, and Lemieux (1996) or Lemieux (2002)[31]. Firpo, Fortin, and Lemieux (2009) use a *recentered influence function*[32] to estimate the counterfactual distribution. They suggest estimating the average marginal effects by OLS or Logit or by a nonparametric estimator all of which are likely to suffer from the shortcomings already discussed given the characteristics of the AIS data and the fact that the number of variables in the specification is not small.

The method by Melly (2005) is to estimate the whole conditional wage distribution by quantile regression, then to obtain an estimate of the unconditional distribution by integrating this conditional distribution over the covariates. The assumption of linearity is criticised by (Fortin et al., 2011, p.63) as very strict. This linear specification can be extended to contain logarithms and squared terms as well without loss of generality though. It would still be problematic with spikes at certain points of the distribution such as with a minimum wage as discussed in (Fortin et al., 2011, p.63), but although minimum wages are paid in a few countries and sectors in the sample, the lower ends of the wage distribution are not the focus of attention in the decomposition done here, thus this problem should not be too severe.

[27] For an (incomplete) discussion on this see Fortin et al. (2011).

[28] Rank preservation would mean that a firm that trades would have the same rank in the counterfactual distribution as it has in the observed distribution. This is a very strict assumption that is likely not to hold.

[29] Independence of the residuals on X

[30] The residuals $v$ may depend on X, as long as $\mathbb{E}[v \mid X]$ is the same for both groups to be compared.

[31] By estimating the counterfactual distribution with a probit or logit estimate of the probability of being in one group conditional on the covariates when there are many variables, as is the case here. Probit and logit estimates depend on homoscedacity for consistency.

[32] The influence function of a distributional statistic is seen as an individual observation's influence on this distributional statistic. Firpo et al. (2009) add back this statistic to the influence function and obtain what they call the *recentered influence function*..

# 5 Data

The UNIDO Africa Investor Survey data has been collected using stratified random sampling from 2009 to 2011 in 20 countries (Organization (2010)).[33]. It contains data on 3600 companies whose main activity has been classified as manufacturing.[34] 2738 of these companies gave information on all relevant variables and are kept in the sample for estimation. They are classified into UN ISIC Rev.3.1 industry sector on the 2-digit level according to their main product sold. [35].

## 5.1 Variables

Average wages, blue collar and white collar wages are in logarithms, so are firm size, firm age, labour productivity and the capital-to-labour ratio.

**Average wages of full-time employees by number of full-time employees**

The total wage bill is divided by the total number of full-time employees asked in the first part of the questionnaire. These might include temporary full-time employees as well. One would expect most temporary employees to be low-skilled. However, there may have been misunderstandings as to whether full-time employees in general or full-time permanent employees were asked[36]. These uncertainties make this variable less informative in what concerns average wages conditional on employment category and may lead to a downward bias for the coefficient on the skill ratio. The total wage bill including supplementary benefits is asked which could be more relevant for medium and high skilled workers. For temporary low skilled jobs monthly payments may be lower than for permanent ones. Estimates for the wages of permanent full-time white and blue collar employees might therefore be more exact than for average wages. The fact that the estimates for average wages do not contradict those for permanent full-time white and blue collar wages is a sign for the wage data being largely consistent.

[33] Burkina Faso, Burundi, Cameroon, Cape Verde, Ethiopia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Senegal, Tanzania, Uganda and Zambia.

[34] i.e. $\geq 50\%$ of its activity.

[35] Firms were asked to list their three main products and the proportions they take up in their total sales. Classification was done according to the highest percentage value.

[36] Considering numbers for casual/temporary and permanant full-time employees adding up to full-time employees for some firms but not for others.

### Wages of permanent full-time employees

Average monthly wages for blue and white collar employees are divided by the respective numbers given in the second part of the questionnaire. Here firms are explicitly asked for permanent, full-time employees.[37]

### Trade dummies

The export dummy is 1 if a company exported any proportion of its output in the last financial year and did not import and zero otherwise. The import dummy is 1 if the firm did not export in the last financial year but imported a positive fraction of its intermediate inputs directly, that is, not through a local importer. This is intended to ensure that only firms are classified as importers that rely on direct interaction with importers which is an important part of the hypothesised relationship. The Twoway dummy is 1 when a firm both exported and imported directly from abroad in the last financial year and zero otherwise.

### Foreign Dummy

The foreign dummy is 1 if a company has foreign ownership of more than 10% and 0 otherwise. Foreign firms could be more induced to prevent shirking with the help of wages because they have a lesser developed network to exert social control. With many foreign employees in the management and unfamiliar with the local environment, they might be less able to control domestic employees because of cultural barriers and misunderstandings as well as language differences. This argument could also be valid for low-skilled and semi-skilled labour. In some working environments, though the output is observable, it might be not clear who is shirking or making mistakes. Depending on how costly more control might be and how easily it can be exerted, higher wages might be paid instead. As a lot of foreign companies are set up to offshore intermediary productions steps and as such engage in exporting, this is a point to consider when analysing trade and wages.[38]

[37] For reasons of simplicity and because it can be hard to make a clear distinction between administrative/clerical employees and technical/managerial employees (Indeed, for some companies, the number of technical/managerial employees is zero whereas some larger companies report no or very few administrative/clerical but many technical/managerial employees.), the two categories have been lumped together as white collar employees.

[38] Consider also the vast amount of literature on productivity and wage differences between foreign and domestic investors.

### Skill Ratio

For average wages, the white collar to blue collar employment ratio should have a large positive effect on average wages as white collar employees are expected to earn considerably more than blue collar employees. When white collar wages are considered separately, it is not clear what to expect. On the one hand skill ratios may be related to technology level, thus having a positive effect on wages, on the other hand, the more white collar employees, the greater the likelihood that any white collar employee is not one of the few most important technical/managerial employees, in this vein, the smaller the average skill premium should be.

### Firm Size

As both the total number of employees and sales figures are frequently used measures for firm size in the trade and wages literature and employee numbers display fewer outliers than sales figures and seem more reliable, the total number of employees is used as a measure for firms size. This includes temporary employees as their number contains significant information on firm size.

### Firm Age

Theory and evidence suggest that incumbents need to be less competitive than entrants to compete with these because they already have incurred the fixed costs of market entry and possibly have already built up a reputation to fight an entrant even if they are not actually able to do so. Younger firms might therefore be less able to offer high wage premia, but whether they are more productive because they are to more intense competition or less because they are smaller and less likely to exploit economies of scale may depend on narrowly defined industry sectors. On average, the latter might prevail. On the other hand, if younger firms are smaller, the proportion of highly qualified staff may be higher too because at least a manager and some technical staff is needed even if the firm is small. Whilst older firms can be expected to find it easier to establish trade relationships (not leastly because reputation may play a role particularly with exporting), the link to wages is not very clear when wage categories are very broad and indicators of skill-levels scarce.

### Labour productivity

Theories of rent-sharing suggest that wages depend positively on firm productivity, therefore, a relationship with total factor productivity would seem reasonable. If it is true that factors are paid their marginal product, however, the relationship with labour productivity should be stronger.

### Capital to labour ratio

Capital-skill complementarity would be a reason to assume that firms with a higher capital-to-labour ratio are more skill intensive and thus pay higher average wages. Capital is measured by the total value of fixed assets, which contains land improvements and other constructions, machinery and other equipment, transport equipment, ICT equipment and intellectual property.

### Industry and country dummies

All OLS and quantile regressions are estimated with country and industry fixed effects. Although industry-specific effects are rather undisputed in theory as well as in empirical research and seem to show quite clearly in the AIS data especially when the same equation is estimated once with a dummy for each combination of country and industry and once with country dummies only, there are several hints that they vary rather a lot across countries. For some country-industry pairs, there are very few observations. As companies are only classified at the two-digit level, there can be considerable variation as to the level of technology, risk premia, etc. For example, a firm in ISIC33 may produce syringes, while another produces apparatus based on the use of radiation. As another example, a firm in ISIC24 might produce soap while another may producand another one pharmaceuticals. The difference in human capital level and the requirements on commitment and exactness of production workers can be substantial, being reflected in wages according to theory. Therefore, with very few observations at a given industry level for most countries, the likelihood that high technology firms are very prevalent in one country whilst in the other country there are low technology firms only is very high. Hence, some variation in wage levels due to quite different requirements to qualifications etc. related to product categories can be expected to remain despite industry fixed effects.

A related variable of interest would be some technology proxy, and training of employees could also reveal higher skill intensity, but the sample does not offer any viable option to account for this. [39].
The cross-sectional structure and lack of control variables for skill-level and technology make analysis challenging. However, the data offer as-to-date unique insights into the relationship of trade and wages over a large range of industry sectors. Some of the countries covered have been surveyed for the first time. Moreover, comparable data on such a large number of countries makes it possible to draw some generalised conclusions. Thus, while awareness for possible pitfalls when interpreting the results is important, the AIS 2010 data is well-suited to give valuable evidence on the research questions laid out in this work.

## 5.2 Descriptive statistics and test results

Sample means of employment variables and other variables used in the estimation as well as sales are reported in table 1 and 2. The KS-test results and mean comparison test results are reported in tables 3 and 4. Except for relative blue and white collar employment, the variables are in logarithms. All dependent variables and covariates are tested on differences in means and in distributions regarding trade status. Categories for trade status are Exporter, Importer, Twoway and Trade. Trade is a dummy which is 1 if any of the latter dummies is 1 and zero otherwise. A problem with simple hypotheses tests here is that the categories considered are not mutually exclusive.

Differences in mean wages are considerable for all wage categories. The biggest differences can be seen for exporters and twoway traders. Comparison between means of traders and the different control groups shows that mean wages are highest for twoway traders. Means differ for all other variables and are higher for traders in all trade

[39] An often used measure of technology would be either the state value or the amount acquired of ICT equipment and intellectual property (IPR) as a fraction of total fixed assets or alternatively the value of ICT and IPR relative to the number of employees. (Feenstra, 2010, p.26f) argues that the fact that the fraction of high-tech equipment in new investment as technology measure explains 99 % of the increased relative wage for nonproduction workers in Feenstra and Hanson (1999) is the reason for the result that offshoring explains only 12% of the increase in nonproduction workers' relative wage. He concludes that "these results are lopsided enough that we might be skeptical of using new investment to measure high-tech equipment and therefore prefer the results using capital stocks". However, ICT and IPR are often missing in the AIS sample and many firms give a lumpsum for the two together with transport equipment. For these firms, it is clear that they do have some amount of high technology, but there is no information how much. A dummy, however, would devide the sample into "high" and "low" technology firms no matter how tiny the amount spent on ICT or IPR. Regarding all entries with lump-sums and those with no entry as missing though reduces the sample greatly and potentially leads to some form of sample selection.

categories compared to their respective control group, that is, for exporters versus importers and foreign versus domestic investors. The only exception is relative white collar employment where mean values are highest for non-traders. Table 1 also shows that variation is particularly high for employment.

Wage differentials between non-production and production employee are considerable. An average non-production employee at a trading firms earns 2.8 times more than a production worker, compared to a bit less than 2.5 times more at a firm that does not trade. At foreign companies, they earn on average 3 times more, compared to 2.5 times at domestic companies.

With a few exceptions, the mean comparison and KS test results are in line with each other. According to the KS-tests, the distributions of traders in all trade categories (Any kind of trade, Importer, Exporter, Twoway trader) stochastically dominate those of non-traders for average wages (including those of temporary and part-time workers and supplementary benefits), for blue collar and white collar wages (of permanent full-time employees only), of total employment (including temporary and part-time workers), and for employment of blue collar and white collar employees, all at mostly high significance levels. Firms that engage in any form of trade unanimously seem to have higher employment and wage levels. The mean comparison tests yield no significant result when companies that import but do not export are considered. Results on the ratio of blue collar employment are a bit surprising if the white collar to blue collar ratio is considered to be a measure for skill-level which is suggested to be higher for traders by theory. The Null of higher relative employment of blue collar workers in non-trading firms is rejected for exporters, twoway traders and firms engaging in any kind of trade. The Null of lower relative employment of blue collar workers in non-trading firms cannot be rejected except for when importing is considered. The KS-tests on the white collar to blue collar ratio (skill ratio) give the complementary result. However, trading firms are significantly bigger than non-traders when size is measured by the total number of employees and they have higher employment in both white and blue collar categories. The result on relative blue collar employment could thus be driven by larger manufacturers needing more production workers relative to smaller manufacturers everything else being equal. The result of non-importers stochastically dominating importers is not in line with this. Possibly, the effect of exporting is so strong that the result is driven by the comparison with exporters, not with non-traders. Some support for this idea would be that importers stochastically dominate the comparison group for the absolute numbers of blue and white collar employees. The mean comparison test results further suggest an ambiguous relationship and differences in magnitudes for importers and exporters. Tests on relative blue collar employment are insignificant when any firm engaging in trade and importers are considered while they suggest that exporters and twoway traders have higher relative blue collar employment than others. When any firms engaging in trade are considered, the mean comparison tests on relative white collar employment reject the Null of non-traders dominating traders. It could be that differences in the distributions of white and blue collar employment are the reason for these somewhat conflicting results.

One more point to consider is the connection with foreign investment. Foreign investors have a significantly higher likelihood to be exporters as well, in fact, about 45 % of all firms with foreign ownership of at least 10% export, while only 20% of domestic firms do (see table 2. Foreign investors are larger and have significantly lower white collar employment, while the mean comparison test on relative blue collar employment yields no significant result. The proportion of twoway traders relative to exporters is the same for foreign and domestic firms though, which could be a sign for importing to be complementary to exporting but not vice versa. That is, it could be that exporting makes importing less costly but importing does not seem to make exporting easier. One factor could also be that, in the case of a foreign parent company, the foreign investment is often set up to supply input goods, which requires less (possibly imported) inputs than a plant producing finished goods. Furthermore, the investment is often set up to process local resources. However, the connection with FDI should not be taken as a complete explanation, as the estimation results in section 6 show.

The KS-tests for firm age indcicate that trading firms stochastically dominate non-traders, except importers. A test on stochastic dominance for importers rejects with a p-value of .085, though a test on the distributions being equal does not reject. For labour productivity, the KS-tests unambiguously reject the Null of non-traders stochastically dominating traders and of equal distribution and do not reject the Null of stochastical dominance of traders in all trade categories. The KS-tests as well as the mean comparison tests reject the Null of no stochastic dominance respectively for no higher means of traders and the equality of distributions for any trade category when the capital to labour ratio is considered. The results on log sales are a bit puzzling: the mean comparison tests suggest higher means for traders at the 1%-level for all trade categories except for insignificant results on importing. The KS-tests are curiously in line with this by suggesting stochastic dominance of traders on all significance levels whilst rejecting the Null of no difference in distributions, of stochastic dominance of importers and of non-importers on the 1%-level. The quantiles of both distributions plotted against the quantiles of the normal distribution (see Appendix, figure 2) reveal that sales figures at lower quantiles are lower for non-importers but the increase over quantiles is steeper, such that at all quantiles higher than the median, the distribution of non-importers lies higher. Possibly this has to do with FDI. Quantile quantile plots for domestic and foreign companies show that all sales figures of foreign companies at all quantiles lie visibly above those of domestic companies, with a some outliers at the upper quantiles, a few of them very large (see Appendix, figure 5). This ambiguity is another argument against using sales as a control variable for size, especially as it shows no major benefits compared to the total number of employees.

Quantile-quantile plots for log average wages show that wages are higher for traders over the whole distribution except for the tails when firms that engage in trade are considered simultaneously, for exporters and for twoway traders (see figure 1).[40] The difference is generally not large. The high differentials at the lower tails in the plot for any kind of trade are driven by the distributions for importers. Interestingly, except for the lower tails, there is not such a big difference in wages for importers and non-importers. At higher quantiles, non-importers pay higher wages than importers. A reason for this could be that at these quantiles, the differentials between all exporters and others are higher. For production wages (see figure 2), the distributions of importers and others seem to be the same, except for a few high values for importers at the higher quantiles. For the other trade categories, the difference is higher. For white collar wages, differences seem to be higher than for blue collar wages, but dispersion is higher, too, especially for twoway traders. Again, differentials are lower when importers are compared to others, with non-importers lying above importers at high quantiles. Generally, the mostly linear pattern for all combinations of trade and wage categories suggest that the assumption of normal distribution of log wages is acceptable. Nonetheless, the tails suggest some deviations, especially for blue collar wages, which can be seen in average wages, too.

White to blue collar wage ratios show considerable deviations from the normal distribution. This is not surprising but an obstacle for fitting a model. Wage ratios are higher for traders than for non-traders at all quantiles, suggesting higher skill premia. The highest observation is a company that does not trade though, whilst a KS-test suggests stochastic dominance of traders, showing the low power of KS-tests at the tails.

[40] Because of large numbers of observations and a small scale and because distributions of separate subsamples are plotted against the inverse normal of the total sample, some observations appear at lower quantiles but actually have higher values for wages than some observations at higher quantiles.

For twoway traders, wage ratios are considerably higher than for the control group at some quantiles above the median, whilst non-twoway traders have higher wages at the highest quantiles. The same is true for firms that export, but do not import, but the pattern is a little less pronounced.

All in all, these results show that it is important to distinguish between exporters, importers and twoway traders. A relationship with wages and wage ratios and variables over which this relationship might be established is particularly strong for twoway traders, and, to a lesser extent, for exporters. Results on imports are mixed, but it is suggested that importing is indeed related to higher wages, too, and again to differences in labour productivity, capital intensity and size. One major factor is that foreign companies have a higher propensity to export and have the highest values in wage and control variables. They are less likely to import and importers are smaller in sales and total employment, though bigger than firms that do not trade at all. Tests on stochastic dominance of exporters versus importers confirm this (see table 3). The results stress the importance to control for foreign ownership and to consider the whole wage distribution rather than the mean only.

# 6 Estimation Results

In the first specification, effects of importing, exporting and twoway trade on the dependent variables are estimated while controlling for foreign ownership. Control variables are subsequently added to test for channels over which the established relationship takes place with specification 6 containing all controls. The dependent variables are average wages (including supplementary benefits and wages of temporary employees), blue collar wages, white collar wages and the white to blue collar wage ratio.

As mentioned in section 4, causality is hard to establish and misspecification with respect to skill-intensity is an obstacle in interpretation. As firm-level effects are in the focus of interest, all equations are estimated with sector and country fixed effects, bearing in mind that the high level of aggregation still leaves room for price effects at the sector level to influence estimated results. Wage levels and control variables are in logarithms, except for dummy variables.

## 6.1 OLS results

OLS estimation results for average, blue collar and white collar wages as well as wage ratios are shown in table 5[41].

### Average Wages

Across all specifications for average wages, the estimated marginal effect of a company being a twoway trader is smaller than that for being an exporter or importer. This is surprising given that mean values for all wage categories are the highest for this trade group - on the other hand, foreign ownership, industry and country is controlled for. Still, even if the complementarity effects suggested by theory were not true, it is not evident why a firm that exports and imports should pay wage premia about a third below those of a firm that only exports. A reason could be that the specification is insufficient and the cross section exhibits considerable variation. The standard deviation is indeed higher for twoway traders than for either importers or exporters. An F-test on equality of coefficients does not reject the Null of no difference. The trade coefficients remain significant at the same levels and hardly change in magnitude when total employment and then firm age are added as control variables. In specification 4, the skill ratio is added. Its coefficient is positive and significant, though very low. This is a sign for the skill ratio being a very crude measure for skills as long as total employment is controlled for. Significance levels of the trade dummies remain the same and coefficients for Exporter and Importer change by less than 10 % of their initial value. When labour productivity is added though, coefficients reduce considerably and become insignificant. The introduction of capital intensity further reduces the coefficients, but by a very small proportion. The $R^2$ is not very high, but this is not unusual for cross-section data. The AIC selects the last specification as the best, the BIC the more parsimonious specification 5.

These results suggest that firms that trade pay higher than average wages. The estimated difference is considerable, around 15 % for exporters and importers and 10% for twoway traders. It is interesting that once the effect of a company being foreign, average wage premia are the same for importers and exporters. Because importers and exporters differ greatly in size and exporters have been found to have significantly higher endowments as far as performance variables are confirmed, these results suggest that at least the estimated difference for importers is not exclusively due to selection

[41] All tables with estimation results have been exported from *Stata* using the commands *eststo* and *esttab* by Jann (2007).

effects.

#### Blue collar wages

All coefficients of interest are significant in the first specification - the export and import coefficient at the 5 %-level contrary to the 1%-level as for average wages. The estimated coefficient on Twoway is larger and significant at a higher level though. This difference might simply be due to the higher variation in wages for twoway traders. The Exporter coefficient becomes insignificant upon introduction of size, whilst the coefficient on Importer changes only by a fifth and does not further change when age and relative white collar employment are added, as is the case forsimilarly to the coefficient on Twoway. When labour productivity is added, they both become insignificant and change only slightly when capital intensity is controlled for. This points towards a more important and more stable influence of importing on production wages compared to exporting, though F-tests on the equality of coefficients all fail to reject the Null. Both AIC and BIC select the 5th specification.

#### White collar wages

Twoway is only significant in the first specification. The coefficient on Exporter reduces by about 40% when total employment is added, the coefficient on Importer by a bit less than a third. They remain stable when age and the skill ratio are added. When labour productivity is added, the coefficient on Exporter reduces by a half and the coefficient on Importer by more than a third. Importer remains significant at the 5%-level though, and hardly changes when capital intensity is added. Again, AIC and BIC select the 5th specification.

#### White collar to blue collar wage ratio

The model fit suggested by the $R^2$ is very bad, which is not surprising given that the assumption of a normal distribution is clearly not true. This might be a reason for AIC choosing the last specification while BIC chooses specification 2. The magnitude of the coefficients suggests that there is a relationship with firms' trade decisions - the estimated marginal effect of the export decision is roughly 36% which is more than twice that for average wages and the estimated marginal effect of the import decision is roughly 17% which is similar for average wages. Due to the bad model fit, patterns in the residuals are likely to play a role in the very high estimated variation in coefficients which leads to the t-tests rejecting the hypothesis of difference from zero. Sample standard deviation of the wage ratio is already very large though (see table 1) and the main coefficients of interest do not become significant when size is controlled for. This could well have to do with the insufficiency of the model when it comes to skill-intensity, which can be expected to have a much higher influence on wage ratios than on levels. Therefore, a regression at the mean does not reveal much and merely gives some weak evidence of there being a relationship of wage ratios with the trade decision of firms.

For wage levels, signs of control variables are as expected by theory, with the exception of the skill-ratio being ambiguous, pointing towards measurement problems for skill-levels. Firm age and size have significant and positive effects on the wage level. While size has a positive and significant impact on relative wages as well, in line with the idea that larger firms exploit economies of scale and can afford to attract more qualified employees, the effect of age is not significant for wage ratios. This may reflect ambiguity on how market entrants compete with incumbents.
It is interesting to note that labour productivity is estimated to have a particularly high influence on wage ratios as compared to wage levels. Theories of rent-sharing are confirmed by productivity having a positive and significant influence on blue collar wages as well. In line with the notion of efficiency wages, these productivity premia are higher for white collar wages though.

## 6.2 QR results

Figures 6 - 13 display QR estimates and confidence intervals at every fifth percentile of the wage distributions of all wage categories for the coefficients on Importer, Exporter and Twoway and specifications 1 and 5. [42] After a brief discussion focussing on the change in coefficients over distributions and on what this means for model fit, QR estimations of all specifications 1 - 6 at quantiles .1, .25, .5, .75 and .9 are discussed in detail.

The fitted coefficient graphs are not very smooth and confidence intervals rather large [43]. This could be due to noise and omitted variable bias. Confidence intervals become particularly large towards higher quantiles. The shape of the curves for specification

[42] The command *grqreg* written by Azevedo (2011) was used for this.
[43] Note that the confidence intervals shown here are based on the standard errors calculated relying on the assumption of homoscedasticity. These tend to underestimate the true variance, so the actual confidence intervals can be expected to be even larger.

1 and increasing confidence intervals at quantiles with many observations suggest that coefficients are not linear over quantiles and quantile regression can indeed reveal more than OLS.

For average wages, the coefficient of Exporter is highest at lower quantiles, decreases slightly and increases very little from the median onwards where confidence intervals become very large. For blue collar wages, the Exporter coefficient increases very little over quantiles and confidence intervals become very large roughly at the seventh quantile. For white collar wages, the fitted curve is roughly U-shaped with the bottom at the median. Although confidence intervals become very large from there onwards, they include zero only at the 9th quantile. The Importer coefficient for average wages decreases up to the second quantile and increases up to the sixth quantile after which the pattern is not clear. For blue collar wages, the Importer coefficient displays a rather sharp increase between the sixth and eighth quantile. Although confidence intervals become larger, they include zero only at the ninth quantile. The Importer coefficient for white collar wages shows a comparibly steady increase and is well above zero at all quantiles, though estimated confidence intervals become very large from the sixth quantile onwards. In line with patterns observed for the OLS regression, the estimated coefficient for Twoway is the least stable. For average wages, it is above zero from the second quantile onwards and increases slightly towards the median. Confidence intervals are large and include zero at several quantiles. For blue collar wages, it moves around 10 % over all quantiles. Confidence intervals are very irregular. For white collar wages, the Twoway coefficient is above zero only from the third quantile onwards while confidence intervals are strictly above zero between the fourth and seventh quantile only. Whithin this array, there is a rather steep increase and a slight decline from the median onwards.

The patterns of estimated coefficients for white and blue collar wages do not conflict with those for average wages but give a much more detailed picture. For white collar wages, Importer and Exporter coefficients are well above zero for specification 1. The same is true for the Twoway coefficients well around the median. For specification 5, all trade coefficients are mostly close to zero and confidence intervals mostly include zero. Although this suggests that most of the estimated effect is explained by the controls, the clearly visible patterns suggest some omitted regularity. The reason could be the assumed functional form of the log-normal distribution does not fit well or that important variables are omitted.

For blue collar wages, the pattern is much more regular. At most quantiles, Exporter and Importer coefficients are above zero, but confidence intervals include zero at most quantiles except for around the median. Towards the highest quantiles, the estimated effect increases. Specification 5 shows very regular patterns of coefficients around zero and there is no significant increase towards higher quantiles anymore. There is no significant effect of twoway trade.

Estimated coefficients for the white to blue collar wage ratio suggest why coefficients at the mean have such high standard deviations. Coefficients steadily increase over quantiles up to roughly .30 for Importer and about .50 for Twoway at the ninth quantile. The confidence interval for Exporter includes zero at the eighth quantile and the highest estimated coefficient is about .30 at the seventh quantile. For specification 5, all these patterns disappear and coefficients are zero except for higher quantiles where confidence intervals are very large.

These observations confirm the OLS-results and suggest nonlinearity in the main coefficients of interest. This nonlinearity is more obvious for white collar wages and wage ratios. Although the estimates for wage ratios suggest bad model fit, their pattern combined with the observation of effects increasing more sharply over quantiles for white collar wages (though the pattern for Exporter is less clear) gives support for the notion of increasing wage premia over quantiles. Again, the patterns for blue and white collar wages suggest that omitted variables are considerably more important for white collar wages. This could be a hint on skill-biasedness of trade which will be further explored in the following sections.

Estimates given in tables 6 - 9 at the 10th, 25th, 50th, 75th and 90th percentile are a bit arbitrary given the irregularity displayed in figures 6 - 13. But, after all, this irregularity might tell us more about the bad model fit than about changes in the true magnitude of the coefficients. It has to be taken into account that the variance is increasing in the tails of the distributions.

**Average wages**

The Exporter dummy is significant at the tenth quantile only in specification 1. When size is controlled for, the estimated marginal effect reduces slightly from around 24% to .22%. Firm age seems to have no effect on the Exporter coefficient, as well as the skill ratio. When labour productivity is added, the estimated coefficient becomes insignificant. Otherwise, the coefficient on Exporter is only significant at the median when size and age are controlled for. This could be a coincidence. The estimated effect of Importer is significant at all quantiles except the ninth in specifications 1, 2, 3 and 4. When labour productivity is added, it is still significant at the median with an estimated marginal effect of 6% relative to a median firm that does not trade. Figure 7 hints that this result is not just a coincidence of choosing the specific quantile, but that there is a significant influence around the median as well. The estimates suggest that the relationship is strongest at the median for Importer and Twoway. It seems that very little of the estimated effects is due to firm size and age. The introduction of the skill ratio (on which the coefficient is positive and significant on the 1% -level but very small) considerably decreases Importer coefficients at the 50th and 75th percentile, while causing an increase respectively a decrease of the Twoway coefficients, which is surprising and could be due to the small sample of twoway traders combined with considerable variation over quantiles. As expected, the estimated marginal effect of labour productivity is large and highly significant, though magnitutes are a little unstable over quantiles.

**Blue collar wages**

The Exporter coefficient is significant at the median and the 75th percentile in specification 1 and only robust to the inclusion of firm size and age at the 75th percentile. When the skill ratio is controlled for, no significant effect can be found. A remarkably stable effect of Twoway is found at the median. Even when labour productivity and capital intensity are controlled for, there is a significant coefficient of .083. Considering that the coefficient is higher than in the previous three specifications and the coefficients on all added variables are positive, this estimate should be taken with much caution.

**White collar wages**

As expected, the estimated effect of a firm being an exporter or importer is most stable over specifications and highest in magnitude when white collar wages alone are considered. There seems to be some nonlinearity in control variables as well, since the estimated effect is not strongest at the same quantiles over specifications for exporters. Outliers could be a reason for this at the 10th and 90th percentile, but at other percentiles, this is not a viable explanation. When only foreign ownership is controlled for, the strongest effect is suggested at the lower quantiles and, to a lesser extent, at the higher quantiles for Exporter, while the strongest effect of Importer is estimated at the 90th quantile respectively at the median. The Exporter dummy remains significant with the inclusion of size, age and the skill ratio at quantiles .1 to .5 only. The importer dummy remains significant at the 10%-level when labour productivity is added, but not with capital intensity. Even though the Twoway dummy is significant only at quantiles .5 and .9 in the first specification, specifications 2-4 suggest a rather strong effect at the median and the 75th percentile, while the coefficient at the 75th percentile remains significant when labour productivity and capital intensity are included.

Wald tests on the equality of coefficients on the different trade dummies suggest inequality only for white collar wages as the dependent variable, and there only at the 10th and the 25th quantile for specifications 1-4, and at the median for specification 4. Wald tests on the equality of coefficients over quantiles do not reject the null hypothesis except for Twoway with white collar wages as the dependent and specifications 1, 4, 5, 6. This might even be a coincidence as it is quite likely that some tests wrongly reject if so many of them are performed. Model fit suggested by $R_2$ is not impressive but not at all unsusual for cross-section data.

**Wage ratios**

Although estimation at different quantiles are a little less problematic than estimation at the mean only in the case of a clearly nonlinear conditional distribution of the dependent variable, model fit is not greatly improved compared to OLS. Some relationship is suggested by various significant coefficients, but the pattern is pretty arbitrary except for the first specification, for which Exporter is significant at all but the 90th percentile. Large standard deviations causing t-statistics to be very small are not surprising given that a straight line is fitted for a distribution that is all but linear. This justifies considering large insignificant coefficients as weak evidence of a relationship as well. There are very few observations at the 90th percentile though. This is a reason for not giving too much weight to the results at the 90th percentile.

Estimated coefficients suggest that the export decision has a positive effect at the median and the 75th percentile that goes mainly over labour productivity. The same goes for Exporter at all quantiles with about half the estimated effect in specification 1 due to size. At the median, there is still an estimated marginal effect of almost 20% when labour productivity and capital intensity are controlled for. For twoway trade, a negative marginal effect of about 17% is estimated at the median in specifications 3-6 which is higher in absolute value than in the previous specifications. Although a pattern according to which Twoway behaves is hard to establish for absolute wages as well, this is a little confusing.

These results confirm a positive relationship between the globalization decision of a firm and its wage levels. The greatest part of this effect is through labour productivity. A distinction between selection of more productive firms into trade and effects of trade on productivity is not possible though. Part of the estimated effect goes through size as well, mainly for exporters. The fraction of the Exporter coefficient that can be attributed to size is rather a sign for self-selection than for a channel over which trade could have an effect on wages. Firm age cannot be excluded to be a factor for self-selection of firms that pay higher wages into trade, but there is no evidence for it to play any significant role as a channel over which trade and wages are related. Still, firm age is confirmed in itself important as a determinant of wages as laid out in the OLS results section.

Signs and magnitudes of coefficients of the ratio of white collar to blue collar employment suggest that it is a very imperfect measure for skill for blue collar wages, but for white collar wages, this effect seems to be outweighted by a high skill ratio meaning many white collar employees and so lower average wages because a great part of them performs medium skilled tasks. The ratio seems to be very stable over different values for total employment as the very low standard deviation suggests.

Although F-tests on the equality of the coefficients over quantiles do not suggest this, it seems that coefficients do vary systematically over quantiles for absolute wages. Surprisingly, the peak of the influence of exporting seems to be at lower quantiles for white collar wages while being at higher quantiles for blue collar wages. This speaks against skill-biasedness of exporting for white collar wages. For blue collar wages, this observation merely suggests that rent-sharing plays a minor role at lower quantiles, a view which is supported by coefficients on covariates, notably labour productivity, increasing over quantiles for blue collar wages but not much so for white collar wages. The results on wage ratios suggest a rather high effect of exporting but there is no reliable evidence for this, whilst estimated coefficients on Twoway further raise doubt about how seriously the estimates can be taken.

F-tests give little evidence for unequal effects of imports, exports and twoway trade but again, estimates suggest that they do differ and that their relationship with other covariates, notably size and labour productivity differs: The estimated effect of importing is increasing over quantiles for white collar wages, for blue collar wages and for wage ratios. The fact that this influence can safely be excluded to be due to size and foreign ownership points towards skill-biasedness for importing.

Part of the variation in trade coefficients over quantiles may be due to variation of the effect of labour productivity. For blue collar wates, the effect is highest at the lower and higher quantiles. The same is true for white collar wages and the wage ratios. The estimated elasticity of blue collar wages with respect to labour productivity ranges between .047 and 0.084, but this effect is reduced by a trifle when capital intensity is introduced, reflecting productivity effects of capital intensity. For white collar wages, elasticities range from .088 to .114. For wage ratios, they are particularly large at the higher quantiles, that is, .154 at the 90th percentile.

The general findings at the mean apply to the whole distribution. However, quantile regression estimates show that the effect of trade is indeed not the same over quantiles. Particularly, effects that cannot be controlled for seem to matter for relative wages and white collar wages.

Estimations at the median based on analytical standard errors (see table 13 in the Appendix) show that these standard errors do not differ much from the bootstrap estimates, giving some support to the notion that the number of replications has been appropriately chosen and that significance levels are therefore valid.

## 6.3 Decomposition

The decompositions are performed on specification 5 whithout country and industry dummies. This may lead to some bias in the estimated differences in dependent variables as trading firms occur in higher frequency in industry sectors and countries that are more open to trade which is generally found to have an effect on wages. However, the assumption that industry and country fixed effects are the same for trading and non-trading firms is not very strict when the focus of interest is not the magnitude of wage differencials but their source.

### Decomposition at the mean

Results are shown in table 10. The decompositions are performed for specification 6 by comparing companies that engage in any form of trade with those that do not trade at all. Decomposing by trade categories would either mean that the comparison group would contain other firms that trade as well which would make interpretation dubious or selectively reduce the sample. Hence, trade is chosen to draw some general, but more tractable conclusions.

For average wages, about 85%- of the estimated total absolute difference in mean wages between trading and non-trading firms is explained by differences in endowments. For white collar wages, differences in endowments are estimated to explain about three quarters of the total difference, almost 90% for blue collar wages and about 80% for wage ratios. Estimated total differences in coefficients and the interaction between these and differences in endowments are tiny and insignificant for average wages and blue collar wages. For wage ratios, differences in coefficients are estimated to be responsible for 47% of the gap between traders and non-traders, but the estimate is insignificant and the sum of estimated effects is greater than the total difference. For white collar wages, differences in coefficients are estimated to explain 20% of the total difference in coefficients. The detailed decompositions shows significant estimates for an effect of coefficients for Foreign (white collar and blue collar wages), firm age (blue collar wages), and the skill ratio, labour productivity and the capital to labour ratio (wage ratios), for which there are significant interaction effects of these three variables as well. The insignificant estimated effects of coefficients give are in line with expectations as far as signs are concerned for blue and white collar wages as well as wage ratios. Capital intensity is an exception, for which coefficients and endowmets are estimated to be considerably higher for non-traders when wage ratios and white collar wages are considered. this is not the case for blue collar wages. Additionally, labour productivity is estimated to pay off more for traders when blue and white collar wages as well as wage ratios are considered, with the estimated difference being particularly high, which is not in line with estimates for average wages. The skill ratio is found to have a much higher coefficient for non-traders, while the ambiguity involved with its interpretation remains. Labour productivity increases wage ratios more in trading firms and so does capital intensity. Effects of differences in endowments are mainly driven by labour productivity across categories, with capital-intensity being a major factor for wage ratios also. For blue collar wages, the estimated difference in the constant is positive which means that average wages given controls are lower for traders. As the equation is misspecified and estimated on noisy cross-section data, this is hard to interpret.

The results for the detailed decomposition estimated with OLS point towards differences in the wage setting function between traders and non-traders. To what extent this plays a role for the typical channels over which trade may influence wages is not totally clear due to somewhat contradictory results. It seems that this kind of decomposition is simply insufficient because of variation of coefficients over quantiles and omitted variables.

**Decomposition at different quantiles**

Results are displayed in table 11. The decomposition is performed at the 10th, the 25th, the 50th, the 75th and the 90th percentile. Results are much less ambiguous than for the *Blinder-Oaxaca*-style decomposition. This could be because if the interpretation of regression results that coefficients vary over quantiles is true, a decomposition at the mean is influenced by violations of the normality assumption for residuals. Additionally, the vulnerability of OLS with respect to outliers applies here as well. There is at best very weak evidence for different residuals by trade involvement for absolute wages. Residuals for wage ratios seem to differ though. Differences in endowments explain the greatest part of total differences for all wage categories and over all quantiles. The latter are highest at the median for absolute wages (and roughly the same at the median and the 75th quantile for blue collar wages) and steeply increasing over quantiles for wage ratios. Differences in coefficients are significant for average wages at all quantiles except .10. Residuals are estimated to decrease the gap and differences in coefficients to increase it half as much as differences in endowments at the 75th percentile. It is not very clear why this should be so. There would have to be some omitted variable that increases wages much more for non-traders than for trades. There is no straight answer which variable this should be. As there is no such result for white collar and blue collar wages, it could be that average wages containing both blue collar and white collar wages is the reason. Support for this idea is lent by the same contradictory results for the decomposition at the mean. Differences in endowments are found to make up roughly 95% and coefficients around 5% of the total difference in blue collar wages at the 75th percentile. For white collar wages, the relative effect of coefficients is decreasing from 49% at the 10th percentile to 35% at the 75th respectively 43% at the 90th percentile.

For average wages, the effect of endowments seems to make up the greatest part of the difference. For blue collar wages, there is no evidence for the wages setting function to differ between traders and non-traders. For white collar wages, there is strong support for differences in the wage setting function. Its relative importance is higher at lower quantiles which could be a hint for skill-biasedness of trade and skill being complementary to factors related to trade as presumed in hypothesis 4.

For relative wages, differences in endowments are responsible for almost the total difference between distributions at the 10th percentile. This is the case at the 25th percentile as well, but effects of residuals and effects of coefficients cancel each other out. At the median, the effect of coefficients is estimated to cause 58% of the total difference and the effect of endowments almost all the rest. At the 75th quantile, coefficients are found to be responsible for 26% of the difference, at the 90th quantile for 20%. At these two quantiles the residuals are estimated to cause a large increase in the difference, contrary to findings at the 25th percentile. These patterns are explained too well by the shape of the wage ratio distribution to be interpreted literally. Nonetheless, the observed pattern combined with the effects estimated for white collar wages would be in line with hypothesis 4 as well.

The hypothesis of correct specification of the model cannot be rejected for any wage category (see table 12). Tests of stochastic dominance for the effect of characteristics suggest that the distributions of traders dominate those of non-traders for all wage variables and that effects are not constant over quantiles for wage ratios and possibly for white collar wages. This is evidence for selection of firms with comparably high wage levels and skill premia into trade or for trade to increase wages by having a positive influence on characteristics that are positively related to wage levels and skill premia. It is possible that both are the case. To what proportion is not clear however. Tests of stochastic dominance yield mixed evidence for traders to stochastically dominate non-traders for average wages and blue collar wages. For white collar wages and wage ratios, there is evidence for the distributions of coefficients for traders to dominate those of non-traders. The hypothesis of a constant effect of coefficients over quantiles is rejected by both the KS-test and the CMS-test for wage ratios, but not for white collar wages. Evidence for effects of the residuals is found for average wages and wage ratios. The hypothesis of a constant effect is rejected. For average wages, residuals are found to increase wages for non-traders relative to those for traders but the above reasoning applies. The KS-test but not the CMS-test reject the hypothesis of no stochastic dominance of traders when residual effects are concerned. The hypothesis of a constant effect is rejected for both categories.

The effect of residuals is not clear though there is evidence for them playing some ambiguous role. This lends some support to hypothesis 5. The decomposition results give strong support to hypothesis 3, confirming the linear regression results. There is strong evidence for different wage-setting between traders and non-traders as well as far as white collar wages and wage ratios are concerned. Whereas factors having a positive influence on wages are found to pay off more for traders, it is not clear which these factors are.

## 6.4 General results

OLS and QR estimation provide evidence for the first hypothesis of a positive relationship between trade and wages both for production and non-production wages. Indeed, a great part of the estimated effect is due to higher productivity levels. Size is an important factor for wages of exporters, which can be attributed to larger firms being more likely to select into exporting and to pay higher wages in general. For importers, size is not an essential part of the relationship. There is very weak evidence for capital intensity to be a factor for blue collar wages but not for white collar wages. Most of the estimated effect for all trade categories is due to productivity.

There is weak evidence for complementarity of importing and exporting when white and blue collar wages are considered separately, but only at the median. Estimates at other quantiles and at the mean give the impression that the number of twoway traders is too small, the variance too high and the relationship between trade and wages at the firm level too indirect and, last but not least, the proportion of twoway traders that are foreign investors too large to draw any reliable conclusion on complementarity.

There is evidence for the second hypothesis that the effect of firm-level exporting is stronger at higher quantiles of blue collar wage distributions. This is not true for the distribution of white collar wages: Estimated marginal effects are highest at lower quantiles and lowest around the median. It is possible that for white collar wages, other factors are more important at higher quantiles, such as technology level and innovation. Given that plots of estimates on every fifth percentile reveal a very shaky pattern, it is not even clear that there is any difference over quantiles at all for exporters. For importers though, the hypothesised relationship is found to be true: Estimated effects of importing is increasing over quantiles for white and blue collar wages as well as wage ratios whith the estimated coefficients being particularly strong for white collar wages, and at the highest quantiles for wage ratios. It could be that selection is a better explanation for the estimated effects when it comes to exporters, while it seems that there is some effect at least from importing to wages for importers.

There is evidence for the third hypothesis that wage ratios depend positively on trade, that is, estimated marginal effects are generally higher for white collar wages than for blue collar wages. OLS and QR regressions for non-production to production wage ratios give positive estimates for the importer and exporter dummy at several quantiles with the estimated effect being significant at several quantiles for the exporter dummy when only foreign ownership is controlled for but high variation and bad model fit are a reason to take this result with much caution. Furthermore, the pattern of coefficients over quantiles and specifications suggests the model lacks explanatory power. Nonetheless, there is rather strong evidence for the third hypothesis when these findings are combined with those for white collar wages.

A *Blinder-Oaxaca*-style decomposition into effects of characteristics, endowments and the interaction between the two attributes much less importance to differences in coefficients than a *Juhn, Murphy and Pierce*-style decomposition into effects of characteristics, coefficients and residuals. Quantile plots and regression results suggest that assumptions needed for OLS being unbiased and efficient are violated. This points towards the decomposition with quantile regression giving the more reliable results, even more so as general conclusions from the two methods do not contradict each other. Even though differences in residuals are only significant at a few quantiles for average wages, white collar wages and wage ratios, they could be a reason for these differences in estimated magnitudes and the significance of the effects. Therefore, it is also doubtful whether the first composition's finding of effects of differences in coefficients exclusively for the foreign dummy is correct, which could be interpreted along the lines of foreign companies paying wage premia in general but of these premia being higher if the company exports. It may well be that effects of coefficients would be significant for other covariates as well were it not for the composition being not very suitable given nonlinearity, outliers and omitted variable bias.

For blue collar wages, the second decomposition gives weak evidence for a difference in coefficients between firms that trade and those that do not at the 75th and the 90th percentile. Given that this suggestion is correct, the difference is considerably smaller than for white collar wages.

For white collar wages, the estimated effect of differences in coefficients increases over quantiles just as the estimated effect of differences in characteristics are increasing over quantiles. The same holds true for average wages. This would be an argument for an effect of coefficients for wage ratios as well. However, this is found at quantiles .5, .75 and .9 only for wage ratios, and, though the effects of coefficients are estimated to be stronger than for white collar wages, this is combined with the residual having overwhelming power in explaining the difference at quantiles .75 and .9. At these quantiles, the residuals are estimated to widen the gap, but at the other quantiles, they seem to decrease it, whilst the effect is estimated to be outstandingly strong at the 25th percentile. This can well be a result of a linear model fitted to a clearly nonlinear dependent variable. Indeed, the estimated effect of residuals is strongest at the quantiles where the quantile plot of wage ratios shows a sharp increase. Are these estimates for differences in residuals an argument against considering the estimates for differences in coefficients for relative wages as completely uninformative? Whereas their magnitude is certainly flawed, their very regular increase over quantiles combined with the findings for absolute wages are reason enough to think that this would be wrong. Additionally, even though for the decomposition based on OLS, the estimate for the total effect is obviously flawed and insignificant, the detailed decomposition suggests some significant effects of differences in coefficients as well.

Thus, it can be concluded there is strong evidence for differences in wage-setting between traders and non-traders which clearly favours white collar wages in trading firms. It is very well possible that the same is true for skill-premia.

# 7 Conclusion

Theory and empirical evidence suggest that more productive firms select into exporting, and, though the body of research is considerably smaller, into importing. Due to transaction costs of trade, only the more productive firms are found to be able to compete on a foreign market despite these costs. Only the more productive firms can afford to incur these transaction costs to gain direct access to imported inputs. Applied work finds that there is a positive effect of the globalisation decision on wages as well. Positive effects of importing and exporting at the firm level are attributed to gains of variety and better quality inputs, positive effects of exporting to access to a larger market and thus to productivity-enhancing effects of increased competition. Furthermore, interaction with a foreign supplier or buyer is seen to stimulate process innovation. A link to wages is established via rent-sharing, be it through wage bargaining or not.

Some authors suggest that by savings in transaction costs, exporting and importing are complementary.

OLS and quantile regression analysis of UNIDO's Africa Investor survey 2010 data finds strong evidence for a positive effect of trade at the firm level for 20 Subsaharan-African countries. A large proportion of the effect found for exporting can be attributed to firm size and to labour productivity. Wage premia paid by importers can to a large extent be explained by higher labour productivity. There is at best very weak evidence for complementarity of exporting and importing.

Trade is found to be related to innovation and technology in the widest sense. Theoretical and empirical works have been dedicated to the skill-biasedness of trade in this respect. Work that draws the attention to skill-biasedness of firm-level trade feature less prominently. If skill is complementary to innovation and technology though, trade induced innovation and access to higher technology through trade form a link between firm level trade and skill premia. Though results on wage ratios between non-production and production workers are mixed due to misspecification, consistently higher estimates of effects on trade for non-production workers are in line with such a link. Again, causality is not clear. Firms paying higher skill-premia might select into trade because they are more innovative and they have higher quality products to sell or because they may simply be more productive by employing higher skilled staff.

If innovation and technology pay more to a company that trades, notably because the gains from innovation and technology can be reaped on a larger market or because they can be multiplied by better inputs, complementarity of innovation and technology to skill might alter wage setting itself. That is, firm characteristics that are related to wages could pay off differently for workers in firms that engage in trade, notably for higher qualified workers. Evidence on the same firm characteristics paying off more for employees in trading firms is found for non-production wages increasing over quantiles of the wage distribution but there is little to no effect on wage setting for production wages. This suggests that skill premia depend more positively on firm characteristics as well but decomposition results on wage ratios give a somewhat unclear picture. Other explanations could be thought of for the decomposition results. Most importantly, absence of variables that control for skill render it impossible to distinguish between a firm whose workers are more skilled and thus earn higher wages and a firm whose workers are a little less skilled but whose skills and effort are rewarded more with higher wages in the first place. So findings could also be due to skill-biasedness itself, not necessarily to differences in wage setting. Nonetheless, the entire distributions of both coefficients and endowments of traders are found to dominate those of non-traders. Such a finding would be unlikely to occur due to measurement problems alone.

The present results provide important insights on different effects of exporting and importing over the whole wage distribution. At the same time, though not giving definite answers, they shed some interesting light on skill-biasedness of trade.

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# 8 APPENDIX

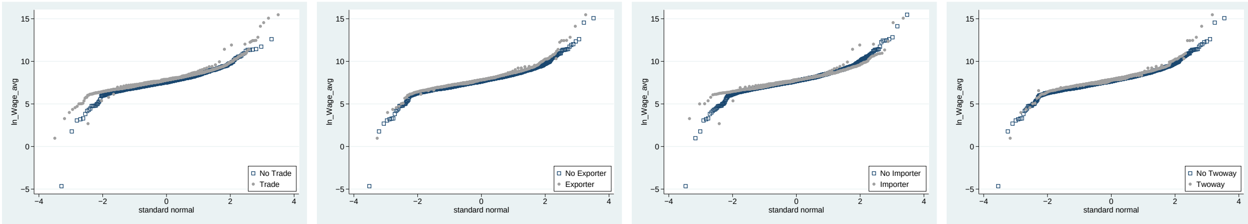


Figure 1: Quantile plots: Average Wages

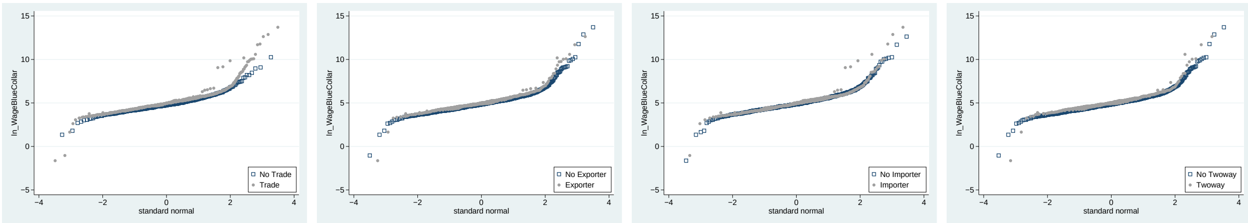


Figure 2: Quantile plots: Blue Collar Wages

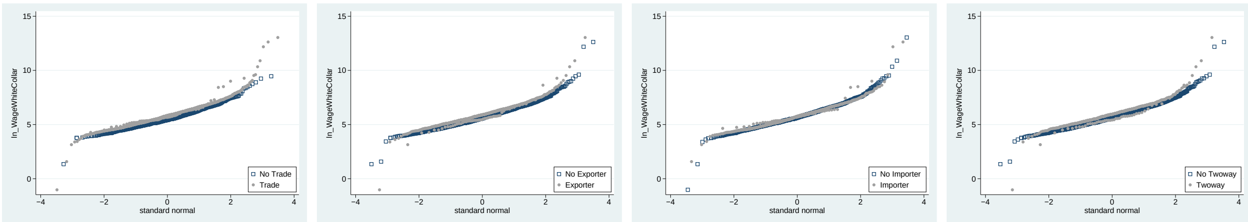


Figure 3: Quantile plots: White Collar Wages

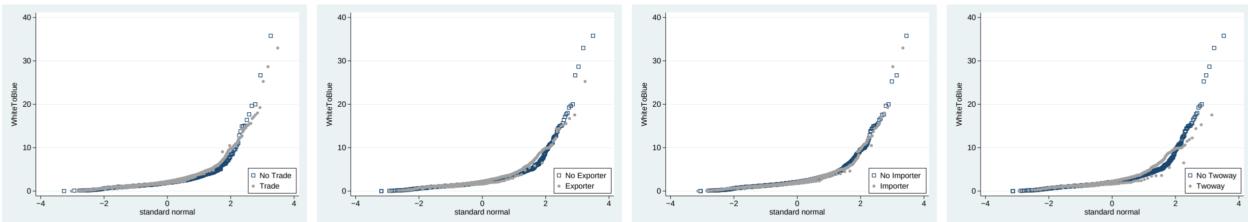


Figure 4: Quantile plots: White collar to blue collar wage ratios

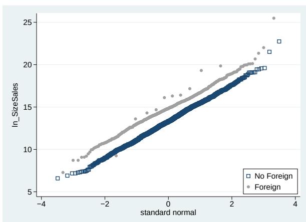


Figure 5: Quantile plot: log sales by ownership

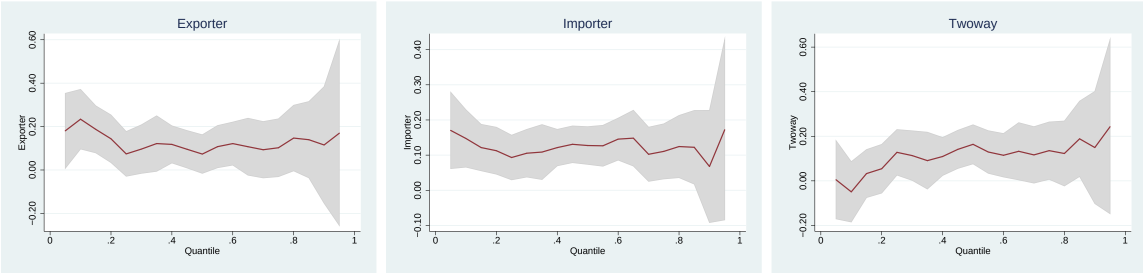


Figure 6: Average Wages: Specification 1

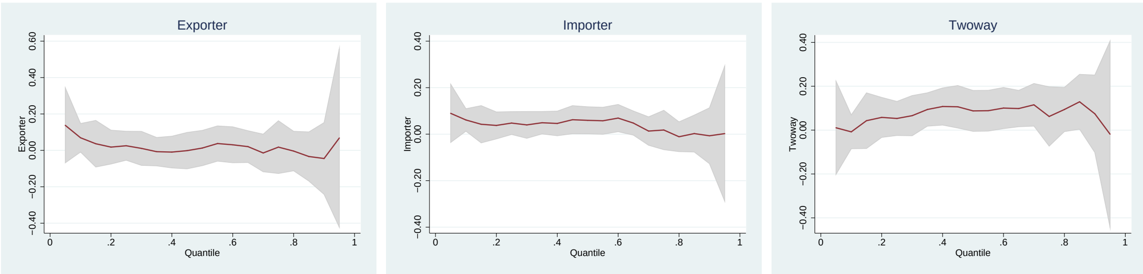


Figure 7: Average Wages: Specification 5

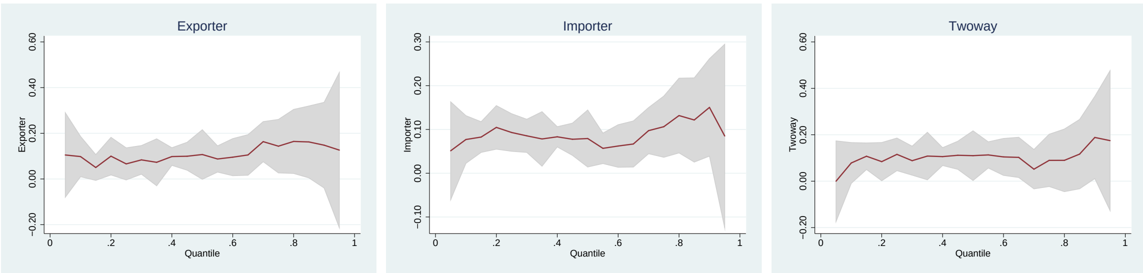


Figure 8: Blue Collar Wages: Specification 1

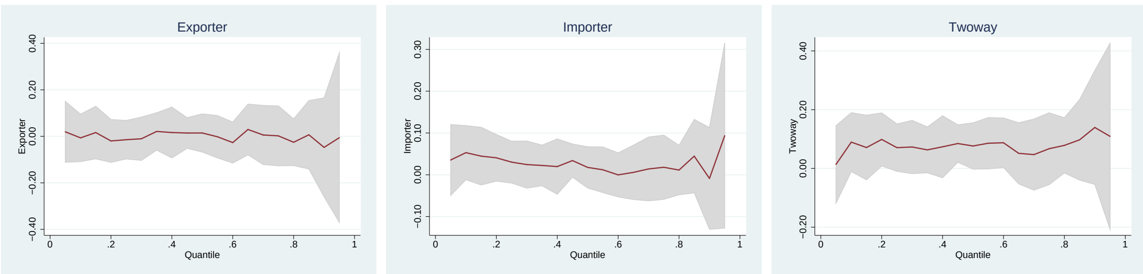


Figure 9: Blue Collar Wages: Specification 5

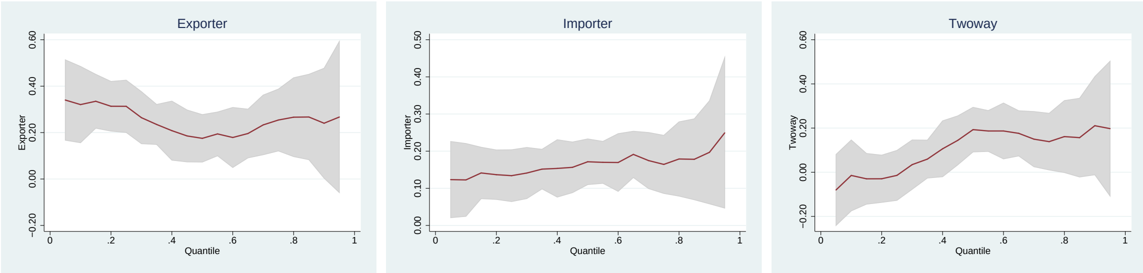


Figure 10: White Collar Wages: Specification 1

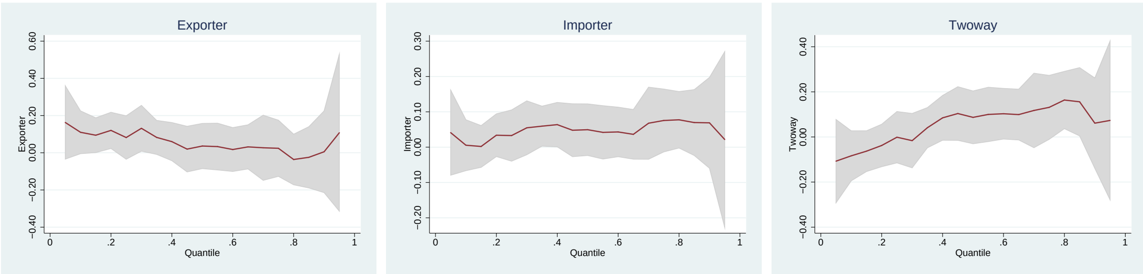


Figure 11: White Collar Wages: Specification 5

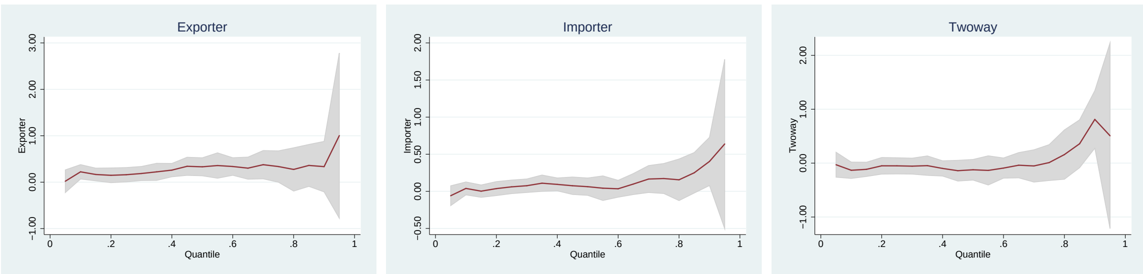


Figure 12: White Collar to Blue Collar Wage Ratio: Specification 1

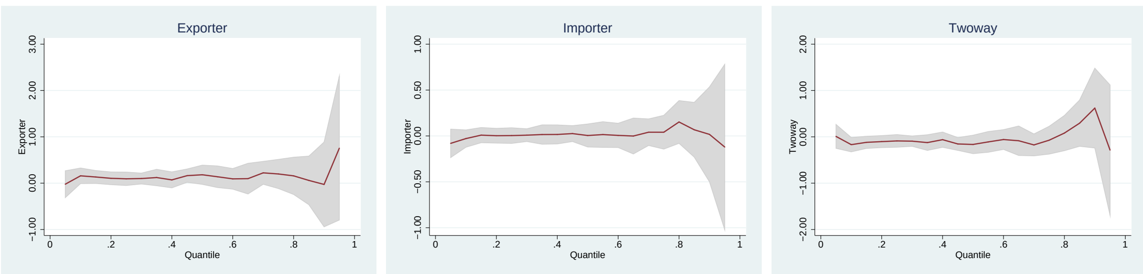


Figure 13: White Collar to Blue Collar Wage Ratio: Specification 5

# Table 1: Summary statistics

| | Trade (any) | | Importer | | Exporter | | Twoway | |
|---|---|---|---|---|---|---|---|---|
| | (trading) | (non-trading) | (trading) | (non-trading) | (trading) | (non-trading) | (trading) | (non-trading) |
| ln_Wage_avg | 7.838 | 7.62 | 7.79 | 7.757 | 7.902 | 7.716 | 7.939 | 7.724 |
| | (.875) | (.878) | (.831) | (.913) | (.928) | (.856) | (.972) | (.85) |
| ln_WageBlueCollar | 5.017 | 4.827 | 4.961 | 4.955 | 5.092 | 4.902 | 5.132 | 4.91 |
| | (.868) | (.781) | (.849) | (.845) | (.887) | (.823) | (.926) | (.817) |
| ln_WageWhiteCollar | 5.847 | 5.508 | 5.767 | 5.724 | 5.954 | 5.653 | 5.99 | 5.674 |
| | (.88) | (.797) | (.862) | (.874) | (.893) | (.844) | (.932) | (.839) |
| WhiteToBlue | 2.821 | 2.448 | 2.75 | 2.675 | 2.918 | 2.617 | 2.893 | 2.655 |
| | (2.36) | (2.387) | (2.373) | (2.375) | (2.34) | (2.383) | (2.178) | (2.422) |
| ln_SizeEmp | 4.204 | 3.312 | 3.865 | 3.966 | 4.664 | 3.622 | 4.712 | 3.714 |
| | (1.225) | (1.196) | (1.08) | (1.401) | (1.261) | (1.165) | (1.223) | (1.216) |
| BlueCollar_Emp | 118.214 | 49.879 | 70.203 | 114.492 | 183.471 | 61.262 | 179.808 | 74.551 |
| | (287.539) | (151.907) | (222.034) | (273.385) | (347.514) | (194.543) | (338.289) | (222.413) |
| WhiteCollar_Emp | 39.362 | 27.086 | 26.762 | 41.306 | 56.487 | 26.905 | 60.658 | 28.756 |
| | (92.346) | (127.104) | (61.123) | (124.831) | (120.597) | (95.886) | (131.391) | (94.936) |
| RelEmpBlueCollar | .691 | .679 | .679 | .692 | .706 | .679 | .709 | .681 |
| | (.254) | (.549) | (.265) | (.428) | (.237) | (.415) | (.243) | (.4) |
| ln_Age | 2.71 | 2.529 | 2.622 | 2.674 | 2.829 | 2.581 | 2.878 | 2.593 |
| | (.808) | (.784) | (.801) | (.807) | (.804) | (.794) | (.788) | (.799) |
| SkillRatio | 31.352 | 35.041 | 32.935 | 32.216 | 29.2 | 33.862 | 29.021 | 33.441 |
| | (18.286) | (21.492) | (17.819) | (20.394) | (18.699) | (19.543) | (17.818) | (19.721) |
| ln_OutputPerHours | 2.429 | 1.603 | 2.296 | 2.09 | 2.611 | 1.991 | 2.697 | 2.03 |
| | (1.514) | (1.565) | (1.421) | (1.666) | (1.614) | (1.525) | (1.528) | (1.56) |
| ln_CapitalLabourRatio | 9.472 | 8.854 | 9.363 | 9.225 | 9.620 | 9.138 | 9.734 | 9.157 |
| | (1.621) | (1.701) | (1.439) | (1.805) | (1.831) | (1.579) | (1.73) | (1.633) |
| ln_SizeSales | 14.434 | 12.726 | 13.951 | 13.871 | 15.09 | 13.413 | 15.211 | 13.549 |
| | (1.971) | (2.101) | (1.848) | (2.345) | (1.944) | (2.055) | (1.821) | (2.11) |

Trader: sample mean of trader. Non-trader: sample mean of non-trader. Sample standard deviations in parantheses

## Table 2: Summary statistics - foreign and domestic

| | (Foreign) | (Domestic) |
|---|---|---|
| Trade | .823 | .613 |
| | (.381) | (.487) |
| Exporter | .449 | .204 |
| | (.498) | (.403) |
| Importer | .374 | .409 |
| | (.484) | (.492) |
| Twoway | .321 | .152 |
| | (.467) | (.359) |
| ln_Wage_avg | 7.979 | 7.653 |
| | (.815) | (.896) |
| ln_WageBlueCollar | 5.129 | 4.862 |
| | (.768) | (.873) |
| ln_WageWhiteCollar | 6.03 | 5.58 |
| | (.830) | (.849) |
| WhiteToBlue | 3.07 | 2.502 |
| | (2.667) | (2.168) |
| ln_SizeEmp | 4.416 | 3.653 |
| | (1.25) | (1.221) |
| BlueCollar_Emp | 152.839 | 65.755 |
| | (352.133) | (172.041) |
| WhiteCollar_Emp | 50.85 | 27.001 |
| | (146.065) | (70.264) |
| RelEmpBlueCollar | .690 | .685 |
| | (.2) | (.44) |
| ln_Age | 2.644 | 2.659 |
| | (.827) | (.793) |
| SkillRatio | 30.483 | 33.626 |
| | (18.721) | (19.704) |
| ln_OutputPerHours | 2.652 | 1.904 |
| | (1.625) | (1.484) |
| ln_CapitalLabourRatio | 9.59 | 9.106 |
| | (1.794) | (1.572) |
| ln_SizeSales | 14.862 | 13.366 |
| | (1.955) | (2.085) |

Sample standard deviations in parantheses

## Table 3: KS-tests

| | Trade (any) | | | Importer | | | Exporter | | | Twoway | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Combined) | (trading) | (non-trading) | (Combined) | (trading) | (non-trading) | (Combined) | (trading) | (non-trading) | (Combined) | (trading) | (non-trading) |
| ln_Wage_avg | 0*** | 0*** | .982 | .032** | .016** | .485 | 0*** | 0*** | .997 | 0*** | 0*** | .99 |
| ln_WageBlueCollar | 0*** | 0*** | .999 | .131 | .066* | .28 | 0*** | 0*** | .998 | 0*** | 0*** | .994 |
| ln_WageWhiteCollar | 0*** | 0*** | .995 | .036** | .018** | .863 | 0*** | 0*** | .987 | 0*** | 0*** | .988 |
| WhiteToBlue | 0*** | 0*** | .989 | .095* | .047** | .690 | 0*** | 0*** | .988 | .022** | .011** | .939 |
| ln_SizeEmp | 0*** | 0*** | 1 | 0*** | .001*** | 0*** | 0*** | 0*** | .999 | 0*** | 0*** | .999 |
| BlueCollar_Emp | 0*** | 0*** | 1 | 0*** | .002*** | 0*** | 0*** | 0*** | 1 | 0*** | 0*** | 1 |
| WhiteCollar_Emp | 0*** | 0*** | .993 | .003*** | .001*** | .025** | 0*** | 0*** | .999 | 0*** | 0*** | 1 |
| RelEmpBlueCollar | .005*** | .002*** | .952 | .002*** | .44 | .001*** | 0*** | 0*** | .983 | .002*** | .001*** | .99 |
| ln_Age | 0*** | 0*** | 1 | .169 | .950 | .085* | 0*** | 0*** | 1 | 0*** | 0*** | 1 |
| SkillRatio | .001*** | 1 | 0*** | .002*** | .001*** | .464 | 0*** | 1 | 0*** | 0*** | .999 | 0*** |
| ln_OutputPerHours | 0*** | 0*** | .998 | 0*** | 0*** | .094* | 0*** | 0*** | .999 | 0*** | 0*** | .999 |
| ln_CapitalLabourRatio | 0*** | 0*** | .998 | .001*** | 0*** | .144 | 0*** | 0*** | .961 | 0*** | 0*** | .991 |
| ln_SizeSales | 0*** | 0*** | 1 | 0*** | 0*** | 0*** | 0*** | 0*** | 1 | 0*** | 0*** | 1 |

| | KS-tests between exporters and importers | | |
|---|---|---|---|
| | (Combined) | (Exporter) | (Importer) |
| ln_Wage_avg | .027** | .013** | .988 |
| ln_WageBlueCollar | 0*** | 0*** | .995 |
| ln_WageWhiteCollar | 0*** | 0*** | .982 |
| WhiteToBlue | .091* | .046** | .789 |
| ln_SizeEmp | 0*** | 0*** | .999 |
| BlueCollar_Emp | 0*** | 0*** | .999 |
| WhiteCollar_Emp | 0*** | 0*** | 1 |
| RelEmpBlueCollar | 0*** | 0*** | .872 |
| ln_Age | 0*** | 0*** | .999 |
| SkillRatio | 0*** | .963 | 0*** |
| ln_OutputPerHours | 0*** | 0*** | .820 |
| ln_CapitalLabourRatio | 0*** | 0*** | .323 |
| ln_SizeSales | 0*** | 0*** | 1 |

Combined: Test on equality of distributions. Trader: favourable to trader. Non-trader: favourable to non-trader.

p-values: ¡.01***, ¡.05**, .10*

# Table 4: Mean comparison tests

| | Trade (any) | | | Importer | | | Exporter | | | Twoway | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Combined) | (trading) | (non-trading) | (Combined) | (trading) | (non-trading) | (Combined) | (trading) | (non-trading) | (Combined) | (trading) | (non-trading) |
| ln_Wage_avg | 0*** | 0*** | 1 | .329 | .165 | .835 | 0*** | 0*** | 1 | 0*** | 0*** | 1 |
| ln_WageBlueCollar | 0*** | 0*** | 1 | .849 | .425 | .575 | 0*** | 0*** | 1 | 0*** | 0*** | 1 |
| ln_WageWhiteCollar | 0*** | 0*** | 1 | .202 | .101 | .899 | 0*** | 0*** | 1 | 0*** | 0*** | 1 |
| WhiteToBlue | 0*** | 0*** | 1 | .419 | .21 | .79 | .003*** | .001*** | .999 | .032** | .016** | .984 |
| ln_SizeEmp | 0*** | 0*** | 1 | .043** | .978 | .022** | 0*** | 0*** | 1 | 0*** | 0*** | 1 |
| BlueCollar_Emp | 0*** | 0*** | 1 | 0*** | 1 | 0*** | 0*** | 0*** | 1 | 0*** | 0*** | 1 |
| WhiteCollar_Emp | .004*** | .002*** | .998 | 0*** | 1 | 0*** | 0*** | 0*** | 1 | 0*** | 0*** | 1 |
| RelEmpBlueCollar | .443 | .221 | .779 | .387 | .806 | .194 | .087* | .043** | .957 | .111 | .055* | .945 |
| ln_Age | 0*** | 0*** | 1 | .102 | .949 | .051* | 0*** | 0*** | 1 | 0*** | 0*** | 1 |
| SkillRatio | 0*** | 1 | 0*** | .343 | .172 | .828 | 0*** | 1 | 0*** | 0*** | 1 | 0*** |
| ln_OutputPerHours | 0*** | 0*** | 1 | .001*** | 0*** | 1 | 0*** | 0*** | 1 | 0*** | 0*** | 1 |
| ln_CapitalLabourRatio | 0*** | 0*** | 1 | .034** | .017** | .983 | 0*** | 0*** | 1 | 0*** | 0*** | 1 |
| ln_SizeSales | 0*** | 0*** | 1 | .345 | .173 | .827 | 0*** | 0*** | 1 | 0*** | 0*** | 1 |

| | Mean comparison tests by foreign | | |
|---|---|---|---|
| | (Combined) | (Foreign) | (Domestic) |
| Trade | 0*** | 0*** | 1 |
| Importer | .077* | .962 | .038** |
| Exporter | 0*** | 0*** | 1 |
| Twoway | 0*** | 0*** | 1 |
| ln_Wage_avg | 0*** | 0*** | 1 |
| ln_WageBlueCollar | 0*** | 0*** | 1 |
| ln_WageWhiteCollar | 0*** | 0*** | 1 |
| WhiteToBlue | 0*** | 0*** | 1 |
| ln_SizeEmp | 0*** | 0*** | 1 |
| BlueCollar_Emp | 0*** | 0*** | 1 |
| WhiteCollar_Emp | 0*** | 0*** | 1 |
| RelEmpBlueCollar | .71 | .355 | .645 |
| ln_Age | .656 | .672 | .328 |
| SkillRatio | 0*** | 1 | 0*** |
| ln_OutputPerHours | 0*** | 0*** | 1 |
| ln_CapitalLabourRatio | 0*** | 0*** | 1 |
| ln_SizeSales | 0*** | 0*** | 1 |

Combined: Test on equality of means. Trader: favourable to trader. Non-trader: favourable to non-trader.
p-values: ¡.01***, ¡.05**, .10*

# Table 5: OLS: All wage categories

| | (1) ln_Wage_avg b/se | (2) ln_Wage_avg b/se | (3) ln_Wage_avg b/se | (4) ln_Wage_avg b/se | (5) ln_Wage_avg b/se | (6) ln_Wage_avg b/se | (7) ln_WageBlueCollar b/se | (8) ln_WageBlueCollar b/se |
|---|---|---|---|---|---|---|---|---|
| Exporter | 0.164*** | 0.130** | 0.130** | 0.119** | 0.039 | 0.032 | 0.142** | 0.080 |
| | (0.059) | (0.062) | (0.061) | (0.060) | (0.062) | (0.061) | (0.058) | (0.059) |
| Importer | 0.142*** | 0.125*** | 0.127*** | 0.115*** | 0.052 | 0.045 | 0.127*** | 0.097*** |
| | (0.037) | (0.038) | (0.038) | (0.037) | (0.037) | (0.036) | (0.037) | (0.037) |
| Twoway | 0.111* | 0.102* | 0.097* | 0.098* | 0.078 | 0.073 | 0.121** | 0.105* |
| | (0.059) | (0.059) | (0.058) | (0.057) | (0.057) | (0.057) | (0.058) | (0.057) |
| Foreign | 0.193*** | 0.174*** | 0.190*** | 0.189*** | 0.134*** | 0.129*** | 0.146*** | 0.113*** |
| | (0.036) | (0.036) | (0.036) | (0.035) | (0.035) | (0.035) | (0.034) | (0.036) |
| ln_SizeEmp | | 0.036** | 0.023 | 0.061*** | 0.052*** | 0.053*** | | 0.065*** |
| | | (0.015) | (0.016) | (0.017) | (0.016) | (0.016) | | (0.014) |
| ln_Age | | | 0.067*** | 0.048** | 0.028 | 0.026 | | |
| | | | (0.023) | (0.022) | (0.021) | (0.021) | | |
| SkillRatio | | | | 0.009*** | 0.008*** | 0.008*** | | |
| | | | | (0.001) | (0.001) | (0.001) | | |
| ln_OutputPerHours | | | | | 0.115*** | 0.102*** | | |
| | | | | | (0.014) | (0.015) | | |
| ln_CapitalLabourRatio | | | | | | 0.027** | | |
| | | | | | | (0.012) | | |
| _cons | 7.442*** | 7.384*** | 7.316*** | 6.909*** | 7.008*** | 6.806*** | 4.499*** | 4.395*** |
| | (0.153) | (0.151) | (0.154) | (0.147) | (0.138) | (0.162) | (0.124) | (0.119) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.271 | 0.273 | 0.276 | 0.310 | 0.339 | 0.341 | 0.251 | 0.258 |
| *AIC* | 6309.060 | 6305.898 | 6294.426 | 6164.881 | 6047.527 | 6042.738 | 6159.101 | 6139.275 |
| *BIC* | 6592.980 | 6601.647 | 6590.175 | 6466.545 | 6355.106 | 6356.232 | 6443.021 | 6435.024 |
| Wald test of equality of coefficients | | | | | | | | |
| | F(1,n-k) / Prob > F | | | | | | F(1,n-k) / Prob > F | |
| Exporter=Importerqf | 0.157 | 0.006 | 0.004 | 0.007 | 0.055 | 0.051 | 0.069 | 0.090 |
| Exporter=Importerqp | 0.692 | 0.937 | 0.952 | 0.935 | 0.814 | 0.821 | 0.794 | 0.764 |
| Exporter=Twowayqf | 0.257 | 0.066 | 0.096 | 0.042 | 0.134 | 0.147 | 0.042 | 0.054 |
| Exporter=Twowayqp | 0.613 | 0.797 | 0.757 | 0.839 | 0.715 | 0.702 | 0.838 | 0.817 |
| Importer=Twowayqf | 0.200 | 0.109 | 0.182 | 0.061 | 0.142 | 0.169 | 0.010 | 0.012 |
| Importer=Twowayqp | 0.654 | 0.741 | 0.670 | 0.806 | 0.706 | 0.681 | 0.922 | 0.914 |

| | (9) ln_WageBlueCollar b/se | (10) ln_WageBlueCollar b/se | (11) ln_WageBlueCollar b/se | (12) ln_WageBlueCollar b/se | (13) ln_WageWhiteCollar b/se | (14) ln_WageWhiteCollar b/se | (15) ln_WageWhiteCollar b/se | (16) ln_WageWhiteCollar b/se |
|---|---|---|---|---|---|---|---|---|
| Exporter | 0.081 | 0.077 | 0.030 | 0.025 | 0.269*** | 0.150*** | 0.150*** | 0.149*** |
| | (0.059) | (0.059) | (0.062) | (0.061) | (0.055) | (0.056) | (0.056) | (0.056) |
| Importer | 0.098*** | 0.094** | 0.057 | 0.052 | 0.187*** | 0.129*** | 0.130*** | 0.129*** |
| | (0.037) | (0.036) | (0.037) | (0.037) | (0.035) | (0.035) | (0.035) | (0.035) |
| Twoway | 0.100* | 0.100* | 0.089 | 0.085 | 0.120** | 0.089 | 0.086 | 0.086 |
| | (0.057) | (0.057) | (0.057) | (0.057) | (0.057) | (0.056) | (0.056) | (0.056) |
| Foreign | 0.126*** | 0.126*** | 0.094*** | 0.091*** | 0.285*** | 0.221*** | 0.230*** | 0.230*** |
| | (0.036) | (0.036) | (0.035) | (0.035) | (0.034) | (0.034) | (0.034) | (0.034) |
| ln_SizeEmp | 0.053*** | 0.067*** | 0.062*** | 0.063*** | | 0.125*** | 0.117*** | 0.121*** |
| | (0.014) | (0.015) | (0.014) | (0.014) | | (0.013) | (0.013) | (0.014) |
| ln_Age | 0.057*** | 0.050** | 0.039* | 0.037* | | | 0.037* | 0.035* |
| | (0.021) | (0.021) | (0.021) | (0.021) | | | (0.020) | (0.020) |
| SkillRatio | | 0.003*** | 0.003*** | 0.003*** | | | | 0.001 |
| | | (0.001) | (0.001) | (0.001) | | | | (0.001) |
| ln_OutputPerHours | | | 0.067*** | 0.058*** | | | | |
| | | | (0.012) | (0.013) | | | | |
| ln_CapitalLabourRatio | | | | 0.019* | | | | |
| | | | | (0.011) | | | | |
| _cons | 4.337*** | 4.183*** | 4.240*** | 4.098*** | 5.311*** | 5.111*** | 5.074*** | 5.031*** |
| | (0.123) | (0.129) | (0.122) | (0.142) | (0.142) | (0.130) | (0.133) | (0.140) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.260 | 0.265 | 0.276 | 0.277 | 0.328 | 0.351 | 0.352 | 0.353 |
| *AIC* | 6130.405 | 6112.699 | 6073.961 | 6074.644 | 6006.795 | 5913.840 | 5913.911 | 5914.276 |
| *BIC* | 6426.154 | 6414.363 | 6381.540 | 6394.053 | 6290.714 | 6203.674 | 6215.575 | 6221.855 |
| Wald test of equality of coefficients | | | | | | | | |
| | | | | | F(1,n-k) / Prob > F | | | |
| Exporter=Importerqf | 0.101 | 0.097 | 0.239 | 0.233 | 2.220 | 0.150 | 0.142 | 0.143 |
| Exporter=Importerqp | 0.750 | 0.755 | 0.625 | 0.629 | 0.136 | 0.698 | 0.707 | 0.705 |
| Exporter=Twowayqf | 0.035 | 0.053 | 0.308 | 0.322 | 2.204 | 0.381 | 0.419 | 0.404 |
| Exporter=Twowayqp | 0.852 | 0.818 | 0.579 | 0.570 | 0.138 | 0.537 | 0.518 | 0.525 |
| Importer=Twowayqf | 0.001 | 0.009 | 0.209 | 0.232 | 1.053 | 0.388 | 0.461 | 0.433 |
| Importer=Twowayqp | 0.981 | 0.924 | 0.647 | 0.630 | 0.305 | 0.533 | 0.497 | 0.510 |

| | (17) ln_WageWhiteCollar b/se | (18) ln_WageWhiteCollar b/se | (19) WageRatio b/se | (20) WageRatio b/se | (21) WageRatio b/se | (22) WageRatio b/se | (23) WageRatio b/se | (24) WageRatio b/se |
|---|---|---|---|---|---|---|---|---|
| Exporter | 0.079 | 0.077 | 0.354 | 0.183 | 0.183 | 0.184 | 0.093 | 0.108 |
| | (0.058) | (0.058) | (0.216) | (0.218) | (0.218) | (0.217) | (0.219) | (0.220) |
| Importer | 0.074** | 0.072** | 0.164 | 0.080 | 0.079 | 0.080 | 0.009 | 0.025 |
| | (0.035) | (0.035) | (0.115) | (0.113) | (0.113) | (0.115) | (0.111) | (0.112) |
| Twoway | 0.068 | 0.067 | -0.034 | -0.079 | -0.074 | -0.074 | -0.097 | -0.085 |
| | (0.056) | (0.056) | (0.209) | (0.210) | (0.209) | (0.209) | (0.209) | (0.208) |
| Foreign | 0.182*** | 0.180*** | 0.486*** | 0.394*** | 0.378*** | 0.378*** | 0.316*** | 0.325*** |
| | (0.033) | (0.034) | (0.101) | (0.105) | (0.104) | (0.104) | (0.099) | (0.099) |
| ln_SizeEmp | 0.113*** | 0.113*** | | 0.180*** | 0.193*** | 0.188*** | 0.178*** | 0.177*** |
| | (0.014) | (0.014) | | (0.043) | (0.045) | (0.046) | (0.046) | (0.046) |
| ln_Age | 0.018 | 0.017 | | | -0.065 | -0.062 | -0.084 | -0.080 |
| | (0.020) | (0.020) | | | (0.059) | (0.060) | (0.060) | (0.060) |
| SkillRatio | -0.000 | -0.000 | | | | -0.001 | -0.003 | -0.003 |
| | (0.001) | (0.001) | | | | (0.004) | (0.004) | (0.004) |
| ln_OutputPerHours | 0.100*** | 0.097*** | | | | | 0.130*** | 0.158*** |
| | (0.012) | (0.013) | | | | | (0.041) | (0.045) |
| ln_CapitalLabourRatio | | 0.008 | | | | | | -0.060* |
| | | (0.012) | | | | | | (0.036) |
| _cons | 5.117*** | 5.058*** | 1.568*** | 1.279*** | 1.345*** | 1.395*** | 1.506*** | 1.948*** |
| | (0.132) | (0.160) | (0.400) | (0.401) | (0.400) | (0.443) | (0.445) | (0.506) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.376 | 0.376 | 0.076 | 0.083 | 0.083 | 0.083 | 0.088 | 0.089 |
| *AIC* | 5814.187 | 5817.537 | 12382.720 | 12365.673 | 12368.510 | 12368.296 | 12354.671 | 12353.416 |
| *BIC* | 6121.766 | 6136.946 | 12666.639 | 12655.507 | 12670.174 | 12669.960 | 12662.250 | 12666.910 |
| Wald test of equality of coefficients | | | | | | | | |
| | | | F(1,n-k) / Prob > F | | | | | |
| Exporter=Importerqf | 0.008 | 0.009 | 0.720 | 0.207 | 0.211 | 0.211 | 0.136 | 0.133 |
| Exporter=Importerqp | 0.928 | 0.926 | 0.396 | 0.649 | 0.646 | 0.646 | 0.712 | 0.716 |
| Exporter=Twowayqf | 0.011 | 0.010 | 0.922 | 0.418 | 0.403 | 0.409 | 0.222 | 0.229 |
| Exporter=Twowayqp | 0.917 | 0.920 | 0.337 | 0.518 | 0.526 | 0.523 | 0.638 | 0.632 |
| Importer=Twowayqf | 0.008 | 0.006 | 0.712 | 0.462 | 0.426 | 0.435 | 0.210 | 0.228 |
| Importer=Twowayqp | 0.931 | 0.938 | 0.399 | 0.497 | 0.514 | 0.509 | 0.647 | 0.633 |

robust standard errors in parantheses. *** p<0.01, ** p<0.05, * p<0.1

# Table 6: QR: Average wages

| | (1) ln_Wage | | | | | (2) ln_Wage | | | | | (3) ln_Wage | | | | | (4) ln_Wage | | | | | (5) ln_Wage | | | | | (6) ln_Wage | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | q10 b/se | q25 b/se | q50 b/se | q75 b/se | q90 b/se | q10 b/se | q25 b/se | q50 b/se | q75 b/se | q90 b/se | q10 b/se | q25 b/se | q50 b/se | q75 b/se | q90 b/se | q10 b/se | q25 b/se | q50 b/se | q75 b/se | q90 b/se | q10 b/se | q25 b/se | q50 b/se | q75 b/se | q90 b/se | q10 b/se | q25 b/se | q50 b/se | q75 b/se | q90 b/se |
| Exporter | 0.234*** | 0.074 | 0.073 | 0.102 | 0.115 | 0.215*** | 0.061 | 0.079 | 0.061 | 0.049 | 0.210*** | 0.063 | 0.101** | 0.054 | -0.008 | 0.215*** | 0.062 | 0.035 | 0.074 | 0.039 | 0.069 | 0.025 | 0.013 | 0.018 | -0.045 | 0.073 | 0.013 | -0.005 | -0.018 | -0.081 |
| | (0.068) | (0.059) | (0.048) | (0.072) | (0.139) | (0.072) | (0.059) | (0.049) | (0.071) | (0.145) | (0.070) | (0.055) | (0.050) | (0.070) | (0.137) | (0.065) | (0.050) | (0.055) | (0.061) | (0.125) | (0.070) | (0.049) | (0.057) | (0.060) | (0.105) | (0.065) | (0.047) | (0.057) | (0.061) | (0.098) |
| Importer | 0.147*** | 0.093** | 0.127*** | 0.111*** | 0.068 | 0.150*** | 0.100** | 0.121*** | 0.102** | 0.068 | 0.120*** | 0.099*** | 0.128*** | 0.105** | 0.047 | 0.121*** | 0.090*** | 0.097*** | 0.066* | 0.042 | 0.061 | 0.048 | 0.060* | 0.018 | -0.007 | 0.061 | 0.037 | 0.050 | -0.009 | -0.001 |
| | (0.042) | (0.039) | (0.028) | (0.041) | (0.079) | (0.042) | (0.040) | (0.029) | (0.041) | (0.080) | (0.044) | (0.037) | (0.027) | (0.042) | (0.074) | (0.047) | (0.034) | (0.029) | (0.038) | (0.073) | (0.040) | (0.032) | (0.031) | (0.038) | (0.069) | (0.039) | (0.032) | (0.031) | (0.040) | (0.070) |
| Twoway | -0.049 | 0.128** | 0.164*** | 0.136* | 0.150 | -0.060 | 0.119** | 0.118** | 0.130* | 0.193 | -0.074 | 0.084 | 0.102** | 0.131* | 0.197 | -0.048 | 0.088** | 0.140*** | 0.087 | 0.125 | -0.008 | 0.053 | 0.088 | 0.062 | 0.075 | -0.012 | 0.062 | 0.089 | 0.090 | 0.099 |
| | (0.072) | (0.055) | (0.048) | (0.071) | (0.125) | (0.073) | (0.055) | (0.051) | (0.068) | (0.130) | (0.073) | (0.052) | (0.050) | (0.070) | (0.122) | (0.061) | (0.044) | (0.051) | (0.066) | (0.114) | (0.063) | (0.047) | (0.057) | (0.060) | (0.103) | (0.061) | (0.044) | (0.058) | (0.059) | (0.093) |
| Foreign | 0.138*** | 0.142*** | 0.227*** | 0.209*** | 0.164*** | 0.143*** | 0.123*** | 0.206*** | 0.187*** | 0.152** | 0.149*** | 0.153*** | 0.224*** | 0.202*** | 0.214*** | 0.155*** | 0.152*** | 0.191*** | 0.169*** | 0.229*** | 0.103*** | 0.092*** | 0.156*** | 0.151*** | 0.151*** | 0.102*** | 0.097*** | 0.158*** | 0.138*** | 0.138** |
| | (0.038) | (0.033) | (0.027) | (0.036) | (0.063) | (0.040) | (0.033) | (0.028) | (0.037) | (0.060) | (0.041) | (0.031) | (0.026) | (0.037) | (0.064) | (0.044) | (0.030) | (0.028) | (0.034) | (0.060) | (0.035) | (0.029) | (0.030) | (0.033) | (0.054) | (0.035) | (0.029) | (0.030) | (0.034) | (0.054) |
| ln_SizeEmp | | | | | | 0.016 | 0.036** | 0.026** | 0.053*** | 0.033 | 0.005 | 0.018 | 0.015 | 0.041*** | 0.022 | 0.049** | 0.060*** | 0.054*** | 0.078*** | 0.085*** | 0.042** | 0.053*** | 0.042*** | 0.066*** | 0.077*** | 0.042** | 0.055*** | 0.040*** | 0.070*** | 0.077*** |
| | | | | | | (0.017) | (0.014) | (0.013) | (0.017) | (0.026) | (0.019) | (0.015) | (0.013) | (0.016) | (0.024) | (0.024) | (0.013) | (0.014) | (0.016) | (0.026) | (0.017) | (0.012) | (0.014) | (0.017) | (0.024) | (0.017) | (0.013) | (0.014) | (0.017) | (0.024) |
| ln_Age | | | | | | | | | | | 0.033 | 0.075*** | 0.073*** | 0.057** | 0.110*** | 0.017 | 0.034* | 0.046*** | 0.041** | 0.079** | -0.000 | 0.024 | 0.038** | 0.035* | 0.073** | -0.002 | 0.019 | 0.037** | 0.033* | 0.066** |
| | | | | | | | | | | | (0.024) | (0.020) | (0.017) | (0.022) | (0.040) | (0.028) | (0.018) | (0.017) | (0.020) | (0.034) | (0.023) | (0.018) | (0.017) | (0.019) | (0.030) | (0.023) | (0.018) | (0.016) | (0.020) | (0.032) |
| SkillRatio | | | | | | | | | | | | | | | | 0.007*** | 0.008*** | 0.008*** | 0.012*** | 0.013*** | 0.005*** | 0.006*** | 0.007*** | 0.010*** | 0.013*** | 0.005*** | 0.006*** | 0.007*** | 0.010*** | 0.012*** |
| | | | | | | | | | | | | | | | | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) |
| ln_OutputPerHours | | | | | | | | | | | | | | | | | | | | | 0.108*** | 0.104*** | 0.089*** | 0.099*** | 0.125*** | 0.109*** | 0.096*** | 0.079*** | 0.084*** | 0.111*** |
| | | | | | | | | | | | | | | | | | | | | | (0.013) | (0.011) | (0.012) | (0.012) | (0.018) | (0.015) | (0.013) | (0.011) | (0.013) | (0.019) |
| ln_CapitalLabourRatio | | | | | | | | | | | | | | | | | | | | | | | | | | 0.001 | 0.012 | 0.026** | 0.031*** | 0.033 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | (0.014) | (0.011) | (0.011) | (0.011) | (0.022) |
| _cons | 7.722*** | 7.627*** | 7.507*** | 7.503*** | 7.365*** | 7.670*** | 7.560*** | 7.553*** | 7.359*** | 7.211*** | 7.731*** | 7.390*** | 7.562*** | 7.266*** | 7.107*** | 7.672*** | 7.413*** | 7.835*** | 7.422*** | 6.903*** | 7.528*** | 7.166*** | 7.524*** | 7.153*** | 6.486*** | 7.518*** | 7.110*** | 7.353*** | 6.843*** | 6.277*** |
| | (0.425) | (0.433) | (0.548) | (0.699) | (0.868) | (0.429) | (0.437) | (0.517) | (0.656) | (0.866) | (0.410) | (0.406) | (0.482) | (0.628) | (0.839) | (0.413) | (0.369) | (0.420) | (0.411) | (0.487) | (0.328) | (0.275) | (0.374) | (0.368) | (0.429) | (0.366) | (0.307) | (0.388) | (0.392) | (0.491) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| pr2_q10 | 0.224 | | | | | 0.225 | | | | | 0.225 | | | | | 0.241 | | | | | 0.276 | | | | | 0.276 | | | | |
| pr2_q25 | 0.242 | | | | | 0.244 | | | | | 0.247 | | | | | 0.272 | | | | | 0.297 | | | | | 0.298 | | | | |
| pr2_q50 | 0.246 | | | | | 0.247 | | | | | 0.250 | | | | | 0.279 | | | | | 0.296 | | | | | 0.297 | | | | |
| pr2_q75 | 0.210 | | | | | 0.213 | | | | | 0.215 | | | | | 0.250 | | | | | 0.272 | | | | | 0.273 | | | | |
| pr2_q90 | 0.163 | | | | | 0.165 | | | | | 0.169 | | | | | 0.203 | | | | | 0.226 | | | | | 0.227 | | | | |

bootstrap standard errors (1075 replications)

Wald test of equality of coefficients on each quantile

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F |
| Exporter=Importer_q10f | 1.820 | 0.999 | 1.800 | 2.199 | 0.016 | 0.040 |
| Exporter=Importer_q10p | 0.177 | 0.318 | 0.180 | 0.138 | 0.899 | 0.842 |
| Exporter=Twoway_q10f | 4.911** | 4.447 | 4.812** | 5.666** | 0.395 | 0.536 |
| Exporter=Twoway_q10p | 0.027 | 0.035 | 0.028 | 0.017 | 0.530 | 0.464 |
| Importer=Twoway_q10f | 5.549** | 6.155** | 5.451** | 5.438** | 0.853 | 1.015 |
| Importer=Twoway_q10p | 0.019 | 0.013 | 0.020 | 0.020 | 0.356 | 0.314 |
| Exporter=Importer_q25f | 0.111 | 0.498 | 0.442 | 0.344 | 0.234 | 0.304 |
| Exporter=Importer_q25p | 0.739 | 0.481 | 0.506 | 0.557 | 0.628 | 0.581 |
| Exporter=Twoway_q25f | 0.266 | 0.326 | 0.050 | 0.095 | 0.103 | 0.369 |
| Exporter=Twoway_q25p | 0.606 | 0.568 | 0.824 | 0.759 | 0.748 | 0.544 |
| Importer=Twoway_q25f | 0.270 | 0.086 | 0.055 | 0.001 | 0.009 | 0.214 |
| Importer=Twoway_q25p | 0.603 | 0.769 | 0.814 | 0.976 | 0.925 | 0.644 |
| Exporter=Importer_q50f | 1.284 | 0.790 | 0.319 | 1.374 | 0.739 | 0.930 |
| Exporter=Importer_q50p | 0.257 | 0.374 | 0.572 | 0.241 | 0.390 | 0.335 |
| Exporter=Twoway_q50f | 1.048 | 0.178 | 0.000 | 1.150 | 0.499 | 0.799 |
| Exporter=Twoway_q50p | 0.306 | 0.673 | 0.991 | 0.284 | 0.480 | 0.372 |
| Importer=Twoway_q50f | 0.465 | 0.003 | 0.208 | 0.573 | 0.188 | 0.410 |
| Importer=Twoway_q50p | 0.495 | 0.959 | 0.648 | 0.449 | 0.665 | 0.522 |
| Exporter=Importer_q75f | 0.014 | 0.373 | 0.574 | 0.017 | 0.000 | 0.030 |
| Exporter=Importer_q75p | 0.907 | 0.542 | 0.449 | 0.897 | 0.999 | 0.862 |
| Exporter=Twoway_q75f | 0.063 | 0.292 | 0.367 | 0.014 | 0.171 | 1.048 |
| Exporter=Twoway_q75p | 0.802 | 0.589 | 0.544 | 0.906 | 0.680 | 0.306 |
| Importer=Twoway_q75f | 0.094 | 0.125 | 0.107 | 0.083 | 0.394 | 1.927 |
| Importer=Twoway_q75p | 0.759 | 0.724 | 0.744 | 0.774 | 0.530 | 0.165 |
| Exporter=Importer_q90f | 0.132 | 0.020 | 0.180 | 0.001 | 0.130 | 0.739 |
| Exporter=Importer_q90p | 0.716 | 0.888 | 0.671 | 0.979 | 0.719 | 0.390 |
| Exporter=Twoway_q90f | 0.019 | 0.308 | 0.712 | 0.149 | 0.381 | 1.078 |
| Exporter=Twoway_q90p | 0.890 | 0.579 | 0.399 | 0.700 | 0.537 | 0.299 |
| Importer=Twoway_q90f | 0.293 | 0.642 | 1.035 | 0.398 | 0.463 | 0.777 |
| Importer=Twoway_q90p | 0.589 | 0.423 | 0.309 | 0.528 | 0.496 | 0.378 |

Wald test of equality of coefficients over quantiles: q_10=q_25=q_50=q_75=q_90

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F |
| Exporter | 1.754 | 1.499 | 1.697 | 2.039* | 0.280 | 0.544 |
| | 0.135 | 0.200 | 0.148 | 0.086 | 0.891 | 0.704 |
| Importer | 0.680 | 0.561 | 0.594 | 0.401 | 0.478 | 0.834 |
| | 0.606 | 0.691 | 0.667 | 0.808 | 0.752 | 0.504 |
| Twoway | 2.367* | 2.375* | 1.841 | 2.227* | 0.482 | 0.607 |
| | 0.051 | 0.050 | 0.118 | 0.064 | 0.749 | 0.658 |

# Table 7: QR: Blue collar wages

| | (1) ln_Wage q10 b/se | (1) ln_Wage q25 b/se | (1) ln_Wage q50 b/se | (1) ln_Wage q75 b/se | (1) ln_Wage q90 b/se | (2) ln_Wage q10 b/se | (2) ln_Wage q25 b/se | (2) ln_Wage q50 b/se | (2) ln_Wage q75 b/se | (2) ln_Wage q90 b/se |
|---|---|---|---|---|---|---|---|---|---|---|
| Exporter | 0.098 | 0.066 | 0.107** | 0.144** | 0.148 | 0.067 | 0.036 | 0.032 | 0.113* | 0.021 |
| | (0.062) | (0.056) | (0.049) | (0.057) | (0.099) | (0.063) | (0.054) | (0.051) | (0.059) | (0.103) |
| Importer | 0.077** | 0.093*** | 0.079*** | 0.106** | 0.150** | 0.069* | 0.065** | 0.054* | 0.068* | 0.104* |
| | (0.039) | (0.034) | (0.030) | (0.041) | (0.062) | (0.040) | (0.032) | (0.029) | (0.038) | (0.063) |
| Twoway | 0.078 | 0.116** | 0.110** | 0.090 | 0.188* | 0.072 | 0.077 | 0.109** | 0.066 | 0.212** |
| | (0.058) | (0.054) | (0.046) | (0.062) | (0.103) | (0.061) | (0.053) | (0.048) | (0.060) | (0.094) |
| Foreign | 0.160*** | 0.116*** | 0.144*** | 0.154*** | 0.150** | 0.153*** | 0.080*** | 0.117*** | 0.124*** | 0.114** |
| | (0.033) | (0.029) | (0.028) | (0.034) | (0.061) | (0.035) | (0.027) | (0.027) | (0.034) | (0.056) |
| ln_SizeEmp | | | | | | 0.025 | 0.059*** | 0.054*** | 0.064*** | 0.098*** |
| | | | | | | (0.016) | (0.011) | (0.012) | (0.014) | (0.023) |
| ln_Age | | | | | | | | | | |
| SkillRatio | | | | | | | | | | |
| ln_OutputPerHours | | | | | | | | | | |
| ln_CapitalLabourRatio | | | | | | | | | | |
| _cons | 4.698*** | 4.844*** | 4.709*** | 4.493*** | 4.089*** | 4.777*** | 4.779*** | 4.636*** | 4.367*** | 4.022*** |
| | (0.312) | (0.311) | (0.371) | (0.552) | (0.770) | (0.315) | (0.328) | (0.368) | (0.558) | (0.767) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| pr2_q10 | 0.250 | | | | | 0.251 | | | | |
| pr2_q25 | 0.247 | | | | | 0.253 | | | | |
| pr2_q50 | 0.233 | | | | | 0.239 | | | | |
| pr2_q75 | 0.199 | | | | | 0.205 | | | | |
| pr2_q90 | 0.159 | | | | | 0.168 | | | | |

| | (3) ln_Wage q10 b/se | (3) ln_Wage q25 b/se | (3) ln_Wage q50 b/se | (3) ln_Wage q75 b/se | (3) ln_Wage q90 b/se | (4) ln_Wage q10 b/se | (4) ln_Wage q25 b/se | (4) ln_Wage q50 b/se | (4) ln_Wage q75 b/se | (4) ln_Wage q90 b/se |
|---|---|---|---|---|---|---|---|---|---|---|
| Exporter | 0.068 | 0.058 | 0.052 | 0.115* | 0.027 | 0.070 | 0.045 | 0.056 | 0.064 | 0.019 |
| | (0.061) | (0.056) | (0.050) | (0.060) | (0.091) | (0.063) | (0.054) | (0.047) | (0.067) | (0.097) |
| Importer | 0.062 | 0.075** | 0.061** | 0.070* | 0.087 | 0.064 | 0.066* | 0.063** | 0.058 | 0.064 |
| | (0.040) | (0.032) | (0.030) | (0.038) | (0.060) | (0.040) | (0.034) | (0.029) | (0.038) | (0.059) |
| Twoway | 0.052 | 0.056 | 0.081* | 0.050 | 0.175* | 0.076 | 0.057 | 0.079* | 0.066 | 0.153* |
| | (0.059) | (0.056) | (0.046) | (0.061) | (0.089) | (0.061) | (0.052) | (0.041) | (0.063) | (0.093) |
| Foreign | 0.164*** | 0.087*** | 0.128*** | 0.142*** | 0.172*** | 0.167*** | 0.095*** | 0.129*** | 0.127*** | 0.168*** |
| | (0.035) | (0.026) | (0.025) | (0.032) | (0.058) | (0.037) | (0.028) | (0.025) | (0.032) | (0.056) |
| ln_SizeEmp | 0.024 | 0.049*** | 0.042*** | 0.050*** | 0.091*** | 0.027 | 0.060*** | 0.053*** | 0.072*** | 0.102*** |
| | (0.016) | (0.012) | (0.012) | (0.014) | (0.023) | (0.017) | (0.013) | (0.012) | (0.016) | (0.024) |
| ln_Age | 0.018 | 0.037** | 0.052*** | 0.057** | 0.085*** | 0.011 | 0.032* | 0.049*** | 0.058*** | 0.081*** |
| | (0.019) | (0.017) | (0.016) | (0.022) | (0.029) | (0.020) | (0.019) | (0.016) | (0.021) | (0.030) |
| SkillRatio | | | | | | 0.001 | 0.002*** | 0.003*** | 0.004*** | 0.006*** |
| | | | | | | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) |
| ln_OutputPerHours | | | | | | | | | | |
| ln_CapitalLabourRatio | | | | | | | | | | |
| _cons | 4.760*** | 4.715*** | 4.611*** | 4.374*** | 3.792*** | 4.338*** | 4.366*** | 4.809*** | 4.470*** | 3.743*** |
| | (0.364) | (0.350) | (0.385) | (0.592) | (0.755) | (0.386) | (0.382) | (0.397) | (0.431) | (0.606) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| pr2_q10 | 0.251 | | | | | 0.252 | | | | |
| pr2_q25 | 0.254 | | | | | 0.256 | | | | |
| pr2_q50 | 0.241 | | | | | 0.245 | | | | |
| pr2_q75 | 0.206 | | | | | 0.213 | | | | |
| pr2_q90 | 0.172 | | | | | 0.180 | | | | |

| | (5) ln_Wage q10 b/se | (5) ln_Wage q25 b/se | (5) ln_Wage q50 b/se | (5) ln_Wage q75 b/se | (5) ln_Wage q90 b/se | (6) ln_Wage q10 b/se | (6) ln_Wage q25 b/se | (6) ln_Wage q50 b/se | (6) ln_Wage q75 b/se | (6) ln_Wage q90 b/se |
|---|---|---|---|---|---|---|---|---|---|---|
| Exporter | -0.007 | -0.015 | 0.014 | 0.002 | -0.047 | -0.006 | -0.022 | -0.014 | -0.027 | -0.025 |
| | (0.065) | (0.056) | (0.048) | (0.065) | (0.089) | (0.069) | (0.057) | (0.047) | (0.065) | (0.089) |
| Importer | 0.053 | 0.030 | 0.018 | 0.018 | -0.009 | 0.037 | 0.019 | 0.014 | 0.001 | -0.008 |
| | (0.038) | (0.035) | (0.029) | (0.038) | (0.060) | (0.039) | (0.036) | (0.028) | (0.040) | (0.059) |
| Twoway | 0.090 | 0.071 | 0.076* | 0.067 | 0.139* | 0.065 | 0.063 | 0.083* | 0.066 | 0.099 |
| | (0.066) | (0.052) | (0.043) | (0.063) | (0.081) | (0.067) | (0.054) | (0.044) | (0.060) | (0.083) |
| Foreign | 0.083** | 0.078*** | 0.099*** | 0.126*** | 0.126** | 0.082** | 0.077*** | 0.092*** | 0.111*** | 0.095* |
| | (0.033) | (0.026) | (0.025) | (0.032) | (0.053) | (0.033) | (0.026) | (0.025) | (0.031) | (0.055) |
| ln_SizeEmp | 0.029* | 0.059*** | 0.049*** | 0.064*** | 0.084*** | 0.038** | 0.059*** | 0.053*** | 0.068*** | 0.097*** |
| | (0.018) | (0.012) | (0.012) | (0.016) | (0.022) | (0.017) | (0.013) | (0.013) | (0.017) | (0.022) |
| ln_Age | -0.001 | 0.019 | 0.035** | 0.043** | 0.092*** | -0.004 | 0.020 | 0.031* | 0.046** | 0.085*** |
| | (0.019) | (0.017) | (0.016) | (0.021) | (0.030) | (0.017) | (0.017) | (0.016) | (0.020) | (0.029) |
| SkillRatio | -0.000 | 0.001 | 0.002*** | 0.004*** | 0.005*** | 0.000 | 0.001 | 0.002*** | 0.004*** | 0.005*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) |
| ln_OutputPerHours | 0.071*** | 0.063*** | 0.058*** | 0.074*** | 0.084*** | 0.057*** | 0.051*** | 0.047*** | 0.062*** | 0.074*** |
| | (0.012) | (0.010) | (0.009) | (0.012) | (0.017) | (0.014) | (0.013) | (0.010) | (0.013) | (0.019) |
| ln_CapitalLabourRatio | | | | | | 0.012 | 0.020* | 0.031*** | 0.028** | 0.021 |
| | | | | | | (0.013) | (0.012) | (0.010) | (0.011) | (0.017) |
| _cons | 4.386*** | 4.277*** | 4.701*** | 4.234*** | 3.474*** | 4.328*** | 4.036*** | 4.431*** | 4.017*** | 3.184*** |
| | (0.366) | (0.344) | (0.368) | (0.399) | (0.551) | (0.395) | (0.366) | (0.378) | (0.427) | (0.537) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| pr2_q10 | 0.266 | | | | | 0.267 | | | | |
| pr2_q25 | 0.267 | | | | | 0.268 | | | | |
| pr2_q50 | 0.254 | | | | | 0.256 | | | | |
| pr2_q75 | 0.225 | | | | | 0.226 | | | | |
| pr2_q90 | 0.191 | | | | | 0.192 | | | | |

bootstrap standard errors (1075 replications)

Wald test of equality of coefficients on each quantile

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F |
| Exporter=Importer_q10f | 0.120 | 0.001 | 0.010 | 0.009 | 0.910 | 0.425 |
| Exporter=Importer_q10p | 0.729 | 0.978 | 0.920 | 0.925 | 0.340 | 0.515 |
| Exporter=Twoway_q10f | 0.032 | 0.002 | 0.023 | 0.003 | 0.651 | 0.332 |
| Exporter=Twoway_q10p | 0.859 | 0.967 | 0.879 | 0.955 | 0.420 | 0.564 |
| Importer=Twoway_q10f | 0.000 | 0.002 | 0.023 | 0.031 | 0.240 | 0.138 |
| Importer=Twoway_q10p | 0.983 | 0.966 | 0.880 | 0.861 | 0.624 | 0.711 |
| Exporter=Importer_q25f | 0.236 | 0.304 | 0.108 | 0.157 | 0.748 | 0.560 |
| Exporter=Importer_q25p | 0.627 | 0.581 | 0.742 | 0.692 | 0.387 | 0.455 |
| Exporter=Twoway_q25f | 0.239 | 0.180 | 0.000 | 0.015 | 0.726 | 0.688 |
| Exporter=Twoway_q25p | 0.625 | 0.672 | 0.987 | 0.901 | 0.394 | 0.407 |
| Importer=Twoway_q25f | 0.134 | 0.044 | 0.088 | 0.019 | 0.408 | 0.480 |
| Importer=Twoway_q25p | 0.714 | 0.834 | 0.767 | 0.890 | 0.523 | 0.488 |
| Exporter=Importer_q50f | 0.373 | 0.223 | 0.037 | 0.028 | 0.006 | 0.400 |
| Exporter=Importer_q50p | 0.542 | 0.637 | 0.848 | 0.866 | 0.939 | 0.527 |
| Exporter=Twoway_q50f | 0.001 | 0.730 | 0.109 | 0.086 | 0.566 | 1.359 |
| Exporter=Twoway_q50p | 0.973 | 0.393 | 0.742 | 0.769 | 0.452 | 0.244 |
| Importer=Twoway_q50f | 0.317 | 0.977 | 0.136 | 0.104 | 1.263 | 1.824 |
| Importer=Twoway_q50p | 0.573 | 0.323 | 0.712 | 0.747 | 0.261 | 0.177 |
| Exporter=Importer_q75f | 0.384 | 0.547 | 0.564 | 0.008 | 0.072 | 0.225 |
| Exporter=Importer_q75p | 0.536 | 0.460 | 0.453 | 0.928 | 0.789 | 0.635 |
| Exporter=Twoway_q75f | 0.236 | 0.182 | 0.339 | 0.000 | 0.302 | 0.676 |
| Exporter=Twoway_q75p | 0.627 | 0.670 | 0.561 | 0.986 | 0.582 | 0.411 |
| Importer=Twoway_q75f | 0.051 | 0.001 | 0.080 | 0.011 | 0.444 | 0.820 |
| Importer=Twoway_q75p | 0.822 | 0.973 | 0.778 | 0.918 | 0.505 | 0.365 |
| Exporter=Importer_q90f | 0.001 | 0.842 | 0.507 | 0.226 | 0.224 | 0.040 |
| Exporter=Importer_q90p | 0.980 | 0.359 | 0.476 | 0.634 | 0.636 | 0.842 |
| Exporter=Twoway_q90f | 0.050 | 1.157 | 0.852 | 0.605 | 1.491 | 0.632 |
| Exporter=Twoway_q90p | 0.823 | 0.282 | 0.356 | 0.437 | 0.222 | 0.427 |
| Importer=Twoway_q90f | 0.100 | 0.838 | 0.660 | 0.706 | 2.208 | 1.133 |
| Importer=Twoway_q90p | 0.752 | 0.360 | 0.417 | 0.401 | 0.137 | 0.287 |

Wald test of equality of coefficients over quantiles: q_10=q_25=q_50=q_75=q_90

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F |
| Exporter | 0.343 | 0.883 | 0.593 | 0.119 | 0.191 | 0.031 |
| | 0.849 | 0.473 | 0.668 | 0.976 | 0.943 | 0.998 |
| Importer | 0.426 | 0.209 | 0.124 | 0.009 | 0.278 | 0.142 |
| | 0.790 | 0.933 | 0.974 | 1.000 | 0.892 | 0.967 |
| Twoway | 0.447 | 1.048 | 0.798 | 0.344 | 0.246 | 0.092 |
| | 0.775 | 0.381 | 0.526 | 0.848 | 0.912 | 0.985 |

# Table 8: QR: White collar wages

| | (1) ln_Wage | | | | | (2) ln_Wage | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | q10 b/se | q25 b/se | q50 b/se | q75 b/se | q90 b/se | q10 b/se | q25 b/se | q50 b/se | q75 b/se | q90 b/se |
| Exporter | 0.321*** | 0.313*** | 0.175*** | 0.254*** | 0.240** | 0.183*** | 0.170*** | 0.103** | 0.074 | 0.117 |
| | (0.065) | (0.055) | (0.060) | (0.082) | (0.111) | (0.066) | (0.055) | (0.051) | (0.070) | (0.118) |
| Importer | 0.123*** | 0.134*** | 0.171*** | 0.164*** | 0.197*** | 0.079* | 0.097*** | 0.090*** | 0.122*** | 0.171** |
| | (0.045) | (0.037) | (0.035) | (0.042) | (0.070) | (0.045) | (0.037) | (0.033) | (0.041) | (0.073) |
| Twoway | -0.015 | -0.014 | 0.193*** | 0.139 | 0.211* | -0.030 | 0.004 | 0.128** | 0.132* | 0.115 |
| | (0.066) | (0.052) | (0.058) | (0.087) | (0.110) | (0.060) | (0.056) | (0.051) | (0.071) | (0.115) |
| Foreign | 0.224*** | 0.226*** | 0.292*** | 0.313*** | 0.316*** | 0.193*** | 0.189*** | 0.211*** | 0.229*** | 0.225*** |
| | (0.038) | (0.037) | (0.034) | (0.040) | (0.060) | (0.036) | (0.036) | (0.033) | (0.040) | (0.058) |
| ln_SizeEmp | | | | | | 0.100*** | 0.110*** | 0.123*** | 0.145*** | 0.135*** |
| | | | | | | (0.019) | (0.014) | (0.013) | (0.017) | (0.026) |
| ln_Age | | | | | | | | | | |
| SkillRatio | | | | | | | | | | |
| ln_OutputPerHours | | | | | | | | | | |
| ln_CapitalLabourRatio | | | | | | | | | | |
| _cons | 5.751*** | 5.607*** | 5.344*** | 5.245*** | 4.999*** | 5.360*** | 5.514*** | 5.151*** | 4.903*** | 4.759*** |
| | (0.428) | (0.373) | (0.430) | (0.507) | (0.632) | (0.458) | (0.341) | (0.330) | (0.432) | (0.553) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| pr2_q10 | 0.236 | | | | | 0.248 | | | | |
| pr2_q25 | 0.252 | | | | | 0.268 | | | | |
| pr2_q50 | 0.261 | | | | | 0.282 | | | | |
| pr2_q75 | 0.233 | | | | | 0.254 | | | | |
| pr2_q90 | 0.186 | | | | | 0.201 | | | | |

| | (3) ln_Wage | | | | | (4) ln_Wage | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | q10 b/se | q25 b/se | q50 b/se | q75 b/se | q90 b/se | q10 b/se | q25 b/se | q50 b/se | q75 b/se | q90 b/se |
| Exporter | 0.203*** | 0.189*** | 0.105** | 0.078 | 0.128 | 0.216*** | 0.189*** | 0.107** | 0.104 | 0.086 |
| | (0.068) | (0.056) | (0.051) | (0.071) | (0.119) | (0.068) | (0.056) | (0.051) | (0.070) | (0.114) |
| Importer | 0.096** | 0.091** | 0.092*** | 0.140*** | 0.164** | 0.083* | 0.092** | 0.094*** | 0.141*** | 0.136** |
| | (0.045) | (0.037) | (0.034) | (0.041) | (0.069) | (0.046) | (0.037) | (0.034) | (0.043) | (0.068) |
| Twoway | -0.046 | -0.028 | 0.126** | 0.140* | 0.104 | -0.040 | -0.030 | 0.126** | 0.130* | 0.112 |
| | (0.060) | (0.055) | (0.054) | (0.072) | (0.118) | (0.063) | (0.055) | (0.054) | (0.070) | (0.115) |
| Foreign | 0.197*** | 0.201*** | 0.212*** | 0.226*** | 0.263*** | 0.192*** | 0.204*** | 0.215*** | 0.227*** | 0.257*** |
| | (0.038) | (0.038) | (0.033) | (0.040) | (0.061) | (0.037) | (0.036) | (0.032) | (0.040) | (0.061) |
| ln_SizeEmp | 0.091*** | 0.105*** | 0.121*** | 0.141*** | 0.125*** | 0.084*** | 0.107*** | 0.122*** | 0.141*** | 0.163*** |
| | (0.020) | (0.014) | (0.013) | (0.017) | (0.025) | (0.020) | (0.015) | (0.014) | (0.017) | (0.026) |
| ln_Age | 0.012 | 0.021 | 0.012 | 0.032 | 0.065 | 0.011 | 0.019 | 0.012 | 0.035 | 0.029 |
| | (0.024) | (0.022) | (0.018) | (0.023) | (0.042) | (0.024) | (0.023) | (0.018) | (0.023) | (0.039) |
| SkillRatio | | | | | | -0.002 | -0.000 | 0.000 | 0.001 | 0.004*** |
| | | | | | | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| ln_OutputPerHours | | | | | | | | | | |
| ln_CapitalLabourRatio | | | | | | | | | | |
| _cons | 5.343*** | 5.553*** | 5.124*** | 4.884*** | 4.652*** | 5.738*** | 5.881*** | 5.947*** | 5.566*** | 5.023*** |
| | (0.466) | (0.360) | (0.311) | (0.392) | (0.512) | (0.505) | (0.384) | (0.371) | (0.355) | (0.381) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| pr2_q10 | 0.248 | | | | | 0.250 | | | | |
| pr2_q25 | 0.268 | | | | | 0.268 | | | | |
| pr2_q50 | 0.282 | | | | | 0.282 | | | | |
| pr2_q75 | 0.255 | | | | | 0.255 | | | | |
| pr2_q90 | 0.202 | | | | | 0.205 | | | | |

| | (5) ln_Wage | | | | | (6) ln_Wage | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | q10 b/se | q25 b/se | q50 b/se | q75 b/se | q90 b/se | q10 b/se | q25 b/se | q50 b/se | q75 b/se | q90 b/se |
| Exporter | 0.110* | 0.082 | 0.036 | 0.024 | 0.005 | 0.090 | 0.081 | 0.026 | 0.008 | -0.011 |
| | (0.064) | (0.057) | (0.059) | (0.067) | (0.130) | (0.063) | (0.056) | (0.062) | (0.067) | (0.132) |
| Importer | 0.005 | 0.033 | 0.049 | 0.076* | 0.069 | -0.010 | 0.032 | 0.044 | 0.068 | 0.059 |
| | (0.041) | (0.036) | (0.037) | (0.046) | (0.066) | (0.039) | (0.034) | (0.035) | (0.045) | (0.064) |
| Twoway | -0.084 | -0.001 | 0.087 | 0.131* | 0.061 | -0.080 | -0.004 | 0.092 | 0.142** | 0.073 |
| | (0.061) | (0.056) | (0.059) | (0.067) | (0.128) | (0.061) | (0.056) | (0.060) | (0.063) | (0.122) |
| Foreign | 0.125*** | 0.124*** | 0.182*** | 0.196*** | 0.174*** | 0.126*** | 0.123*** | 0.175*** | 0.194*** | 0.163*** |
| | (0.037) | (0.036) | (0.034) | (0.041) | (0.057) | (0.035) | (0.036) | (0.033) | (0.039) | (0.058) |
| ln_SizeEmp | 0.095*** | 0.092*** | 0.114*** | 0.133*** | 0.159*** | 0.097*** | 0.092*** | 0.110*** | 0.128*** | 0.159*** |
| | (0.017) | (0.014) | (0.015) | (0.018) | (0.024) | (0.017) | (0.014) | (0.015) | (0.017) | (0.025) |
| ln_Age | -0.005 | 0.009 | 0.017 | 0.016 | 0.025 | -0.012 | 0.009 | 0.014 | 0.009 | 0.030 |
| | (0.022) | (0.022) | (0.018) | (0.023) | (0.035) | (0.021) | (0.022) | (0.018) | (0.025) | (0.036) |
| SkillRatio | -0.003*** | -0.001* | -0.001* | 0.000 | 0.001 | -0.003*** | -0.001 | -0.002* | 0.000 | 0.000 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) |
| ln_OutputPerHours | 0.119*** | 0.099*** | 0.090*** | 0.095*** | 0.121*** | 0.113*** | 0.098*** | 0.088*** | 0.096*** | 0.114*** |
| | (0.017) | (0.013) | (0.011) | (0.014) | (0.019) | (0.018) | (0.014) | (0.012) | (0.017) | (0.021) |
| ln_CapitalLabourRatio | | | | | | 0.010 | 0.001 | 0.010 | 0.016 | 0.016 |
| | | | | | | (0.015) | (0.012) | (0.010) | (0.016) | (0.023) |
| _cons | 5.952*** | 5.729*** | 5.659*** | 5.209*** | 4.916*** | 5.925*** | 5.718*** | 5.588*** | 5.037*** | 4.738*** |
| | (0.399) | (0.323) | (0.315) | (0.328) | (0.363) | (0.412) | (0.339) | (0.312) | (0.355) | (0.436) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| pr2_q10 | 0.277 | | | | | 0.277 | | | | |
| pr2_q25 | 0.288 | | | | | 0.288 | | | | |
| pr2_q50 | 0.296 | | | | | 0.296 | | | | |
| pr2_q75 | 0.271 | | | | | 0.271 | | | | |
| pr2_q90 | 0.224 | | | | | 0.224 | | | | |

bootstrap standard errors (1075 replications)

Wald test of equality of coefficients on each quantile

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F |
| Exporter=Importerq10f | 9.317*** | 2.876* | 2.845* | 4.033** | 2.660 | 2.543 |
| Exporter=Importerq10p | 0.002 | 0.090 | 0.092 | 0.045 | 0.103 | 0.111 |
| Exporter=Twowayq10f | 8.104*** | 3.657* | 4.827* | 4.960** | 2.836* | 2.219 |
| Exporter=Twowayq10p | 0.004 | 0.056 | 0.028 | 0.026 | 0.092 | 0.136 |
| Importer=Twowayq10f | 3.322* | 2.165 | 3.775* | 2.764* | 1.594 | 1.018 |
| Importer=Twowayq10p | 0.068 | 0.141 | 0.052 | 0.097 | 0.207 | 0.313 |
| Exporter=Importerq25f | 12.035*** | 1.857 | 3.539* | 3.257* | 0.765 | 0.872 |
| Exporter=Importerq25p | 0.001 | 0.173 | 0.060 | 0.071 | 0.382 | 0.350 |
| Exporter=Twowayq25f | 11.859*** | 2.861* | 4.919** | 4.954** | 0.690 | 0.736 |
| Exporter=Twowayq25p | 0.001 | 0.091 | 0.027 | 0.026 | 0.406 | 0.391 |
| Importer=Twowayq25f | 5.532** | 1.990 | 3.185* | 3.513* | 0.274 | 0.292 |
| Importer=Twowayq25p | 0.019 | 0.158 | 0.074 | 0.061 | 0.601 | 0.589 |
| Exporter=Importerq50f | 0.004 | 0.070 | 0.079 | 0.069* | 0.052 | 0.086 |
| Exporter=Importerq50p | 0.949 | 0.791 | 0.779 | 0.792 | 0.820 | 0.770 |
| Exporter=Twowayq50f | 0.027 | 0.080 | 0.052 | 0.040** | 0.222 | 0.349 |
| Exporter=Twowayq50p | 0.870 | 0.777 | 0.820 | 0.841 | 0.637 | 0.555 |
| Importer=Twowayq50f | 0.102 | 0.413 | 0.298 | 0.254 | 0.317 | 0.511 |
| Importer=Twowayq50p | 0.750 | 0.521 | 0.585 | 0.614 | 0.574 | 0.475 |
| Exporter=Importerq75f | 1.224 | 0.509 | 0.825 | 0.287 | 0.579 | 0.860 |
| Exporter=Importerq75p | 0.269 | 0.476 | 0.364 | 0.592 | 0.447 | 0.354 |
| Exporter=Twowayq75f | 0.536 | 0.210 | 0.231 | 0.040 | 0.784 | 1.383 |
| Exporter=Twowayq75p | 0.464 | 0.647 | 0.631 | 0.841 | 0.376 | 0.240 |
| Importer=Twowayq75f | 0.069 | 0.016 | 0.000 | 0.019 | 0.483 | 0.966 |
| Importer=Twowayq75p | 0.793 | 0.901 | 0.999 | 0.891 | 0.487 | 0.326 |
| Exporter=Importerq90f | 0.159 | 0.212 | 0.092 | 0.194 | 0.253 | 0.306 |
| Exporter=Importerq90p | 0.691 | 0.645 | 0.761 | 0.659 | 0.615 | 0.580 |
| Exporter=Twowayq90f | 0.021 | 0.000 | 0.011 | 0.015 | 0.052 | 0.122 |
| Exporter=Twowayq90p | 0.886 | 0.992 | 0.915 | 0.903 | 0.819 | 0.726 |
| Importer=Twowayq90f | 0.011 | 0.160 | 0.188 | 0.032 | 0.003 | 0.009 |
| Importer=Twowayq90p | 0.915 | 0.689 | 0.664 | 0.859 | 0.958 | 0.922 |

Wald test of equality of coefficients over quantiles: q_10=q_25=q_50=q_75=q_90

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F |
| Exporter | 1.879 | 0.638 | 0.855 | 0.812 | 0.357 | 0.357 |
| | 0.111 | 0.636 | 0.491 | 0.517 | 0.839 | 0.840 |
| Importer | 0.409 | 0.424 | 0.562 | 0.446 | 0.422 | 0.556 |
| | 0.802 | 0.792 | 0.690 | 0.775 | 0.793 | 0.695 |
| Twoway | 3.879*** | 1.922 | 2.546 | 2.451** | 2.048* | 2.225** |
| | 0.004 | 0.104 | 0.038 | 0.044 | 0.085 | 0.064 |

# Table 9: QR: Wage ratios

| | (1) Wage Ratio | | | | | (2) Wage Ratio | | | | | (3) Wage Ratio | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | q10 | q25 | q50 | q75 | q90 | q10 | q25 | q50 | q75 | q90 | q10 | q25 | q50 | q75 | q90 |
| | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se |
| Exporter | 0.223** | 0.161* | 0.331*** | 0.337* | 0.335 | 0.157 | 0.108 | 0.168 | 0.202 | 0.360 | 0.144 | 0.114 | 0.155 | 0.205 | 0.181 |
| | (0.090) | (0.082) | (0.127) | (0.176) | (0.371) | (0.097) | (0.082) | (0.135) | (0.189) | (0.371) | (0.100) | (0.080) | (0.139) | (0.191) | (0.387) |
| Importer | 0.039 | 0.060 | 0.063 | 0.173 | 0.403* | -0.023 | 0.000 | 0.018 | 0.122 | 0.217 | -0.025 | 0.002 | 0.016 | 0.095 | 0.164 |
| | (0.050) | (0.043) | (0.059) | (0.112) | (0.208) | (0.048) | (0.046) | (0.059) | (0.116) | (0.219) | (0.047) | (0.045) | (0.058) | (0.117) | (0.227) |
| Twoway | -0.133 | -0.050 | -0.123 | 0.010 | 0.811* | -0.132 | -0.110 | -0.112 | -0.025 | 0.565 | -0.117 | -0.108 | -0.114 | -0.009 | 0.550 |
| | (0.088) | (0.082) | (0.124) | (0.182) | (0.444) | (0.095) | (0.087) | (0.129) | (0.211) | (0.476) | (0.098) | (0.088) | (0.134) | (0.210) | (0.466) |
| Foreign | 0.101** | 0.202*** | 0.296*** | 0.427*** | 0.681*** | 0.101** | 0.147*** | 0.228*** | 0.323*** | 0.446** | 0.106** | 0.146*** | 0.206*** | 0.280*** | 0.536** |
| | (0.046) | (0.049) | (0.064) | (0.111) | (0.217) | (0.043) | (0.048) | (0.065) | (0.106) | (0.203) | (0.045) | (0.050) | (0.067) | (0.107) | (0.211) |
| ln_SizeEmp | | | | | | 0.045*** | 0.074*** | 0.120*** | 0.215*** | 0.335*** | 0.049*** | 0.073*** | 0.137*** | 0.222*** | 0.343*** |
| | | | | | | (0.014) | (0.020) | (0.027) | (0.054) | (0.091) | (0.015) | (0.020) | (0.029) | (0.054) | (0.101) |
| ln_Age | | | | | | | | | | | -0.008 | -0.009 | -0.037 | -0.072 | -0.159 |
| | | | | | | | | | | | (0.023) | (0.027) | (0.034) | (0.065) | (0.122) |
| SkillRatio | | | | | | | | | | | | | | | |
| ln_OutputPerHours | | | | | | | | | | | | | | | |
| ln_CapitalLabourRatio | | | | | | | | | | | | | | | |
| _cons | 2.722*** | 2.616*** | 2.248** | 2.663** | 1.063 | 2.588*** | 2.684*** | 2.258** | 1.974* | 0.508 | 2.593*** | 2.664*** | 2.361** | 2.168* | 0.641 |
| | (0.919) | (0.840) | (0.908) | (1.229) | (1.503) | (0.943) | (0.849) | (0.882) | (1.187) | (1.516) | (0.952) | (0.896) | (0.970) | (1.211) | (1.476) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| pr2_q10 | 0.051 | | | | | 0.054 | | | | | 0.054 | | | | |
| pr2_q25 | 0.057 | | | | | 0.060 | | | | | 0.060 | | | | |
| pr2_q50 | 0.069 | | | | | 0.074 | | | | | 0.074 | | | | |
| pr2_q75 | 0.077 | | | | | 0.084 | | | | | 0.084 | | | | |
| pr2_q90 | 0.098 | | | | | 0.104 | | | | | 0.106 | | | | |

| | (4) Wage Ratio | | | | | (5) Wage Ratio | | | | | (6) Wage Ratio | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | q10 | q25 | q50 | q75 | q90 | q10 | q25 | q50 | q75 | q90 | q10 | q25 | q50 | q75 | q90 |
| | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se |
| Exporter | 0.175** | 0.110 | 0.200 | 0.253 | 0.217 | 0.159* | 0.094 | 0.182 | 0.199 | -0.027 | 0.164* | 0.088 | 0.197 | 0.223 | 0.050 |
| | (0.081) | (0.078) | (0.131) | (0.202) | (0.367) | (0.092) | (0.078) | (0.130) | (0.211) | (0.401) | (0.085) | (0.075) | (0.127) | (0.194) | (0.408) |
| Importer | -0.032 | 0.035 | 0.024 | 0.095 | 0.168 | -0.029 | 0.004 | 0.005 | 0.041 | 0.017 | -0.048 | 0.006 | 0.024 | 0.034 | 0.065 |
| | (0.050) | (0.041) | (0.058) | (0.122) | (0.242) | (0.051) | (0.041) | (0.060) | (0.117) | (0.232) | (0.051) | (0.040) | (0.060) | (0.121) | (0.229) |
| Twoway | -0.168** | -0.060 | -0.155 | -0.099 | 0.509 | -0.169* | -0.088 | -0.164 | -0.073 | 0.620 | -0.174** | -0.078 | -0.164 | -0.122 | 0.639 |
| | (0.081) | (0.083) | (0.124) | (0.211) | (0.429) | (0.088) | (0.082) | (0.122) | (0.214) | (0.480) | (0.085) | (0.079) | (0.117) | (0.205) | (0.473) |
| Foreign | 0.110** | 0.145*** | 0.204*** | 0.330*** | 0.436** | 0.096** | 0.138*** | 0.184*** | 0.268** | 0.509** | 0.098** | 0.145*** | 0.179*** | 0.266** | 0.472** |
| | (0.048) | (0.049) | (0.068) | (0.107) | (0.207) | (0.047) | (0.047) | (0.061) | (0.112) | (0.226) | (0.049) | (0.047) | (0.063) | (0.110) | (0.220) |
| ln_SizeEmp | 0.039** | 0.057*** | 0.105*** | 0.207*** | 0.369*** | 0.036** | 0.051*** | 0.090*** | 0.199*** | 0.327*** | 0.032* | 0.050*** | 0.099*** | 0.217*** | 0.348*** |
| | (0.016) | (0.019) | (0.029) | (0.055) | (0.101) | (0.018) | (0.018) | (0.031) | (0.055) | (0.104) | (0.018) | (0.017) | (0.030) | (0.055) | (0.106) |
| ln_Age | -0.011 | 0.008 | -0.008 | -0.054 | -0.156 | -0.007 | 0.005 | -0.018 | -0.095 | -0.134 | -0.009 | 0.006 | -0.018 | -0.087 | -0.159 |
| | (0.022) | (0.025) | (0.035) | (0.069) | (0.121) | (0.023) | (0.025) | (0.036) | (0.072) | (0.122) | (0.023) | (0.024) | (0.038) | (0.069) | (0.125) |
| SkillRatio | -0.003*** | -0.005*** | -0.006*** | -0.006** | -0.004 | -0.004*** | -0.006*** | -0.006*** | -0.008*** | -0.006 | -0.004*** | -0.006*** | -0.006*** | -0.007*** | -0.004 |
| | (0.001) | (0.001) | (0.001) | (0.003) | (0.005) | (0.001) | (0.001) | (0.001) | (0.003) | (0.005) | (0.001) | (0.001) | (0.001) | (0.003) | (0.005) |
| ln_OutputPerHours | | | | | | 0.015 | 0.040*** | 0.058*** | 0.118*** | 0.162** | 0.016 | 0.047*** | 0.066*** | 0.134*** | 0.154** |
| | | | | | | (0.016) | (0.013) | (0.020) | (0.032) | (0.068) | (0.017) | (0.015) | (0.021) | (0.037) | (0.075) |
| ln_CapitalLabourRatio | | | | | | | | | | | 0.008 | -0.019 | -0.023 | -0.059* | -0.058 |
| | | | | | | | | | | | (0.015) | (0.013) | (0.019) | (0.032) | (0.069) |
| _cons | 3.235*** | 3.670*** | 3.369*** | 4.829*** | 3.047** | 3.206*** | 3.550*** | 3.243*** | 4.732*** | 2.426 | 3.134*** | 3.677*** | 3.431*** | 5.321*** | 3.010* |
| | (1.092) | (1.025) | (1.108) | (1.278) | (1.289) | (1.134) | (1.083) | (1.134) | (1.355) | (1.525) | (1.095) | (1.036) | (1.107) | (1.235) | (1.551) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| pr2_q10 | 0.058 | | | | | 0.059 | | | | | 0.059 | | | | |
| pr2_q25 | 0.066 | | | | | 0.068 | | | | | 0.068 | | | | |
| pr2_q50 | 0.077 | | | | | 0.079 | | | | | 0.080 | | | | |
| pr2_q75 | 0.085 | | | | | 0.088 | | | | | 0.090 | | | | |
| pr2_q90 | 0.106 | | | | | 0.109 | | | | | 0.109 | | | | |

bootstrap standard errors (1075 replications)

Wald test of equality of coefficients on each quantile

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F | F(1,n-k) / Prob > F |
| Exporter=Importer_q10f | 4.534** | 3.606* | 3.018 | 6.817*** | 4.938** | 6.581** |
| Exporter=Importer_q10p | 0.033 | 0.058 | 0.082 | 0.009 | 0.026 | 0.010 |
| Exporter=Twoway_q10f | 4.401* | 2.462 | 1.873 | 5.353** | 3.854 | 4.617** |
| Exporter=Twoway_q10p | 0.036 | 0.117 | 0.171 | 0.021 | 0.050 | 0.032 |
| Importer=Twoway_q10f | 2.831* | 1.077 | 0.727 | 2.269 | 1.946 | 1.780 |
| Importer=Twoway_q10p | 0.093 | 0.300 | 0.394 | 0.132 | 0.163 | 0.182 |
| Exporter=Importer_q25f | 1.592 | 1.756 | 1.945 | 0.925 | 1.298 | 1.121 |
| Exporter=Importer_q25p | 0.207 | 0.185 | 0.163 | 0.336 | 0.255 | 0.290 |
| Exporter=Twoway_q25f | 1.920 | 1.973 | 2.061 | 1.285 | 1.519 | 1.364 |
| Exporter=Twoway_q25p | 0.166 | 0.160 | 0.151 | 0.257 | 0.218 | 0.243 |
| Importer=Twoway_q25f | 1.408 | 1.342 | 1.330 | 1.079 | 1.054 | 0.952 |
| Importer=Twoway_q25p | 0.236 | 0.247 | 0.249 | 0.299 | 0.305 | 0.329 |
| Exporter=Importer_q50f | 4.810 | 1.353 | 1.096 | 1.831 | 1.939 | 2.047 |
| Exporter=Importer_q50p | 0.028 | 0.245 | 0.295 | 0.176 | 0.164 | 0.153 |
| Exporter=Twoway_q50f | 3.695* | 1.259 | 1.086 | 2.178 | 2.148 | 2.478 |
| Exporter=Twoway_q50p | 0.055 | 0.262 | 0.297 | 0.140 | 0.143 | 0.116 |
| Importer=Twoway_q50f | 1.844 | 0.823 | 0.780 | 1.788 | 1.584 | 1.960 |
| Importer=Twoway_q50p | 0.175 | 0.364 | 0.377 | 0.181 | 0.208 | 0.162 |
| Exporter=Importer_q75f | 0.842 | 0.173 | 0.342 | 0.615 | 0.549 | 0.971 |
| Exporter=Importer_q75p | 0.359 | 0.677 | 0.559 | 0.433 | 0.459 | 0.325 |
| Exporter=Twoway_q75f | 1.083 | 0.396 | 0.360 | 0.892 | 0.499 | 0.909 |
| Exporter=Twoway_q75p | 0.298 | 0.529 | 0.549 | 0.345 | 0.480 | 0.340 |
| Importer=Twoway_q75f | 0.602 | 0.380 | 0.180 | 0.656 | 0.220 | 0.406 |
| Importer=Twoway_q75p | 0.438 | 0.537 | 0.671 | 0.418 | 0.639 | 0.524 |
| Exporter=Importer_q90f | 0.030 | 0.145 | 0.002 | 0.018 | 0.012 | 0.002 |
| Exporter=Importer_q90p | 0.863 | 0.704 | 0.965 | 0.894 | 0.911 | 0.968 |
| Exporter=Twoway_q90f | 0.406 | 0.072 | 0.233 | 0.177 | 0.670 | 0.545 |
| Exporter=Twoway_q90p | 0.524 | 0.789 | 0.629 | 0.674 | 0.413 | 0.461 |
| Importer=Twoway_q90f | 0.739 | 0.456 | 0.574 | 0.521 | 1.337 | 1.201 |
| Importer=Twoway_q90p | 0.390 | 0.500 | 0.449 | 0.471 | 0.248 | 0.273 |

Wald test of equality of coefficients over quantiles: q_10=q_25=q_50=q_75=q_90

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F | F(4,n-k) / Prob > F |
| Exporter | 0.721 | 0.214 | 0.091 | 0.330 | 0.415 | 0.513 |
| | 0.577 | 0.931 | 0.985 | 0.858 | 0.798 | 0.726 |
| Importer | 0.854 | 0.440 | 0.286 | 0.651 | 0.149 | 0.382 |
| | 0.491 | 0.780 | 0.887 | 0.626 | 0.963 | 0.822 |
| Twoway | 1.601 | 0.583 | 0.556 | 1.184 | 1.085 | 1.282 |
| | 0.171 | 0.675 | 0.695 | 0.316 | 0.362 | 0.275 |

# Table 10: Mean decomposition

| | ln_Wage_avg | | | | ln_WageWhiteCollar | | | | ln_WageBlueCollar | | | | WhiteToBlue | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | overall | endowments | coefficients | interaction | overall | endowments | coefficients | interaction | overall | endowments | coefficients | interaction | overall | endowments | coefficients | interaction |
| | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se |
| group_1 | 7.620*** | | | | 5.508*** | | | | 4.827*** | | | | 2.448*** | | | |
| | (0.030) | | | | (0.027) | | | | (0.027) | | | | (0.082) | | | |
| group_2 | 7.838*** | | | | 5.847*** | | | | 5.017*** | | | | 2.821*** | | | |
| | (0.020) | | | | (0.020) | | | | (0.020) | | | | (0.054) | | | |
| difference | -0.217*** | | | | -0.338*** | | | | -0.190*** | | | | -0.373*** | | | |
| | (0.036) | | | | (0.034) | | | | (0.033) | | | | (0.098) | | | |
| endowments | -0.170*** | | | | -0.256*** | | | | -0.168*** | | | | -0.295*** | | | |
| | (0.022) | | | | (0.021) | | | | (0.020) | | | | (0.052) | | | |
| coefficients | -0.002 | | | | -0.072* | | | | -0.018 | | | | -0.177 | | | |
| | (0.045) | | | | (0.043) | | | | (0.045) | | | | (0.113) | | | |
| interaction | -0.045 | | | | -0.011 | | | | -0.004 | | | | 0.099 | | | |
| | (0.033) | | | | (0.031) | | | | (0.033) | | | | (0.091) | | | |
| Foreign | | -0.042*** | 0.057 | -0.030 | | -0.052*** | 0.084** | -0.044** | | -0.031*** | 0.068* | -0.036* | | -0.065** | 0.089 | -0.047 |
| | | (0.009) | (0.036) | (0.019) | | (0.010) | (0.034) | (0.018) | | (0.009) | (0.035) | (0.019) | | (0.026) | (0.112) | (0.059) |
| ln_SizeEmp | | 0.005 | -0.005 | 0.001 | | -0.038** | -0.012 | 0.002 | | -0.009 | -0.005 | 0.001 | | -0.108** | -0.223 | 0.047 |
| | | (0.016) | (0.155) | (0.033) | | (0.016) | (0.129) | (0.027) | | (0.017) | (0.129) | (0.027) | | (0.043) | (0.370) | (0.078) |
| ln_Age | | -0.021*** | -0.189 | 0.013 | | -0.018*** | -0.141 | 0.009 | | -0.026*** | -0.278** | 0.019** | | 0.026** | 0.356 | -0.024 |
| | | (0.006) | (0.129) | (0.009) | | (0.006) | (0.116) | (0.008) | | (0.007) | (0.121) | (0.009) | | (0.013) | (0.341) | (0.023) |
| SkillRatio | | 0.026*** | -0.044 | -0.005 | | -0.010* | 0.087 | 0.010 | | 0.010* | -0.083 | -0.010 | | -0.050*** | 0.799*** | 0.094*** |
| | | (0.008) | (0.069) | (0.008) | | (0.005) | (0.060) | (0.007) | | (0.005) | (0.058) | (0.007) | | (0.019) | (0.244) | (0.036) |
| ln_OutputPerHours | | -0.130*** | 0.012 | -0.004 | | -0.150*** | -0.093 | 0.032 | | -0.091*** | -0.030 | 0.010 | | -0.217*** | -0.420** | 0.143** |
| | | (0.018) | (0.079) | (0.027) | | (0.019) | (0.072) | (0.024) | | (0.016) | (0.064) | (0.022) | | (0.050) | (0.207) | (0.071) |
| ln_CapitalLabourRatio | | -0.008 | 0.307 | -0.020 | | 0.012 | 0.319 | -0.021 | | -0.022** | -0.170 | 0.011 | | 0.119*** | 1.756*** | -0.115*** |
| | | (0.009) | (0.260) | (0.017) | | (0.010) | (0.247) | (0.016) | | (0.009) | (0.228) | (0.015) | | (0.030) | (0.595) | (0.041) |
| _cons | | | -0.140 | | | | -0.316 | | | | 0.480* | | | | -2.534*** | |
| | | | (0.270) | | | | (0.259) | | | | (0.258) | | | | (0.610) | |
| Observations_NoTrade | 853 | | | | 853 | | | | 853 | | | | 853 | | | |
| Observations_Trade | 1885 | | | | 1885 | | | | 1885 | | | | 1885 | | | |

robust standard errors in parantheses. *** p<0.01, ** p<0.05, * p<0.1

# Table 11: Quantile decomposition

| | (1)<br>Average Wages<br>b/se/ci95 | (2)<br>Blue Collar Wages<br>b/se/ci95 | (3)<br>White Collar Wages<br>b/se/ci95 | (4)<br>Wage Ratio<br>b/se/ci95 |
|---|---|---|---|---|
| Differences between observable distributions | | | | |
| Distributionsq10 | -0.234*** | -0.125*** | -0.260*** | -0.121*** |
| | (0.047) | (0.038) | (0.038) | (0.034) |
| | [-0.326,-0.141] | [-0.200,-0.050] | [-0.335,-0.185] | [-0.188,-0.054] |
| Distributionsq25 | -0.220*** | -0.188*** | -0.303*** | -0.142*** |
| | (0.033) | (0.031) | (0.034) | (0.035) |
| | [-0.285,-0.154] | [-0.249,-0.128] | [-0.370,-0.236] | [-0.210,-0.073] |
| Distributionsq50 | -0.235*** | -0.212*** | -0.382*** | -0.296*** |
| | (0.032) | (0.029) | (0.036) | (0.054) |
| | [-0.298,-0.172] | [-0.268,-0.156] | [-0.453,-0.312] | [-0.402,-0.191] |
| Distributionsq75 | -0.202*** | -0.213*** | -0.381*** | -0.618*** |
| | (0.045) | (0.041) | (0.048) | (0.092) |
| | [-0.291,-0.114] | [-0.292,-0.133] | [-0.476,-0.286] | [-0.798,-0.438] |
| Distributionsq90 | -0.092 | -0.127* | -0.329*** | -0.840*** |
| | (0.070) | (0.066) | (0.062) | (0.211) |
| | [-0.229,0.045] | [-0.256,0.002] | [-0.450,-0.207] | [-1.252,-0.427] |
| Effect of characteristics | | | | |
| Characteristics_q10 | -0.207*** | -0.122*** | -0.212*** | -0.082*** |
| | (0.033) | (0.029) | (0.033) | (0.030) |
| | [-0.272,-0.142] | [-0.178,-0.066] | [-0.278,-0.146] | [-0.140,-0.024] |
| Characteristics_q25 | -0.190*** | -0.159*** | -0.231*** | -0.151*** |
| | (0.029) | (0.025) | (0.031) | (0.030) |
| | [-0.247,-0.133] | [-0.208,-0.110] | [-0.291,-0.170] | [-0.209,-0.093] |
| Characteristics_q50 | -0.191*** | -0.151*** | -0.263*** | -0.194*** |
| | (0.029) | (0.022) | (0.032) | (0.042) |
| | [-0.247,-0.135] | [-0.195,-0.108] | [-0.324,-0.201] | [-0.277,-0.112] |
| Characteristics_q75 | -0.206*** | -0.177*** | -0.306*** | -0.249*** |
| | (0.034) | (0.030) | (0.035) | (0.073) |
| | [-0.273,-0.140] | [-0.236,-0.117] | [-0.375,-0.237] | [-0.393,-0.105] |
| Characteristics_q90 | -0.206*** | -0.189*** | -0.317*** | -0.342** |
| | (0.051) | (0.049) | (0.049) | (0.169) |
| | [-0.305,-0.106] | [-0.285,-0.093] | [-0.414,-0.220] | [-0.672,-0.012] |
| Effect of coefficients | | | | |
| Coefficients_q10 | -0.050 | -0.014 | -0.128*** | -0.089 |
| | (0.041) | (0.031) | (0.048) | (0.074) |
| | [-0.131,0.031] | [-0.076,0.048] | [-0.222,-0.033] | [-0.233,0.056] |
| Coefficients_q25 | -0.069* | -0.021 | -0.140*** | -0.107 |
| | (0.040) | (0.033) | (0.051) | (0.075) |
| | [-0.147,0.009] | [-0.085,0.043] | [-0.240,-0.040] | [-0.255,0.040] |
| Coefficients_q50 | -0.092** | -0.053 | -0.152*** | -0.173** |
| | (0.045) | (0.035) | (0.057) | (0.085) |
| | [-0.179,-0.004] | [-0.121,0.015] | [-0.263,-0.040] | [-0.339,-0.006] |
| Coefficients_q75 | -0.101* | -0.080* | -0.133* | -0.164* |
| | (0.053) | (0.042) | (0.069) | (0.098) |
| | [-0.204,0.002] | [-0.162,0.001] | [-0.267,0.001] | [-0.356,0.027] |
| Coefficients_q90 | -0.105* | -0.094** | -0.141* | -0.171* |
| | (0.061) | (0.046) | (0.077) | (0.100) |
| | [-0.225,0.015] | [-0.183,-0.005] | [-0.292,0.010] | [-0.367,0.025] |
| Effect of residuals | | | | |
| Residuals_q10 | 0.023 | 0.011 | 0.080* | 0.049 |
| | (0.041) | (0.038) | (0.048) | (0.070) |
| | [-0.056,0.103] | [-0.064,0.085] | [-0.014,0.173] | [-0.088,0.187] |
| Residuals_q25 | 0.039 | -0.008 | 0.068* | 0.116** |
| | (0.029) | (0.026) | (0.040) | (0.059) |
| | [-0.019,0.096] | [-0.060,0.044] | [-0.012,0.147] | [0.001,0.232] |
| Residuals_q50 | 0.047* | -0.008 | 0.032 | 0.070* |
| | (0.024) | (0.020) | (0.031) | (0.039) |
| | [-0.000,0.095] | [-0.047,0.031] | [-0.029,0.092] | [-0.007,0.148] |
| Residuals_q75 | 0.105*** | 0.044 | 0.058 | -0.205** |
| | (0.035) | (0.036) | (0.043) | (0.090) |
| | [0.035,0.174] | [-0.026,0.114] | [-0.027,0.143] | [-0.381,-0.029] |
| Residuals_q90 | 0.218*** | 0.156** | 0.129* | -0.326 |
| | (0.070) | (0.072) | (0.077) | (0.283) |
| | [0.081,0.355] | [0.014,0.298] | [-0.022,0.281] | [-0.881,0.229] |
| Observations_NoTrade | 853 | 853 | 853 | 853 |
| Observations_Trade | 1885 | 1885 | 1885 | 1885 |

bootstrap standard errors (1075 replications). Pointwise confidence intervals

# Table 12: Bootstrap inference

| Null-hypothesis | Average Wages P-values KS-statistic | Average Wages P-values CMS-statistic | Blue Collar Wages P-values KS-statistic | Blue Collar Wages P-values CMS-statistic | White Collar Wages P-values KS-statistic | White Collar Wages P-values CMS-statistic | Wage Ratio P-values KS-statistic | Wage Ratio P-values CMS-statistic |
|---|---|---|---|---|---|---|---|---|
| Correct specification of the parametric model 0 | .40186 | .375814 | .943256 | .898605 | .76 | .504186 | .48 | .556279 |
| Correct specification of the parametric model 1 | .623256 | .572093 | .698605 | .446512 | .531163 | .464186 | .389767 | .523721 |
| Differences between the observable distributions | | | | | | | | |
| No effect: QE(tau)=0 for all taus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Constant effect: QE(tau)=QE(0.5) for all taus | .055814 | .151628 | .097674 | .105116 | .017674 | .011163 | 0 | 0 |
| Stochastic dominance: QE(tau)¿0 for all taus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Stochastic dominance: QE(tau)¡0 for all taus | .806512 | .806512 | .822326 | .822326 | .849302 | .849302 | .84 | .84 |
| Effects of characteristics | | | | | | | | |
| No effect: QTE(tau)=0 for all taus | .00093 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Constant effect: QE(tau)=QE(0.5) for all taus | .765581 | .76186 | .568372 | .421395 | .261395 | .092093 | .028837 | .051163 |
| Stochastic dominance: QE(tau)¿0 for all taus | .00093 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Stochastic dominance: QE(tau)¡0 for all taus | .793488 | .793488 | .821395 | .821395 | .822326 | .822326 | .813023 | .813023 |
| Effects of coefficients | | | | | | | | |
| No effect: QE(tau)=0 for all taus | .104186 | .083721 | .111628 | .131163 | .021395 | .017674 | .097674 | .093953 |
| Constant effect: QE(tau)=QE(0.5) for all taus | .302326 | .306047 | .088372 | .026047 | .724651 | .621395 | .058605 | .07814 |
| Stochastic dominance: QE(tau)¿0 for all taus | .014884 | 0 .085581 | .017674 | .00093 | 0 | .033488 | 0 | |
| Stochastic dominance: QE(tau)¡0 for all taus | .749767 | .749767 | .60093 | .60093 | .738605 | .738605 | .671628 | .671628 |
| Effects of residuals | | | | | | | | |
| No effect: QE(tau)=0 for all taus | .015814 | .014884 | .16093 | .305116 | .325581 | .116279 | .095814 | .042791 |
| Constant effect: QE(tau)=QE(0.5) for all taus | .036279 | .054884 | .066977 | .103256 | .391628 | .213023 | .009302 | .034419 |
| Stochastic dominance: QE(tau)¿0 for all taus | .933023 | .933023 | .597209 | .705116 | .903256 | .903256 | .032558 | .415814 |
| Stochastic dominance: QE(tau)¡0 for all taus | .00093 | .00093 | .126512 | .225116 | .083721 | .009302 | .113488 | .106047 |

# Table 13: QR: median, all wage categories

| | (1)<br>ln_Wage_avg<br>b/se | (2)<br>ln_Wage_avg<br>b/se | (3)<br>ln_Wage_avg<br>b/se | (4)<br>ln_Wage_avg<br>b/se | (5)<br>ln_Wage_avg<br>b/se | (6)<br>ln_Wage_avg<br>b/se | (7)<br>ln_WageBlueCollar<br>b/se | (8)<br>ln_WageBlueCollar<br>b/se |
|---|---|---|---|---|---|---|---|---|
| Exporter | 0.152*** | 0.103** | 0.188*** | 0.388*** | 0.129** | 0.007 | 0.105* | 0.209* |
| | (0.051) | (0.049) | (0.056) | (0.119) | (0.051) | (0.049) | (0.054) | (0.121) |
| Importer | 0.133*** | 0.077*** | 0.173*** | 0.070 | 0.129*** | 0.040 | 0.099*** | 0.030 |
| | (0.030) | (0.028) | (0.035) | (0.057) | (0.031) | (0.028) | (0.034) | (0.057) |
| Twoway | 0.087* | 0.091* | 0.193*** | -0.154 | 0.076 | 0.105** | 0.128** | -0.132 |
| | (0.050) | (0.048) | (0.056) | (0.118) | (0.050) | (0.047) | (0.054) | (0.116) |
| Foreign | 0.213*** | 0.145*** | 0.278*** | 0.301*** | 0.193*** | 0.115*** | 0.209*** | 0.253*** |
| | (0.028) | (0.026) | (0.033) | (0.059) | (0.029) | (0.026) | (0.032) | (0.061) |
| ln_SizeEmp | | | | | 0.039*** | 0.061*** | 0.120*** | 0.118*** |
| | | | | | (0.013) | (0.011) | (0.012) | (0.025) |
| ln_Age | | | | | | | | |
| SkillRatio | | | | | | | | |
| ln_OutputPerHours | | | | | | | | |
| ln_CapitalLabourRatio | | | | | | | | |
| _cons | 9.295*** | 4.663*** | 6.620*** | 2.242*** | 9.253*** | 4.553*** | 6.540*** | 2.107*** |
| | (0.368) | (0.229) | (0.377) | (0.547) | (0.363) | (0.224) | (0.372) | (0.536) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

| | (9)<br>ln_WageBlueCollar<br>b/se | (10)<br>ln_WageBlueCollar<br>b/se | (11)<br>ln_WageBlueCollar<br>b/se | (12)<br>ln_WageBlueCollar<br>b/se | (13)<br>ln_WageWhiteCollar<br>b/se | (14)<br>ln_WageWhiteCollar<br>b/se | (15)<br>ln_WageWhiteCollar<br>b/se | (16)<br>ln_WageWhiteCollar<br>b/se |
|---|---|---|---|---|---|---|---|---|
| Exporter | 0.133*** | 0.038 | 0.100* | 0.169 | 0.067 | 0.045 | 0.102* | 0.179 |
| | (0.051) | (0.049) | (0.054) | (0.121) | (0.049) | (0.048) | (0.054) | (0.116) |
| Importer | 0.123*** | 0.050* | 0.109*** | 0.017 | 0.096*** | 0.058** | 0.104*** | 0.039 |
| | (0.031) | (0.028) | (0.034) | (0.057) | (0.029) | (0.029) | (0.034) | (0.057) |
| Twoway | 0.053 | 0.072 | 0.137** | -0.103 | 0.093** | 0.084* | 0.125** | -0.119 |
| | (0.050) | (0.047) | (0.054) | (0.116) | (0.048) | (0.046) | (0.054) | (0.112) |
| Foreign | 0.204*** | 0.120*** | 0.212*** | 0.235*** | 0.202*** | 0.126*** | 0.208*** | 0.225*** |
| | (0.029) | (0.026) | (0.032) | (0.062) | (0.027) | (0.026) | (0.032) | (0.061) |
| ln_SizeEmp | 0.029** | 0.052*** | 0.115*** | 0.119*** | 0.056*** | 0.056*** | 0.121*** | 0.098*** |
| | (0.013) | (0.011) | (0.013) | (0.026) | (0.012) | (0.012) | (0.013) | (0.026) |
| ln_Age | 0.062*** | 0.039** | 0.012 | -0.017 | 0.042*** | 0.041** | 0.007 | 0.004 |
| | (0.017) | (0.016) | (0.018) | (0.034) | (0.016) | (0.016) | (0.018) | (0.033) |
| SkillRatio | | | | | 0.009*** | 0.003*** | 0.001 | -0.006*** |
| | | | | | (0.001) | (0.001) | (0.001) | (0.001) |
| ln_OutputPerHours | | | | | | | | |
| ln_CapitalLabourRatio | | | | | | | | |
| _cons | 9.140*** | 4.579*** | 6.503*** | 2.082*** | 8.276*** | 4.446*** | 6.443*** | 2.345*** |
| | (0.387) | (0.226) | (0.378) | (0.546) | (0.342) | (0.222) | (0.391) | (0.546) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

| | (17)<br>ln_WageWhiteCollar<br>b/se | (18)<br>ln_WageWhiteCollar<br>b/se | (19)<br>WageRatio<br>b/se | (20)<br>WageRatio<br>b/se | (21)<br>WageRatio<br>b/se | (22)<br>WageRatio<br>b/se | (23)<br>WageRatio<br>b/se | (24)<br>WageRatio<br>b/se |
|---|---|---|---|---|---|---|---|---|
| Exporter | 0.032 | 0.034 | 0.094* | 0.163 | 0.011 | -0.011 | 0.081 | 0.178 |
| | (0.050) | (0.050) | (0.057) | (0.119) | (0.052) | (0.050) | (0.057) | (0.122) |
| Importer | 0.039 | 0.026 | 0.059* | 0.011 | 0.040 | 0.006 | 0.055 | 0.014 |
| | (0.030) | (0.029) | (0.035) | (0.059) | (0.031) | (0.029) | (0.036) | (0.060) |
| Twoway | 0.079 | 0.066 | 0.051 | -0.127 | 0.071 | 0.074 | 0.055 | -0.163 |
| | (0.049) | (0.047) | (0.055) | (0.113) | (0.050) | (0.048) | (0.056) | (0.115) |
| Foreign | 0.151*** | 0.097*** | 0.172*** | 0.203*** | 0.158*** | 0.095*** | 0.177*** | 0.183*** |
| | (0.028) | (0.026) | (0.033) | (0.064) | (0.028) | (0.026) | (0.033) | (0.064) |
| ln_SizeEmp | 0.041*** | 0.047*** | 0.109*** | 0.087*** | 0.044*** | 0.053*** | 0.108*** | 0.100*** |
| | (0.012) | (0.012) | (0.014) | (0.027) | (0.012) | (0.012) | (0.014) | (0.028) |
| ln_Age | 0.037** | 0.029* | 0.010 | -0.012 | 0.032** | 0.029* | 0.013 | -0.019 |
| | (0.016) | (0.017) | (0.018) | (0.035) | (0.016) | (0.017) | (0.018) | (0.035) |
| SkillRatio | 0.007*** | 0.002** | -0.001 | -0.006*** | 0.007*** | 0.002** | -0.001 | -0.006*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| ln_OutputPerHours | 0.096*** | 0.058*** | 0.091*** | 0.058*** | 0.081*** | 0.045*** | 0.086*** | 0.067*** |
| | (0.011) | (0.009) | (0.012) | (0.019) | (0.011) | (0.010) | (0.013) | (0.022) |
| ln_CapitalLabourRatio | | | | | 0.030*** | 0.032*** | 0.007 | -0.023 |
| | | | | | (0.010) | (0.010) | (0.010) | (0.020) |
| _cons | 8.112*** | 4.526*** | 6.255*** | 2.327*** | 8.014*** | 4.323*** | 6.227*** | 2.725*** |
| | (0.339) | (0.221) | (0.386) | (0.558) | (0.354) | (0.238) | (0.395) | (0.617) |
| country dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

analytical standard errors in parantheses

# 9 Abstract

Using the UNIDO Africa Investor Survey 2010 data on manufacturing companies in 20 sub-Saharan African countries, the firm-level effect of importing intermediate inputs and exporting on production and non-production wages as well as relative wages is explored using OLS and quantile regression. There is strong support for a positive relationship for both production and non-production wages as well as for wage ratios. Effects of importing are found to be due to differences in labour productivity to a great extent. The effect found for exporting are due to differences in size and labour productivity. Both these effects vary over different quantiles of the wage distribution. The hypothesis of skill-biasedness of trade resulting in different wage-setting functions for traders and non-traders is tested using decomposition methods. There is strong evidence for differences in wage-setting that favour white collar wages in trading firms. However, evidence is mixed on whether the estimated effects go from trade to wages or whether high-wage firms select into trade.

# 10 Zusammenfassung

Anhand von UNIDO Africa Investor Survey 2010 - Daten ueber die verarbeitende Industrie in 20 Subsahara-afrikanischen Laendern wird der Effekt des Imports intermediaerer Gueter und Exports von Fertigguetern auf die Loehne von ProduktionsarbeiterInnen, Loehne von technischen, administrativen und leitenden Angestellten sowie auf relative Loehne auf Firmenebene mittels OLS und Quantilregression untersucht. Die Ergebnisse weisen auf eine deutlich positive Beziehung zwischen Handel und Loehnen von ProduktionsarbeiterInnen, Loehnen von Angestellten und relativen Loehnen hin. Die geschaetzten Effekte von Importen koennen zum groeten Teil durch Produktivitaetsunterschiede erklaert werden, waehrend die fuer Exporte gefundenen Effekte mit Firmengroee und Produktivitaet in Relation stehen. Beide Effekte unterscheiden sich stark ueber die Quantile der Lohnverteilung hinweg. Mit Hilfe von Zerlegungen wird getestet, ob ein moeglicher Skill Bias im Handel zu unterschiedlichen Lohnsetzungsfunktionen fuer handel- bzw. nicht handeltreibende Firmen fuehrt. Die empirischen Befunde deuten stark auf Unterschiede zugunsten von Angestellten in handeltreibenden Firmen hin. Die Analyse gibt jedoch keinen genauen Aufschluss darueber, ob Handel Loehne beeinflusst oder ob die Gruende, aus denen Firmen hoehere Loehne zahlen, ebenso dazu fuehren, dass Firmen mit hoeheren Lohnniveaus eher Handel treiben.

# 11 Curriculum Vitae

PERSONAL INFORMATION

| | |
|---|---|
| Date of Birth | 27/12/1985 |
| Citizenship | German |
| | |
| Contact address | anna.pauls [at] gmail.com |

EDUCATION

| | |
|---|---|
| October 2005 — present | Vienna University<br>Economics |
| October 2009 — present | Vienna University<br>Sinology (MA) |
| October 2005 — June 2009 | Vienna University<br>Sinology (Bakk. phil.) |
| March 2005 | Max-Planck-Gymnasium Trier<br>Abitur |
| October 2003 — February 2005 | University of Trier<br>Chinese language classes |
| July — August 2004 | Beijing Language and Culture University<br>Chinese language classes (Scholarship of the Embassy of the People's Republic of China to Germany) |