Labour as leverage for the exchange rate

Does labour intensity magnify the effect that exchange rates have on output?

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Abstract

This thesis examines if the amount of labour intensity within a sector changes the effect that the real effective exchange rate have on output. Fixed panel data regressions for Sweden, Norway and Denmark lend support to the hypothesis that labour intensive sectors' output react more to changes in the real exchange rate than its less labour intensive counterparts. The regressions show that the labour intensity and the change in the real effective exchange rate interact which other to create a leveraging effect on output. This suggests that targeting a competitive exchange rate affects labour intensive sectors the most and has further policy implications for countries aiming for a weaker real exchange rate. The robustness of the results comes into question due to a low degree of explained variance and unexpected coefficients of the control variables within the models. Statistical significance of the interaction term is reached inconsistently which further casts doubt upon the results. Future research could further investigate how labour intensity and the exchange rate affect the output of sectors, as well as ways to optimize the model to make it more consistent and to explain a greater deal of currently unexplained variance.

Table of Contents

1. Introduction

The world relies less upon exchange rates to influence the flow of international trade. The world economy is also moving towards a more service oriented economy, which are increasingly contributing to the countries´ production. (Buckley 2018). As the service sectors are more labour-intensive the following question becomes of interest. Does an increased amount of labour intensity make the exchange rate produce a different effect on output?

As the world moves on to a more service oriented economy, it is bound to change the relationships we´ve come to understand, such as the one exchange rates exert on trade and output. Relying upon more human capital, instead of physical capital, and producing a qualitatively different product is should to change some interactions that some economists and policymakers haven´t considered. As service sectors and labour intensive manufacturers are found to be the ones most affected by changes in the exchange rate, the question probes into a more generalized relationship if more labour means a higher sensitivity towards exchange rate. The intuition is that real wages account for a greater amount of expenditure in labour intensive sectors. When the exchange rate changes, so does the real wage and hence the cost of the firm. A more labour intensive firm is more affected than a capital intensive firm. In capital intensive industries, depreciations affect the firms through a worsening balance sheet makes borrowing more expensive and increasing the risk premium associated with the currency.

The thesis uses annual panel data from 2000 to 2014 from Sweden, Norway and Denmark to answer the question. Using their 56 industrial sectors I investigate if there is an interaction between the real exchange rate and the labour intensity that would explain some of the variation in output.

The question is further interesting because of different reasons. The first reason is to complement other studies such as Soyres et al (2018) which find intermediary inputs to play a big part in curbing the effect of exchange rates.
The second reason concerns the trend towards a more service oriented economy in the industrialized countries which would imply that the economies of these countries are becoming more susceptible towards exchange rate fluctuations compared with their past.
The third reason for investigating this topic is the poor performing Swedish krona and its effect on its economy. The krona exchange rate has been steadily declining in recent years

causing questions regarding the Swedish central bank's policy and performance. The Swedish central bank is pursuing a low inflation which also undermines the real exchange rate. The effects have not been well met by business leaders and makes the topic of a depreciating exchange rate even more contemporary.

My results show that there is an effect between labour intensity and the real effective exchange rate on output. The effect is not consistently significant in the regressions but whenever it does it displays the expected sign in all but 1 instance. As such the results generate questions and a basis for further research and optimization of the model in order to produce more consistent results and to examine the transmission channels. The findings give ground to the hypothesis that labour intensity enhances the effect that the real exchange rate has on output. An appreciation causes a greater drop in output when the industry is labour intensive compared to the capital intensive industry. This lends support to previous studies which have examined the relationship that labour intensity and exchange rates have an intensifying effect on output.

Part 2 contains theory concerning the exchange rate´s effect on exports and the results from previous studies investigating the same phenomenon. The hypothesis, data and the results of the regressions are presented in part 3, which contain the empirical analysis. The result will be tied together with previous research and policy implication. The conclusion in part 4 summarizes the thesis.

2. Theory and previous research

Previous studies have shown a correlation where the most labour intensive firms´ output are more affected by change in the exchange rate compared to their less labour intensive counterparts. This effect is theorized to be transmitted through changes in the real wage cost and the real cost of borrowing.

2.1 Background

Production within a country is meant for domestic or foreign consumption. Comparative Advantage is the main theory and explanation for why certain countries produce certain goods. Although one country may have a better ability to produce all goods within an

economy, it will still specialise in the one that gives it the most value. According to comparative advantage the effective country would produce the good that it´s best at compared to its competitive countries and import the rest of its needs (Marrewijk 2012, p.55). Sweden would for example be a net exporter of steel and a net importer of produce, despite being very good at producing both goods.

In the macroeconomic schoolbook example, a country´s export is driven by two parts when viewed in a narrow time frame. One part being the GDP of the countries being exported to and the other coming from the real exchange rate (Burda and Wyplosz, 2013, p.239). A country's real exchange rate (RER) affects exports by making the exported product more expensive to purchase by another country whilst increased foreign GDP increases demand for all goods. The output and exports are therefore positively influenced by the RER and foreign GDP. An appreciation (increase) in RER is influenced negatively by the foreign price level. The currency may also be affected negatively by the price level in the country or by the nominal exchange rate.

Previous studies concerning the countries´ responses towards changes in the exchange rate follows the following discourse. Sweden has previously been found to be very price inelastic in its exports when price was measured as the bilateral real exchange rate (Hatemi-J 2005). The elasticity towards foreign income is however much greater and foreign income was therefore found to be more influential. The period examined was between 1960 and 1999 which encompasses the Bretton Woods system (Riksbank) which might have produced a different effect due to the fixed exchange rate regime. Norweigan GDP was found by Makin (2016) to be positively but insignificantly affected by an increase of the Terms of Trade. The period examined was between 2018 and 2011 and indicated that relative prices produced no or little effect on GDP over a timer period of 10 quarters. Baranová (2013) examined Denmark and 9 other countries and confirmed the expectation that economic growth is negatively affected by the real exchange rate and the cost of labour per unit produced.

The effect of the RER has had a decreasing importance on exports over time. This is something that Ahmed, Appendino and Ruta (2015) link to increasing participation in global value chains and so do Amiti, Itskhoki and Konings (2014). An increase in the amount of intermediate goods imported for an industry therefore reduces the effect that RER has on export volumes. A firm integrated in a global value chain would see demand rise for its products following a depreciation but would also have higher costs in order to obtain the same

amount of inputs necessary for production. The outcome is that the increased production costs and increased demand offset each other and produce a negligible effect on the export volume when the value chain becomes more global. Correcting for global value chains, Ahmed et al (2015) found that the effect of the RER hasn´t declined over time. The increased participation in global value chains has however made the total effect less striking.

Factors on the international market which have been found to affect the output of a country and its sectors in the short run are the foreign GDP, the price of the products and the share of inputs needed to complete the product. In the long run, output and the trade that follows from it is to a large part determined by comparative advantages.

2.2 The real exchange rate and labour capital ratio

Previous studies concerning how output was affected by the exchange rate and labour capital ratio arrived at similar conclusions. The output of labour intensive firms or groups of firms was more affected by the exchange rate if they were labour intensive. An appreciation of the exchange rate decreased the output of firms more in labour intensive firms compared to their capital intensive counterparts.

Forbes (2002) found that nominal devaluations in developing countries led to an increase in the volume of output as predicted by theory. The effect on output was however more prominent in firms with relatively high labour-capital ratios and if the devaluation didn´t increase the cost of capital in an economically significant way. Firms which were more labour intensive than the median were found to increase their investments more than their counterparts which Forbes interpreted as a greater increase in future output. Another study looked at macroeconomic policy in Argentina targeting a competitive (and therefore low) RER. They found that it coincided with an export surge (Palazzo and Rapetti 2017) which varied between industries. Firms classified as low and medium technology manufacturers saw the greatest share of export surges compared to the other groups. The low and medium technology manufacturers were also the most labour intensive, as measured by workers per Value Added.

Olsson (2017) finds that service sectors are more sensitive towards changes in RER and finding statically weak connections between goods exports and the exchange rate. Cheung and

Sengupta (2013) also find that firms exporting goods are less sensitive to negative changes in the Real Effective Exchange Rate (REER) compared to the firms exporting services. Eichengreen and Gupta (2012) also finds that services are more sensitive towards changes in the real exchange rate and propose that this is due to using fewer imported inputs, low fixed costs of entry or that the demand is more elastic. In addition they find no consistent evidence that advanced and developing countries react differently to changes in the exchange rate. This makes Forbes (2002) study on developing countries more general and applicable towards advanced countries.

2.2.1 Transmission channels

The channel through which labour-intensity increases the RER´s effect may be explained by decreasing real costs of labour and increasing real costs of capital. Following depreciation, goods from abroad would become more expensive since more Home currency is needed to gain the same amount of goods from Foreign. The price of a basket of goods that a consumer buys has therefore increased, depending on how much the currency has depreciated and the amount of imported goods that the basket contains. As such, the relative returns to workers have decreased. The decrease in relative return to workers is synonymous to a lower hourly- and quantity-dependent cost making an output increase profitable for the firm.
Forbes (2002) points to decreasing relative labour costs as producing a short term effect during a devaluation and increasing capital costs offsetting the cost reduction in the long run. The firms that Forbes investigated therefore benefited from cheaper labour straight away yet had an uncertain outcome in the long run. Ping (2007) found that a real appreciation exerts a negative effect on Chinese labour intensity due to higher wages and Campa and Goldberg (2001) gained similar results that wages increased. Cheung and Sengupta (2013) discovered that labour costs may amplify the exchange rate effect on trade in the Indian firm-level case. An increase in labour costs implies a stronger reliance on a labour intensive means of production. Cabrail and Mollick (2017) finds that a depreciation between the dollar and the Mexican pesos leads to higher Mexican prices and thus lower real wages as predicted by theory.

Leung and Yuen (2010) examines the effect that nominal exchange rate changes have on a part of capital and finds that 10% depreciation increases the price of “Machinery & Equipment” by 5.2% and decreases the capital-labour ratio by 1.7%. Landon and Smith

(2007) provides a less straightforward answer, pointing to the destinations and origins of exports and "Machinery & Equipment" imports as affecting the labour-capital ratio. Depreciation towards the source of imports leads to a reduction in capital and increase in labour-capital ratio whilst a depreciation leads to an increase in capital for the country being exported to. The reduction in capital implies that a higher cost of capital has led to the reduction. Ng and Souare (2014) also finds that investments as a whole are positively affected by an appreciation, providing another viewpoint of the other side of exchange rate movements. The cost of capital increases according to Serana and Sousa (2018) because a large depreciation is associated with a deterioration of a firm´s balance sheet in the form of increased liability or decreased value to be used as collateral when money is lent in a foreign currency. Dao (2017) shares that sentiment but points to depreciations as increasing investments when the firm is labour intensive since the real wage is reduced. The reduction in real wages promotes profit and investments in order to seize the increase in Marginal revenue that capital experience. The investments and capital may increase although the labour-capital ratio might still increase. Campa, Minoiu and Ostry (1999) finds that investment in high-markup sector is less affected by the exchange rate as they are able to pass on investment costs onto their consumers.

2.2.2 Summary

Previous research indicates that labour intensive industries are more prone to react to changes in the RER compared to capital intensive industries. This amplifying effect is due to reduced real wages and increased capital costs following a depreciation. Real wage decrease because the price of a basket of goods that a worker wants increases whilst their wages are paid in nominal amounts, disconnected from inflation and changing very slowly. (Forslund 2005) In the case of devaluations or large depreciations, the risk premium may increase as depreciations indicate a risk within the economy and for investors. For a depreciation not spurred on by a devaluation, the cost of investments are increased because of the worsening balance sheet.

3. Empirical analysis

3.1 Method

Examination of the combined effect that labour intensity and changes in the real exchange rate have on output will be done through the use of fixed effects panel data. Panel data divided among the sectors and the countries are used to account for some of the variation that exist between the industries. The amplification of the real exchange rate effect will be done through an interaction term where the labour intensity is multiplied with the change in the real exchange rate. The model will have the appearance:

$$\Delta LnVA_{i,t} = b_{0,i} + b_1 \sum_{k=1}^{n} \Delta LnREER_{t-k,i} + b_2 \sum_{k=1}^{n} (\Delta LnREER_{t-k,i} * LK_{t-k,i}) + b_3 \sum_{k=1}^{n} Control_{t-k,i} + \varepsilon \qquad (1)$$

VA is the real value of Value Added which will be used instead of exports due to the lack of detailed data. *REER* is the real effective exchange rate which is just the real exchange rate weighted by how much trade exists between those countries. The real exchange rate is the nominal exchange rate that uses baskets of goods to show how much a domestic currency is worth in another currency. The summation sign offers additional lags to be used rather than just 1. In the regressions a maximum lag length of 2 will be used to account for the possibility that some countries are slow to react to changes in relative prices. The coefficient of *REER* should have a negative sign since a higher exchange rate makes goods and services more expensive to purchase from the investigated countries.. The higher price results in a lower demand and therefore a lower value of *VA*. The possibility of a positive effect is however not impossible if the term "*REER*LK*" is part of the regression.

The interaction term "*REER*LK*" is the real effective exchange rate multiplied by the Labour-Capital ratio and its coefficient is expected to take on a negative value. Given a certain increase in *REER*, it is amplified by the labour-capital ratio if it follows Forbe's (2002) and Palazzo's (2017) results. An appreciation (increase in *REER*) would therefore have a greater negative effect if *LK* is large. This is expected since an appreciation makes imported goods cheaper which increases the real wage of workers at the same time as the output is more

expensive for foreigners to purchase. A smaller *LK* given the same change in *REER* would produce an absolute smaller effect on *VA*.

$$\frac{d\Delta LnVA_{t,i}}{d\Delta LnREER_{t-1,i}} = b_1 + b_2 * LK_{t-1,i} \qquad (2)$$

The combined effect of a change in *REER* would therefore look like equation (2) where b_2 is expected to be negative, since more labour means more real wage cost increases when *REER* appreciates. $b_1$is expected to take on a more ambiguous sign. It could be a negative value in order to capture that the products of the firm are demanded less on the international market due to the higher price but may also take on a positive value. The positive value would arise in part because of the previous reasoning that capital becomes cheaper but it is more plausible that it would become positive to "compensate" for the negative sign of b_2. The effect that *REER* have on *VA* in the first lag will be:

Finally "*Control*" is a variable containing factors that would influence Value Added but are of not interested to this study. It is composed of the GDP for the 3 largest trade partners of the investigated countries, the value of the real intermediary goods and the cost of capital. GDP of the trading partners is used as a control variable since increased foreign production causes more demand overall. The increase in demand is satisfied by importing goods from other countries such as the countries being examined, leading to higher output (Burda and Wyplosz, p.239). Δ*LnUSA* represent the logged and first differenced GDP of USA and Δ*LnChina* represent the logged and first differenced GDP of China. Δ*LnEU15* represent the logged and first differenced value of the GDP of EU15 countries subtracting the examined country´s GDP. The value of the intermediary inputs (*II*) is considered in order to capture participation in global value chains as shown by Soyres et al (2018). *Capital cost* is included in order to offset any reduction in investments which Forbes (2002) found to make or break the future output following a depreciation. The cost of capital is the capital compensation divided by the real capital stock in order to account for the increase in capital costs. Compensation to capital is divided by the real capital stock so that it doesn´t capture that increased capital stock increase compensation to capital, due to more capital being employed. The variables are logged and then differentiated in order to compensate for unit root and to produce a symmetric interpretation expressed in elasticities. In addition, the explanatory variables are lagged in order to produce a clearer causal effect. By lagging, a potential causal effect of

outputs affecting any explanatory variables is eliminated. By using individual fixed effects panels some of the particular characteristics of an industry and country will be captured.

The service sectors have been categorized as such using the method developed by Normann (2000, p.28) which defines services as a product that can´t be stored, where production occurs at the same time as consumption and which is difficult to demonstrate. The method yielded 22 industries defined as goods sectors and 33 industries defined as service sectors.

3.2 Data

The World Input Output Database (Timmer 2015) provided with nominal value added, thousands of hours worked, nominal capital stock, compensation to capital as well as price indexes in order to deflate the values and make them real. The data from WIOD was used since it covers a lot of sectors of varying degrees of output, amount of labour and amount of capital used as well as having a balanced share of service and goods producing sectors. Data of real GDP of China, USA, the investigated countries and the combined GDP of EU15 were all gathered from the Federal Reserve Bank of St. Louis. GDP deflators were collected from the International Monetary Fund and The Real Effective Exchange Rate from the World Bank. The *REER* is the weighted real exchange rate of a country and is usually measured as an index. The "effective" part of the *REER* is the real exchange rate that the country as a whole faces towards the world and the one used is weighted by trade in manufactured goods (Klau and Fung 2006). One of the variables representing foreign GDP is EU15. In order to avoid counting the domestic GDP as a part of the EU15 GDP, Denmark´s and Sweden´s real GDP were subtracted from the GDP of EU15 when that country was investigated. Since Norway wasn´t a part of the union during the time period, no such correction had to be made. The Swedish and Danish GDP were subtracted from EU15 using the average nominal conversion rate during 2010 which was gathered from the European Central Bank.

The data has been augmented in such a way that makes it not take into account changes in the price of the products, inputs or the factors of productions Nominal capital stock and GDP have been made real with their corresponding GDP-deflation with the base year of 2010. Value added and intermediary inputs have been made real with the base year 2010 following the price-index supplied by the WIOD. The labour-capital ratio has been created by dividing

the thousands of hours worked during the year by the real capital stock present during the year.

Unit root tests were conducted in order to prevent spurious regressions which would have made coefficients appear significant when in fact, they were not. Unit root was found in the dependent variable *VA*, *China* and *II* as can be seen from Table 1. Two types of unit root test were used in order to provide nuance for the possibility of non-stationarity. Despite that the Levin, Lin and Chu test didn´t show signs of non-stationary, the variables were still first differenced. Previous research (Aslanidis N. & Fountas S. 2014) has found that GDP is non-stationary for the countries investigated for the examined time period. The Augmented Dickey Fuller test showed in addition that variables are non-stationary, the most important one for the thesis being Value Added (*VA*). The variables with unit root were stationary in their first differences due to the ADF test indicating non-stationarity as they were and that previous research have found non-stationarity in some of the selected variables. The other stationary variables were first differenced in order to produce a more symmetric interpretation. The variables were then logged in order to produce an interpretation in elasticities, rather than absolute values. Since heteroscedasticity results in inefficient OLS estimators and makes F- and t-tests invalid, robust standard errors was used in all regressions. Robust standard errors will still leave the estimators inefficient but will make hypothesis testing valid (Dougherty 2011, p.294). It is valid to use robust standard errors since the purpose of this thesis is to investigate the effect and statistical significance of the interaction term and not the size of the. With that said, there is still some value gained from exemplifying the effect of the exchange rate to gain an intuitive feeling despite inefficient estimators.

Table 1 – Descriptive statistics and unit root tests

Variable	Mean	Min	Max	LLC t-test	LLC Order of Integration*	ADF t-test	ADF order of integration*
Labour-capital ratio	1.71	0.00975	14.598	-14.8812	I(0)	428.737	I(0)
LnREER	4.60	4.47	4.69	-29.6651	I(0)	910.463	I(0)
LnEU15	14.8	14.5	14.9	-17.5726	I(0)	386.469	I(0)
LnUSA	9.62	9.48	9.74	-5.97925	I(0)	88.7211	I(0)
LnChina	16.1	15.5	16.7	-20.9084	I(0)	220.025	I(1)
LnII	10.1	6.74	12.5	7.49220	I(0)	303.099	I(1)
LnCapital cost	-1.77	-8.17	1.80	-18.1875	I(0)	543.841	I(0)
LnVa	5.23	-0.726	8.78	-5.29065	I(0)	306.740	I(1)
Δ*LnREER*	0.00273	-0.105	0.0823	-31.4690	I(0)	1057.18	I(0)
Δ*LnEU15*	0.00999	-0.0449	0.0315	-31.6372	I(0)	901.364	I(0)
Δ*LnUSA*	0.0180	-0.0257	0.0373	-8.55481	I(0)	559.401	I(0)
Δ*LnChina*	0.0837	0.0499	0.114	-33.5692	I(0)	1037.45	I(0)
Δ*LnII*	0.0156	-0.610	0.713	-33.6093	I(0)	1152.63	I(0)
Δ*LnCapital cost*	-0.0005	-6.38	6.33	-46.8635	I(0)	1550.69	I(0)
Δ*LnVa*	0.00863	-2.56	0.987	-35.6198	I(0)	1296.09	I(0)

LLC is the Levin, Lin Chu test. ADF is the Augmented Dickey Fuller test Fisher Chi-square.
*significant at 5%

3.3 Results

Table 2 shows the regressions made on Sweden. Columns with odd numbers are the extended regression containing all the previously mentioned control variables and all odd columns are in the reduced form. The regressions are subdivided into service sector (1-2), goods sector (3-4) and the country as a whole (5-6).

Since all the variables are the differences between time period t and t-1, the results should be interpreted as any change causing a change in the dependent variable. The logged nature of the variables makes the coefficients answer what happens when an explanatory variable increases by 1 percentage point. For example, the "$\Delta LnUSA_{t-1}$"-coefficient with 1 lag in model (1) for Sweden produces the following interpretation. As US GDP increases by 1 percentage point, the value added will increase by 1.296 percentage point in the next time period.

3.3.1 Sweden

In the Swedish table 2 there is only one significant interaction term "$\Delta LnREER*LK$" which is in the service sector and at the 1 lag case. That the coefficients in the goods and all sectors don´t produce a statistically significant result would however correspond to previous results by Olsson (2017). Service sectors were found to more affected by the $\Delta LnREER$ compared to the goods sector in Sweden. In addition $\Delta LnREER$ also provides a positive coefficient indicating that output increases as the currency experiences a real appreciation. This seems odd at first glance but it should be remembered that the total effect is the one that matters.

The negative sign is present in the interaction term because as $\Delta LnREER$ increases, it decreases the output of that sector. This value is enhanced with higher labour intensity. Higher labour intensity is associated with a higher value of the interaction term which therefore produces a greater effect on the Value Added.

The effect as a whole according to equation (2) depends on the value of the labour-capital ratio. When $\Delta LnREER$ increases by 1 percentage point in model (1), the value added decreases by 1.57 percentage points for the sector with the highest labour-capital ratio and increases by 0.54 for the minimum value. A low labour-capital ratio in the service sector therefore produces a growth in output when the exchange rate appreciates. That interpretation shouldn´t be interpreted all too strict however, especially given the robust standard errors causing the estimators to become inefficient. There is however the possibility that this relationship exists since input goods become cheaper.

The contribution that the control variables have on the coefficients present in the reduced model seems to be of a softening effect. When the control variables are removed, the absolute value of the interaction-coefficient increases. This might indicate that they´re correlated with the interaction term and that the interaction term captures some part of the control variables in the reduced form.

When comparing the statically significance and the sign and absolute value of the coefficients, there emerges a pattern. When the interaction term is sufficiently large and negative, it reaches significance which mostly holds for the following tables.

As expected, the variables capturing foreign GDP are mostly significant but the *capital costs* and $\Delta LnII$ don´t reach significance as often. The negative coefficients on $\Delta LnEU15$ are

interesting as this go against theory. When European GDP increases, it affects the Swedish service production negatively when instead it should be increasing it. More European GDP indicates more demand which should be satisfied by Swedish output. This holds for all the regressions as well which makes it seem less like a fluke. One, unlikely, possibility is that Sweden produces inferior goods which see decreased demand when European countries get richer. Another possibility is that the negative coefficients indicate that the model is inadequate in explaining the large degree of variation in output. This reasoning coupled with the low Adjusted R^2 indicate that the model might not take into account certain variables or that these variables need to be expressed in different ways.

Δ*LnII* and Δ*LnCapital costs* reach significance at 5 and 10% in model (3) and (5) when the interaction term is insignificant. This would indicate that service sectors and the goods sectors are prone to different variables affecting their outcome. If the goods sector is more affected by intermediary inputs and capital costs than exchange rates and capital-labour ratio, there might be a factor not considered in the regression. This variable may affect the exchange rate and Δ*LnII* and Δ*LnCapital cost* by increasing the importance of the first and decreasing the importance of the two last.

Table 2 – Regression results for Sweden

	Service sector		Goods sector		All sectors	
	(1)	(2)	(3)	(4)	(5)	(6)
b_0	-0.0523	0.0277**	-0.4588**	0.0066**	-0.2129**	0.0187**
	(0.0380)	(0.0012)	(0.1668)	(0.0010)	(0.0707)	(0.0022)
$\Delta LnREER_{t-1,i}$	0.5395**	0.4120*	-0.7503	-0.6580	0.01986	-0.01262
	(0.2395)	(0.2278)	(0.7367)	(0.4455)	(0.3457)	(0.2198)
$\Delta LnREER_{t-2,i}$	-0.1257	0.02666	-0.6027*	-0.7280*	-0.4704**	-0.3891*
	(0.1441)	(0.1126)	(0.3462)	(0.3895)	(0.1827)	(0.2015)
$(\Delta LnREER_{t-1,i} * LK_{t-1,i})$	-0.1443**	-0.1537**	0.3567	0.384	-0.0153	-0.0176
	(0.067)	(0.0703)	(0.2111)	(0.2727)	(0.071)	(0.076)
$(\Delta LnREER_{t-2,i} * LK_{t-2,i})$	-0.0243	-0.0236	-0.0173	0.0953	0.0751	0.0735
	(0.0386)	(0.0323)	(0.1582)	(0.1931)	(0.0456)	(0.060)
$\Delta LnEU15_{t-1}$	-1.917**		-5.332**		-3.089**	
	(0.6604)		(1.798)		(0.7620)	
$\Delta LnEU15_{t-2}$	-0.3901		-1.753**		-0.8273**	
	(0.2768)		(0.7714)		(0.3596)	
$\Delta LnUSA_{t-1}$	1.296**		3.890*		2.220**	
	(0.4995)		(2.030)		(0.8359)	
$\Delta LnUSA_{t-2}$	1.283**		1.738		1.412**	
	(0.4635)		(1.080)		(0.5790)	
$\Delta LnChina_{t-1}$	0.4782		3.498**		1.740**	
	(0.2997)		(1.058)		(0.4971)	
$\Delta LnChina_{t-2}$	0.05288		1.260		0.4867	
	(0.2157)		(1.387)		(0.5523)	
$\Delta LnII_{t-1}$	0.03070		-0.09516		-0.04747	
	(0.1246)		(0.1103)		(0.08583)	
$\Delta LnII_{t-2}$	0.01897		-0.3130**		-0.1696*	
	(0.07548)		(0.1465)		(0.08749)	
$\Delta LnCapital\ cost_{t-1}$	-0.02856		-0.06915*		-0.05615**	
	(0.03768)		(0.03887)		(0.02018)	
$\Delta LnCapital\ cost_{t-2}$	-0.02829		-0.02171		-0.04078	
	(0.03592)		(0.04574)		(0.02665)	
$\Delta LnVA_{t-1}$	-0.1518*	-0.1602**	-0.1709**	-0.2304**	-0.1821**	-0.2208**
	(0.08937)	(0.06204)	(0.05632)	(0.06290)	(0.04703)	(0.05886)
$\Delta LnVA_{t-2}$	-0.1448**	-0.1634**	0.06183	-0.02781	0.01180	-0.06086
	(0.05752)	(0.03916)	(0.04128)	(0.1163)	(0.08249)	(0.1132)
n	362	372	252	264	614	636
Adj. R^2	0.1517	0.0675	0.2792	0.0919	0.1799	0.0624

The dependent variable is the logged difference of Value Added in 2010 prices and the parenthesis contain robust standard errors. All regressions include sector specific fixed effects. ***/**/* represent significance at 1/5/10% respectively.

3.3.2 Denmark

The significance is pushed back into the second lag of both $\Delta LnREER$ and the interaction term model (1) in table 3 yet achieves some degree of significance in model (4). The 2nd lag of the interaction term in (1) shows the wrong sign, as expected from theory. This is strange but may be considered as a bounce-back effect that corrects for the 1st lagged value and a reversion to the mean. Looking at the bigger picture and examining the interaction term and the $\Delta LnREER$ in the 2^{nd} lag produce a more reasonable result. An appreciation reduces the output in the second time period but more labour intensive industries have a smaller decrease in output. While this interpretation makes more sense, it goes against previous research and the intuition that follows from it. Labour intensive industries are expected to react more to changes in the exchange rate, not less. Considering that none of the previous research has indicated that an appreciation increases output makes the relationship seem dubious. Since $\Delta LnREER$ is aggregated on the national level, it might be affected by aggregation bias. Landon and Smith (2007) points to the origin and flow of trade as determining if a depreciation is output enhancing or not. Danish services will increase their output if Danish services uses foreign capital and they experience an appreciation towards that country. The country exporting capital to Denmark has to then not be a country that imports those services from Denmark. If the other country was also importing those services, there would be a cancelling out since the price of that output has increased due to the appreciation. This explanation seems however unlikely given that the aggregate explanatory variables don´t capture enough nuance to make that possible.

Going from the extended model (3) to the reduced model (4) produces an absolutely bigger coefficient for the interaction term and making it statically significant as experienced in the Swedish service sector. The coefficient is also several times larger than in the Swedish service sector, indicating either a much stronger effect, or a lower labour-capital ratio in the Danish goods sectors. With its negative coefficient it is the result expected from theory. That the goods sector (4) is the one to provide the expected coefficient with significance is surprising given the results that Sweden showed. Palazzo and Rapetti´s (2017) research about labour intensive industries might be valid here as well as Campa, Minoiu and Ostry´s (1999) findings that high-markup sectors are more able to pass along price increases to their consumers, leaving output at a stable level. Considering that Denmark follows a fixed exchange rate regime tied to the euro could also create another relationship, unconsidered and not embedded within the model.

To illustrate the relationship between $\Delta LnREER$ and capital-labour ratio figure 1 displays the isoquant for the Danish model (4) and at the first lag case. The figure displays labour-capital ratio on the horizontal axis and the logged change in the real effective exchange rate on the vertical axis. The curve indicates what combinations of $\Delta LnREER$ and *LK* that would produce the same amount of value added as predicted by theory. The value added is also logged and differenced. Figure 1 displays the isoquant when $\Delta LnVA$ increases by 1 percentage point. A hypothetical Norwegian firm with an average labour-capital ratio of 1.13 is plotted in the figure with the dotted vertical line. The average firm would see its output (*VA*) increase by 1 percentage point if the exchange rate decreased by 2.3 percentage points. The equation is gained by rearranging equation (3):

$$\Delta LnVA = b_1 * \Delta LnREER + b_2 * \Delta LnREER * LK \qquad (3)$$

Into equation (4) with *REER* on the left hand side, keeping $\Delta LnVA$ constant and *LK* a variable that can change:

$$\Delta LnREER = \frac{\overline{\Delta LnVA}}{b_1 + b_2 * LK} \qquad (4)$$

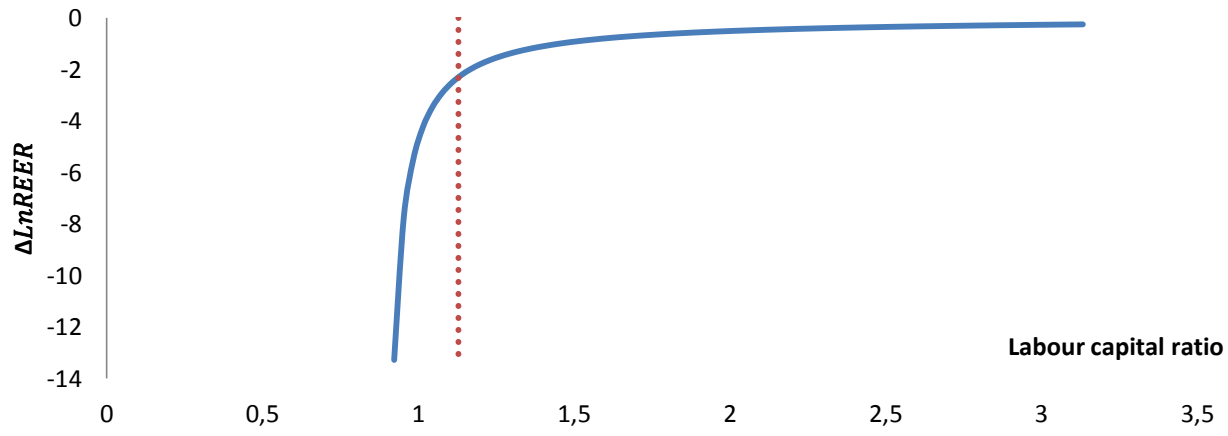

Figure 1 - Constant increase in Value Added given certain labour intensity and decreases in REER for the Danish model (4)
Note: only displays negative change in *LnREER*

Table 3 - Regression results for Denmark

	Service sector		Goods sector		All sectors	
	(1)	(2)	(3)	(4)	(5)	(6)
b_0	-0.09032	0.02408**	-0.2604	-0.04320**	-0.1697**	-0.0006336
	(0.05773)	(0.004627)	(0.1656)	(0.005048)	(0.07488)	(0.002635)
$\Delta LnREER_{t-1,i}$	0.2707	-0.6533	1.152	1.528*	0.3863	-0.2325
	(0.2958)	(0.9622)	(0.7768)	(0.7471)	(0.3280)	(0.5907)
$\Delta LnREER_{t-2,i}$	-0.7514**	-0.1572	-1.212	-0.03038	-1.043**	-0.1919
	(0.2584)	(0.2280)	(1.178)	(0.8851)	(0.3802)	(0.2900)
$(\Delta LnREER_{t-1,i} * LK_{t-1,i})$	-0.150	0.9234	-0.662	-1.737**	-0.147	-0.1483
	(0.118)	(0.2994)	(0.566)	(0.588)	(0.1208)	(0.2176)
$(\Delta LnREER_{t-2,i} * LK_{t-2,i})$	0.270**	0.1054	-0.211	0.0846	0.190	0.097
	(0.095)	(0.0922)	(0.898)	(0.746)	(0.124)	(0.114)
$\Delta LnEU15_{t-1}$	-2.041**		-3.505**		-2.690**	
	(0.4548)		(1.322)		(0.6344)	
$\Delta LnEU15_{t-2}$	-0.6479		-2.851**		-1.740**	
	(0.3893)		(1.093)		(0.5046)	
$\Delta LnUSA_{t-1}$	1.664**		4.039**		2.648**	
	(0.4395)		(1.425)		(0.7009)	
$\Delta LnUSA_{t-2}$	0.4853		0.7996		0.7084	
	(0.3314)		(1.271)		(0.5256)	
$\Delta LnChina_{t-1}$	1.013**		1.754		1.287**	
	(0.3384)		(1.065)		(0.5031)	
$\Delta LnChina_{t-2}$	-0.0002606		0.7413		0.4738	
	(0.4934)		(1.032)		(0.4993)	
$\Delta LnII_{t-1}$	0.08800		0.2457**		0.1787**	
	(0.08451)		(0.08390)		(0.06598)	
$\Delta LnII_{t-2}$	0.04889		-0.003298		0.02833	
	(0.04812)		(0.1011)		(0.06690)	
$\Delta LnCapital\ cost_{t-1}$	-0.02088		-0.02049**		-0.01221	
	(0.01268)		(0.006347)		(0.01019)	
$\Delta LnCapital\ cost_{t-2}$	-0.0007319		-0.02481*		-0.01708	
	(0.01050)		(0.01308)		(0.01129)	
$\Delta LnVA_{t-1}$	0.09915	-0.04122	-0.4216**	-0.3635**	-0.3099*	-0.2839**
	(0.09605)	(0.04751)	(0.1885)	(0.08942)	(0.1695)	(0.1045)
$\Delta LnVA_{t-2}$	-0.1402**	-0.2416**	-0.02359	-0.2197**	-0.02432	-0.2165**
	(0.06679)	(0.07082)	(0.04198)	(0.05680)	(0.03577)	(0.03768)
n	356	384	242	264	598	648
Adj. R^2	0.1418	0.0716	0.3021	0.1484	0.1930	0.0973

The dependent variable is the logged difference of Value added in 2010 prices and the parenthesis contain robust standard errors. All regressions include sector specific fixed effects. ***/**/* represent significance at 1/5/10% respectively.

3.3.3 Norway

As can be seen from table 4 there is no significance on the first lag of the interaction term of all the models. Δ*LnREER* have however 2 coefficient being significant in the first lag in model (2) and 3. Coefficients of the interaction term reach statistical significance when the 2nd lag is considered. That the later lags reach significance whilst the first one doesn´t, indicate that Norway is slow to respond to the exchange rate, something backed up by previous studies. Makin (2016) found that changes in the Terms of trade caused insignificant changes in the short run across 10 quarters when Norway received a ToT shock.

Model (3) has a bigger absolute and significant coefficient on Δ*LnCapital cost* compared to that of model (1). The models differ in the coefficient on their Δ*LnCapital costs* where the goods sector responds less to increases in costs of capital. Forbes (2012) found that a depreciation was output enhancing beyond the short run if the cost of capital didn´t increase too much.

The coefficients display the predicted sign but are placed in the sector with the lowest capital-labour ratio. That significance is reached in the goods sector and not the service sector is strange considering that Sweden showed the opposite result and the previous findings by Olsson (2017). Manufacturing sectors in previous studies (Palazzo 2017) found similar results that labour intensive manufacturers increased outputs more than their capital intensive counterparts. Just as with the Danish regression, the goods sector shows significance on the interaction variables and none in the service sector.
In the 2nd lag of the interaction term in model (3), (4) and (6) significance with the correct sign is shown, however with a great spread between the coefficients. Also interesting is the lack of significance in the lagged dependent variables when the model is extended (1, 3, and 5).

Table 4 - Regression results for Norway

	Service sector		Goods sector		All sectors	
	(1)	(2)	(3)	(4)	(5)	(6)
b_0	-0.04485	0.01512**	-0.1674	0.01270**	-0.1050**	0.01400**
	(0.03602)	(0.002560)	(0.1070)	(0.002575)	(0.04835)	(0.002093)
$\Delta LnREER_{t-1,i}$	-0.003621	-0.4948*	0.6427*	0.1225	0.2243	-0.3056
	(0.2090)	(0.2810)	(0.3582)	(0.2920)	(0.1664)	(0.2221)
$\Delta LnREER_{t-2,i}$	0.08290	0.06646	1.180**	1.152**	0.3273**	0.2878*
	(0.1679)	(0.1420)	(0.3772)	(0.4740)	(0.1412)	(0.1649)
$(\Delta LnREER_{t-1,i} * LK_{t-1,i})$	-0.0006	0.233	-0.278	-0.117	-0.0414	0.2027
	(0.0317)	(0.1753)	(0.185)	(0.195)	(0.0398)	(0.171)
$(\Delta LnREER_{t-2,i} * LK_{t-2,i})$	0.0034	-0.0004	-0.572**	-0.718**	-0.0436	-0.0646*
	(0.0396)	(0.031)	(0.252)	(0.275)	(0.0384)	(0.0338)
$\Delta LnEU15_{t-1}$	-0.9330**		-2.369**		-1.575**	
	(0.4197)		(1.046)		(0.5151)	
$\Delta LnEU15_{t-2}$	-0.7806*		-1.568		-1.136**	
	(0.4414)		(1.192)		(0.5304)	
$\Delta LnUSA_{t-1}$	1.108**		1.647*		1.387**	
	(0.4688)		(0.8976)		(0.4115)	
$\Delta LnUSA_{t-2}$	1.207*		1.052		1.244*	
	(0.6550)		(1.516)		(0.7159)	
$\Delta LnChina_{t-1}$	0.4066		1.847**		1.096**	
	(0.2971)		(0.7879)		(0.3632)	
$\Delta LnChina_{t-2}$	0.1611		0.07388		0.1104	
	(0.2558)		(0.6986)		(0.3310)	
$\Delta LnII_{t-1}$	-0.03933		0.2794**		0.09392*	
	(0.04517)		(0.09289)		(0.05074)	
$\Delta LnII_{t-2}$	-0.08157**		-0.1418		-0.1139**	
	(0.03335)		(0.1002)		(0.04018)	
$\Delta LnCapital\ cost_{t-1}$	-0.04405**		-0.02411**		-0.03290**	
	(0.01728)		(0.01007)		(0.01115)	
$\Delta LnCapital\ cost_{t-2}$	0.002614		-0.006350		-0.006794	
	(0.01018)		(0.009595)		(0.007172)	
$\Delta LnVA_{t-1}$	-0.03987	-0.3033**	-0.1379	-0.1550	-0.06385	-0.2554**
	(0.06737)	(0.05139)	(0.1200)	(0.1173)	(0.07632)	(0.07174)
$\Delta LnVA_{t-2}$	-0.1370	0.1697*	-0.08240	-0.08590	-0.1119	0.06933
	(0.1188)	(0.09356)	(0.1494)	(0.07051)	(0.08823)	(0.1007)
n	355	384	251	264	606	648
Adj. R^2	0.1612	0.1984	0.2188	0.0606	0.1425	0.1032

The dependent variable is the logged difference of Value added in 2010 prices and the parenthesis contain robust standard errors. All regressions include sector specific fixed effects. ***/**/* represent significance at 1/5/10% respectively.

3.4 Discussion of results

From the 18 regressions, a pattern consistent with previous research emerges. The interaction terms are found to be significant in almost 2/5 of the regressions and with the expected sign of the coefficient in all but one of the regressions. The interaction terms reach significance in tandem with the exchange rate coefficient which increases the robustness of my findings. If the interaction term would have lain dormant whilst the exchange rate reached significance, there would have been more cause for doubt of the hypothesis. A change in the exchange rate would then not have been amplified by the labour-capital ratio but instead by the exchange rate itself or by another factor leveraging the effect.

Since the interaction term and the exchange rate reach significance in less than half of the regressions, another interpretation can be made. The industries where they don´t reach significance wouldn´t have been affected by the exchange rate at all. Those industries may therefore be more affected by other variables which are not included in the model. My results gain less ground since there seems to be no tendency of the exchange rate to reach significance in any particular country or sector. Where the regressions reach significance therefore hinders any classification that a particular industry or country is more susceptible to exchange rate fluctuations and reduces the general applicability of the model.

In more than 3/5 of all the regressions there is no significance reached for the interaction term. If the regression been more robust and the relationship more clear cut, significance would have been reached in all or most of the regression with a tendency towards a specific country or sector of production. The shifting significance of the interaction term and unpredictability of where significance is reached is therefore cause for concern and reduces the usability of the model. Why this shift appears may be due to the way the real effective exchange rate was used. Since the REER is constructed per country basis and not industry basis, there might be some variation in industry specific-REER that is not captured by the aggregate. There might also be other factors influencing output which are not considered in the model and produces unexplained variance. Given that the adjusted R^2 in all 18 models is so low gives reason to believe model lacks explanatory power. The model doesn´t either consider the possibility that there are different effects and magnitudes during a depreciation versus an appreciation which was out of scope for this thesis.

Despite this, there are some valuable insights and ways in which new relations have been discovered. Previous studies such as Palazzo and Rapetti (2017) examined if manufacturers with high labour intensity contributed to export surges in greater effect would have otherwise been expected. My study didn´t use such a method but instead examined if labour intensity created leverage for the exchange rate. My more continuous approach produces a more general interpretation although not as straight forward as Palazzo´s. Using many more different industries than Palazzo´s 4 classifications also makes my approach more general and expand upon their research. Another contribution that my thesis has done compared to other studies is the continuous nature of the interaction term, the exchange rate and the labour-capital ratio. Forbes (2002) divided the labour intensive firms in two equal parts where the median was used as a dividing line. By letting the explanatory variables affect the output in a continuous fashion, more subtleties and nuances can be exploited given the large dataset using my method. In addition to Forbe´s and Palazzo´s study I used a time period which saw no devaluations of the currencies by their respective central banks and no objective of keeping a competitive exchange rate, factors which may have affected output.

4. Conclusion

This thesis has investigated if labour intensity changes the way that a real exchange rate affects output of three small and open Nordic countries. The results are promising to the hypothesis that an increased labour intensity produces a greater effect on output whenever the real exchange rate changes. Although the effect differ in magnitude between the models and countries, it still show the expected sign when they are statically significant. It is very likely that the model doesn´t capture the true relationship, given the high level of unexplained variance and the unusual coefficient from European GDP and the lagged dependent variable. A more complex relationship may exist where differing sizes, directions or other variables contribute to a model with higher R^2. Previous research found that that there is a difference between industries of different labour intensity but did not construct a way for the exchange rate and labour-capital ratio to interact. My findings contribute to previous research by using continuous variables to estimate the affect which aimed at making it more general.

The implications of this thesis are that the industries of the three Nordic countries should not be treated as homogenous. They are different in what they produce, the way that they are made and their response to changes in the real exchange rate. This differing response towards the real exchange rate is increased, the more labour an industry uses. As the world moves on

towards a more labour intensive service oriented economy, so would the economies also become more sensitive towards fluctuations of the exchange rate.

An important policy application is for those states trying to boost their output through the use of the exchange rate in order to avoid or shorten their time in a recession. A country with a heavy reliance on capital intensive production would see its expectations fall short and have only made its citizens poorer in the process, from a depreciation. An important policy implication and hot topic in the financial world for the last few months has been the weak Swedish krona which has caused an uproar from Swedish business leaders. A deteriorating Krona would only have output enhancing effects on labour intensive industries and reducing the position of the capital intensive goods. Future research may optimize the model to make the results more general and to further investigate the relationship that the real exchange rate and labour intensity have on firms´ output.

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