Product Quality and the Human Capital Content of Swedish Trade in 1997 and 2000

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Abstract

This paper contributes to the literature of the human capital content of trade by offering a new computational framework. We use the factor input requirements of each of a country's trading partners when calculating the skill content of imports, in such way that if factor price equalization fails, factor contents should be measured by the production technology of the exporting country. This paper uses vertical intra-industry trade (VIIT) in the calculations of the human capital content of trade: with perfect information, a specific product variety sold at a higher price must be of higher quality than the variety sold at a lower price. Using Swedish data on the manufacturing sector in 1997 and 2000, we found that Sweden had higher skill content in its exports compared to imports for both years.

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This paper has benefited greatly from discussions and comments by …

1. Introduction

Sweden is a small open economy with an external trade that represents about 85 percent of GDP over the period 2000-2015.[1] Therefore it is relevant to learn more about the size and direction of the factor content of the external trade, with special focus on the human capital, which is an important indication of the country's international competitiveness. To our knowledge, there are no published papers focusing on the human capital content of Swedish trade. However, Widell (2005) in a working paper using Swedish data on the manufacturing sector during the period 1990-2000, found that the human capital content in Swedish imports was higher relative to exports. His result might be mainly driven by the calculation of the human capital content of trade using a common technology matrix for both exports and imports,[2] due to factor price equalization between countries in the Heckscher-Ohlin-Vanek (HOV)-model.[3] A common technology matrix excludes any differences in production technology across countries, and therefore the adoption of a common technology matrix for all countries can lead to attenuation bias.[4]

This paper aims to contribute to the literature by offering a new computational framework. We use the factor input requirements of each of a country's trading partners when calculating the skill content of imports, in such way that if factor price equalization fails, factor contents should be measured by the production technology of the exporting country. However, data on factor input requirements for all, or even only the most important exporting countries, are hard to obtain. To overcome this problem, this paper uses vertical intra-industry trade (VIIT) in the calculations of the human capital content of trade: with perfect information, a specific product variety sold at a higher price must be of higher quality than the variety sold at a lower price.[5] Using Swedish data on the manufacturing sector in 1997 and 2000, we found that Sweden had higher skill content in its exports compared to imports for both years. This is opposite to the results reported by Widell (2005) for 1990-2000.

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[1] Own average computed using annual data from the national accounts data at Statistics Sweden, www.scb.se.

[2] Other possible explanations for the results in Widell (2005) are i) that trade in services are excluded from the calculations, due to lack of good data and ii) the exclusion of the public sector from the calculation, which is highly skill-intensive and relatively large in Sweden in comparison with many countries, the supply of skilled workers available to the manufacturing sector become relatively smaller compared to other countries.

[3] See equation 1 below or equation 11 in Widell (2005).

[4] See Trefler (1993 and 1995), chapter 3 in Wood (1994), Davis & Weinstein (2000) and Widell (2005).

[5] Stiglitz (1987) gives several examples also in cases with imperfect information.

The remainder of the paper is organized as follows. Section 2 presents the theoretical framework of factor content of trade and vertical intra-industry trade, which is used to derive the equation used in the calculations of the quality adjusted human capital content of trade in exports relative to imports in Sweden 1997 and 2000. Section 3 introduces the data and the derivation of the equation used in the calculations. Section 4 presents the results together with a robustness analysis. Finally, conclusions are provided in section 5.

2. Theoretical framework

This paper uses the theory behind the factor content of trade and the theory of vertical intra-industry trade to form a theoretical framework for the calculations of the results in section 4.

Factor content of trade

The standard model for predicting factor services trade in a multifactor, multicommodity, and multicountry setting is the HOV-model.[6] According to the HOV-model, countries, in a balanced trade situation, who have an abundant relative endowment of a factor will have an embodied net export of that factor and a net import of a factor in which they have a scarce relative endowment.

The HOV-model is based on a number of assumptions *inter alia* identical technologies across countries; identical and homothetic preferences across countries; differing factor endowments; free trade in products and services and no factor intensity reversals. If those assumptions are fulfilled it will lead to factor (and product) price equalization between countries, i.e., in equilibrium all countries will face a common technology matrix.

The HOV-model can be formalized using the following equation,

$$F^c \equiv AT^c = V^c - s^c V^w \quad (1)$$

where F^c is factor content of trade in country c, A is a vector or matrix of factor input requirements (the technology matrix), T^c is a vector of net trade in country c, V^c is the endowment vector of a specific factor/factors in country c, s^c is a vector of country c's share of world consumption, and V^w is the world endowment vector of a specific factor/factors.

[6] See Vanek (1968), Leamer (1980) and Feenstra (2003).

Net trade in embodied services of production factors *f* for country *c*, i.e., an element in AT^c, and summing over industries *i*, can be written as

$$F_f^c = \sum_{i=1}^{I} T_i^c\, a_{ifc} = \sum_{i=1}^{I} X_i^c\, a_{ifc} - \sum_{i=1}^{I} M_i^c\, a_{ifc} = \sum_{i=1}^{I} X_i^c \sum_{i=1}^{I} x_i^c\, a_{ifc} - \sum_{i=1}^{I} M_i^c \sum_{i=1}^{I} m_i^c\, a_{ifc} \qquad (2)$$

where T_i^c, is net exports for industry *i* in country *c*, X_i^c and M_i^c are exports and imports respectively, from (to) industry *i* in country *c*, x_i^c and m_i^c the share of the *i*:th industry in the total exports and imports respectively, from (to) country *c*, and a_{if} is the use of factor *f* per unit of production from the *i*:th industry.

The comparison of the human capital content of exports and imports can be made in difference form, as in equation (2) above, or as a ratio,[7]

$$z_{fc} = \frac{\sum_{i=1}^{I} x_i^c a_{ifc}}{\sum_{i=1}^{I} m_i^c a_{ifc}} \qquad (3)$$

z_{fc} is a measure of the factor content of exports relative to the factor content of imports of country *c*. It indicates that country *c* is a net exporter if its value is higher than one and it indicates that country *c* is a net importer if its value is lower than one.

Vertical Intra-industry trade

The term intra-industry trade, also known as two-way trade, was first used by Balassa (1966), later catalogued into the Grubel-Lloyd index by Grubel & Lloyd (1971), is one of the important components in each trade economist's toolbox.[8] It implies simultaneous exports and imports of the same statistical product group. However, until the beginning of the 1980s, most of the literature on intra-industry trade has thought of product differentiation as a horizontal phenomenon, meaning that different varieties of a specific product are of a similar quality. Afterwards, there has been a distinction between horizontal intra-industry trade (HIIT) and VIIT that has grown in importance, where VIIT arises when different varieties of the same product are of different qualities.[9] According to Sutton (1986), the one

[7] This structural measure were developed by Lundberg & Wiker (1997).
[8] There have been several other studies confirming the large share of intra-industry trade; see e.g. Abd-el-Rahman (1991) on French data, Crespo & Fontoura (2001) on Portuguese data, Greenaway et al. (1994) on UK data, and Lundberg (1982) and Greenaway & Torstensson (2000) on Swedish data.
[9] The distinction between HIIT and VIIT draws here on Greenaway *et al.* (1994). Lloyd & Grubel (2003), however, note that there was a different distinction earlier in the literature, dated back to the mid-1970s,

product with the highest quality will be preferred by all consumers, given two varieties of the same product offered at the same price. Hence, if products that are both exported and imported are vertically differentiated, it is reasonable to expect that the difference in product quality is associated with differences in human capital content, i.e., a high quality product implies a higher content of skilled labor than low quality products.[10]

Since international specialization does not only emerge in countries specializing in producing products in different industries, but of different varieties of products within the same industry both vertically and horizontally, the different types of international trade have to be separated. Another reason for doing this is that the trade expansion have different implications on factor markets since the determinants behind VIIT and HIIT differ (see, e.g., Aturupane *et al.*,1999, and Torstensson, 1992 and 1996a). Empirically, Greenaway *et al.* (1995; 1999) find that VIIT is markedly more important than HIIT for the UK. Fontagné & Freudenberg (1997) find similar results using intra-EU trade. But, Hansson (1994) finds that VIIT in the Swedish manufacturing sector in 1983 is an important determinant of intra-industry trade and that it is most common in trade with other developed countries.

One problem is how to empirically distinguish between HIIT and VIIT in the trade data. Earlier studies, (e.g., Greenaway *et al.* 1994 and Fontagné & Freudenberg 1997) use unit value ratios together with a dispersion factor to find the two forms of intra-industry trade. In a more recent study, Azhar & Elliot (2006) used a different method based on the share of HIIT or VIIT in total intra-industry trade. They used an index that has symmetrical limits and is equally distributed between both lower and upper bounds.

There is, however, not a straightforward theoretical link between product quality,[11] price and human capital.[12] Greenaway & Milner (1986) has

where HIIT meant the exchange of competing or substitute products while VIIT meant the exchange of products at different stages in the production process of the products.

[10] Celi (1999) also uses the assumption that VIIT is driven by differences in skill content. Greenaway *et al.* (1994) and (1995) implicitly assumes the same, since they use the ratio of manual workers to total employment of each industry as a proxy variable for quality differentiation.

[11] Two ways to measure quality has been proposed in the literature by Cooper et al. (1993) (hedonic pricing) and Brenton & Winters (1992) (price elasticities). A problem with both those methods are that they are too data intensive and more appropriate to use in analyses of individual product markets compared to the multiproduct analysis carried out here. However, Redding (1996) argues that a country's scarcity in education and other types of training is highly related to firms' product quality investments.

[12] Stokey (1990), however, develops a growth model with heterogeneous labor, differentiated by human capital, as the only factor of production and where she assumes that higher-skilled labor produces higher-quality products.

suggested, though, that it is human capital and not physical capital that is highly positively related to product quality. Torstensson (1996b) draws on this suggestion and reports empirical evidence that human capital is more important than physical capital in influencing the quality of vertically differentiated products in Swedish imports in 1985 and 1986. However, Hansson (1994) finds a weak empirical support for the relationship between quality (measured by price per tonne) and capital intensity (physical and/or human) using data on the manufacturing sector in 1983. But, Greenaway & Torstensson (2000) finds that abundant human capital endowment increases the quality of the OECD countries manufacturing exports, using Swedish data from 1969, 1981 and 1994.

3. Data and method of computation

3.1 Data

Our final data is extracted both from the COMTRADE database from the United Nations Statistics Division and linked data from Statistics Sweden.[13]

The COMTRADE data consists of Swedish bilateral commodity trade, i.e., both imports and exports, with all its partner countries, classified according to SITC rev.3 at 4/5-digit level for the years 1997 and 2000. Small trade volumes, with a value less than 20,000 USD will be removed from the data together with trade flows without any information on quantity.[14] The data are reported both in monetary units (in USD) and in quantity units (e.g., in tonnes).[15]

The linked data from Statistics Sweden cover all Swedish firms and consists of several linked register-based data sets, i.e., Labor Force Statistics (RAMS), Industrial Statistics/Financial Statistics (IS/FS) and the Foreign Trade Statistics. From RAMS both total wages and wages by educational groups were collected at 4-digit ISIC rev.3 level, with skilled labor measured using educational attainment levels[16]; and from IS/FS total wages and gross production at the same 4-digit ISIC rev. 3 level have been collected. Wage

[13] See table A.1 in appendix for a condensed presentation of the data.
[14] Following Aturupane *et al.* (1999), Crespo & Fontoura (2001) and Gullstrand (2002), small trade volumes will be removed from the sample together with trade flows without any information on quantity. Other limits than 20,000 USD have been tested, e.g. 10,000 USD and 0 USD, and it gives only very small (or no) effect on the calculated z-values in equation (9). Results from those calculations are available upon request from the author.
[15] The COMTRADE data will only be used in calculating the industry weights (IndUVR) in equation (9).
[16] A broad definition of human capital includes all characteristics of the labor force that gives in return a higher productivity of the worker, e.g. education, on-the-job and off-the-job training. Educational attainment is used as the measure of human capital, since the other two are difficult to measure.

taken from RAMS is annual earnings and wage taken from IS/FS is labor costs inclusive of social security costs. Exports and imports at the same ISIC level were collected from the foreign trade statistics. The chosen years for the study were 1997 and 2000. In this paper only the manufacturing sector were investigated, i.e., industries 1511-3720 (ISIC rev.3).

The choice of years in the study are restricted by the available data. The human capital content of trade in exports compared to imports in 1997 is calculated, with all data originating from 1997, and in 2000, with product trade data from 2001 and all other data from 2000. In 1997 (year 2000 within parenthesis), the COMTRADE data contains around 51 500 (53 000) observations on import values and 77 000 (79 500) observations on export values. In the calculations of unit value ratios, equation (4), around 27 000 (29 000) bilateral observations are used. After calculating equation (7) around 2 100 (2 200) observations (unique products) remain and when calculating equation (8) around 115 (115) observations (unique industries) remain. The dataset from Statistics Sweden contains around 220 (220) observations on industry level.

3.2 The method of computation

The most common way to separate different product quality levels in datasets is to calculate a unit value (UV) by dividing the monetary value of trade by the quantity, resulting in for example a price per tonne.[17] The rationale for using unit values is that a product of a higher quality should get a higher price. Therefore, it can be considered as an, although not perfect, proxy of quality.[18] In this context, when measuring the human capital content of net trade, it is reasonable to assume that differences in product quality are associated with differences in skill content. This implies that a high quality product should incorporate a high content of skilled labor.

The calculation of a VIIT adjusted[19] human capital content of trade in Swedish exports relative to imports follows a step-by-step procedure according to the following. First, the unit-value ratio of a product *p*, defined by

$$UVR_{pic} = \frac{UV_{pic}^{x}}{UV_{pic}^{m}} \tag{4}$$

[17] Torstensson (1991), on the contrary, uses unit values per item as an alternative to unit values per tonne.
[18] See Stiglitz (1987). However, Nielsen & Lüthje (2002) discuss that unit-value ratios are poor indicators of quality. Since a better alternative measure of quality haven't been found, unit values is the choice in this study.
[19] This will be referred to as *quality adjusted* from now on.

where *p* denote product, *i* industry , *c* country, between Swedish exports (*x*) and imports (*m*) is calculated for each single bilateral trade flow,[20] using data from COMTRADE at SITC rev. 3 (4/5-digit). Following Greenaway *et al.* (1995) the distinction between horizontal- and vertical IIT is performed using,

$$\begin{aligned} &HIIT: (1-\alpha) \leq UVR_{pic} \leq (1+\alpha) \\ &VIIT: (1-\alpha) > UVR_{pic} > (1+\alpha), \end{aligned} \tag{5}$$

where α denote the dispersion factor.[21] The UVR_{pic} need to be logarithmized in order to ensure symmetry between the lower and upper bounds in terms of their relative distance from unity when distinguishing between VIIT and HIIT.[22] This implies the following equation,

$$\begin{aligned} &HIIT: \log(1-\alpha) \leq \log UVR_{pic} \leq \log(1+\alpha) \\ &VIIT: \log(1-\alpha) > \log UVR_{pic} > \log(1+\alpha), \end{aligned} \tag{6}$$

which are the equations used for distinguishing between VIIT and HIIT.

The unit value ratios that are revealed to be of the horizontal category (HIIT) will be set to 1, while those that are revealed by equation (6) to be vertical (VIIT) will keep the calculated values from equation (4).[23]

Secondly, the unit value ratios for each product will be aggregated separately using trade weights, i.e., by SITC rev. 3 products, according to,

$$ProdUVR_{pi} = \sum_c \left(UVR_{pic} * \frac{(X_{pic}+M_{pic})}{\sum_{UVR \in \Omega_p}(X_{pic}+M_{pic})} \right) \forall_p \tag{7}$$

[20] I.e., unit value of Swedish export of product p_1 to country c_1 divided by the unit value of Swedish import of product p_1 from country c_1.

[21] There is no firm theoretical support for what α to use in the calculations and how the limits should be calculated (Ito and Okubo, 2012). Greenaway et al (1994), on the one hand, checks if the calculated value lies within an interval [(1-α), (1+α)], which indicates HIIT, or not, which indicates VIIT. Fontagné & Freudenberg (1997), on the other hand, use the interval [1/(1-α), (1+α)], with a similar interpretation. In this study, three values on α (0.00, 0.15 and 0.25) will be used to see how sensitive the results are from using different dispersion factors.

[22] See Fontagné & Freudenberg (1997) and the discussion about the “proportionality” effect in Azhar & Elliot (2006) for a more thorough treatment of this issue.

[23] The separation between HIIT and VIIT is made by equation (6), but equation (4) is used (after setting the horizontal category to 1) hereafter, since unit value ratios less than one will have a negative value in its logged form.

where Ω_p is the set of unit value ratios (UVR_{pic}) that belong to a specific product p.

Thirdly, the products that belong to each industry group according to the 4-digit level of ISIC rev.3 will be aggregated. The allocation of products to industries was based on a correspondence table between SITC rev. 3 (4/5 digit) and ISIC rev. 3 (4-digit) attained from the Eurostat classification server Ramon.[24] This is done according to the following,

$$IndUVR_i = \sum_p \left(ProdUVR_{pi} * \frac{(X_{pi}+M_{pi})}{\sum_{p\in\Omega_i}(X_{pi}+M_{pi})} \right) \forall_i \quad (8)$$

where Ω_i is the set of products that belongs to a specific industry i. This gives a set of industry weights that will, in the next step, either scale up or scale down the skill intensity in the separate industries respectively. These industry weights are used as a weighting scheme in calculating the human capital content of exports relative to imports in Sweden in 1997 and 2000.

The equation used in measuring the human capital content of trade in exports relative to imports, adjusted for quality differences, is derived from equation (3). If a superior (high quality) VIIT is revealed within an industry in equation (6), the factor input requirements of skilled labor in imports, i.e., the denominator in equation (3), will be weighed down by the $IndUVR_i$-number from equation (8) and the opposite for inferior (low quality) VIIT.[25] The *adjusted* equation (3) will then become,

$$z_{fc} = \frac{\sum_{i=1}^{I} x_i^c a_{ifc}}{\sum_{i=1}^{I}(m_i^c a_{ifc}/IndUVR_i)} \quad (9)$$

The interpretation of the adjusted z-measure in equation (9) is straightforward: the average requirements of a factor f, weighted by trade shares, per unit of exchange of exports, compared to the average requirements of the imports, adjusted for quality differences. This gives us information about the difference in export and import structure with respect to a particular factor's intensity in products and services (taken the quality differences into account), regardless of the trade balance. Equation (9) will form the basis of the empirical analysis in section 4.

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[24] See http://europa.eu.int/comm/eurostat/ramon.

[25] The *IndUVR*'s are not used to actually indicate the skill-intensity of a particular product or industry. Instead they are used to scale relative factor intensity among partner countries given a particular factor intensity that is industry specific.

The method proposed for calculating quality adjusted human capital content of trade builds on two assumptions. The first assumption is that the price, measured by unit-value ratios of a product p in a given industry i, UVR_{pi}, is proportional to the input requirements of skilled labor in that industry, i.e., $a_{pif} = b_f \times UVR_{pi}$, where b_f is a constant and sub-index f indicates factors; second, that the constant b_f is identical among all industries i for each factor f.

Finally, a note on the factor input requirements, i.e., variable a_{ifc} in equation (9). Theoretically total factor input requirements shall be used in the calculations of the factor content of trade (see e.g. Hamilton & Svensson (1983) or Deardorff (1984)). However, since Statistics Sweden only has published symmetrical input-output tables on a highly aggregated level[26], direct factor input requirements will be used instead when calculating the z-value in equation (9). Widell (2005) have shown that, using equation (3), both the choice of total- over direct factor input requirements on a 2-digit level (ISIC rev. 3) and the choice of aggregation level of the data do matter in a cross-sectional approach (as is done here). Feenstra & Hanson (2000) also show that aggregating different industries together gives a substantial aggregation bias.

4. Results and robustness analysis

4.1 Results

Table 4.1 reports the quality adjusted human capital content of Swedish exports relative to imports (the z-value) in 1997, i.e., calculations using equation (9). Regardless of the dispersion factor α and of groups of countries analyzed, the quality adjusted human capital content values are higher than one, implying that Swedish exports are more skill intensive than imports in 1997. However, the calculated values using Swedish trade with non OECD-countries (column 4) are higher than those using OECD-countries[27] (column 3). This result might be explained by the fact that OECD countries have a skill content in products more similar to Sweden and, therefore, are imports from those countries expected to be of similar quality to those products produced in Sweden.[28]

[26] Statistics Sweden has published IO-tables for 1995 and 2000 on a 2-digit ISIC rev.3 level.
[27] The OECD dataset contains those countries that were members of the OECD in January 1, 1997.
[28] See Wood (1994) for a similar argument about quality differences between North (developed countries) and South (developing countries).

Table 4.1 *The quality adjusted human capital content of Swedish exports relative to imports in 1997*

Dispersion factor (α) (1)	z-value (all countries) (2)	z-value (OECD) (3)	z-value (non-OECD) (4)
0.25	1.380	1.348	1.626
0.15	1.381	1.350	1.624
0.00	1.380	1.349	1.624

Notes: The calculations are based on equation (9). The "all countries" z-value is based on a dataset including all of Sweden's trade partners; the "OECD" z-value is based on a dataset including Sweden's trade with the OECD countries only; and the "non-OECD" z-value is based on a dataset including Sweden's trade with the non-OECD countries only. Limit trade value: 20 000 USD.

Table 4.2 reports that the quality adjusted human capital content of Swedish exports relative to imports (the z-value) in 2000 are higher than one, regardless of α and analyzed data set. This implies that Swedish exports were more skill intensive than imports even in 2000. Furthermore, the calculated values using Swedish trade with non OECD-countries (column 4) are also in year 2000 higher than those using OECD-countries (column 3).

Table 4.2 *The quality adjusted human capital content of Swedish exports relative to imports in 2000*

Dispersion factor (α) (1)	z-value (all countries) (2)	z-value (OECD) (3)	z-value (non-OECD) (4)
0.25	1.653	1.599	1.761
0.15	1.651	1.596	1.760
0.00	1.652	1.597	1.759

Notes: The calculations are based on equation (9). The "all countries" z-value is based on a dataset including all of Sweden's trade partners; the "OECD" z-value is based on a dataset including Sweden's trade with the OECD countries only; and the "non-OECD" z-value is based on a dataset including Sweden's trade with the non-OECD countries only. Limit trade value: 20 000 USD.

The values of quality adjusted human capital content of exports relative to imports reported for 2000 (Table 4.2) are higher than the values computed for 1997 (Table 4.1), which indicates either an increased skill intensity in Swedish exports or a decreased skill intensity in Swedish imports between the years.

4.2 Robustness analysis

To find out whether our results from the calculations of the quality adjusted human capital content of trade in Sweden 1997 and 2000 are reliable or not, a different measure is constructed using a slightly different approach to quality adjustment in the technology matrix introduced by Trefler (1995). Trefler (1993, 1995) develop extended versions of the HOV-model allowing for technological differences between countries. In the 1993-study, all factors in every country are allowed to differ in their productivities, while in the study from 1995, the factor input requirements matrix are allowed to differ across countries. The difference between the two ways of allowing for technological differences are that in the first case, a factor in a country is assumed to be, for example, 5 percent more productive than in another country, while in the second case, a country is assumed to need 5 percent more of a production factor to produce the same amount of products than another country. The Trefler (1995) method of allowing for technological differences will form the basis for the model used in the robustness analysis.

Following Trefler (1995), a recalculation of equation (9) have been done as follows,

$$z_{fc} = \frac{\sum_{i=1}^{I} x_i^c a_{ifc} \left(\frac{\bar{a}_{ifc}^{VH}}{\bar{a}_{ifc}^{tot}} \right)}{\sum_{i=1}^{I} m_i^c a_{ifc} \left(\frac{\bar{a}_{ifc}^{VL}}{\bar{a}_{ifc}^{tot}} \right)} \tag{10}$$

where $\bar{a}_{ifc}^{VH}$ is the average factor input requirements of those industries that are revealed to produce high quality products (VIIT high) in equation (10), $\bar{a}_{ifc}^{VL}$is the average factor input requirements of those industries that are revealed to produce low quality products (VIIT low); and $\bar{a}_{ifc}^{tot}$ is the average factor input requirements for all industries. The motivation for using average values is that a high quality product is assumed to be produced with higher skill content and *vice versa* with a low quality product. The distinction between VIIT high and VIIT low is done as previously following equation (6).

Table 4.3 presents results from the calculations of the Trefler (1995) adjusted average human capital content of exports relative to imports in the Swedish manufacturing sector in 1997 and 2000. Even these results suggest that

Swedish exports are more skill intensive relative to imports for both years.[29] However, the values of Trefler (1995) adjusted average human capital content of exports relative to imports reported for all countries and OECD-countries in 1997 are higher than the values computed for 2000 (Table 4.3). This indicates either a decreased skill intensity in Swedish exports or an increased skill intensity in Swedish imports between the years.

Table 4.3 *Trefler (1995) adjusted average human capital content of Swedish exports compared to imports in 1997 and 2000*

Year (1)	z-value (all countries) (2)	z-value (OECD) (3)	z-value (non-OECD) (4)
1997	1.198	1.117	1.153
2000	1.041	1.045	1.270

Notes: The "all countries" z-value is based on a dataset including all of Sweden's trade partners; the "OECD" z-value is based on a dataset including Sweden's trade with the OECD countries only; and the "non-OECD" z-value is based on a dataset including Sweden's trade with the non-OECD countries only. All calculations are based on equation (10). Limit trade value: 20 000 USD; Dispersion factor (α): 0.25.

The results based on Trefler (1995) are reverse to our results produced with the algorithm in equation (9) and presented in Section 4.1. The Trefler (1995) adjusted values for non OECD-countries, on the contrary, follows those results presented in section 4.1, with a higher value in 2000 compared to 1997. The calculated values for non OECD-countries are higher than those for OECD-countries in both years. However, values presented for all countries are higher compared to OECD-countries and non OECD-countries in 1997 and lower than those countries in 2000. This result might be explained by the use of averages of aggregated data in the calculations.

5. Conclusions

This paper has presented results from calculations of quality adjusted human capital content of exports relative to imports in the Swedish manufacturing sector in 1997 and 2000. The quality adjustment were made using the idea of quality differences between products within the same statistical product group (vertical intra-industry trade) in the calculations.

[29] Other values of the dispersion factor than $\alpha = 0.25$ have been tested, e.g. 0.15 and 0.00, and it gives only very small (or no) effect on the calculated z-values in equation (10). Results from those calculations are available upon request from the author.

Using product trade data from COMTRADE[30], linked with Swedish register data on the manufacturing sector in 1997 and 2000, we found that Sweden had higher skill content in its exports compared to imports for both years. Our results are different from Widell (2005), who reported that the skill content in Swedish imports was higher relative to exports for 1990-2000.[31] However, the calculations in this study hinges on the idea that a specific product variety sold at a higher price must be of a higher quality than the variety sold at a lower price. Furthermore, the results also shows that the presented values of the human capital content of exports relative to imports has increased between the two years indicating either an increased skill intensity in Swedish exports or a decreased skill intensity in Swedish imports between the years.

A general conclusion is that Sweden is revealed by trade to have a higher skill content in its exports compared to imports. If the quality adjustment of the human capital content of exports relative to imports is reliable, and that the choice of years are representative for the adjacent time-period, the skill intensity in Swedish net trade of manufacturing products has been increasing over the years.

In order to extend this study, the same calculations as in Section 4 can be done using either more recent data or by calculating values for adjacent years.

[30] A database from the United Nations Statistics Division.

[31] The results reported in Widell (1995) were 0.906 in 1997 and 0.890 in 2000.

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Appendix

Variable definitions and data source

Table A.1 *Variable definitions and data description*

Variable definition	Data source
- Export (product) - Import (product)	Trade data (exports and imports in values and quantities) from the UN statistics database COMTRADE, classified according to SITC rev.3 and recorded at the 4/5-digit level. Values are recorded in US dollars.
- Export (industry) - Import (industry)	Trade data (exports and imports in values) from the foreign trade statistics at Statistics Sweden, classified according to ISIC rev. 3 (SNI-92) and recorded at the 4-digit level. Values are recorded in Swedish kronor.
Factor input requirements (a_{ifc} in equation 2, 3 and 9) Variables: - Total wages by industry - Total wages by educational group and industry	Data collected from Statistics Sweden's database RAMS (register based labor market statistics). All data is classified according to ISIC rev.3 and recorded at the 4-digit level.
Factor input requirements (a_{ifc} in equation 2, 3 and 9) Variables: - Total wages by industry - Gross production by industry	Data collected from Statistics Sweden's database IS/FS (industrial statistics/ financial statistics). All data is classified according to ISIC rev.3 and recorded at the 4-digit level.

Note! The COMTRADE database can be found at: http://unstats.un.org/unsd/comtrade/default.aspx; and the various databases from Statistics Sweden can be found at: http://www.scb.se.