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Estimation of substitution and transformation elasticities for South African trade

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Abstract: The objective of this paper is to estimate transformation and Armington substitution elasticities for South African trade. We use linear methods to estimate elasticities without growth factors. We then employ a non-linear system of equations to estimate Armington import elasticities and related growth factors. Using the linear estimation method, we find positive (0.386-1.379) short-run Armington substitution elasticities for most studied industries. Moreover, positive transformation elasticities for exports contradict our assumption that increased relative export prices result in increased exports. The results of the non-linear estimation suggest that growth affects imports more than domestic consumption of domestic production in the manufacturing industry.

Keywords: South Africa, trade, Armington elasticity, constant elasticity of transformation
JEL classification: F1

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1 Introduction

The Armington import demand elasticity and constant elasticity of transformation (henceforth CET) for export supply are key parameters for trade policy analysis. Armington elasticity is based on the assumption that the same kinds of commodities of different origin are not perfect substitutes in demand (Armington 1969). Whereas for the CET assumption, in the context of trade, the commodities sold at different market destinations are imperfect substitutes in supply. Armington elasticity represents the degree of substitutability between domestic and imported commodities due to changes in the relative prices of these commodities, while CET is the degree of substitutability between exported commodities and those sold at the domestic market. These trade elasticities play a major role in computable general equilibrium (CGE) modelling that is used to assess the impacts of trade and other policies. The outcomes of CGE models are almost invariably sensitive to trade elasticities, and therefore the proper estimation of CETs and Armington elasticities is vital for reliable CGE modelling (Gallaway et al. 2003).

The objective of this work is to estimate Armington and CET elasticities and functions for different industries of South Africa. We first estimate the short- and where possible, long-run elasticities using the most common approach in previous Armington elasticity literature. This method applies the first order conditions of cost minimization for Armington function, and first order conditions of revenue maximization for CET function, in order to use linear methods to estimate the elasticities. Next, we employ a non-linear method to estimate normalized Armington functions by feasible generalized least squares estimators. Previously this method has been mainly applied to study constant elasticity of substitution, and direction of technological growth between capital and labour (for details about the methodology see Klump et al. 2007 and 2011; León-Ledesma et al. 2010, and for application on South Africa see Kreuser et al. 2015). The advantage of non-linear estimation of normalized Armington function is that it allows us also to estimate growth factors, which affect the relative value (value shares of the total composite supply) of DCDP and imports over time.

The rest of this paper is organized as follows. Section 2 presents the Armington and CET functions and the methods for their estimation. Section 3 describes the data used in the estimations. The results are presented and discussed in Section 4. Section 5 concludes the paper.

2 Background and estimation procedure

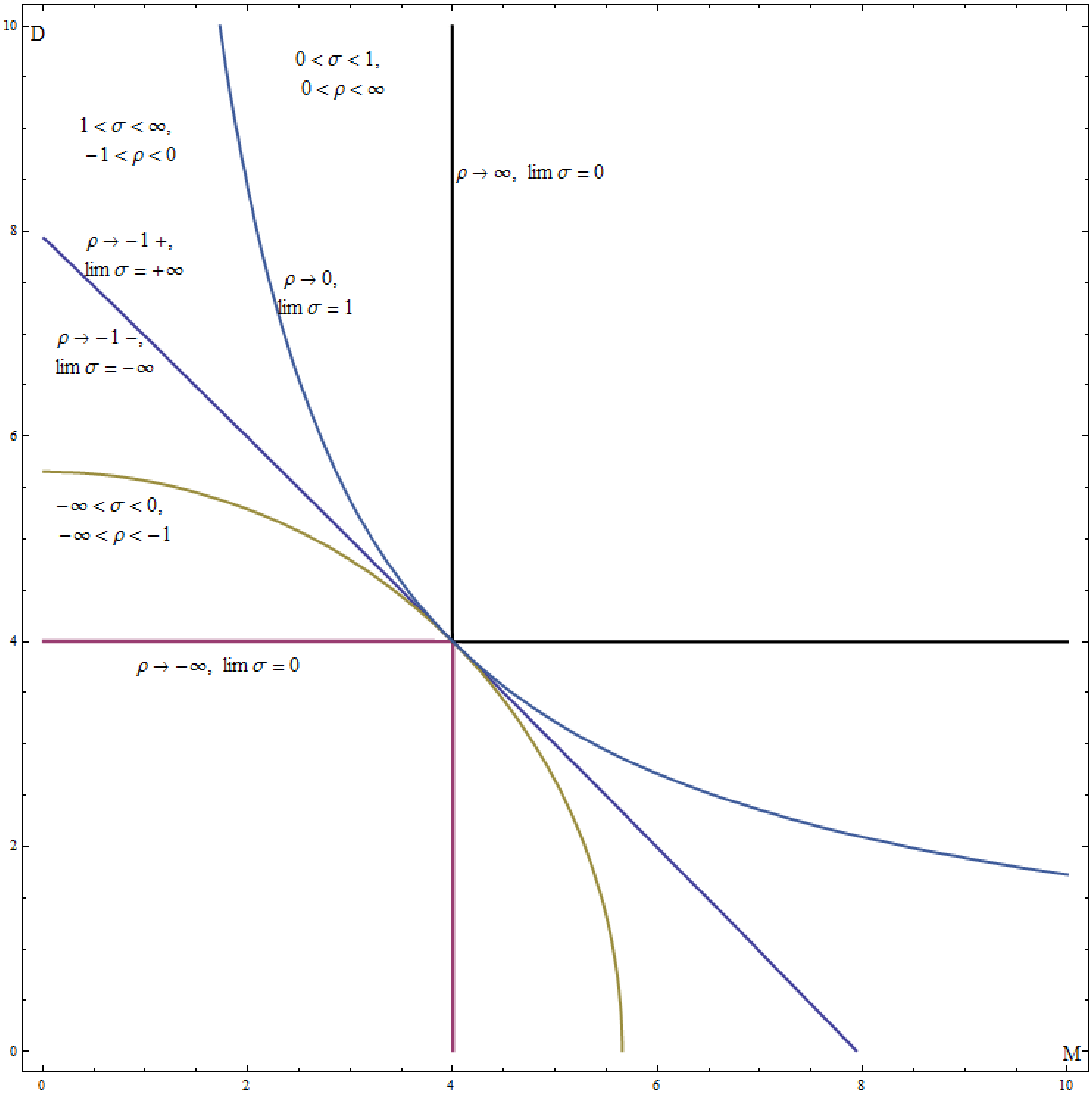
2.1 Background

We assume that a representative consumer draws utility from the composite supply of domestic and imported goods. This forms the basis for an Armington function, whereas for CET function the assumption is that producers face a production possibility frontier between domestic and exported goods. The unnested Armington or CET function that formalizes the concept of constant elasticity of substitution or transformation can be defined simply as:

$$Y = \gamma(\delta M^{-\rho} + (1 - \delta)D^{-\rho})^{-1/\rho}, \tag{1}$$

where Y is the output, which can be perceived as the composite supply for Armington function and aggregate marketed domestic production for CET function. Input M denotes the imports in Armington function and exports in the CET function and D is the domestic consumption of domestic production (henceforth DCDP). γ is the shift parameter. The share parameter that defines the distribution between imports/exports and DCDP is denoted by δ, and finally ρ is a function exponent that defines the constant elasticity between the inputs. This elasticity is given by $\sigma = 1/(1+\rho)$, where it is assumed that $\rho \in (-1,0) \cup (0,\infty)$ for an Armington function and $\rho < -1$ for a CET function (Lofgren et al. 2002). The values of ρ are assumed to be members of these given sets to assure that the isoquant is concave to origin and convex to origin for Armington function and CET function respectively. The concavity and convexity of the Armington and CET function isoquants are illustrated in Figure 1, where all isoquants are drawn assuming equal Armington and CET function outputs and parameters, except the function exponent.

Figure1: Isoquants of Armington and CET functions



Source: Author's own illustration based on Equation (1).

In order to employ a linear estimation method, we use first order conditions of cost minimization for Armington function, and first order conditions of revenue maximization for CET function to define the logarithmic ratios between imports/exports and DCDP:

$$\ln\left[\frac{M}{D}\right] = \sigma \ln\left[\frac{\delta}{1-\delta}\frac{p_D}{p_M}\right], \tag{2}$$

where p_D and p_M denote the prices of DCDP and imported/exported products. If the concavity and convexity assumptions of isoquants are assumed to hold, the constant elasticity σ needs to be positive for Armington function and negative for CET function. These assumptions ensure that an increase in the relative price $\frac{p_D}{p_M}$ increases the ratio between imports and DCDP for Armington function and decreases the ratio between exports and DCDP for the CET function.

2.2 Estimation procedure

For estimation purposes, equation (2) can be rewritten as:

$$y = \alpha + \beta x, \tag{3}$$

where $y = \ln\left[\frac{M}{D}\right]$, $x = \ln\left[\frac{p_D}{p_M}\right]$, $\alpha = \sigma\ln\left[\frac{\delta}{1-\delta}\right]$ and β is the constant elasticity of substitution or transformation σ for the Armington or CET function respectively. We follow the work by Gallaway (2003) and take into account possible non-stationarity and co-integration of the data to estimate long-run elasticity estimates, where possible. This approach has also been previously applied to estimate Armington elasticities for South Africa (Gibson 2003). However, due to the data issues, Gibson (2003) was not able to define long-run elasticities for most of the industries in her paper.

We first study the stationarity and co-integration of our data by the weighted symmetric unit root test and the Engle-Granger procedure. Then, one of the following estimation equations is applied to estimate the elasticities for given industry according to stationarity and co-integration of the data. If both x and y are stationary the following estimation model is estimated:[1]

$$y_t = \alpha + \beta_1 x_t + \beta_2 y_{t-1} + u_t\,, \tag{4}$$

where u_t is an iid error term. Long run elasticity is $\hat{\sigma}_{LR} = \beta_1/(1-\beta_2)$ if $0 < \beta_2 < 1$, otherwise β_1 is the short run elasticity $\hat{\sigma}_{SR}$. If both x and y are non-stationary and cointegrated, then the following estimation equation is employed:

$$\Delta y_t = \alpha + \beta_1 \Delta x_t + \beta_2 y_{t-1} + \beta_3 x_{t-1} + u_t\,, \tag{5}$$

where $\Delta y_t = y_t - y_{t-1}$ and $\Delta x_t = x_t - x_{t-1}$. Short-run elasticity is $\hat{\sigma}_{SR} = \beta_1$ and long run elasticity is $\hat{\sigma}_{LR} = -(\beta_3/\beta_2)$. If both x and y are non-stationary and not cointegrated or if only one of them is non-stationary, then the estimation is defined by equation:

$$\Delta y_t = \alpha + \beta_1 \Delta x_t + u_t\,, \tag{6}$$

[1] Outliers of the data are handled in the linear estimation by adding factor dummies for each outlier year (max three for each industry).

where $\hat{\sigma}_{SR} = \beta_1$is the short-run elasticity.

Finally, we estimate elasticities and input specific growth rates for Armington function using a non-linear estimation method and normalized functional form (Klump et al. 2011). The input specific growth rates define how much the given input's share of the total output value grows over time. Thus, growth rates reflect the change in the relative utility value between the inputs. In order to take growth effects into account, we redefine the Armington function (1) for time period t and industry i in logarithmic normalized form with growth parameters γ_{Mi} and γ_{Di}:

$$\ln(\frac{Y_{it}}{\tilde{Y}_i}) = \ln(\xi_i) + \frac{\sigma_i}{\sigma_i - 1}\ln(\bar{\delta}_i(e^{\gamma_{Mi}(t-\bar{t})}\frac{M_{it}}{\tilde{M}_i})^{\frac{\sigma_i - 1}{\sigma_i}} + (1-\bar{\delta}_i)(e^{\gamma_{Di}(t-\bar{t})}\frac{D_{it}}{\tilde{D}_i})^{\frac{\sigma_i - 1}{\sigma_i}}), \qquad (7)$$

where $\bar{\delta}_i$ is the arithmetic mean of value share of imports of the output Y, and $\bar{t}$ is the arithmetic mean of the time period. $\tilde{Y}_i, \tilde{M}_i$ and $\tilde{D}_i$ represent the geometric means of output, imports, and DCDP respectively (for more about normalized CES functions and their estimation, see for example Klump et al. 2007; León-Ledesma et al. 2010; Kreuser et al. 2015). ξ_i is a normalization constant to control for the biases due to the use of geometric means in the normalization. It is assumed to be close to unity. σ_i is the constant Armington elasticity. Following the first order conditions of cost minimization, the logarithmic prices for imports and domestic production are defined as (Klump et al. 2011):

$$\ln(p_{M_{it}}) = \ln(\bar{\delta}_i\frac{\tilde{Y}_i}{\tilde{M}_i}) + \frac{1}{\sigma_i}\ln(\frac{Y_{it}/\tilde{Y}_i}{M_{it}/\tilde{M}_i}) + \frac{\sigma_i - 1}{\sigma_i}(\ln(\xi_i) + \gamma_{Mi}(t-\bar{t})) \qquad (8)$$

$$\ln(p_{D_{it}}) = \ln((1-\bar{\delta}_i)\frac{\tilde{Y}_i}{\tilde{D}_i}) + \frac{1}{\sigma_i}\ln(\frac{Y_{it}/\tilde{Y}_i}{D_{it}/\tilde{D}_i}) + \frac{\sigma_i - 1}{\sigma_i}(\ln(\xi_i) + \gamma_{Di}(t-\bar{t})) \qquad (9)$$

A system of equations (7)-(9) is estimated jointly to attain estimates for the elasticity and growth parameters. For CES production functions, the estimation of the normalized production function together with the first order conditions has proven to be superior to single equation approaches (León-Ledesma et al. 2010). We apply similar system of equations to the context of Armington functions. An estimation method of non-linear equation systems *nlsystemfit* provided by the R-software *systemfit* package is used to estimate this system of equations. We employ a feasible generalized least squares version of a two-stage least squares estimator (aka three-stage least squares estimator) *3SLS* that allows the errors across regressions to be contemporaneously correlated, and controls for the endogeneity of the regressors in the equation system (Henningsen and Hamann 2007, 2015).

3 Data sources and descriptive statistics

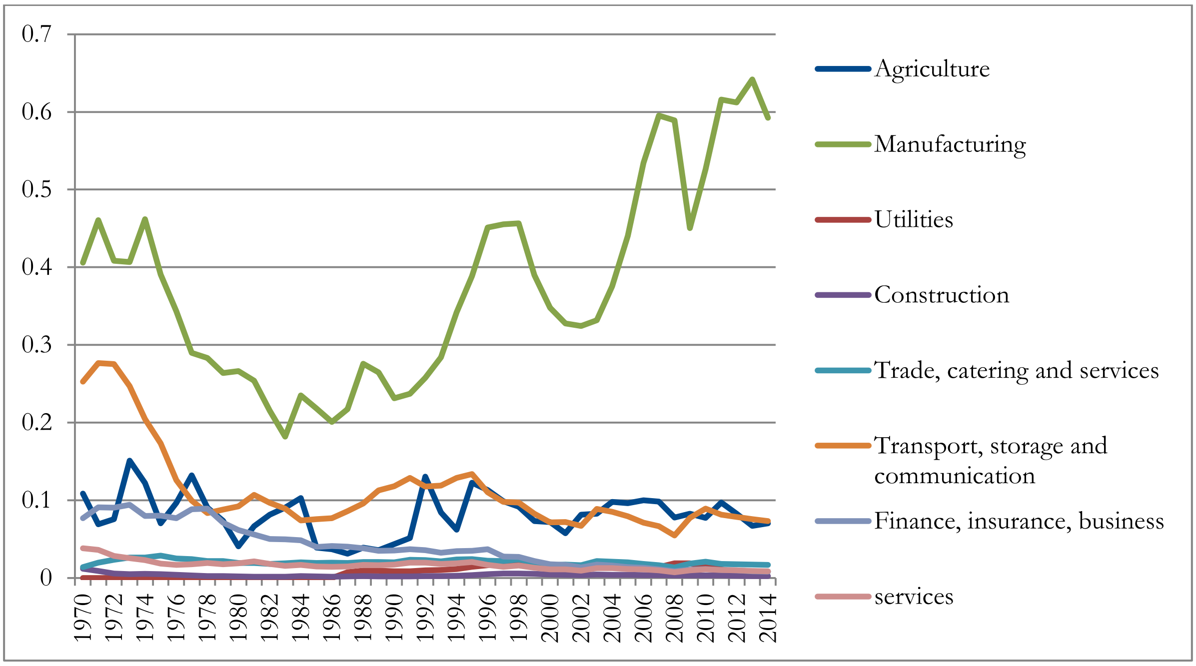
3.1 Price and quantity data

All data series are derived from the input/output tables of the Quantec-database provided by the National Treasury of South Africa.[2] The Quantec database provides annual data for 64 industries

[2] This data can be obtained from www.quantec.co.za. Requires permissions to use the data. We further use consumer price indices for an additional estimation of export supply elasticities. These price indices can be obtained from http://data.worldbank.org/indicator/FP.CPI.TOTL.

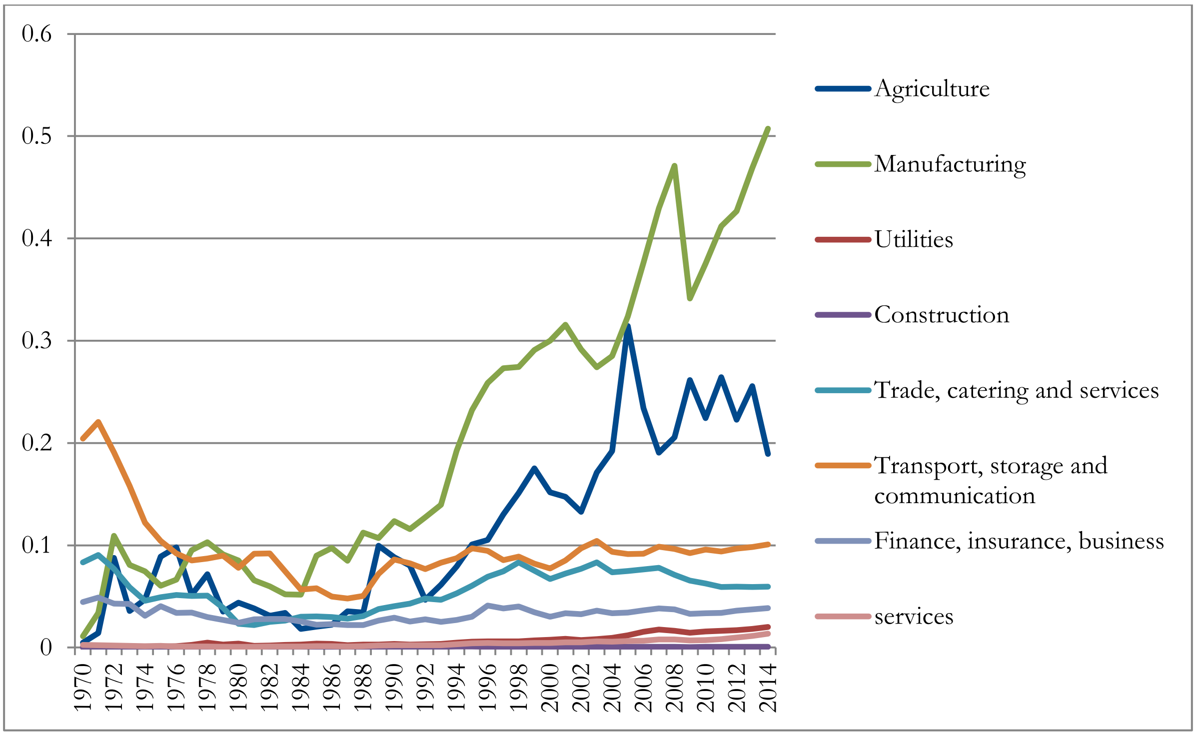
from as early as 1970. This leaves us with 45 observations for each industry. For both Armington and CET functions, one of the inputs D is the real valued (in 2010 South African rands) domestic consumption of domestic production (DCDP). It is defined as the total domestically produced output, including intermediate input and final output, minus the exports. The other input M is the absolute value of real imports for the Armington function and real exports for the CET function. Figures 2 and 3 illustrate the ratio of imports or exports and DCDP over the studied time period of 1970-2014 for the main aggregated industries (excluding mining and quarrying). From these figures, we can see that for industries other than manufacturing, the imports during recent years have been less than 10 per cent of the DCDP, whereas in the case of exports the highest ratios are for manufacturing and agriculture.

Figure 2: Ratio between real valued imports and real valued DCDP for all main aggregated industries except mining and quarrying



Source: Author's own calculations based on the data from Quantec database.

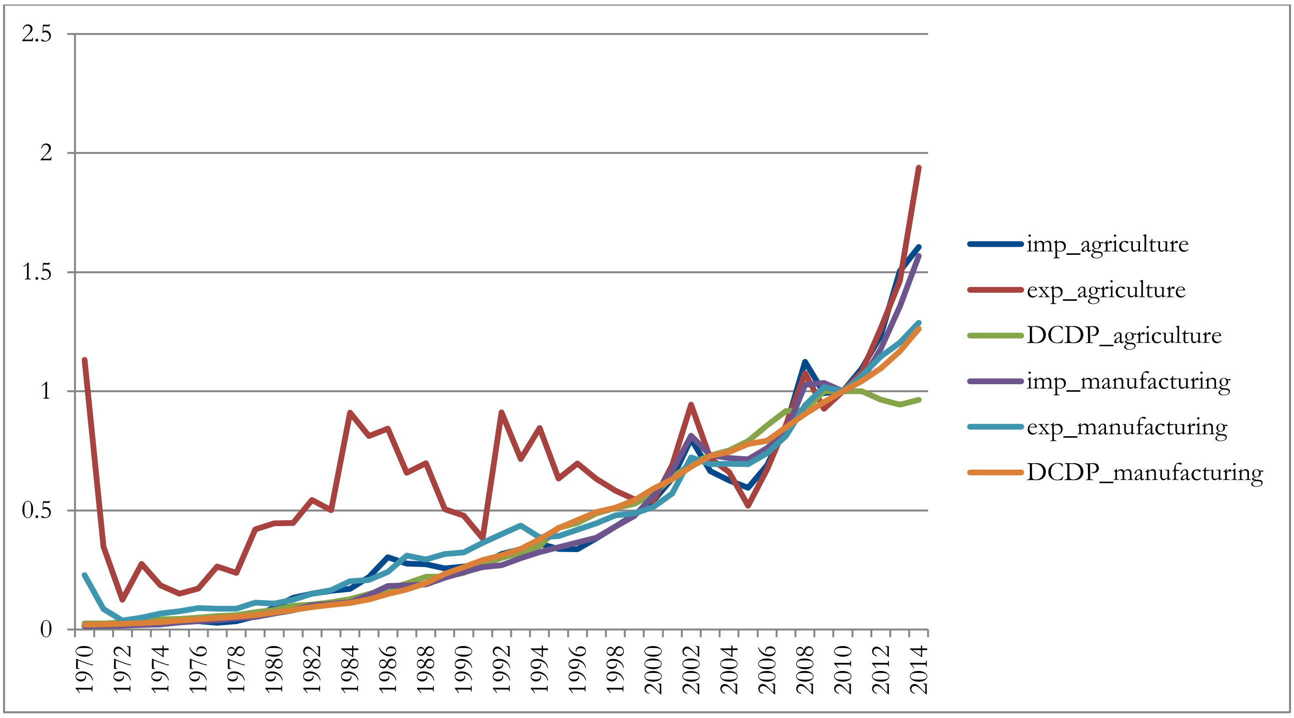
Figure 3: Ratio between real valued exports and real valued DCDP for all main aggregated industries except mining and quarrying



Source: Author's own calculations based on the data from Quantec database.

The relevant price indices p_D and p_M are defined as a ratio of current value and real value for each input. In the nonlinear estimations of the Armington function parameters, output value Y is defined as the supply of an industry in the domestic market in current prices. The value share of imports used in the normalized Armington function is calculated as the ratio of current value of imports to current value of total supply in the domestic market. The price indices for manufacturing and agriculture (highest import and export to DCDP ratios) are presented in Figure 4. We can see that the price indices that deviate most from the general trend are the price indices of agricultural imports and exports.

Figure 4: Price indices for agriculture and manufacturing

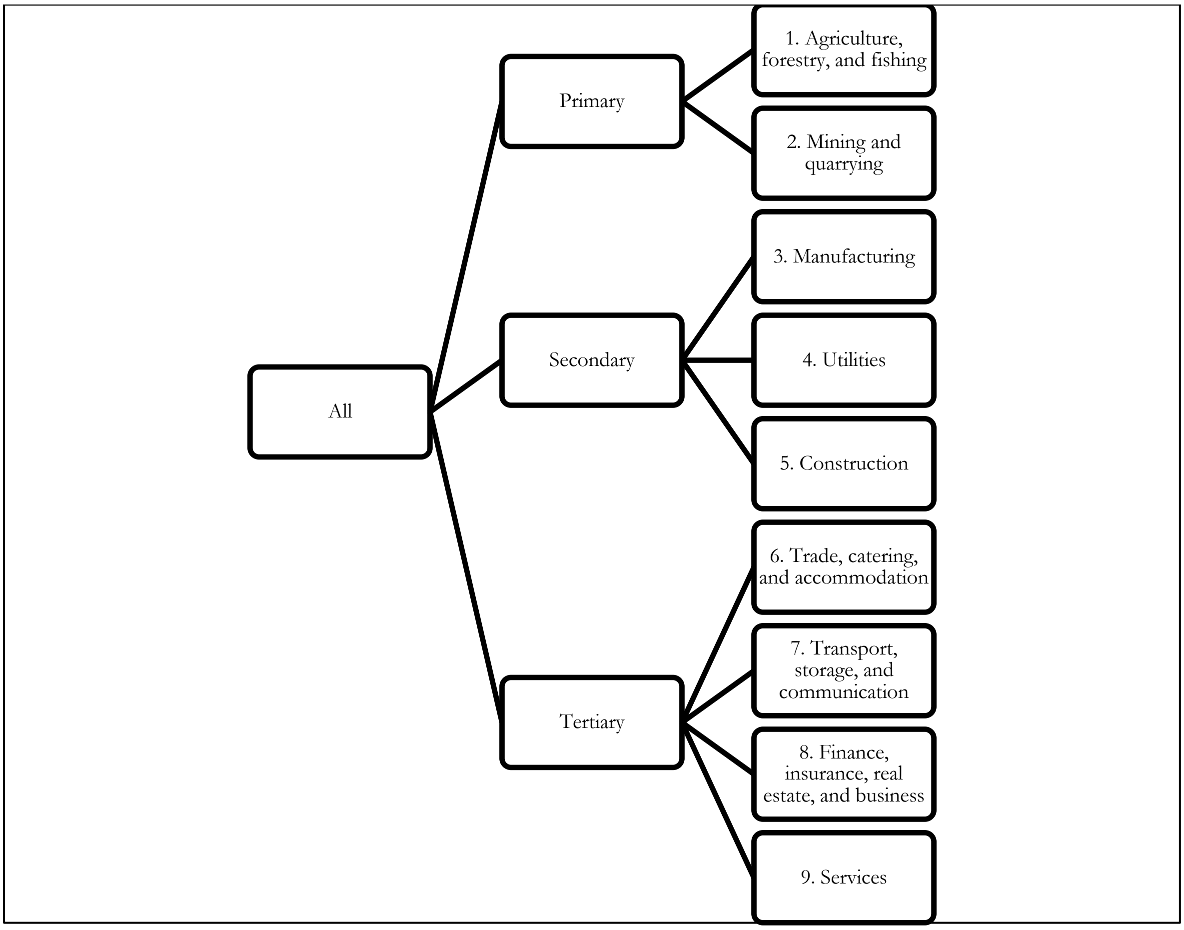


Source: Author's own calculations based on the data from Quantec database.

3.2 Industry aggregation levels

We use several industrial aggregation levels in the estimations following the Standard Industry Classification (SIC) of the Quantec database. In the most aggregated level, there are nine industries, which are described in Figure 5. These industries are divided into 26 sub-industries of which 10 belong to manufacturing. The manufacturing industry has further 27 sub-sub-industries and an industry class, services, has two sub-industries (detailed diagrams of all industries are available from the author by request). In total, there are 64 aggregation units, but some of them do not have sufficient import/export data to run the estimations. The linear estimation method is applied individually for each aggregation unit that has sufficient data.

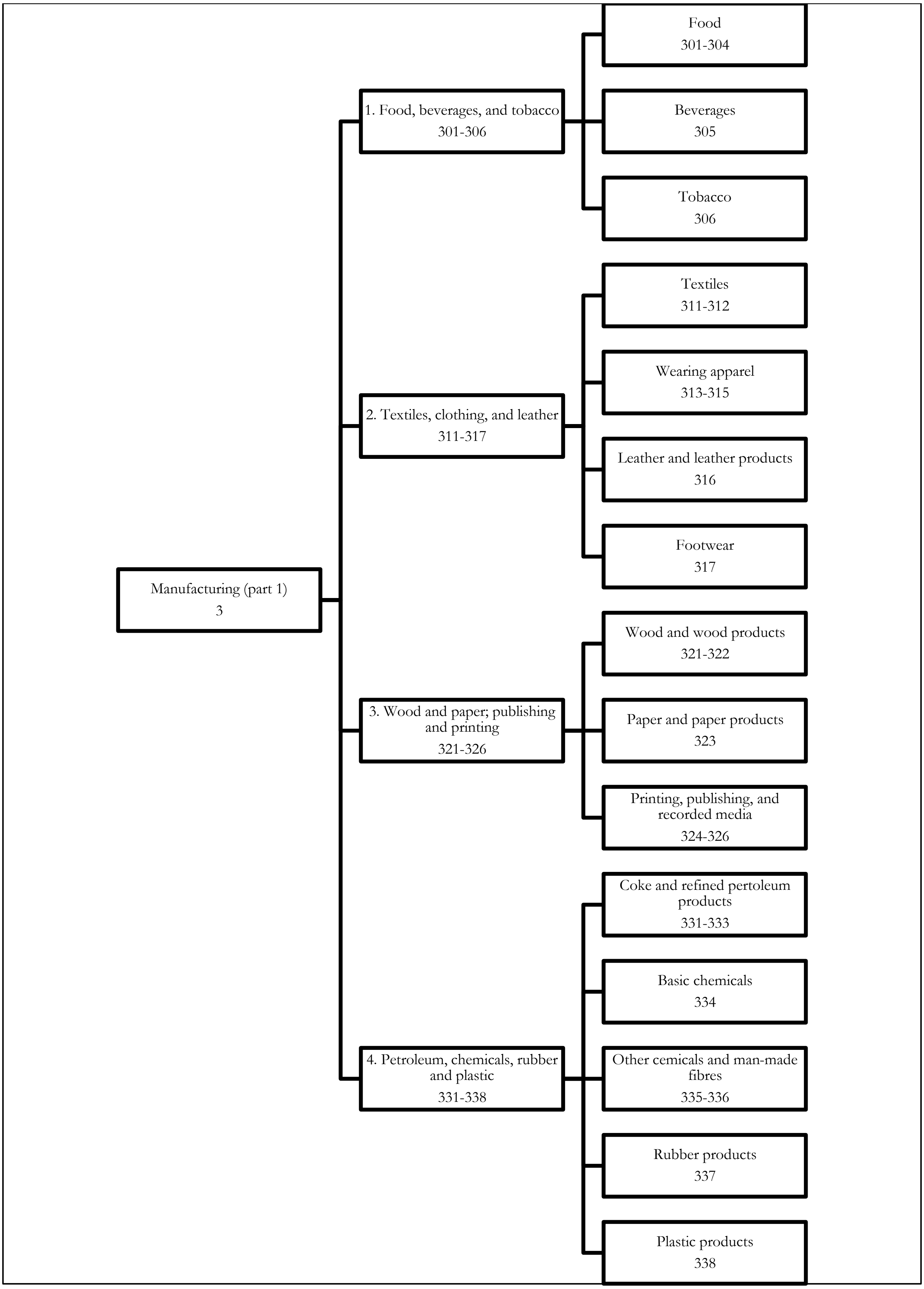
Figure 5: Aggregated industries



Source: Author’s own illustration based on SIC classification of Quantec database.

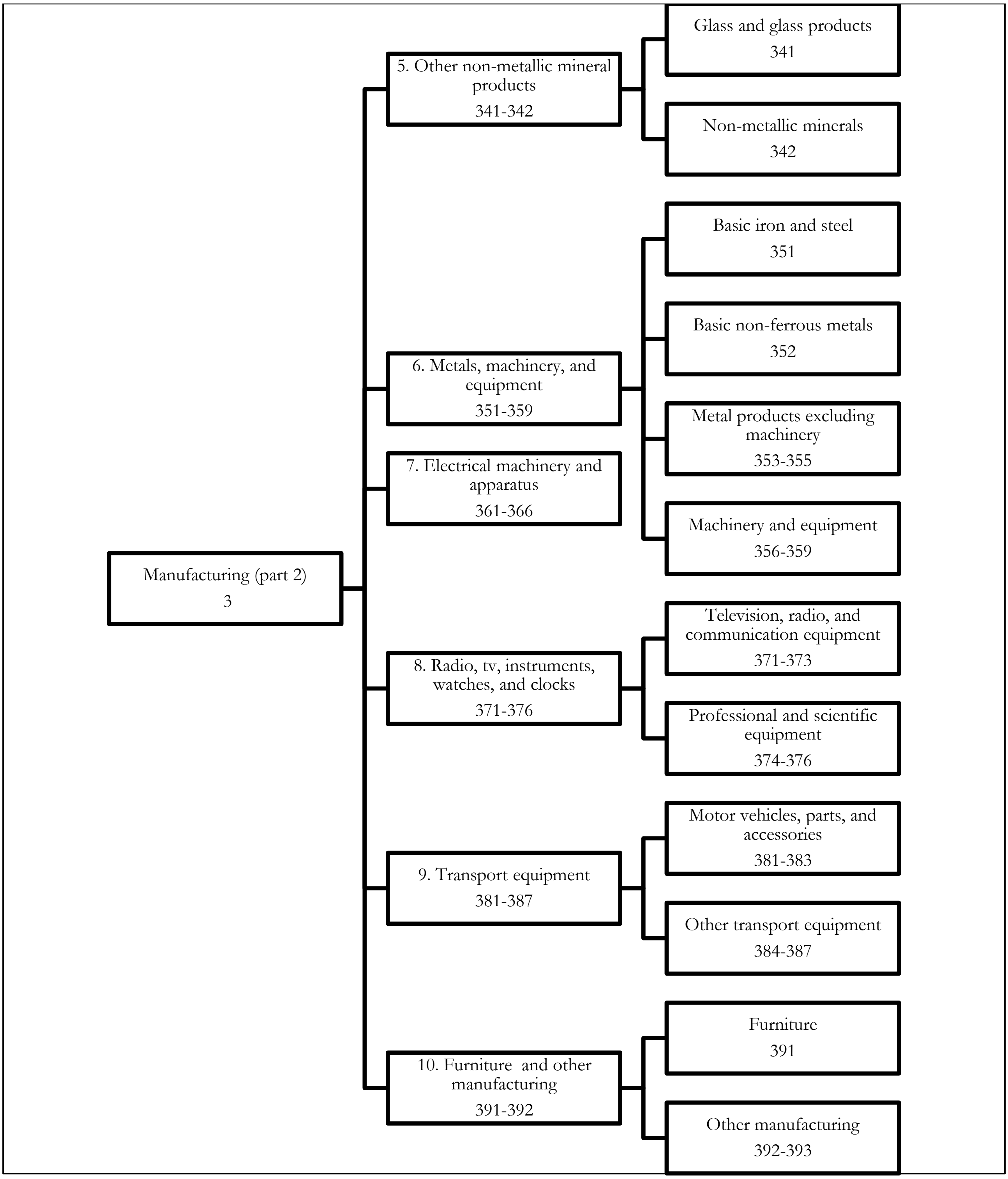
Using the nonlinear estimation method and normalized logarithmic Armington functions, we estimate growth and elasticity parameters jointly for different industries. First, the parameters are estimated jointly for the nine aggregated industries presented in Figure 5. We then focus on the manufacturing industry and estimate normalized logarithmic Armington functions for manufacturing sub-industries and sub-sub-industries. Compared to the other nine main aggregated industries, the ratio between the imports and DCDP has been relatively high for the manufacturing industry. During the whole period of this study (1970-2014), the average ratio is 0.49 in 2010 prices and 0.39 in current prices whereas for the other nine industries except mining and quarrying, the average ratios vary between 0.003 (construction) and 0.09 (transport, storage, and communication). When measured in total industry output including the intermediate inputs, manufacturing industry has the highest output value of all industries (on average 28 per cent of all real valued industry outputs during 1970-2014). Due to the trade intensiveness and the abundance of sub-industries and sub-sub-industries, manufacturing industry is an auspicious target to use nonlinear method and normalized functional form to estimate Armington function parameters jointly for different industries. The first four sub-industries (1-4) and their sub-industries (sub-sub-industries) of manufacturing are presented in Figure 6 and the last six sub-industries (5-10) and their sub-sub-industries are presented in Figure 7.

Figure 6: First four sub-industries and related sub-sub-industries of manufacturing



Source: Author's own illustration based on SIC classification of Quantec database.

Figure 7: Last six sub-industries and related sub-sub-industries of manufacturing



Source: Author's own illustration based on SIC classification of Quantec database

4 Results and discussion

4.1 Armington elasticities and growth parameters

Results of the linear estimation for Armington elasticities of the main aggregated industries are given in Table 1, whereas the estimation results for sub-industries are provided in Appendix 1, Table A1.1. For all of the main industries and for most of the sub-industries, the elasticities are estimated using the estimation equation (6). This equation is used because for all these industries, both $\ln[\frac{p_D}{p_M}]$ and $\ln\left[\frac{M}{D}\right]$ are non-stationary and not cointegrated, or only one of them is non-stationary. For the main industries, the elasticity values are all significant on the level of 5 per cent except for electricity, gas, and water where the p value is 0.065 and therefore significant only at the 10 per cent level. The Armington elasticities of the main industries vary between 0.429 for mining and quarrying and 1.258 for construction. The results are tested for heteroscedasticity and serial correlation by Breusch-Pagan (HS in Table 1) and Durbin-Watson (DW in Table 1) tests respectively. If heteroscedasticity is detected, the standard errors are corrected accordingly. The Durbin-Watson test statistics are significantly higher than one for most industries, which indicates that overall, there is no alarming serial correlation among residuals.

The positive and significant ($p < 0.10$) short run Armington elasticities, with positive adjusted R^2 values, for other industries vary between 0.386 for other mining, and 1.379 for basic non-ferrous metals. Because most of the industries are estimated using the regression Equation(6), we are only able to estimate short run elasticities except for rubber products, for which we attain a long run elasticity of 2.563. The other most import-sensitive industries in the short run are beverages (1.332) and wearing apparel (1.303). In addition to other mining, the industries with the lowest significant short run Armington elasticities with positive adjusted R^2 values are printing, publishing, and recorded media (0.413) and, wood and paper; publishing and printing (0.531).

Table 1. Results of the linear estimation for main aggregated industries: Armington elasticities

Industry name and SIC	σ	s.e.	P	Adj.R^2	HS	DW
Agriculture, forestry, and fishing [1]***	0.993	0.254	0.000	0.230	-	2.452
Mining and quarrying [2]***	0.429	0.120	0.001	0.243	-	2.277
Manufacturing [3]**	0.716	0.265	0.010	0.103	-	1.914
Electricity, gas, and water [4]* N=27, years 1987-2014	0.965	0.497	0.065	0.249	x	1.794
Construction (contractors) [5]***	1.258	0.248	0.000	0.494	-	1.512
Trade, catering, and accommodation services [6]***	0.787	0.095	0.000	0.695	-	1.631
Transport, storage, and communication [7]***	0.960	0.115	0.000	0.610	-	1.486
Financial intermediation, insurance, real estate, and business services [8]***	0.825	0.098	0.000	0.631	-	0.911
Community, social, and personal services [9]***	0.912	0.089	0.000	0.722	-	2.048

Note: *, **, *** reflects significance at 10, 5, and 1 per cent level respectively. N=45, years: 1970-2014, if not mentioned otherwise.

Source: Author's own calculations based on Quantec data.

Next, we present the non-linear estimation results of normalized logarithmic Armington function (7) and logarithmic price equations (8-9) for nine main aggregated industries and then focus more closely on the manufacturing industry. The four parameter starting value sets used in the estimations are combinations of elasticity values σ =0.5 or σ=3, and growth parameter values $\gamma_M = \gamma_D = 0.1$ or $\gamma_M = \gamma_D = 0.8$. The starting values can be perceived as initial guesses for the estimated parameters, which are then used as the starting values in the minimization of the objective function for the 3SLS estimator (for more detailed definition see Henningsen and Hamann 2015: 29). The main problems related to the assigned non-linear estimation method (nlsystemfit, 3SLS) are possible convergence issues and sensitivity to the estimation starting values.[3] We first estimate the normalized Armington function for the nine main aggregated industries presented in Figure 5. In the estimations, we assume that the growth parameters or elasticities do not vary among these nine industries. The results are given in Table 2.

Table 2: Results for normalized Armington function parameters for all nine main aggregated industries for years 1987-2014

	Import augmenting	DCDP augmenting	Both estimated freely
ξ	0.941 (0.033)	0.986 (0.011)	0.978 (0.009)
σ	1.036 (0.004)	1.003 (0.017)	2.163 (0.091)
γ_M	0.473 (0.031)	-	0.098 (0.002)
γ_D	-	0.085 (0.002)	0.075 (0.001)
adj. R2 (Y) adj. R2 (p_M) adj. R2 (p_D) N	0.626 0.924 0.994 252	0.964 0.912 0.994 252	0.975 0.972 0.977 252

Note: Standard errors in parentheses. All p<0.01, if not mentioned otherwise.

Source: Author's own calculations based on Quantec data.

In Table 2, several estimations are made based on different assumptions on the growth factors γ_{Mi} and γ_{Di}. We first assume that the growth is only import augmenting, by setting the growth factor of DCDP to zero, $\gamma_D = 0$, and estimating the growth factor for imports γ_M freely. Next, we set the growth factor of imports to zero, $\gamma_M = 0$, and estimate the growth factor for DCDP freely. Finally, we estimate both growth factors with no constraints on them. The interpretation of the growth factors depends on the value of the estimated Armington elasticity. When $\sigma < 1$, then imports and DCDP are gross complements whereas in the case of $\sigma > 1$, they can be perceived as gross substitutes (Klump et al. 2011). If $\sigma < 1$, then growth factor $\gamma_M > 0$ increases the demand for DCDP more than for imports, whereas if $\sigma > 1$, then growth $\gamma_{Mi} > 0$ augments only the imports. In the case where $\sigma = 1$, growth does not favour either. Due to these interpretations, it is obvious that different values of Armington elasticities and growth factors could yield equivalent outcomes. In Table 2, the first two elasticity values (1.036 and 1.003) are very close to one and growth factors are positive when one growth factor is set to zero. Based on these results, it is not possible to draw conclusions that growth favours either imports or DCDP for the nine main aggregated industries. However, when both growth factors are estimated freely, then elasticity is significantly higher than one and growth factor is higher for imports (0.098). This might suggest that growth may favour imports more than DCDP. The results of the estimations for main aggregated industries divided into categories: Primary industries, Secondary industries, and Tertiary industries support the finding that there is no strong evidence that growth favours either imports or DCDP (these results are provided in Appendix 1, Table A1.2).

We then estimate the growth parameters and elasticities for the ten aggregated manufacturing subindustries. These results are provided in Table 3. Now the Armington elasticity is higher than

[3] Kreuser et al. (2015) also report that the use of feasible, generalized non-linear least squares estimator might result in elasticity estimates that are biased to unity, and this can likely be corrected by using an iterative feasible generalized non-linear least squares estimator. Our results do not support this claim, because in our estimations, an increase in the number of iterations does not affect the estimated elasticities or growth parameters.

one (1.080) when growth is import augmenting and lower than one (0.891) when growth is domestic supply augmenting. In both cases, the growth parameters are positive. This implies that growth benefits imports. In the case where growth affects both inputs, the elasticity (0.931) is lower than one, which means that growth parameters have a higher impact on the other input. In this case, the growth parameter is negative (-0.096) whereas the growth of DCDP is positive (0.158), which supports that growth has a more positive effect on imports.

Table 3: Results for normalized Armington function for all ten aggregated manufacturing sub-industries for years 1970-2014

	Import augmenting	Domestic augmenting	Both estimated freely
ξ	0.862 (0.027)	0.954 (0.014)	0.972 (0.024)
σ	1.080 (0.005)	0.891 (0.008)	0.931 (0.007)
γ_M	0.345 (0.010)	-	-0.096 (0.016)
γ_D	-	0.130 (0.002)	0.158 (0.006)
adj. R2 (Y)	0.743	0.947	0.867
adj. R2 (p_M)	0.979	0.957	0.965
adj. R2 (p_D)	0.978	0.972	0.973
N	450	450	450

Note: All p<0.01, if not mentioned otherwise.

Source: Author's own calculations based on Quantec data.

Tables 4-5 show the estimation results for the ten manufacturing sub-industries assuming that growth affects either imports or DCDP. These results are estimated using the data of sub-sub-industries and grouping them by sub-industries. The results add to the evidence that growth favours imports. For all of the industries except for 'wood and paper; publishing and printing', the Armington elasticities are higher than one and growth factors for imports are positive when growth of DCDP is set to zero. Whereas in the case where the growth factor of DCDP is estimated freely and the growth factor of imports is set to zero, the elasticities are lower than one and the growth factors are positive. In Table 6, where both growth parameters are estimated freely for the ten manufacturing sub-industries, all the estimated elasticities are higher than one and all growth factors are higher for imports than for DCDP.

Table 4: Results for normalized Armington function elasticities and growth parameters individually for sub-industries of manufacturing when growth related to DCDP is set to zero and growth related to imports is estimated freely for years 1970-2014

$\gamma_D = 0$							
Manufacturing sub-industries	ξ	σ	γ_M	**adj. R2 (Y)**	**adj. R2 (p_M)**	**adj. R2 (p_D)**	**N**
Food, beverages, and tobacco	0.719 (0.041)	1.015 (0.001)	1.672 (0.070)	0.749	0.938	0.999	135
Textiles, clothing, and leather	0.692 (0.025)	1.126 (0.006)	0.350 (0.010)	0.871	0.926	0.989	180
Wood and paper; publishing and printing	1.033 (0.030)	0.997 (0.002)	0.897 (0.018)	0.965	0.981	0.999	135
Petroleum, chemicals, rubber, and plastic	0.843 (0.035)	1.073 (0.005)	0.431 (0.014)	0.875	0.917	0.995	225
Other non-metallic mineral products	0.826 (0.050)	1.027 (0.003)	0.656 (0.028)	0.867	0.972	0.999	90
Metals, machinery, and equipment	0.757 (0.036)	1.231 (0.015)	0.245 (0.011)	0.684	0.973	0.959	180
Radio, tv, instruments, watches, and clocks	0.822 (0.031)	1.514 (0.034)	0.133 (0.004)	0.943	0.990	0.904	90
Transport equipment	0.792 (0.035)	1.181 (0.023)	0.194 (0.007)	0.898	0.975	0.929	90
Furniture and other manufacturing	0.705 (0.038)	1.070 (0.005)	0.675 (0.033)	0.890	0.838	0.996	90

Note: .All $p<0.01$, if not mentioned otherwise.

Source: Author's own calculations based on Quantec data.

Table 5: Results for normalized Armington function elasticities and growth parameters individually for sub-industries of manufacturing when growth related to imports is set to zero and growth related to DCDP is estimated freely for years 1970-2014

$\gamma_M = 0$							
Manufacturing sub-industries	ξ	σ	γ_D	**adj. R2 (Y)**	**adj. R2 (p_M)**	**adj. R2 (p_D)**	**N**
Food, beverages, and tobacco	1.001 (0.012)	0.889 (0.006)	0.111 (0.001)	0.985	0.920	1.000	135
Textiles, clothing, and leather	1.048 (0.020)	0.727 (0.010)	0.120 (0.002)	0.966	0.788	0.984	180
Wood and paper; publishing and printing	0.917 (0.022)	1.047 (0.003)	0.118 (0.002)	0.973	0.981	0.999	135
Petroleum, chemicals, rubber, and plastic	1.019 (0.012)	0.754 (0.014)	0.121 (0.001)	0.983	0.837	0.995	225
Other non-metallic mineral products	1.016 (0.020)	0.887 (0.006)	0.121 (0.002)	0.977	0.957	0.999	90
Metals, machinery, and equipment	0.932 (0.025)	0.825 (0.016)	0.136 (0.003)	0.920	0.908	0.937	180
Radio, tv, instruments, watches, and clocks	1.287 (0.055)	0.813 (0.012)	0.280 (0.010)	0.924	0.942	0.876	90
Transport equipment	0.935 (0.032)	0.914 (0.018)	0.188 (0.188)	0.958	0.948	0.902	90
Furniture and other manufacturing	1.033 (0.021)	0.674 (0.013)	0.095 (0.002)	0.978	0.521	0.992	90

Note: All $p<0.01$, if not mentioned otherwise.

Source: Author's own calculations based on Quantec data.

Table 6: Results for normalized Armington function elasticities and growth parameters individually for subindustries of manufacturing when both growth factors are estimated freely for years 1970-2014

Both estimated freely								
Manufacturing sub-industries	ξ	σ	γ_M	γ_D	adj. R2 (Y)	adj. R2 (p_M)	adj. R2 (p_D)	N
Food, beverages, and tobacco[a]	0.956 (0.013)	2.057 (0.019)	0.128 (0.002)	0.097 (0.001)	0.982	0.975	0.993	135
Textiles, clothing, and leather[a]	0.861 (0.017)	3.736 (0.156)	0.108 (0.002)	0.084 (0.002)	0.955	0.974	0.946	180
Wood and paper; publishing and printing	1.058 (0.023)	1.326 (0.006)	0.122 (0.006)	0.101 (0.002)	0.975	0.982	0.998	135
Petroleum, chemicals, rubber, and plastic[a]	0.989 (0.016)	1.809 (0.094)	0.127 (0.004)	0.083 (0.002)	0.981	0.948	0.988	225
Other non-metallic mineral products[a]	0.917 (0.029)	2.000 (0.018)	0.126 (0.003)	0.102 (0.002)	0.966	0.987	0.987	90
Metals, machinery, and equipment[a]	0.889 (0.018)	2.488 (0.120)	0.126 (0.002)	0.086 (0.002)	0.950	0.981	0.957	180
Radio, tv, instruments, watches, and clocks[a]	0.915 (0.026)	2.374 (0.085)	0.110 (0.002)	0.064 (0.004)	0.967	0.986	0.900	90
Transport equipment[a]	0.889 (0.031)	3.132 (0.224)	0.105 (0.003)	0.093 (0.003)	0.957	0.967	0.944	90
Furniture and other manufacturing	0.868 (0.022)	2.214 (0.039)	0.118 (0.002)	0.081 (0.002)	0.965	0.940	0.974	90

Note: [a]The results are different when starting values σ=0.5 and $\gamma_D = \gamma_D$ = 0.1 are used in the estimations. These results are reported in Appendix 1, Table A1.3. All p<0.01, if not mentioned otherwise.

Source: Author's own calculations based on Quantec data.

4.2 Export supply elasticities

The results for CET elasticities of the main aggregated industries are presented in Table 7 (results for other industries are given in appendix 1, Table A1.4). For CET functions, we were only able to estimate positive elasticities, which contradict our hypothesis that relatively higher export prices would increase the relative supply of exports compared with production aimed at the domestic market. The positivity also means that the isoquant is concave to origin for all CET functions.

Table 7: Results of the linear estimation for the main aggregated industries: CET

Industry name and SIC	σ	s.e.	P	Adj R^2	DW
Agriculture, forestry, and fishing [1]***	1.125	0.109	0.000	0.711	2.764
Mining and quarrying [2]***	0.312	0.103	0.005	0.139	2.581
Manufacturing [3]***	0.905	0.235	0.000	0.739	1.725
Electricity, gas, and water [4]***	1.038	0.147	0.000	0.704	1.587
Construction (contractors) [5]***	0.912	0.115	0.000	0.629	1.310
Trade, catering, and accommodation services [6]***	0.819	0.182	0.000	0.303	1.372
Transport, storage, and communication [7]***	0.823	0.157	0.000	0.390	1.610
Financial intermediation, insurance, real estate, and business services [8]***	0.750	0.136	0.000	0.405	1.858
Community, social, and personal services [9]***	0.715	0.118	0.000	0.459	1.465

Note: *, **, *** reflects significance at 10, 5, and 1 per cent level respectively. Years: 1970-2014 (N=45), if not mentioned otherwise.

Source: Author's own calculations based on Quantec data.

We do some additional estimations to understand better our CET estimation results. For this purpose, we estimate the following equation $\ln[M] = \alpha + \beta\ln[\frac{p_M}{CPI}]$ where M is the real valued exports, p_M is the price index of the exports and CPI is the consumer price index for South Africa. For the study period of 1992-2014, we have positive and significant β values for three of the nine main industries (Table 8). However, these positive values do not translate as negative CET elasticity values.

Table 8: Results of the additional estimations on export supply

Industry name and SIC	β	s.e.	P	Adj R^2
Agriculture, forestry, and fishing [1]***	-1.592	0.283	0.000	0.582
Mining and quarrying [2]***	-0.313	0.027	0.000	0.859
Manufacturing [3]*	-2.286	1.232	0.078	0.100
Electricity, gas, and water [4]	-0.224	0.409	0.590	-0.033
Construction (contractors) [5]**	-0.841	0.384	0.040	0.147
Trade, catering, and accommodation services [6]***	2.316	0.492	0.000	0.490
Transport, storage, and communication [7]***	-3.634	1.110	0.004	0.306
Financial intermediation, insurance, real estate, and business services [8]***	3.817	0.420	0.000	0.788
Community, social and personal services [9]***	1.907	0.288	0.000	0.660

Note: *, **, *** reflects significance at 10, 5, and 1 per cent level respectively.

Source: Author's own calculations based on Quantec data.

5 Conclusions

The objective of this paper was to estimate Armington and CET elasticities and related function parameters for different industries of South Africa. We found positive (0.386-1.379) and significant short-run Armington elasticity values for most of the studied industries. However, we were not able to estimate long-run elasticity values for almost any industry, because of stationarity and co-integration characteristics of our data. For CET elasticities, we failed to estimate negative values, which contradict our initial assumption that CET elasticities are negative. This may be at least partly due to issues related to the data used in the estimation of CET elasticities. For example, our price data includes export taxes and tariffs and therefore, it is not perfectly equivalent to the true export prices that producers face. Using the normalized Armington functions and non-linear estimation method, we were able to estimate Armington elasticities simultaneously with related import and DCDP growth factors. The results of these estimations suggest that growth over time is higher for imports than DCDP in the manufacturing industry. This results in an increase in the import's share of total value of domestic supply.

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Appendices

Appendix 1 Additional results

Table A1.1 Results of the linear estimation: Armington elasticities

Industry name and SIC	EQ	σ	s.e.	P	Adj.R^2	HS	DW	Prev SR
Agriculture, forestry, and fishing [1]	6	0.993	0.254	0.000	0.230	-	2.452	1.273
Mining and quarrying [2]	6	0.429	0.120	0.001	0.243	-	2.277	-
Manufacturing [3]	6	0.716	0.265	0.010	0.103	-	1.914	-
Electricity, gas, and water [4] N=27, years 1987-2014	6	0.965	0.497	0.065	0.249	x	1.794	-
Construction (contractors) [5]	6	1.258	0.248	0.000	0.494	-	1.512	-
Trade, catering, and accommodation services [6]	6	0.787	0.095	0.000	0.695	-	1.631	-
Transport, storage, and communication [7]	6	0.960	0.115	0.000	0.610	-	1.486	-
Financial intermediation, insurance, real estate, and business services [8]	6	0.825	0.098	0.000	0.631	-	0.911	-
Community, social, and personal services [9]	6	0.912	0.089	0.000	0.722	-	2.048	-
Coal mining [21]	6	0.527	1.163	0.653	0.217	-	1.757	2.771
Gold and uranium ore mining [23]	-	-	-	-	-	-	-	-
Other mining [22/24/25/29]	4	0.386	0.221	0.089	0.467	-	NA	-
Food, beverages, and tobacco [301-306]	6	0.861	0.238	0.001	0.196	-	1.983	-
Food [301-304]	6	0.888	0.257	0.001	0.179	-	2.131	0.937
Beverages [305]	6	1.332	0.319	0.000	0.309	-	1.838	1.570
Tobacco [306]	6	0.898	0.240	0.001	0.276	-	2.479	1.350
Textiles, clothing, and leather [311-317]	6	0.911	0.273	0.002	0.257	-	2.435	-
Textiles [311-312]	6	0.609	0.224	0.010	0.166	-	2.796	1.262
Wearing apparel [313-315]	6	1.303	0.412	0.003	0.321	-	1.977	1.164
Leather and leather products [316]	6	1.283	0.177	0.000	0.541	-	2.172	1.474
Footwear [317]	6	1.008	0.555	0.077	0.008	-	1.728	2.040
Wood and paper; publishing and printing [321-326]	6	0.531	0.135	0.000	0.308	-	1.928	-
Wood and wood products [321-322]	6	1.065	0.167	0.000	0.577	-	1.764	1.205
Paper and paper products [323]	6	0.843	0.176	0.000	0.423	-	2.127	0.789

Industry name and SIC	EQ	σ	s.e.	P	Adj.R^2	HS	DW	Prev SR
Printing, publishing, and recorded media [324-326]	6	0.413	0.186	0.033	0.168	-	2.109	0.083
Petroleum products, chemicals, rubber, and plastic [331-338]	6	0.825	0.282	0.006	0.128	-	2.019	-
Coke and refined petroleum products [331-333]	6	0.937	0.244	0.000	0.407	-	1.914	0.730
Basic chemicals [334]	6	0.277	0.376	0.466	-0.057	-	2.231	0.677
Other chemicals and man-made fibres [335-336]	6	0.735	0.362	0.049	0.103	x	1.984	0.792
Rubber products [337]	5	s.r 1.140 l.r. 2.563	s.r. 0.303	s.r. 0.001	0.2910	-	NA	1.135
Plastic products [338]	6	0.770	0.189	0.000	0.240	x	2.313	0.275
Other non-metallic mineral products [341-342]	6	0.734	0.251	0.006	0.270	-	1.188	-
Glass and glass products [341]	6	0.769	0.250	0.004	0.145	-	1.981	0.942
Non-metallic minerals [342]	6	0.517	0.326	0.120	0.140	-	1.516	0.655
Metals, metal products, machinery, and equipment [351-359]	6	1.002	0.261	0.000	0.419	-	1.852	-
Basic iron and steel [351]	6	1.274	0.385	0.002	0.295	-	1.936	-
Basic non-ferrous metals [352]	6	1.379	0.302	0.000	0.410	-	2.525	0.595
Metal products excluding machinery [353-355]	6	0.650	0.165	0.000	0.243	-	2.230	0.747
Machinery and equipment [356-359]	6	0.320	0.416	0.446	0.403	-	1.987	0.490
Electrical machinery and apparatus [361-366]	6	0.886	0.181	0.000	0.424	-	1.664	0.944
Radio, TV, instruments, watches, and clocks [371-376]	6	0.658	0.211	0.003	0.259	-	1.813	-
Television, radio, and communication equipment [371-373]	6	0.632	0.422	0.142	0.131	-	1.940	0.441
Professional and scientific equipment [374-376]	6	0.826	0.315	0.012	0.326	x	1.840	0.505
Transport	6	0.295	0.210	0.167	-0.024	-	2.325	-

Industry name and SIC	EQ	**σ**	s.e.	P	Adj.R^2	HS	DW	Prev SR
equipment [381-387]								
Motor vehicles, parts, and accessories [381-383]	6	0.224	0.301	0.461	-0.059	-	2.477	0.786
Other transport equipment [384-387]	6	-1.063	0.412	0.014	0.081	-	2.115	0.932
Furniture and other manufacturing [391-392]	6	1.109	0.344	0.003	0.159	-	2.151	-
Furniture [391]	6	0.909	0.420	0.036	0.048	-	2.378	1.075
Other manufacturing [392-393]	6	1.119	0.315	0.001	0.204	-	2.154	0.417
Electricity, gas, and steam [41] N=27, years: 1987-2014	6	0.952	0.359	0.014	0.227	-	1.796	1.437
Water supply [42]	-	-	-	-	-	-	-	-
Building construction [51]	6	1.248	0.357	0.001	0.248	-	0.923	0.584
Civil engineering and other construction [52-53]	6	1.278	0.337	0.001	0.414	-	1.061	1.280
Wholesale and retail trade [61-63]	6	0.848	0.090	0.000	0.670	-	0.946	0.603
Catering and accommodation services [64]	6	0.830	0.096	0.000	0.706	-	1.545	0.420
Transport and storage [71-74]	6	0.989	0.132	0.000	0.561	-	1.297	0.861
Communication [75]	6	0.637	0.281	0.029	0.372	-	0.648	0.568
Finance and insurance [81-82]	6	0.804	0.122	0.000	0.532	-	1.209	0.616
Business services [83-88]	6	0.849	0.083	0.000	0.713	-	0.884	1.066
Other services [93-96]	6	0.895	0.164	0.000	0.386	-	1.061	-
Medical, dental, and veterinary services [93]	6	0.879	0.164	0.000	0.375	-	1.096	1.135
Excluding medical, dental, and veterinary services [94-96]	6	0.893	0.169	0.000	0.368	-	1.019	1.040
Other producers [98]	6	0.996	0.127	0.000	0.618	-	1.989	1.065
General government services [99]	-	-	-	-	-	-	-	-

Note: The last column of Table A1.1 (Prev SR) shows the short-run Armington elasticity estimates of the study by Gibson (2003) on South-African Armington elasticities. The results were estimated using data from years 1970-2001 and the structure of their import data differs from the import data used in our study. This might explain why some of our elasticity estimates compare poorly to those of Gibson (2003). N=45, years: 1970-2014, if not mentioned otherwise.

Source: Author's own calculation based on Quantec data.

Table A1.2 Results for normalized Armington function elasticities and growth parameters for primary, secondary, and tertiary industries

$\gamma_D = 0$								
Industry group	ξ	σ	γ_M		adj. R2 (Y)	adj. R2 (p_M)	adj. R2 (p_D)	N
Primary Industries	0.933 (0.080)	1.005 (0.007)	0.356 (0.026)		0.736	0.962	0.993	90
Secondary Industries years 1987-2014	0.920 (0.054)	1.084 (0.006)	0.480 (0.034)		0.521	0.946	0.992	84
Tertiary Industries	1.048 (0.092)	0.995 (0.000)	2.994 (0.167)		0.561	0.964	1.000	180
$\gamma_M = 0$								
Industry group	ξ	σ	γ_D		adj. R2 (Y)	adj. R2 (p_M)	adj. R2 (p_D)	N
Primary Industries	0.962 (0.038)	1.029 (0.019)	0.127 (0.004)		0.940	0.962	0.994	90
Secondary Industries years 1987-2014	0.985 (0.013)	0.824 (0.024)	0.082 (0.002)		0.979	0.870	0.988	84
Tertiary Industries	0.946 (0.016)	1.152 (0.002)	0.111 (0.001)		0.983	0.973	0.999	180
Both estimated freely								
Industry group	ξ	σ	γ_M	γ_D	adj. R2 (Y)	adj. R2 (p_M)	adj. R2 (p_D)	N
Primary Industries	0.954 (0.023)	2.594 (0.190)	0.093 (0.003)	0.097 (0.002)	0.979	0.969	0.981	90
Secondary Industries years 1987-2014	0.971 (0.014)	1.992 (0.062)	0.118 (0.003)	0.070 (0.002)	0.975	0.976	0.986	84
Tertiary Industriesa	0.939 (0.015)	4.579 (0.050)	0.114 (0.001)	0.107 (0.001)	0.982	0.985	0.979	180

Note: [a]Results are different when starting values σ=0.5 and $\gamma_D = \gamma_D$ = 0.1 are used in the estimations. These results are reported in Appendix 1, Table A1.3.

Source: Author's own calculation based on Quantec data.

Table A1.3 Results for normalized Armington function elasticities for manufacturing subindustries when starting values $\boldsymbol{\sigma = 0.5}$ and $\boldsymbol{\gamma_M = \gamma_D = 0.1}$ are used as starting values in the estimations

Both growth factors estimated freely, starting values: ($\boldsymbol{\sigma = 0.5 \text{ and } \gamma_M = \gamma_D = 0.1}$)								
Aggregated industries	$\boldsymbol{\xi}$	$\boldsymbol{\sigma}$	$\boldsymbol{\gamma_M}$	$\boldsymbol{\gamma_D}$	adj. R2 (Y)	adj. R2 ($\boldsymbol{p_M}$)	adj. R2 ($\boldsymbol{p_D}$)	N
Tertiary Industries	1.053 (0.038)	0.985 (0.001)	1.126 (0.089)	0.070 (0.004)	0.923	0.964	1.000	180
Manufacturing sub-industries	$\boldsymbol{\xi}$	$\boldsymbol{\sigma}$	$\boldsymbol{\gamma_M}$	$\boldsymbol{\gamma_D}$	adj. R2 (Y)	adj. R2 ($\boldsymbol{p_M}$)	adj. R2 ($\boldsymbol{p_D}$)	N
Food, beverages, and tobacco	1.062 (0.020)	0.960 (0.005)	-0.400 (0.062)	0.132 (0.004)	0.981	0.933	1.000	135
Textiles, clothing, and leather	386.952 (373.367)	0.995 (0.001)	-6.142 (0.957)	2.147 (0.317)	-23.362	0.899	0.991	180
Wood and paper; publishing and printing	same as for other starting values							
Petroleum, chemicals, rubber, and plastic	1.061 (0.017)	0.833 (0.017)	-0.048 (0.014)	0.133 (0.004)	0.976	0.868	0.995	225
Other non-metallic mineral products	1.030 (0.018)	0.933 (0.007)	-0.120 (0.028)	0.141 (0.005)	0.979	0.963	1.000	90
Metals, machinery, and equipment	0.983 (0.061)	0.906 (0.011)	-0.157 (0.026)	0.186 (0.011)	0.660	0.936	0.948	180
Radio, tv, instruments, watches, and clocks	1.607 (0.205)	0.879 (0.022)	-0.074 (0.035)	0.411 (0.064)	0.800	0.953	0.884	90
Transport equipment	1.027 (0.063)	0.948 (0.012)	-0.114 (0.033)	0.283 (0.029)	0.926	0.955	0.909	90
Furniture and other manufacturing	same as for other starting values							

Source: Author’s own calculation based on Quantec data.

Table A1.4 Results of the linear estimation: CET

Industry name and SIC	EQ	σ	s.e	P	Adj R^2	HS	DW
Agriculture, forestry, and fishing [1]	6	1.125	0.109	0.000	0.711	-	2.764
Mining and quarrying [2]	6	0.312	0.103	0.005	0.139	-	2.581
Manufacturing [3]	6	0.905	0.235	0.000	0.739	-	1.725
Electricity, gas, and water [4]	6	1.038	0.147	0.000	0.704	-	1.587
Construction (contractors) [5]	6	0.912	0.115	0.000	0.629	-	1.310
Trade, catering, and accommodation services [6]	6	0.819	0.182	0.000	0.303	-	1.372
Transport, storage, and communication [7]	6	0.823	0.157	0.000	0.390	-	1.610
Financial intermediation, insurance, real estate, and business services [8]	6	0.750	0.136	0.000	0.405	-	1.858
Community, social, and personal services [9]	6	0.715	0.118	0.000	0.459	-	1.465
Coal mining [21]	6	0.320	0.187	0.095	0.275	-	1.460
Gold and uranium ore mining [23]	-	-	-	-	-	-	-
Other mining [22/24/25/29]	4	l.r. 0.686	-	-	0.675	-	NA
Food, beverages, and tobacco [301-306]	6	0.969	0.104	0.000	0.852	-	1.536
Food [301-304]	6	0.946	0.110	0.000	0.840	-	1.556
Beverages [305]	6	1.304	0.319	0.000	0.552	-	1.831
Tobacco [306]	6	0.466	1.040	0.657	0.049	x	2.246
Textiles, clothing, and leather [311-317]	6	0.735	0.206	0.001	0.735	-	1.757
Textiles [311-312]	6	0.743	0.198	0.001	0.734	-	2.098
Wearing apparel [313-315]	6	0.784	0.303	0.014	0.540	-	1.454
Leather and leather products [316]	6	0.754	0.260	0.006	0.518	-	2.303
Footwear [317]	6	0.955	0.197	0.000	0.324	-	1.881
Wood and paper; publishing and printing [321-326]	6	1.247	0.119	0.000	0.718	-	1.808
Wood and wood products [321-322]	6	1.288	0.163	0.000	0.662	-	1.862
Paper and paper products [323]	6	1.198	0.120	0.000	0.704	-	1.930
Printing, publishing, and recorded media [324-326]	6	1.286	0.205	0.000	0.509	-	2.603
Petroleum products, chemicals, rubber, and plastic [331-338]	6	1.356	0.210	0.000	0.697	-	2.265
Coke and refined petroleum products [331-333]	6	0.983	0.252	0.000	0.304	-	2.762
Basic chemicals [334]	6	0.957	0.167	0.000	0.557	-	2.119
Other chemicals and man-made fibres [335-336]	6	1.057	0.255	0.000	0.584	-	2.316
Rubber products [337]	6	0.755	0.244	0.004	0.549	-	1.532
Plastic products [338]	6	1.246	0.312	0.000	0.505	-	1.493
Other non-metallic mineral products [341-342]	6	0.751	0.180	0.000	0.403	-	2.026
Glass and glass products [341]	6	1.110	0.183	0.000	0.440	-	1.823
Non-metallic minerals [342]	6	0.605	0.240	0.016	0.113	-	2.510
Metals, metal products, machinery, and equipment [351-359]	6	0.961	0.123	0.000	0.646	-	1.874
Basic iron and steel [351]	6	1.017	0.153	0.000	0.599	-	2.321
Basic non-ferrous metals [352]	6	0.707	0.324	0.035	0.386	-	2.531
Metal products excluding machinery [353-355]	6	1.070	0.202	0.000	0.624	-	1.872
Machinery and equipment [356-359]	6	1.126	0.215	0.000	0.364	-	1.734
Electrical machinery and apparatus [361-366]	6	1.172	0.285	0.000	0.591	-	2.092
Radio, TV, instruments, watches, and clocks [371-376]	6	0.876	0.162	0.000	0.385	-	2.150
Television, radio, and communication equipment [371-373]	6	0.729	0.283	0.014	0.206	x	2.129
Professional and scientific equipment [374-376]	6	0.954	0.140	0.000	0.509	-	1.929
Transport equipment [381-387]	6	0.889	0.208	0.000	0.263	-	2.434
Motor vehicles, parts, and accessories [381-383]	6	0.869	0.214	0.000	0.239	-	2.407
Other transport equipment [384-387]	6	0.395	0.251	0.123	0.027	-	2.466
Furniture and other manufacturing [391-392]	6	1.036	0.127	0.000	0.611	-	2.262
Furniture [391]	6	1.587	0.330	0.000	0.334	-	1.228
Other manufacturing [392-393]	6	1.016	0.137	0.000	0.565	-	2.299
Electricity, gas, and steam [41] N=27, years: 1987-2014	6	1.051	0.150	0.000	0.699	-	1.577
Water supply [42]	-	-	-	-	-	-	-

Industry name and SIC	EQ	*σ*	s.e	P	Adj R^2	HS	DW
Building construction [51]	-	-	-	-	-	-	-
Civil engineering and other construction [52-53]	6	1.282	0.208	0.000	0.551	-	1.621
Wholesale and retail trade [61-63]	6	0.824	0.187	0.000	0.287	-	1.282
Catering and accommodation services [64]	6	0.990	0.202	0.000	0.530	x	1.288
Transport and storage [71-74]	6	0.895	0.164	0.000	0.408	-	1.579
Communication [75]	6	-0.372	0.366	0.315	0.354	-	1.167
Finance and insurance [81-82]	6	0.740	0.131	0.000	0.558	-	1.619
Business services [83-88]	6	0.898	0.153	0.000	0.591	-	1.280
Other services [93-96]	6	0.492	0.095	0.000	0.498	-	1.365
Medical, dental, and veterinary services [93]	6	0.817	0.065	0.000	0.787	-	1.700
Excluding medical, dental, and veterinary services [94-96]	6	0.545	0.203	0.011	0.391	x	0.957
Other producers [98]	6	1.209	0.154	0.000	0.590	-	0.772
General government services [99]	-	-	-	-	-	-	-

Note: N=45, years: 1970-2014, if not mentioned otherwise.

Source: Author’s own calculation based on Quantec data.