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Substitution Elasticities in Swiss Manufacturing

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Zusammenfassung

Abstract

Branchenspezifische Schätzungen von Substitutionselastizitäten zwischen den Produktionsfaktoren Kapital, Arbeit, Energie und Material existieren bereits für verschiedenste Industrien und Länder. Allerdings fehlen solche Schätzungen bisher für Schweizer Industriesektoren. Basierend auf einem neu zusammengestellten Datensatz, welcher den Zeitraum von 1997 bis 2008 abdeckt, schätzen wir solche Substitutionselastizitäten für die Schweiz. Dabei verwenden wir zwei verschiedene Modellansätze. Zum einen unterstellen wir eine Translog-Kostenfunktion, und zum anderen eine verschachtelte CES Produktionsfunktion. Dieses Vorgehen erlaubt uns technische sowie ökonomische Substitutionselastizitäten zu schätzen. Unsere Schätzresultate vergleichen wir mit branchenspezifischen Substitutionselastizitäten von anderen europäischen Ländern sowie mit gepoolten Schätzungen. Wir diskutieren unsere Schätzresultate, zeigen auf, wie Substitutionselastizitäten richtig interpretiert werden müssen und weisen auf wichtige Aspekte bei der Verwendung von branchenspezifischen Substitutionselastizitäten in CGE Modellen hin.

Im Auftrag des Bundesamts für Energie (BFE) schätzen wir in diesem Projekt Substitutionselastizitäten für 12 Schweizer Industriesektoren. Schätzungen von Elastizitäten der Substitution zwischen den Produktionsfaktoren Kapital, Arbeit, Energie und Material existieren bisher für die Schweiz nur auf aggregierter Basis oder aber sie stammen aus den 80er Jahren. Ziel dieses Projekts ist es diese Lücke zu schliessen und möglichst aktuelle Elastizitäten für die Schweizer Industriesektoren zu schätzen.

Dabei sollen ökonomische wie auch technische Elastizitäten geschätzt werden. Ökonomische Elastizitäten zeigen auf, wie sich die Mengen von Produktionsfaktoren aufgrund von Änderungen der Faktorpreise anpassen. Sie geben Informationen darüber ab, wie sich Unternehmen gewisser Branchen im Falle von Faktorpreisveränderungen verhalten. Technische Elastizitäten geben hingegen Aufschluss darüber, inwiefern Firmen in ihren Produktionsprozessen zwischen verschiedenen Produktionsfaktoren technisch substituieren können. Technische Elastizitäten sind ein wichtiger Bestandteil in Computational General Equilibrium (CGE)-Modellen. Mithilfe dieser CGE-Modelle können die langfristigen Auswirkungen von politischen Massnahmen wie z.B. einer Steuer auf Treibhausgase abgeschätzt werden. Beide Elastizitätskonzepte sind miteinander verbunden, betonen aber unterschiedliche Aspekte der Substitution.

Als Datenbasis für die Schätzung der Elastizitäten sind sektorspezifische Daten wie z.B. Preise der Produktionsfaktoren und Ausgaben der Firmen für die verschiedenen Produktionsfaktoren notwendig. Da es in der Schweiz keinen einzelnen Datensatz gibt, der alle dafür relevanten Daten über einen längeren Zeitraum enthält, wurden im Rahmen des Projekts verschiedene Datensätze verbunden und auf die grösstmögliche Anzahl an verschiedener Industriesektoren aggregiert. Der zusammengestellte Datensatz umfasst Jahresdaten über den Zeitraum von 1997 bis 2008 für 12 Industriesektoren.

Als theoretische Basis für die Schätzung der ökonomischen Elastizitäten verwenden wir die Translog-Kostenfunktion. Diese funktionelle Form wird häufig gewählt, da sie zum einen eine grosse Flexibilität aufweist und sich zum anderen die Datenanforderungen in Grenzen halten. Wir schätzen Eigenpreiselastizitäten, Kreuzpreiselastizitäten und Morishima-Elastizitäten mit dem Seemingly Unrelated Regressions (SUR)-Ansatz. Die ersten beiden Elastizitätentypen geben dabei an, wie sich die Menge eines Faktors ändert falls sich der Preis eines Faktors ändert. Morishima Elastizitäten drücken demgegenüber aus, wie sich das Mengenverhältnis zweier Faktoren aufgrund der Preisänderung eines Faktors verändert. Als theoretische Fundierung für die Schätzung der technischen Elastizitäten verwenden wir eine verschachtelte Constant Elasticity of Substitution (CES)-Produktionsfunktion. Diese Funktion impliziert, dass Firmen einen Produktionsfaktor in einem konstanten Verhältnis durch einen anderen Produktionsfaktor ersetzen können. Die zusätzliche Verschachtelung erlaubt es unterschiedliche Elastizitäten zwischen den Produktionsfaktoren anzunehmen. Wir verwenden einen Non-Linear-Least-Squares (NLS)-Schätzer um die technischen Elastizitäten zu schätzen.

Ein wichtiger Untersuchungsgegenstand der Studie besteht darin festzustellen, ob Produktionsfaktoren Komplemente oder Substitute sind. Im ersten Fall führt eine Preiserhöhung des einen Faktors zu einer Abnahme des anderen Faktors. Im zweiten Fall führt eine Preiserhöhung des einen Faktors zu einer Zunahme des anderen Faktors. Generell lässt sich sagen, dass bei einem Anstieg des Preises eines Faktors und gleichbleibender Produktionsmenge, die Gesamtkosten weniger stark ansteigen falls Produktionsfaktoren Substitute sind. In der Fachliteratur wird dabei zwischen CPE-Substituten und MES-Substituten bzw. CPE-Komplemente und MES-Komplemente unterschieden.

Unsere Resultate zeigen auf, dass die Produktionsfaktoren Energie und Kapital sowie Arbeit und Kapital in den meisten Fällen CPE-Substitute sind. Die Wirkungsbeziehung zwischen den Faktoren Energie und Arbeit ist allerdings nicht eindeutig und je nach betrachtetem Industriesektor unterschiedlich. Es zeigt sich weiter, dass die Produktionsfaktoren in den meisten Industrien MES-Substitute sind. Jedoch sind die Standardfehler der Morishima- wie auch der CPE-Elastizitäten relativ gross, was zu einigen insignifikanten Resultaten führt.

Zum Vergleich haben wir branchenspezifische Elastizitäten für sieben weitere europäische Länder geschätzt (Belgien, Dänemark, Deutschland, Grossbritannien, Holland, Schweden und Spanien). Die Resultate zeigen, dass in den meisten Ländern und Sektoren Arbeit und Kapital sowie Arbeit und Energie CPE-Substitute sind. Hingegen ist die Evidenz bei der Substitutabilität zwischen Kapital und Energie nicht so eindeutig. Alle Faktoren sind vorwiegend MES-Substitute und zwar in allen Ländern. Unsere Schätzresultate zeigen jedoch auch einige substantielle Unterschiede zwischen den Ländern in einzelnen Sektoren auf. Auch hier sind einige Standardfehler sehr hoch.

Deswegen werden die Schweizer Daten in einem nächsten Schritt mit den Daten der sieben europäischen Länder gepoolt und die branchenspezifischen Elastizitäten neu geschätzt. Die Standardfehler fallen aufgrund der höheren Anzahl Beobachtungen substantiell kleiner aus. Die absoluten Werte der gepoolten Elastizitäten sind dabei kleiner als im Fall der individuellen Schätzung, jedoch stimmen die Vorzeichen meistens überein. Wie zuvor sind die Produktionsfaktoren Arbeit und Kapital CPE-Substitute. Bei den anderen Produktionsfaktoren ist die CPE-Wechselwirkung weniger eindeutig und sektorabhängig, es gibt auch Hinweise auf einige Komplemente. Mit wenigen Ausnahmen sind die Produktionsfaktoren aller Sektoren zudem MES-Substitute, wenn die gepoolte Schätzung zugrunde gelegt wird.

Basierend auf dem Schweizer Datensatz wurden zusätzlich die technischen Elastizitäten geschätzt. Alle technischen Elastizitäten liegen in einem Bereich von 0.3 bis 0.7. Sie sind auch zwischen den einzelnen Sektoren in den meisten Fällen sehr ähnlich. Werden die technischen Elastizitäten in ökonomische Elastizitäten transformiert, so sind unter dem CES-Modell alle Produktionsfaktoren CPE-Substitute. Ähnlich wie schon bei den gepoolten Resultaten, fallen die absoluten Werte kleiner aus als bei der branchenspezifischen Translog-Spezifikation.

Ein kurzer Literaturvergleich zeigt schliesslich auf, dass die geschätzten Substitutionselastizitäten der Schweiz grundsätzlich mit anderen Schätzungen aus der internationalen Literatur vergleichbar sind. Die CPE- und MES-Elastizitäten liegen ähnlich wie bei anderen Schätzungen im Bereich von -5 und +5, die technischen Elastizitäten wie erwähnt zwischen 0.3 und 0.7. Allerdings können die Abweichungen im Einzelfall beträchtlich sein, was auch damit zusammenhängt, dass die in der bestehenden Literatur verwendeten Vorgehensweisen und unterstellten Annahmen sehr unterschiedlich ausfallen.

Schliesslich zeigen wir an zwei Beispielen, welche Implikationen durch die Höhe der ökonomischen und technischen Substitutionselastizitäten für die Firmen aus einer Branche resultieren, also beispielsweise welchen Effekt eine Erhöhung der Strompreise auf die totalen Kosten haben kann. Wir schliessen die Studie mit einer kurzen Betrachtung über mögliche Schwächen bei der Schätzung der Elastizitäten ab und legen dar, für welche Anwendungen sich die geschätzten Elastizitäten eignen und wann Vorsicht geboten ist.

Substitution Elasticities in Swiss Manufacturing*

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Abstract

Estimates of sectoral elasticities of substitution between capital, labor, energy and material inputs are ubiquitously found in the economic literature covering a variety of different industries and countries. So far, however, no such estimates exist for Swiss manufacturing sectors. We close this gap by using a newly assembled dataset covering the period from 1997 to 2008 and by estimating substitution elasticities employing different modeling approaches, namely a translog cost function and a nested CES production function. We interpret the resulting technical and economic elasticities of substitution and contrast the estimates from Switzerland with elasticities from other European countries using existing datasets. Additionally, we provide a short discussion on the usefulness of these elasticities in practical applications and their limitations.

Keywords:	Substitution elasticities, Swiss manufacturing sectors
JEL Classification:	C33, Q41

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1 Introduction

Availability, quality and pricing of production factors are important determinants of firms' success and therefore essentially affect the prosperity of an economy. These production factors can broadly be classified as labor, capital, material and energy inputs. Price changes of energy inputs are especially relevant for manufacturing firms whose production is relatively energy-intensive compared to, for example, firms active in the service sector. In this respect, the debate on the finiteness of natural resources has raised questions of how these firms will adjust to price changes of such scarce commodities. Policy measures to increase the efficiency of production and to achieve the reduction goals for greenhouse gas emissions have even amplified the interest in such questions. Additionally, the nuclear incident in Fukushima 2011 has recently raised the issue of an adequate mix of energy sources. As a consequence and shortly after the accident, the Swiss government has decided to aim for a nuclear phaseout. While the actual consequences of this policy change for the economy are still rather unclear, its implied adjustments in policy measures is sure to yield important consequences on the demand and the supply side of the energy provision in Switzerland, potentially changing absolute and relative prices of different energy sources.

Regardless of whether price changes originate from price shocks on international commodity markets or from government policies, they will alter the production patterns of firms and industries. Price increases of oil, fuel or electricity will presumably reduce the demand for energy. Adjustments in energy prices will furthermore change the demand for other input factors. Depending on the elasticities of the production factors, firms will produce more or less capital or labor intensively. Additionally, such changes yield important implications for the production costs of firms and - in a small open economy like Switzerland - their international competitiveness. It is hence evident that elasticities of substitution play an essential role in assessing the effects of changes in energy prices - or more generally - of changes in input factor prices on the Swiss economy.

The empirical literature has shown that the magnitude of such elasticities depends on a variety of factors. Importantly, these findings indicate that elasticities vary significantly between countries, industries and time periods. It is hence essential that policy evaluations are based on adequate elasticities.[1] However, such elasticities of substitution between input factors covering recent years have not been estimated for Swiss manufacturing industries, the reason being a lack of data availability.[2]

In this article, we close this gap and estimate sectoral elasticities of substitution between energy, capital, labor and material inputs for Swiss manufacturing covering the period from 1997 to 2008 and using different modeling approaches. The consideration of different modeling specifications is important since different elasticity types may be used to address different policy questions. For example, technical elasticities estimated from CES production functions are used in CGE models that assess effects of certain policy measures on the whole economy. In contrast, economic elasticities like cross-price or Morishima elasticities are often estimated from a translog cost function and may be used to evaluate how the substitutability between input factors actually works in firms of certain industries upon price changes, and to calculate what direct costs are imposed on firms during this process.

The results of the analysis can be summarized as follows. First, using the translog cost function, we present estimates of own- and cross-price elasticities as well as Morishima elasticities of substitution for Switzerland. We observe that labor and capital as well as energy and capital are estimated as CPE-substitutes while evidence is mixed regarding the substitution pattern of energy and labor. On the other hand, all factor inputs are estimated as being Morishima substitutes in most industries. Standard errors of the estimates are, however, relatively large resulting in many insignificant estimates.

Second, we provide pooled estimates using additional data on seven European countries. Standard errors decrease substantially. We furthermore observe smaller elasticities in magnitude. Regarding the substitution pattern, capital and labor are estimated as substitutes as in the Swiss case while evidence on the substitutability of labor and energy as well as capital and energy is mixed. All inputs tend to be Morishima substitutes with some exceptions in selected industries.

[1] A prevalent way to evaluate and forecast the impact of price shocks or policies on the economy is to assume different scenarios (e.g., the implementation of greenhouse gas reduction goals by a high or low carbon tax) and estimate the effects with computational general equilibrium (CGE) models. An example of such a model is the MultiSWISS-Energy model (Ecoplan, 2007)

[2] An exception is Bodmer (2005). His estimates of Swiss substitution elasticities between input factors are, however, restricted to aggregate manufacturing.

Third, we contrast the Swiss estimates to individual estimates of elasticities in the seven European countries. We find that elasticities may differ greatly in selected industries, however, we do not find any systematic differences to Swiss estimates. Substitution patterns in other countries are often similar to the ones in Switzerland.

Fourth, we apply a nested CES production function to estimate technical elasticities of substitution for Swiss manufacturing industries. Surprisingly, we find no substantial differences between different industries. Also, alternative nesting structures do not yield substantially different results. We transform the technical elasticities into own- and cross-price elasticities and find that all input factors are estimated as being substitutes. Additionally, we observe much lower estimates in comparison to the translog specification.

Fifth, we provide a discussion on how to interpret the different elasticities of substitution and show implications of an energy price increase on factor use, factor shares and total production costs by using the estimated elasticities of a selected industry.

The remainder of this article is structured as follows. In Section 2, we discuss the theoretical models employed and illustrate how economic and technical elasticities are calculated. In Section 3, we provide an overview of the dataset and present the estimation strategy. Section 4 discusses the regression results and illustrates the substitution patterns of Swiss manufacturing sectors. Furthermore, the elasticities of Swiss manufacturing are compared to elasticities of seven European economies and a pooled cross-section estimate. We conclude this section by providing a short discussion on possible uses and misuses of the presented estimates. Section 5 concludes.

2 Modeling Approach

We estimate the elasticities of factor substitution using two different modeling approaches. First, we employ a translog cost function as it is the prevalent approach used in the literature. Second, we use nested CES production functions since these functions are often the basis of CGE models, used for instance to assess the effects of various policy changes. In both cases, we assume a sector-specific production technology with input factors capital (K), labor (L), energy (E), and material (M). These two distinct modeling approaches are discussed in the following.

2.1 Translog Cost Function

The transcendental logarithmic (translog) cost function was proposed in Christensen et al. (1973) and subsequently adopted in a seminal paper by Berndt and Christensen (1973) to estimate the substitution patterns in U.S. manufacturing. It is more flexible than other modeling approaches as it does not impose any prior constraints on the elasticities and on the optimal path of input factor adjustments.[3]

The functional form of the translog function embodies the following important implications for parameterization. First, the sum of the factor shares equals one in every sector, and second, symmetry of the cross-price derivatives must be satisfied ($\beta_{ij} = \beta_{ji}$ for $i, j = 1, .., I$). The first property induces singularity because the sum of the error terms of the four factor shares has to equal zero for every sector. We obtain a non-singular system by dropping one of the factor share equations. Therefore, all factor prices are normalized by the price of material which allows us to omit the factor share equation of material.[4] The second property is satisfied by imposing constraints directly on the regression equation (see Section 3.2). Furthermore, concavity properties are not generally met using translog cost functions. We test for this property in Section 4.

The factor share equations can be obtained by differentiating the logarithm of the translog cost function (which is omitted here) with respect to the logarithm of the prices. The factor shares are given by

$$s_{in,t} = \beta_{in} + \sum_{j} \beta_{ijn} \ln(p_{jn,t}) + \beta_{iny} \ln y_{n,t} + \beta_{in,t} t, \tag{1}$$

where i and j are indices for input factors, n is the industry index and t is a time index capturing the time trend. Hence, the factor share $s_{in,t}$ of input i in industry n's production equals the sum of a constant β_{in} and the own-price and cross-price derivatives β_{ijn} (i.e., the share elasticities) multiplied by the logarithm of the input prices. Moreover, we add the logarithm of output $y_{n,t}$ and a time trend. The coefficient β_{iny} yields information

[3]It is standard to estimate elasticities from the translog model using cost functions instead of production functions. One reason for this approach is that no arbitrary restrictions of the production patterns have to be assumed (Jorgenson, 1986). Another reason is that the data requirements are less rigorous than for estimating production functions because cost functions only require data on factor shares and factor unit prices.

[4]The elasticities of the input factor material can be derived by using the imposed restrictions.

about the form of the returns to scale in a particular industry. The time trend parameter $\beta_{in,t}$ varies with i and thus additionally allows us to account for non-neutral technological change.

Economic substitution elasticities can be derived from the estimates of β_{ijn}. Three types of economic elasticities are commonly used in the literature: the cross-price elasticity (CPE), the Morishima elasticity of substitution (MES) and the Allen partial elasticity of substitution (AES) which is a normalized version of the CPE. It has been argued by many scholars that the AES do not yield any interpretation in the case of more than two input factors.[5] We therefore refrain from calculating such elasticities in our contribution.

The first type of elasticity we compute is the cross-price elasticity CPE_{x_i,p_j} which measures the relative change of quantity x_i of a production factor i due to the relative price change of p_j of a factor j. In the remainder of the paper, we denote such elasticities by CPE_{ij}, where the first index indicates the factor whose quantity is affected and the second one the factor experiencing the initial price change. These elasticities can be derived from the estimated share elasticities (β_{ij}) and the factor shares:[6]

$$\text{CPE}_{ij} \equiv \frac{\partial \ln x_i}{\partial \ln p_j} = \frac{\hat{\beta}_{ij} + s_i s_j}{s_i}, \qquad \text{CPE}_{ii} \equiv \frac{\partial \ln x_i}{\partial \ln p_i} = \frac{\hat{\beta}_{ii} + s_i s_i - s_i}{s_i}. \tag{2}$$

where the second expression is the formula for the own-price elasticities.

The second type of elasticity, the Morishima elasticity of substitution $\text{MES}_{x_i/x_j,p_j}$, measures the relative change of the quantity ratio x_i/x_j of production factors i, j due to a relative price change in p_j of factor j. We denote these elasticities by MSE_{ij}. To obtain the Morishima elasticity, the own price elasticity is subtracted from the cross-price elasticity:

$$\text{MES}_{ij} \equiv \frac{\partial \ln(x_i/x_j)}{\partial \ln p_j} = \text{CPE}_{ij} - \text{CPE}_{jj}. \tag{3}$$

Using Equation 3 and remembering that the own-price elasticity is negative, then it follows that: $\text{MES}_{ij} > \text{CPE}_{ij}$. Moreover, the MES can be used to obtain information on how the ratio of two factor shares changes due to a price increase of one input factor.

[5]See for example Thompson and Taylor (1995), Blackorby and Russell (1989) or Frondel (2011).

[6]Anderson and Thursby (1986) argue in favor of using time means of factor shares since they provide desirable properties regarding the distribution of the elasticity estimators.

Equation 4 shows how the share ratio changes due to a price change p_j:

$$\begin{aligned}
\frac{\partial \ln(p_i x_i/p_j x_j)}{\partial \ln p_j} &= \frac{\partial \ln(p_i x_i)}{\partial \ln p_j} - \frac{\partial \ln(p_j x_j)}{\partial \ln p_j} = \frac{\partial \ln x_i}{\partial \ln p_j} - 1 - \frac{\partial \ln x_j}{\partial \ln p_j} \\
&= \mathrm{CPE}_{ij} - \mathrm{CPE}_{jj} - 1 = \mathrm{MSE}_{ij} - 1, \\
\frac{\partial \ln(p_j x_j/p_i x_i)}{\partial \ln p_j} &= 1 - \mathrm{MSE}_{ij},
\end{aligned} \tag{4}$$

where $p_i x_i / \sum_k p_k x_k = s_i$. Hence, the share ratio s_i/s_j increases if $\mathrm{MSE}_{ij} > 1$.

Following Koetse et al. (2008) the standard errors of the elasticities have been derived by using the Delta method (see e.g., Greene (2000)). The variance of the CPE is:

$$\mathrm{var}(\mathrm{CPE}_{ij}) = \left(\frac{1}{s_i}\right)^2 \mathrm{var}(\hat{\beta}_{ij}). \tag{5}$$

The expression determining the variance of own-price elasticities can be derived analogously and is omitted here. The variance of the Morishima elasticity is given by

$$\begin{aligned}
\mathrm{var}(\mathrm{MES}_{ij}) &= \mathrm{var}(\mathrm{CPE}_{ij}) + \mathrm{var}(\mathrm{CPE}_{jj}) - 2\mathrm{cov}(\mathrm{CPE}_{ij}, \mathrm{CPE}_{jj}) \\
&= \left(\frac{1}{s_i}\right)^2 \mathrm{var}(\hat{\beta}_{ij}) + \left(\frac{1}{s_j}\right)^2 \mathrm{var}(\hat{\beta}_{jj}) - 2\left(\frac{1}{s_i s_j}\right) \mathrm{cov}(\hat{\beta}_{ij}, \hat{\beta}_{jj}).
\end{aligned} \tag{6}$$

2.2 Nested CES Production Function

The constant elasticity of substitution (CES) modeling approach assumes that elasticities between different production factors are equal and constant for all possible price or quantity combinations. To allow for constant but different elasticities between the production factors, CES production functions can be divided into subfunctions, so called *nests*. Nested CES functions are more flexible than the standard CES function, since through the flexible nesting structure, elasticities between the factors are allowed to differ.

To conform with global regularity conditions, nested CES functions rely on specific properties: All production factors have to be technical substitutes. Moreover, the nesting structure implies separability of the production factors in a nest with the factors outside; production factors in a nest are additively separable from the production factors outside of the nest. Hence, nested CES functions are more restrictive compared to more flexible functional forms (e.g. the translog function) since some technical elasticities are equalized.

We employ a three-level nested CES production function, again consisting of input factors K, L, E, and M.

Thereby, we consider three different modeling structures: In all three cases, the first level of the production function is identical; the KLE-nest is combined with M as is displayed by equation (7). We choose this structure since it is common in the literature[7] and because our primary interest lies in the substitutability between the other three input factors. Some scholars argue, however, that omitting material in the estimation procedure leads to biased estimates (see Section 4.3). Therefore, we include material into our estimation procedure.

The second and third levels, however, differ by case: In case a (equation (8a)), K and L are combined on the third level. The second level then combines KL with E. In case b (equation (8b)) K and E are combined on the third level. The second level then combines KE with L. In case c (equation (8c)) L and E are combined on the third level. The second level then combines LE with K.

$$Y_t = A_{i;t}\left[a_i X_{i;t}(KLE)^{-\beta_1} + (1-a_i)M_t^{-\beta_1}\right]^{-\frac{1}{\beta_1}}. \tag{7}$$

The three different cases of the KLE-nest are:

$$X_{KL,E;t}(KLE) = A_{1;t}\left[b_1 A_{2;t}^{-\beta_2}\left(c_1 K_t^{-\beta_3} + (1-c_1)L_t^{-\beta_3}\right)^{\frac{\beta_2}{\beta_3}} + (1-b_1)E_t^{-\beta_2}\right]^{-\frac{1}{\beta_2}}, \tag{8a}$$

$$X_{KE,L;t}(KLE) = A_{3;t}\left[b_2 A_{4;t}^{-\beta_4}\left(c_2 K_t^{-\beta_5} + (1-c_2)E_t^{-\beta_5}\right)^{\frac{\beta_4}{\beta_5}} + (1-b_2)L_t^{-\beta_4}\right]^{-\frac{1}{\beta_4}}, \tag{8b}$$

$$X_{LE,K;t}(KLE) = A_{5;t}\left[b_3 A_{6;t}^{-\beta_6}\left(c_3 L_t^{-\beta_7} + (1-c_3)E_t^{-\beta_7}\right)^{\frac{\beta_6}{\beta_7}} + (1-b_3)K_t^{-\beta_6}\right]^{-\frac{1}{\beta_6}}, \tag{8c}$$

where β_i is a substitution parameters and a_i, b_i and c_i are distribution parameters. $A_{i;t}$ is the time-varying technology parameter.

In the following, we will provide a detailed description of case (a) regarding elasticities and corresponding variances. The formulas for the other two cases can be found in the Appendix A.1. Figure 1 illustrates the nesting structure of case (a).

[7] Many application use value-added as a measure for output (net of material costs) instead of total sales. These studies consider material as weakly separable from the other input factors and therefore estimate the production function with the input factors K, L and E.

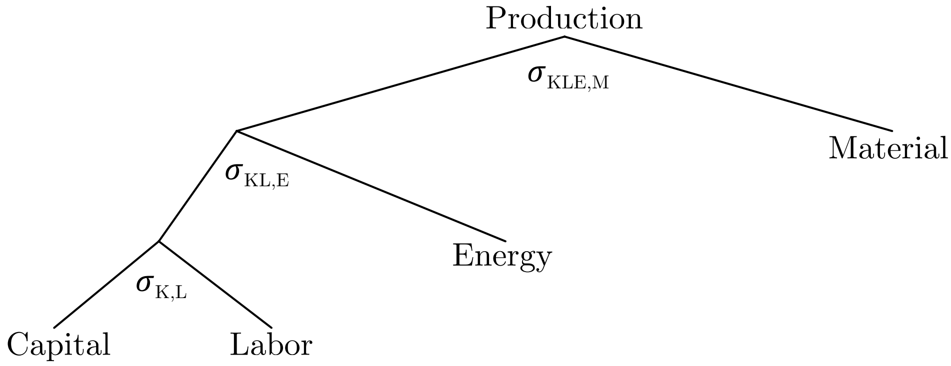

Figure 1: Nested CES production function, case (a)

Parameters of the CES model enable the calculation of so-called *technical* (or *engineering*) elasticities of substitution σ_{ij}. The concept of the technical elasticity describes the marginal rate of technical substitution between factors x_i and x_j holding output and all input factors except x_i and x_j constant. They can be derived from the substitution parameters (β_i) as follows.

$$\begin{aligned}
\frac{1}{1+\beta_1} &= \sigma_1^a \quad (\sigma_{KM}, \sigma_{LM}, \sigma_{EM}), \\
\frac{1}{1+\beta_2} &= \sigma_2^a \quad (\sigma_{KE}, \sigma_{LE}), \\
\frac{1}{1+\beta_3} &= \sigma_3^a \quad (\sigma_{KL}). \qquad (9)
\end{aligned}$$

The variance of the technical elasticity σ_n^i can be derived with the Delta method and the corresponding $\hat{\beta}_m$:

$$\operatorname{var}(\sigma_n^i) = \left[\frac{1}{(1+\hat{\beta}_m)^2}\right]^2 \operatorname{var}(\hat{\beta}_m). \qquad (10)$$

Technical elasticities are not directly comparable to our estimated economic elasticities of the translog form. In contrast to economic elasticities, technical elasticities illustrate how factors can be substituted in the actual production process as they measure the marginal rate of technical substitution. This rate expresses to what extent a production factor has to be substituted by another one to keep output constant. This solely depends on the production technology of firms, but not on the magnitude of prices or price increases of different production factors.

While this information is valuable and is often used for the calibration of CGE models, it is our intention to compare the translog estimates to the estimates from the nested CES case. For this purpose, we transform the technical elasticities into CPEs. To do this in a traceable and concise manner, the engineering elasticities are first transformed into symmetric AES elasticities, following Perroni and Rutherford (1998):

$$
\begin{aligned}
\mathrm{AES}_{KM} &= \mathrm{AES}_{LM} = \mathrm{AES}_{EM} = \sigma_1^a, \\
\mathrm{AES}_{MM} &= -\frac{1-s_M}{s_M}\sigma_1^a, \\
\mathrm{AES}_{KL} &= \sigma_1^a + \frac{\sigma_3^a - \sigma_2^a}{s_K + s_L} + \frac{\sigma_2^a - \sigma_1^a}{s_K + s_L + s_E}, \\
\mathrm{AES}_{KE} &= \mathrm{AES}_{LE} = \sigma_1^a + \frac{\sigma_2^a - \sigma_1^a}{s_K + s_L + s_E}, \\
\mathrm{AES}_{KK} &= \sigma_1^a - \frac{\sigma_3^a}{s_K} + \frac{\sigma_3^a - \sigma_2^a}{s_K + s_L} + \frac{\sigma_2^a - \sigma_1^a}{s_K + s_L + s_E}, \\
\mathrm{AES}_{LL} &= \sigma_1^a - \frac{\sigma_3^a}{s_L} + \frac{\sigma_3^a - \sigma_2^a}{s_K + s_L} + \frac{\sigma_2^a - \sigma_1^a}{s_K + s_L + s_E}, \\
\mathrm{AES}_{EE} &= \sigma_1^a - \frac{\sigma_2^a}{s_E} + \frac{\sigma_2^a - \sigma_1^a}{s_K + s_L + s_E}.
\end{aligned} \tag{11}
$$

In a second step, the asymetric CPEs can be derived from the AESs by multiplying by the adequate shares:[8]

$$\mathrm{CPE}_{ij} = s_j AES_{ij}.$$

3 Data and Estimation Strategy

3.1 Data

To estimate the elasticities discussed above, sector-specific data is required containing information on factor cost shares, prices and deflators of the input factors capital, labor, energy and material as well as on revenue and production. We use data covering Switzerland as well as Germany, Belgium, the Netherlands, Great Britain, Denmark, Sweden and Spain. The sample of countries is first restricted by data availability and second by our intention to limit the sample to advanced economies in the vicinity of Switzerland.

The Swiss Federal Statistical Office (SFSO) and the Swiss Federal Office of Energy (SFOE) are the main sources of the data on Swiss manufacturing industries. This

[8]See for example Prywes (1986). We do not report Allen elasticities in this study since they are rightly criticized for being of limited meaningfulness. See for example Blackorby and Russell (1989).

dataset was compiled in the study "Energy-Related Data for Swiss Manufacturing Sectors" (Mohler and Müller, 2011).[9] Additionally, section A.2 in the Appendix describes the employed variables.

Data for the other countries stem from the database EU KLEMS.[10] This database covers data on labor, capital and intermediate inputs, where the intermediates are divided into material, energy and service inputs. Data on gross output as well as price indices of intermediate inputs and labor costs are also readily available.

For all countries, data is generally available on ISIC 3.1 2-digit levels.[11] This industry classification defines 23 manufacturing industries. Due to data limitations, however, we aggregate these ISIC industries into 12 manufacturing industries we use in our analysis.[12] Table 1 provides an overview on these industries. We use the term manufacturing industries and sectors interchangeably in the text.

Table 1: Definition of manufacturing industries

Aggregates (industries[1])	Description	Revenue share
1 (15,16)	Food products and beverages	10%
2 (17,18,19)	Textiles, textile products, leather and footwear	1%
3 (20)	Wood and products of wood and cork	3%
4 (21,22)	Pulp, paper, paper products, printing and publishing	5%
5 (24)	Chemicals and chemical products	22%
6 (25)	Rubber and plastic products	3%
7 (26)	Other non-metallic mineral products	2%
8 (27,28)	Basic metals and fabricated metal products	10%
9 (29)	Machinery and equipment	14%
10 (30,31,32,33)	Electrical and optical equipment	25%
11 (34,35)	Transport equipment	3%
12 (36)	Furniture and other manufacturing	2%

[1] Industries according to NOGA 2002 industrial classification of Switzerland, 2-digit.
Source: Swiss Federal Statistical Office.

In Appendix A.3, we provide a detailed depiction of the price evolution of all production factors considered and output for all 12 industries in Switzerland. We first note that one single capital price series is used for all 12 industries. This is due to data limitations

[9] Available as an SFOE working paper on *http://www.ewg-bfe.ch*.

[10] An extensive description of the KLEMS database can be found in Timmer et al. (2007) and O'Mahony and Timmer (2009).

[11] ISIC 3.1 corresponds to NOGA 2002 which is the industry classification predominantly used in Switzerland.

[12] We exclude sectors 23 (manufacture of coke, refined petroleum products) and 37 (recycling) due to the lack of availability in the Swiss dataset.

(also see Section A.2). Furthermore observe that some movements are observable for our capital price proxy as displayed in Figure 2. Regarding labor prices, we observe a steady increase in all industries with no substantial differences between the considered industries in Figure 3. Differences can, however, be observed regarding the evolution of material prices in Figure 4: While all but one industries experience rising material prices, the extent of this increase differs from industry to industry. Prices of different energy sources are assumed to be the same for all industries and are displayed in Table 5. These prices are then used to construct sectoral price indices using the sectoral shares of the different energy sources. As a result, we observe rising energy prices for all industries in Figure 6, but again, the magnitude of the increase differs substantially across industries. Figure 7 then depicts the evolution of output prices where we also observe some sectoral differences.

Table 21 and Table 22 then compare the average annual price changes of input factors and output in Switzerland with descriptive statistics on input factor prices of the EU KLEMS data for the other seven countries considered. According to Table 21, price increases in labor and energy inputs are relatively low in Switzerland while changes in material and capital prices are similar compared to other European economies. The same is true for output prices as Table 22 illustrates, although some differences between industries can be observed.

Appendix A.4 contains information on the evolution of the cost shares of different input factors in Swiss manufacturing industries. Figure 8 illustrates that the material cost share is highest in all industries while the energy cost shares are, as expected, lowest. Labor costs rank second in most industries. Cost shares remain relatively stable throughout the whole period. Figure 9 shows the energy shares in a smaller scale to reveal some details: We observe that in about half of the industries, the energy share is slightly decreasing while in the remaining industries, it remains on a relatively constant level. Figure 10 depicts the sectoral energy mix. In all industries, electricity takes the largest share, in most cases followed by natural gas or light fuel oil. Some substantial differences between industries are observable.

Table 23 displays the average cost shares of capital, labor, energy and material for Switzerland. In addition, the medians, minimums and maximums from the other countries are displayed. The cost share of material, comprising all intermediate products, varies between 37.5 percent in paper and printing (sector 4) and 62.3 percent in food products and beverages (sector 1). The cost share of labor lies around 30 percent; the capital share is slightly lower. The cost share of energy varies between 0.6 percent in non-metallic products (sector 9) and 4.5 percent in electrical and optical equipment (sector 7). A comparison to European data shows that the Swiss factor shares are comparable with those of other countries. Some differences are, however, noteworthy: While the labor share is slightly above average - possibly due the skill-intensive production in Switzerland - energy shares are slightly below average indicating that Switzerland produces less energy-intensively than other countries on average.

3.2 Estimation Strategy

To estimate the share elasticities of the translog cost functions in equation (1), we use a Seemingly Unrelated Regression (SUR) approach. The advantage of SUR is that the estimation procedure takes into account the cross-correlations between the error terms (covariance of the disturbances) in the system of factor share equations. To illustrate this, we present the system of factor share equations. As above, for the sake of comprehensibility, the system of equations is displayed for one country only. We use the following matrix formulation:

$$\begin{bmatrix} s_{E1} \\ s_{K1} \\ s_{L1} \\ \vdots \\ s_{EN} \\ s_{KN} \\ s_{LN} \end{bmatrix} = \begin{bmatrix} X_1 & 0 & \cdots & 0 \\ X_1 & 0 & & 0 \\ X_1 & 0 & & 0 \\ \vdots & & \ddots & \vdots \\ 0 & 0 & & X_N \\ 0 & 0 & & X_N \\ 0 & 0 & \cdots & X_N \end{bmatrix} \begin{bmatrix} B_{E1} \\ B_{K1} \\ B_{L1} \\ \vdots \\ B_{EN} \\ B_{KN} \\ B_{LN} \end{bmatrix} + \begin{bmatrix} \epsilon_{E1} \\ \epsilon_{K1} \\ \epsilon_{L1} \\ \vdots \\ \epsilon_{EN} \\ \epsilon_{KN} \\ \epsilon_{LN} \end{bmatrix} \tag{12}$$

$$\mathbf{s} = \mathbf{XB} + \mathbf{E}$$

where

$$X_n = [1, p_{En}, p_{Kn}, p_{Ln}, y_n], \qquad B_{in} = [\beta_{in}, \beta_{iEn}, \beta_{iKn}, \beta_{iLn}, \beta_{yn}].$$

The LHS of **s**=**XB**+**E** consists of a vector of factor shares including energy, capital and labor for industry 1 to industry N. The RHS consists of a system of vector multiplications **XB** plus a vector of the error terms. X_n is a vector of a constant, the factor prices and output for industry n. B_{in} is a vector of coefficients for the constant, the cross-price derivatives and the output for input share i in industry n. The covariance matrix of the system of regressions is

$$\mathbf{\Sigma} = \begin{bmatrix} \sigma_{E1E1} & \cdots & \sigma_{E1L1} & \cdots & \sigma_{E1EN} & \cdots & \sigma_{E1LN} \\ \vdots & \sigma_{K1K1} & \vdots & & \vdots & \sigma_{K1KN} & \vdots \\ \sigma_{L1E1} & \cdots & \sigma_{L1L1} & & \sigma_{L1EN} & \cdots & \sigma_{L1LN} \\ \vdots & & & \ddots & & & \vdots \\ \sigma_{ENE1} & \cdots & \sigma_{ENL1} & & \sigma_{ENEN} & \cdots & \sigma_{ENLN} \\ \vdots & \sigma_{KNK1} & \vdots & & \vdots & \sigma_{KNKN} & \vdots \\ \sigma_{LNE1} & \cdots & \sigma_{LNL1} & \cdots & \sigma_{LNEN} & \cdots & \sigma_{LNLN} \end{bmatrix} \tag{13}$$

The covariance matrix Σ indicates how the error terms are related between all factor share equations. If the non-diagonal values of the matrix Σ are not equal to zero, then the error terms are correlated between different factors, industries or countries. In this case, SUR provides more efficient estimates than separate OLS estimation.[13]

We also impose the symmetry restrictions directly on the estimation procedure by setting up constraints in the form of $\beta_{ij} = \beta_{ji}$. Furthermore, we use one year lagged prices in the share equations to account for inertia in the adjustment process of the input factors as well as for endogeneity issues.[14]

To estimate the technical substitution elasticities in the nested CES production function case, we use nonlinear least squares (NLS) regression. The limited number of time-series observations requires us to estimate each nest separately. As an example, we estimate the third level of the nested CES as

[13]We apply this method in the pooled regression. Due to the limited number of time-series observations, we are not able to estimate the coefficients of all sectors simultaneously for Swiss manufacturing. However, we are still able to estimate the three share equations of each sector in one step.

[14]Prices of input factors are often themselves influenced by the behavior of firms. This behavior changes the relative demand on factor markets and thus the factor prices. Hence, a major issue in estimating elasticities is the endogeneity problem. We estimate different specifications using present and lagged values of input prices. We find that the concavity property is best met when using a one year lag.

$$X_{K,L;t} = \alpha_{A2} + \alpha_{A2;t} * t + \left[\gamma_1 K^{-\beta_3} + (1-\gamma_1) L_t^{-\beta_3}\right]^{-\frac{1}{\beta_3}} + \epsilon_3, \quad (14)$$

where the parameters α_{A2}, $\alpha_{A2;t}$, β_3 and γ_1 are estimated simultaneously. We make use of the separability assumption and replace the unknown value of $X_{K,L;t}$ by Y_t. We then use the prediction $\hat{X}_{K,L;t}$ for the estimation of the upper nest.[15]

4 Results

We organize the discussion of the results as follows. Section 4.1 discusses the results from the estimation of the translog cost function. In a first step, we present the sectoral elasticities of Swiss manufacturing industries. We then contrast these results with the estimates from other countries and with pooled cross-country and cross-sector estimates. In Section 4.2, technical and economic elasticities using the nested CES model are presented. Section 4.3 briefly discusses our results and highlights the insights gained regarding the substitutability debate and discusses possible uses and misuses of the presented factor elasticities.

4.1 Translog Cost Function

4.1.1 Swiss Manufacturing

Table 2 displays the own-price elasticities regarding labor, capital and energy inputs for all manufacturing industries in Switzerland.[16] Own-price elasticities state how the quantity of one input changes due to a price increase of this input, holding output and all other prices constant. For example, the own-price elasticity of energy in sector 1 implies that if the price of energy increases by one percent, the quantity of energy utilized to produce a constant amount of output will decrease by 1.15 percent consequently. If the own-price elasticity is smaller than -1, then not only the quantity but also the cost share of this

[15]If the separability restriction is not met, this may bias our results. However, we estimate several specifications and find that the resulting technical elasticities of substitution are always similar in magnitude: For example, we estimate the shares γ_i in a first step and use these shares in a second step to estimate all β_i's simultaneously.

[16]We refrain from presenting elasticities concerning the factor material. These elasticities are available from the authors. The inclusion of materials into the modeling approach is nonetheless very important since the omission of a product factor can lead to biased results as is shown by Berndt and Wood (1979).

factor decreases upon a price increase. Our estimates of the own-price elasticities range between -4 and 1.8 which is a fairly broad range. Note however that the standard errors displayed in parentheses are rather large, especially for the energy elasticities. This is also illustrated by Figure 11 in the Appendix.

Table 2: Own-price elasticities, Swiss manufacturing industries

Sector	CPE_{LL}	CPE_{KK}	CPE_{EE}
1	0.02	-0.78*	-1.15
	(0.45)	(0.25)	(1.21)
2	0.82	-0.76	-1.54
	(0.83)	(0.72)	(0.95)
3	-1.58	-1.14*	-3.18
	(0.82)	(0.54)	(3.49)
4	-0.89*	-0.33	-1.40*
	(0.08)	(0.83)	(0.61)
5	-1.83*	-0.65*	-1.42
	(0.31)	(0.26)	(1.41)
6	-0.84*	-1.26*	0.61
	(0.30)	(0.25)	(2.14)
7	-1.87*	-0.75*	-1.29
	(0.34)	(0.33)	(0.87)
8	-1.30*	-1.31*	-0.87
	(0.13)	(0.16)	(1.65)
9	-1.15*	-0.82*	1.06
	(0.18)	(0.32)	(3.13)
10	-0.92*	-1.55*	-0.86
	(0.16)	(0.30)	(1.47)
11	-1.66*	-1.64	1.79
	(0.41)	(0.86)	(4.70)
12 *	-0.37	-0.33	-4.05*
	(0.39)	(0.43)	(1.13)
Concavity Test:			
Negative[a]	**10 (8)**	**12 (8)**	**9 (2)**
Positive[a]	**2 (0)**	**0 (0)**	**3 (0)**

Note: Swiss data only, translog specification.
[a] Number of significant cases are in parantheses.
[b] Elasticities of sector 12 are estimated from the sample dataset, see Appendix 2.
* Indicates significance at the 5% level.

Well-behaved production functions have to satisfy the concavity property as discussed above. Since translog functions do not globally satisfy this principle, it has to be tested.

If own-price elasticities are all negative, then the concavity conditions are satisfied. The concavity test shows that there are five positive values, but none of them is significantly different from zero. Hence, we find no apparent misspecification.

Table 3: Cross-price elasticities, Swiss manufacturing industries

Sector	CPE_{LE}	CPE_{EL}	CPE_{KE}	CPE_{EK}	CPE_{KL}	CPE_{LK}
1	-0.20	-2.51	0.10	1.30	0.54*	0.57*
	(0.15)	(1.87)	(0.10)	(1.36)	(0.17)	(0.18)
2	-0.15	-2.49	0.06	0.64	0.95	0.60
	(0.13)	(2.11)	(0.12)	(1.25)	(0.62)	(0.39)
3	0.14	3.62	0.17	2.57	0.23	0.14
	(0.20)	(5.12)	(0.24)	(3.73)	(0.72)	(0.44)
4	0.01	0.12	0.17	1.23	1.51*	1.08*
	(0.04)	(0.39)	(0.15)	(1.05)	(0.22)	(0.15)
5	-0.08	-0.94	0.05	1.09	0.30*	0.65*
	(0.13)	(1.41)	(0.06)	(1.38)	(0.12)	(0.25)
6	0.20	4.21	0.08	1.25	0.91*	0.69*
	(0.11)	(2.18)	(0.11)	(1.76)	(0.23)	(0.18)
7	0.21	1.38	0.11	0.60	1.63*	1.39*
	(0.16)	(1.04)	(0.18)	(1.04)	(0.25)	(0.21)
8	0.09	1.34	0.03	0.25	1.11*	0.73*
	(0.07)	(1.10)	(0.10)	(0.98)	(0.14)	(0.09)
9	0.06	2.91	-0.04	-1.52	1.06*	0.73*
	(0.08)	(3.84)	(0.08)	(2.84)	(0.16)	(0.11)
10	-0.12	-3.97	0.04	1.17	0.74*	0.73*
	(0.07)	(2.35)	(0.04)	(1.32)	(0.08)	(0.08)
11	-0.03	-0.67	-0.50	-5.86	0.19	0.11
	(0.22)	(4.46)	(0.39)	(4.57)	(0.64)	(0.37)
12[b]	0.08*	2.42*	0.09*	1.95*	0.04	0.03
	(0.03)	(1.02)	(0.04)	(0.91)	(0.35)	(0.25)
Substitutes or Complements:						
Substitutes[a]	**7 (1)**	**7 (1)**	**10 (1)**	**10 (1)**	**12 (8)**	**12 (8)**
Complements[a]	**5 (0)**	**5 (0)**	**2 (0)**	**2 (0)**	**0 (0)**	**0 (0)**

Note: Swiss data only, translog specification.
[a] Number of significant cases are in parantheses.
[b] Elasticities of sector 12 are estimated from the sample dataset, see Appendix 2.
* Indicates significance at the 5% level.

Table 3 displays all six cross-price elasticities between input factors and prices of capital, labor and energy. Cross-price elasticities state how the relative quantity of one input changes due to a relative price increase of another input, holding output and all other prices constant. Considering again sector 1 and the cross-price elasticity that evaluates the impact of an energy price change on labor use, CPE_{LE}, we find that if energy prices increase by one percent, the quantity of labor utilized to produce the constant amount of output will decrease by 0.2 percent. As expected, elasticities that evaluate the effect of energy price changes (rows one and three) are generally small due to the mostly small energy share in production while relative price changes of more important input factors yield a larger impact. Labor and capital price changes have larger relative effects, especially on the utilization of energy.

Table 3 also reveals that the standard errors of the estimates are relatively large (also see Figure 12 in the Appendix). Most elasticities that are significantly different from zero are found in the last two columns. Furthermore, while most elasticities between capital and labor as well as between energy and capital hint at the substitutability of these factors, the picture is less clear regarding energy and labor inputs.

Analogously, Table 4 displays all six Morishima elasticities. Morishima elasticities belong to the class of *two factor-one price* elasticities. In contrast to the CPE, the Morishima elasticities state how the ratio of two input quantities changes due to a price change of the factor in the denominator, holding output and all other prices constant. The Morishima elasticity CPE_{EL} in sector 1 implies that an energy price change of one percent leads to an increase of the labor-energy ratio of 0.95 percent.

Again, the standard errors are relatively large, except for the elasticities in the last two columns of the table. Figure 13 in the Appendix visualizes the corresponding confidence intervals. Furthermore, most Morishima elasticities are positive, implying substitutability between the input factors. The implications of these results for substitutability in general are discussed in more detail in Section 4.3. Table 24 presents some key statistics from the estimations performed to obtain the elasticities discussed in this section.

Table 4: Morishima elasticities, Swiss manufacturing industries

Sector	MES_{LE}	MES_{EL}	MES_{KE}	MES_{EK}	MES_{KL}	MES_{LK}
1	0.95	-2.53	1.24	2.08	0.52	1.35*
	(1.15)	(1.83)	(1.30)	(1.51)	(0.55)	(0.38)
2	1.40	-3.31	1.61	1.41	0.13	1.37*
	(1.01)	(2.61)	(1.03)	(1.52)	(0.64)	(0.69)
3	3.32	5.20	3.35	3.71	1.81	1.28
	(3.63)	(5.28)	(3.69)	(3.93)	(1.11)	(0.71)
4	1.41*	1.01*	1.57*	1.56	2.40*	1.41
	(0.62)	(0.40)	(0.58)	(1.02)	(0.22)	(0.84)
5	1.34	0.89	1.47	1.74	2.13*	1.30*
	(1.46)	(1.45)	(1.46)	(1.41)	(0.35)	(0.44)
6	-0.41	5.05*	-0.53	2.50	1.75*	1.95*
	(2.14)	(2.16)	(2.18)	(1.73)	(0.24)	(0.23)
7	1.50	3.24*	1.40	1.34	3.50*	2.13*
	(0.83)	(1.00)	(1.02)	(1.27)	(0.46)	(0.41)
8	0.96	2.64*	0.90	1.55	2.41*	2.03*
	(1.70)	(1.11)	(1.73)	(1.06)	(0.18)	(0.18)
9	-1.00	4.06	-1.10	-0.70	2.22*	1.55*
	(3.16)	(3.91)	(3.20)	(2.88)	(0.16)	(0.26)
10	0.74	-3.05	0.90	2.73*	1.66*	2.28*
	(1.47)	(2.38)	(1.49)	(1.35)	(0.22)	(0.35)
11	-1.82	0.98	-2.29	-4.22	1.84*	1.75
	(4.78)	(4.50)	(4.87)	(4.67)	(0.86)	(1.08)
12[b]	4.13*	2.79*	4.14*	2.28*	0.41	0.36
	(1.14)	(1.26)	(1.16)	(0.93)	(0.59)	(0.57)
Substitutes or Complements:						
Substitutes[a]	**9 (2)**	**9 (5)**	**9 (2)**	**10 (2)**	**12 (8)**	**12 (8)**
Complements[a]	**3 (0)**	**3 (0)**	**3 (0)**	**2 (0)**	**0 (0)**	**0 (0)**

Note: Swiss data only, translog specification.
[a] Number of significant cases are in parentheses.
[b] Elasticities of sector 12 are estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

4.1.2 A Comparison to other Country Estimates

We estimate own-price, cross-price and Morishima elasticities for Germany, Belgium, the Netherlands, Great Britain, Denmark, Sweden and Spain using EU KLEMS data and the same theoretical and empirical strategy as described above. In Figures 14 to 16 in the Appendix, these elasticities are depicted alongside the Swiss estimates. The figures reveal that Swiss estimates are not systematically different than estimates from other European countries. However, no obvious pattern emerges and there are also some elasticities that are substantially different in comparison to other countries. An inspection of the confidence intervals of Swiss (shown in Figures 14 to 16) and other European (not shown) estimates also reveals that the majority estimates for other countries are not significantly different from the elasticities estimated for Switzerland in a statistical sense (i.e. the confidence intervals overlap). However, since standard errors of both the Swiss estimates and the estimates of other European countries (see Tables 25 to 39[17]) are relatively large, the informative value of this observation is limited.

Table 5: Concavity test, all countries

	CPE_{LL}				CPE_{KK}				CPE_{EE}			
	Negative		Positive		Negative		Positive		Negative		Positive	
CHE	10	(8)	2	(0)	12	(8)	0	(0)	9	(2)	3	(0)
GER	11	(7)	1	(0)	7	(5)	5	(2)	8	(2)	4	(0)
BEL	11	(11)	1	(0)	11	(11)	1	(1)	12	(5)	0	(0)
NLD	10	(7)	2	(0)	12	(6)	0	(0)	12	(6)	0	(0)
GRB	10	(8)	2	(0)	10	(6)	2	(1)	10	(1)	2	(0)
DNK	12	(10)	0	(0)	11	(4)	1	(1)	12	(2)	0	(0)
SWE	12	(11)	0	(0)	12	(7)	0	(0)	11	(7)	1	(0)
ESP	12	(8)	0	(0)	10	(6)	2	(1)	5	(3)	7	(1)

Note: Country estimates, translog specification.
[a] Number of significant cases are in parentheses.

Table 5 illustrates that in the vast majority of estimates, the concavity test is met, i.e. the own-price elasticities are not significantly larger than zero. Thus, in general the elasticity estimates for the other countries meet the regularity conditions.[18] As is the case for the Swiss estimates, imprecise estimates occur predominantly for energy elasticities. Tables 25 to 27 in the Appendix depict point estimates and standard errors of all own-price elasticities.

Table 6 displays the percentages of sectors with positive CPE elasticities for all country estimates. The first column shows the substitution pattern between capital and labor, the second column the substitution pattern between capital and energy and the third column the substitution pattern between labor and energy. For example, the point estimates in

[17]For some countries and sectors, very large and implausible elasticity estimates occur. While we verified our Swiss data by using information from different data sources and checked for plausibility, we used data on the other countries as it is readily available from EU-KLEMS without performing extensive plausibility checks.

[18]Furthermore note that the estimation specification has been selected to suit the Swiss data. This may be the reason for some positive value in other countries.

Switzerland imply that the factors capital and energy are substitutes in 83% of all cases and complements in 17% of all cases. Considering other country estimates, some heterogeneity can be found. While labor and energy as well as capital and labor are found to be CPE substitutes in most countries and sectors, evidence is mixed on the substitutablity of Capital and Energy. This result is in line with other findings from the literature.[19] One has to keep in mind that many of these estimates are not significantly different from zero. Point estimates and standard errors can again be found in the Appendix, Tables 28 to 33.

Table 6: Cross-price substitutability, all countries

Country	Capital-Labor	Capital-Energy	Labor-Energy
CHE	**100%**	**83%**	**58%**
GER	50%	17%	75%
BEL	83%	50%	50%
NLD	58%	25%	75%
GRB	58%	75%	50%
DNK	83%	58%	67%
SWE	100%	17%	67%
ESP	92%	42%	50%

Note: Numbers denote the percentage of sectors with positive cross-price elasticities.

Table 7 analogously displays the percentages of sectors found to be MES substitutes. For example, all point estimates in Switzerland imply that capital on labor are MES substitutes. Our empirical evidence clearly suggest that in the majority of manufacturing sectors, capital, labor and energy are substitutes.[20] Point estimates and standard errors are available from Tables 34 to 39 in the Appendix.

[19]See for example Thompson and Taylor (1995).

[20]As noted above, MESs are always larger than CPEs. Thus, the percentage of substitutes using MESs should always be larger than the percentage of substitutes using CPEs. An exception is the substitutability pattern of capital and energy in Switzerland. It can be explained by some insignificant but positive own-price elasticities of the factor energy.

Table 7: Morishima substitutability, all countries

Country	Capital-Labor	Capital-Energy	Labor-Energy
CHE	**100%**	**79%**	**75%**
GER	63%	50%	75%
BEL	88%	83%	63%
NLD	58%	71%	79%
GRB	79%	79%	54%
DNK	96%	83%	75%
SWE	100%	54%	75%
ESP	96%	46%	58%

Note: Numbers denote the percentage of sectors with positive Morishima elasticities.

4.1.3 Estimates from Pooled Regressions

One possibility of obtaining more precise point-estimates is to pool data across the different countries or industries. While the first specification implies equality of sectoral elasticities across countries, the latter imposes the equality of elasticities across sectors within a country. We start with the second approach.

Pooling across industries: Table 8 depicts own-price elasticities of a total manufacturing sector for each of the eight considered countries. First note that the own price elasticity for an aggregate manufacturing sector of -0.59 in Switzerland is slightly lower than the average of the individual sector estimates. The same is true for most other countries. Second, the standard errors are generally smaller and as a consequence, more estimates are found to be significantly different from zero. Furthermore we note, that no own-price elasticity is significantly larger than zero and thus the concavity test is met. Figure 17 in the Appendix displays the point estimates and corresponding confidence intervals graphically.

Table 8: Own-price elasticities, pooled across sectors

Country	CPE_{LL}	CPE_{KK}	CPE_{EE}
CHE	-0.59*	-0.78*	0.42
	(0.12)	(0.14)	(0.47)
GER	-0.21*	0.44	-0.11
	(0.08)	(0.24)	(0.26)
BEL	-0.65*	-0.33	-0.59*
	(0.18)	(0.17)	(0.29)
NLD	-0.82*	-0.07	-0.80*
	(0.14)	(0.18)	(0.20)
GRB	-0.29*	-0.48*	-1.54*
	(0.11)	(0.20)	(0.49)
DNK	-0.96*	-0.76*	-0.61*
	(0.14)	(0.16)	(0.08)
SWE	-1.04*	-0.39	-0.81*
	(0.19)	(0.21)	(0.21)
ESP	-0.69*	-0.87*	0.49
	(0.19)	(0.24)	(0.29)
Concavity Test:			
Negative[a]	**8 (8)**	**7 (4)**	**6 (5)**
Positive[a]	**0 (0)**	**1 (0)**	**2 (0)**

Note: Elasticities of total manufacturing are estimated with pooled industry data using fixed effects. We use the translog cost function as functional form.
[a] Number of significant cases are in parentheses.
* Indicates significance at the 5% level.

Table 9 analogously depicts the cross-price elasticities of the total manufacturing sector for all eight countries. The low values of CPE_{LE} and CPE_{KE} are striking. This implies that a price increase of the factor energy only has a small effect on the quantities of labor and capital. The cross-price elasticities between labor and capital are of similar size. In six out of eight countries energy and labor are CPE-substitutes with the exception of Switzerland and the Great Britain. Comparing the factors capital and energy, we find CPE-complementarity in seven countries. The factors capital and labor tend to be CPE-substitutes in most countries. Figure 18 in the Appendix displays the point estimates and corresponding confidence intervals graphically.

Table 9: Cross-price elasticities, pooled across sectors

Country	CPE_{LE}	CPE_{EL}	CPE_{KE}	CPE_{EK}	CPE_{KL}	CPE_{LK}
CHE	-0.03	-0.53	-0.02	-0.39	0.65*	0.63*
	(0.03)	(0.48)	(0.03)	(0.58)	(0.10)	(0.10)
GER	0.03	0.23	-0.07	-0.59	-0.39*	-0.36*
	(0.03)	(0.26)	(0.06)	(0.50)	(0.11)	(0.10)
BEL	0.00	0.02	-0.03	-0.26	0.05	0.09
	(0.07)	(0.38)	(0.05)	(0.45)	(0.10)	(0.17)
NLD	0.01	0.05	-0.07*	-0.86*	0.14	0.22
	(0.04)	(0.33)	(0.03)	(0.42)	(0.10)	(0.16)
GRB	-0.10*	-1.06*	0.18*	1.56*	-0.05	-0.04
	(0.04)	(0.43)	(0.07)	(0.63)	(0.12)	(0.10)
DNK	0.07*	0.88*	-0.02	-0.27	0.66*	0.56*
	(0.02)	(0.27)	(0.02)	(0.25)	(0.13)	(0.11)
SWE	0.08	0.75	-0.09*	-1.31*	0.42*	0.65*
	(0.05)	(0.46)	(0.04)	(0.57)	(0.14)	(0.21)
ESP	0.02	0.14	-0.02	-0.16	0.03	0.05
	(0.06)	(0.41)	(0.06)	(0.56)	(0.12)	(0.18)
Substitutes or Complements:						
Substitutes	**6 (1)**	**6 (1)**	**1 (1)**	**1 (1)**	**6 (3)**	**6 (3)**
Complements	**2 (1)**	**2 (1)**	**7 (2)**	**7 (2)**	**2 (1)**	**2 (1)**

Note: Elasticities of total manufacturing are estimated with pooled industry data using fixed effects. We use the translog cost function as functional form.
[a] Number of significant cases are in parentheses.
* Indicates significance at the 5% level.

Table 10 displays the Morishima elasticities of the total manufacturing sector for the eight countries. In most countries, aggregate Morishima elasticities are positive implying substitutability. Only one single elasticity is significantly smaller than zero. Figure 19 in the Appendix displays the point estimates and corresponding confidence intervals graphically. Table 40 additionally presents some key statistics from the estimations performed to obtain the elasticities discussed in this section.

Table 10: Morishima elasticities, pooled across sectors

Country	MES_{LE}	MES_{EL}	MES_{KE}	MES_{EK}	MES_{KL}	MES_{LK}
CHE	-0.45	0.06	-0.45	0.39	1.24*	1.42*
	(0.48)	(0.50)	(0.20)	(0.19)	(0.19)	(0.20)
GER	0.14	0.44	0.04	-1.03	-0.18	-0.80*
	(0.26)	(0.27)	(0.31)	(0.16)	(0.16)	(0.31)
BEL	0.59	0.67	0.56	0.06	0.70*	0.41
	(0.30)	(0.41)	(0.30)	(0.27)	(0.27)	(0.30)
NLD	0.81*	0.88*	0.73*	-0.79	0.97*	0.29
	(0.20)	(0.37)	(0.30)	(0.23)	(0.23)	(0.30)
GRB	1.44*	-0.76	1.72*	2.05*	0.25	0.44
	(0.49)	(0.48)	(0.28)	(0.21)	(0.21)	(0.28)
DNK	0.68*	1.85*	0.59*	0.49	1.63*	1.32*
	(0.09)	(0.32)	(0.25)	(0.25)	(0.25)	(0.25)
SWE	0.89*	1.79*	0.71*	-0.92	1.46*	1.04*
	(0.23)	(0.58)	(0.40)	(0.33)	(0.33)	(0.40)
ESP	-0.47	0.83	-0.50	0.71	0.73*	0.92*
	(0.31)	(0.49)	(0.35)	(0.28)	(0.28)	(0.35)
Substitutes or Complements:						
Substitutes	**6 (4)**	**7 (3)**	**6 (4)**	**5 (1)**	**7 (6)**	**7 (4)**
Complements	**2 (0)**	**1 (0)**	**2 (0)**	**3 (0)**	**1 (0)**	**1 (1)**

Note: Elasticities of total manufacturing are estimated with pooled industry data using fixed effects. We use the translog cost function as functional form.
[a] Number of significant cases are in parentheses.
* Indicates significance at the 5% level.

Pooling across countries: We estimate CPE's and MES's using a panel of the eight countries mentioned above including Switzerland. Table 11 displays the resulting own-price elasticities. Note that standard errors are substantially smaller due to the higher number of observations. Another observation is that most own-price elasticities lie in the range of 0 and -1. Most of the own-price estimates are significantly smaller than zero with the exception of the input factor energy. Again, the own-price elasticities are not significantly larger than zero except in one case, indicating that concavity conditions are largely met. Figure 20 depicts point estimates as well as confidence intervals graphically.

Table 11: Own-price elasticities, pooled across countries

Sector	CPE_{LL}	CPE_{KK}	CPE_{EE}
1	-0.46*	-0.52*	0.08
	(0.05)	(0.06)	(0.13)
2	-0.68*	-1.38*	0.31*
	(0.05)	(0.19)	(0.13)
3	-0.60*	-0.28*	0.32
	(0.06)	(0.13)	(0.19)
4	-0.39*	-0.38*	-0.43*
	(0.04)	(0.10)	(0.07)
5	-0.60*	-0.37*	-0.94*
	(0.07)	(0.06)	(0.17)
6	-0.57*	-0.45*	0.04
	(0.05)	(0.11)	(0.14)
7	-0.50*	-0.81*	-0.66*
	(0.06)	(0.08)	(0.09)
8	-0.31*	-0.42*	-0.57*
	(0.05)	(0.07)	(0.12)
9	-0.44*	-0.49*	-0.57*
	(0.05)	(0.10)	(0.15)
10	-0.58*	-0.74*	-1.46*
	(0.07)	(0.11)	(0.13)
11	-0.55*	-0.96*	-0.57*
	(0.09)	(0.18)	(0.16)
12	-0.86*	-0.91*	0.35
	(0.07)	(0.14)	(0.20)
Concavity Test:			
Negative[a]	**12 (12)**	**12 (12)**	**7 (7)**
Positive[a]	**0 (0)**	**0 (0)**	**5 (1)**

Note: Pooled estimates, translog specification.
[a] Number of significant cases are in parentheses.
* Indicates significance at the 5% level.

Table 12 displays the corresponding cross-price elasticities. Again, compared to country estimates, the elasticities are often of smaller magnitude. As in the Swiss case depicted in Table 3, labor-energy elasticities are sometimes positive, sometimes negative. Also, capital-labor CPEs are generally positive. Using pooled data, capital-energy elasticities are however more often estimated as being complements. Two thirds of all estimates are found to be significantly different from zero. Figure 21 in the Appendix depicts point estimates as well as confidence intervals graphically.

Table 12: Cross-price elasticities, pooled across countries

Sector	CPE_{LE}	CPE_{EL}	CPE_{KE}	CPE_{EK}	CPE_{KL}	CPE_{LK}
1	0.03*	0.45*	-0.05*	-1.19*	0.08*	0.13*
	(0.01)	(0.21)	(0.01)	(0.24)	(0.03)	(0.05)
2	-0.05*	-0.91*	0.02	0.20	0.54*	0.26*
	(0.01)	(0.21)	(0.02)	(0.24)	(0.11)	(0.05)
3	0.01	0.11	-0.12*	-1.77*	0.44*	0.32*
	(0.02)	(0.32)	(0.03)	(0.42)	(0.08)	(0.06)
4	0.01	0.14	-0.06*	-0.64*	0.01	0.01
	(0.01)	(0.08)	(0.01)	(0.14)	(0.05)	(0.05)
5	-0.10*	-0.63*	0.04*	0.71*	0.13*	0.32*
	(0.03)	(0.19)	(0.02)	(0.29)	(0.03)	(0.07)
6	0.03	0.37	-0.15*	-1.70*	0.20*	0.18*
	(0.02)	(0.19)	(0.03)	(0.30)	(0.06)	(0.05)
7	0.16*	0.71*	0.02	0.11	0.33*	0.40*
	(0.02)	(0.10)	(0.03)	(0.14)	(0.04)	(0.05)
8	-0.03	-0.27	0.02	0.12	0.03	0.03
	(0.02)	(0.16)	(0.02)	(0.19)	(0.05)	(0.05)
9	-0.03*	-0.89*	0.03*	0.77*	0.24*	0.21*
	(0.01)	(0.27)	(0.01)	(0.31)	(0.06)	(0.05)
10	0.02*	0.54*	0.08*	2.05*	0.11	0.12
	(0.01)	(0.23)	(0.01)	(0.34)	(0.07)	(0.08)
11	0.03*	0.52*	-0.05*	-1.02*	-0.27*	-0.32*
	(0.01)	(0.25)	(0.02)	(0.32)	(0.10)	(0.11)
12	-0.08*	-1.69*	0.02	0.39	0.68*	0.59*
	(0.02)	(0.36)	(0.03)	(0.56)	(0.08)	(0.08)
Substitutes or Complements:						
Substitutes[a]	**7 (4)**	**7 (4)**	**7 (3)**	**7 (3)**	**11 (8)**	**11 (8)**
Complements[a]	**5 (4)**	**5 (4)**	**5 (5)**	**5 (5)**	**1 (1)**	**1 (1)**

Note: Pooled estimates, translog specification.
[a] Number of significant cases are in parentheses.
* Indicates significance at the 5% level.

Table 13 displays the corresponding Morishima elasticities. It is found that labor and capital are estimated to be Morishima substitutes, as is the case for Swiss manufacturing. However, while not a single MES concerning labor-energy and capital-energy substitution is estimated as being significantly smaller than zero using only Swiss data, we find more evidence for the complementarity of these factors using a pooled dataset. Again, more than two thirds of all estimates are found to be significantly different from zero. Figure 21 in the Appendix depicts point estimates as well as confidence intervals graphically.

Table 13: Morishima elasticities, pooled across countries

Sector	MES_{LE}	MES_{EL}	MES_{KE}	MES_{EK}	MES_{KL}	MES_{LK}
1	-0.05	0.91*	-0.13	-0.67*	0.54*	0.65*
	(0.13)	(0.21)	(0.13)	(0.25)	(0.06)	(0.08)
2	-0.36*	-0.23	-0.29*	1.58*	1.21*	1.64*
	(0.13)	(0.21)	(0.13)	(0.31)	(0.12)	(0.20)
3	-0.31	0.71*	-0.43*	-1.50*	1.04*	0.60*
	(0.19)	(0.33)	(0.19)	(0.44)	(0.10)	(0.14)
4	0.45*	0.52*	0.37*	-0.26	0.40*	0.39*
	(0.07)	(0.09)	(0.07)	(0.17)	(0.07)	(0.11)
5	0.84*	-0.03	0.98*	1.08*	0.72*	0.69*
	(0.17)	(0.20)	(0.17)	(0.30)	(0.08)	(0.10)
6	-0.01	0.94*	-0.19	-1.26*	0.77*	0.62*
	(0.14)	(0.20)	(0.14)	(0.32)	(0.08)	(0.12)
7	0.81*	1.21*	0.68*	0.92*	0.84*	1.21*
	(0.09)	(0.12)	(0.09)	(0.16)	(0.07)	(0.10)
8	0.54*	0.04	0.59*	0.54*	0.34*	0.44*
	(0.13)	(0.17)	(0.13)	(0.20)	(0.07)	(0.09)
9	0.55*	-0.45	0.60*	1.25*	0.68*	0.69*
	(0.15)	(0.28)	(0.15)	(0.33)	(0.08)	(0.12)
10	1.48*	1.12*	1.54*	2.78*	0.69*	0.86*
	(0.13)	(0.24)	(0.13)	(0.36)	(0.10)	(0.14)
11	0.60*	1.06*	0.52*	-0.06	0.27*	0.64*
	(0.16)	(0.26)	(0.16)	(0.37)	(0.14)	(0.22)
12	-0.45*	-0.45	-0.37	0.41	1.49*	1.53*
	(0.20)	(0.36)	(0.21)	(0.58)	(0.11)	(0.16)
Substitutes or Complements:						
Substitutes[a]	**7 (7)**	**8 (7)**	**7 (7)**	**7 (7)**	**12 (12)**	**12 (12)**
Complements[a]	**5 (2)**	**4 (1)**	**5 (2)**	**5 (3)**	**0 (0)**	**0 (0)**

Note: Pooled estimates, translog specification.
[a] Number of significant cases are in parentheses.
* Indicates significance at the 5% level.

The moderate magnitude of the pooled estimates compared to the Swiss estimates may be due to the lesser importance of outliers as a result of the larger sample size or to an "averaging-out" effect owed to country heterogeneity. If one is willing to accept that substitution processes are similar in Western European countries, this specification is nonetheless of great interest. Table 41 presents some key statistics from the estimations performed to obtain the elasticities discussed in this section.

4.2 Nested CES Production Function

This section reports estimates of engineering and economic elasticities between the input factors K, L, E and M for 12 Swiss manufacturing sectors. Table 14 displays the estimates of the technical elasticities for the three cases. The first column shows the technical elasticities of substitution ($\sigma_{K,L}$) of the third level nest, the second column the elasticities ($\sigma_{KL,E}$) of the second level and the third column shows the elasticity of the first level for case (a). Columns four to nine display the results for cases (b) and (c). All technical elasticities are significant and positive, implying that input factors are technical substitutes. This is in line with the CES modeling approach.

Table 14: Technical elasticities, Swiss manufacturing industries, nested CES

	KL,E			KE,L			LE,K		
Sector	$\sigma_{K,L}$	$\sigma_{KL,E}$	$\sigma_{KLE,M}$	$\sigma_{K,E}$	$\sigma_{KE,L}$	$\sigma_{KEL,M}$	$\sigma_{L,E}$	$\sigma_{LE,K}$	$\sigma_{LEK,M}$
1[a]	0.51*	0.58*	0.52*	0.54*	0.53*	0.52*	0.63*	0.45*	0.53*
	(0.06)	(0.03)	(0.02)	(0.03)	(0.03)	(0.01)	(0.07)	(0.04)	(0.02)
2	0.57*	0.58*	0.45*	0.50*	0.61*	0.46*	0.62*	0.52*	0.45*
	(0.04)	(0.03)	(0.02)	(0.10)	(0.03)	(0.01)	(0.03)	(0.03)	(0.02)
3[a]	0.48*	0.50*	0.50*	0.43*	0.51*	0.50*	0.50*	0.49*	0.50*
	(0.02)	(0.03)	(0.00)	(0.05)	(0.02)	(0.00)	(0.04)	(0.02)	(0.00)
4	0.54*	0.50*	0.49*	0.22*	0.56*	0.49*	0.65*	0.49*	0.49*
	(0.02)	(0.03)	(0.01)	(0.06)	(0.02)	(0.01)	(0.03)	(0.03)	(0.01)
5	0.48*	0.51*	0.49*	0.40*	0.58*	0.49*	0.58*	0.55*	0.49*
	(0.10)	(0.08)	(0.01)	(0.08)	(0.07)	(0.01)	(0.19)	(0.08)	(0.01)
6	0.57*	0.51*	0.47*	0.52*	0.58*	0.47*	0.59*	0.52*	0.47*
	(0.03)	(0.04)	(0.00)	(0.06)	(0.03)	(0.01)	(0.05)	(0.03)	(0.01)
7[a]	0.51*	0.50*	0.52*	0.34*	0.57*	0.52*	0.60*	0.43*	0.52*
	(0.04)	(0.01)	(0.01)	(0.03)	(0.02)	(0.01)	(0.03)	(0.03)	(0.01)
8	0.50*	0.52*	0.49*	0.42*	0.55*	0.49*	0.54*	0.46*	0.49*
	(0.03)	(0.04)	(0.00)	(0.07)	(0.02)	(0.00)	(0.10)	(0.02)	(0.00)
9	0.57*	0.48*	0.47*	0.31*	0.58*	0.47*	0.67*	0.49*	0.47*
	(0.04)	(0.06)	(0.00)	(0.11)	(0.03)	(0.00)	(0.06)	(0.02)	(0.00)
10	0.62*	0.44*	0.48*	0.35*	0.60*	0.47*	0.66*	0.50*	0.48*
	(0.01)	(0.04)	(0.01)	(0.06)	(0.02)	(0.00)	(0.08)	(0.01)	(0.00)
11	0.57*	0.52*	0.47*	0.53*	0.58*	0.47*	0.56*	0.53*	0.47*
	(0.03)	(0.04)	(0.01)	(0.08)	(0.03)	(0.01)	(0.04)	(0.03)	(0.01)
12[a]	0.53*	0.50*	0.49*	0.49*	0.52*	0.49*	0.52*	0.52*	0.49*
	(0.01)	(0.01)	(0.00)	(0.02)	(0.02)	(0.01)	(0.04)	(0.01)	(0.00)

Note: Swiss data only, nested CES specification. All technical elasticities are significantly different from zero.
[a] Estimates from the sample, see Appendix A.2.
* Indicates significance at the 5% level.

We then convert the technical elasticities of substitution into economic CPEs. Below we present the own-price and cross-price elasticities of specification (a). Table 15 displays the own-price elasticities. All own-price elasticities are negative and the values are between -1.04 and -0.3. The magnitudes of the elasticities is similar to the other two specifications that are presented in Appendix A.6.2 (Tables 44 to 48).

Table 15: Own-price elasticities, Swiss manufacturing, nested CES, spec. (a)

Sector	CPE_{KK}	CPE_{LL}	CPE_{EE}	CPE_{MM}
1[a]	-0.40	-0.43	-0.57	-0.36
2	-0.44	-0.36	-0.57	-0.47
3[a]	-0.38	-0.36	-0.48	-0.53
4	-0.40	-0.34	-0.48	-0.81
5	-0.31	-0.40	-0.50	-0.58
6	-0.43	-0.38	-0.50	-0.50
7[a]	-0.35	-0.35	-0.48	-1.04
8	-0.38	-0.32	-0.51	-0.70
9	-0.44	-0.38	-0.48	-0.45
10	-0.43	-0.42	-0.44	-0.54
11	-0.45	-0.37	-0.51	-0.41
12[a]	-0.39	-0.34	-0.49	-0.68
Concavity Test:				
Negative	**12**	**12**	**12**	**12**
Positive	**0**	**0**	**0**	**0**

Note: Swiss data only, nested CES, specification (a).
[a] Estimates from the sample, see Appendix A.2.

Table 16 displays the cross-price elasticities for specification (a). All elasticities are estimated to be positive, implying that input factors are substitutes. The magnitude of the cross-price elasticities is rather small. Again results are similar to the ones in cases (b) and (c). One exception are the capital-energy elasticities in specification (b) where some CPEs are found to be significantly lower than zero.

Comparing the economic elasticities of the nested CES production function with the results of the translog production function shows that there is less variation between estimates of different manufacturing industries. Moreover, almost all cross-price elasticities are found to be substitutes, where the translog estimates are partly negative, indicating complementarity between input factors.

Table 16: Cross-price elasticities, Swiss manufacturing, nested CES, spec. (a)

Sector	$\text{CPE}_{KM}{}^{a}$	CPE_{MK}	CPE_{ML}	CPE_{ME}	CPE_{KL}	CPE_{LK}	$\text{CPE}_{KE}{}^{b}$	CPE_{EK}	CPE_{EL}
1[c]	0.30	0.12	0.09	0.01	0.09	0.11	0.01	0.15	0.12
2	0.22	0.09	0.14	0.01	0.20	0.13	0.01	0.13	0.21
3[c]	0.25	0.11	0.13	0.01	0.12	0.10	0.01	0.11	0.13
4	0.18	0.12	0.17	0.02	0.20	0.14	0.02	0.12	0.17
5	0.23	0.18	0.08	0.01	0.08	0.16	0.01	0.18	0.09
6	0.23	0.10	0.13	0.01	0.19	0.14	0.01	0.12	0.15
7[c]	0.17	0.16	0.16	0.03	0.16	0.15	0.02	0.15	0.15
8	0.20	0.11	0.17	0.01	0.17	0.11	0.01	0.12	0.19
9	0.24	0.09	0.14	0.00	0.19	0.13	0.00	0.10	0.14
10	0.23	0.12	0.13	0.00	0.20	0.19	0.00	0.10	0.11
11	0.25	0.08	0.13	0.01	0.20	0.11	0.01	0.10	0.16
12[c]	0.20	0.12	0.16	0.01	0.18	0.13	0.01	0.12	0.17
Substitutes or Complements:									
Subst.	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**
Compl.	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Note: Swiss data only, nested CES, specification (a).
[a] The following elasticities are identical: $\text{CPE}_{KM} = \text{CPE}_{LM} = \text{CPE}_{EM}$.
[b] The following elasticities are identical: $\text{CPE}_{KE} = \text{CPE}_{LE}$.
[c] Estimates from the sample, see Appendix A.2.

The differences can be explained by the restrictive assumption of nested CES functions that all engineering elasticities have to be substitutes. An inspection of the formula for AES_{ij} on the first line of Equation 11 reveals that complementarity is impossible for elasticities involving the input factor M, since $\sigma_1^a > 0$. Negative economic elasticities are only possible for input factors arranged in the lower levels of the nesting structure. Complementarity can only occur between these input factors if the technical elasticity of the first level is larger than the technical elasticities of the other two levels.

Moreover, the separability conditions between input factors in a nest with input factors outside of the nest are implied under the nested CES function. The advantage of the nested CES function is that the regularity conditions (nondecreasing and concave in prices) are globally satisfied. In contrast, substitution patterns for the translog function are more flexible, which is also reflected in the larger differences between different sector and factor estimates.

4.3 A Brief Discussion of the Results

In this section we first compare our results with some results from the existing literature, both using the translog as well as the nested CES specification. Second, we provide an interpretation of some of our estimates using a selected industry. Third, we discuss the possible uses of such elasticities but also point to some potential pitfalls in their application.

4.3.1 Comparison with Results from the Existing Literature

For a comprehensive discussion of the substitutability/complementarity debate between the input factors capital and energy we refer to Apostolakis (1990). The author displays the elasticity results from most of the major studies that have been conducted after the first oil-price shock. For a more recent comparison of the CPE and Morishima elasticities between energy and capital we refer to Koetse et al. (2008). The authors conduct a meta analysis of available estimates to show that the heterogeneity in the estimates can be explained by differences in, for example, data characteristics (cross-section vs. time-series) or the specification of the model (KLEM vs. KLE).

Nonetheless, in the following we present some estimates from the literature to compare the magnitude of our estimates with other studies. Table 17 lists a selection of studies that utilize the translog specification. Some of the studies estimate aggregate elasticities and some sector specific elasticities. Two of the studies use firm-level data to estimate the elasticities. We observe that our estimates are largely in line with estimates from other studies estimating sector-specific elasticities. Studies estimating aggregate manufacturing elasticities usually find elasticities of lower magnitude as we do in our pooled specifications.

Table 17: Comparison of assumptions and results of translog studies

Study	Structure	Country	Sectors	Time	Method	Technology	Estimates
Mohler Mueller[a]	KLEM	CHE+7 C.	12	1997-08	SURE	factor-specific	-5.2 - 5.9
Arnberg Bjorner[b]	KLE	DEN	micro panel	1993-97	SURE	factor-specific	-1.5 - 2.6
Christopoulos[c]	KLE	GRE	pooled	1970-90	IZEF*	Hicks-neutral	0.0 - 1.3
Dissou Ghazal[d]	KLEM	CAN	2 (4-digit)	1961-03	SURE	factor-specific	-0.4 - 0.5
Falk Koebel[e]	KLEM	GER	aggregate	1978-90	SURE	Hicks-neutral	-0.3 - 0.2
Krishnapillai Thompson[f]	KLE	USA	3 (4-digit)	2007	SURE	Hicks-neutral	-12.3 - 9.6
Medina Vega-Cervera[g]	KLE	3 C.	aggregate	1980-96	SURE	Hicks-neutral	-0.4 - 0.4
Nguyen Streitwieser[h]	KLEM	USA	micro data	1991	IZ3SLS**	factor-specific	-3.8 - 3.2
Yi[i]	KLE	SWE	9 (2-digit)	1965-89	SURE	factor-specific	-0.5 - 1.0

Note: Comparison of studies that estimate elasticities from a translog specification. * Nonlinear iterative Zellner estimation. ** Iterative Zellner three stage least squares. [a] We report engineering and economic elasticities; translog and CES specification. [b] Arnberg and Bjorner (2007) distinguish between electricity and other energy; Cross-section estimates as well as fixed-effects estimates; Additionally they apply a linear logit specification. [c] Christopoulos (2000) distinguishes between crude oil, electricity and diesel; estimates long-run elasticities from a dynamic structure; elasticities containing diesel are larger. [d] Dissou and Ghazal (2010) Additionally to the translog cost function they apply a Symmetric Generalized McFadden (SGM) cost function. [e] Koebel and Falk (1999) use the normalised quadratic cost function; calculate the aggregate output elasticity as a weighted average of sectoral elasticities; distinguish between different skill levels of labor. [f] Krishnapillai and Thompson (2012) use electricity instead of energy; aggregated to three categories. [g] Medina and Vega-Cervera (2001) estimate elasticities of manufacturing for Italy, Portugal and Spain. [h] Nguyen and Streitwieser (1999) use a cross-section dataset; estimate elasticities for small plants and large plants. [i] Yi (2000) distinguishes between electricity and fuels; estimates a dynamic translog (TL) version and a general Leontief (GL) version.

Table 18 compares econometric studies that estimated engineering elasticities from nested CES models. Three of the studies use pooled cross-country data to estimate sector specific elasticities. Again, we find that our elasticities are largely in line with the ones from other studies. We conclude that our results compare well to existing evidence from the literature.

Table 18: Comparison of assumptions and results of nested CES studies

Study	Structure	Country	Sectors	Time	Method	Technology	Estimates
Mohler Mueller[a]	KL-E-, KE-L-, LE-K-M	CHE	12	1997-08	NLS	Hicks-neutral	0.3 - 0.7
Balistreri et al.[b]	K-L	USA	28 (2-digit)	1947-98	lin. aprox.	Hicks-neutral	0.3 - 3.7
Kemfert[c]	KL-E, KE-L, LE-K	GER	7 (2-digit)	1970-93	lin. aprox.	Hicks-neutral	0.0 - 1.0
Koesler Schymura[d]	KL-E-M	33 C.	35 (2-digit)	1995-06	NLS	Hicks-neutral	0.0 - 2.7
Okagawa Ban[e]	KL-E-M, KE-L-M	14 C.	19 (2-digit)	1995-04	lin. aprox.	Hicks-neutral	0.0 - 1.3
Prywes[f]	KE-L-M	USA	20 (2-digit)	1971-76	lin. aprox.	factor-specific	0.0 - 1.6
Van der Werf[g]	KL-E, KE-L, LE-K	12 C.	7 (pooled)	1978-96	lin. aprox.	factor-specific	0.2 - 1.0

Note: Comparison of studies that estimate elasticities from nested CES production functions. [a] We report engineering and economic elasticities; translog and CES specification. [b] Balistreri et al. (2003) assume 3 different spec.; long-run and short-run elasticities; supports Cobb-Douglas spec. between the factors capital and labor. [c] Kemfert (1998) compares different nesting structures. The KL-E structure fits the data best on the industry level. [d] Koesler and Schymura (2012) reject Cobb-Douglas and Leontief; manufacturing and service sectors included. [e] Okagawa and Ban (2008) reject Cobb-Douglas only for some nests. [f] Prywes (1986) reports engineering and economic elasticities. [g] Van der Werf (2008) rejects Cobb-Douglas; KL-E structure fits the data best; estimates industry-specific and country-specific elasticities with pooled data.

CGE models are the standard way to simulate the effects of changes in policy. Assumptions about production technologies, technological change and, prominently, about elasticities of substitution between the production factors are required to apply these models. A glance at different CGE models used in the literature shows that the used parameter values for the elasticities are very diverse. Values range from a Leontief production function to the Cobb-Douglas case to CES productions functions. For an overview on the differing assumptions made in CGE models see e.g., Van der Werf (2008). The same author shows that the nesting structure can not be chosen arbitrarily and that the extreme assumptions like Leontief production functions or Cobb-Douglas production functions are not appropriate to use in these models.

4.3.2 Interpretation of the Elasticity Estimates

We estimate different types of elasticities in this paper that measure the effects of different shocks on different dependent variables. In this section, we illustrate the effects of these estimated elasticities for a particular sector in Switzerland, namely non-metallic products (industry 7), a relatively energy-intensive industry. Table 19 displays the effects of an energy quantity adjustment on the quantity of another input factor given all other input factors and output are constant. The engineering elasticities of the nested CES estimation of case (a) are used to examine this issue. They indicate that if energy use is reduced by 1 percent and only one input factor is allowed to adjust, the input quantity of this factor has to be increased by approximately 0.5 percent to hold output constant. The effects are displayed for all three input factors.

Table 19: Effects of an energy quantity change on factor quantities

	Shock:
Δx_E	-1.00%
	σ_{iE}:
Δx_L	+0.50%
Δx_K	+0.50%
Δx_M	+0.52%

In a second step, we consider economic elasticities to evaluate the effect of an exogenous energy price increase on factor use, cost shares, as well as on the total cost of production. Table 20 illustrates the implications of the CPEs in the translog case; an energy increase of 1.00% leads to a reduction in the employed quantity of energy of 1.29%, keeping output and other factor prices constant. Labor and capital inputs only slightly increase by 0.21% and 0.11%, respectively while material reduces by 0.07%. The MES then imply that the energy price change increases the quantity ratios of labor, capital and material by between 1.22% and 1.50%. Since the MES are larger than one, the price increase also increases the relative shares of labor, capital and materials with respect to energy. Finally, weighting the relative changes in quantities by the mean factor shares, we obtain an estimate of the change of total production costs for a constant output level. The second column displays effects in the same industries using the nested CES estimates.

Table 20: Effects of an energy price change on factor quantities and factor costs

	Translog	**CES**
	Exogenous shock:	
Δp_E	+1.00%	+1.00%
	CPEs:	
Δx_E	-1.29%	-0.48%
Δx_L	+0.21%	+0.02%
Δx_K	+0.11%	+0.02%
Δx_M	-0.07%	+0.03%
	MES:	
$\Delta x_L/x_E$	+1.50%	+0.50%
$\Delta x_K/x_E$	+1.40%	+0.50%
$\Delta x_M/x_E$	+1.22%	+0.51%
	MES$-$1:	
$\Delta s_L/s_E$	+0.50%	-0.50%
$\Delta s_K/s_E$	+0.40%	-0.50%
$\Delta s_M/s_E$	+0.22%	-0.49%
	Mean factor shares:	
$\bar{s}_E$	0.045	0.045
$\bar{s}_L$	0.297	0.297
$\bar{s}_K$	0.252	0.252
$\bar{s}_M$	0.406	0.406
	Effect on total cost:	
Δ Total costs	+0.05%	+0.05%

Regardless of which model is used to estimate economic elasticities, effects on total production costs in the non-metallic manufacturing industry are limited. The reason are the low CPEs of energy prices on other input factors in relation to the larger magnitude of the own-price elasticities of energy. Substitution elasticity estimates are, however, subject to important qualifications. Estimations rely on many assumptions which have to be taken into account when they are employed in policy evaluations or forecasts. In the following we present some of these caveats and their potential effects.

4.3.3 Limitations of the Estimated Elasticities in Practical Applications

Partial equilibrium issues The concepts of the economic elasticities (CPE and MES) describe changes of one or two factors due to a exogenous price change holding output constant, thus relying on a partial equilibrium analysis. In a general equilibrium model, prices of input factors are endogenous. In the case of Switzerland, this is especially relevant for production factors with a low international mobility, e.g. labor. If prices are endogenous, aggregate production of different industries may influence prices and vice versa. Additionally, demand side effects are neglected. The elasticity of consumer demand, income effect or shifts in consumer tastes may influence manufacturing production, for example through the adaption of new technologies or the relative importance of industries. These issues may bias the elasticity estimates.

Aggregation issues A very severe shortcoming of the presented estimates is the fact that they rely on aggregate sectoral data. Estimating sectoral elasticities implicitly makes the assumption that firms use the same production technology and produce a homogeneous good. Compositional changes between different commodities in addition to factor substitution are not taken into account (see for example Solow (1987)). It is reasonable to assume that commodities within broadly defined sectors are far from being homogeneous in important characteristics. For example, there may be types of goods that require higher energy intensity within a single industry – maybe due to technical aspects of the production process. An increase in energy prices raises the relative price of these goods and decreases their market share. On an aggregate level, this results in a substitution of energy by other input shares, expressed by large positive cross-price elasticities. In reality, however, individual firms may still use the same factor shares in the output production as before. Some product types have just been crowded out from the market.

In this respect, Solow (1987) points out that on the sectoral level it is not possible to differentiate between substitution effects and composition effects. When factor price increases lead also to changes in the composition of manufacturing output then the substitution effect appears contemporaneously with the composition effect. This implies that effective substitution is smaller than in the estimates and focusing on individual firms the adjustment costs to price shocks might be larger.

This theoretical observations are consistent with findings from firm-level studies and is confirmed in the meta-analysis by Koetse et al. (2008). The authors show that using aggregate data in the analysis results in larger substitution estimates. They conclude that estimates from aggregated data may overestimate substitution behavior. A further example is Nguyen and Streitwieser (1999) who estimate substitution elasticities for US manufacturing plants. Their results suggest that energy and capital are CPE-substitutes for small plants but CPE-complements for large plants. Also, Arnberg and Bjorner (2007) use micro panel data for Denmark and find under a firm-fixed-effect specification that energy and capital are CPE-complements. All these results should be interpreted with caution as the number firm-level studies is still very limited.

Time horizon issues The estimates of the elasticities for Swiss manufacturing industries presented above are short-run elasticities retrieved from time-series data covering a period of twelve years. The time dimension matters greatly since empirical studies suggest that short-run elasticities can differ substantially from long-run elasticities. In the short-run, some production factors are rigid. In the long-run, firms can invest into new technologies, increase or decrease plant size or produce different products. Thus, in the long-run even rigid factors can be adjusted and the new cost minimizing long-run equilibrium can be reached. Unfortunately, most of the empirical studies assume a static model, thus, are not able to distinguish between short-run and long-run elasticities. Sometimes it is argued that cross-section data yield long-run elasticities where time-series data yield short-run elasticities (See for example Griffin and Gregory (1976), Berndt and Wood (1979), Griffin (1981) or Berndt and Wood (1981). However, this argument is controversial.[21]

Additionally, large adjustments in the utilization of different factors feed back on factor markets. As a consequence, endogeneity or aggregation issues are amplified. Under these circumstances, long-term welfare effects are difficult to quantify and hence forecasts are to be used with caution.

Related to this issue is the question how scholars should deal with technological change. The majority of studies assume Hicks-neutral technical change. Other studies assume factor augmenting technical change. We choose the later. More specifically, we account for technical change by the time trend. Broadstock (2010) shows that the underlying assumption of technological progress (linear vs. nonlinear) influences the magnitude, and

[21] See Apostolakis (1990) for a detailed overview.

in some cases even the sign, of the elasticity estimates.

Policy regime issues While the translog function has the advantage that no inherent restrictions are assumed, the drawback is that important regularity conditions are not globally met (see Section 2.1). As a consequence, the translog function is only well-behaved for a limited range of prices and shares since it is only a local approximation of the effective production function as Jorgenson (1986) states. Thus, estimates of elasticities are only valid for situations where factor prices and shares are similar to the data employed for estimation. Hence, one has to be cautious when basing evaluations of large-scale policy changes whose effects are severe and materialize in the long term on such estimates.

In contrast to the translog function, global regularity conditions are met in a nested CES model. Hence, if the assumptions of the model are true, elasticities are valid for all factor prices and cost shares. However, restriction imposed by the CES model are strong, often failing in practice as for example Berndt and Wood (1975) show for manufacturing in the US. In that case, CES estimates are biased and the same issues as in the translog case apply.

Lessons for Evaluating the Welfare Effects of Factor Price Changes As discussed in this section, most elasticities estimated in the literature – and also those reported in this study – are subject to important drawbacks. In general, these elasticities are well-suited for short-term evaluations under stable conditions, i.e. moderate policy changes. Even then, rigorous sensitivity analyses are required because even in the short-run, issues such as the level of aggregation or partial equilibrium restrictions may bias the estimates. Evaluating effects of large policy challenges – and the Swiss nuclear phase-out combined with considerable emission reduction objectives is such a challenge - requires even more prudence from the part of the researchers.

Notwithstanding, the estimated elasticities of substitution presented in this study are a first step towards understanding the structure of Swiss manufacturing in general. Furthermore, these elasticities can be helpful for policy evaluations if the potential drawbacks are properly taken into account.

5 Concluding Remarks

This contribution is the first study in which sectoral substitution elasticities for Swiss manufacturing are estimated. We use different modeling approaches and compare the obtained Swiss sectoral elasticities with those from other countries and with pooled elasticity estimates. The results are discussed in detail in the text and summarized in the introduction.

While we provide useful first results, it is important to note that these elasticities have some major drawbacks as we discuss in the last section of this study. Our discussion may serve as a starting point for future work. Aggregation and time-horizon issues seem especially important to us. One reason is that these issues may severely bias the estimates of the elasticities. Another reason is that these issues can in principle be resolved under relatively moderate data requirements and may therefore be suitable fields of future work.

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A Appendix

A.1 Elasticities of the Nested CES Production Function

A.1.1 Case (b)

Engineering Elasticities:

$$
\begin{aligned}
\frac{1}{1+\beta_1} &= \sigma_1^b \quad (\sigma_{KM}, \sigma_{LM}, \sigma_{EM}), \\
\frac{1}{1+\beta_4} &= \sigma_2^b \quad (\sigma_{KL}, \sigma_{LE}), \\
\frac{1}{1+\beta_5} &= \sigma_3^b \quad (\sigma_{KE}).
\end{aligned} \tag{15}
$$

Economic elasticities:

$$
\begin{aligned}
\mathrm{AES}_{KM} &= \mathrm{AES}_{LM} = \mathrm{AES}_{EM} = \sigma_1^b, \\
\mathrm{AES}_{MM} &= -\frac{1-s_M}{s_M}\sigma_1^b, \\
\mathrm{AES}_{KE} &= \sigma_1^b + \frac{\sigma_3^b - \sigma_2^b}{s_K + s_E} + \frac{\sigma_2^b - \sigma_1^b}{s_K + s_L + s_E}, \\
\mathrm{AES}_{KL} &= \mathrm{AES}_{LE} = \sigma_1^b + \frac{\sigma_2^b - \sigma_1^b}{s_K + s_L + s_E}, \\
\mathrm{AES}_{KK} &= \sigma_1^b - \frac{\sigma_3^b}{s_K} + \frac{\sigma_3^b - \sigma_2^b}{s_K + s_E} + \frac{\sigma_2^b - \sigma_1^b}{s_K + s_L + s_E}, \\
\mathrm{AES}_{LL} &= \sigma_1^b - \frac{\sigma_2^b}{s_L} + \frac{\sigma_2^b - \sigma_1^b}{s_K + s_L + s_E}, \\
\mathrm{AES}_{EE} &= \sigma_1^b - \frac{\sigma_3^b}{s_E} + \frac{\sigma_3^b - \sigma_2^b}{s_K + s_E} + \frac{\sigma_2^b - \sigma_1^b}{s_K + s_L + s_E}.
\end{aligned} \tag{16}
$$

A.1.2 Case (c)

Engineering Elasticities:

$$
\begin{aligned}
\frac{1}{1+\beta_1} &= \sigma_1^c \quad (\sigma_{KM}, \sigma_{LM}, \sigma_{EM}), \\
\frac{1}{1+\beta_6} &= \sigma_2^c \quad (\sigma_{KL}, \sigma_{KE}), \\
\frac{1}{1+\beta_7} &= \sigma_3^c \quad (\sigma_{LE}).
\end{aligned} \tag{17}
$$

Economic elasticities:

$$
\begin{aligned}
\mathrm{AES}_{KM} &= \mathrm{AES}_{LM} = \mathrm{AES}_{EM} = \sigma_1^c, \\
\mathrm{AES}_{MM} &= -\frac{1-s_M}{s_M}\sigma_1^c, \\
\mathrm{AES}_{LE} &= \sigma_1^c + \frac{\sigma_3^c - \sigma_2^c}{s_L + s_E} + \frac{\sigma_2^c - \sigma_1^c}{s_K + s_L + s_E}, \\
\mathrm{AES}_{KL} &= \mathrm{AES}_{KE} = \sigma_1^c + \frac{\sigma_2^c - \sigma_1^c}{s_K + s_L + s_E}, \\
\mathrm{AES}_{KK} &= \sigma_1^c - \frac{\sigma_2^c}{s_K} + \frac{\sigma_2^c - \sigma_1^c}{s_K + s_L + s_E}, \\
\mathrm{AES}_{LL} &= \sigma_1^c - \frac{\sigma_3^c}{s_L} + \frac{\sigma_3^c - \sigma_2^c}{s_L + s_E} + \frac{\sigma_2^c - \sigma_1^c}{s_K + s_L + s_E}, \\
\mathrm{AES}_{EE} &= \sigma_1^c - \frac{\sigma_3^c}{s_E} + \frac{\sigma_3^c - \sigma_2^c}{s_L + s_E} + \frac{\sigma_2^c - \sigma_1^c}{s_K + s_L + s_E}.
\end{aligned} \tag{18}
$$

A.2 Description of the Datasets

Data for the seven European Union member countries (Germany, Belgium, the Netherlands, Great Britain, Denmark, Sweden and Spain) are taken from the EU KLEMS database and is readily available for download at *http://www.euklems.net/*. This database provides sectoral data on prices and quantities of different input and output variables for about 30 countries. Data coverage varies substantially across countries and we selected the countries with comparable coverage to our Swiss dataset (see below). Furthermore, we restricted our analysis to countries located in Western Europe that are supposedly similar to Switzerland in their manufacturing structure. We use data from 1995 to 2005 with the exception of Great Britain (1996 to 2005).

Most data used to estimate the Swiss elasticities has been assembled during a precursory project, see Mohler and Müller (2011). In all our analysis of Swiss manufacturing sectors we use data from 1997 to 2008. In the following, we discuss the relevant variables for our analysis. We use sales by sector as surveyed by the Swiss Federal Statistical Office (SFSO) in the Produktions- und Wertschöpfungsstatistik as our output variable. Material and labor expenditures stem from the same survey. Energy expenditures are calculated by using the survey EVID from the Swiss Federal Office of Energy (SFOE) which comprises the physical quantities of different energy sources used by manufacturing sectors. Unfortunately, this dataset is not available at the 2-digit NOGA level. Hence, we aggregate the 21 relevant NOGA 2-digit sectors into 12 manufacturing sectors as laid out in Table 1. We then calculate the energy expenditures of each sector by using energy prices published by the IEA and the SFOE and the physical quantities from the EVID database. Capital expenditures are calculated as a residual by taking the difference of sales, material, labor and energy expenditures.

As for the price indices used in the analysis, we employ output and material price indices available from the OECD. We use a wage index from the survey Sammelstelle für die Statistik der Unfallversicherung published by the SFSO. Sectoral energy price indices are calculated by using the above mentioned data on physical energy use and the energy prices using a Laspeyres price index approach. Capital price indices are not available for different manufacturing sectors in Switzerland. We use an investment/capital goods import price index published by the Swiss Federal Customs Administration (EZV) to proxy capital price changes as we are mainly interested in the price evolution of physical capital.

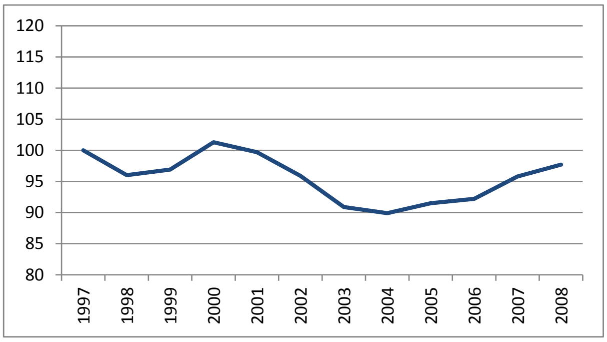
To estimate the technical elasticities of substitution using the nested CES production function, we also use physical employment (number of full-time employees) to obtain a proxy for real labor input. We use deflators to deflate all the other variables (sales, material expenditure, energy expenditure, capital expenditure) to obtain the real values that are required for this analysis.

Note that we cannot use the above data for sector 12, Furniture and other manufacturing, because some data is not available for the corresponding NOGA sector 36 separately, but only as an aggregate with NOGA category 37, Recycling. To include Recycling to this sector 12 is, in our view, not appropriate. We therefore use a different dataset to estimate all elasticities of this sector. We also use this dataset for the NLS estimation of the technical elasticities of substitution of the nested CES function if we do not achieve convergence with the standard dataset. To assemble this dataset, we use sales, material expenditures, labor expenditures as well as energy expenditures from a sample of surveyed firms (approximately 2,000 per year). The survey is conducted by the SFSO each year (Produktions- und Wertschöpfungsstatistik). Capital expenditure is again calculated as a residual. We use the same price indices as discussed above for this dataset.

A.3 Descriptive Statistics on Input and Output Price Data

A.3.1 Capital Prices

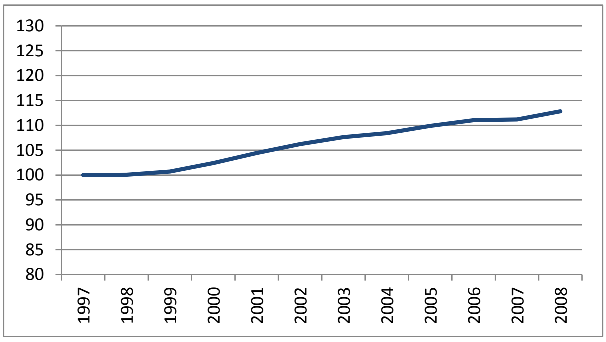
Figure 2: Evolution of capital prices, 1997-2008



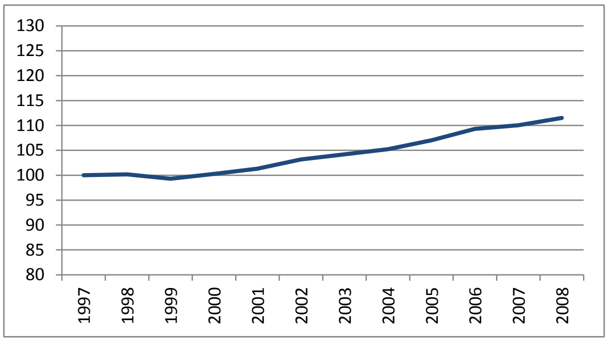
Notes: Prices are index values with 1997 as base year. Source: Import price index from investment goods of the Swiss Federal Customs Administration (EZV).

A.3.2 Labor Prices

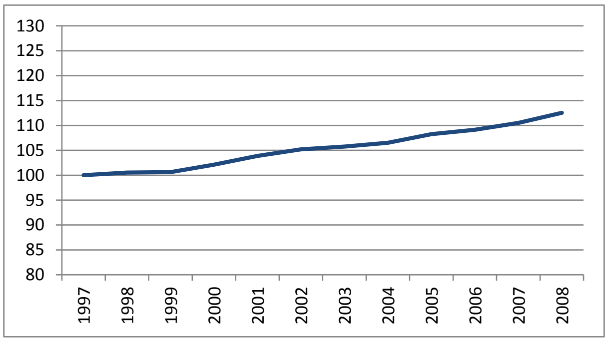
Figure 3: Sectoral labor prices, 1997-2008 (I)



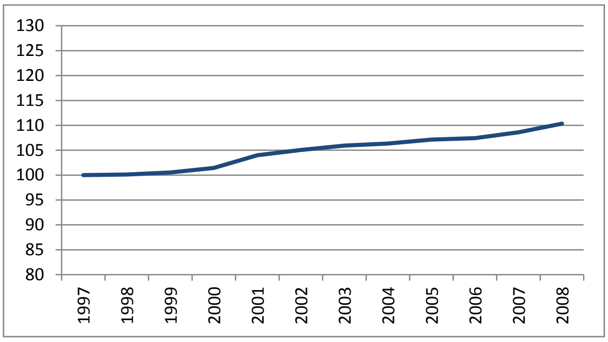
(a) 15,16



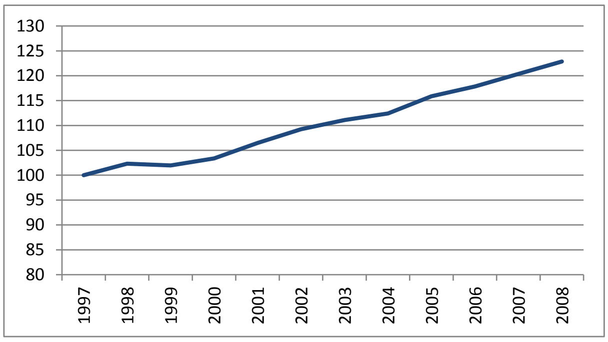
(b) 17,18,19



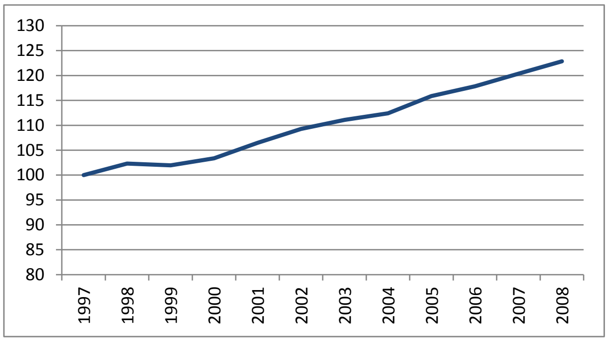
(c) 20



(d) 21,22



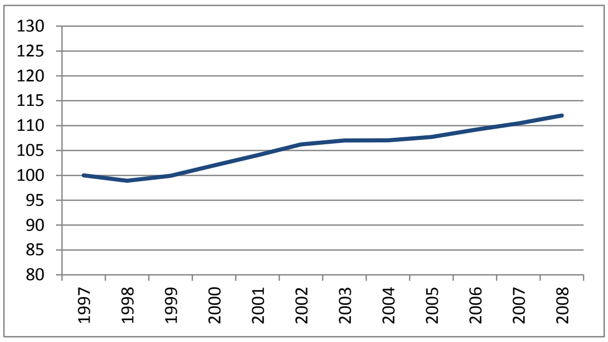
(e) 24



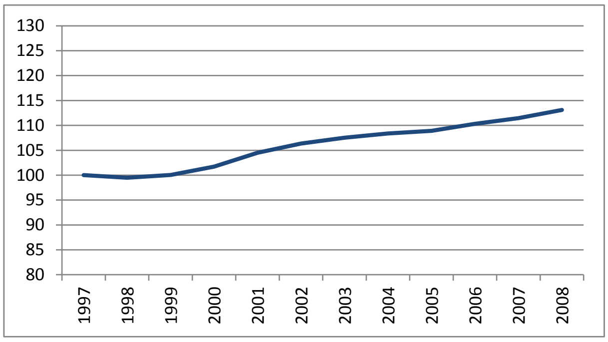
(f) 25

Notes: Prices are index values with 1997 as base year.

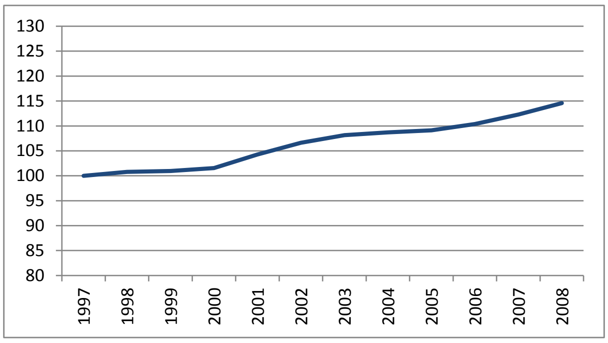
Figure 3: Sectoral labor prices, 1997-2008 (II)



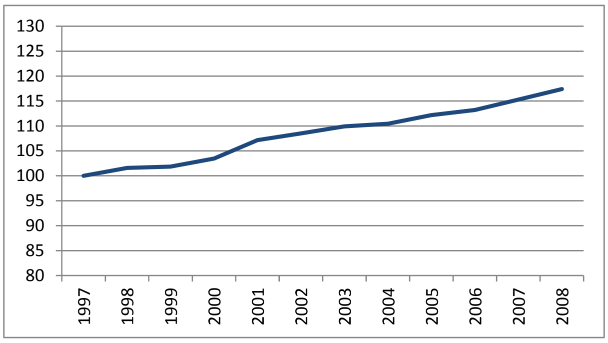
(g) 26



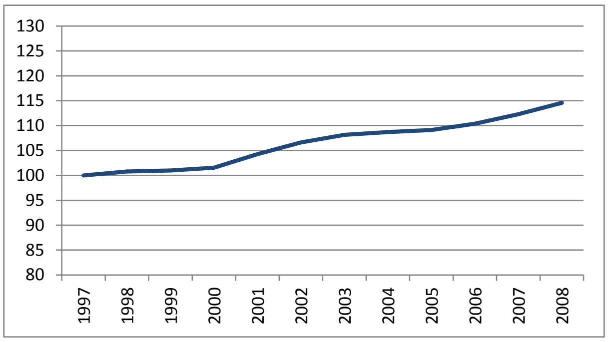
(h) 27,28



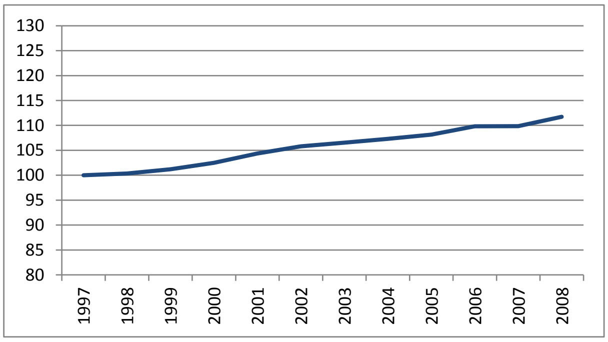
(i) 29



(j) 30,31,32,33



(k) 34,35

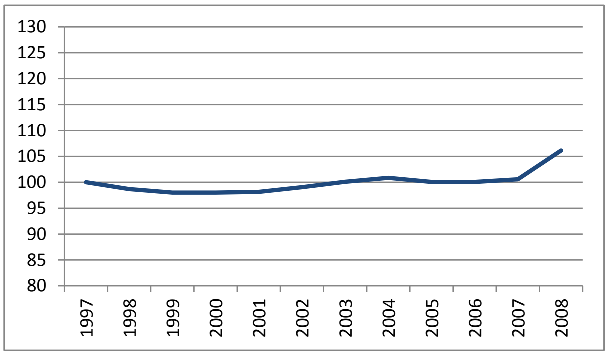


(l) 36

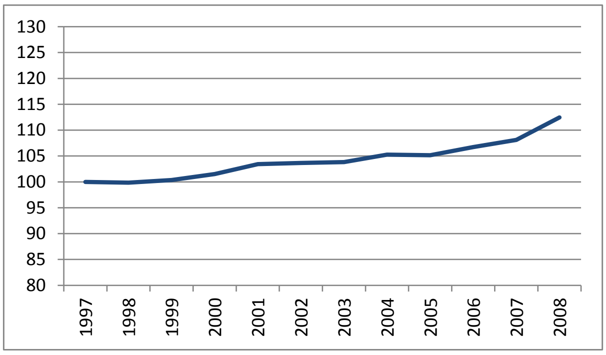
Notes: Prices are index values with 1997 as base year.

A.3.3 Material Prices

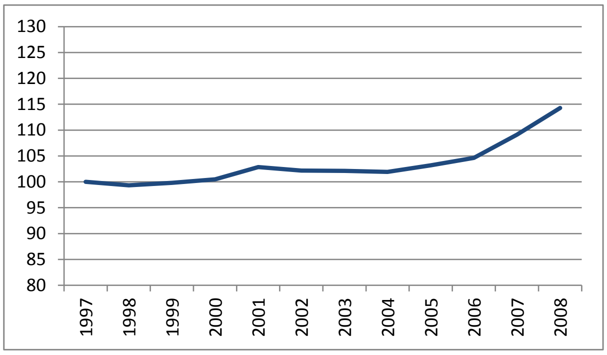
Figure 4: Sectoral material prices, 1997-2008 (I)



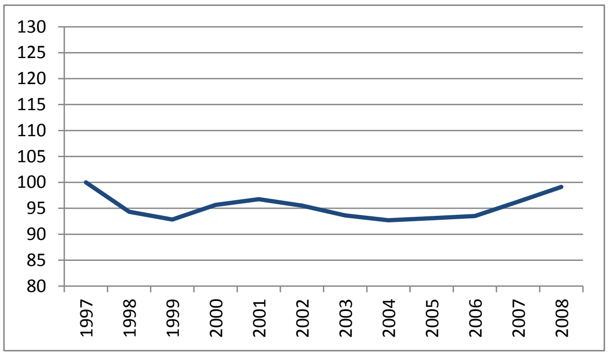
(a) 15,16



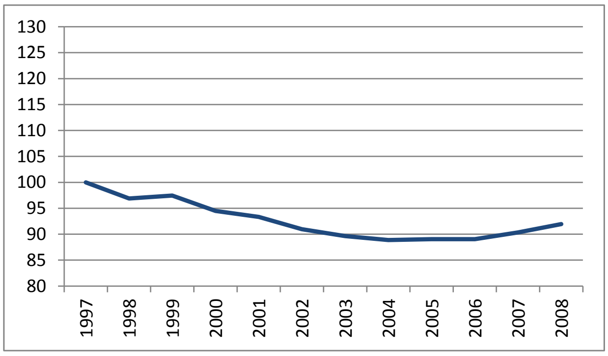
(b) 17,18,19



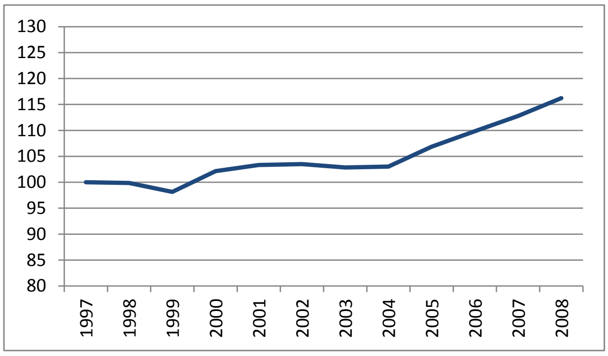
(c) 20



(d) 21,22



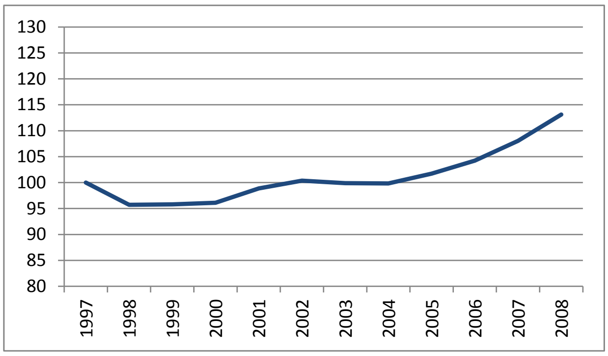
(e) 24



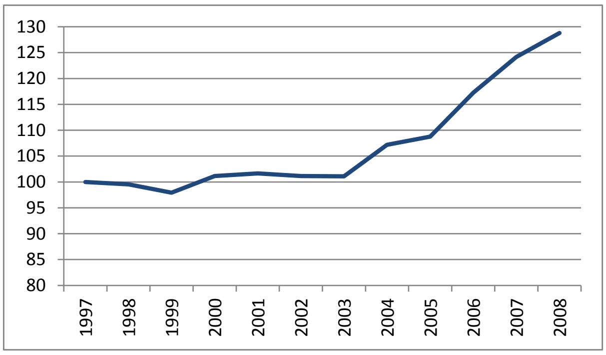
(f) 25

Notes: Prices are index values with 1997 as base year.

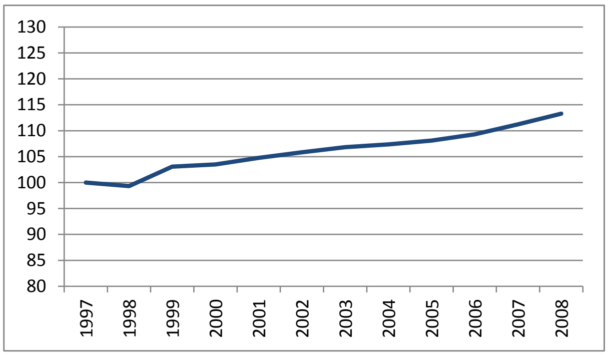
Figure 4: Sectoral material prices, 1997-2008 (II)



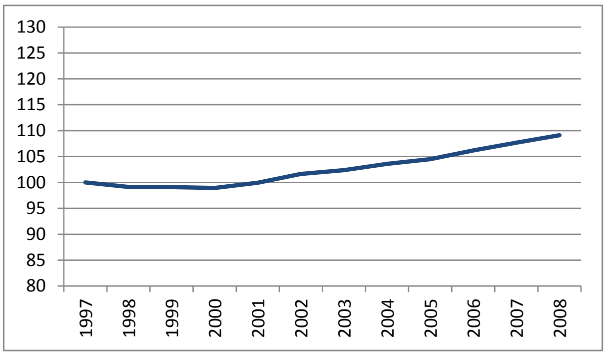
(g) 26



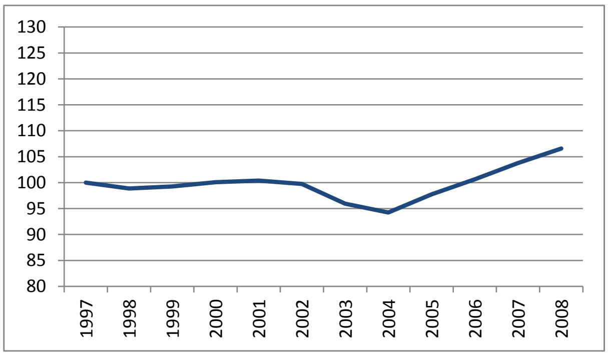
(h) 27,28



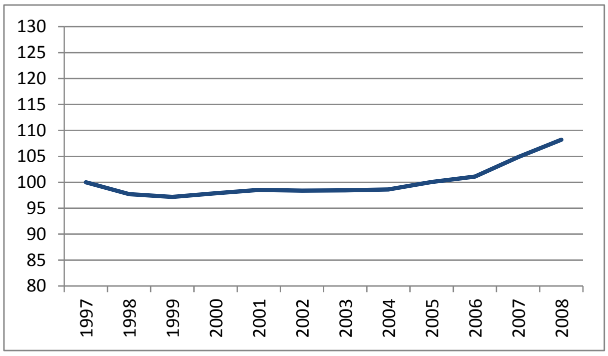
(i) 29



(j) 30,31,32,33



(k) 34,35

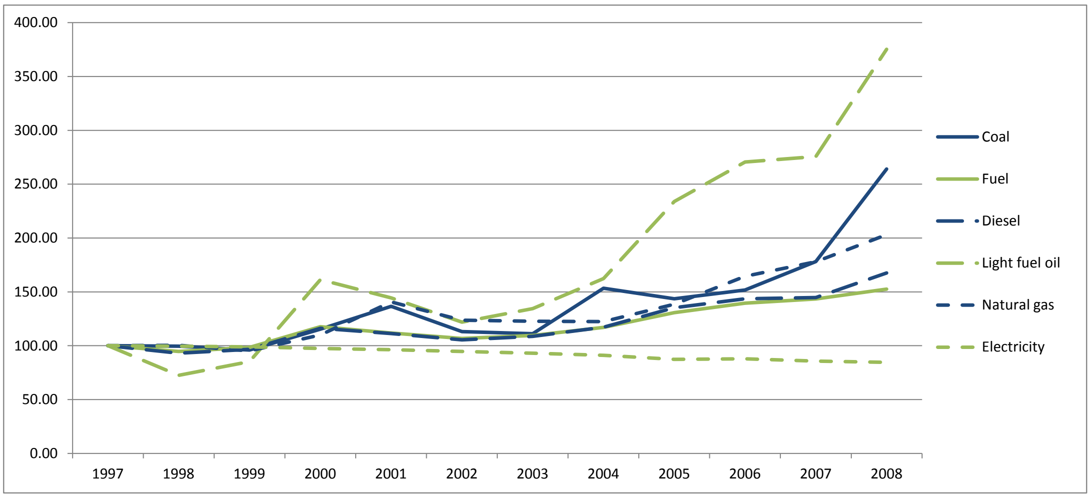


(l) 36

Notes: Prices are index values with 1997 as base year.

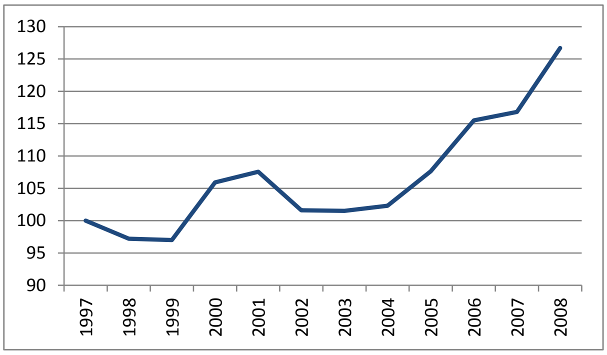
A.3.4 Energy Prices

Figure 5: Prices of different energy sources, 1997-2008

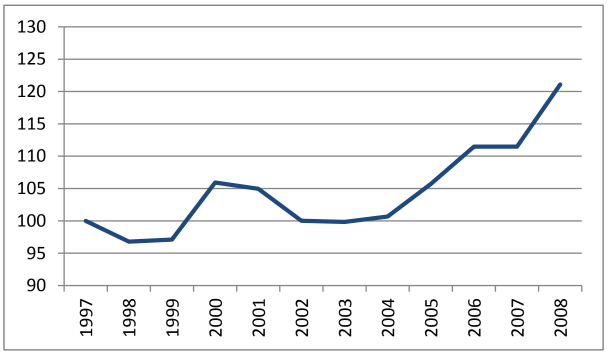


Notes: Prices are index values with 1997 as base year.

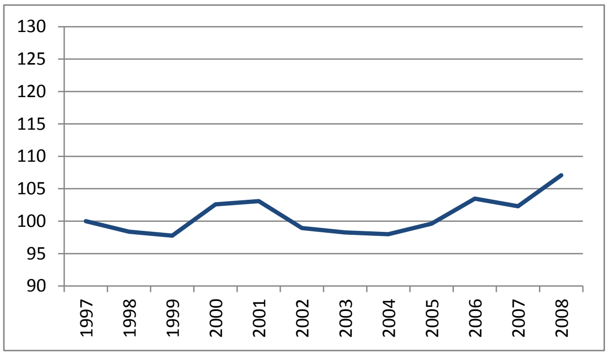
Figure 6: Sectoral energy prices, 1997-2008 (I)



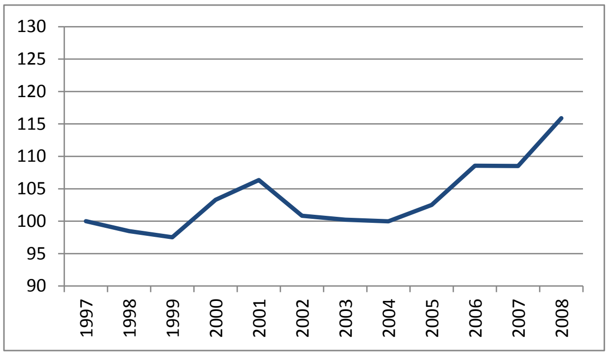
(a) 15,16



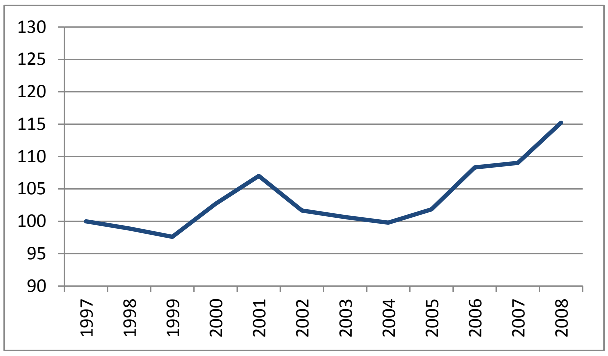
(b) 17,18,19



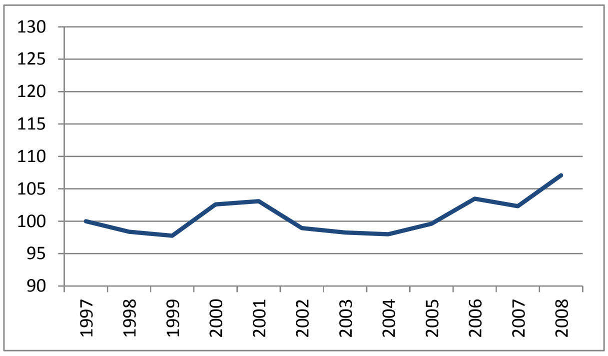
(c) 20



(d) 21,22



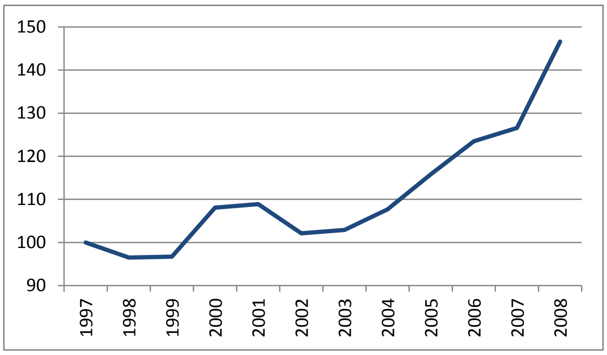
(e) 24



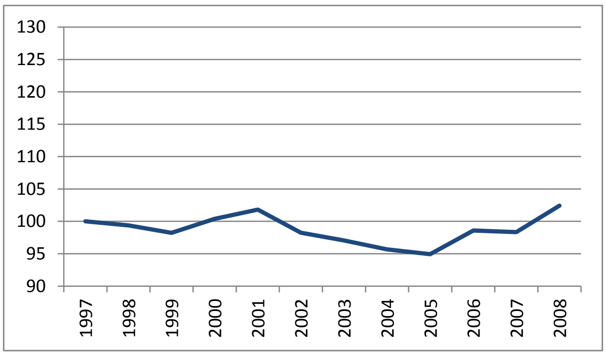
(f) 25

Notes: Prices are index values with 1997 as base year.

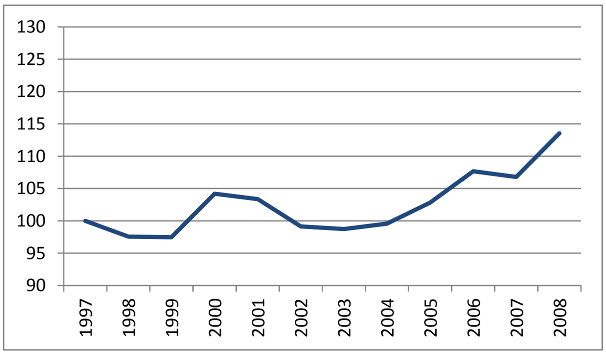
Figure 6: Sectoral energy prices, 1997-2008 (II)



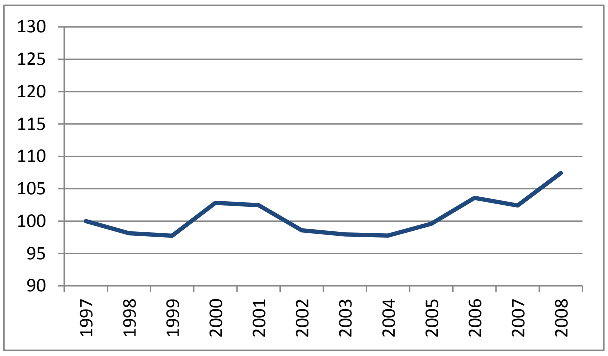
(g) 26



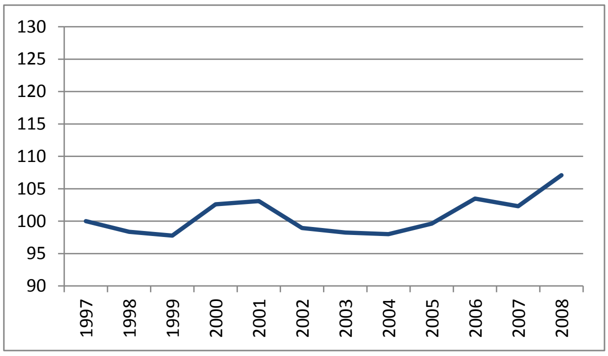
(h) 27,28



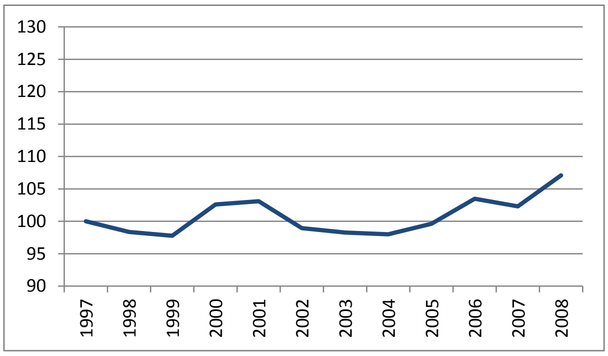
(i) 29



(j) 30,31,32,33



(k) 34,35

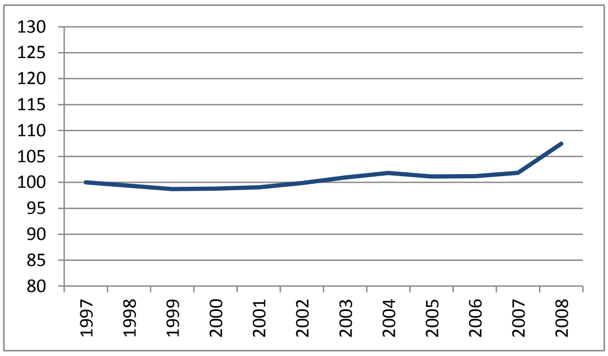


(l) 36

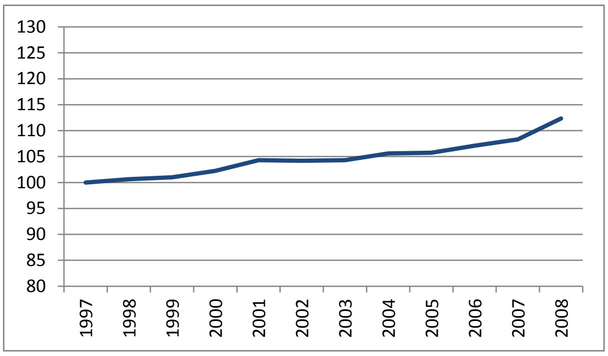
Notes: Prices are index values with 1997 as base year.

A.3.5 Output Prices

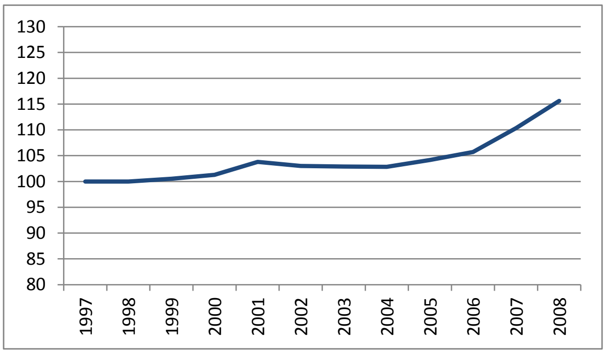
Figure 7: Sectoral output prices, 1997-2008 (I)



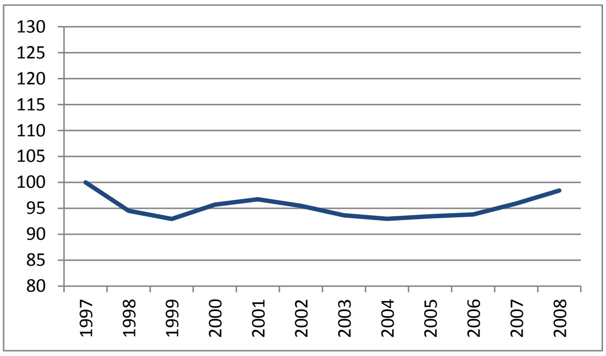
(a) 15,16



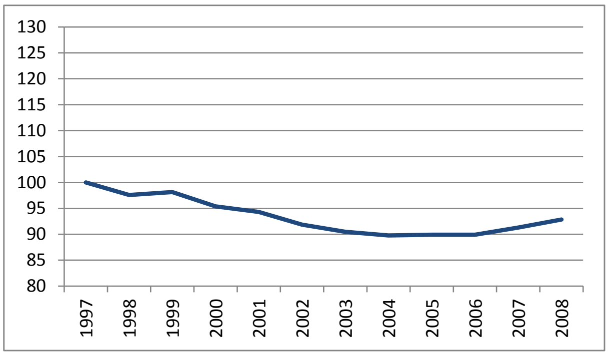
(b) 17,18,19



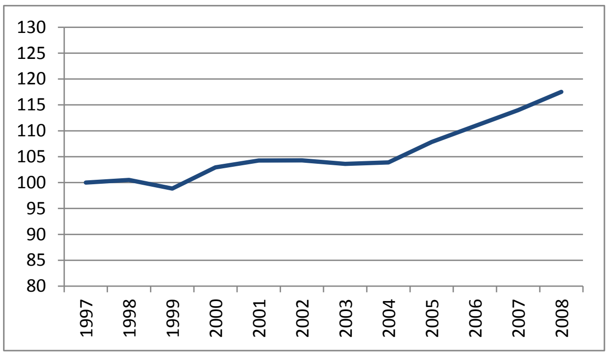
(c) 20



(d) 21,22



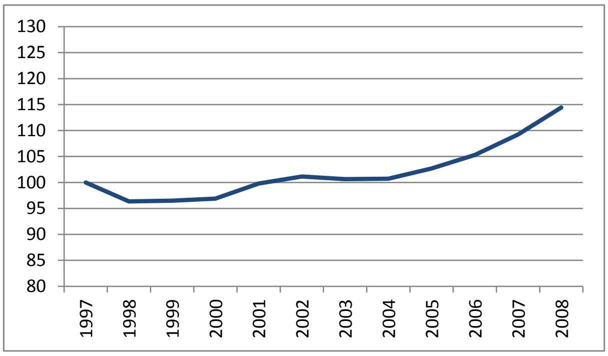
(e) 24



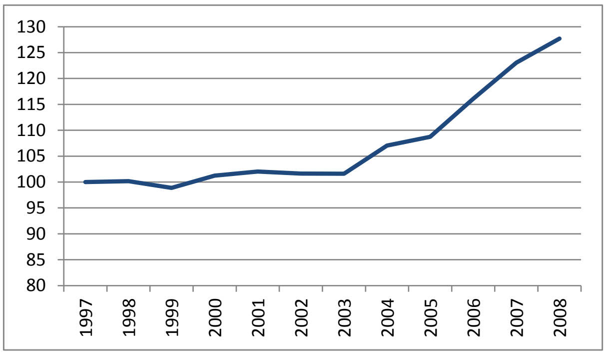
(f) 25

Notes: Prices are index values with 1997 as base year.

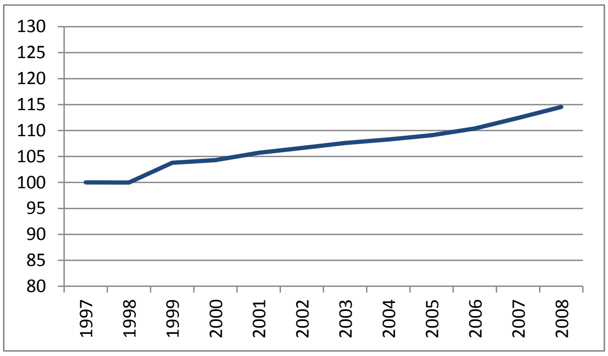
Figure 7: Sectoral output prices, 1997-2008 (II)



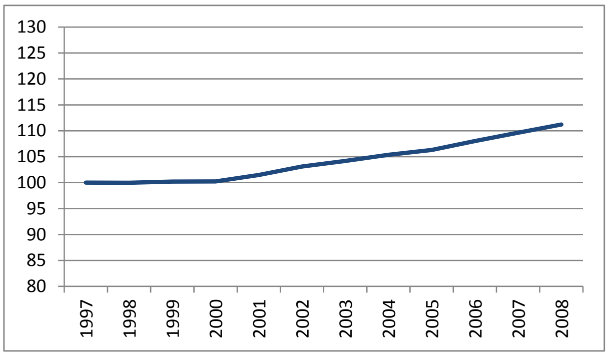
(g) 26



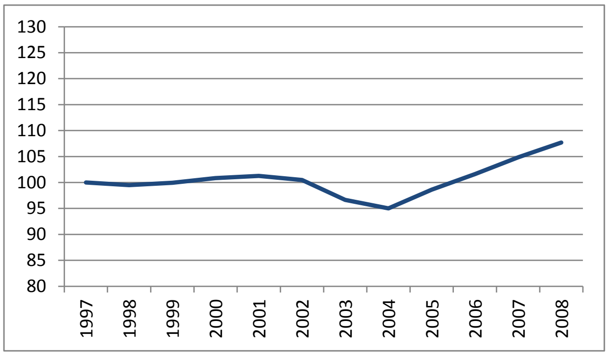
(h) 27,28



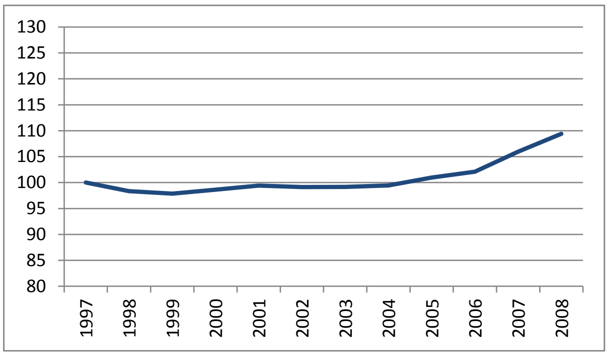
(i) 29



(j) 30,31,32,33



(k) 34,35



(l) 36

Notes: Prices are index values with 1997 as base year.

A.3.6 Average Annual Price Changes

Table 21: Average annual price changes of input factors

	Capital				Labor				Energy				Material			
Sector	**CHE**	Med	Min	Max	**CHE**	Med	Min	Max	**CHE**	Med	Min	Max	**CHE**	Med	Min	Max
1	**-0.21**	0.46	-2.30	3.75	**1.10**	2.06	-0.27	3.54	**2.17**	3.75	-2.59	6.47	**0.54**	-0.14	-0.76	0.98
2	**-0.21**	0.46	-2.30	3.75	**0.99**	2.80	0.99	5.15	**1.76**	2.88	-1.29	5.88	**1.07**	0.43	-0.28	1.07
3	**-0.21**	0.46	-2.30	3.75	**1.08**	2.22	-0.61	3.64	**0.63**	2.74	-1.50	8.07	**1.22**	-0.10	-1.29	1.37
4	**-0.21**	0.46	-2.30	3.75	**0.90**	2.00	-0.89	4.06	**1.35**	3.91	0.78	6.84	**-0.08**	-0.22	-0.91	1.61
5	**-0.21**	0.46	-2.30	3.75	**1.89**	2.32	-0.06	4.35	**1.30**	6.40	-0.88	7.94	**-0.76**	1.07	-0.76	4.00
6	**-0.21**	0.46	-2.30	3.75	**1.89**	2.18	0.20	5.84	**0.63**	2.72	-0.88	9.37	**1.38**	1.16	-0.39	2.20
7	**-0.21**	0.46	-2.30	3.75	**1.04**	2.28	-0.58	4.28	**3.54**	4.79	-0.23	6.54	**1.13**	1.54	0.01	2.22
8	**-0.21**	0.46	-2.30	3.75	**1.13**	2.11	0.36	4.94	**0.22**	3.84	0.22	5.74	**2.33**	2.12	1.06	3.44
9	**-0.21**	0.46	-2.30	3.75	**1.24**	2.46	-0.74	4.98	**1.16**	4.27	-1.42	7.44	**1.14**	1.09	-1.38	1.54
10	**-0.21**	0.46	-2.30	3.75	**1.47**	2.62	0.39	4.52	**0.65**	3.24	0.65	8.25	**0.80**	-0.77	-4.53	0.80
11	**-0.21**	0.46	-2.30	3.75	**1.24**	2.90	-0.42	4.16	**0.63**	3.04	-1.34	5.09	**0.58**	0.70	-0.83	1.97
12	**-0.21**	0.46	-2.30	3.75	**1.01**	2.45	-0.56	4.19	**0.63**	3.34	-0.95	6.38	**0.72**	0.75	-0.20	1.58

Swiss average annual price changes are contrasted with average annual price changes (median, minimum, maximum) of Germany, Belgium, the Netherlands, Great Britain, Denmark, Sweden and Spain. Numbers are average percentage rates.

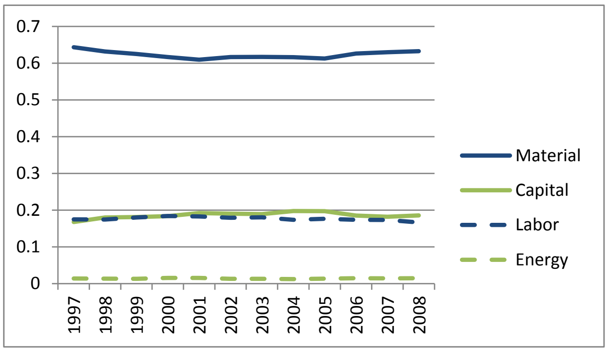
Table 22: Average annual price changes of sector output

Output				
Sector	**CHE**	Med	Min	Max
1	**0.66**	0.66	0.02	1.58
2	**1.06**	0.62	-0.32	1.49
3	**1.33**	0.39	-1.01	2.33
4	**-0.14**	0.77	-0.30	1.41
5	**-0.67**	0.94	-0.67	2.36
6	**1.48**	1.13	-0.34	2.17
7	**1.23**	1.39	-0.73	2.13
8	**2.25**	1.95	0.63	2.39
9	**1.24**	1.15	-2.09	2.08
10	**0.97**	-0.58	-5.04	0.99
11	**0.68**	0.74	-0.85	2.07
12	**0.82**	1.49	-0.76	2.04

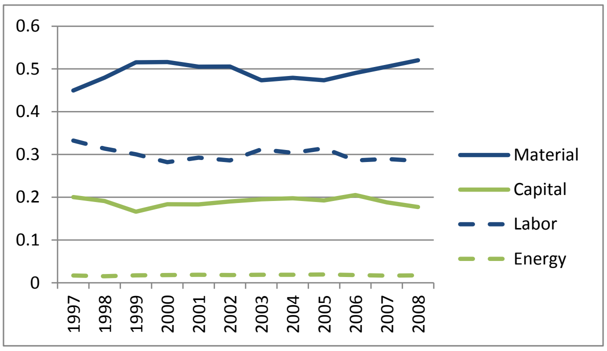
Swiss average annual price changes are contrasted with average annual price changes of EU countries.
Numbers are average percentage rates.

A.4 Descriptive Statistics on Cost Shares

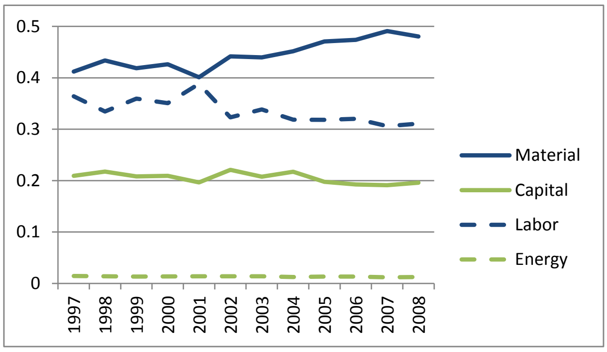
Figure 8: Sectoral factor shares, 1997-2008 (I)



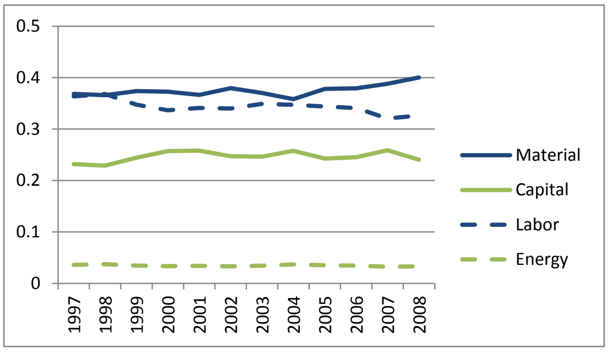
(a) 15,16



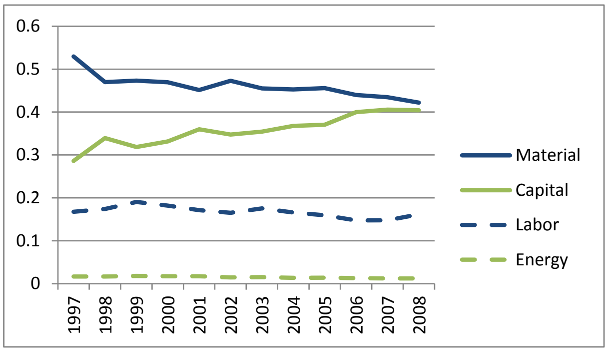
(b) 17,18,19



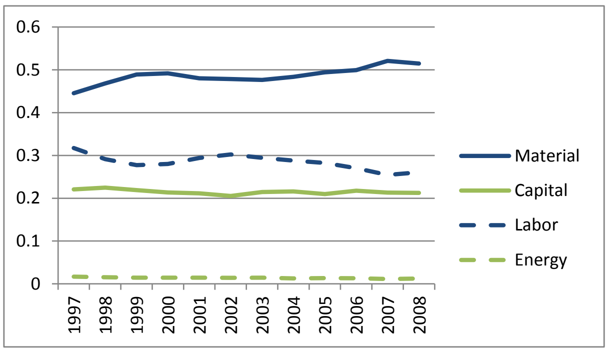
(c) 20



(d) 21,22



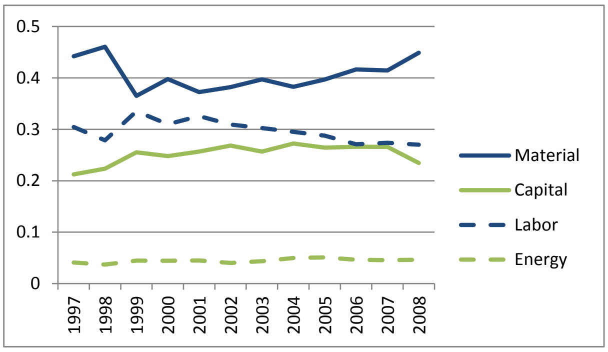
(e) 24



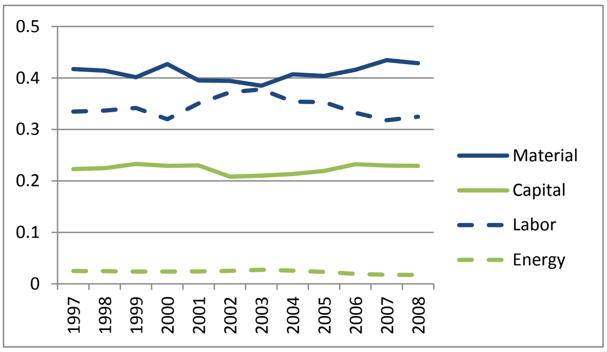
(f) 25

Notes: The figure displays the evolution of the factor shares for every manufacturing sector.

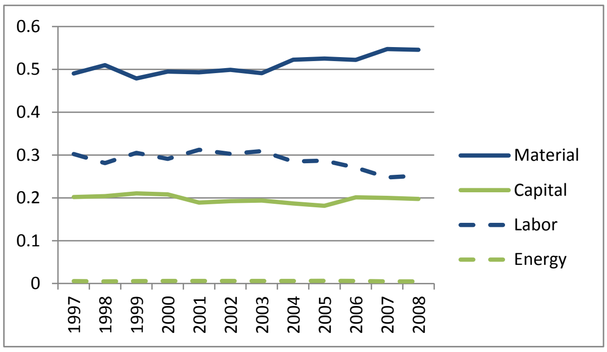
Figure 8: Sectoral factor shares, 1997-2008 (II)



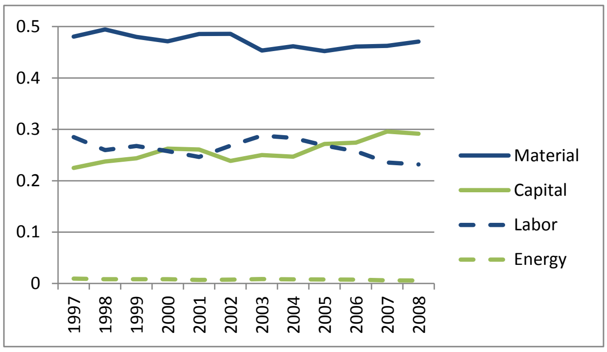
(g) 26



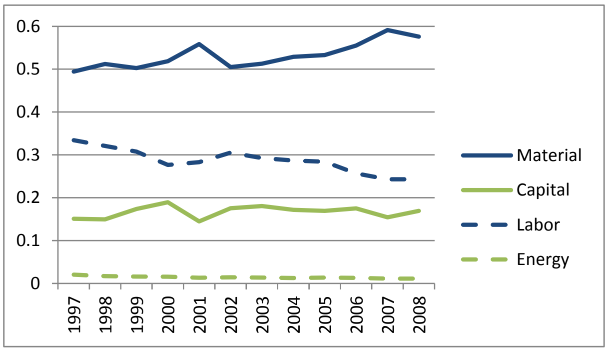
(h) 27,28



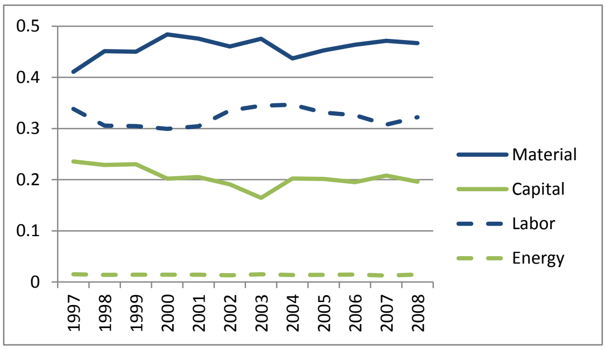
(i) 29



(j) 30,31,32,33



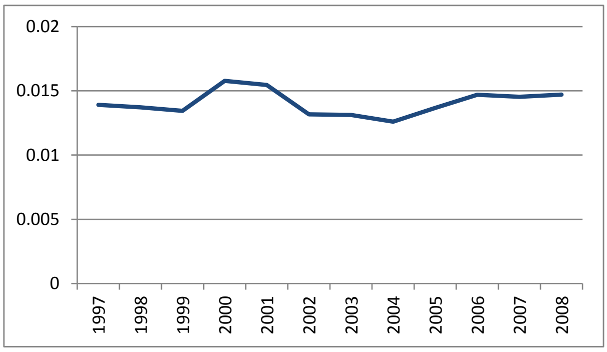
(k) 34,35



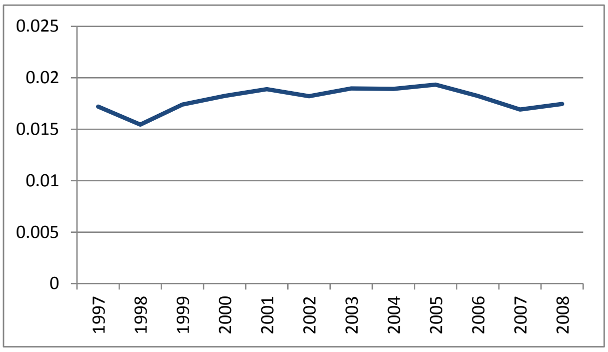
(l) 36

Notes: The figure displays the evolution of the factor shares for every manufacturing sector.

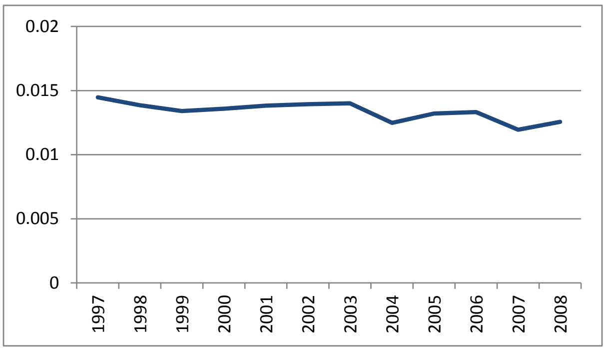
Figure 9: Sectoral energy shares, 1997-2008 (I)



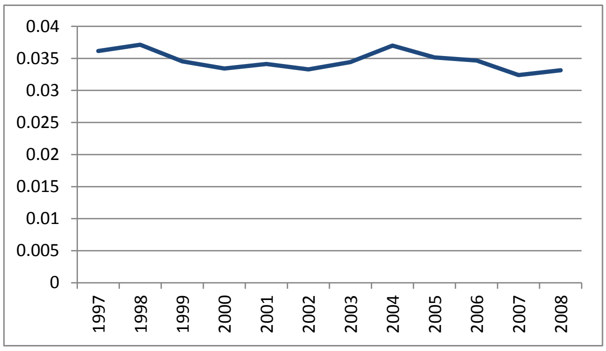
(a) 15,16



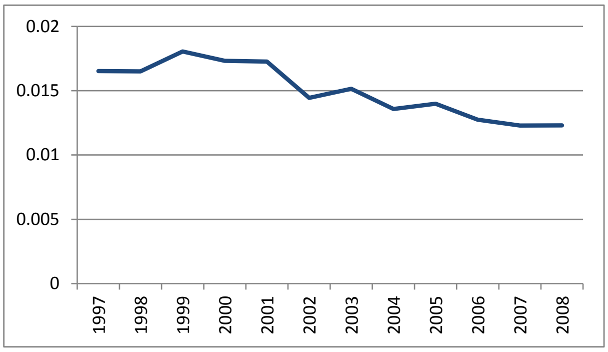
(b) 17,18,19



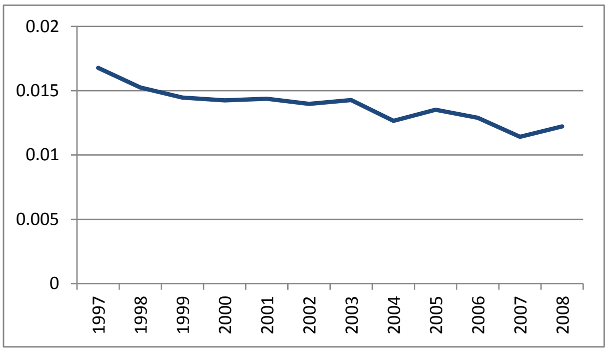
(c) 20



(d) 21,22



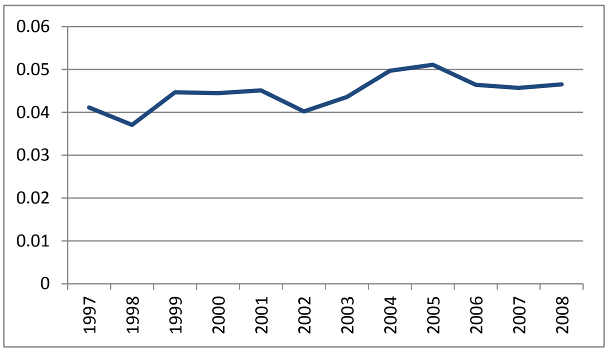
(e) 24



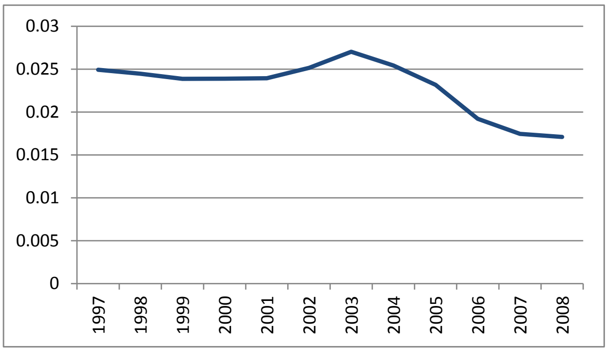
(f) 25

Notes: The figure displays the evolution of the energy share for every manufacturing sector.

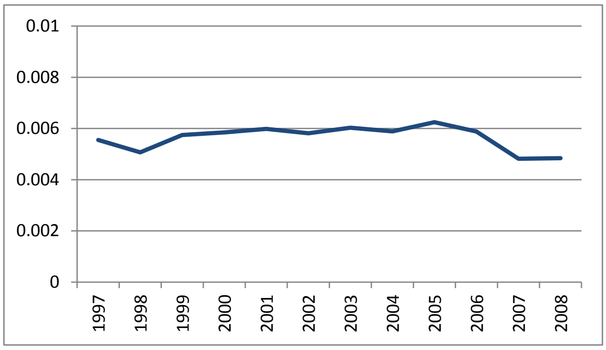
Figure 9: Sectoral energy shares, 1997-2008 (II)



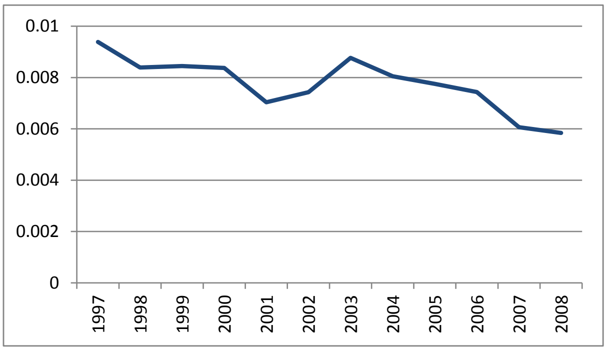
(g) 26



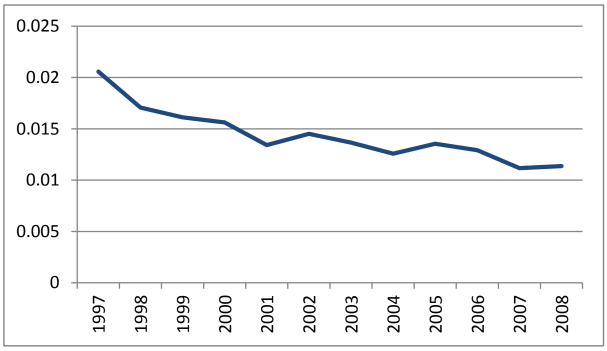
(h) 27,28



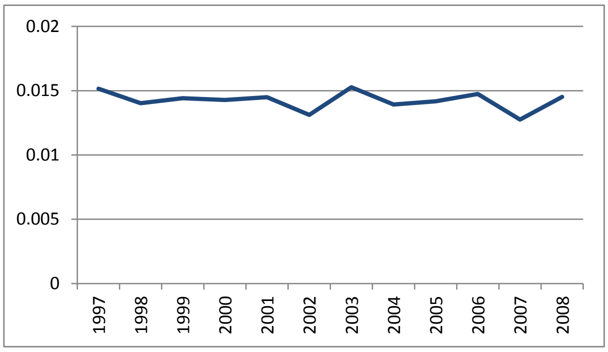
(i) 29



(j) 30,31,32,33



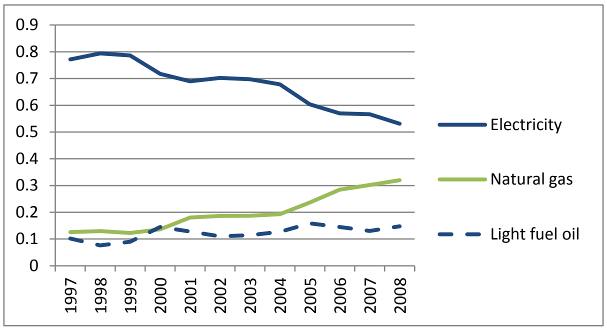
(k) 34,35



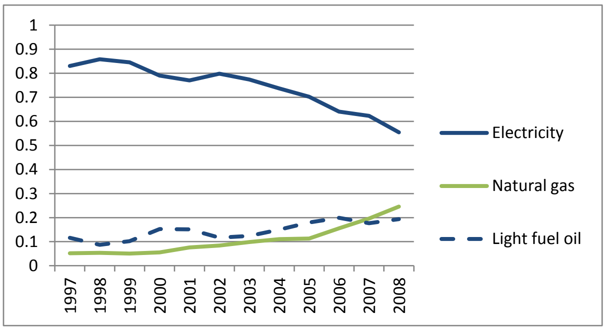
(l) 36

Notes: The figure displays the evolution of the energy share for every manufacturing sector.

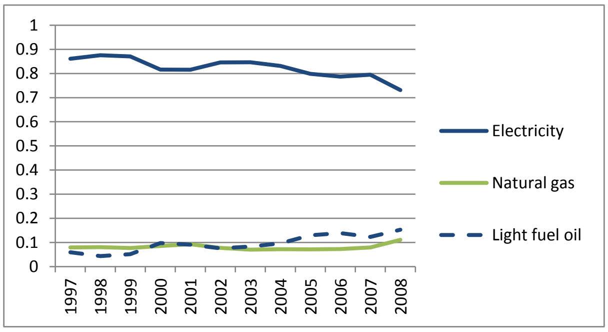
Figure 10: Sectoral energy mix, 1997-2008 (I)



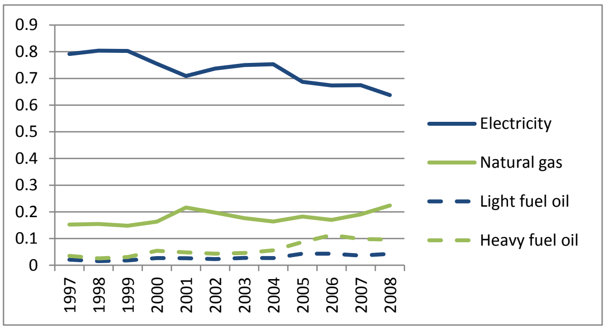
(a) 15,16



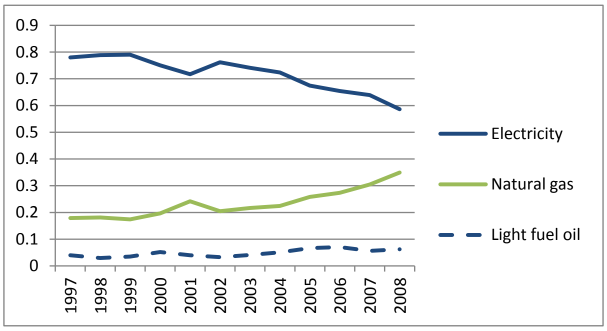
(b) 17,18,19



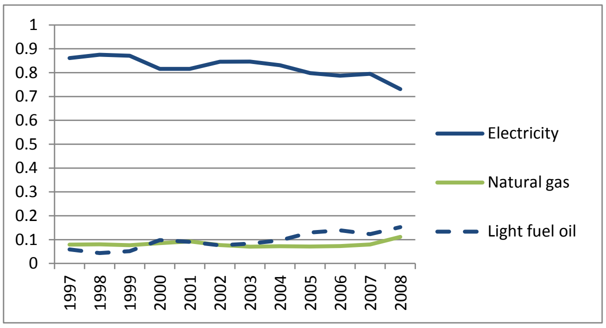
(c) 20



(d) 21,22



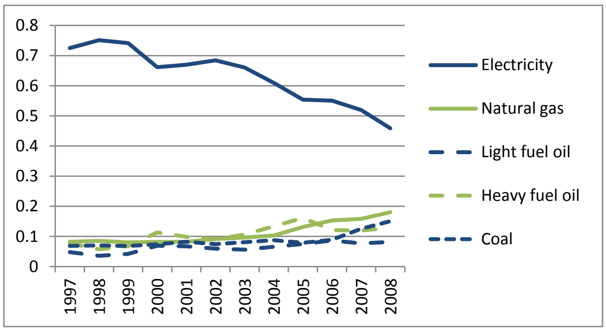
(e) 24



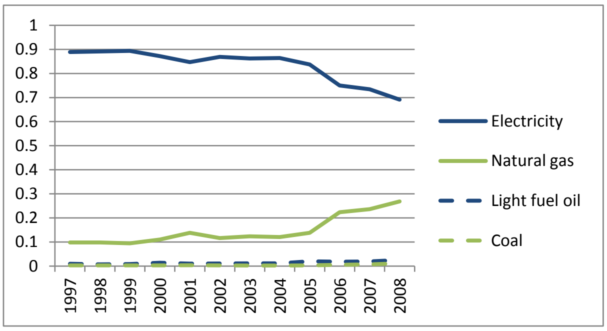
(f) 25

Notes: The figure displays the composition of energy expenses for every manufacturing sector. Included are the energy sources that account for more than one percent of total energy expenses in the respective sector.

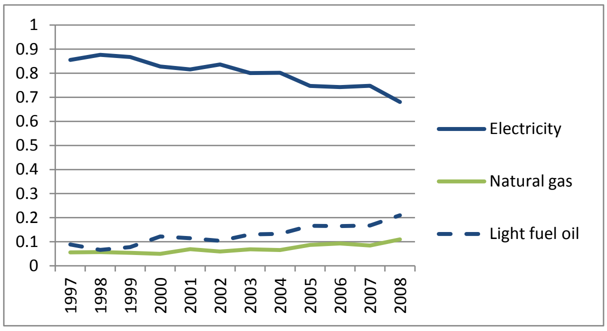
Figure 10: Sectoral energy mix, 1997-2008 (II)



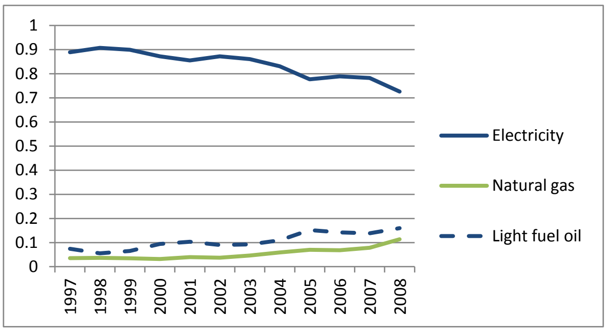
(g) 26



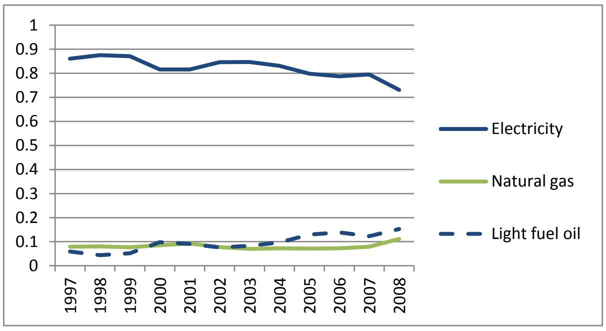
(h) 27,28



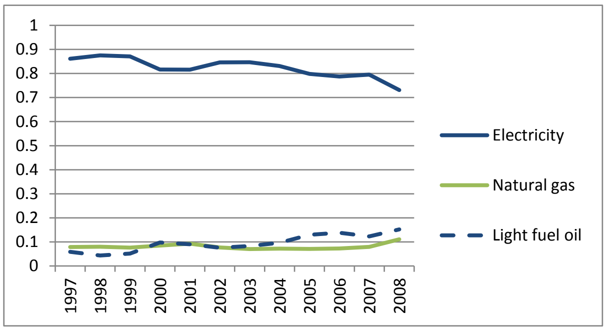
(i) 29



(j) 30,31,32,33



(k) 34,35



(l) 36

Notes: Graphs display the composition of energy expenses for every sector. Included are the energy sources that account for more than one percent of total energy expenses in the respective sector.

Table 23: Average input cost shares

	Capital				Labor				Energy				Material			
Sector	**CHE**	Med	Min	Max	**CHE**	Med	Min	Max	**CHE**	Med	Min	Max	**CHE**	Med	Min	Max
1	**0.186**	0.251	0.161	0.402	**0.177**	0.170	0.113	0.241	**0.014**	0.016	0.011	0.034	**0.623**	0.572	0.409	0.663
2	**0.189**	0.222	0.084	0.347	**0.300**	0.256	0.170	0.414	**0.018**	0.018	0.013	0.041	**0.493**	0.481	0.363	0.562
3	**0.205**	0.233	0.154	0.383	**0.336**	0.265	0.156	0.388	**0.013**	0.023	0.012	0.102	**0.445**	0.474	0.377	0.591
4	**0.247**	0.319	0.229	0.428	**0.344**	0.262	0.191	0.368	**0.035**	0.025	0.012	0.050	**0.375**	0.382	0.338	0.478
5	**0.357**	0.351	0.286	0.564	**0.167**	0.171	0.092	0.266	**0.015**	0.049	0.012	0.132	**0.461**	0.422	0.227	0.536
6	**0.215**	0.261	0.205	0.362	**0.284**	0.258	0.181	0.326	**0.014**	0.026	0.011	0.098	**0.487**	0.441	0.358	0.521
7	**0.252**	0.306	0.212	0.425	**0.297**	0.265	0.203	0.342	**0.045**	0.061	0.032	0.094	**0.406**	0.334	0.263	0.461
8	**0.224**	0.236	0.122	0.318	**0.343**	0.246	0.165	0.378	**0.023**	0.036	0.017	0.071	**0.410**	0.467	0.385	0.537
9	**0.197**	0.245	0.168	0.344	**0.287**	0.266	0.208	0.342	**0.006**	0.012	0.005	0.028	**0.510**	0.463	0.403	0.547
10	**0.258**	0.254	0.183	0.477	**0.262**	0.237	0.168	0.369	**0.008**	0.011	0.003	0.022	**0.472**	0.463	0.321	0.564
11	**0.167**	0.203	0.078	0.305	**0.286**	0.168	0.108	0.334	**0.014**	0.011	0.005	0.021	**0.532**	0.591	0.494	0.683
12	**0.205**	0.236	0.079	0.365	**0.322**	0.292	0.162	0.493	**0.014**	0.015	0.008	0.056	**0.458**	0.451	0.289	0.545

Note: Swiss average shares are contrasted with shares (median, minimum, maximum) from Germany, Belgium, the Netherlands, Great Britain, Denmark, Sweden and Spain.

A.5 Translog Cost Function Estimation Results

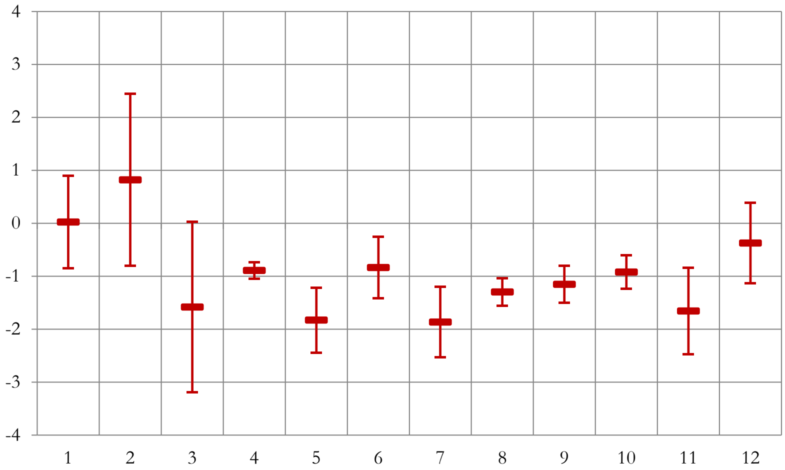
A.5.1 Swiss Sectoral Manufacturing Estimates

Table 24: Key statistics of the Swiss sectoral estimates

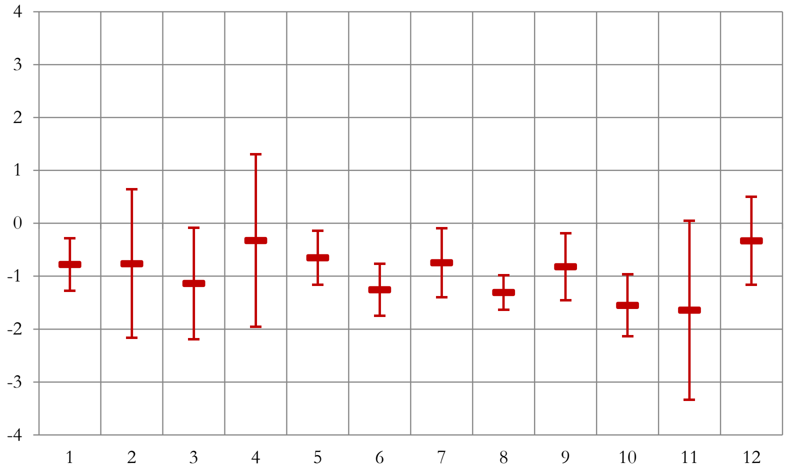
Sector	Equation	Observations	RMSE	R-squared	p-value
1	Capital	11	0.004	0.46	0.005
	Labor	11	0.002	0.85	0.000
	Energy	11	0.001	0.29	0.631
2	Capital	11	0.009	0.18	0.391
	Labor	11	0.006	0.73	0.000
	Energy	11	0.001	0.71	0.077
3	Capital	11	0.008	0.45	0.190
	Labor	11	0.014	0.63	0.000
	Energy	11	0.000	0.79	0.863
4	Capital	11	0.005	0.65	0.000
	Labor	11	0.002	0.98	0.000
	Energy	11	0.000	0.89	0.000
5	Capital	11	0.008	0.92	0.000
	Labor	11	0.003	0.93	0.000
	Energy	11	0.000	0.96	0.000
6	Capital	11	0.004	0.35	0.000
	Labor	11	0.003	0.96	0.000
	Energy	11	0.001	0.40	0.070
7	Capital	11	0.007	0.75	0.000
	Labor	11	0.005	0.94	0.000
	Energy	11	0.002	0.67	0.022
8	Capital	11	0.004	0.79	0.000
	Labor	11	0.004	0.95	0.000
	Energy	11	0.001	0.93	0.000
9	Capital	11	0.006	0.59	0.000
	Labor	11	0.002	0.99	0.000
	Energy	11	0.000	0.43	0.477
10	Capital	11	0.007	0.88	0.000
	Labor	11	0.001	1.00	0.000
	Energy	11	0.000	0.96	0.000
11	Capital	11	0.010	0.41	0.142
	Labor	11	0.008	0.89	0.000
	Energy	11	0.001	0.61	0.501
12	Capital	11	0.008	0.75	0.000
	Labor	11	0.007	0.82	0.000
	Energy	11	0.002	0.56	0.000

Note: For each sector we estimated a SUR consisting of three share equations. We list the number of observations, the root mean square error, the r-squared and the p-value for each equation.

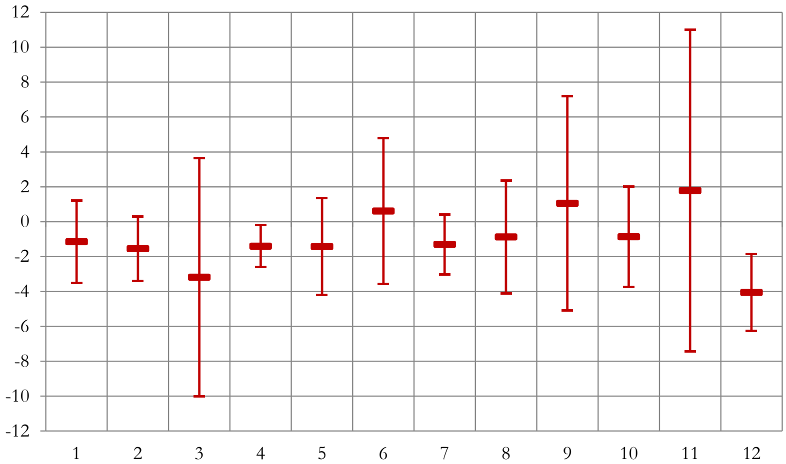
Figure 11: Own-price elasticities of Swiss manufacturing industries



(a) CPE_{LL}



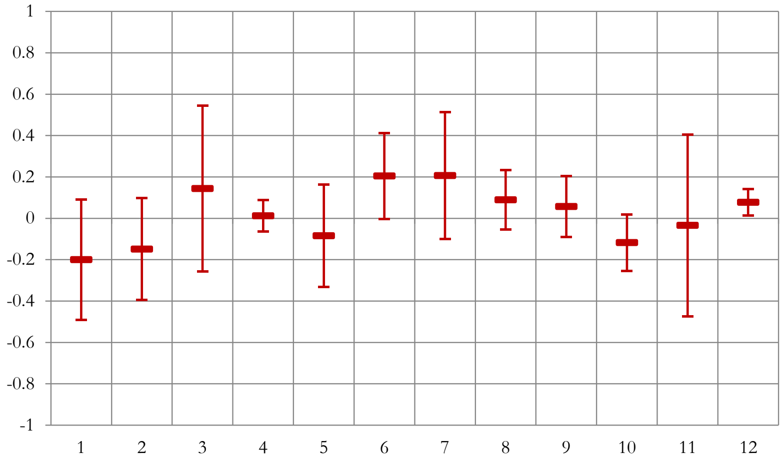
(b) CPE_{KK}



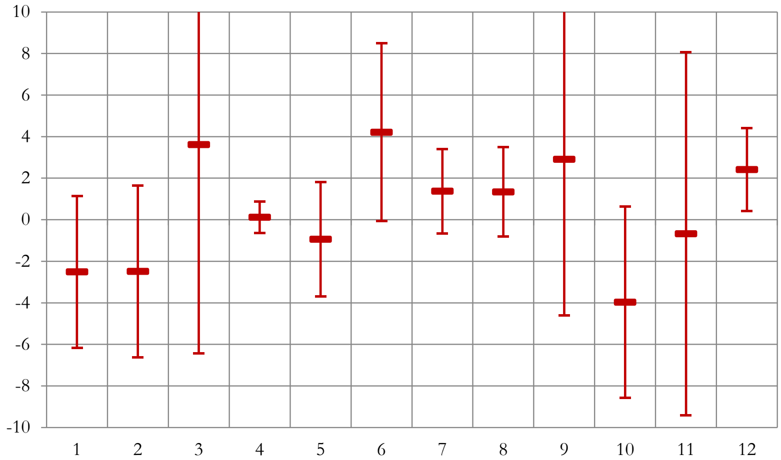
(c) CPE_{EE}

Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for the 12 manufacturing industries in Switzerland. We use the translog cost function as functional form.

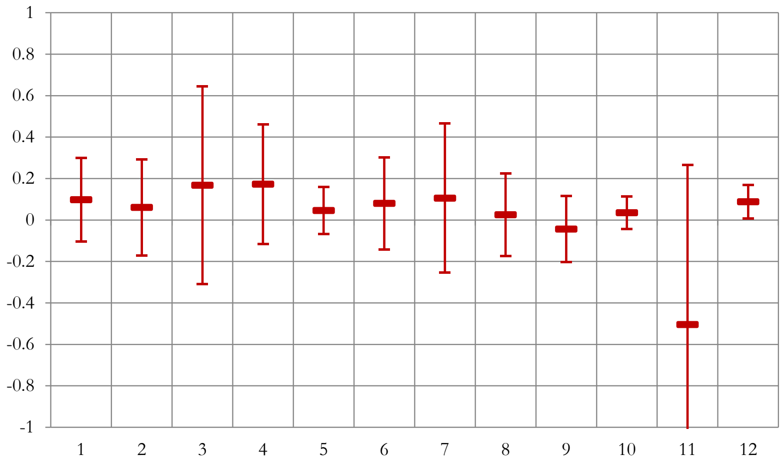
Figure 12: Cross-price elasticities of Swiss manufacturing industries (I)



(a) CPE_{LE}



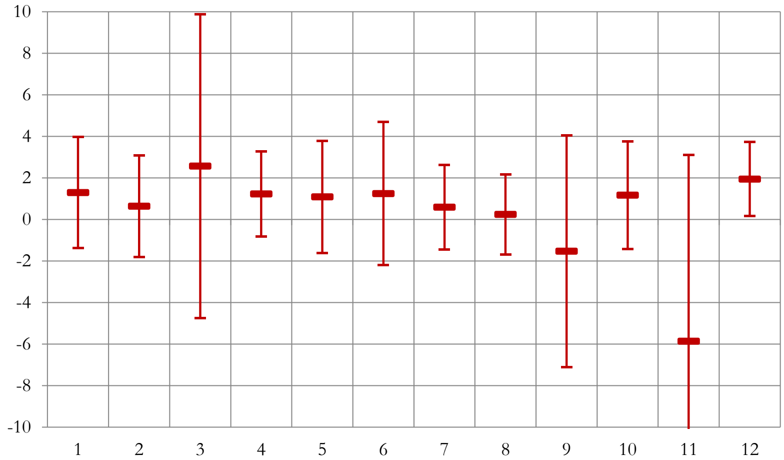
(b) CPE_{EL}



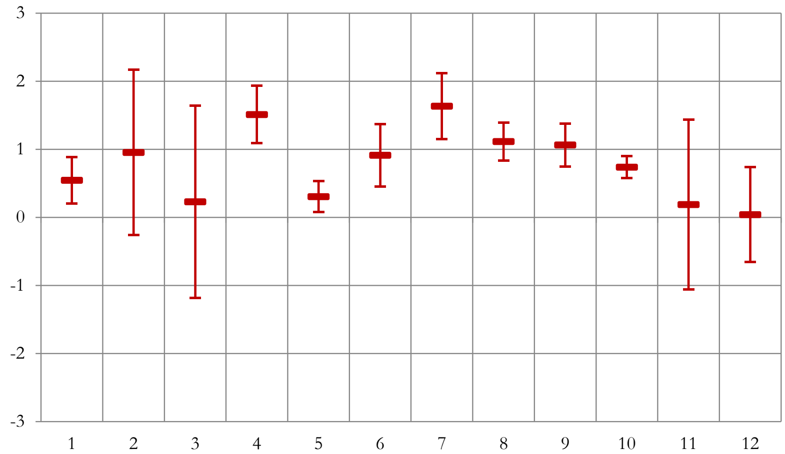
(c) CPE_{KE}

Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for the 12 manufacturing industries in Switzerland. We use the translog cost function as functional form.

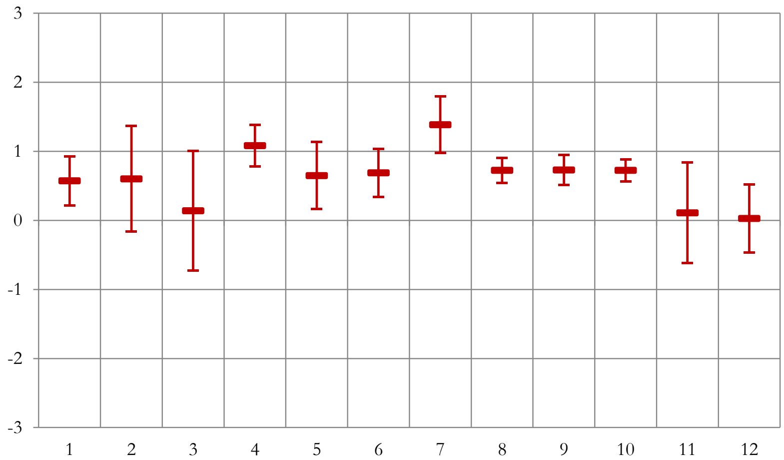
Figure 12: Cross-price elasticities of Swiss manufacturing industries (II)



(d) CPE_{EK}



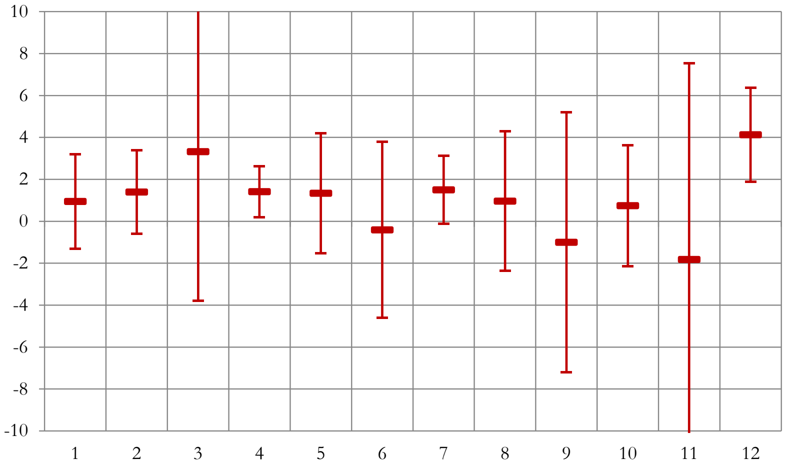
(e) CPE_{KL}



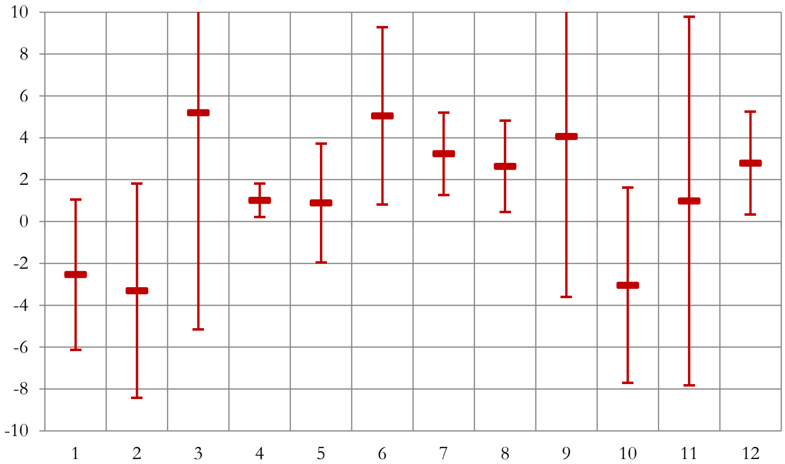
(f) CPE_{LK}

Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for the 12 manufacturing industries in Switzerland. We use the translog cost function as functional form.

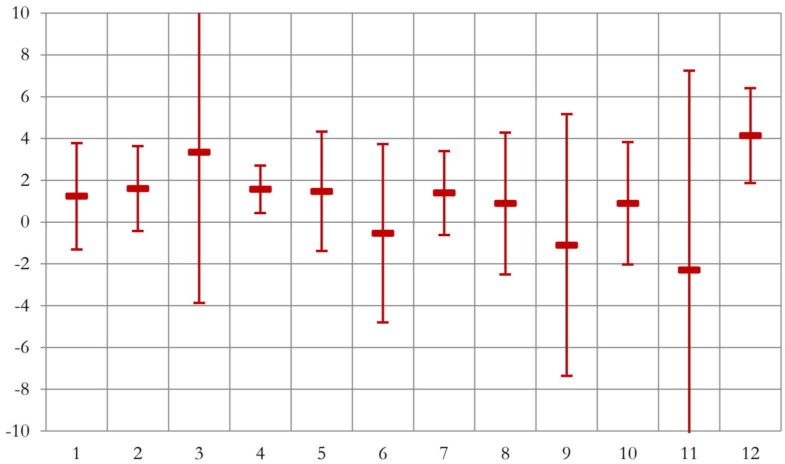
Figure 13: Morishima elasticities of Swiss manufacturing industries (I)



(a) MES_{LE}



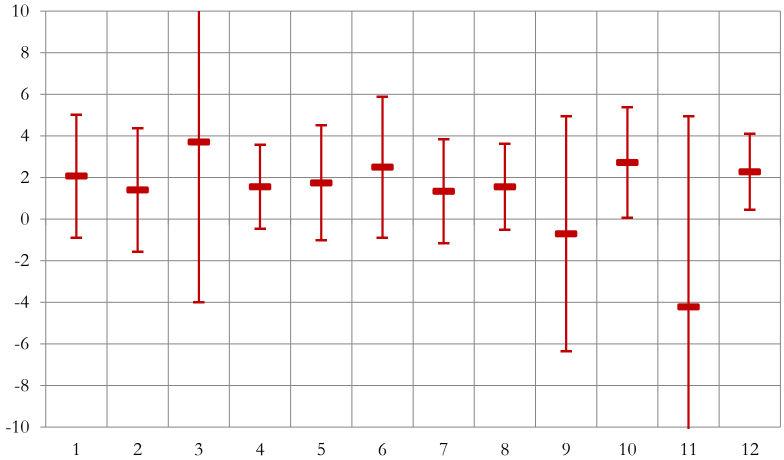
(b) MES_{EL}



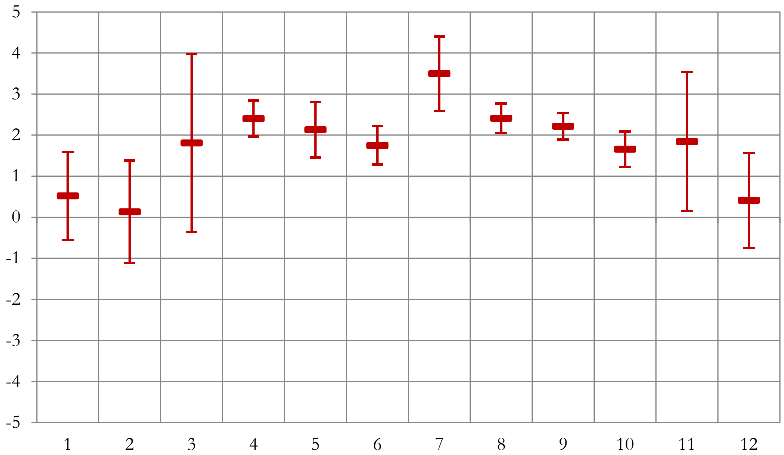
(c) MES_{KE}

Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for the 12 manufacturing industries in Switzerland. We use the translog cost function as functional form.

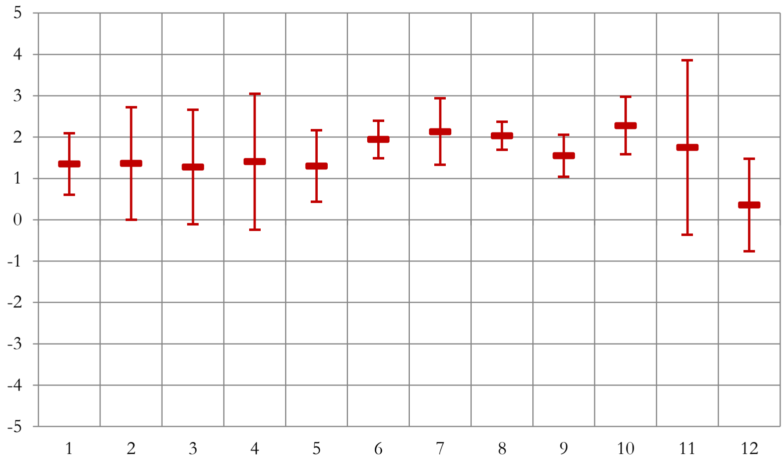
Figure 13: Morishima elasticities of Swiss manufacturing industries (II)



(d) MES_{EK}



(e) MES_{KL}

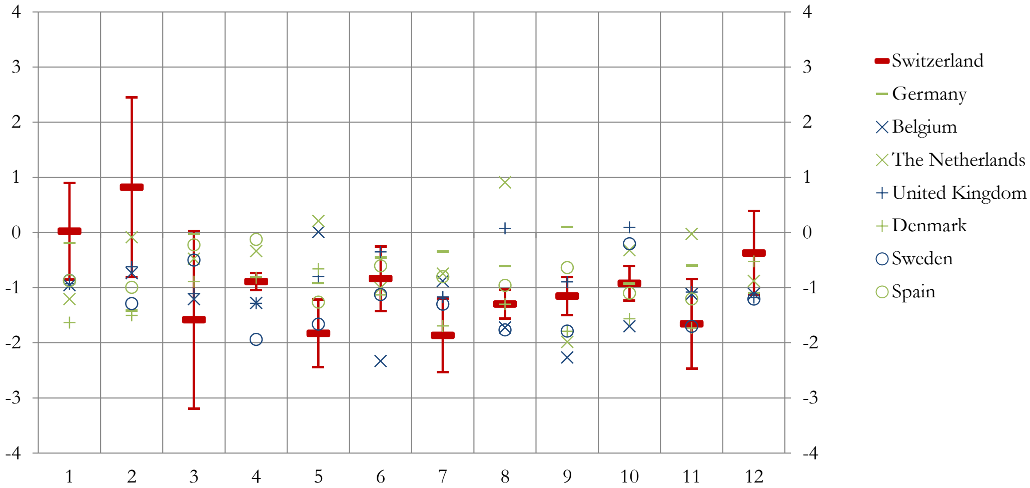


(f) MES_{LK}

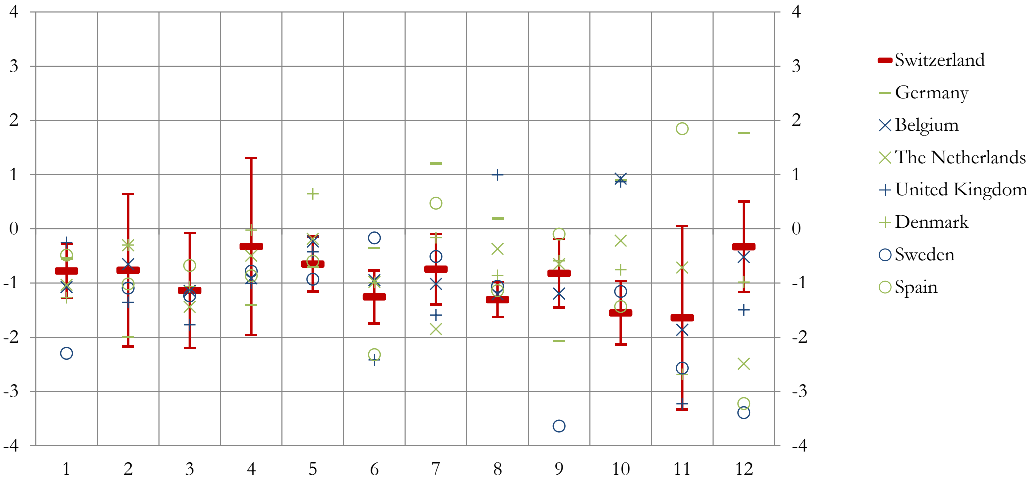
Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for the 12 manufacturing industries in Switzerland. We use the translog cost function as functional form.

A.5.2 Comparison to other Sectoral Country Estimates

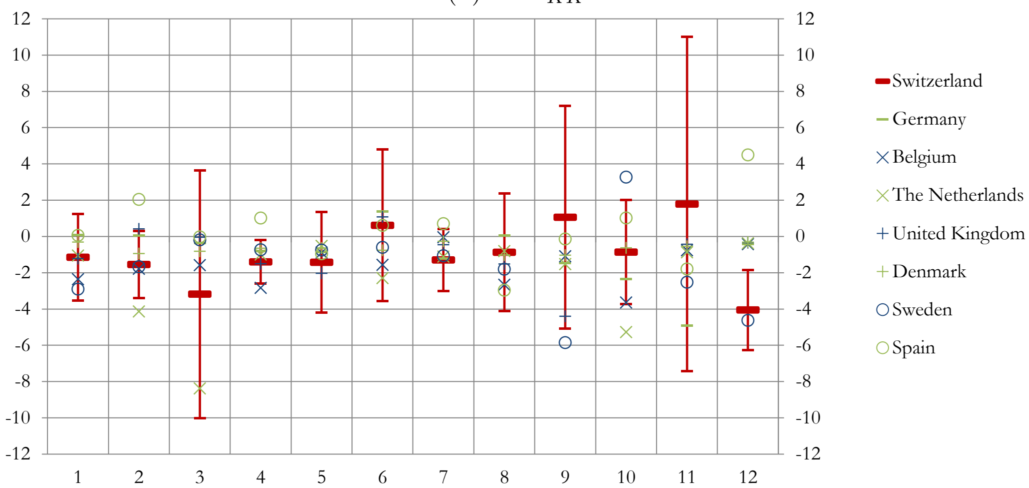
Figure 14: Country comparison of own-price elasticities



(a) CPE_{LL}



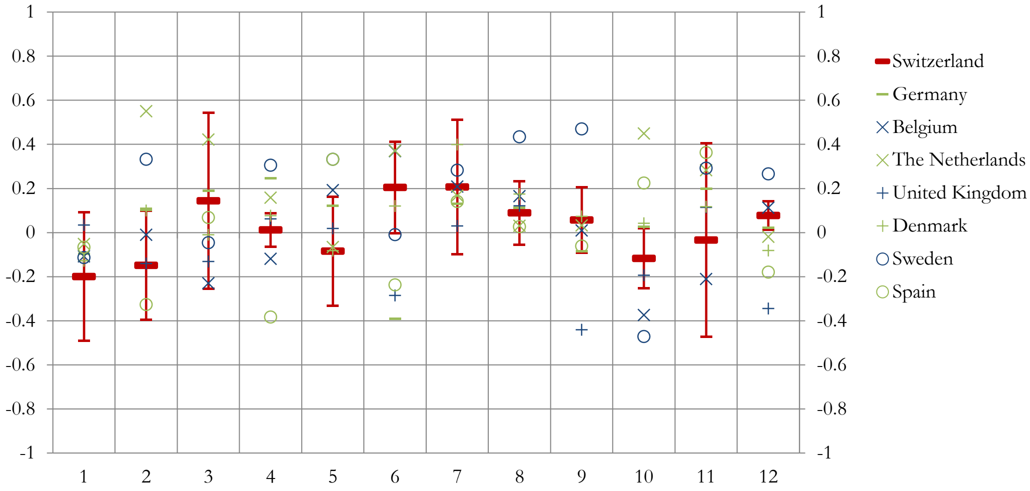
(b) CPE_{KK}



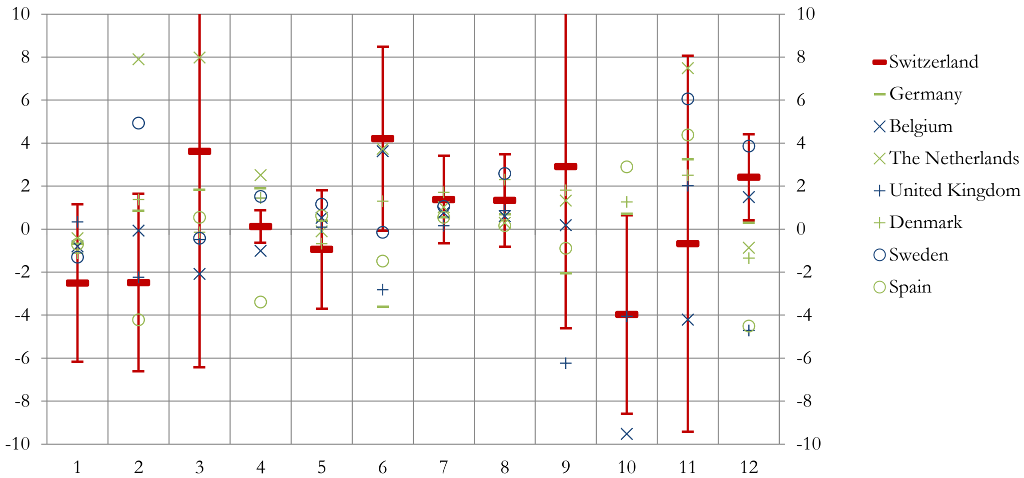
(c) CPE_{EE}

Notes: Figures display the point estimates of all countries and additionally the 95 % confidence interval of the elasticities for Switzerland. We use the translog cost function as functional form.

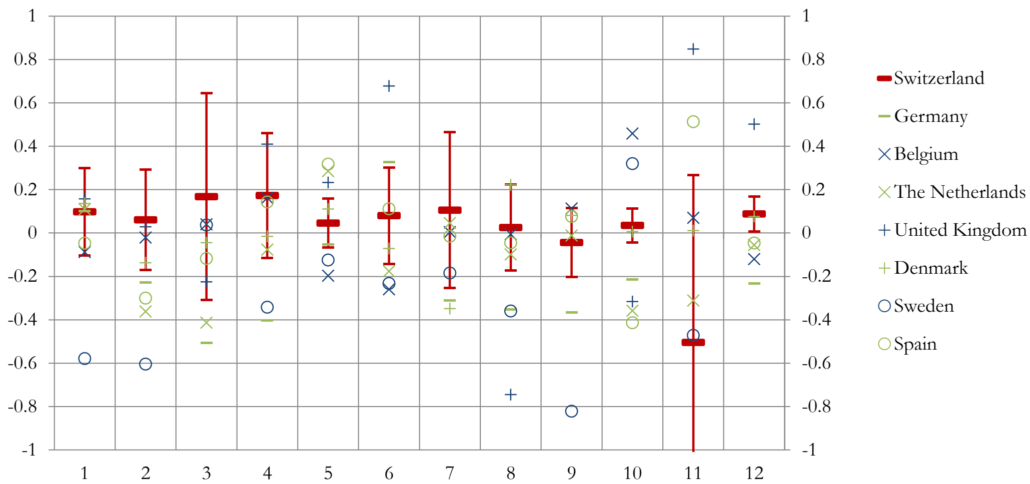
Figure 15: Country comparison of cross-price elasticities (I)



(a) CPE_{LE}



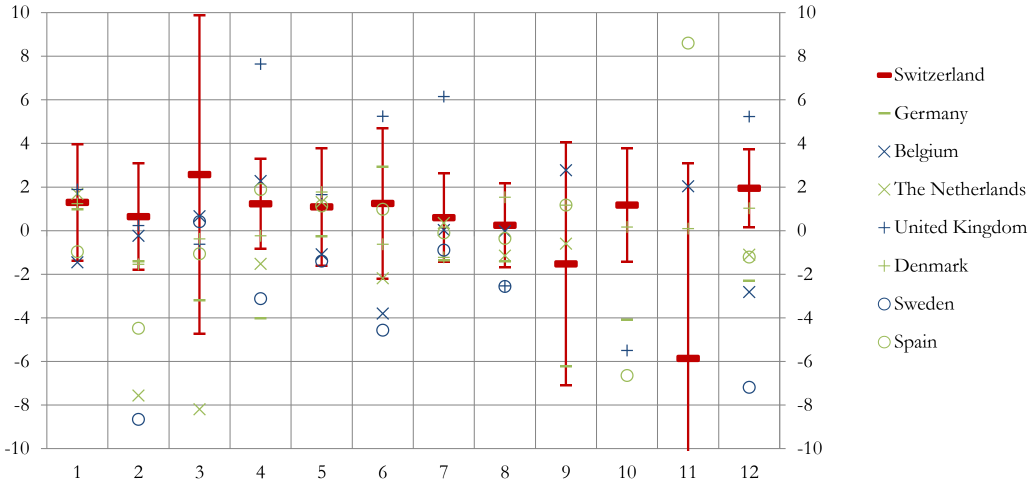
(b) CPE_{EL}



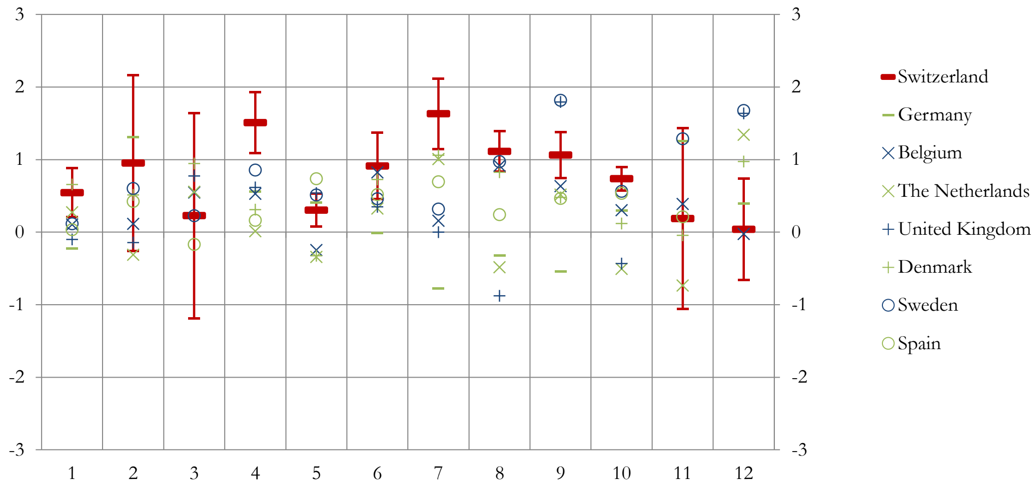
(c) CPE_{KE}

Notes: Figures display the point estimates of all countries and additionally the 95 % confidence interval of the elasticities for Switzerland. We use the translog cost function as functional form.

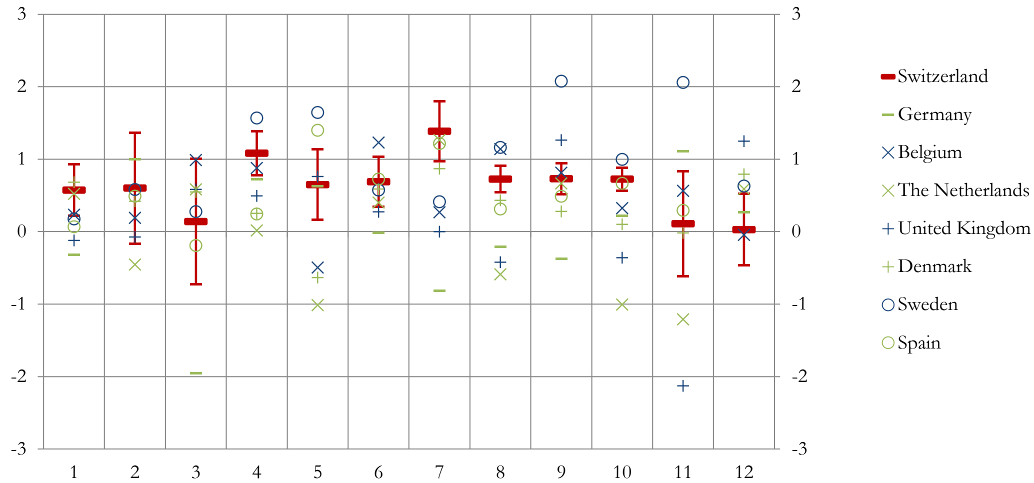
Figure 15: Country comparison of cross-price elasticities (II)



(d) CPE_{EK}



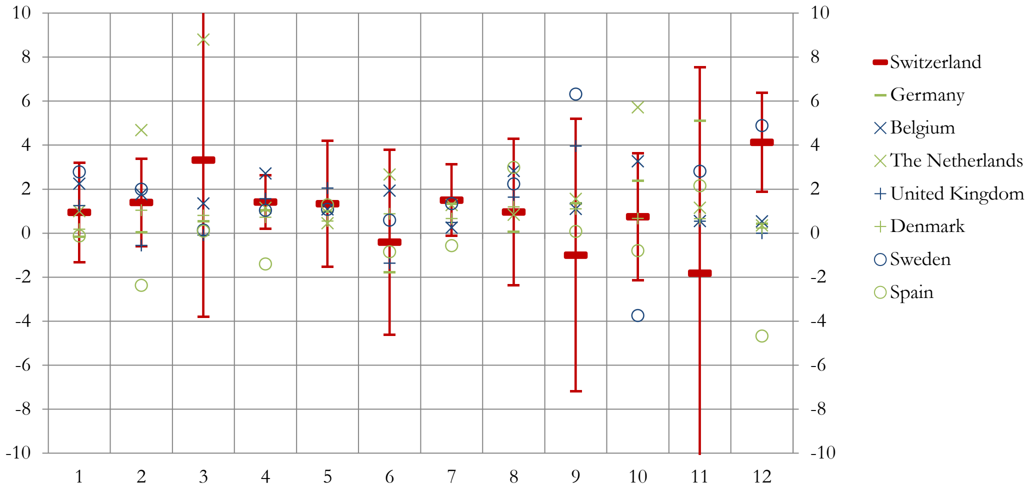
(e) CPE_{KL}



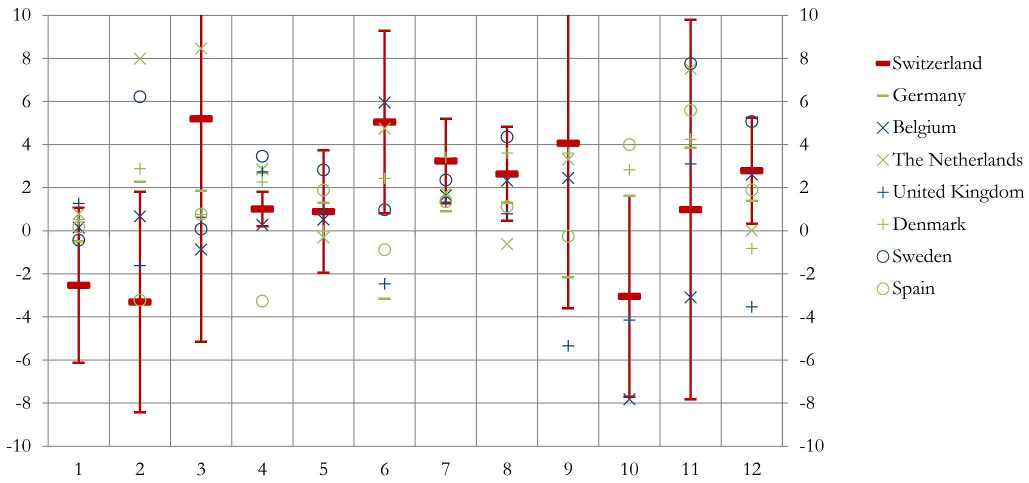
(f) CPE_{LK}

Notes: Figures display the point estimates of all countries and additionally the 95 % confidence interval of the elasticities for Switzerland. We use the translog cost function as functional form.

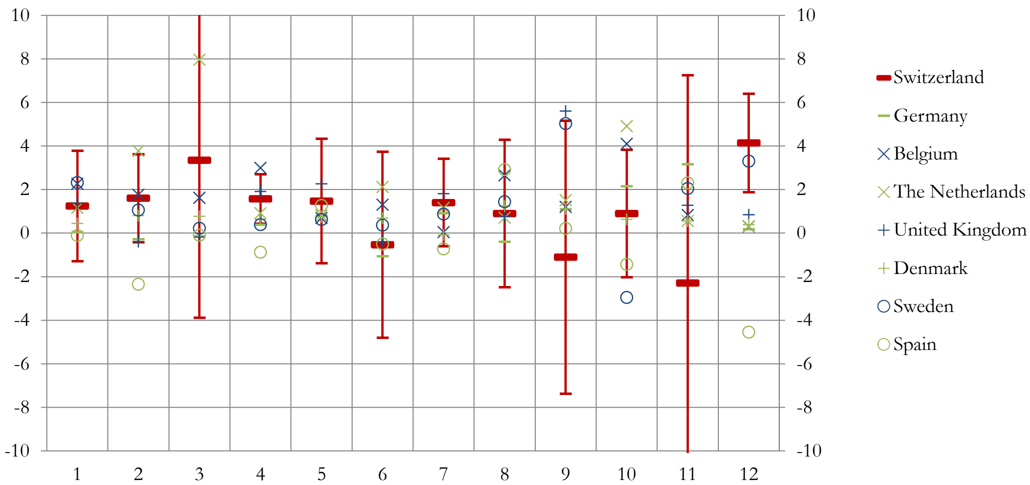
Figure 16: Country comparison of Morishima elasticities (I)



(a) MES_{LE}



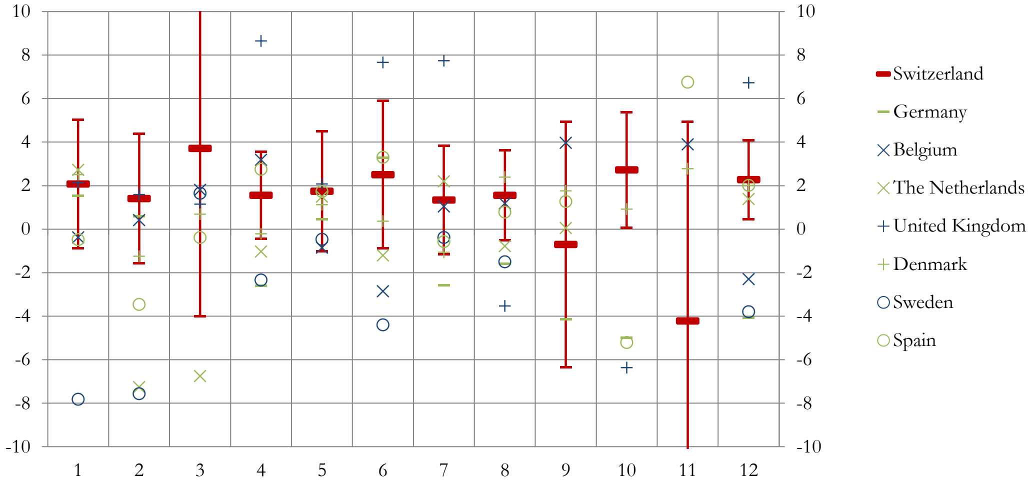
(b) MES_{EL}



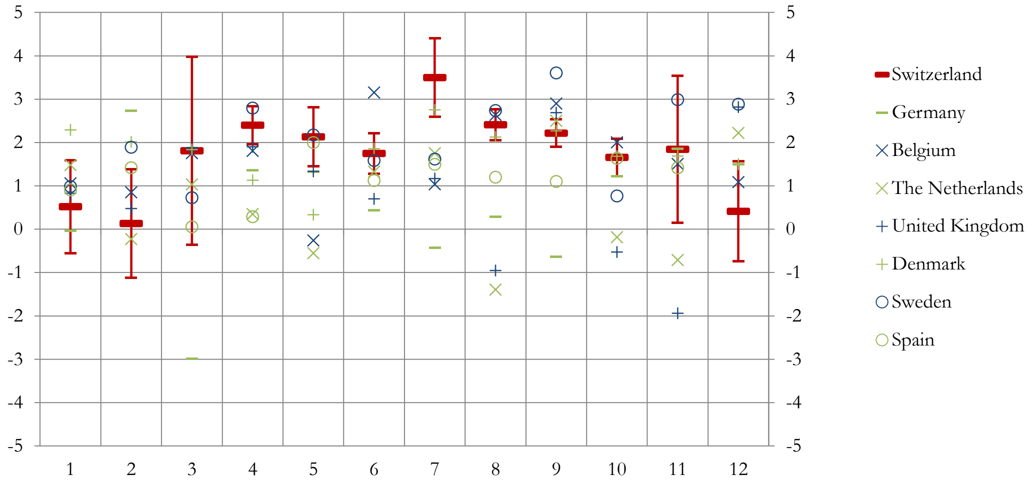
(c) MES_{KE}

Notes: Figures display the point estimates of all countries and additionally the 95 % confidence interval of the elasticities for Switzerland. We use the translog cost function as functional form.

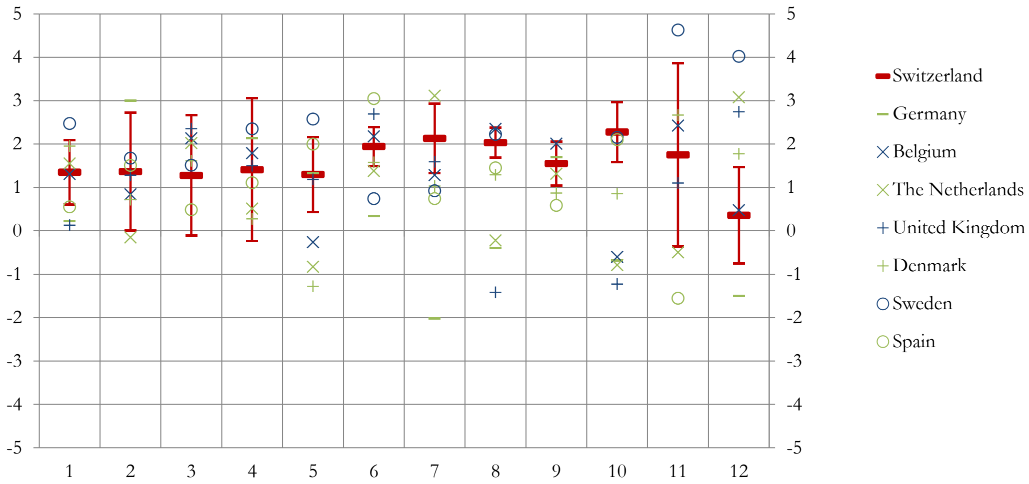
Figure 16: Country comparison of Morishima elasticities (II)



(d) MES_{EK}



(e) MES_{KL}



(f) MES_{LK}

Notes: Figures display the point estimates of all countries and additionally the 95 % confidence interval of the elasticities for Switzerland. We use the translog cost function as functional form.

Table 25: Own-price elasticities of labor (CPE_{LL}), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	0.02	-0.19	-0.96*	-1.21*	-0.93*	-1.63*	-0.87*	-0.87*
	(0.45)	(0.33)	(0.13)	(0.16)	(0.10)	(0.24)	(0.27)	(0.21)
2	0.82	-1.42*	-0.74*	-0.08	-0.62	-1.50*	-1.29*	-0.99*
	(0.83)	(0.18)	(0.06)	(0.27)	(0.45)	(0.15)	(0.13)	(0.17)
3	-1.58	-0.03	-1.21*	-0.48*	-1.11*	-0.89*	-0.50*	-0.22
	(0.82)	(0.23)	(0.16)	(0.24)	(0.35)	(0.12)	(0.23)	(0.15)
4	-0.89*	-0.80*	-1.28*	-0.34	-1.28*	-0.82*	-1.94*	-0.13
	(0.08)	(0.20)	(0.40)	(0.39)	(0.25)	(0.07)	(0.25)	(0.68)
5	-1.83*	-0.91*	0.01	0.21	-0.80*	-0.66	-1.66*	-1.26*
	(0.31)	(0.38)	(0.80)	(0.30)	(0.12)	(0.77)	(0.19)	(0.17)
6	-0.84*	-0.45	-2.33*	-1.00*	-0.35	-1.13*	-1.13*	-0.60
	(0.30)	(0.41)	(0.37)	(0.31)	(0.21)	(0.21)	(0.39)	(0.38)
7	-1.87*	-0.35	-0.88*	-0.75*	-1.17*	-1.69*	-1.30*	-0.80*
	(0.34)	(0.32)	(0.16)	(0.26)	(0.17)	(0.27)	(0.48)	(0.14)
8	-1.30*	-0.61*	-1.72*	0.91*	0.07	-1.30*	-1.77*	-0.96*
	(0.13)	(0.21)	(0.37)	(0.20)	(0.23)	(0.34)	(0.30)	(0.35)
9	-1.15*	0.10	-2.27*	-1.98*	-0.89*	-1.79*	-1.79*	-0.64
	(0.18)	(0.25)	(0.46)	(0.51)	(0.26)	(0.22)	(0.22)	(0.42)
10	-0.92*	-0.93*	-1.70*	-0.32	0.09	-1.56*	-0.20	-1.10*
	(0.16)	(0.38)	(0.35)	(0.29)	(0.37)	(0.59)	(0.55)	(0.26)
11	-1.66*	-0.60*	-1.12*	-0.03	-1.08*	-1.73*	-1.70*	-1.20*
	(0.41)	(0.19)	(0.21)	(0.95)	(0.27)	(0.35)	(0.19)	(0.38)
12	-0.37	-1.10*	-1.11*	-0.88*	-1.18*	-0.52	-1.21*	-6.40*
	(0.39)	(0.18)	(0.14)	(0.35)	(0.17)	(0.49)	(0.23)	(0.80)
Concavity Test:								
Negative[a]	**10 (8)**	**11 (7)**	**11 (11)**	**10 (6)**	**10 (8)**	**12 (10)**	**12 (11)**	**12 (8)**
Positive[a]	**2 (0)**	**1 (0)**	**1 (0)**	**2 (1)**	**2 (0)**	**0 (0)**	**0 (0)**	**0 (0)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

Table 26: Own-price elasticities of capital (CPE_{KK}), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	-0.78*	-0.55	-1.08*	-1.03*	-0.25	-1.27*	-2.30*	-0.49
	(0.25)	(0.34)	(0.20)	(0.13)	(0.47)	(0.35)	(0.40)	(0.41)
2	-0.76	-2.00	-0.65*	-0.30	-1.36	-0.30	-1.09*	-1.02*
	(0.72)	(1.93)	(0.23)	(0.57)	(1.02)	(0.51)	(0.42)	(0.44)
3	-1.14*	10.30*	-1.14*	-1.44*	-1.77*	-1.07	-1.24	-0.68
	(0.54)	(1.76)	(0.19)	(0.58)	(0.76)	(0.56)	(0.77)	(0.58)
4	-0.33	-1.41*	-0.91*	-0.50*	-1.01*	-0.02	-0.78*	-0.87*
	(0.83)	(0.17)	(0.27)	(0.22)	(0.32)	(0.21)	(0.20)	(0.21)
5	-0.65*	-0.71*	-0.23	-0.19	-0.42	0.65*	-0.93*	-0.60
	(0.26)	(0.18)	(0.29)	(0.13)	(0.33)	(0.18)	(0.13)	(0.49)
6	-1.26*	-0.35	-0.95*	-0.98*	-2.42*	-0.99*	-0.17	-2.32*
	(0.25)	(0.60)	(0.47)	(0.38)	(0.45)	(0.25)	(0.81)	(0.43)
7	-0.75*	1.20*	-1.02*	-1.85*	-1.59*	-0.16	-0.51	0.47
	(0.33)	(0.39)	(0.19)	(0.59)	(0.49)	(0.40)	(0.46)	(0.28)
8	-1.31*	0.19	-1.21*	-0.37	1.00*	-0.86*	-1.06*	-1.14*
	(0.16)	(0.33)	(0.35)	(0.48)	(0.45)	(0.28)	(0.18)	(0.29)
9	-0.82*	-2.07*	-1.20*	-0.65	-6.37*	-0.59	-3.64*	-0.10
	(0.32)	(0.64)	(0.31)	(0.65)	(1.52)	(0.56)	(0.45)	(0.28)
10	-1.55*	0.90*	0.93*	-0.22	0.87	-0.76	-1.16	-1.43*
	(0.30)	(0.42)	(0.40)	(0.28)	(1.15)	(0.47)	(2.23)	(0.33)
11	-1.64	-10.65*	-1.86*	-0.71	-3.23	-2.69	-2.57*	1.85*
	(0.86)	(2.13)	(0.47)	(1.27)	(3.34)	(1.50)	(0.55)	(0.91)
12	-0.33	1.77	-0.52*	-2.49*	-1.50*	-0.98*	-3.39	-3.22*
	(0.43)	(1.00)	(0.20)	(0.95)	(0.28)	(0.35)	(1.90)	(0.54)
Concavity Test:								
Negative[a]	**12 (8)**	**7 (4)**	**11 (10)**	**12 (6)**	**10 (6)**	**11 (4)**	**12 (7)**	**10 (6)**
Positive[a]	**0 (0)**	**5 (3)**	**1 (1)**	**0 (0)**	**2 (1)**	**1 (1)**	**0 (0)**	**2 (1)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

Table 27: Own-price elasticities of energy (CPE_{EE}), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	-1.15	0.07	-2.36	-1.05*	-1.22	-0.31	-2.90*	0.06
	(1.21)	(0.72)	(1.26)	(0.53)	(1.69)	(0.41)	(1.02)	(2.30)
2	-1.54	0.06	-1.78*	-4.13	0.42	-0.94	-1.66*	2.05
	(0.95)	(0.66)	(0.45)	(3.89)	(0.50)	(0.96)	(0.59)	(2.23)
3	-3.18	-0.36	-1.58*	-8.38*	-0.04	-0.82*	-0.19	-0.02
	(3.49)	(0.60)	(0.70)	(3.80)	(0.98)	(0.28)	(0.22)	(0.58)
4	-1.40*	-0.79	-2.83*	-0.99	-1.50	-0.65	-0.73*	1.02
	(0.61)	(1.61)	(0.91)	(0.56)	(1.21)	(0.59)	(0.30)	(2.29)
5	-1.42	-0.85	-0.89*	-0.52	-2.03	-0.63*	-0.75	-0.95*
	(1.41)	(0.46)	(0.45)	(0.47)	(1.46)	(0.21)	(0.46)	(0.36)
6	0.61	1.39	-1.56	-2.29*	1.08	-0.76	-0.60	0.61
	(2.14)	(0.81)	(0.90)	(0.87)	(0.67)	(0.48)	(0.48)	(0.88)
7	-1.29	-1.21*	-0.04	-1.11*	-0.45	-0.27	-1.06*	0.71
	(0.87)	(0.47)	(0.35)	(0.44)	(1.34)	(0.40)	(0.47)	(0.90)
8	-0.87	0.05	-2.66*	-0.81	-1.52	-1.02	-1.80*	-2.96*
	(1.65)	(0.89)	(0.55)	(0.85)	(1.48)	(0.61)	(0.38)	(0.81)
9	1.06	-1.45	-1.09	-1.52*	-4.40*	-1.03	-5.85*	-0.14
	(3.13)	(0.88)	(1.59)	(0.55)	(0.86)	(0.61)	(1.19)	(1.64)
10	-0.86	-2.36	-3.64	-5.27*	-17.11	-0.63	3.27	1.02
	(1.47)	(1.55)	(3.24)	(2.19)	(10.71)	(0.33)	(3.75)	(1.43)
11	1.79	-4.90*	-0.76	-0.87	-0.43	-0.54	-2.52*	-1.79
	(4.70)	(2.08)	(1.17)	(1.63)	(1.15)	(0.37)	(1.27)	(4.24)
12	-4.05*	-0.40	-0.42	-0.37	-0.34	-0.31	-4.62	4.50*
	(1.13)	(0.24)	(0.88)	(1.81)	(0.99)	(0.27)	(2.45)	(2.29)
Concavity Test:								
Negative[a]	**9 (2)**	**8 (2)**	**12 (5)**	**12 (6)**	**10 (1)**	**12 (2)**	**11 (7)**	**5 (2)**
Positive[a]	**3 (0)**	**4 (0)**	**0 (0)**	**0 (0)**	**2 (0)**	**0 (0)**	**1 (0)**	**7 (1)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

Table 28: Cross-price elasticities, energy price on labor input (CPE_{LE}), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	-0.20	-0.10	-0.11	-0.05	0.03	-0.13	-0.11	-0.07
	(0.15)	(0.14)	(0.09)	(0.06)	(0.09)	(0.08)	(0.10)	(0.14)
2	-0.15	0.11	-0.01	0.55*	-0.14*	0.10	0.33*	-0.33*
	(0.13)	(0.09)	(0.05)	(0.18)	(0.03)	(0.06)	(0.05)	(0.12)
3	0.14	0.19*	-0.23*	0.42*	-0.13	-0.01	-0.05	0.07
	(0.20)	(0.09)	(0.08)	(0.16)	(0.22)	(0.03)	(0.06)	(0.07)
4	0.01	0.25	-0.12	0.16	0.06	0.08*	0.31*	-0.38
	(0.04)	(0.13)	(0.13)	(0.08)	(0.06)	(0.03)	(0.09)	(0.35)
5	-0.08	0.12	0.19	-0.07	0.02	-0.08	0.33*	0.33*
	(0.13)	(0.11)	(0.16)	(0.13)	(0.17)	(0.08)	(0.06)	(0.06)
6	0.20	-0.39*	0.37*	0.37*	-0.29*	0.12	-0.01	-0.24
	(0.11)	(0.11)	(0.13)	(0.11)	(0.06)	(0.07)	(0.06)	(0.20)
7	0.21	0.13	0.21*	0.17	0.03	0.40*	0.28*	0.14
	(0.16)	(0.12)	(0.05)	(0.11)	(0.13)	(0.10)	(0.13)	(0.11)
8	0.09	0.11	0.17	0.03	0.12	0.17*	0.43*	0.03
	(0.07)	(0.12)	(0.09)	(0.09)	(0.11)	(0.06)	(0.12)	(0.17)
9	0.06	-0.08	0.01	0.03	-0.44*	0.07*	0.47*	-0.06
	(0.08)	(0.05)	(0.08)	(0.03)	(0.09)	(0.03)	(0.08)	(0.15)
10	-0.12	0.03	-0.37*	0.45*	-0.19	0.04	-0.47*	0.22
	(0.07)	(0.09)	(0.16)	(0.11)	(0.18)	(0.05)	(0.14)	(0.12)
11	-0.03	0.20*	-0.21*	0.28	0.11	0.12*	0.29*	0.36
	(0.22)	(0.10)	(0.07)	(0.17)	(0.11)	(0.06)	(0.08)	(0.27)
12	0.08*	0.02	0.11*	-0.02	-0.34*	-0.08	0.27	-0.18
	(0.03)	(0.04)	(0.05)	(0.05)	(0.08)	(0.06)	(0.15)	(0.18)
Substitutes or Complements:								
Substitutes[a]	**7 (1)**	**9 (2)**	**6 (3)**	**9 (4)**	**6 (0)**	**8 (5)**	**8 (7)**	**6 (1)**
Complements[a]	**5 (0)**	**3 (1)**	**6 (3)**	**3 (0)**	**6 (4)**	**4 (0)**	**4 (1)**	**6 (1)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

Table 29: Cross-price elasticities, labor price on energy input (CPE_{EL}), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	-2.51	-0.67	-0.80	-0.42	0.34	-1.12	-1.30	-0.70
	(1.87)	(1.00)	(0.65)	(0.52)	(0.92)	(0.67)	(1.14)	(1.48)
2	-2.49	0.87	-0.07	7.90*	-2.24*	1.38	4.93*	-4.22*
	(2.11)	(0.69)	(0.36)	(2.54)	(0.54)	(0.77)	(0.68)	(1.59)
3	3.62	1.84*	-2.08*	7.98*	-0.48	-0.15	-0.42	0.55
	(5.12)	(0.85)	(0.75)	(3.00)	(0.80)	(0.47)	(0.57)	(0.57)
4	0.12	1.89	-1.01	2.51	1.45	1.44*	1.52*	-3.39
	(0.39)	(0.97)	(1.07)	(1.33)	(1.34)	(0.54)	(0.46)	(3.08)
5	-0.94	0.39	0.53	-0.10	0.09	-0.67	1.16*	0.62*
	(1.41)	(0.35)	(0.43)	(0.20)	(0.85)	(0.66)	(0.21)	(0.12)
6	4.21	-3.60*	3.62*	3.74*	-2.82*	1.30	-0.15	-1.48
	(2.18)	(0.97)	(1.25)	(1.08)	(0.61)	(0.74)	(0.93)	(1.26)
7	1.38	0.55	0.77*	1.02	0.16	1.71*	1.06*	0.55
	(1.04)	(0.51)	(0.16)	(0.69)	(0.71)	(0.42)	(0.49)	(0.42)
8	1.34	0.69	0.60	0.29	0.86	2.31*	2.59*	0.16
	(1.10)	(0.77)	(0.31)	(0.89)	(0.78)	(0.76)	(0.73)	(1.01)
9	2.91	-2.06	0.19	1.33	-6.23*	1.81*	12.14*	-0.89
	(3.84)	(1.20)	(1.53)	(1.36)	(1.32)	(0.74)	(2.04)	(2.19)
10	-3.97	0.71	-9.52*	12.85*	-4.05	1.27	-23.68*	2.90
	(2.35)	(2.44)	(4.16)	(3.25)	(3.81)	(1.58)	(7.27)	(1.53)
11	-0.67	3.26*	-4.21*	7.49	2.02	2.51*	6.06*	4.38
	(4.46)	(1.56)	(1.47)	(4.48)	(2.04)	(1.24)	(1.75)	(3.32)
12	2.42*	0.30	1.49*	-0.87	-4.71*	-1.35	3.86	-4.51
	(1.02)	(0.61)	(0.72)	(2.16)	(1.09)	(1.04)	(2.17)	(4.56)
Substitutes or Complements:								
Substitutes[a]	**7 (1)**	**9 (2)**	**6 (3)**	**9 (4)**	**6 (0)**	**8 (5)**	**8 (7)**	**6 (1)**
Complements[a]	**5 (0)**	**3 (1)**	**6 (3)**	**3 (0)**	**6 (4)**	**4 (0)**	**4 (1)**	**6 (1)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

Table 30: Cross-price elasticities, energy price on capital input (CPE$_{KE}$), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	0.10	0.10	-0.09	0.11*	0.16	0.14*	-0.58*	-0.05
	(0.10)	(0.10)	(0.07)	(0.04)	(0.21)	(0.07)	(0.11)	(0.11)
2	0.06	-0.23	-0.02	-0.36	0.03	-0.14	-0.60*	-0.30
	(0.12)	(0.33)	(0.03)	(0.27)	(0.14)	(0.14)	(0.08)	(0.18)
3	0.17	-0.51	0.04	-0.41	-0.23	-0.04	0.04	-0.12
	(0.24)	(0.30)	(0.07)	(0.24)	(0.36)	(0.10)	(0.09)	(0.15)
4	0.17	-0.40*	0.16	-0.08	0.41*	-0.02	-0.34*	0.14
	(0.15)	(0.11)	(0.09)	(0.06)	(0.07)	(0.06)	(0.06)	(0.13)
5	0.05	-0.05	-0.20*	0.29*	0.23	0.11*	-0.12*	0.32*
	(0.06)	(0.08)	(0.10)	(0.09)	(0.19)	(0.04)	(0.05)	(0.11)
6	0.08	0.33*	-0.26*	-0.18	0.68*	-0.07	-0.23*	0.11
	(0.11)	(0.16)	(0.12)	(0.11)	(0.13)	(0.08)	(0.10)	(0.12)
7	0.11	-0.31	0.00	0.05	1.36*	-0.35*	-0.18	-0.01
	(0.18)	(0.18)	(0.07)	(0.09)	(0.20)	(0.16)	(0.10)	(0.11)
8	0.03	-0.35	-0.01	-0.10	-0.74*	0.22*	-0.36*	-0.05
	(0.10)	(0.19)	(0.12)	(0.11)	(0.31)	(0.11)	(0.09)	(0.14)
9	-0.04	-0.37*	0.11	-0.01	1.20*	0.08	-0.82*	0.08
	(0.08)	(0.15)	(0.08)	(0.03)	(0.29)	(0.10)	(0.11)	(0.13)
10	0.04	-0.21	0.46*	-0.36*	-0.32	0.01	0.32	-0.41*
	(0.04)	(0.12)	(0.16)	(0.08)	(0.53)	(0.03)	(0.21)	(0.09)
11	-0.50	-1.73*	0.07	-0.31*	0.85*	0.01	-0.47*	0.51
	(0.39)	(0.47)	(0.07)	(0.14)	(0.42)	(0.13)	(0.09)	(0.36)
12	0.09*	-0.23*	-0.12*	-0.06	0.50*	0.08	-1.32*	-0.05
	(0.04)	(0.12)	(0.06)	(0.25)	(0.11)	(0.06)	(0.67)	(0.15)
Substitutes or Complements:								
Substitutes[a]	**10 (1)**	**2 (1)**	**6 (1)**	**3 (2)**	**9 (6)**	**7 (3)**	**2 (0)**	**5 (1)**
Complements[a]	**2 (0)**	**10 (4)**	**6 (3)**	**9 (2)**	**3 (1)**	**5 (1)**	**10 (9)**	**7 (1)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

Table 31: Cross-price elasticities, capital price on energy input (CPE_{EK}), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	1.30	0.99	-1.45	1.70*	1.89	1.24*	-10.11*	-0.97
	(1.36)	(0.93)	(1.20)	(0.66)	(2.56)	(0.63)	(1.94)	(2.34)
2	0.64	-1.40	-0.24	-7.56	0.24	-1.54	-8.65*	-4.48
	(1.25)	(2.05)	(0.39)	(5.57)	(1.14)	(1.63)	(1.18)	(2.68)
3	2.57	-3.20	0.66	-8.19	-0.62	-0.38	0.41	-1.06
	(3.73)	(1.86)	(1.19)	(4.70)	(1.00)	(0.83)	(0.96)	(1.35)
4	1.23	-4.01*	2.28	-1.52	7.64*	-0.23	-3.12*	1.89
	(1.05)	(1.05)	(1.32)	(1.11)	(1.33)	(0.86)	(0.55)	(1.77)
5	1.09	-0.26	-1.08*	1.31*	1.65	1.77*	-1.40*	1.13*
	(1.38)	(0.40)	(0.53)	(0.41)	(1.31)	(0.56)	(0.57)	(0.38)
6	1.25	2.94*	-3.80*	-2.18	5.25*	-0.62	-4.56*	0.98
	(1.76)	(1.48)	(1.72)	(1.36)	(0.98)	(0.74)	(1.97)	(1.05)
7	0.60	-1.37	0.03	0.35	6.15*	-1.22*	-0.89	-0.10
	(1.04)	(0.78)	(0.45)	(0.71)	(0.91)	(0.56)	(0.50)	(0.78)
8	0.25	-1.40	-0.02	-1.15	-2.53*	1.53*	-2.56*	-0.36
	(0.98)	(0.73)	(0.54)	(1.32)	(1.06)	(0.74)	(0.64)	(1.10)
9	-1.52	-6.21*	2.77	-0.60	11.99*	1.17	-24.21*	1.17
	(2.84)	(2.50)	(1.91)	(1.63)	(2.88)	(1.46)	(3.36)	(2.01)
10	1.17	-4.09	12.52*	-20.35*	-5.49	0.17	28.49	-6.64*
	(1.32)	(2.22)	(4.33)	(4.42)	(9.23)	(0.87)	(18.94)	(1.51)
11	-5.86	-25.02*	2.04	-13.54*	10.60*	0.09	-15.63*	8.60
	(4.57)	(6.82)	(2.08)	(6.13)	(5.21)	(1.13)	(2.88)	(6.01)
12	1.95*	-2.30*	-2.81*	-1.10	5.23*	1.03	-7.18*	-1.21
	(0.91)	(1.15)	(1.43)	(4.91)	(1.18)	(0.80)	(3.65)	(3.87)
Substitutes or Complements:								
Substitutes[a]	**10 (1)**	**2 (1)**	**6 (1)**	**3 (2)**	**9 (6)**	**7 (3)**	**2 (0)**	**5 (1)**
Complements[a]	**2 (0)**	**10 (4)**	**6 (3)**	**9 (2)**	**3 (1)**	**5 (1)**	**10 (9)**	**7 (1)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

Table 32: Cross-price elasticities, labor price on capital input (CPE_{KL}), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	0.54*	-0.23	0.10	0.27*	-0.10	0.66*	0.12	0.03
	(0.17)	(0.23)	(0.07)	(0.10)	(0.18)	(0.20)	(0.19)	(0.18)
2	0.95	1.31*	0.11*	-0.31	-0.14	0.51*	0.60*	0.42*
	(0.62)	(0.39)	(0.05)	(0.25)	(0.52)	(0.16)	(0.18)	(0.21)
3	0.23	-3.02*	0.55*	0.56*	0.77*	0.95*	0.23	-0.17
	(0.72)	(0.63)	(0.10)	(0.26)	(0.37)	(0.25)	(0.25)	(0.20)
4	1.51*	0.56*	0.53*	0.01	0.62*	0.31*	0.86*	0.16
	(0.22)	(0.12)	(0.23)	(0.23)	(0.27)	(0.10)	(0.15)	(0.27)
5	0.30*	0.41*	-0.25	-0.34*	0.54*	-0.33	0.51*	0.74*
	(0.12)	(0.15)	(0.31)	(0.10)	(0.12)	(0.20)	(0.07)	(0.16)
6	0.91*	-0.01	0.82*	0.33	0.35	0.73*	0.46	0.52
	(0.23)	(0.38)	(0.31)	(0.24)	(0.23)	(0.21)	(0.26)	(0.26)
7	1.63*	-0.78*	0.16*	1.01*	0.00	1.06*	0.32	0.69*
	(0.25)	(0.26)	(0.06)	(0.14)	(0.23)	(0.27)	(0.32)	(0.11)
8	1.11*	-0.32	0.92*	-0.48*	-0.88*	0.83*	0.97*	0.24
	(0.14)	(0.27)	(0.31)	(0.25)	(0.32)	(0.32)	(0.20)	(0.23)
9	1.06*	-0.54	0.63*	0.52	1.79*	0.48*	1.82*	0.47
	(0.16)	(0.29)	(0.19)	(0.44)	(0.59)	(0.14)	(0.25)	(0.27)
10	0.74*	0.30	0.30	-0.51*	-0.43	0.12	0.56	0.54*
	(0.08)	(0.38)	(0.31)	(0.16)	(0.62)	(0.19)	(0.80)	(0.18)
11	0.19	1.26*	0.39*	-0.74	-3.02*	-0.04	1.29*	0.21
	(0.64)	(0.36)	(0.14)	(0.77)	(0.88)	(0.64)	(0.19)	(0.38)
12	0.04	0.40	-0.03	1.34*	1.64*	0.97*	1.68	3.92*
	(0.35)	(0.32)	(0.08)	(0.59)	(0.19)	(0.22)	(0.95)	(0.40)
Substitutes or Complements:								
Substitutes[a]	**12 (8)**	**6 (4)**	**10 (8)**	**7 (4)**	**7 (5)**	**10 (9)**	**12 (6)**	**11 (5)**
Complements[a]	**0 (0)**	**6 (2)**	**2 (0)**	**5 (3)**	**5 (2)**	**2 (0)**	**0 (0)**	**1 (0)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

Table 33: Cross-price elasticities, capital price on labor input (CPE_{LK}), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	0.57*	-0.32	0.23	0.52*	-0.12	0.68*	0.18	0.07
	(0.18)	(0.32)	(0.16)	(0.19)	(0.22)	(0.21)	(0.29)	(0.35)
2	0.60	1.00*	0.19*	-0.45	-0.07	0.42*	0.58*	0.49*
	(0.39)	(0.30)	(0.09)	(0.36)	(0.27)	(0.13)	(0.17)	(0.24)
3	0.14	-1.96*	0.99*	0.58*	0.58*	0.55*	0.28	-0.19
	(0.44)	(0.41)	(0.18)	(0.27)	(0.28)	(0.14)	(0.31)	(0.23)
4	1.08*	0.73*	0.88*	0.02	0.49*	0.25*	1.57*	0.24
	(0.15)	(0.16)	(0.39)	(0.29)	(0.22)	(0.08)	(0.28)	(0.40)
5	0.65*	0.62*	-0.49	-1.01*	0.76*	-0.63	1.64*	1.40*
	(0.25)	(0.22)	(0.63)	(0.28)	(0.17)	(0.39)	(0.22)	(0.30)
6	0.69*	-0.01	1.23*	0.40	0.27	0.59*	0.57	0.73
	(0.18)	(0.37)	(0.47)	(0.29)	(0.18)	(0.17)	(0.33)	(0.37)
7	1.39*	-0.82*	0.27*	1.26*	0.00	0.87*	0.41	1.22*
	(0.21)	(0.27)	(0.10)	(0.17)	(0.20)	(0.22)	(0.41)	(0.19)
8	0.73*	-0.21	1.14*	-0.59*	-0.42*	0.43*	1.16*	0.31
	(0.09)	(0.17)	(0.38)	(0.30)	(0.15)	(0.17)	(0.24)	(0.29)
9	0.73*	-0.37	0.81*	0.67	1.26*	0.28*	2.08*	0.49
	(0.11)	(0.20)	(0.24)	(0.57)	(0.42)	(0.08)	(0.29)	(0.28)
10	0.73*	0.22	0.32	-1.01*	-0.36	0.10	1.00	0.67*
	(0.08)	(0.28)	(0.34)	(0.32)	(0.51)	(0.16)	(1.42)	(0.22)
11	0.11	1.11*	0.56*	-1.21	-2.13*	-0.02	2.06*	0.29
	(0.37)	(0.32)	(0.20)	(1.26)	(0.62)	(0.25)	(0.31)	(0.52)
12	0.03	0.27	-0.04	0.59*	1.25*	0.79*	0.63	4.11*
	(0.25)	(0.22)	(0.15)	(0.26)	(0.14)	(0.18)	(0.36)	(0.42)
Substitutes or Complements:								
Substitutes[a]	**12 (8)**	**6 (4)**	**10 (8)**	**7 (4)**	**7 (5)**	**10 (9)**	**12 (6)**	**11 (5)**
Complements[a]	**0 (0)**	**6 (2)**	**2 (0)**	**5 (3)**	**5 (2)**	**2 (0)**	**0 (0)**	**1 (0)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

Table 34: Morishima elasticities, energy price on labor intensity (MES_{LE}), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	0.95	-0.17	2.25	1.00	1.25	0.18	2.79*	-0.13
	(1.15)	(0.65)	(1.27)	(0.55)	(1.68)	(0.39)	(1.04)	(2.23)
2	1.40	0.05	1.77*	4.68	-0.56	1.04	2.00*	-2.37
	(1.01)	(0.73)	(0.47)	(3.94)	(0.51)	(0.96)	(0.59)	(2.26)
3	3.32	0.55	1.35	8.80*	-0.09	0.81*	0.14	0.09
	(3.63)	(0.66)	(0.69)	(3.83)	(1.03)	(0.30)	(0.24)	(0.54)
4	1.41*	1.04	2.71*	1.15	1.56	0.72	1.04*	-1.40
	(0.62)	(1.59)	(0.90)	(0.61)	(1.25)	(0.58)	(0.38)	(2.56)
5	1.34	0.97*	1.08*	0.45	2.05	0.55*	1.08*	1.29*
	(1.46)	(0.45)	(0.40)	(0.45)	(1.62)	(0.23)	(0.49)	(0.38)
6	-0.41	-1.78*	1.93*	2.67*	-1.36	0.88	0.59	-0.85
	(2.14)	(0.83)	(0.92)	(0.84)	(0.70)	(0.47)	(0.48)	(1.01)
7	1.50	1.35*	0.25	1.28*	0.48	0.66	1.34*	-0.57
	(0.83)	(0.44)	(0.33)	(0.53)	(1.42)	(0.43)	(0.47)	(0.93)
8	0.96	0.06	2.83*	0.84	1.64	1.20	2.24*	2.99*
	(1.70)	(0.91)	(0.56)	(0.90)	(1.44)	(0.62)	(0.48)	(0.89)
9	-1.00	1.37	1.10	1.56*	3.96*	1.11	6.32*	0.08
	(3.16)	(0.87)	(1.60)	(0.56)	(0.79)	(0.61)	(1.24)	(1.58)
10	0.74	2.39	3.27	5.72*	16.91	0.67*	-3.74	-0.80
	(1.47)	(1.58)	(3.14)	(2.17)	(10.83)	(0.32)	(3.76)	(1.45)
11	-1.82	5.10*	0.55	1.15	0.54	0.66	2.81*	2.15
	(4.78)	(2.14)	(1.15)	(1.67)	(1.25)	(0.40)	(1.33)	(4.42)
12	4.13*	0.43	0.54	0.35	0.00	0.23	4.89	-4.68
	(1.14)	(0.23)	(0.85)	(1.82)	(0.97)	(0.31)	(2.55)	(2.39)
Substitutes or Complements:								
Substitutes[a]	**9 (2)**	**10 (3)**	**12 (5)**	**12 (5)**	**8 (1)**	**12 (3)**	**11 (8)**	**5 (2)**
Complements[a]	**3 (0)**	**2 (1)**	**0 (0)**	**0 (0)**	**4 (0)**	**0 (0)**	**1 (0)**	**7 (0)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

Table 35: Morishima elasticities, labor price on energy intensity (MES_{EL}), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	-2.53	-0.48	0.15	0.79	1.27	0.51	-0.43	0.17
	(1.83)	(0.88)	(0.66)	(0.60)	(0.92)	(0.62)	(1.21)	(1.41)
2	-3.31	2.28*	0.67	7.99*	-1.62	2.88*	6.22*	-3.22*
	(2.61)	(0.79)	(0.39)	(2.59)	(0.87)	(0.80)	(0.77)	(1.63)
3	5.20	1.87	-0.87	8.46*	0.63	0.75	0.08	0.77
	(5.28)	(1.03)	(0.75)	(3.05)	(0.95)	(0.51)	(0.73)	(0.54)
4	1.01*	2.70*	0.27	2.85	2.73	2.26*	3.46*	-3.26
	(0.40)	(0.94)	(1.18)	(1.48)	(1.54)	(0.52)	(0.66)	(3.62)
5	0.89	1.30*	0.52	-0.31	0.89	-0.01	2.83*	1.89*
	(1.45)	(0.63)	(0.61)	(0.33)	(0.95)	(0.67)	(0.38)	(0.13)
6	5.05*	-3.15*	5.95*	4.74*	-2.46*	2.43*	0.98	-0.88
	(2.16)	(1.01)	(1.42)	(1.14)	(0.66)	(0.73)	(1.20)	(1.55)
7	3.24*	0.90	1.65*	1.77	1.33	3.41*	2.36*	1.35*
	(1.00)	(0.56)	(0.24)	(0.90)	(0.82)	(0.52)	(0.60)	(0.45)
8	2.64*	1.29	2.33*	-0.62	0.79	3.61*	4.35*	1.12
	(1.11)	(0.83)	(0.60)	(0.98)	(0.84)	(0.99)	(0.98)	(1.18)
9	4.06	-2.15	2.45	3.31*	-5.34*	3.60*	13.93*	-0.25
	(3.91)	(1.31)	(1.37)	(1.52)	(1.21)	(0.82)	(2.19)	(2.03)
10	-3.05	1.63	-7.82*	13.17*	-4.15	2.83	-23.48*	4.00*
	(2.38)	(2.63)	(3.93)	(3.15)	(3.91)	(1.55)	(7.32)	(1.53)
11	0.98	3.86*	-3.09*	7.51	3.10	4.24*	7.76*	5.59
	(4.50)	(1.64)	(1.48)	(4.73)	(2.27)	(1.44)	(1.89)	(3.60)
12	2.79*	1.40*	2.61*	0.01	-3.53*	-0.82	5.07*	1.90
	(1.26)	(0.54)	(0.70)	(2.30)	(1.06)	(1.48)	(2.29)	(5.11)
Substitutes or Complements:								
Substitutes[a]	**9 (5)**	**9 (5)**	**9 (4)**	**10 (5)**	**7 (0)**	**10 (7)**	**10 (8)**	**8 (3)**
Complements[a]	**3 (0)**	**3 (1)**	**3 (2)**	**2 (0)**	**5 (3)**	**2 (0)**	**2 (1)**	**4 (1)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

Table 36: Morishima elasticities, energy price on labor intensity (MES_{KE}), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	1.24	0.03	2.27	1.16*	1.38	0.44	2.32*	-0.11
	(1.30)	(0.71)	(1.26)	(0.53)	(1.85)	(0.44)	(0.99)	(2.38)
2	1.61	-0.29	1.76*	3.77	-0.39	0.80	1.06	-2.35
	(1.03)	(0.61)	(0.44)	(3.73)	(0.54)	(0.91)	(0.60)	(2.31)
3	3.35	-0.15	1.62*	7.96*	-0.18	0.77*	0.22	-0.10
	(3.69)	(0.49)	(0.73)	(3.80)	(0.89)	(0.32)	(0.19)	(0.68)
4	1.57*	0.39	2.99*	0.92	1.91	0.63	0.39	-0.87
	(0.58)	(1.60)	(0.94)	(0.55)	(1.21)	(0.63)	(0.34)	(2.28)
5	1.47	0.79	0.69	0.80	2.26	0.74*	0.63	1.27*
	(1.46)	(0.51)	(0.49)	(0.42)	(1.48)	(0.22)	(0.47)	(0.41)
6	-0.53	-1.06	1.30	2.12*	-0.40	0.69	0.37	-0.50
	(2.18)	(0.82)	(0.92)	(0.94)	(0.70)	(0.53)	(0.49)	(0.87)
7	1.40	0.90	0.05	1.16*	1.81	-0.08	0.87	-0.72
	(1.02)	(0.63)	(0.37)	(0.44)	(1.43)	(0.47)	(0.51)	(0.93)
8	0.90	-0.40	2.66*	0.71	0.77	1.24*	1.44*	2.92*
	(1.73)	(0.87)	(0.62)	(0.88)	(1.49)	(0.62)	(0.35)	(0.76)
9	-1.10	1.09	1.20	1.51*	5.60*	1.11	5.03*	0.21
	(3.20)	(0.79)	(1.58)	(0.55)	(1.07)	(0.62)	(1.13)	(1.57)
10	0.90	2.15	4.10	4.91*	16.79	0.63*	-2.95	-1.43
	(1.49)	(1.54)	(3.31)	(2.17)	(10.26)	(0.32)	(3.77)	(1.46)
11	-2.29	3.17	0.83	0.56	1.28	0.55	2.05	2.30
	(4.87)	(1.82)	(1.22)	(1.68)	(1.30)	(0.38)	(1.26)	(4.36)
12	4.14*	0.17	0.30	0.32	0.84	0.39	3.30	-4.54*
	(1.16)	(0.30)	(0.88)	(2.02)	(1.05)	(0.27)	(2.33)	(2.32)
Substitutes or Complements:								
Substitutes[a]	**9 (2)**	**8 (0)**	**12 (4)**	**12 (6)**	**9 (1)**	**11 (4)**	**11 (3)**	**4 (2)**
Complements[a]	**3 (0)**	**4 (0)**	**0 (0)**	**0 (0)**	**3 (0)**	**1 (0)**	**1 (0)**	**8 (1)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

Table 37: Morishima elasticities, capital price on energy int. (MES_{EK}), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	2.08	1.54	-0.37	2.73*	2.14	2.51*	-7.82*	-0.48
	(1.51)	(0.90)	(1.22)	(0.64)	(2.90)	(0.82)	(1.64)	(2.56)
2	1.41	0.60	0.42	-7.26	1.59	-1.24	-7.56*	-3.46
	(1.52)	(2.06)	(0.45)	(5.35)	(1.74)	(1.59)	(1.12)	(2.88)
3	3.71	-13.50*	1.81	-6.75	1.15	0.69	1.65	-0.38
	(3.93)	(1.70)	(1.26)	(4.55)	(1.19)	(1.13)	(0.99)	(1.75)
4	1.56	-2.60*	3.19*	-1.03	8.65*	-0.21	-2.34*	2.75
	(1.02)	(1.07)	(1.38)	(1.10)	(1.22)	(0.95)	(0.59)	(1.75)
5	1.74	0.45	-0.85	1.50*	2.08	1.13	-0.46	1.73*
	(1.41)	(0.43)	(0.72)	(0.35)	(1.38)	(0.62)	(0.58)	(0.32)
6	2.50	3.29*	-2.85	-1.20	7.66*	0.37	-4.40*	3.30*
	(1.73)	(1.59)	(1.76)	(1.54)	(1.23)	(0.88)	(2.11)	(1.09)
7	1.34	-2.57*	1.04*	2.20*	7.74*	-1.06	-0.38	-0.57
	(1.27)	(1.10)	(0.51)	(0.61)	(0.94)	(0.77)	(0.48)	(0.78)
8	1.55	-1.59*	1.19	-0.78	-3.53*	2.39*	-1.50*	0.78
	(1.06)	(0.65)	(0.65)	(1.41)	(1.18)	(0.77)	(0.59)	(0.97)
9	-0.70	-4.14*	3.97*	0.05	18.36*	1.76	-20.57*	1.27
	(2.88)	(2.10)	(1.89)	(1.79)	(4.04)	(1.59)	(2.99)	(1.88)
10	2.73*	-4.98*	11.59*	-20.13*	-6.36	0.92	29.65	-5.21*
	(1.35)	(2.18)	(4.46)	(4.37)	(8.94)	(1.01)	(19.23)	(1.48)
11	-4.22	-14.37*	3.90	-12.82	13.83*	2.78	-13.06*	6.76
	(4.67)	(5.25)	(2.09)	(6.71)	(6.43)	(2.09)	(2.64)	(6.23)
12	2.28*	-4.07*	-2.29	1.39	6.73*	2.01*	-3.79	2.01
	(0.93)	(1.90)	(1.44)	(5.49)	(1.25)	(0.89)	(3.86)	(3.99)
Substitutes or Complements:								
Substitutes[a]	**10 (2)**	**4 (1)**	**8 (4)**	**5 (3)**	**10 (6)**	**9 (3)**	**2 (0)**	**7 (2)**
Complements[a]	**2 (0)**	**8 (8)**	**4 (0)**	**7 (1)**	**2 (1)**	**3 (0)**	**10 (7)**	**5 (1)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

Table 38: Morishima elasticities, labor price on capital intensity (MES_{KL}), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	0.52	-0.04	1.06*	1.48*	0.83*	2.29*	0.98*	0.91*
	(0.55)	(0.48)	(0.19)	(0.19)	(0.27)	(0.42)	(0.39)	(0.37)
2	0.13	2.73*	0.85*	-0.23	0.48	2.02*	1.89*	1.42*
	(0.64)	(0.49)	(0.10)	(0.46)	(0.88)	(0.28)	(0.29)	(0.32)
3	1.81	-2.99*	1.75*	1.03*	1.88*	1.84*	0.73	0.06
	(1.11)	(0.80)	(0.22)	(0.31)	(0.62)	(0.31)	(0.45)	(0.31)
4	2.40*	1.36*	1.81*	0.35	1.90*	1.13*	2.79*	0.29
	(0.22)	(0.31)	(0.62)	(0.62)	(0.49)	(0.14)	(0.36)	(0.91)
5	2.13*	1.32*	-0.26	-0.55	1.34*	0.33	2.17*	2.00*
	(0.35)	(0.47)	(1.10)	(0.38)	(0.17)	(0.95)	(0.26)	(0.14)
6	1.75*	0.44	3.15*	1.33*	0.70	1.86*	1.59*	1.12
	(0.24)	(0.76)	(0.66)	(0.53)	(0.36)	(0.41)	(0.59)	(0.59)
7	3.50*	-0.43	1.04*	1.75*	1.17*	2.75*	1.62*	1.50*
	(0.46)	(0.52)	(0.21)	(0.34)	(0.32)	(0.51)	(0.47)	(0.21)
8	2.41*	0.28	2.64*	-1.39*	-0.95	2.13*	2.74*	1.20*
	(0.18)	(0.42)	(0.67)	(0.43)	(0.53)	(0.63)	(0.49)	(0.55)
9	2.22*	-0.63	2.90*	2.50*	2.69*	2.27*	3.61*	1.10
	(0.16)	(0.50)	(0.64)	(0.90)	(0.78)	(0.30)	(0.44)	(0.63)
10	1.66*	1.22	2.00*	-0.18	-0.53	1.68*	0.77	1.64*
	(0.22)	(0.71)	(0.54)	(0.38)	(0.95)	(0.61)	(1.33)	(0.38)
11	1.84*	1.86*	1.51*	-0.71	-1.94*	1.69	2.99*	1.42*
	(0.86)	(0.49)	(0.31)	(1.66)	(0.72)	(0.87)	(0.30)	(0.66)
12	0.41	1.49*	1.09*	2.22*	2.82*	1.50*	2.88*	10.33*
	(0.59)	(0.36)	(0.20)	(0.86)	(0.26)	(0.65)	(1.15)	(1.12)
Substitutes or Complements:								
Substitutes[a]	**12 (8)**	**8 (5)**	**11 (11)**	**7 (6)**	**9 (7)**	**12 (10)**	**12 (10)**	**12 (8)**
Complements[a]	**0 (0)**	**4 (1)**	**1 (0)**	**5 (1)**	**3 (1)**	**0 (0)**	**0 (0)**	**0 (0)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

Table 39: Morishima elasticities, capital price on labor intensity (MES_{LK}), all countries

Sector	CHE[b]	GER	BEL	NLD	GRB	DNK	SWE	ESP
1	1.35*	0.23	1.31*	1.55*	0.13	1.95*	2.47*	0.55
	(0.38)	(0.62)	(0.26)	(0.23)	(0.67)	(0.44)	(0.61)	(0.74)
2	1.37*	3.00	0.84*	-0.15	1.28	0.72	1.68*	1.51*
	(0.69)	(2.06)	(0.20)	(0.84)	(1.04)	(0.59)	(0.57)	(0.61)
3	1.28	-12.26*	2.13*	2.02*	2.35*	1.61*	1.51	0.49
	(0.71)	(2.15)	(0.31)	(0.52)	(0.91)	(0.59)	(1.00)	(0.70)
4	1.41	2.13*	1.79*	0.51	1.50*	0.28	2.35*	1.11
	(0.84)	(0.31)	(0.63)	(0.49)	(0.50)	(0.21)	(0.43)	(0.58)
5	1.30*	1.33*	-0.26	-0.83*	1.19*	-1.28*	2.58*	2.00*
	(0.44)	(0.34)	(0.88)	(0.35)	(0.36)	(0.50)	(0.31)	(0.34)
6	1.95*	0.34	2.18*	1.38*	2.69*	1.58*	0.74	3.05*
	(0.23)	(0.92)	(0.87)	(0.57)	(0.60)	(0.39)	(0.90)	(0.77)
7	2.13*	-2.02*	1.28*	3.11*	1.59*	1.03	0.92*	0.74*
	(0.41)	(0.59)	(0.24)	(0.61)	(0.61)	(0.56)	(0.34)	(0.38)
8	2.03*	-0.40	2.35*	-0.22	-1.42*	1.29*	2.22*	1.45*
	(0.18)	(0.48)	(0.71)	(0.77)	(0.57)	(0.40)	(0.40)	(0.55)
9	1.55*	1.69*	2.01*	1.32	7.64*	0.87	5.72*	0.59
	(0.26)	(0.69)	(0.42)	(1.14)	(1.91)	(0.59)	(0.70)	(0.50)
10	2.28*	-0.68	-0.60	-0.79	-1.23	0.86	2.15	2.10*
	(0.35)	(0.65)	(0.59)	(0.52)	(1.60)	(0.48)	(3.63)	(0.41)
11	1.75	11.76*	2.43*	-0.50	1.10	2.67	4.63*	-1.55
	(1.08)	(2.36)	(0.53)	(2.47)	(2.97)	(1.66)	(0.76)	(1.23)
12	0.36	-1.50	0.48	3.08*	2.74*	1.78*	4.02	7.33*
	(0.57)	(0.97)	(0.24)	(1.09)	(0.36)	(0.39)	(2.20)	(0.86)
Substitutes or Complements:								
Substitutes[a]	**12 (8)**	**7 (4)**	**10 (9)**	**7 (5)**	**10 (7)**	**11 (5)**	**12 (8)**	**11 (7)**
Complements[a]	**0 (0)**	**5 (2)**	**2 (0)**	**5 (1)**	**2 (1)**	**1 (1)**	**0 (0)**	**1 (0)**

Note: All countries estimated separately, translog specification. The standard errors are in parentheses.
[a] Number of significant cases are in parentheses.
[b] Elasticity of sector 12 for Switzerland is estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

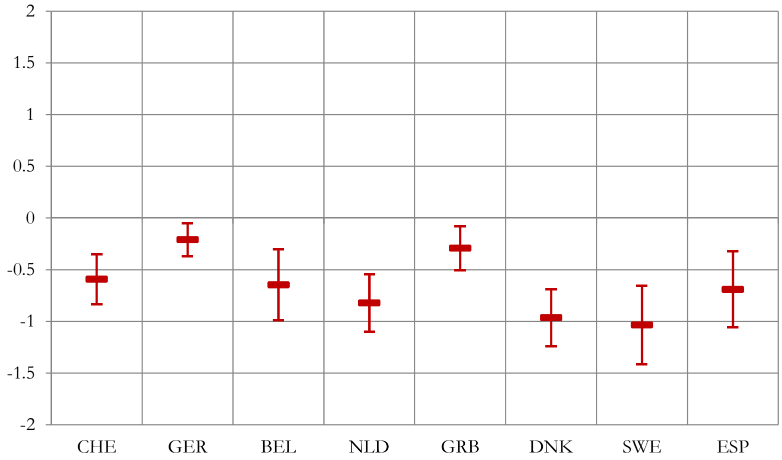
A.5.3 Pooled Estimates: Pooling across Industries

Table 40: Key statistics of the pooled estimates across industries

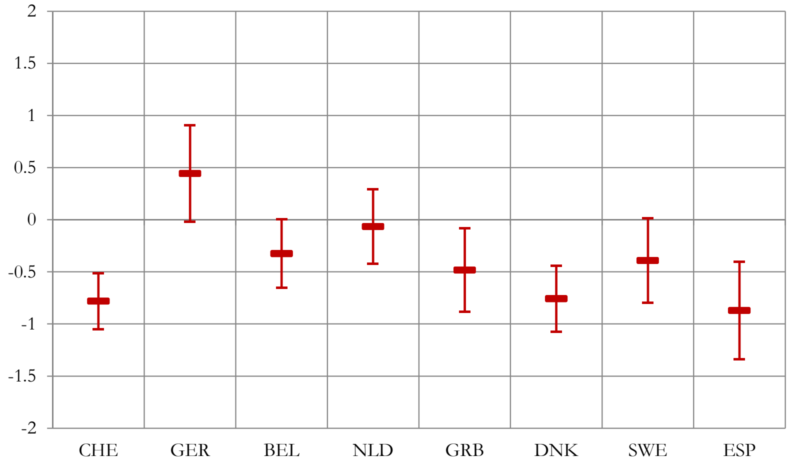
Country	Equation	Observations	RMSE	R-squared	p-value
CHE	Capital	132	0.012	0.94	0.000
	Labor	132	0.011	0.96	0.000
	Energy	132	0.001	0.98	0.000
GER	Capital	120	0.013	0.95	0.000
	Labor	120	0.011	0.94	0.000
	Energy	120	0.004	0.96	0.000
BEL	Capital	120	0.018	0.89	0.000
	Labor	120	0.008	0.95	0.000
	Energy	120	0.005	0.94	0.000
NLD	Capital	120	0.015	0.93	0.000
	Labor	120	0.007	0.99	0.000
	Energy	120	0.003	0.98	0.000
GRB	Capital	108	0.011	0.94	0.000
	Labor	108	0.012	0.94	0.000
	Energy	108	0.005	0.95	0.000
DNK	Capital	120	0.013	0.97	0.000
	Labor	120	0.011	0.95	0.000
	Energy	120	0.002	0.99	0.000
SWE	Capital	120	0.021	0.95	0.000
	Labor	120	0.010	0.97	0.000
	Energy	120	0.004	0.95	0.000
ESP	Capital	120	0.016	0.92	0.000
	Labor	120	0.008	0.96	0.000
	Energy	120	0.004	0.97	0.000

Note: Data pooled across industries with fixed effects. For each country we estimated a SUR consisting of three share equations. We list the number of observations, the root mean square error, the r-squared and the p-value for each equation.

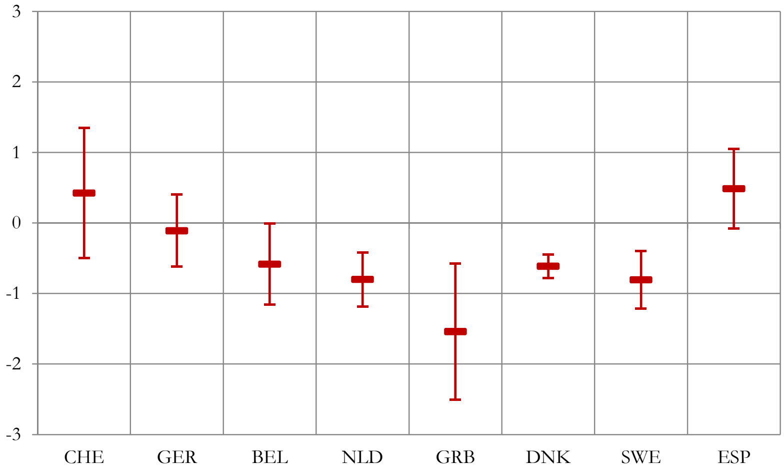
Figure 17: Own-price elasticities pooled across industries



(a) CPE_{LL}



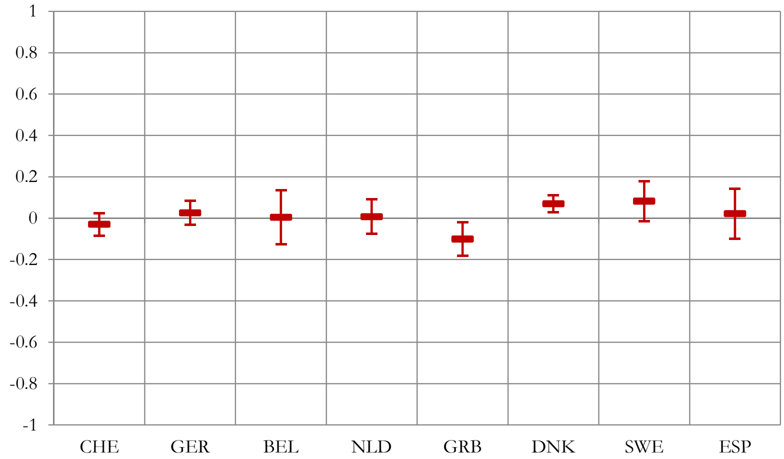
(b) CPE_{KK}



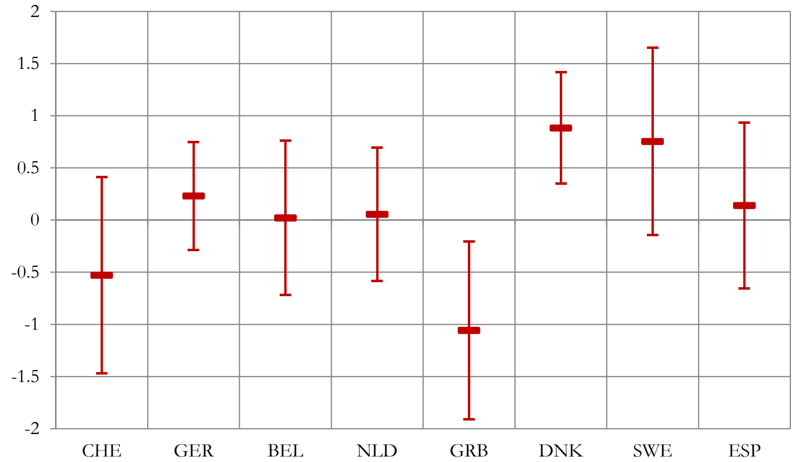
(c) CPE_{EE}

Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for total manufacturing. Pooled estimates with fixed effects, translog cost function.

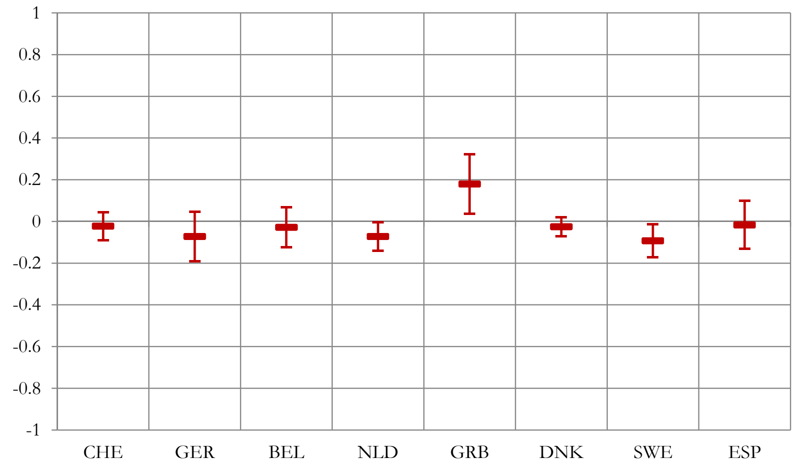
Figure 18: Cross-price elasticities pooled across industries (I)



(a) CPE_{LE}



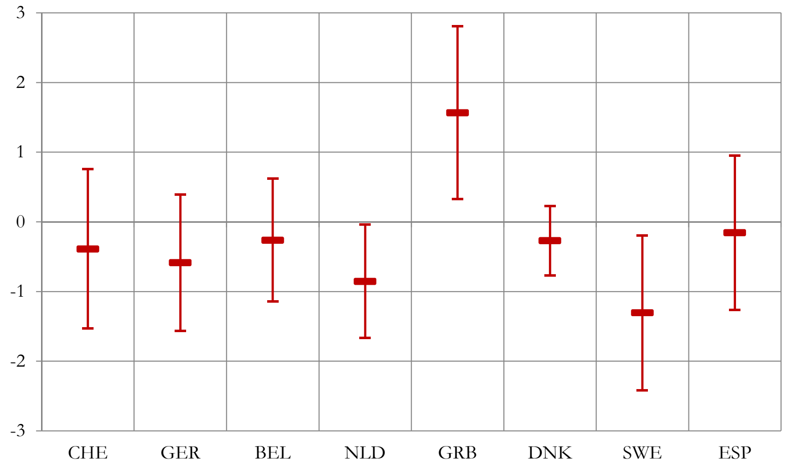
(b) CPE_{EL}



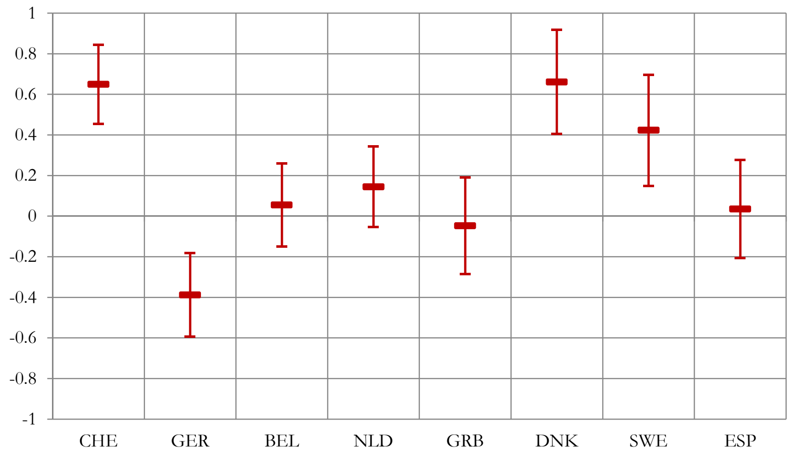
(c) CPE_{KE}

Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for total manufacturing. Pooled estimates with fixed effects, translog cost function.

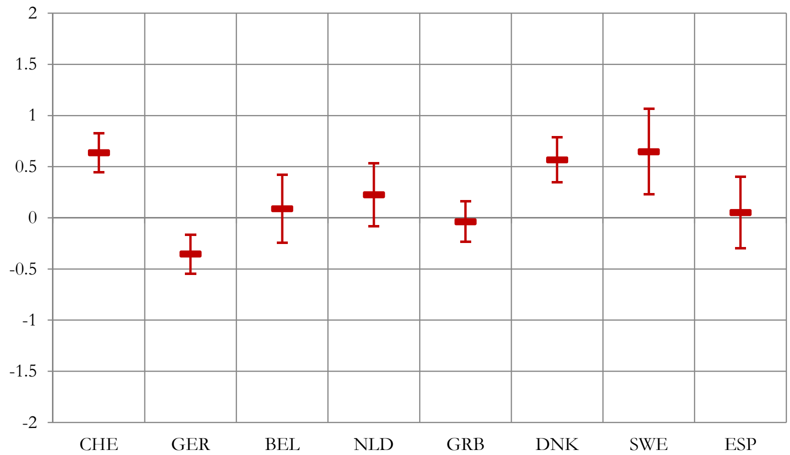
Figure 18: Cross-price elasticities pooled across industries (II)



(d) CPE_{EK}



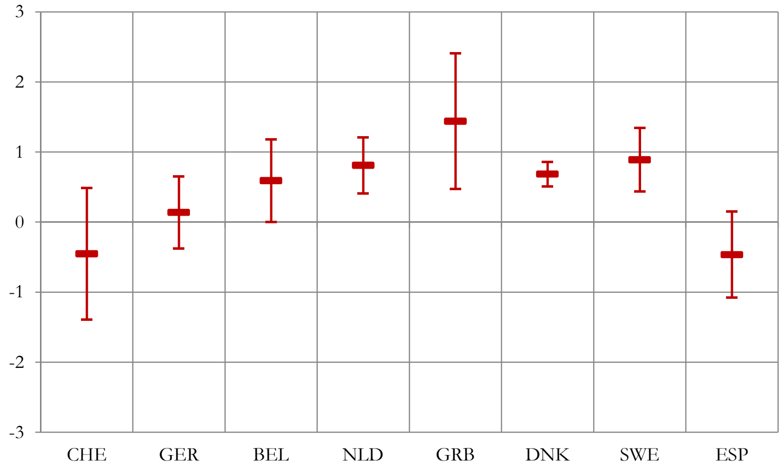
(e) CPE_{KL}



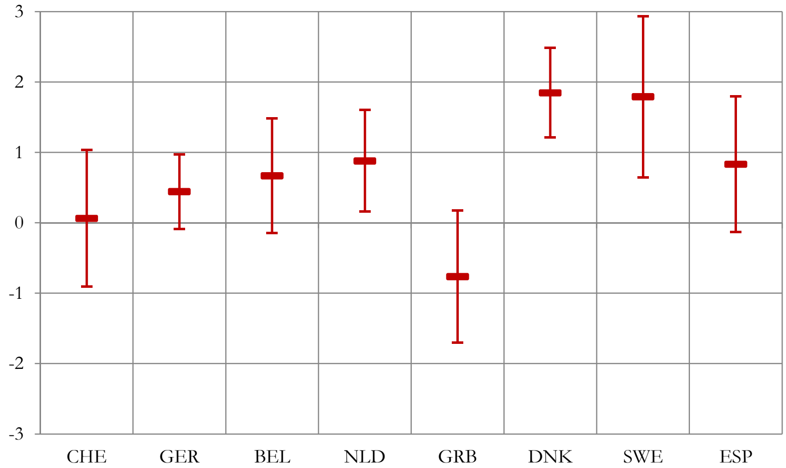
(f) CPE_{LK}

Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for total manufacturing. Pooled estimates with fixed effects, translog cost function.

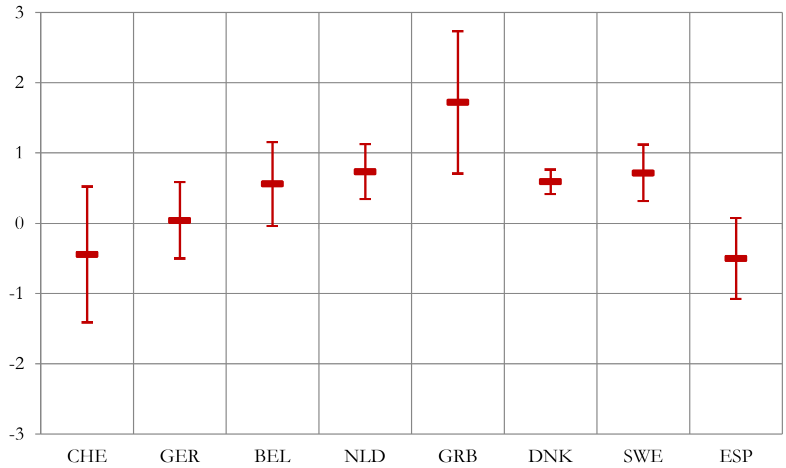
Figure 19: Morishima elasticities pooled across industries (I)



(a) MES_{LE}



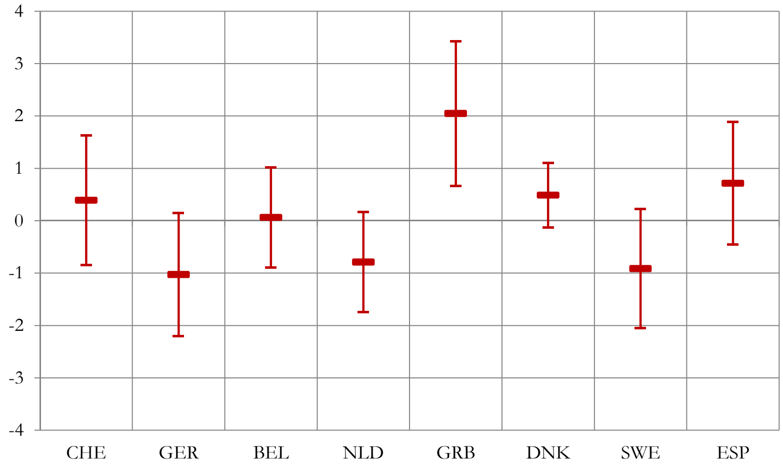
(b) MES_{EL}



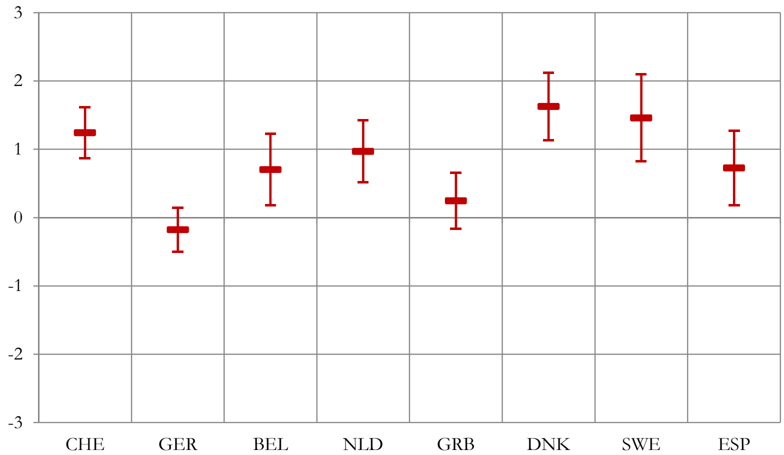
(c) MES_{KE}

Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for total manufacturing. Pooled estimates with fixed effects, translog cost function.

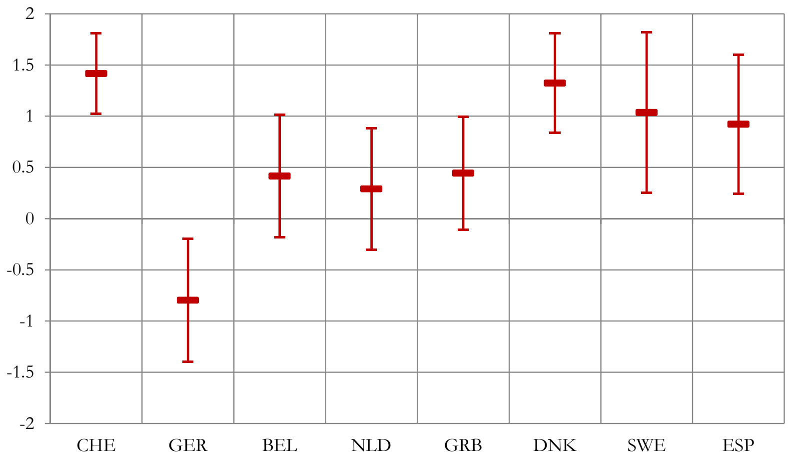
Figure 19: Morishima elasticities pooled across industries (II)



(d) MES_{EK}



(e) MES_{KL}



(f) MES_{LK}

Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for total manufacturing. Pooled estimates with fixed effects, translog cost function.

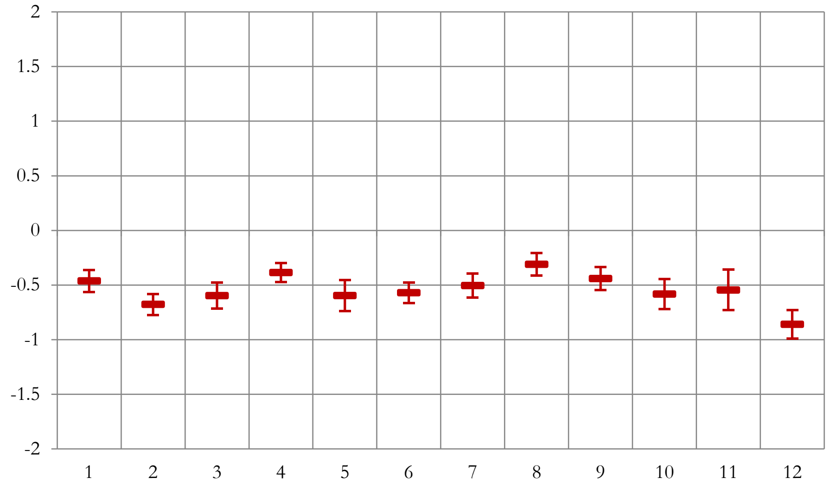
A.5.4 Pooled Estimates: Pooling across Countries

Table 41: Key statistics of the pooled estimates over countries

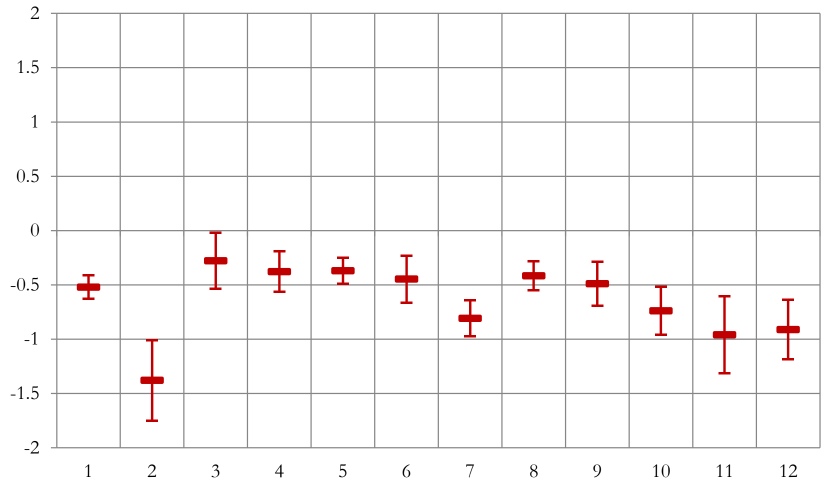
Sector	Equation	Observations	RMSE	R-squared	p-value
1	Capital	87	0.010	0.94	0.000
	Labor	87	0.004	0.98	0.000
	Energy	87	0.002	0.82	0.000
2	Capital	87	0.014	0.93	0.000
	Labor	87	0.010	0.96	0.000
	Energy	87	0.002	0.82	0.000
3	Capital	87	0.018	0.88	0.000
	Labor	87	0.013	0.94	0.000
	Energy	87	0.004	0.96	0.000
4	Capital	87	0.017	0.90	0.000
	Labor	87	0.011	0.96	0.000
	Energy	87	0.002	0.93	0.000
5	Capital	87	0.015	0.95	0.000
	Labor	87	0.008	0.96	0.000
	Energy	87	0.007	0.94	0.000
6	Capital	87	0.016	0.86	0.000
	Labor	87	0.010	0.92	0.000
	Energy	87	0.004	0.96	0.000
7	Capital	87	0.013	0.95	0.000
	Labor	87	0.008	0.95	0.000
	Energy	87	0.006	0.78	0.000
8	Capital	87	0.011	0.94	0.000
	Labor	87	0.010	0.97	0.000
	Energy	87	0.006	0.78	0.000
9	Capital	87	0.014	0.92	0.000
	Labor	87	0.010	0.93	0.000
	Energy	87	0.002	0.89	0.000
10	Capital	87	0.022	0.91	0.000
	Labor	87	0.010	0.93	0.000
	Energy	87	0.002	0.72	0.000
11	Capital	87	0.013	0.93	0.000
	Labor	87	0.010	0.97	0.000
	Energy	87	0.001	0.86	0.000
12	Capital	87	0.015	0.90	0.000
	Labor	87	0.014	0.97	0.000
	Energy	87	0.004	0.73	0.000

Note: Data pooled across countries with fixed effects. For each sector we estimated a SUR consisting of three share equations. We list the number of observations, the root mean square error, the r-squared and the p-value for each equation.

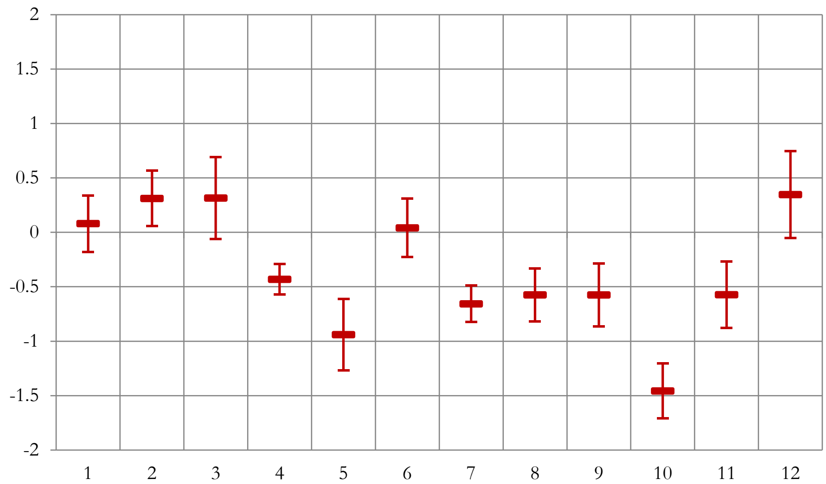
Figure 20: Own-price elasticities pooled across countries



(a) CPE_{LL}



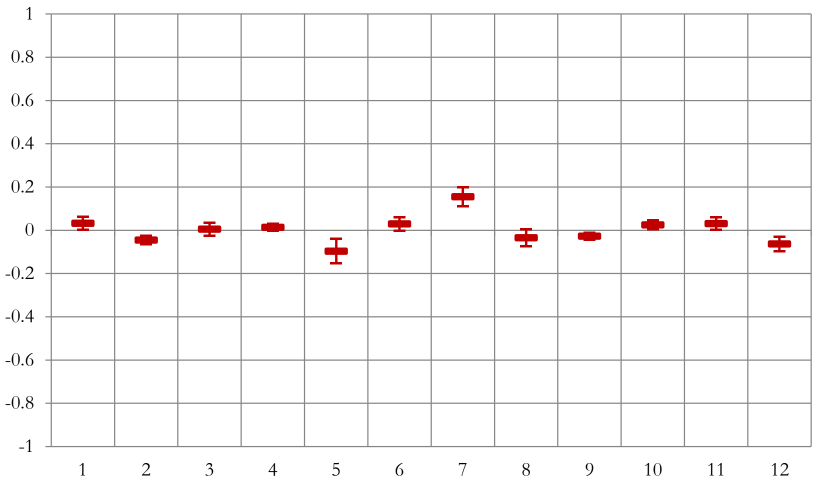
(b) CPE_{KK}



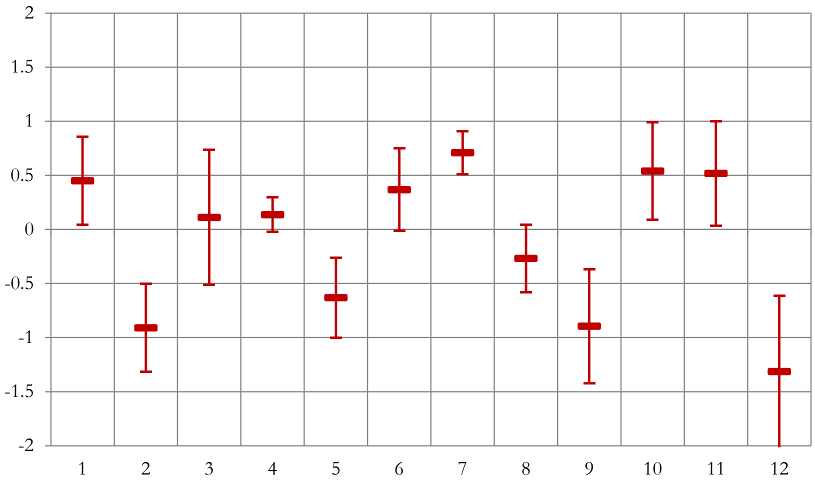
(c) CPE_{EE}

Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for the 12 manufacturing industries in Switzerland. Pooled estimates with fixed effects, translog cost function.

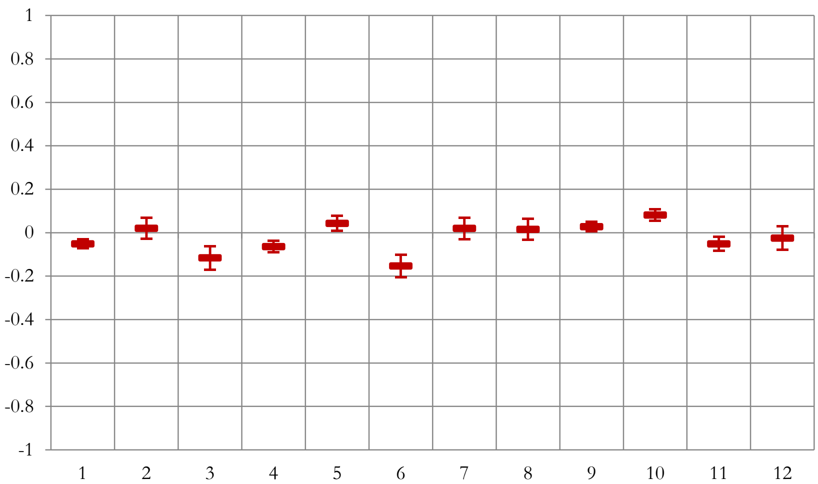
Figure 21: Cross-price elasticities pooled across countries (I)



(a) CPE$_{LE}$



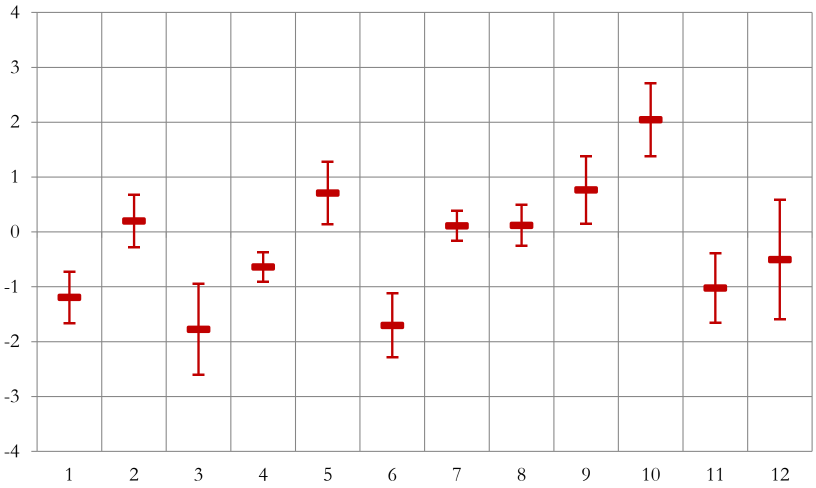
(b) CPE$_{EL}$



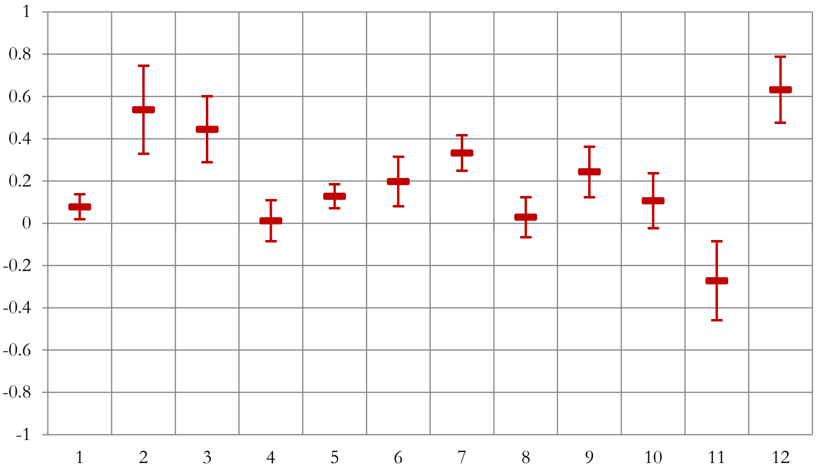
(c) CPE$_{KE}$

Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for the 12 manufacturing industries in Switzerland. Pooled estimates with fixed effects, translog cost function.

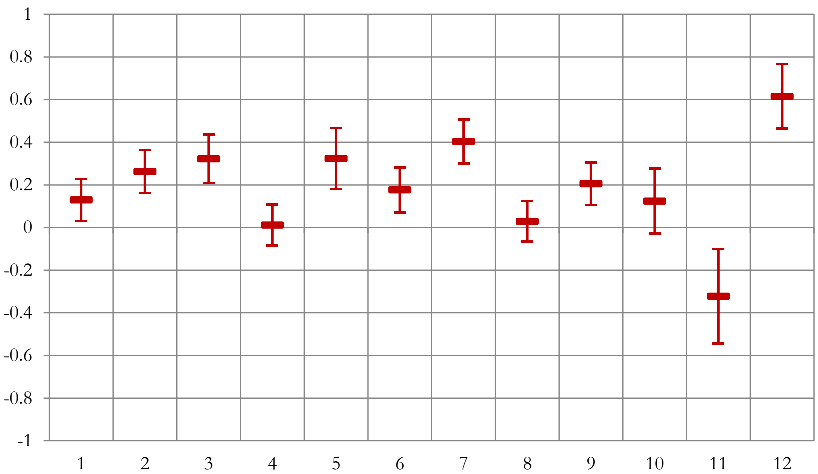
Figure 21: Cross-price elasticities pooled across countries (II)



(d) CPE_{EK}



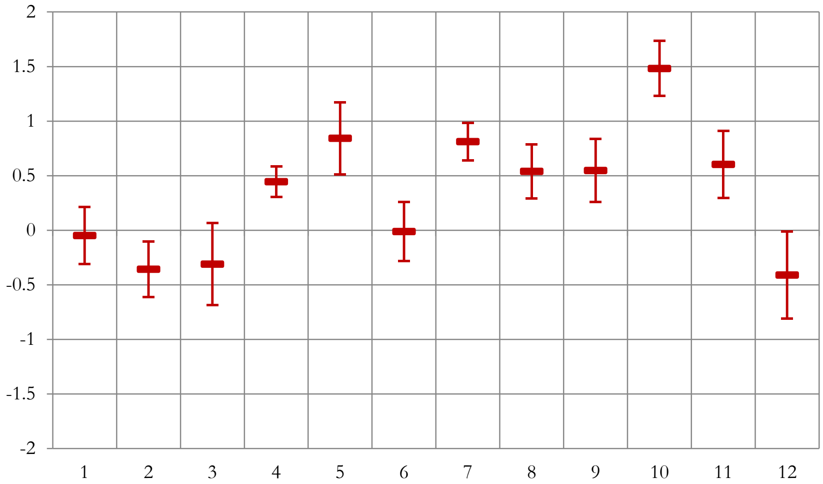
(e) CPE_{KL}



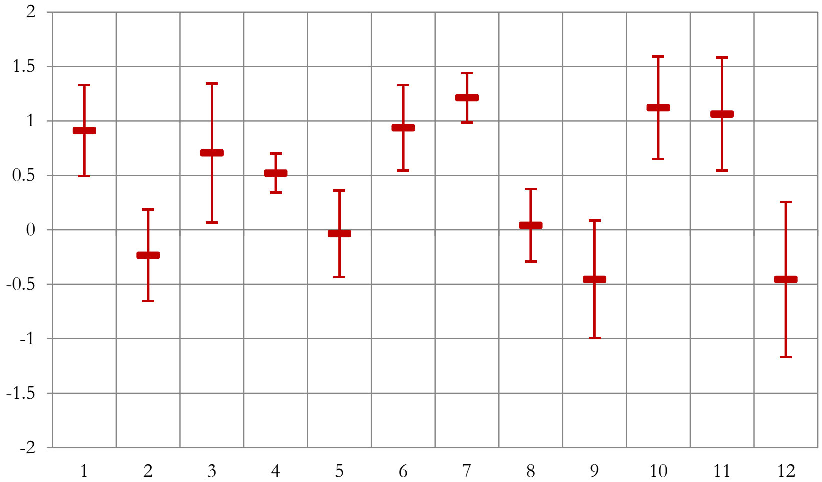
(f) CPE_{LK}

Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for the 12 manufacturing industries in Switzerland. Pooled estimates with fixed effects, translog cost function.

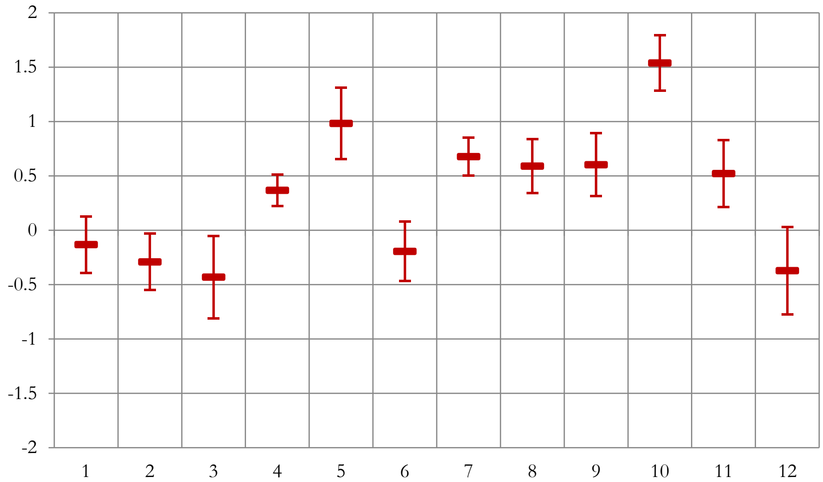
Figure 22: Morishima elasticities pooled across countries (I)



(a) MES_{LE}



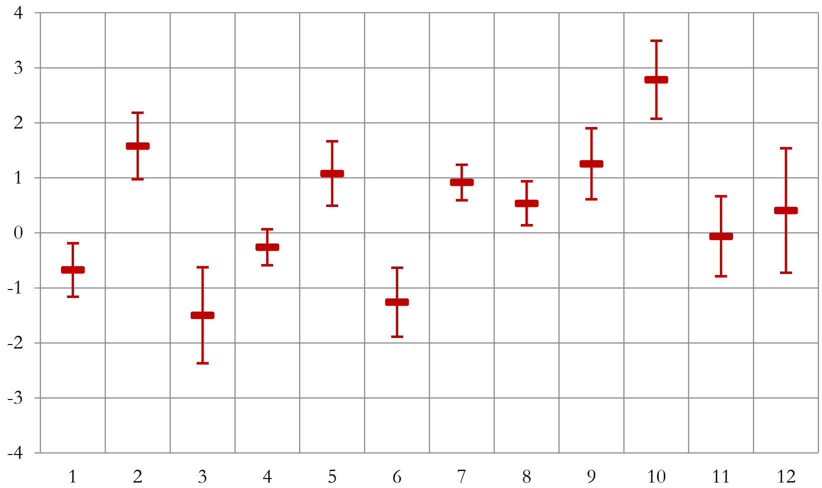
(b) MES_{EL}



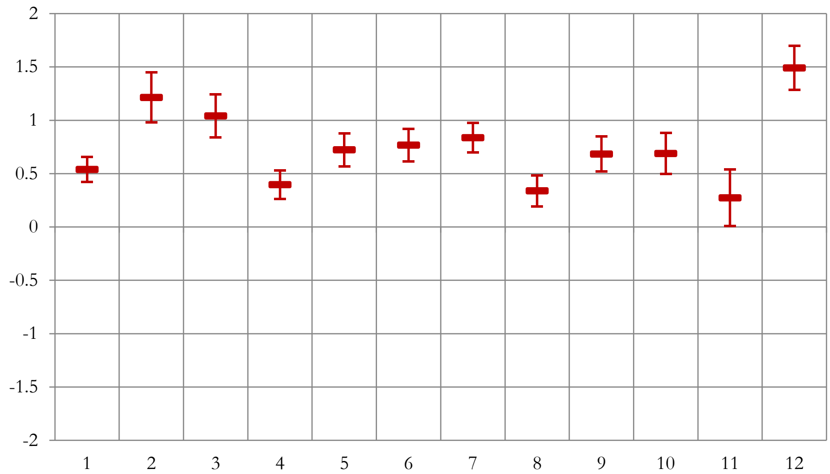
(c) MES_{KE}

Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for the 12 manufacturing industries in Switzerland. Pooled estimates with fixed effects, translog cost function.

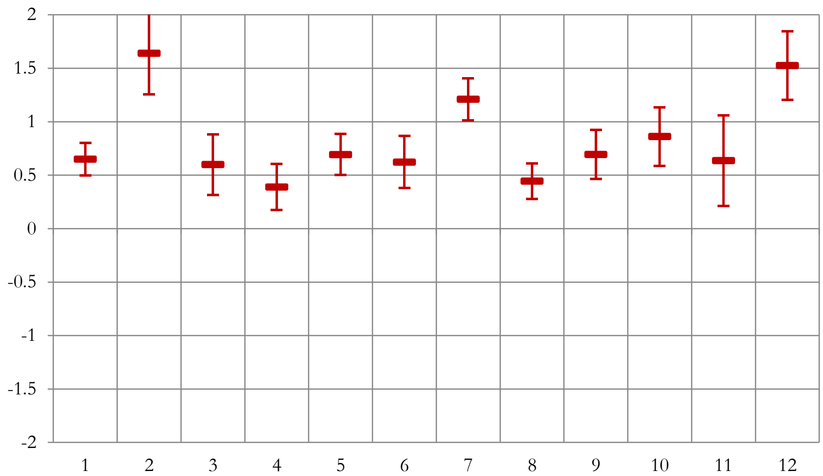
Figure 22: Morishima elasticities pooled across countries (II)



(d) MES_{EK}



(e) MES_{KL}



(f) MES_{LK}

Notes: Figures display the point estimates and the 95 % confidence interval of the elasticities for the 12 manufacturing industries in Switzerland. Pooled estimates with fixed effects, translog cost function.

A.6 Nested CES production function estimation results

A.6.1 Technical Elasticities, Swiss Manufacturing Nested CES

Table 42: Technical elasticities ($\sigma_{i,j}$), Swiss manufacturing, nested CES

	KL,E			KE,L			LE,K		
Sector	$\sigma_{K,L}$	$\sigma_{KL,E}$	$\sigma_{KLE,M}$	$\sigma_{K,E}$	$\sigma_{KE,L}$	$\sigma_{KEL,M}$	$\sigma_{L,E}$	$\sigma_{LE,K}$	$\sigma_{LEK,M}$
1[a]	0.51*	0.58*	0.52*	0.54*	0.53*	0.52*	0.63*	0.45*	0.53*
	(0.06)	(0.03)	(0.02)	(0.03)	(0.03)	(0.01)	(0.07)	(0.04)	(0.02)
2	0.57*	0.58*	0.45*	0.50*	0.61*	0.46*	0.62*	0.52*	0.45*
	(0.04)	(0.03)	(0.02)	(0.10)	(0.03)	(0.01)	(0.03)	(0.03)	(0.02)
3[a]	0.48*	0.50*	0.50*	0.43*	0.51*	0.50*	0.50*	0.49*	0.50*
	(0.02)	(0.03)	(0.00)	(0.05)	(0.02)	(0.00)	(0.04)	(0.02)	(0.00)
4	0.54*	0.50*	0.49*	0.22*	0.56*	0.49*	0.65*	0.49*	0.49*
	(0.02)	(0.03)	(0.01)	(0.06)	(0.02)	(0.01)	(0.03)	(0.03)	(0.01)
5	0.48*	0.51*	0.49*	0.40*	0.58*	0.49*	0.58*	0.55*	0.49*
	(0.10)	(0.08)	(0.01)	(0.08)	(0.07)	(0.01)	(0.19)	(0.08)	(0.01)
6	0.57*	0.51*	0.47*	0.52*	0.58*	0.47*	0.59*	0.52*	0.47*
	(0.03)	(0.04)	(0.00)	(0.06)	(0.03)	(0.01)	(0.05)	(0.03)	(0.01)
7[a]	0.51*	0.50*	0.52*	0.34*	0.57*	0.52*	0.60*	0.43*	0.52*
	(0.04)	(0.01)	(0.01)	(0.03)	(0.02)	(0.01)	(0.03)	(0.03)	(0.01)
8	0.50*	0.52*	0.49*	0.42*	0.55*	0.49*	0.54*	0.46*	0.49*
	(0.03)	(0.04)	(0.00)	(0.07)	(0.02)	(0.00)	(0.10)	(0.02)	(0.00)
9	0.57*	0.48*	0.47*	0.31*	0.58*	0.47*	0.67*	0.49*	0.47*
	(0.04)	(0.06)	(0.00)	(0.11)	(0.03)	(0.00)	(0.06)	(0.02)	(0.00)
10	0.62*	0.44*	0.48*	0.35*	0.60*	0.47*	0.66*	0.50*	0.48*
	(0.01)	(0.04)	(0.01)	(0.06)	(0.02)	(0.00)	(0.08)	(0.01)	(0.00)
11	0.57*	0.52*	0.47*	0.53*	0.58*	0.47*	0.56*	0.53*	0.47*
	(0.03)	(0.04)	(0.01)	(0.08)	(0.03)	(0.01)	(0.04)	(0.03)	(0.01)
12[a]	0.53*	0.50*	0.49*	0.49*	0.52*	0.49*	0.52*	0.52*	0.49*
	(0.01)	(0.01)	(0.00)	(0.02)	(0.02)	(0.01)	(0.04)	(0.01)	(0.00)

Note: Swiss data only, nested CES specification. All technical elasticities are significantly different from zero.
[a] Elasticities are estimated from the sample dataset, see Appendix A.2.
* Indicates significance at the 5% level.

A.6.2 Economic Elasticities, Swiss Manufacturing, Nested CES

Own-price Elasticities

(a) KL-nest Combined with E:

Table 43: Own-price elasticities, Swiss manufacturing, nested CES, spec. (a)

Sector	CPE_{KK}	CPE_{LL}	CPE_{EE}	CPE_{MM}
1[a]	-0.40	-0.43	-0.57	-0.36
2	-0.44	-0.36	-0.57	-0.47
3[a]	-0.38	-0.36	-0.48	-0.53
4	-0.40	-0.34	-0.48	-0.81
5	-0.31	-0.40	-0.50	-0.58
6	-0.43	-0.38	-0.50	-0.50
7[a]	-0.35	-0.35	-0.48	-1.04
8	-0.38	-0.32	-0.51	-0.70
9	-0.44	-0.38	-0.48	-0.45
10	-0.43	-0.42	-0.44	-0.54
11	-0.45	-0.37	-0.51	-0.41
12[a]	-0.39	-0.34	-0.49	-0.68
Concavity Test:				
Negative	**12**	**12**	**12**	**12**
Positive	**0**	**0**	**0**	**0**

Note: Swiss data only, nested CES specification.
[a] Elasticities are estimated from the sample dataset, see Appendix A.2.

(b) KE-nest Combined with L:

Table 44: Own-price elasticities, Swiss manufacturing, nested CES, spec. (b)

Sector	CPE_{KK}	CPE_{LL}	CPE_{EE}	CPE_{MM}
1[a]	-0.41	-0.44	-0.53	-0.36
2	-0.46	-0.38	-0.50	-0.47
3[a]	-0.38	-0.38	-0.42	-0.53
4	-0.37	-0.35	-0.24	-0.81
5	-0.34	-0.47	-0.39	-0.58
6	-0.43	-0.38	-0.52	-0.50
7[a]	-0.36	-0.38	-0.34	-1.04
8	-0.40	-0.35	-0.41	-0.70
9	-0.44	-0.38	-0.32	-0.45
10	-0.41	-0.41	-0.35	-0.53
11	-0.46	-0.38	-0.52	-0.41
12[a]	-0.39	-0.34	-0.48	-0.67
Concavity Test:				
Negative	**12**	**12**	**12**	**12**
Positive	**0**	**0**	**0**	**0**

Note: Swiss data only, nested CES specification.
[a] Elasticities are estimated from the sample dataset, see Appendix A.2.

(c) LE-nest Combined with K:

Table 45: Own-price elasticities, Swiss manufacturing, nested CES, spec. (c)

Sector	CPE_{KK}	CPE_{LL}	CPE_{EE}	CPE_{MM}
1[a]	-0.38	-0.41	-0.61	-0.37
2	-0.41	-0.35	-0.60	-0.47
3[a]	-0.38	-0.37	-0.49	-0.53
4	-0.37	-0.34	-0.62	-0.81
5	-0.33	-0.45	-0.57	-0.57
6	-0.40	-0.36	-0.58	-0.49
7[a]	-0.32	-0.34	-0.56	-1.04
8	-0.36	-0.31	-0.52	-0.70
9	-0.39	-0.35	-0.66	-0.45
10	-0.37	-0.37	-0.65	-0.53
11	-0.43	-0.36	-0.55	-0.41
12[a]	-0.39	-0.34	-0.52	-0.68
Concavity Test:				
Negative	**12**	**12**	**12**	**12**
Positive	**0**	**0**	**0**	**0**

Note: Swiss data only, nested CES specification.
[a] Elasticities are estimated from the sample dataset, see Appendix A.2.

Cross-price Elasticities

(a) KL-nest Combined with E:

Table 46: Cross-price elasticities, Swiss manufacturing, nested CES, spec. (a)

Sector	$\text{CPE}_{KM}{}^{a}$	CPE_{MK}	CPE_{ML}	CPE_{ME}	CPE_{KL}	CPE_{LK}	CPE_{KE}	CPE_{EK}	CPE_{LE}	CPE_{EL}
1^b	0.30	0.12	0.09	0.01	0.09	0.11	0.01	0.15	0.01	0.12
2	0.22	0.09	0.14	0.01	0.20	0.13	0.01	0.13	0.01	0.21
3^b	0.25	0.11	0.13	0.01	0.12	0.10	0.01	0.11	0.01	0.13
4	0.18	0.12	0.17	0.02	0.20	0.14	0.02	0.12	0.02	0.17
5	0.23	0.18	0.08	0.01	0.08	0.16	0.01	0.18	0.01	0.09
6	0.23	0.10	0.13	0.01	0.19	0.14	0.01	0.12	0.01	0.15
7^b	0.17	0.16	0.16	0.03	0.16	0.15	0.02	0.15	0.02	0.15
8	0.20	0.11	0.17	0.01	0.17	0.11	0.01	0.12	0.01	0.19
9	0.24	0.09	0.14	0.00	0.19	0.13	0.00	0.10	0.00	0.14
10	0.23	0.12	0.13	0.00	0.20	0.19	0.00	0.10	0.00	0.11
11	0.25	0.08	0.13	0.01	0.20	0.11	0.01	0.10	0.01	0.16
12^b	0.20	0.12	0.16	0.01	0.18	0.13	0.01	0.12	0.01	0.17
Substitutes or Complements:										
Substitutes	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**
Complements	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Note: Swiss data only, nested CES, specification (a).
[a] The following elasticities are identical: $\text{CPE}_{KM} = \text{CPE}_{LM} = \text{CPE}_{EM}$.
[b] Elasticities are estimated from the sample dataset, see Appendix A.2.

(b) KE-nest Combined with L:

Table 47: Cross-price elasticities, Swiss manufacturing, nested CES, spec. (b)

Sector	CPE_{KM}[a]	CPE_{MK}	CPE_{ML}	CPE_{ME}	CPE_{KL}	CPE_{LK}	CPE_{KE}	CPE_{EK}	CPE_{LE}	CPE_{EL}
1[b]	0.30	0.12	0.09	0.01	0.10	0.12	0.01	0.13	0.01	0.10
2	0.23	0.09	0.14	0.01	0.23	0.15	0.00	0.04	0.01	0.23
3[b]	0.25	0.11	0.13	0.01	0.13	0.12	0.01	0.04	0.01	0.13
4	0.18	0.12	0.17	0.02	0.21	0.15	-0.02	-0.15	0.02	0.21
5	0.23	0.18	0.08	0.01	0.11	0.24	0.00	0.06	0.01	0.11
6	0.23	0.10	0.13	0.01	0.19	0.15	0.01	0.10	0.01	0.19
7[b]	0.17	0.16	0.16	0.03	0.19	0.18	-0.00	-0.02	0.03	0.19
8	0.20	0.11	0.17	0.01	0.20	0.13	0.00	0.01	0.01	0.20
9	0.24	0.09	0.14	0.00	0.20	0.14	-0.00	-0.12	0.00	0.20
10	0.22	0.12	0.12	0.00	0.18	0.18	-0.00	-0.06	0.01	0.18
11	0.25	0.08	0.13	0.01	0.20	0.12	0.01	0.07	0.01	0.20
12[b]	0.20	0.12	0.16	0.01	0.18	0.13	0.00	0.10	0.01	0.18
Substitutes or Complements:										
Substitutes	**12**	**12**	**12**	**12**	**12**	**12**	**8**	**8**	**12**	**12**
Complements	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**4**	**0**	**0**

Note: Swiss data only, nested CES, specification (b).
[a] The following elasticities are identical: $CPE_{KM} = CPE_{LM} = CPE_{EM}$.
[b] Elasticities are estimated from the sample dataset, see Appendix A.2.

(c) LE-nest Combined with K:

Table 48: Cross-price elasticities, Swiss manufacturing, nested CES, spec. (c)

Sector	$\text{CPE}_{KM}{}^a$	CPE_{MK}	CPE_{ML}	CPE_{ME}	CPE_{KL}	CPE_{LK}	CPE_{KE}	CPE_{EK}	CPE_{LE}	CPE_{EL}
1^b	0.32	0.12	0.09	0.01	0.06	0.07	0.00	0.07	0.02	0.22
2	0.22	0.09	0.14	0.01	0.17	0.11	0.01	0.11	0.02	0.27
3^b	0.25	0.11	0.13	0.01	0.12	0.11	0.01	0.11	0.01	0.13
4	0.18	0.12	0.17	0.02	0.17	0.12	0.02	0.12	0.03	0.32
5	0.22	0.17	0.08	0.01	0.10	0.21	0.01	0.21	0.01	0.13
6	0.23	0.10	0.13	0.01	0.16	0.12	0.01	0.12	0.01	0.22
7^b	0.17	0.16	0.16	0.03	0.12	0.12	0.02	0.12	0.04	0.27
8	0.20	0.11	0.17	0.01	0.15	0.10	0.01	0.10	0.01	0.22
9	0.24	0.09	0.14	0.00	0.15	0.10	0.00	0.10	0.01	0.32
10	0.23	0.12	0.13	0.00	0.14	0.14	0.00	0.14	0.01	0.29
11	0.25	0.08	0.13	0.01	0.17	0.10	0.01	0.10	0.01	0.20
12^b	0.20	0.12	0.16	0.01	0.18	0.13	0.01	0.13	0.01	0.18
Substitutes or Complements:										
Substitutes	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**
Complements	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Note: Swiss data only, nested CES, specification (c).
[a] The following elasticities are identical: $\text{CPE}_{KM} = \text{CPE}_{LM} = \text{CPE}_{EM}$.
[b] Elasticities are estimated from the sample dataset, see Appendix A.2.