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Decomposition analysis of changes in value added. A case study of the sawmilling and wood processing industry in Germany

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ABSTRACT

It is basically assumed that a higher level of domestic wood harvesting leads to a higher level of domestic wood use and thus to an increase of value added in the wood processing industry. However, in the past years, the wood input increased in some wood processing sectors in Germany whereas their value added decreased. Against this background we aimed to decompose changes in input and output in order to isolate the effects of value added and to determine the role of wood as intermediate input of the sawmilling and wood processing industries. We regarded the years 2006 compared to 2002 and 2010 compared to 2006. Based on statistical data, a decomposition method was developed that determines changes in the product price, the intermediate input price, the growth and the structural effect. Furthermore, a special focus was set on the impacts of price and quantity changes of the input of wood-based products. We found out, that the growth effect is connected to the wood input in the sawmilling industry in the considered years. Also, it became apparent that a higher input of wood and wood products does not automatically lead to an increase in value added.

1. Introduction and research objective

There is a prevailing understanding that a higher or lower level of domestic harvesting and utilisation of wood induces a higher or lower level of value added in the wood-based industry (*e.g.*, Dieter, 2008). The wood charter of the German Federal Government, for instance, aimed for a 20% increase of the domestic per-capita consumption of sustainably produced wood and wood products, and thus, amongst others for an increase in value added in rural regions (BMELV, 2004).

It is also basically assumed that a higher or lower material input of wood automatically leads to a higher or lower material output of wood products and value added in the wood-based industry. In reality a bundle of factors (*e.g.*, availability of raw materials, substitutional effects and technological improvements) influences input, output and changes of value added. Therefore, for the single industries of the wood-based sector, a general causal link between wood-based input, output and value added is not detectable. Some sectors even show an opposite direction between the development of wood input and the development of value added: whereas wood input is increasing, the value added is decreasing (StBA: F 4 R 4.3; StBA Arbeitsunterlage Rohholz, Mantau, 2012; Seintsch, 2013).

As to the question on the connection between (wood-based) input, output and value added Sinn (2005) provides a possible explanation. According to him, two general trends could be noted in German industrial enterprises in the past few years: an increase in 1) offshoring, *i.e.*, shifting of labour-intensive parts of value added chains to branches abroad and in 2) foreign outsourcing, *i.e.*, buying of material and commodities from foreign suppliers and therefore both avoiding the expensive German labour-costs. Based on this finding, Sinn (2005: 6) developed the "Bazaar-Hypothesis" which states that "the foreign share of value added of the industrial production, the so called vertical integration, declines in favour of foreign countries and that Germany increasingly specialises in "Bazaar-Activities"". He explains, that between 1995 and 2003 four fifth of the decline of value added can be explained by foreign and about one fifth by domestic outsourcing and offshoring. Thus, according to Sinn (2005) an increase in the share of intermediate input and a decrease in the share of value added in a national economy mean to a large extent an outsourcing to foreign economies.

Dieter (2005, 2010) analysed the Bazaar-Hypothesis for the foreign trade with wood and wood-based products of the German economy. Dieter (2005) observed an increase in the balance of foreign trade for timber and timber products. He tested the "Bazaar-Hypothesis" in regard to the timber market by means of input–output-tables for the years 1993 and 2006 and also detected a slight decrease of vertical integration. However, he explained that "within a single sector a decrease of value added could also mean a shifting of intermediate input by means of domestic outsourcing" (Dieter, 2005: 7). Also Dieter (2010) analysed input–output tables for 2004 and discovered mostly domestic outsourcing in the case of the wood-based industry, meaning that production value remains largely within Germany. He explained that outsourcing may also signify a concentration on the core-business

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of the enterprise and an intensification of labour division, helping enterprises to specialise and thus to secure and enhance sales quantities Dieter (2010: 39).

Against this background, we aim to decompose the changes in input and output in order to isolate the effects on value added. We consider changes in product prices, intermediate input prices, growth and structural changes. A special emphasis is put on the effects of price and quantity changes in wood input. As two case study objects we use the economic sectors ES 1610 "Sawmilling and planing of wood" and ES 1621 "Veneer sheets and wood-based panels", both major players in the wood-based industry. We regard the time period between 2002 and 2010. For our purpose a method, based on statistical data, was developed and applied to ES 1610 and ES 1621.

Within the paper, the following research questions shall be discussed:

1. To what extent can the effects be attributed to changes in value added?
2. What is the influence of the intermediate input group "raw wood" and other wood-based commodities on changes in value added?

2. Literature review

So far, diverse methods of a decomposition of effects were used for different purposes of analysis. In general, decomposition studies seek to analyse the effects of single elements of changes in *e.g.*, economic growth, competitiveness, energy consumption or employment over a defined period of time.

Klein et al. (2009), for example, determined regional changes of employment trends of the German wood-based industry, decomposed into national trends, sectoral trends and regional conditions by means of a shift-share analysis. Sakamoto and Fan (2009) examined the disparity of regional income in China, based on value-added data. They focussed on the aspect of distribution which was decomposed into employee's wages, depreciations, operating surplus and net tax on production using a population weighted coefficient of variation.

The industrial economic growth in Bulgaria was examined by Ivanov and Webster (2010). They identified three existing approaches of decomposition for their purpose: the decomposition of the contribution of production factors, the decomposition of types of expenditures and the decomposition of the role of single industries to economic growth. For their study they extended the third approach in order to create the possibility of inter-industrial comparison, by using the gross domestic product as well as the gross value added of industries. Another approach, this time for productivity change, was developed by O'Donnell (2012) by using an aggregate quantity framework to decompose index numbers of total factor productivity "into measures of technical change, technical efficiency change, mix efficiency change and scale efficiency change" (O'Donnell, 2012: 269).

In regard to the determination of competitiveness by means of decomposition Dieter and Englert (2007, 2009), for example, analysed the competitiveness of the global wood industry sector, and especially on Germany. They analysed the growth of export of timber and timber products, amongst others, based on the formula of constant market share analyses (CMS) developed by Milana (1988). In this study, the "periodical change in a country's overall exports is divided into […] (1) the world growth effect, (2) the commodity-composition effect, (3) the market distribution effect and (4) the residual, which is usually interpreted as the competitiveness effect" (Dieter and Englert, 2007: 407).

The method of decomposition is also often used to identify factors of change in energy and environmental indicators. In 1995, Ang (1995) already identified 51 studies featuring decomposition analyses in the energy sector. Ang et al. (1998) used a logarithmic mean weight function for a complete decomposition of changes of energy demand and gas emissions and applied it on case studies for China, Korea and Singapore. Sun and Ang (2000) developed decomposition models by extending basic models by Laspeyres, Paasche and Marshall–Edgeworth in order to eliminate residuals and tested them on a case study on energy-related CO_2-emissions in 15 European countries.

In conclusion, although numerous studies have been conducted, using the decomposition approach in various fields, so far there is no analysis dealing with the effects of changes of production on the value added, especially in the wood-based sector. In contrast to the abovementioned studies, our paper therefore focuses on the decomposition of changes in value added of the economic sectors ES 1610 "Sawmilling and planing of wood" and ES 1621 "Veneer sheets and wood-based panels" in Germany in order to understand its driving factors and the influence of wood input in particular.

3. Material and methods

3.1. Decomposition analysis

As discussed above, an increase in product output, *ceteris paribus*, leads to an increase in value added. However, according to economic theory, an increase in product output also leads to an at least marginal decrease in product prices and an at least marginal increase in input prices. Also, there are other factors which have an impact on input and output prices and changes value added.

Indeed, as mentioned before, for the past years the economic sectors ES 1610 and ES 1621 in Germany have lost value added shares referred to total output value for the benefit of (i) domestic intermediate input (domestic outsourcing) and imports of (ii) intermediate input from abroad (foreign outsourcing) and (iii) products through removal of own production capacities to foreign countries (offshoring).

Taking these considerations into account the (nominal) value added can basically change between two periods or years due to four reasons:

I Change in (nominal) product prices
II Change in (nominal) prices of input goods for intermediate consumption (in the following called intermediate input)
III Change in output of products
IV Change in shares of intermediate input and value added due to outsourcing and offshoring in one direction or vertical integration in the other.

These four reasons can be mathematically formulated as the four elements of change in value added as shown in Eq. (1).

$$\Delta VA = I + II + III + IV \tag{1}$$

With

$$I = X_1^G * P_1^G - X_1^G * P_0^G$$
$$II = X_1^V * P_0^V - X_1^V * P_1^V$$
$$III = (X_1^G * P_0^G - X_0^G * P_0^G) * (1 - S_0^V)$$
$$IV = S_0^V * X_1^G * P_0^G - X_1^V * P_0^V$$

and

$$S_0^V = \frac{X_0^V * P_0^V}{X_0^G * P_0^G}$$

VA	value added
X	quantity of goods
P	price
G	output
V	intermediate input
0	base year
1	reporting year
S^V	share of intermediate input referred to total output value.