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CUTTING EXPORT SUBSIDIES, CROPPING DOMESTIC PRODUCTION: INPUT-OUTPUT ANALYSIS OF THE SWISS DAIRY SECTOR AFTER ABOLISHMENT OF THE 'CHOCOLATE LAW' SUBSIDIES

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Cutting export subsidies, cropping domestic production: input-output analysis of the Swiss dairy sector after abolishment of the 'Chocolate law' subsidies

The `Chocolate law' in Switzerland enables subsidies for dairy and wheat farmers, bound to the condition that their products are exported after processing (Swiss Federation, 2011). Though the Ministerial Conference of the World Trade Organization has decided in December 2015 that this law has to be abolished by 2021 [WTO, 2015]. Cutting subsidies might lead to a demand shock and consequently a cropped domestic production (Miller and Blair, 1985). We analysed in this study the interdependence of the agro-food sectors by a Leontief input-output model and their linkages to other sectors (Chereny and Watanabe, 1958, Leontief 1986) and additionally, the amount, direction and dispersion of the possible demand shock. Hence, non-meat food processors and dairy processing were determined as key sectors as they have strong linkage effects and are rather concentrated to few sectors. Both sectors rely strongly on the output of the raw milk producers and have few sectors to sell their products. Outside of the cut sectors, these sectors will be challenged the most from this new policy.

Key words: agriculture; food production; agro-food sector; dairy production; dairy processing; export subsidies; input-output analysis; legislation; Chocolate law; Switzerland

Ukinitev izvoznih subvencij, zmanjševanje domače proizvodnje: input-output analiza švicarskega mlečnega sektorja po ukinitvi subvencij v okviru "Čokoladnega zakona"

"Čokoladni zakon" v Švici omogoča subvencije za proizvajalce mleka in pšenice, ob pogoju, da bodo šli njihovi proizvodi v izvoz po predelavi (Swiss Federation, 2011). Tako je ministrska konferenca Svetovne trgovinske organizacije decembra 2015 odločila, da je ta zakon treba odpraviti do leta 2021 (WTO, 2015). Ukinitev subvencij lahko vodi do šoka povpraševanja in posledično zmanjšanja domače proizvodnje (Miller in Blair, 1985). V tej študiji smo analizirali soodvisnost agroživilskih sektorjev z Leontievim input-output modelom in njihovih povezav z drugimi panogami (Chereny in Watanabe, 1958, Leontief 1986) in dodatno proučili obseg, smer in razpršenost morebitnega šoka povpraševanja. Predelovalce hrane, razen predelovalcev mesa, in predelovalce mleka in mlečnih izdelkov smo opredelili kot ključne sektorje, ker imajo močne povezave, večinoma koncentrirane na manjše število sektorjev. Oba sektorja sta močno odvisna od prireje surovega mleka in imata omejeno število sektorjev za prodajo svojih izdelkov. Izvzemši sektorje, kjer bodo ukinili subvencije, bosta ravno ta dva sektorja najbolj prizadeta z novo politiko.

Ključne besede: kmetijstvo; živilstvo; kmetijsko-živilski sektor; mleko; prireja; mlečni izdelki; izvozne subvencije; input-output analiza; zakonodaja; Čokoladni zakon; Švica

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1 INTRODUCTION

1.1 DAIRY PRODUCTION AND TRADE IN SWITZERLAND

1.1.1 CAPTURING AGRICULTURAL ECONOMICS OF SWITZERLAND

Switzerland is a relatively small country with 41'285 km^2, 8.3 million inhabitants, low unemployment and high gross domestic production (GDP) (BFS, 2016b, OECD, 2015). In 2014, agricultural commodities were produced on an area of 1.5 thousand hectares, worth 9'536 million Swiss francs (CHF) (BFS, 2015a, BFS, 2015b). This makes a share of 0.74 % of the total GDP. For comparison, the GDP share of agriculture of the EU was 1.6 % and in Slovenia 2.2 % (World Bank, 2016). This output was produced by 54'046 farms, or in employment numbers by 158'762 full-time equivalents (BFS, 2015a). So, 3.25 % of the employees in Switzerland work in the agricultural sector. The sectors in the agricultural value chain including agricultural production, food processing, trade, retail and hospitality industry covered about 11 % of all employees (BFS, 2016b). About 55.7 % of the agricultural production, or 5'305 million Swiss francs (CHF), was accounted to total animal production. Raw milk production was a seemingly important sector with 23.9 % of the agricultural production, or 2'332 million CHF (BFS, 2015a). In terms of quantities dairy farms produced 4'099 million kg of milk equivalents in 2014. These milk equivalents were processed and valorised accordingly: 36.8 % to cheese, 14.0 % to butter, 12.5 % for animal feed, 11.0 % to milk for human consumption, 9.3 % to permanent milk products, 6.9 % to cream, 5.4 % to yoghurt and 4.2 % for other products (AGRISTAT, 2015).

1.1.2 GOVERNMENTAL FRAMEWORK FOR AGRICULTURAL PRODUCTION

The political framework for Swiss agriculture ensured in the federal constitution that policy measures incited sufficient food provision and the use of the multifunctionality of agriculture. These measures were steered by direct payments to farmers who contributed to the objectives as for example biodiversity in agricultural areas, reduction of the nitrate and phosphate level near rivers and lakes, especially animal-friendly conditions for livestock, sustainable use of summer pastures and more (BLW, 2016b, OECD, 2015, Swiss Federation, 1998). In 2015 the Swiss government spent 3,667 million CHF for the account of agriculture and food production. This made 5.6 % of the total expenditures (EFV, 2016). About 79.8 % of the account on agriculture and food production was spent in 2015 for direct payments (BFS, 2016a). Direct payments might be one factor stimulating what and how to produce. Another one are market and sales potential in which the export is a factor.

1.1.3 RAW MILK PRICING ACCORDING TO USE

The agricultural sector, the dairy sector in particularly, was highly regulated. These regulations included besides of legal restrictions and taxation also subsidies. Subsidies influenced the flow of goods towards the products they are processed or valorised. So a dairy farmer got 0.15 CHF per kg milk if the milk is processed to cheese, and additional 0.04 CHF per kg if the cows were fed without silage. This support aided dairy processors to purchase raw milk by a lower price and dairy processors to have this lower price compensated. The sector organization for dairy farmers (Branchenorganisation Milch – BO Milch) negotiated and calculated the prices for raw milk according to its valorisation and use. The milk

Table 1: *Trade of dairy products in 2015 in Switzerland*
Preglednica 1: *Trgovina z mlečnimi izdelki v letu 2015 v Švici*

	Import		Export	
	Quantity	Value	Quantity	Value
Products	10^6 *kg*	10^6 *CHF*	10^6 *kg*	10^6 *CHF*
Milk and cream, not concentrated nor containing added sweeteners	25.06	19.79	7.13	11.72
Milk and cream, concentrated or containing added sweeteners	2.78	9.61	9.36	31.22
Yoghurt and processed milk drinks	10.67	16.28	5.21	17.60
Whey	8.67	30.60	91.26	25.23
Butter	0.19	0.90	1.89	6.06
Cheese and curd	55.47	346.11	64.23	572.88

prices were segmented in A-, B-, or C-milk since 2011. Throughout the year 2015, the recommended milk price for raw milk which had been domestically processed, under border protection but which received 'raw material compensation', alias A-milk, was 0.68 CHF per kg. Even if the raw milk was domestically protected, the processed products were exported. This was achieved through governmental aid using price compensations. The median milk price for milk which was not under border protection, alias B-milk, was 0.477 CHF per kg. This milk was mostly processed for domestic or EU markets. Lastly, the median milk price for unprotected raw milk at world market price, alias C-milk, was 0.202 CHF per kg. This type of milk was mainly exported as butter or milk powder [BO Milch, 2016a]. As for the pricing, dairy producers and processors agree contractually for the price and quantity. Except for C-milk: dairy producers are protected from price dumping or being pressured to subscribe a contract for C-milk. The milk price segmentation had the purpose to guarantee a high raw milk price for highly valorised products[4] (BO Milch, 2016b).

1.2 AGRICULTURAL TRADE AND TRADE POLICY

1.2.1 AGRICULTURAL TRADE POLICY IN SWITZERLAND

Switzerland is not part of the European Union (EU), but the EU is their most important trade partner (OECD, 2015). By not being part of the EU the Swiss market has been kept protected by tariffs, especially for agricultural products. Hence Swiss farmers profited by marketing products with a higher price. The producer prices for agricultural commodities were in average over 40 % of the world market prices (OECD, 2015). In general, trade allows to use cost advantages to access less costly input (Smith, 1776). Two examples showed the differences in price levels for agricultural goods: First example showed the raw milk price differences between Switzerland and Germany, a neighbour country. Between June 2015 and May 2016, the raw milk price had been kept in Switzerland around the average of 61.7 Rappen per kg (= 56.8 Euro cents per kg)[5]. The raw milk price has been kept almost stable with a slight decrease (BLW, 2016a). By having a look on Switzerland's neighbour country Germany, the milk price has been decreasing since January 2014 from 44.9 Euro cents per kg raw milk to 22.1 Euro cents per kg in June 2016. As for the period between June 2015 and May 2016, the average raw milk price was 22.4 Euro cents per kg (ife, 2016).

Another example is wheat production. The sector organization for wheat producers (swiss granum) classified the different recommended species according to their quality in five different classes. The tests included quality measurements for cultivation, as for example steadiness or resistance to pests, measurements for yield, as for example smooth rupture wort weight or yield per area. Each quality class had their own benchmark price from 520 CHF (= 478.62 Euros) per tonne for the best quality to 365 CHF (= 335.96 Euros) per tonne for 'Fodder wheat' (swiss granum, 2016a, swiss granum, 2016b). In 2015, the average price for soft wheat of the 28 EU countries was 164 Euros per tonne and for durum wheat 279 Euros per tonne (EUROSTAT, 2016). Hence, these price differences urged Swiss farmers to advocate protectionism.

1.2.2 TRADE PATTERNS OF DAIRY PRODUCTS

As Switzerland gradually abolished the border protection in 2003 for cheese and curd the trade patterns have changed. This policy change counteracted the trend of decreasing cheese exports: the quantity of cheese exports was decreasing from 1990 to 2003 by 1.6 % per year but increasing by 2.4 % per year between 2003 and 2011. Though the increase was slowed down due to currency exchange rates from 2008 on. On the other hand, the imports increased by 1.6 % per year between 1990 and 2004. Between 2005 to 2011 the imports increased to 6.5 % per year (BAKBASEL, 2012). The import and export time series from the Eidgenössische Zollverwaltung (EZV – Swiss Federal Customs Administration) for dairy products revealed similar change for other dairy products after the year 2003. Table 1 illustrates the scope of trade patterns of dairy products in 2015 (EZV, 2016b). Discussions on abolishment of trade barriers for other milk products, as raw milk is part of the current debate. However, since the abolishment of the 'Chocolate law' subsidies was decided, the output structure of Switzerland's agricultural products was facing a change.

1.2.3 A SYSTEM FOR CHOCOLATE: 'CHOCOLATE LAW'

Besides various factors as input prices or currency exchange rates, demand is a major determinant for the flow of products. Next to domestic demand, foreign demand, saturated by exports, is important factor. This can

4 A list with products and their segmentations can be retrieved in German at: http://www.iplait.ch/images/stories/pdf/Marktentlastung/prod_liste_segm_121112_d.pdf

5 Exchange rate: 1 Euro - 0.92 CHF. Retrieved on 08.07.2016

be influenced by trade policies, as regulations of import or export quantities. Imports and exports can be inhibited by tariff barriers or non-tariff barriers as quotas. Besides of reducing the trade, trade can be also supported, for example by subsidizing exports. So is it done in Switzerland. Raw milk and wheat producer received financial support to compensate price differences. This was linked to the condition that the final product was exported, mostly after processing, and ensured to reach sales potential abroad (Swiss Federation, 2011). This sort of export subsidy was legally contributed by the so-called 'Chocolate law' (Swiss Federation, 2011). Contributions from the 'Chocolate law' were set for 2016 to 94.6 million CHF, of which 81.6 million CHF for dairy producers and 13.0 million CHF for wheat producers (EZV, 2016a). 'Chocolate law' expenditures were statistically not recorded as export subsidies, but in fact, they were that. Export subsidies contradicted global trade treaties as the one from the World Trade Organization (WTO).

1.3 POLICY CHANGE: WORLD TRADE ORGANIZATION

1.3.1 THE PURPOSE OF THE WORLD TRADE ORGANIZATION

The WTO pursued liberalization of the markets: a distortion free trade by enhancing competition through, for example, lowering tariffs[6]. WTO was established in 1995 as the result of the Uruguay Round and predecessor General Agreement on Tariffs and Trade (GATT) negotiations. GATT negotiations started in Geneva in 1947 and pursued reducing of trade barriers and abolishment of trade discrimination. The Uruguay Round stands for negotiations between 1986–1994 fostering trade by contracting the partners to lower subsidies or allow foreign investments with a non-discrimination principle between its members. The non-discrimination principle was a mechanism which led to apply the best trade agreements (lowest tariffs and restrictions) among two countries to all of their trade partners, with few exceptions particularly for least developed countries.

1.3.2 EXPECTATIONS FROM EXTENDED TRADE AND PROMISES OF THE WTO

Governmental interferences led to market distortions regarding the price, quantity and so the surpluses (Varian, 2010). Already Smith (1776) and Ricardo (1817) stated that liberalization of the markets was promising to have access and choice for the least costly inputs and to all products over the globe to choose the best fit for the production. A survey from 1976 stated that 97 % of the economists partly or fully agreed upon the statement *"Tariffs and import quotas reduce general economic welfare."* (Kearl et al., 1979). This conclusion was also given by the established textbooks on economics as from Mankiw (2014) or Varian (2010). The interactive map of the World Trade Organization (WTO) on market access data visualised the tariffs for several products on a global scale. It visualized that the tariffs are generally higher for agricultural products than for other commodities, and in particularly high for dairy products (WTO, 2016a). The aim of WTO was to improve the living standards and welfare of the people in its member countries. By November 2015 the WTO counted 162 countries as members (WTO, 2016b).

1.3.3 WTO MINISTERIAL CONFERENCE

As retrieved from the WTO's homepage[7]:

"The WTO Ministerial Conference is the top-most decision making body of the WTO."

"Its structure is headed by a Ministerial Conference meeting at least once every two years. A General Council oversees the operation of the agreement and ministerial decisions on a regular basis. This General Council acts as a Dispute Settlement Body and a Trade Policy Review Mechanism, which concern themselves with the full range of trade issues covered by the WTO, and has also established subsidiary bodies such as a Goods Council, a Services Council and a TRIPs Council. The WTO framework ensures a "single undertaking approach" to the results of the Uruguay Round — thus, membership in the WTO entails accepting all the results of the Round without exception."

The WTO Ministerial Conference meeting in Nairobi, has decided in December 2015 the abolishment of 'Chocolate law' subsidies by 2021 (WTO, 2015). An assessment the influence of this subsidy cut will have on domestic production became necessary.

1.4 THE NEED FOR A SYSTEMIC ASSESSMENT

Enhancing trade, lowering tariffs and cutting export subsidies are not novel ideas, but its implementa-

6 http://www.wto.org

7 World Trade Organization's homepage. Online, retrieved: 10.07.2016: http://www.wto.org

Table 2: *A symmetrical input-output table*
Preglednica 2: *Simetrična vhodno-izhodna preglednica*

Sector from / to	1	...	j	...	n	Final demand	Total output
1	$X11$	...	X_1j	...	$X1n$	$Y1 = C1 + N1 + G1 + E1$	X_1
...	...		...		...	...	...
i	X_i1	...	X_{ij}	...	Xin	$Yi = Ci + Ni + Gi + Ei$	X_i
...	...		...		...	...	...
n	$Xn1$	...	Xnj	...	Xnn	$Yn = Cn + Nn + Gn + En$	X_n
Imports	M_1	...	M_j	...	M_n		
Value added	V_1	...	V_j	...	V_n		
Labour	L_1	...	L_j	...	L_n		
Total input	X_1	...	X_j	...	X_n		

tion has found its most recent spot for agricultural commodities. The agricultural sector is characterized for its embeddedness in natural production systems, interdependence with other agricultural sectors by purchases for inputs and influence in downstream sectors by sales of its outputs. Hence, each change of final demand effects the upstream or downstream sector, knowing which way is helpful for policy makers or consultants (Miller and Blair, 1985, Augustinovics, 1970). This makes it necessary to assess the impact between the cut of export subsidies and domestic production by an input-output model. We expected that our results would provide information about the magnitude of change for different sectors and determine to which products the export in these sectors will react sensitively.

Following, research questions are defined:

1. How seriously will the sectors within the agro-food chain reduce their production due to the abolishment of the 'Chocolate law' subsidies?
2. Which agricultural sectors react sensitive on the cut of 'Chocolate law' subsidies?

2 MATERIAL AND METHODS

2.1 INPUT-OUTPUT MODEL: THEORETICAL FOUNDATIONS

2.1.1 APPROACH TO QUANTIFY SECTORAL FLOWS

The input-output analysis method had the fundamental purpose to study the interdependence of sectors of an economy (Miller and Blair, 1985). This was done by quantifying the monetary flows from supplied output sectors to used input sectors. Each sector aggregates its output as homogeneous products (Leontief, 1986, ten Raa, 2010). Hence, an input-output table illustrated financial flows between sectors and was qualified for a structural analysis of the economy (BFS, 2015c). Input-output models were related with general equilibrium approaches in empirical studies of interdependencies (Leontief, 1986). Following, the strengths of the input-output method is to compute and analyse sectoral distribution of the demand driven changes. The changes of produced output were calculated after appropriate manipulation of the final demand as vector shocks. Sensitive key sectors were determined by calculation of multiplier effects (Miller and Blair, 1985). After all, an input-output model is an application of linear algebra using common spreadsheet applications. Furthermore, academicians, researcher and policy designer developed this approach in various ways: from company specific applications to multi-regional input-output tables or to include environmental assessments as energy use or pollution impacts (Isard, 1951, Miller and Blair, 1985, Mattas et al., 2006, Banaszewska et al., 2013).

2.1.2 DATA GATHERING AND ORGANIZATION

Data for this approach has to be gathered from direct surveys and later organized in supply and use tables (Leontief, 1986). Though data gathering is a time- and thus expenses-consuming approach. Following, the modellers of input-output tables as statistical offices or research institutes retrieved data from secondary sources as from statistics of enterprise structures. This data has been organized in supply and use tables. The supply table illustrated the production of goods per sector, a use table analogously illustrated the use by the purchasing industry and final demand. Symmetrical input-output table was compiled out of both tables. The term symmetrical emphasized that the number of sectors for both input and output have to be the same. The values of this input-output table are formally written as a matrix with the elements X_{ij}. An example of such a table was outlined formally in Table 2. If the table is read as from the row (*i*) to the column (*j*), each row *i* described the sold output to each sector to a column *j*. Hence, the columns listed the required inputs by a sector to produce its outputs. The symmetrical matrix of $n \times n$ elements is called the transaction matrix. The transaction matrix summarized the direct requirements for producing a unit of output from the respective sector. Additional columns as the vector for final demand (*Y)* are added to the end. Final demand consists of the sectoral sum of consumption (*C*), investments (*N*), government expenditures (*G*) and exports (*E*). Additional rows might describe imports (*M*) and additional non-industrial inputs as value added (*V)* or labour (*L*). Total output (or input respectively) is the row (or column respectively) sum (Miller and Blair, 1985, Leontief, 1986, Mattas et al., 2006).

2.1.3 LEONTIEF MODEL

Once the data is organized in an input-output table a Leontief model can be derived from. The Leontief model is characterized by following elements (Leontief, 1986, Mattas et al., 2006):

2.1.3.1 Direct requirements matrix

The transaction matrix is retrieved by dividing the X_{ij} elements by the total output of the sector. Hence the transaction matrix alike equation 2 with the technical coefficients from the equation 1 has been constructed. The technical coefficients illustrate the required input per produced output.

$$\mathrm{a_{ij}} = \frac{\mathrm{X_{ij}}}{\Sigma_{\mathrm{i=1}}^{\mathrm{n}} \mathrm{X_{ij}}} \tag{1}$$

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} \tag{2}$$

2.1.3.2 Leontief inverse

The Leontief inverse is the matrix of interdependence coefficients. It is computed by the equation $(I - A)^{-1}$. *I* is the identity matrix, a $(n \times n)$ matrix with the diagonal values 1 where all other values are 0. This matrix included the impact of inter-sectoral effects, namely effects of other sectors than the sector *i*. Thus, this matrix is the key of the analysis (Miller and Blair, 1985). The elements of the Leontief inverse matrix were described with b_{ij}.

The Leontief model had this known form (Leontief, 1986):

$$X = (I - A)^{-1} \times Y \tag{3a}$$

$$\Delta X = (I - A)^{-1} \times \Delta Y \tag{3b}$$

For this analysis, the equation 3b was used due to particular interest in sensitivity of the sector rather than prediction.

2.1.3.3 Assumptions

The calculation of the matrices with their elements defined some assumptions of Leontief's basic input-output model:

- Sectors produce homogeneous products
- Externalities are absent
- No constraints in the capacity of production factors
- Fixed coefficients of production

2.1.4 INPUT-OUTPUT MULTIPLIER

Linkage effects in general describe whether the change of final demand for a sector effects the sectors from which the inputs were bought or increases the production of the sectors to which outputs were sold (Miller and Blair, 1985, Augustinovics, 1970). Various authors have described methods to calculate linkage effects with their specifications and advantages (Dietzenbacher and van der Linden, 1997, Miller and Blair, 1985, Hirschman, 1958, Chereny and Watanabe, 1958, Rasmussen, 1956). The most basic one was described by Chenery and Watanabe (1958) as direct linkage multipliers were calculated by the sums of the matrix elements of the direct requirements matrix *A*. Column sums described backward linkages, while row sums analogously described forward linkages. These multipliers have been criticised to only consider direct linkage effects. Yet total linkage multipliers consider the effects by other than the observed sector. Hence, the total linkage multipliers were taken into account for this study. They were analogously calculated as direct linkage multipliers, but from the matrix of the

Leontief inverse. The total backward linkage multiplier explained the dependence of the observed sector on other sectors. The total forward linkage multiplier explained the dependence of other sectors on the observed sector. Hence, if the total forward linkage multiplier was rather high, it indicated a sector which supplies other sectors. On the other hand, a rather low total forward linkage multiplier indicated a sector which produced for final demand. As for the total backward linkage multipliers, a higher number indicated high sales to manufacturing sectors, and vice versa (Temurshoev, 2004, Chereny and Watanabe, 1958, Rasmussen, 1956). Equation 4a described the calculation of the total backward linkages as column sums of the Leontief inverse and 4b the total forward linkages as row sums of the Leontief inverse.

$$\Gamma_i = \sum_{j=1}^{n} b_{ij} \tag{4a}$$

$$\Gamma_j = \sum_{i=1}^{n} b_{ij} \tag{4b}$$

Magnitude and dispersion of the shock to other sectors was not considered by the linkage effects. Thus, their magnitude and variance coefficients needed to be assessed. The coefficient was introduced with the variable π. This coefficient quantified the magnitude of effects by a sector's change of final demand to other sectors. If π was greater than 1, it meant that this sector affected other sectors stronger compared to the average and *vice versa*. The calculation of the coefficient is described in equations 5a and 5b (Rasmussen, 1956, Fernández Fernández and Santos, 2015). Equation 5a worked with total backward linkages and assessed its power of dispersion. Analogously it works for the total forward linkages by the equation 5b. Additionally equation 5b can be understood as sensitivity to changes of demand (Fernández Fernández and Santos, 2015). Rasmussen (1956) classified according to the value of this magnitude coefficients the sectors whether they are: key sectors, pushing sectors, strategic sectors or independent sectors.

$$\pi_i = \Gamma_i \times \left(\frac{\sum_{i=1}^{n} \Gamma_i}{n} \right)^{-1} \tag{5a}$$

$$\pi_i = \Gamma_j \times \left(\frac{\sum_{j=1}^{n} \Gamma_j}{n} \right)^{-1} \tag{5b}$$

Calculation of the coefficients π_i and π_j assume that the effects are uniformly distributed. Hence, the dispersion of the shock had to be assessed. This was calculated by the variable ρ with the equations 6a and 6b. The coefficient ρ_i assessed the dependence, whether the sector relied on rather more or less upstream sector's output. A large ρ_i indicated that the sector purchased their input from relatively few sectors. *Vice versa* was the coefficient for the downstream effects calculated and interpreted by ρ_j (Fernández Fernández and Santos, 2015, Humavindu and Stage, 2013, Schuschny, 2005, Rasmussen, 1956).

$$\rho_i = \frac{\sqrt{\frac{1}{n-1} \Sigma_{j=1}^{n} \left(b_{ij} - \Gamma_i \right)^2}}{\Gamma_i} \tag{6a}$$

$$\rho_j = \frac{\sqrt{\frac{1}{n-1} \Sigma_{i=1}^{n} \left(b_{ij} - \Gamma_j \right)^2}}{\Gamma_j} \tag{6b}$$

2.1.5 CLASSIFICATION OF THE EFFECTS

Rasmussen (1956) classified the key sectors accordingly:

- If $\pi_i > 1$ and $\pi_j > 1$, the sectors are classified as key sectors. These sectors have effects of a high pushing capacity to other sectors. In the same time, these sectors sensitively rely to their inputs.
- If $\pi_i > 1$ and $\pi_j < 1$, the sectors are classified as pushing sectors. These sectors effect with an above average magnitude to upstream sectors.
- If $\pi_i < 1$ and $\pi_j > 1$, they are classified as strategic sectors. These sectors largely depend on the demand by the downstream sectors.
- The remaining sectors are classified as independent sectors. A low interdependence to both upstream and downstream sectors are characterizing these sectors.

The visualisation of the effects was leaned on to the works of Ruenda-Cantuche et al. (2009) and Humavindu & Stage (2013). This had the advantage of including Rasmussen's classification and additionally assigning the relative dispersion of the shock. Hence, the dispersions for both backward and forward effects ρ were normalized as described in equation 7a and 7b, respectively. $\rho^N_{i,j} < 1$ indicated that the backward or forward effects were rather dispersed. At the same time $\rho^N_{i,j} > 1$ indicated that the effects were concentrated to a few sectors. From that, sectors' sensitivity was interpreted.

$$\rho_i^N = \frac{n\rho_i}{\sum_{i=1}^{n}\rho_i} \quad (7a)$$

$$\rho_j^N = \frac{n\rho_j}{\sum_{j=1}^{n}\rho_j} \quad (7b)$$

2.2 THE GTAP MODEL

2.2.1 THE GTAP CONSTRUCT

The Global Trade Analysis Project (GTAP) met the demand for a quantitative policy analysis tool for a globally integrated economy. The interest to estimate impact of trade policies was approached. The used approach was a sectoral analysis by calculating a general equilibrium with the aid of input-output tables (Hertel, 1996). According to the project webpage, first release of the GTAP data base was in 1993, while the most recent version, GTAP 9 data base, was published in May 2015[8]. Besides of economic production data the GTAP Data Base contains environmental data as well. The GTAP had a track record of success over the decades. Google Scholar calculations of all the nine GTAP Data Base versions documented more than 2600 scholar citations. And furthermore, over thousand applications of the model for studies on international trade and over 890 on growth and development were recorded (Aguiar et al., 2016). The success underlined the commitment of a large network of individuals contributing to the GTAP Data Base. Their contribution of input-output tables was followed by a procedure to bring these tables to a common level regarding specifications of the project (Huff et al., 2000, Aguiar et al., 2016). The Leontief inverse was compiled as described above.

2.2.2 GTAP DATA BASE 9 AND SWITZERLAND

The GTAP Data Base 9 covered 120 countries, 57 sectors and all but 2 % of the world's GDP for the reference years 2004, 2007 and 2011. Besides production data, GTAP Data Base 9 contained data on consumption, energy use, CO_2 emissions, labour and international trade (Aguiar et al., 2016). GTAP Data Base 9 was released in May 2015, hence the most recent input-output table of Switzerland for the year 2011 was not published at this time. Thus, the input-output table of the year 2008 was disaggregated for the use of GTAP Data Base 9, same as it was used in GTAP Data Base 8 (van Nieuwkoop and Nathani, 2012). The advantage of using the GTAP Data Base input-output table laid in the high disaggregation of the agro-food sectors. Out of the 57 sectors, 20 dealt with agriculture or its downstream sectors (Aguiar et al., 2016).

For this study the selected sectors are all sectors from the agricultural sectors or downstream sectors including trade and retail. The sector for paddy rice (GTAP ID 01) was excluded because Switzerland has actually no rice production according to statistics (BFS, 2016b). Following sectors, declared with GTAP ID and explained, were chosen to be assessed by this study:

02 wht: Wheat: wheat and meslin
03 gro: Other grains: maize, barley and other cereals
04 v f: Vegetables and fruits
05 osd: Oil seeds
06 c b: Cane and beet
07 pfb: Plant fibres
08 ocr: Other crops
09 ctl: Cattle
10 oap: Other animal products (swine, poultry, egg, ...)
11 rmk: Raw milk
19 cmt: Cattle meat (fresh or chilled)
20 omt: Other Meat (pig etc.)
21 vol: Vegetable Oil and by-products
22 mil: Milk: dairy products
23 pcr: Rice processing
24 sgr: Sugar processing
25 ofd: Other food (rest)
26 b t: Beverages and tobacco
47 trd: Trade and retail

2.3 SHOCK DESIGN

As the Leontief model described, the abolishment of the export subsidies directly affected the final demand. The system has been shocked by a change of the final demand vector. The chocolate law subsidies affected the sectors for wheat and milk production, namely the sectors with the GTAP ID 02 and 11. The 'Chocolate law' subsidies were increasing for the years 2014, 2015 and 2016 from 70 to 95.6 million CHF. For the observed period the share of the subsidies for wheat production were 15.96 % and for raw milk production 84.04 %. A shock vector to simulate the changes in final demand was needed. This shock vector was described as a column vector as equation 2.3. As for the shock vectorfor this study the amount of 'Chocolate law' subsidies were set to 100 million US$. The subsidies were distributed according to the average mentioned above: Y_{02} = 15.96 and Y_{11} = 84.04. The model was run twice. Once with the change in final demand for the wheat producing sector, and once for raw milk production. Probably due to

8 https://www.GTAP.agecon.purdue.edu/databases/

***Table 3:** Results of the calculations: Output, intensity and dispersion of the linkages*
***Preglednica 3:** Rezultati izračunov: obseg, intenzivnost in disperzija povezav*

Sectors	Output reduction				Total linkages				Dispersion coefficients			
(GTAP ID)	10^6 US$	Rank	in %	Rank	Γ_i	Rank	Γ_j	Rank	ρ_i	Rank	ρ_j	Rank
Raw milk production (11)	96.001	1	4.41	2	9.944	18	5.428	32	3.218	42	3.545	15
Trade and retail (47)	65.485	3	0.11	36	112.485	2	5.752	31	0.297	56	36.549	3
Food processing, other (25)	25.463	6	0.35	6	27.402	10	17.210	14	1.636	47	3.164	19
Wheat production (02)	17.149	10	18.40	1	1.444	43	7.680	27	23.137	16	1.014	40
Milk processing (22)	15.344	11	0.31	7	20.150	13	24.751	7	2.911	43	1.641	35
Beverages and tobacco (26)	2.384	24	0.12	27	5.678	25	15.963	16	7.695	30	0.768	44
Other meat (20)	2.148	26	0.17	18	5.247	28	19.254	12	8.926	27	0.704	45
Other crops (08)	2.080	27	0.38	5	3.193	36	4.094	41	9.900	24	2.262	26
Other animal products (10)	2.032	29	0.17	17	5.944	24	8.791	23	5.673	35	1.635	36
Cattle (09)	1.952	30	0.16	20	6.429	23	4.817	36	4.929	36	2.884	21
Cattle meat processing (19)	1.872	31	0.17	16	4.856	31	12.182	21	7.796	29	0.959	41
Sugar processing (24)	1.136	36	0.29	8	3.475	34	7.054	29	10.072	23	2.283	25
Other grains (03)	0.552	40	1.40	3	1.261	49	89.368	2	162.364	2	0.091	56
Cane and beet (06)	0.432	41	0.28	9	2.362	39	4.062	42	13.373	21	2.387	23
Vegetable oil (21)	0.373	43	0.21	14	1.619	42	57.118	4	74.878	4	0.148	54
Vegetables and fruits (04)	0.325	44	0.25	10	1.346	46	22.357	9	41.016	9	0.341	52
Rice processing (23)	0.075	48	0.13	25	1.120	50	3.057	52	28.058	14	2.466	22
Oil seeds (05)	0.017	51	0.23	12	1.333	47	156.596	1	270.362	1	0.062	57
Plant fibres (07)	0.007	54	0.15	23	1.019	54	54.228	5	114.137	3	0.140	55

Figure 1: *Distribution of the shock: Due to decrease of wheat and raw milk production*
Slika 1: *Porazdelitev šoka: zaradi zmanjšanja pridelave pšenice in prireje surovega mleka*

linearity, the results were summed together to have a total for ΔX. By this approach, the quantity of output reduction was identified by the sector of which the final demand was reduced.

$$\Delta \mathrm{Y} = \begin{pmatrix} Y_{01} = 0 \\ Y_{02} = x \\ \vdots \\ Y_{11} = y \\ \vdots \\ Y_{57} = 0 \end{pmatrix} \qquad (8)$$

3 RESULTS AND DISCUSSION

3.1 CHANGE OF OUTPUT

The total reduction of the output due to reduced final demand was calculated to 578.7 million US$, or by 0.11 %. A detailed view to agro-food chain sectors and trade are summarized in Table 3, assorted by a decreasing change of output. Additionally, Figure 1 visualizes the share to which sector the reduction is due to in percentage. The highest reduction of output is expected for raw milk production by 96.0 million US$. This means a reduction by 4.46 %, which is the second highest share. The reduction of the dairy sector, including the 15.3 million US$ of dairy processors, might have a major effect to grain producers. The grain producing sector is the fifth highest affected sector in terms of percentage of output reduction. Even if the absolute output reduction is only about 0.5 million US$, the decrease in dairy production and processing might affect this sector majorly, mainly because of feed and fodder production. Also the dairy processors will decrease their output processed from domestic input by 15.3 million US$ or 90.3 % due to the subsidy abolishment of the raw milk sector.

The second highest reduction of output is expected for the trade and retail sector by up to 65.5 million US$. Though compared with the share to the total output it is the least affected sector involved in the agro-food chain. A relatively high share of 23.5 % is due to the reduction of the trade and retail sector as a consequence of the abolishment of the subsidies for the wheat sector.

Thirdly, the cut of 'Chocolate law' subsidies cropped the calculated output of the food processing sector (25) by up to 25.5 million US$. This is to 90.4 % because of the reduction of the subsidies for the raw milk producers. As for the decrease in wheat production, the output might be reduced by 17.1 million US$ which makes 18.40 %. This is the highest reduction in percentages. The output reduction of the remaining sectors is more than factor 6 compared to milk processors, as listed in table 3. However, it is interesting to point out, that the sector other grains will reduce their output by 1.41 % which is the third highest reduction compared to output within the selected sectors. This is expected due to the fodder supply to the dairy sector.

3.2 MULTIPLIER EFFECTS

3.2.1 LINKAGE EFFECTS

The multipliers were calculated as described in equations 4a and 4b, and 5a and 5b. The results are summarized in table 3. The sectors 09, 11, 25 and 47 show a higher

Table 4: Arrangement and classification of the linkage effects and their dispersion
***Preglednica 4:** Razporeditev in klasifikacija učinkov povezav in njihova disperzija*

Linkage		$\pi_j > 1$		$\pi_j < 1$	
	Dispersion	$\rho^N_j < 1$	$\rho^N_j > 1$	$\rho^N_j < 1$	$\rho^N_j > 1$
$\pi_i > 1$	$\rho^N_i < 1$	22, 25	–	–	47
	$\rho^N_i > 1$	–	–	–	–
$\pi_i < 1$	$\rho^N_i < 1$	–	–	09, 10, 11	–
	$\rho^N_i > 1$	03, 04, 05, 07, 20, 21	–	02, 06 08, 19, 23, 24, 26	–

total forward linkage, the remaining sectors effect rather upstream sectors. The 'Chocolate law' subsidies receiving sectors, wheat production (02) and raw milk production (11) differ at the point in which way the change of final demand will affect the economy. Wheat production (02) has a much higher total backward linkage (Γ_i) than total forward linkage (Γ_j). While the abolishment of 'Chocolate law' subsidies in raw milk production (11) will effect sectors using their output.

Some of the linkage multipliers are very high, as for example $\Gamma_{j=05}$ = 156.596 or $\Gamma_{i=47}$ = 112.485. It has been stated that calculating linkage effects with the method of Chenery and Watanabe (1958) or Rasmussen (1956) might overestimate the values (Dietzenbacher and van der Linden, 1997). The purpose of this study is not to estimate the linkage multipliers with the highest accuracy but to have a first insight in their directionality and relative intensity. Hence, the simpler and more robust method by Rasmussen (1956) was kept and normalized as mentioned in section 2.1.

3.2.2 MAGNITUDE AND DISPERSION OF LINKAGE EFFECTS AND DEPENDENCY

The linkage multipliers were normalized to π and assessed, whether they are greater or less than 1. This procedure allowed to set the results in relation to each sector rather than focusing on absolute numbers (Schuschny, 2005, Rasmussen, 1956). This helped to determine the key sectors. The key sectors were distinguished by having π_i and π_j greater than one. Hence, the sectors of food processing (GTAP ID: 25) and milk processing (GTAP ID: 22) were defined as key sectors. Both of these sectors have a high influence to downstream sectors and highly rely on the upstream sectors. For both ways, they are dependent on rather many sectors, for having a ρ_i and ρ_j less than 1. As for the sector trade and retail (GTAP ID: 47) it shows a high backward linkage. The changes of output for this sector will highly affect the upstream sectors because of ist high dependence and influence on the upstream sectors. In the Rasmussen classification, this would be defined as a pushing sector (Fernández Fernán-

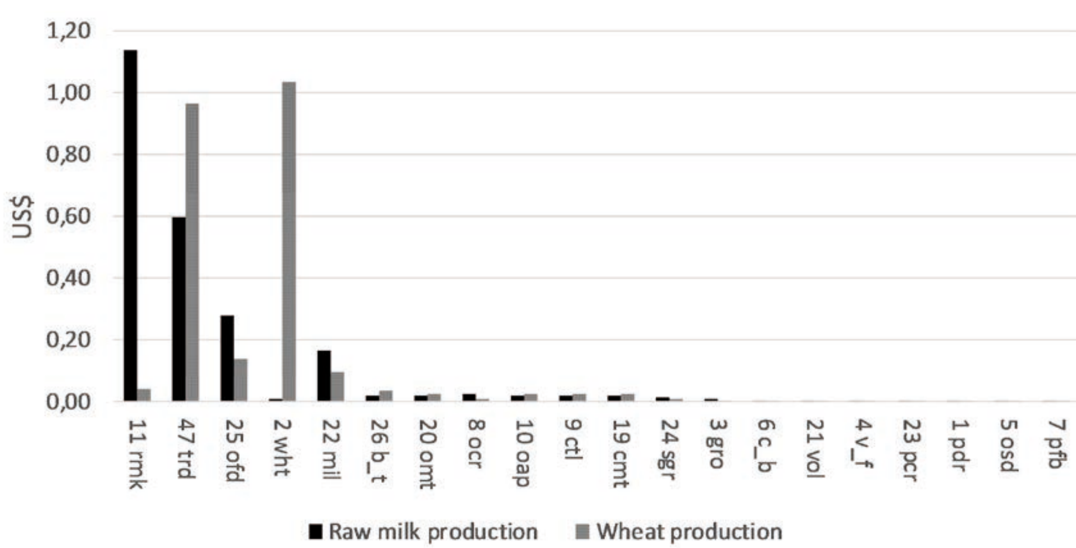

***Figure 2:** Reduction of the sector output per 1 US$ subsidy reduction per sector*
***Slika 2:** Zmanjšanje sektorskega proizvoda na 1 dolar zmanjšanja podpor na sektor*

dez and Santos, 2015, Rasmussen, 1956). The impact on the downstream sector is low, but concentrated to few sectors above average.

There are sectors from primary production classified as having strong forward linkages. This is true for production of grains (GTAP ID: 03), vegetables and fruits (GTAP ID: 04), oil seeds (GTAP ID: 05) and plant fibres (GTAP ID: 07), as well as for processors in the agrifood chain the processors of non-cattle meat (GTAP ID: 20) and vegetable oil and by-products (GTAP ID: 21). These sectors have rather little but concentrated effects on the sectors where they are buying their inputs, but at the same time rather high but dispersed effects on the downstream sectors. In the classification of Rasmussen (1958) these sectors count as strategic sectors. The rest of the sectors, including wheat production (GTAP ID: 02) show low interdependence.

3.3 SENSITIVITY

The shock sensitivity was assessed by calculating the change of output ΔX per unit US$. Figure 2 shows the sensitivity. Sectors 02, 07, 26 and 47 are seemingly more sensitive to the reduction of final demand for wheat, whereas sectors 03, 04, 06, 08, 11, 22, 24 and 25 are seemingly more sensitive to the reduction of final demand for raw milk. The key sectors as dairy processing sector (GTAP ID: 22) rely to 63.9 % to raw milk inputs and other food processors (GTAP ID: 25) even up to 66.9 %. The sectors 05, 09, 10, 19, 20, 21 and 23 vary at 50 ± 10 %.

4 CONCLUSION

A first assessment of the effects of the abolishment of the 'Chocolate law' subsidies on domestic production was conducted. The used 57 × 57 Leontief matrix for the Input Output model and GTAP Data systemically approached the crop of domestic production by a change in final demand. Sensitivity to change was calculated by the change of output by change of final demand per unit US$. Our calculations showed the interdependencies with coefficients for the magnitude and dispersion of linkage effects and the scale of the effects of the abolishment of 'Chocolate law' subsidies.

Regarding the methods, besides of many advantages of using the Leontief input-output model, as its robustness and systemic approach, the limitations as fixed economies of scale have to be remembered. The usage of GTAP Data Base had the advantage to use relatively well disaggregated data for research of the primary sector. We calculated first results and might have called the attention for further research. Hence, if the regional differences want to be considered, a multiregional input-output model might help out. This might be a particular interest of Switzerland due to differences in regions whether they are alpine, hilly or from the mid-lands. If the interest is in trade patterns, GTAP models can be used, as developed for that purpose, with a General Equilibrium Model. As trade is one answer for an economic shortage of self-sufficiency, trade relations might be assessed in the future step. This can be done in various approaches varying from quantitative models to qualitative methods, or a mixture of both.

After all, the food processing sector for dairy and other non-meat products (GTAP IDs: 22 and 25) were emerged as sectors with a high impact to upstream and downstream sectors as well. Hence, their impact is rather concentrated to a few sectors. Additionally, both sectors rely on inputs from raw milk producers. These dependencies have to be considered cautiously when implementing the decision of the 2015 WTO Ministerial Conference of abolishment of the 'Chocolate law' subsidies. The shares and stakes of the food industry are addressed to develop strategies to encounter the possible reduction of sales. The reduction of subsidies for wheat production affects the most sensitive beverages and tobacco production (GTAP ID: 26), plant fibre production (GTAP ID: 07) and trade and retail (GTAP ID: 47). The trade and retail sector has a strong but dispersed backward linkage, but a rather low and focussed forward linkage. This indicates that this sector will directly affect the customers as households.

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