WELFARE EFFECT OF SUNFLOWER SEEDS EXPORT DUTY CANCELATION IN UKRAINE

by

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Abstract

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The paper estimates welfare implications of sunflower seed export duty cancelation in Ukraine for the period 2010-2019. The data used in the analyses is aggregate for Ukraine.

Partial equilibrium analysis is conducted using R for doing regression and estimating elasticities of demand and supply, and welfare implications are evaluated using Microsoft Excel.

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GLOSSARY

CPT is "carriage paid to". This is an Incoterms[1] term used in international trade to specify obligations of a seller to clear the goods and arrange carriage to the named place of destination. Responsibility of the seller ends when the good is received by the first carrier.

FOB is "free-on-board". This is an Incoterms term used in international trade to specify obligations of a seller to bare all responsibilities and costs for the good until it is loaded on the vessel in the agreed port of departure, including custom clearance. After that the buyer bares all the costs and responsibility for the good.

EXW is "ex works". It is referred to the price of a good without transportation cost, or so called "farm-gate" price.

[1] Glossary by International Chamber of Commerce

C h a p t e r 1

INTRODUCTION

Agricultural sector accounted for 10.1% in Ukrainian GDP in 2018 and has not ever lowered to a number less than 6%, while it was 11.8% in 1999[1]. The dynamics of Ukrainian agriculture is presented in Figure 1, which complements the idea of historical and present importance of the sector for Ukrainian economy.

Ukrainian government had first introduced an export duty of 23% for sunflower seeds in September 1999, decreased it to 17% in July of 2001, and by 1% annually starting in 2007 until it declined to 10% in 2013 without further changes[2].

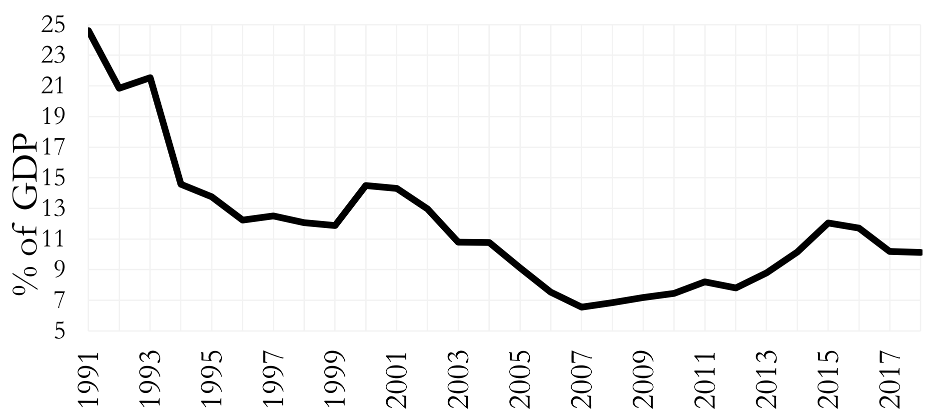

Figure 1. Agriculture as % of Ukrainian GDP

[1] https://data.worldbank.org - Agriculture, forestry, and fishing, value added (% of GDP) - Ukraine

[2] https://zakon.rada.gov.ua - Law of Ukraine "On Export Duty Rates for Seeds of Some Oil Plants".

The measure was first introduced to combat the perceived threat to the development of the sunflower oil industry, which was about 4 times less in export until the first export tax imposition. In the following years Ukrainian share of sunflower oil in the world market increased a lot, as seen from the Figure 2. This move regards to the infant industry argument articulated by Alexander Hamilton in 1790.

Export tax affected the competitiveness of Ukrainian sunflower seed producers in the international markets and caused redistribution of export gains from seed producers and traders to sunflower oil and sunflower meal exporters, with appearance of additional gains for seed crushers and oil exporters, as well as redistribution of profits from farmers to crushers.

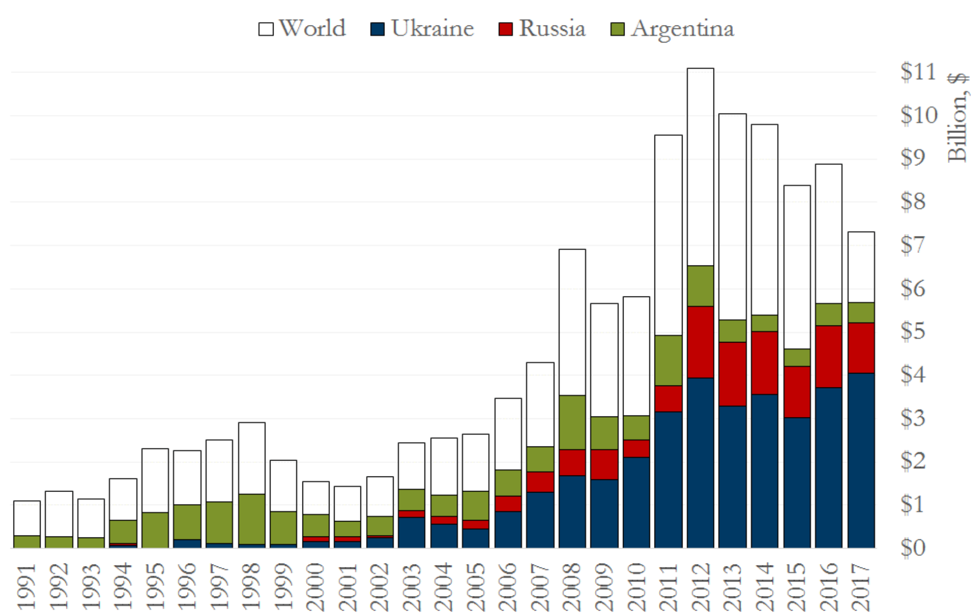

Figure 2. World export of sunflower oil by country, 1991-2017[1]

[1] Author's calculations, data from https://comtrade.on.org

This also might have contributed to the motivation of big agricultural enterprises who own the land and grow sunflower to establish value chains to include seed crushing, selling by-products as seed meal and owning sunflower oil brands.

Interests of raw seeds producers can be set in a row with interests of seeds processors, who crush raw seeds and get sunflower oil and sunflower meal as a by-product. Processing industry within the country was supposed to bring higher value added and become more beneficial for the country's economy. This move was probably forced by conscious and unconscious followers of the infant industry argument, which was also well-suited into the views on political economy dominating in the soviet period of Ukrainian history and inherited through the Soviet Union economic education and tradition of government practices. Another guess is that can be appropriate for Ukraine, there were some business interests involved, where some parties were lobbying the policy to increase profitability of own crushing enterprises.

The tax was weakened with time but there have not happened any significant changes in the export of raw seeds relative to the sunflower oil. But the conclusions are not obvious due to the existence of a duty for seeds export on the level of 10%, which distorts the market and makes Ukrainian raw seeds less competitive in the world market.

This work is aimed to reveal whether tax imposition was beneficial or not for Ukrainian economy in the long term. To answer this question, we undertake a welfare analysis with an attempt to examine costs and benefits of the policy in focus.

Chapter 2

LITERATURE REVIEW

Ukraine has comparatively big territory, which is 2nd big in Europe after Russia, accounting for 5.9% of European area[1], and with one of the most suitable for agricultural activities land called "chernozem" or black earth, which is one of the most fertile soils in the world and can be found on 2/3 of Ukraine's territory (Magocsi, 2010). It has temperate climate appropriate for agriculture. Thus, we can assume that Ukraine should have a comparative advantage in agriculture in European region, a concept based on the theory of international trade first introduced by David Ricardo in 18th century and since then widely developed and used in trade economics.

Microeconomic theory, e.g. by Nicholson and Snyder (2008), tells us that export tariff implies higher losses for domestic producers than gains to the government and domestic consumers. Thus, avoiding trade restrictions maximizes welfare gains. This fact signals about importance to reflect on the justification of export tariff for sunflower seeds. How much has Ukraine actually gained by specializing on sunflower oil instead of sunflower seed? Who has gained and who lost in Ukraine, if anybody? What would happen with crushers industry and oil production if the duty was not in place?

Another important factor to remember for the quality of analysis relates to the small- and big country cases differentiated in international economics. Since

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[1] https://en.wikipedia.org/wiki/List_of_European_countries_by_area

Ukraine has about a half of the world's sunflower oil production, it is fairly a "big country" in this industry and maybe become such only because of government policy. As for the sunflower seed industry, Ukraine fell under the small country case in time when the export duty was first introduced, that theoretically implies domestic prices decrease for the amount of tax, where cost outperforms the benefit and the tariff reduces welfare, as discussed by Krugman et al. (2012). From the other hand, if we consider market for vegetable oil, where many substitutes for sunflower oil exist (palm, soybean, rapeseed, peanut, coconut, olive, etc. oils) Ukraine stops being a "big" country.

Partial equilibrium analysis takes into account only restricted part of the economy as opposed to the general equilibrium. So this approach can be criticized. However, results of such analysis can be similar to the general equilibrium analysis, as discussed by Feder and Schmitz (1976), who analyzed infant industry protection using both approaches and concluded similarity in open two-sector economy.

Melitz (2005) discussed when and how should infant industries be protected. The work examines how the industry experiences technological change from learning by doing while being protected. There the conclusion is that in the long term quotas are even better for the industry protection than tariffs or production subsidies, while it depends on the learning curve of an industry and degree of substitutability of domestic and foreign goods.

Very similar case was considered by Warr (2002) investigating welfare implications of export levy for coconuts in Philippines to enforce coconut oil production. Warr conducted general equilibrium analysis and compared the results of partial equilibrium analysis. They occurred to be almost the same.

A good work reviewing literature on the topic was done by Kuznetsova (2007). The author discussed how results of estimation can differ for partial versus general equilibrium analysis, small versus large country cases, different exchange rate regimes, static and dynamic overview, welfare implications for quotas versus duties and export versus local tariffs. There was also discussed existence of optimal tariff. Kuznetsova concluded that from the literature itself it is hard to conclude whether export restrictions are harmful *per se*. Author made a welfare analysis for the market of grain export restrictions and confirmed that export restrictions bring losses for the welfare of Ukraine.

A great deal of work in the literature, where implications of trade restrictions and other policy interventions for the welfare are analyzed, is focused on identification of supply and demand data to estimate the corresponding elasticities. The problem is to separate supply and demand in the market evidence of prices and quantities. In other words, to find causal relation between variables, except for mere association. According to Angrist, Imbens & Rubin (1996), causality was sought in literature for last 40 years with structural equations models. According to them, historical review of these models was made by Goldberger (1972) and Morgan (1990), and roots go back to Wright (1928, 1934) and Haavelmo (1943, 1944) who use instrumental variables, including them in some equations and not including in others to let coefficients correlate only with particular variables.

Since Wright (1928), weather has been considered as an instrumental variable for supply shifts in agriculture, which made possible an unbiased estimation of demand equation coefficients. There is no reason for unobserved demand shifts to depend on supply shifts provoked by weather changes.

Theil (1953) and, independently, Basmann (1957) described an econometric method 2SLS useful to resolve the interdependency of quantity and price of a good sold, and later Zelner with Theil (1962) presented 3SLS method to solve a system of identified supply and demand equations. However, these works are purely econometric and require adaptation to the field of agriculture.

According to a survey by Askari and Cummings (1977), literature on agricultural supply response proposes much varying elasticities of supply with little significance. Based on such variation in results Roberts and Schlenker (2013) review and come to a conclusion, that weather-based instruments are rarely used in literature and decide to do it themselves. They identified supply and demand elasticities of four agricultural commodities (maize, wheat, rice and soybeans) to quantify implications for the US ethanol mandate. They have done a great work of addressing endogeneity problem of price in supply and demand equations and provided very detailed theoretical and empirical analysis of how they handled the issue.

Thus in our case, we would like to address an identification problem, where price for sunflower seeds influence both demand and supply equations, and unobserved shifts in supply and demand influence price through equilibrium. We use their approach to minimize bias in elasticity estimation.

Chapter 3

DATA AND INDUSTRY OVERVIEW

3.1 Dataset description

State Statistics Service of Ukraine open data makes it possible to receive oblast-level monthly data on sunflower seeds. The following information was obtained:

1) processed seeds from the beginning of the year in tons. To receive absolute monthly amounts instead of cumulative from the start of the year the same operation as above was conducted;
2) production or supply of sunflower seeds in tons. This data is present in most years for 3 month from August till October when the crop is usually collected;
3) sold seeds in tons. This variable is present for all months, because seeds can be stored at elevators until their sale;
4) price of seeds sold in UAH per ton, converted into USD per ton.
5) area harvested in ha;
6) yields in ton per ha obtained by dividing supply of seeds by area harvested.

To convert prices into USD we use the average monthly exchange rates of UAH to USD received from averaging daily exchange rates in each month from the beginning of 2011.

From the APK Inform-Agency open data were received weekly and then converted to average monthly prices. Weekly prices there were specified for

Fridays, so to convert into USD where required the same date exchange rates were taken.

1) Domestic EXW prices for sunflower seeds in UAH and converted into USD.

2) Export CPT prices for seeds in USD. Here was a gap in data from mid-2010 to mid-2011.

3) Export FOB prices for crude oil in USD.

4) Export CPT prices for rapeseeds and soybeans, since these are also oil plants and can serve as substitutes for sunflower.

Exchange rates were taken from the National Bank of Ukraine web site in daily format.

Information about export tariffs on sunflower seeds were taken from the Parliament website rada.gov.ua, where the majority of Ukrainian laws with their change history are stored. In particular, we used the Law of Ukraine "On Export Duty Rates for Seeds of Some Oil Plants".

Database of the Foreign Agricultural Service of United States Department of Agriculture (FAS USDA) contains aggregated Ukrainian annual data on sunflower seeds and oil by the amount produced, total supply, export, crush (for seed only), domestic consumption and area harvested (for seed only). This data was mostly used to check the monthly data. There was some difference between Ukrainian and American numbers, which is curious, because data by FAS USDA probably was obtained from Ukrainian State Statistical Service as well. But this difference is not large enough to affect results and goes beyond the scope of this research. As for possible reasons, some reporting features may be involved.

Oblast level data from 2011 to the beginning of 2020 contains 2896 observations, including city of Kyiv and aggregate "Ukraine" observations. Data for Crimea and city of Sevastopol were available only until spring 2014. Sevastopol was excluded because it was empty all the time, Crimea was included only until the start of 2014.

Aggregate data for supply is also available from 2000, monthly oil FOB prices are available since 2002 and seed export CPT from 2000.

Some oblasts have not been providing some of the factors referencing the law of confidentiality, however the same factors were reported all the time by others. This might be caused by such reasons as operational issues of local state departments or presence of 1 major player in the region, whose production would be easily identified by competitors.

Monthly exports for Ukraine since 2010 was taken from Comtrade database of the United Nations, though oblast-level export is not available. Annual was present from 1996.

Table 1 below has descriptive statistics of a resulting dataset.

Table 1 - Descriptive Statistics

Variable	**Stats / Values**	**Freqs (% of Valid)**	**Missing**
exp_tax	Mean (sd) : 0.1 (0)	0.10 : 2248 (74.2%)	0
[numeric]	min < med < max:	0.11 : 324 (10.7%)	
	0.1 < 0.1 < 0.2	0.12 : 324 (10.7%)	
	IQR (CV) : 0 (0.2)	0.13 : 12 (0.4%)	
obl	1. Cherkasy	110 (3.6%)	0
[factor]	2. Chernihiv	110 (3.6%)	
	3. Chernivtsi	110 (3.6%)	
	4. city of Kyiv	110 (3.6%)	

Table 1 - Continued

Variable	Stats / Values	Freqs (% of Valid)	Missing
	5. Crimea	36 (1.2%)	
	6. Dnipropetrovsk	110 (3.6%)	
	7. Donetsk	110 (3.6%)	
	8. IvanoFrankivsk	110 (3.6%)	
	9. Kharkiv	110 (3.6%)	
	10. Kherson	110 (3.6%)	
	[17 others]	2002 (66.1%)	
year	Mean (sd) : 2014.6 (3.4)	21 distinct values	0
[integer]	min < med < max:		
	2000 < 2015 < 2020		
	IQR (CV) : 5 (0)		
mon	Mean (sd) : 6.4 (3.5)	12 distinct values	0
[integer]	min < med < max:		
	1 < 6 < 12		
	IQR (CV) : 6 (0.5)		
month	1. Apr	248 (8.2%)	0
[factor]	2. Aug	248 (8.2%)	
	3. Dec	248 (8.2%)	
	4. Feb	274 (9.0%)	
	5. Jan	274 (9.0%)	
	6. Jul	248 (8.2%)	
	7. Jun	248 (8.2%)	
	8. Mar	248 (8.2%)	
	9. May	248 (8.2%)	
	10. Nov	248 (8.2%)	
	[2 others]	496 (16.4%)	
P_seed_processors	Mean (sd) : 354.5 (136.7)	314 distinct values	1430
[integer]	min < med < max:		
	0 < 340.5 < 5018		

Table 1 - Continued

Variable	Stats / Values	Freqs (% of Valid)	Missing
	IQR (CV) : 78 (0.4)		
Q_seed_proc_year	Mean (sd) : 567695.3 (1323298.2)	1833 distinct values	1113
[integer]	min < med < max:		
	2 < 201875 < 12264041		
	IQR (CV) : 450075.5 (2.3)		
Q_seed_proc_mon	Mean (sd) : 91447.7 (192211.7)	1756 distinct values	1134
[integer]	min < med < max:		
	0 < 41496.5 < 1295472		
	IQR (CV) : 73251.8 (2.1)		
Q_seed_sold_year	Mean (sd) : 250589.7 (804968.7)	2665 distinct values	132
[integer]	min < med < max:		
	0 < 60899.5 < 10676934		
	IQR (CV) : 207983.8 (3.2)		
Q_seed_sold_mon	Mean (sd) : 52669.8 (169449.5)	2529 distinct values	132
[integer]	min < med < max:		
	0 < 13143.5 < 2133504		
	IQR (CV) : 42978 (3.2)		
P_seed_sold	Mean (sd) : 356.9 (101.1)	2607 distinct values	132
[numeric]	min < med < max:		
	0 < 347.1 < 1447.3		
	IQR (CV) : 88.9 (0.3)		
area_all	Mean (sd) : 142892 (441284.4)	471 distinct values	2368
[integer]	min < med < max:		
	0 < 32250 < 4116000		
	IQR (CV) : 121750 (3.1)		
production_all	Mean (sd) : 310311.5 (978067.7)	603 distinct values	2368
[integer]	min < med < max:		
	0 < 68050 < 10783540		
	IQR (CV) : 272917.5 (3.2)		

Table 1 - Continued

Variable	Stats / Values	Freqs (% of Valid)	Missing
yield_all	Mean (sd) : 2.1 (0.8)	601 distinct values	2368
[numeric]	min < med < max:		
	0 < 2.2 < 4.2		
	IQR (CV) : 0.9 (0.4)		
Q_seed_export	Mean (sd) : 15179.1 (21104.9)	107 distinct values	2921
[numeric]	min < med < max:		
	350.6 < 5230.1 < 87252.7		
	IQR (CV) : 16889.1 (1.4)		
P_seed_export	Mean (sd) : 552.7 (167.1)	107 distinct values	2921
[numeric]	min < med < max:		
	308.1 < 534.4 < 1344.2		
	IQR (CV) : 178.8 (0.3)		
Rev_seed_export	Mean (sd) : 7962102.2 (11063440.7)	107 distinct values	2921
[integer]	min < med < max:		
	197668 < 2927017 < 53868669		
	IQR (CV) : 8483345 (1.4)		
P_seed_exw	Mean (sd) : 350.4 (144.2)	242 distinct values	2786
[numeric]	min < med < max:		
	106.2 < 356.4 < 835.6		
	IQR (CV) : 188.6 (0.4)		
P_seed_cpt_exp	Mean (sd) : 333.9 (121.9)	210 distinct values	2818
[numeric]	min < med < max:		
	121.4 < 344.3 < 651.9		
	IQR (CV) : 183.8 (0.4)		
P_oil_fob	Mean (sd) : 823.3 (266)	195 distinct values	2813
[numeric]	min < med < max:		
	500 < 763.1 < 1852.5		
	IQR (CV) : 243.7 (0.3)		
P_soyb_cpt_exp	Mean (sd) : 395.2 (64.6)	92 distinct values	2925

Table 1 - Continued

Variable	Stats / Values	Freqs (% of Valid)	Missing
[numeric]	min < med < max:		
	309.2 < 373.8 < 553.8		
	IQR (CV) : 86.5 (0.2)		
P_rapes_cpt_exp	Mean (sd) : 471.9 (97.7)	106 distinct values	2922
[numeric]	min < med < max:		
	306.3 < 427.8 < 682.2		
	IQR (CV) : 177 (0.2)		

3.2 Industry overview

There are several types of sunflower seeds by its biochemical properties, containing different amount of monounsaturated, polyunsaturated and saturated fats. These fats or acids are used in beauty industry, oil paints and in food industry for humans and animals.

Seeds are composed of a shell (hull) and an edible kernel. Hull is usually considered to be a by-product, but can be utilized by burning as a biomass fuel as discussed by Zabaniotou et al. (2008). Kernels can be used as a food itself, mostly being used as snacks after frying, or to extract oil from them. When the oil is extracted, it can be used in various industries as discussed above. By-product of oil extraction is called sunflower meal and rich in proteins and fiber, and can be used as animal feed, fertilizer or fuel as discussed by Lomascolo (2012).

Ukraine is the biggest exporter of sunflower meal in the world, as well as of sunflower oil, that is seen from Figures 3 and 4, where largest exporters are placed against the total world export. However, it is far from the biggest exporters of sunflower seeds. Moreover, its seed export has decreased after duty imposition and, accounting for the growing seed production in the country, we can roughly say that export relatively to production has been declining ever since.

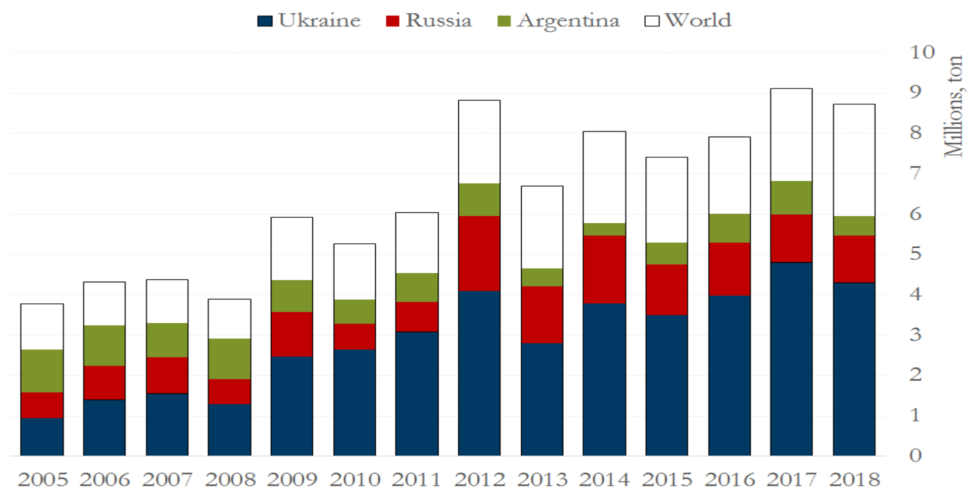

Figure 3. Export of sunflower meal[1]

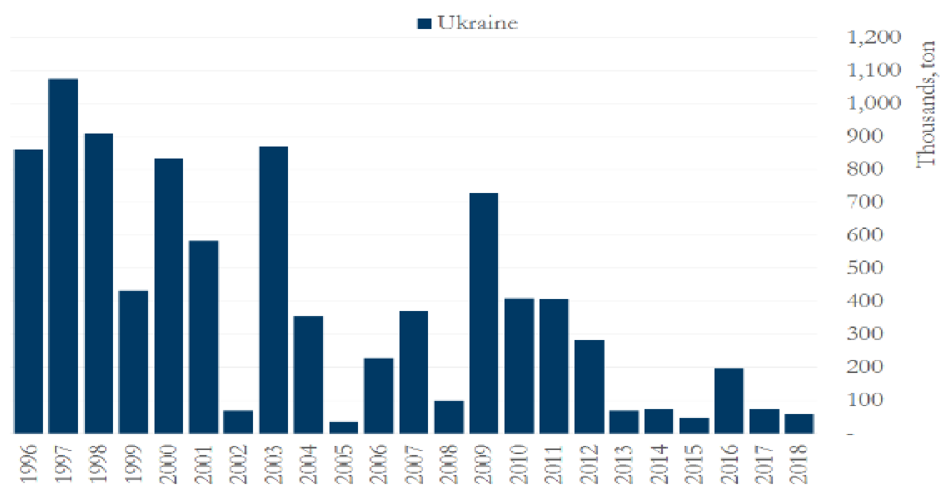

Figure 4. Export of sunflower seeds[2]

[1] UN Comtrade data, author's calcualtions

[2] UN Comtrade data

Supply of seeds in the country happens from August to October, when they are harvested with peak in September but demand happens during the whole year, because storing facilities are used by producers as well as by crushers and exporters.

Chapter 4

MODEL

4.1 Model of welfare

Export duty is an effective method to limit international trade of a good on which this duty is imposed. There are two possible rationales for such a measure. One is to decrease domestic prices for a commodity and protect local consumers of the good from higher international prices. Another is to create another source of revenue for the state. We can consider two parties who are affected by the policy: exporting country under our focus and importing rest of the world. The extent to which each agent is affected depends on their market power or simply on the share of exporting county on the given market. When this share is small or we have a case of a "small" country in international trade, there is no significant change in price of a good in the world and the side under effect is producers in the exporting country. On the other hand, in the case of a "large" country, the effect is shared by both importing side and exporting producers. The distribution of effect depends on the slope of supply and demand curves of exporting country and demand of the importing side.

Ukraine is the biggest producer of sunflower seeds in the world and has more than a quarter of the world's production. Nevertheless, most part of the country's seeds is bought within the country by the oil extracting plants setting Ukraine far from the biggest seed exporters. At the same time Ukraine is the biggest exporter of sunflower oil in the world and one of many vegetable oil exporters. Thus, we consider Ukraine as a factually "big" country in the market of sunflower oil and potentially big in the market of sunflower seeds and here is why. Assume Ukraine cancels export duty for sunflower oilseeds. Such a move would cause price for seeds increase to the world price. Since Ukraine is the biggest seed producer, there is a potential for huge export amounts. Thus, Ukrainian producers could start exporting a lot, which would change the world market supply of seeds and affect the world price moving equilibrium from its place. So in the analyses Ukraine is considered a "big" country because of this exporting potential.

We assume perfectly competitive markets and downward slope of the world's import demand for sunflower seeds, that means export duty implies zero-increase of world price for sunflower seed.

Another assumption is zero logistics cost.

Here is the model of welfare for 2-country case presented on the Figure 4, Ukraine trading seeds with World.

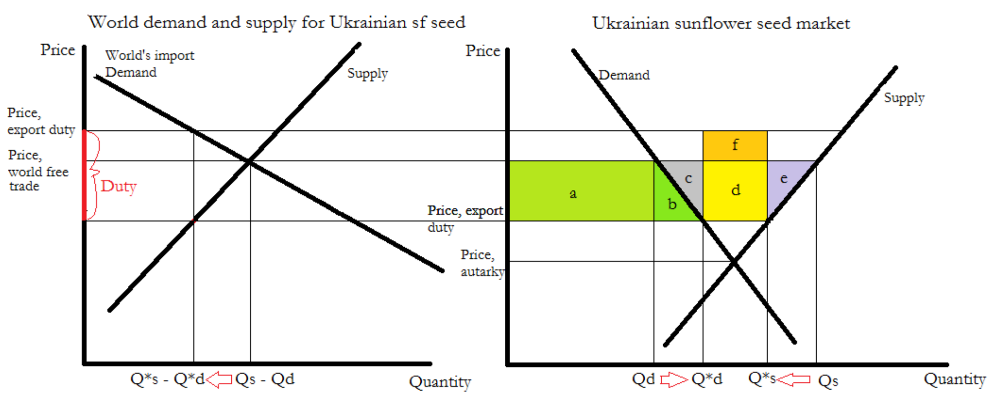

Figure 5. "Large" country export duty, domestic and world prices

In autarky price on a local market would be as in the equilibrium of domestic demand and supply. However, we trade with the rest of the world, because it is ready to buy seeds at a price above than in autarky equilibrium. On the left plot are shown export supply curve and World import demand. World equilibrium price is higher, so that in a free trade Ukraine will be supplying Qs – Qd.

After Ukrainian government imposes an export duty, world price will rise and domestic price will drop as prices on the graph, marked by "export duty", assuming "large" country case. The higher World's import elasticity, the more drastic is decrease of price on the local market and less the increase of the world price.

As a result, there are 3 changes in the seed market of Ukraine:

1. supply decreases from Qs to Q*s;
2. demand increases from Qd to Q*d;
3. export decreases from (Qs – Qd) to (Q*s – Q*d).

The welfare effects are following. Seed crushers (consumers in this case) win because consumer surplus increases by +(a+b). At the same time producers of sunflower seeds cannot enjoy the result, as their producer surplus declines by (a+b+c+d+e). Yet another gainer is the government, as they collect their duty in the amount of +(d+f). Here a and b flow from producers to consumers, d and f are collected by government, where f is the effect of Terms of Trade due to Ukraine's relative trade power. However, c and e are collected by no one and lost forever, they form deadweight loss and are called consumption and production distortion respectively.

4.2 Quantification of export duty impact on the welfare

4.2.1 Simple model

To quantify the effects of duty imposition - the areas shown on the graph – we use a partial equilibrium analysis. The result will show us how the welfare of agents in Ukraine changes if we cancel export duty for sunflower seeds without implying changes on other sectors of Ukrainian economy.

First, we have to find elasticities of domestic demand and supply curves, as well as World's import demand elasticity.

Simple view of the equations is as follows.

- Domestic demand, assuming constant elasticity:

$$Q^D(P) = a \cdot P^{\varepsilon_D},$$

ε_D – elasticity of demand;

- Long-run domestic supply, assuming constant elasticity:

$$Q^S(P) = b \cdot P^{\varepsilon_S},$$

ε_S – long-run supply elasticity. We consider long-run supply, because in the short-run supply for sunflower is perfectly inelastic in each given year, because we can have harvest of crops only once, after the fixed planted area in the previous season, so no matter the price, production remains constant. Thus, short-term supply

$$Q^S = \text{production},$$

- World import demand, assuming constant elasticity, considering that it might be different for main season of sale from October to February and offseason time from March to September:

$$Id(P) = c \cdot P^{\varepsilon_D^W * season},$$

ε_D^W – world's import demand elasticity.

- Export supply to the World in the short run:

$$Q^{S}_{EXP}(P) = production - a \cdot P^{\varepsilon_D},$$

and in the long-run:

$$Q^{S}_{EXP}(P) = b \cdot P^{\varepsilon_S} - a \cdot P^{\varepsilon_D}.$$

We run next regression models for country-level data

For domestic demand:

$$\ln(D)_t = \alpha_0 + \alpha_1 \ln(P)_t + \alpha_2 \ln\left(P^{oil}_{FOB}\right)_t + \alpha_3 \ln(D)_{t-12} + \alpha_4 \ln(D)_{t-1} + \eta_t ,$$

monthly values, D is amount ton of processed seed, P is domestic seed price EXW in usd, P^{oil}_{FOB} – FOB export price for sunflower oil, and there are lagged values of demand to eliminate autocorrelation.

For long-run supply:

$$\ln(S)_t = \beta_0 + \beta_1 \ln(P)_{t-1} + \beta_2 \ln(area)_t + \mu_t,$$

annual production S ton, P - lagged export price from UN Comtrade in USD, *area* of harvest in hectares. We take lagged price, because farmers decide on the current year's supply looking at prices in the previous period.

For world import demand:

$$\ln(Id) = \gamma_0 * offseason + \gamma_1 \ln\left(P_{\text{exp}}\right)_{t-1} * offseason + \gamma_2 \ln\left(P_{\text{exp}}\right)_{t-1} * season + \gamma_3 \ln\left(P^{soy}_{\text{cpt}}\right)_{t-1} + \gamma_4 \ln\left(P^{rapes}_{cpt}\right)_{t-1} + \vartheta_t,$$

monthly values, *Id* – world import of seed, *offseason* an *season* – dummies for sale seasons, *Pexp* – lagged CPT export price in USD, and there are CPT lagged prices for soy and rapeseed as oil cultures which might also affect farmers' decision of what to plant for the next year.

As seen from Table 2, we get that domestic demand is elastic if we round its value with 0.001 precision to -1. Domestic long-run supply is inelastic with value of elasticity ~0.4. In world import demand regression season dummies did not give significant results, so they were dropped out from the regression and we got that world demand for Ukrainian exports of seeds is elastic with value -1.16.

Table 2. Results of regressions estimation

Domestic Demand (monthly)			Long-run domestic supply			World Import Demand		
Variables	**Coef**	**P-val**	**Variables**	**Coef**	**P-val**	**Variables**	**Coef**	**P-val**
Price	-0.9992	0.001**	Area_harvested	1.426	<0.001	Lag_Pexp	-1.16	0.02*
Export price of oil	0.4869	0.064.	Lag1_Price	0.397	<0.013	Lag_Pexp_soy	-0.86	0.34
Lag1_demand	0.3061	<0.001 ***				Lag_Pexp_rapes	1.62	0.06.
Lag12_demand	0.6617	<0.001 ***				Lag1_demand	0.62	<0.001
R^2_adj = 0.606			**R^2_adj = 0.947**			**R^2_adj = 0.44, p-val < 0.001, F-sts = 16.98**		

4.2.2 Applying elasticities

Now, we can replicate data using calibration technique. We configure the demand and supply curves for each year.

1) We know from the empirical data that the domestic demand curve passes through the point (Q^*_D; $P_{export\ duty}$) on the local market graph (Figure 1 for

notations), which is (annual demand; weighted average price). We also recall that the domestic demand equation is of the form

$$Q^D(P) = a \cdot P^{\varepsilon_D}.$$

Thus, the value of *a* can be found as

$$a = Q^D / P^{\varepsilon_D},$$

where $\varepsilon_D = -1$

2) The world import demand line goes through the point ($Q^*_S - Q^*_D$; $P_{export\ duty}$) on the world import graph, or (annual export; weighted average annual P_{CPT}). Recall $Id(P) = c \cdot P^{\varepsilon_D^W}$, the parameter c can be found as follows:

$$c = \frac{Id}{Pcpt^{\varepsilon_D^W}},$$

$\varepsilon^W_D = -1.16$

3) Domestic supply coefficient:

$$b = \frac{Q_S}{P^{\varepsilon_S}},$$

$\varepsilon_S = 0.4$

4) As for export supply, we recall the long-run:

$$Q_{EXP}^S(P) = Qs - a \cdot P^{\varepsilon_D}.$$

Using Excel demand and supply equations were estimated (Table 3).

Table 3. Estimated supply and demand equations

year	Domestic demand: Q_D ($P_{dom\ duty}$)=	World import demand Q^W_D =	l-r dom supply	Export supply Q^W_S =
2011	3954861819*P^1	483427341*$P^{1.16}$	1296659*$P^{0.31}$	8671000 -3954861819*P^1
2012	4405191477*P^1	348192603*$P^{1.16}$	1149051*$P^{0.31}$	8387000 - 4405191477*P^1
2013	3727429039*P^1	105607609*$P^{1.16}$	1531141*$P^{0.31}$	11051000 - 3727429039*P^1

Table 3 - Continued

year	Domestic demand: Q_D ($P_{dom\ duty}$)=	World import demand Q^W_D =	l-r dom supply	Export supply Q^W_S =
2014	$3710086098*P^1$	$66465123*P^{1.16}$	$1331175*P^{0.31}$	$10134000 - 3710086098*P^1$
2015	$3279815178*P^1$	$2756709*P^{1.16}$	$1544045*P^{0.31}$	$11181000 - 3279815178*P^1$
2016	$3625939680*P^1$	$210836188*P^{1.16}$	$2068034*P^{0.31}$	$13627000 - 3625939680*P^1$
2017	$4441783277*P^1$	$79111324*P^{1.16}$	$1934377*P^{0.31}$	$12236000 - 4441783277*P^1$
2018	$4055799397*P^1$	$61851095*P^{1.16}$	$2200694*P^{0.31}$	$14165000 - 4055799397*P^1$
2019	$4555600670*P^1$	47691991.38	2248774.703	$15254000- 4555600670*P^1$

To estimate free trade price, we have to equalize export supply and world import demand curves. We should also recall that we have transactional cost in the real world. Since we estimated world demand with export prices and domestic supply with farm-gate, we have to adjust variable price in the export supply by some coefficient. Let coefficient be

$$k = P_{export} / Pexw.$$

Thus,

$$Q^W{}_D(P_{export}) = Q^W{}_S(P_{export}/k).$$

Important feature is to mind export duty, so k becomes

$$P_{export}/[(1+tax)*Pexw].$$

In 2011 and 2012 duty was 12% and 11%, and 10% ever since. K is reported in the appendix (Table 6).

Now we count theoretical free-trade prices and compare them with actual prices in Table 4.

Table 4. Free trade vs. actual prices

year	Actual exw price, lag1, usd	free-trade P_exw, usd	Actual export price, lag1, usd	free-trade P_exp, usd	Actual export, ton	free-trade export, ton	Actual domestic use, ton	free-trade domestic use, ton
2011	380	756	459	912	406,070	178,084	7,573,752	5,234,518
2012	407	702	609	1,050	282,097	108,895	8,804,220	6,275,696
2013	447	513	587	675	70,209	55,209	7,724,281	7,262,531
2014	374	392	698	732	73,896	31,595	10,255,089	9,453,697
2015	323	319	594	587	47,.690	1,695	8,134,664	10,268,071
2016	347	421	438	532	196,583	145,120	9,120,943	8,609,747
2017	333	630	384	726	73,230	37,979	11,107,235	7,046,534
2018	331	467	406	573	58,704	39,102	10,142,034	8,676,743
2019	403	500	481	597	45,897	28,712	12,264,041	9,110,858

The results are curious, because we get reduction in both production and export of sunflower seeds.

Theoretical free-trade prices were used to estimate welfare effects of cancelation of export duty. The results are presented in the Table 5. From it we see the amount of surplus whether negative or positive induced by export duty. Overall, in the last 9 years Ukraine could gain tens of millions of dollars to its general welfare from duty cancelation, according to out partial equilibrium analyses. However, we cannot tell about the whole picture without properly analyzing implications for sunflower oil and sunflower meal markets.

Table 5. Welfare implications of duty cancelation

year	Consumer surplus	Producer surplus	Government revenue	General welfare
2011	($2,402,429,535)	$2,511,998,516	($22,379,909)	**$87,189,071**
2012	($2,223,490,196)	$2,281,140,923	($18,902,756)	**$38,747,972**
2013	($496,643,322)	$500,799,503	($4,124,566)	**$31,614**
2014	($182,019,982)	$182,994,247	($5,156,079)	**($4,181,815)**
2015	$35,513,027	($35,608,328)	($2,831,663)	**($2,926,964)**
2016	($661,004,980)	$673,743,765	($8,609,428)	**$4,129,356**
2017	($2,696,381,346)	$2,712,899,176	($2,811,103)	**$13,706,726**
2018	($1,279,642,761)	$1,286,293,379	($2,383,635)	**$4,266,984**
2019	($1,041,372,824)	$1,045,007,731	($2,207,200)	**$1,427,707**

CONCLUSIONS

For many years Ukraine have lost a lot of money in terms of general welfare, according to the partial equilibrium analysis. Export duty is still present and causes losses. Every loss has its opportunity cost, thus impacts the pace of countries development. Whenever Ukrainian government decides to actually boost economic growth, one of the policies should be decrease or cancelation of the export duty.

There are a few concerns connected to the model used. Firstly, the model seems to give unrealistic results, where free trade prices become almost 2 times as big current price. Domestic consumption drops by about quarter, but exports do not rise for the same amount, implying decrease of world's sunflower oil supply by ~12%. Secondly, the fact that Ukraine lays under "large" country case requires further investigation for sunflower seed world market. Thirdly, it was found that Ukraine imports sunflower seeds, so this has to somehow interact with its export. Finally, without proper solution for identification problem, elasticities cannot be considered as unbiased in unpredictable direction.

Intuition and theory tells, that having no advantage in terms of trade regarding sunflower seeds in the world market and being the biggest exporter of processed from sunflower seeds products influences general welfare of Ukraine negatively, brings little benefit in terms of duty for government, harms producers without full value chain (therefore big players have an advantage), and stops processors from being even more productive, because lack of competition makes it cheaper for crushers to buy seeds form farmers.

To achieve reliable and complete results, in addition to resolving the mentioned concerns, it would be great to deeper analyze redistribution of income among agents involved in sunflower products value chain in Ukraine.

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Appendix A

Table 6. Values of coefficients in the partial equilibrium analysis

year	***a***	***b***	***c***	***k***
2011	3954861819	805330	483427341	1.078002
2012	4405191477	758136	348192603	1.348225
2013	3727429039	962261	105607609	1.194878
2014	3710086098	947639	66465123.3	1.696126
2015	3279815178	1108281	2756709.25	1.669727
2016	3625939680	1313643	210836188	1.148756
2017	4441783277	1198148	79111324.1	1.047064
2018	4055799397	1390132	61851095.3	1.113723
2019	4555600670	1384978	47691991.4	1.085957