Introduction

In a multiperson situation with strategic interdependence each agent recognizes that the profit he receives depends not only on his own action, but also on the behavior of other producers on the market. Multiperson economic situations vary greatly in the degree to which strategic interaction is present. Considering different types of markets, as well as industrial organizations in terms of various strategies, we can easily recognize that kind of dependency between only a few market players. This relationship does not take place on perfectly competitive nor monopolistic market. In setting a perfect competition or a monopolistic competition the nature of strategic interaction is minimal. As Heffernan pointed out, oligopolies are highly interdependent (Heffernan, Sinclair, 1990).

In this paper I will present model of international duopoly and effects of governments support for their national producer. The outline of this paper is as follows. First, I analyze demands, outputs and welfare levels in pure duopoly – with no government intervention. Secondly, there will be made an analysis of the import tariff or export subsidy effects on the market where two governments decide to intervene. Then I will turn to consider what changes if only one country intervenes and the other does nothing.

Finally, some final thoughts are provided in the concluding section. I assess the effects of the previously noted intervention instruments on a national welfare and firms’ profit under circumstances of international oligopoly.

1. Basic model of international oligopoly

It is crucial to explain what it exactly means that firms create the oligopoly. According to Augustin Cournot, who described classic model of oligopoly in 1838, it means, that firm objective is to maximize profit and every firm on the market is an output setter and believes that its rival will not respond to its own decision. The model considers oligopolistic market and takes into account two firms on it. They operate in two different countries: H - home country, F - foreign country, and produce homogeneous goods (steel industry or aircraft producers). Due to the various demands in each country, they trade. Output (x) in country H does not cover the demand there (w). Country H needs to be an importer. The situation in country F is opposite – demand (v) is met by domestic producer (y) and additional stock has to be sold. Country F is an exporter.

The assumptions used in the model are following:

(i) The number of firms is fixed – one in each country.

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(ii) Marginal cost function is common and curve of this function is horizontal in order to assure symmetry. Firms are similar and horizontal marginal cost simplifies analysis. So that, marginal cost is common at a given value $c$. (Heffernan, Sinclair, 1990)

(iii) In order to define countries demand, consider the demands as a linear function, where $p$ denotes price in country $H$ and $o$ denotes price in country $F'$, $z$ represents the vertical intercept on the market demand curve, and $b$ is the slope of the demand curve.

$$w = a \frac{z - p}{b}$$

$$v = (1 - a) \frac{z - o}{b}$$

![Demand function in country H and country F](image)

Figure 1: Demand function in country H and country F

(iv) In demand functions $a$ expresses the difference between countries ($0 < a < 1$). In this model demand in country $H$ is greater than in country $F$ (model feature), so for all the analysis $a$ should be greater than 0.5.

Aggregated world production of particular goods is the sum of production in country $H$ and country $F$ and it is equal to aggregated demand.

$$x + y = w + v$$

2. Import tariff and export subsidy

   a) simultaneous governments intervention

As long as there is only one firm in each country, its profit will increase country welfare. In this case, the government has an incentive to provide the policy, which supports its national producer. It can use trade policy instruments such as import tariff (in importing country), export subsidy (in exporting country) which are treated as trade policy tools.

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1 Markets are segmented so that consumers are not able to chose less expensive goods. There is no price arbitrage. Prices are differed by the appropriate instrument of the government intervention.
At the beginning price in country $H$ is equal to price in country $F$. Prices will obviously change, when governments provide any trade policy. When the government in country $H$ imposes a tariff ($t$) for imported goods from country $F$, the price in country $H$ will increase and will be higher than abroad by the rate of the tariff:

$$p = p_0 + t$$

Simultaneously, when the foreign government imposes export subsidy, the price in country $F$ will be higher than in country $H$ by the amount of export subsidy:

$$o = o_0 + r$$

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**Figure 2: Import tariff effect**
Figure 3: Export subsidy effect

In this case, price function in country $H$, which has been already affected by governments interventions ($t$ and $r$), is as follows: $p = z+(1-a)(t-r)-b(x+y)$ and price function in country $F$: $o = z-a(t-r)-b(x+y)$.

Firms behave like in the Cournot oligopoly, and they take each others output as given from the market. Having the equation: $x+y=w+v$ and the mentioned price functions, reaction functions could be set up:

$$x = \frac{z-c+(t-r)(1-a)-by}{2b} \quad \text{and} \quad y = \frac{z-c-a(t-r)-bx}{2b}$$

Each firm may settle its optimal output levels as a function of import tariff and export subsidy:

$$x = \frac{z-c+(2-a)(t-r)}{3b} \quad \text{and} \quad y = \frac{z-c-(1+a)(t-r)}{3b}$$

Considering both outputs as functions of $t$ and $r$, we can substitute $x$ and $y$ in each function, where they appeared before:

$$p = \frac{z+2c-(t-r)(1-2a)}{3}$$

$$w = a \frac{2(z-c)+(t-r)(1-2a)}{3b}$$

$$v = 2(1-a) \frac{z-c+(t-r)(2-a)}{3b}$$

$$o = \frac{z+2c-2(t-r)(2-a)}{3}$$

All analysis are aimed to find welfare function in respect to $t$ or $r$. If country welfare ($W$) is defined as the sum of consumers’ surplus ($CS$), producer’s profit ($Th$) and cost of government intervention ($GR$), it can be express in the following way:

$$W_h = CS_h + \Pi_h + GR_h = \left[ \frac{1}{2}(z-p)w \right] + \left[ px-cx \right] + \left[ t(w-x) \right] = w \left( \frac{z-p}{2} + t \right) + x(p-c-t)$$

Using the first order condition, we can set up the optimal level of $t$. At this value of import tariff national welfare is maximized.

$$t = \frac{(z-c)(2a^2+1)-r(a^2+3a-1)(a-2)}{(2-a)(a^2+6a+2)}$$
Similar analysis are provided for country F. Welfare function is as follows:

\[ W_f = CS_f + \Pi_f + GR_f = \left[ \frac{1}{2} (z-o)v \right] + [py-cy] + [r(v-y)] = v \left( \frac{z-o}{2} + r \right) + y(o-c-r) \]

According to the first order condition, optimal \( r \) is set up:

\[ r = \frac{(z-c)(2a^2 - 4a + 3) + t(a+1)(a^2 - 5a + 3)}{(a+1)(a^2 - 8a + 9)} \]

When \( r \) is substituted into the \( t \) equation and vice versa, we can illustrate the Cournot equilibrium in the international oligopoly where the governments take actions. Optimal level of import tariff in country \( H \) and export subsidy in country \( F \) are set up simultaneously. It is therefore shown that, \( t \) as well as \( r \) depends on \( a \) and \( z-c \) (the difference between price at which demand vanishes and marginal cost of production)\(^2\).

\[ t = \frac{(z-c)(4a^4 - 6a^3 + 8a^2 - 10a - 1)}{(a+1)(a-2)(-8a^2 + 8a + 7)} \quad r = \frac{(z-c)(4a^4 - 10a^3 + 14a^2 - 4a - 5)}{(a+1)(a-2)(-8a^2 + 8a + 7)} \]

Import tariff and export subsidy expressions show that the main element what affect their amount seems to be the different demand condition. It is denoted by the variable \( a \). Concluding, it is mainly the difference in demand between countries that determinates the level of trade policy instruments.

![Figure 4: Optimal import tariff (t) and export subsidy (r) as a function of a difference in demand (a)](image)

As it is presented on the graph, import tariff is equal to export subsidy when countries are similar, that is when \( a=0.5 \). Surprisingly, at this point neither \( t \) or \( r \) are “zero”:

\(^2\) For all further analysis and comparisons: \( z-c=1 \)
First significant results suggest, that if there is no difference between countries, and they do not trade, optimal import tariff and export subsidy are supposed to be greater than zero in order to reach or maintain Cournot equilibrium. Consequently, if countries do not trade and have \( t=r=0 \), there is no equilibrium. When \( t=0 \), then it is proved that \( r \) should be greater than zero. In this case, welfare will increase and the country (as an agent in the game) will be more satisfied.

In the event that countries become different (and keeping in mind the forth assumption of the model, \( a>0.5 \)), they start trade. Country \( H \) has got output deficit and in order to meet market demand, it buys goods abroad - becomes an importer. Import tariff start to increase from the value of 0.222, not from ”zero”, as it could have been expected (see figure 4). National welfare will be maximized.

Analytical result of the model shows that for \( a>0.5 \) tariff placed on the imported goods is greater than export subsidy. We can conclude, that price in country with import tariff is greater than price in country with export subsidy.

\[
p_0 + t = o_0 + r \quad t > r
\]

According to these, when countries are in Cournot equilibrium and they are similar, they need to set up respectively, an import tariff and export subsidy greater than zero in order to reach maximum welfare.

Having \( t \) and \( r \) as a function of \( a \), we can calculate trade volume. Countries will trade at a level depending on how much demand in country \( H \) is greater than their output. Therefore, import in country \( H \) will be equal to export of country \( F \).

\[
I = E = \frac{(z-c)(2a^2-2a-1)(2a-1)}{b(8a^2-8a-7)}
\]
grounds. In this model welfare function is very complex, using previous assumptions (x-c=1 and b=1), we can evaluate its values:

![Welfare functions graph](image)

**Figure 6: Welfare functions**

It is shown, that graph is symmetric with respect to \( a=0.5 \). Welfare graph marks that country \( H \) would gain more and more from the import tariff if only greater demand is generated (growing \( a \)), but aggregated welfare (as a sum of welfare in country \( H \) and in country \( F \)) decreases when \( a \) grows from 0.5 to 1.

**b) intervention in country \( H \)**

In this case government in country \( H \) decides to impose import tariff \( (t_i) \) at the level that maximize national welfare. Government in country \( F \) does not take any action. In order to protect domestic market import tariff may obviously be set up at lower level than before \( (t) \), it means, that if only government in country \( H \) intervene, protection of domestic market is less expensive \( (t_i) \) if there is no export subsidy abroad.
Figure 7: Import tariffs as a function of $a$ ($t$ – two governments intervene, $t_1$- intervention in country $H$)

$$t_1 = \frac{(z - c)(2a^2 + 1)}{(2 - a)(a^2 + 6a + 2)}$$

Because of the market protection, domestic firm can produce more. As long as not all output is sold domestically, surplus can be exported. The threshold for export is $a=0.7675$.

![Figure 8: Import volume as a function of $a$](image)

Until variable $a$ reaches the value of 0.7675, country $H$ is an exporter. This result prompts for relaxing one of the previous assumptions: $t$ is a import tariff in country $H$, and $r$ is an export subsidy in country $F$. Because there is no import, $t_1$ is not an import tariff in this case. We conclude that as long as countries are similar ($0.5 < a < 0.75$) and only one of them can provide a trade policy, that country will be an exporter and will impose an export subsidy in order to gain from the trade.

c) intervention in country $F$

Let us now look briefly at the effects of intervention of the government in country $F$. It offers an export subsidy for the national producer.

$$r_1 = \frac{(z - c)(2a^2 - 4a + 3)}{(a + 1)(a^2 - 8a + 3)}$$
It is clear that firm in country $F$ sells more abroad than would sell having no any financial support regarding exportable goods. How expensive for government is that support?

![Figure 8: Export subsidy as a function of $a$ ($r$ – two governments intervene, $r_1$- intervention in country $F$)](image)

In this case export subsidy ($r_1$) is less expensive (comparing to export subsidy ($r$) what is imposed simultaneously with import tariff abroad) only to the barrier of $a=0.697$. It means that government would like to impose export subsidy alone if only demand is not significantly different that abroad. If only it is more than two times smaller than abroad, less expensive for government is to provide trade policy accompanying by import tariffs abroad. Why is it like that? This situation is resulted from very small demand on the market, and consequently large amount of output what has to be sold abroad. Government is obliged to give significant funds for exporter, what assures export profitable.

Regarding aggregated welfare (world welfare as a sum of welfare in country $H$ and country $F$) we noticed significant difference. When small country support its national producer, than total welfare will be rising for rising $a$. It falls in two previous cases, so it leads to the conclusion, that export subsidy may affect total welfare improvement (see graphs in appendix 1).

**3. Trade policy effects in oligopoly**

The structure of the strategic environment faced by governents is similar to the environment faced by oligopolistic firms (Brander, 1987). The payoff to each player or participant depends on its own action and on the action of its rival. These payoffs might be considered in terms of the country (welfare) as well as firm (profit).

We can point out four cases of the international duopoly with regard to trade policy:

(i) international duopoly with no governents’ intervention

(ii) government in country $H$ places an import tariff
(iii) government in country $F$ support national producer through export subsidy

(iv) government $H$ as well as government $F$ intervenes on the market.

Keeping assumption, that $z$ and $c$ are fixed in that model ($z-c=1$), we can evaluate and compare some numbers what governments and firms are interested in. They can be presented as a game of the market players’ behavior\(^3\).

First, we create the game box for trade policy effects in welfares.

![Figure 9: Results of game in trade policy in national welfare, foreign welfare and total welfare.](image)

Presented results prompt to the conclusion that as long as firms behave as duopoly, Nash equilibrium is always reached when governments take action. For example, government in country $H$ is not interested in getting rid off import tariff, because it would decline national welfare from 0.312 to 0.273. Country $F$ would also lose if only abandon exports promotion (from 0.124 to 0.118).

\(^3\) for all analysis with regard to the game payoffs, variable $a$ is fixed at the value of 0.75.
Firm in country H is familiar with import tax, because it receives profit 0.146 and would get only 0.066 without protection.

On the other hand, the country H always gains, no matter national welfare or producers interests. National welfare without market protection amounts 0.278 and rises to 0.306 as the result of import tariff. It also increases (from 0.306 to 0.312) if foreign government imposes the export subsidy.

How country F gains from government intervention? If it imposes export subsidy national welfare will be improved (from 0.167 to 0.178), but will decline (from 0.178 to 0.124) just after country H replies by imposing import tariff. Finally country F is even in worse condition than it would be if there were no interventions on the market. The firm in country F also loses. Its profit will rise from 0.111 to 0.192 if government places export subsidy, but immediately after country H protection barriers, profit will fall to 0.07. So that, firm is even worse condition than would be with no support.

Raising question, whether the countries’ welfares and firms’ profit are in better condition when the government intervenes on the market using production subsidies. Will they more useful for welfare improvement? In further research I relaxed the assumption regarding trade policy instruments and check out the results of production subsidy in international oligopoly.

**Conclusions**

An analyze of the Cournot model oligopoly in terms of the open market and governments’ interventions leads to a few conclusions.

First result is that Nash equilibrium on the market takes place when governments intervene. The main element in this finding is that governments have access to tools, such as tariff or subsidy, which the firms do not have. So that, not only firms try to deter rivals by market interaction. Each government provides its trade policy also recognizes the strategic possibilities in the international oligopoly. These policies can lead to a national advantage.

As further research showed, it is not even important if they impose trade policy instruments or subsidy production. The only difference is that in the second case, countries do not trade, because all domestic
demand is met by domestic output. Price on the market is equal to marginal cost – feature of perfectly competitive solution, but surprisingly, firms still behave like duopoly and they are taking their decisions strategically. Due to Nash equilibrium, the intervention stage is reasonable from the point of view consumers, and firms as well.

Next important conclusion is the fact that large country gains a lot from its government activity. When government in country $H$ places trade policy instrument or production subsidy, the welfare improvement and profit increase were significantly bigger than results of the same policy in country $F$. Small country always lose no matter if its government protects the market or subsidies an export. The jump from non-intervention stance to intervention can improve welfare in small country only if government in the other country do not react. Unless it is bind by any international agreement, that stance is not stable. In these circumstances, rival will always has an incentive to start its action. Consequently the final result for the small country is much worse than it did not take any action. In a small open economy, no type of trade intervention can be first-best (Neary, 1991).

We can provide some empirical prove for this conclusion. First is the policy of the World Trade Organization. This institution tries to assure free trade and react for many remarks of the interventionism. But as world market shows, it is extremely difficult, because, as it was mentioned before, countries have got many incentives to intervene – especially their national producers when they compete abroad as part of the international oligopoly. Recently such situation took place in aircraft industry in Canada and Brazil, Governments supported their own national producers of aircraft (Bombardier and Embrarer), which were competing for export contracts.

Another example concerns to small countries. International agreements can let to impose export subsidy. It will affect welfare improvement and profit increase in small country, but as soon as large country react by imposing any barriers, all gains of small country will disappear and finally it will be at the worst condition.

In all concerned cases neither any firm nor government is expected standing passively by watching the rival’s strategic behavior as long as all of them are playing on the oligopolistic market. They will react strategically treating output and price of the rival as given. Each government is involved in international trade competition. It seems to be obvious in terms of the international oligopolistic market, when every firm comes from a different country. Than governments might offer a support for its domestic firm in order to improve its international competitiveness and consequently improve national welfare.

The problem faced by government is to choose appropriate time of reaction on rival’s decision and optimal level of the policy instrument. No matter if it is export subsidy or import tariff, the difficulty of choosing them in a welfare or profit-shifting context have a structure of game. And this is an international game, which are governments involved in. An export subsidy or import tariff chosen at the optimal level in one country – forces others to act.
References


