Social welfare theorem and the wider impact of sanctions: Are the winners and losers of sanctions only those expected?

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Abstract

It is well-established that trade restrictions, while not ideal for consumers, can benefit a select few, at the expense of the general public. This chapter expands on this idea and examines the unintended consequences of trade restrictions in the form of sanctions on major energy-producing countries. This paper demonstrates that the Social Welfare Function in the sender(s) and third countries decreases if even one free-rider is present. Secondly, the analysis indicates that a slight increase in marginal costs has a larger impact on reducing consumer surplus, compared with a decrease in the number of firms by one. Thirdly, at the firm level, it shows that a greater loss results from an increase in marginal costs (*i.e*. removal of a primary producer) than from any increase in profits coming from the reduction in the number of competitors. Lastly, it shows that the withdrawal of international firms benefits some non-frontier firms in the target country, both through reduced competition and through the expropriation of foreign resources.

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Innovation takes place in the North and technology transfer increases the variety of products in the less developed countries. Technology transfer increases the adoption rate of new technology in developing countries and leaves workers in developed countries worse off because it shifts the demand to the south. In contrast, innovation increases the North-South wage differential, and hence the terms of trade shift in favour of the North (Krugman, 1996). Sanctions impose restrictions on technology transfer and reduces the income of the North as it reduces the rent from their monopoly of newly developed products. These two perspectives show that trade restrictions do not benefit all firms and not all firms lose. However, trade restrictions (e.g. on technology transfer, and energy exports) encourage rent-seeking, and create space and scope for free riding activities.

Considering the issue of monopoly rent, *i.e.* export income on the one hand and on the other, imports from the target country *e.g.* energy, despite the secondary sanctions, countries will take sanction circumvention activities to increase their profits. This infringes the sustainability goals and comes at the expense of the countries affected by the sanctions and those complying with the secondary sanction terms. The ability to buy at discounted prices from the target, or sell at premium prices to the target, reduces costs and increases profit for these opportunistic countries. It makes them more competitive at the expense of the countries that follow the terms of sanctions and promotes lawfare, as opposed to healthy competition (Gu and Zhao, 2023). This is an important issue, sustainable development requires countries to be commercially competitive, but sanction circumventing activities have a big impact on the achievement of sustainable development goals. They could also exacerbate tensions such as those between the "North" and the "Global South". Sanctions could create an incentive to form alliances that

would circumvent global policies aimed at facilitating technological transition. This paper examines 1) how free riders diminish the payoff of the sanction imposing countries; 2) how sanctions on major energy producers impact the payoff of the imposing countries; and 3) how sanctions can benefit the elite/government in the targeted country. These questions are important because they highlight the unintended impacts of sanctions on the taxpayers' competitiveness of both the sender and target countries. They highlight the loopholes in international policy and how countries tactically and strategically work around these policies, thereby undermining the effectiveness of sanctions.

To motivate this study, we assume a setting with many countries and introduce four key conditions. The first of these conditions is that these countries can be categorised into two groups; countries that mainly produce primary products and countries that produce manufactured goods. Secondly, the latter group might also have an endowment of primary products (*e.g.* the USA). It is assumed that the sender is a world player *e.g.* the USA and imposes sanctions on a major primary goods producer (*e.g.* Russia), as the third condition. Finally, to deter sanction busting, the sender places secondary sanctions on third countries to deter trade with the target country. The imposition of secondary sanctions forces all players in the network to take a stance: for the USA's allies and smaller countries there is no choice but to follow. Some larger countries could see an opportunity to secure cheaper imports by not following the sanctions. In the extreme case, once the sanctions are imposed all international firms leave the target country and there is an autarky, the target is left in the hands of domestic capitalists who can decide how much profit they receive and how much they invest.

We use the Social Welfare Function (SWF) to measure the payoff for countries and define it as the sum of consumer surplus and profits made by firms of a country in domestic and international markets (Goyal and Joshi, 2006). To address the first two research questions, we made two adjustments to the SWF initially established by Goyal and Joshi (2006). Aghion and Howitt (1992) explain that non-frontier firms cannot compete with frontier firms and therefore, the former group benefit from the absence of the latter. We, therefore, examined how sanctions on a specific target could benefit the firms in that target state within a monopolistic competition framework and consumers, from the perspective of *Taste for Variety*. To the best of our knowledge, no other study has addressed these research questions using the SWF, and the concept of monopolistic competition.

These findings present a mixed picture and necessitate careful consideration. The analysis demonstrates that free-riders can reduce profits for firms in countries complying with the terms of sanctions in the international market. We show that sanctions on a major energy producer reduce both consumer surplus and profits for the firms that have a short position in energy, both in domestic and international markets. In the presence of sanctions, the market becomes segmented, causing prices to remain unaligned and preventing them from converging. This gives significant buying power to free-rider countries to purchase commodities such as oil and gas at discounted prices.

Sanctions placed on a major international primary producer can either reduce or increase profits for the firms that hold short or long positions on that primary good (both those directly hit and third countries), such as in the energy sector. Importantly, our analysis indicates that a firm experiences greater hardship as its marginal costs rise, especially when a supplier is removed from the domestic market, as opposed to when a competing firm is added to the domestic market (the loss because of increasing own cost greater than the loss because of an extra competitor). These effects are not limited to the sender country, and third countries undergo similar dynamics.

We assume that the target country is a developing nation with lower economic fitness *e.g.* lower ability to produce advanced technology, therefore, domestic firms in the target country are non-frontier. This raises an important consideration: if these firms produce manufactured products that have little opportunity to sell in the domestic market in the presence of foreign firms, then they can significantly benefit from the sanctions as they are not competitive in the international market even without the sanctions. On the other hand, primary producer firms such as energy producers, agricultural products, or skilled local handcraft products (*e.g.* rugs) suffer significant losses as they no longer benefit from exports in the international market. Our analysis argues that sanctions in the target country act in the same way as the *Corn laws* and benefit a small group of elites, at a significant cost to others. These elites are powerful individuals or firms that have access to lower exchange rates or low-rate loans[1].

From the perspective of the target country, an increase in inflation and a significant decrease in competition for domestic firms, implicitly assume cost is inclusive, but profits are exclusive to the elites who run these firms. These firms are either state-run or run by the elite connected to the leadership, and therefore, sanctions benefit the very people they intend to hurt. While we acknowledge that significant sanctions do harm the target country, our research uniquely shows that sanctions can have unintended consequences, such as strengthening the resolve of the elite (capitalists) in the target country while burdening ordinary citizens with higher prices and reduced access to goods and services. Specifically, we argue that despite the unfavourable policies of target countries, such as Iran or Russia, the elite is motivated by "profit incentives" that result from the redistribution of the costs of sanctions from the government to ordinary citizens. They benefit from increased demand for non-frontier products and an expanded labour market.

This paper makes significant contributions to the literature on sanctions in several key areas. First, it demonstrates that the SWF in the originating and recipient countries decreases when even one free rider is present. Secondly, the analysis indicates that a slight increase in marginal costs has a larger impact

[1] See for example rent instead of economic development, Etemad newspaper, (0.404.2024): https://www.etemadnewspaper.ir/fa/main/detail/215132/%D8%AA%D9%88%D8%B2%D9%8A%D8%B9-%D8%B1%D8%A7%D9%86%D8%AA-%D8%A8%D9%87-%D8%AC%D8%A7%D9%8A-%D8%AA%D9%88%D8%B3%D8%B9%D9%87-%D8%A7%D9%82%D8%AA%D8%B5%D8%A7%D8%AF%D9%8A-

on reducing consumer surplus compared to a decrease in the number of firms by one. Thirdly, at the firm level, it shows that a greater loss results from an increase in marginal costs (*i.e.* removal of a primary producer) than from the increase in profits due to a reduction in the number of players. Lastly, it shows that the withdrawal of international firms benefits some non-frontier firms in the target country both through reduced competition and through the expropriation of foreign resources. This work highlights that the unintended consequences of sanctions are complex, and policymakers should be mindful of their potential repercussions.

The rest of this paper is organised as follows: section 2 is the literature review; in section 3 we construct a model based on a modified version of that posited by Joshi and Goyal (2006) and then move on to examine the impact of free riders in section 4. Section 5 assesses the impact of eliminating a major energy producer on the model described in section 3. Section 6 employs the concept of monopolistic competition to examine the impact of sanctions on the elite and citizens in the target country. This is followed by a discussion and the conclusion in sections 7 and 8 .

2.Literature review

The consensus in the literature is that the terms of trade have generally favoured producers of manufactured goods, as indicated by measures such as net barter. This is well-documented in the literature and is supported by both dependency and neo-classical theorists. The former categorise countries into "periphery" and "centre" while the latter discusses the "perceived differences" in the elasticities of demand between primary and manufactured goods. For example, for the period 1900 to 1988 a study by Grillli and Yang (1988) showed the relative price of all primary commodities fell by 0.5 percent. Later on in 2010, Harvey et al. used the data from 1650 to 2005 and showed that 11 price series present, a downward trend. This idea is known as the Prebisch-Singer hypothesis (Prebisch-Singer, 1950).

A concept closely linked to Prebisch-Singer's (1950) hypothesis, is 'economic fitness'. The traditional growth theories suggest that differences in output per capita between countries are explained by the accumulation of physical factors. As early as 1957 Solow argued that a major part of growth in developed countries is a function of the improvement in technology rather than the accumulation of capital. Krugman, (1979, p255) argued that it is the "superior ability" that explains advances in developed countries more than any other factors (e.g. a greater endowment of non-human resources). Later, Sutton (2002), and Sutton and Trefler (2016) challenged the conventional theories of growth, arguing it is the set of capabilities that is the source of key differences in output per capita. A study by Ferrarini and Scaramozzino (2016) showed that production complexity explains the differences in economic performance. Sbardella et. al. (2019) demonstrated that fitness plays a prominent role in explaining economic growth. The fitness of a country represents its competitiveness and development (Cristelli et al, 2013) and is a proxy that measures the complexity of its capability (Tacchella et

al.,2013). Therefore, different levels of complexity are synonymous with different fitness values (Pugliese, 2021). If low-fitness countries can produce and export products, then these products most likely require low complexity. As a result, this theory argues that low-fitness countries are unlikely to be home to frontier firms.

The are several reasons why the Prebisch-Singer (1950) hypothesis and economic fitness are relevant to each other. In the case of a major energy producer, their main interaction with the rest of the world is through exporting their primary product, which can be limited by sanctions. By assumption, a target is likely to belong to the peripheries and have lower economic fitness compared to advanced economies. Countries that produce manufactured goods require primary goods, while primary goods producers need manufactured goods and related services. Although they may negotiate prices, they do not directly compete, as in the Cournot game, for example. These theories suggest that there is interdependence in trade between the North and South, meaning that sanctions on a major primary goods producer have repercussions for both sides. We will explore how these repercussions affect the SWF in the sending country and in third countries, which are the focus of our first and second research questions.

To investigate the impact of sanctions on the distribution of national income between capital and labour, we start with the analysis of Dixit and Stiglitz (1977). They utilise the concept of the convexity of indifference curves for various goods. They explain that if a consumer is equally content with having either of two different goods, they would rather have a combination of the two than just one or the other. They show that the consumer has a taste for variety and prefers to consume a differentiated bundle of goods. Grossman and Helpman's (1991) model brings together the variety (horizontal) and quality (vertical) of products together. They state that innovation is the technology required for a product to make a discrete jump on the quality ladder. They assert that research responds to profit incentives, or as Aghion and Howitt (1992) put it, monopoly rents. Capitalist economies (centre countries) are largely motivated by innovations to earn the monopoly rent. The process of "creative destruction" (Schumpeter 1942, p.83) is the essence of capitalist economies.

The nature of monopoly rent in developing countries differs from that in industrialised regions. Pedersen (1995) explains that in developing countries, economic policies are often designed to satisfy small influential groups, rather than for economic development. The list of sanctioned countries suggests that the targets tend to be developing nations and non-Western democracies.[2] The naïve theory of sanctions (Gutlang, 1967) suggests that, for a rational target state, there is a positive linear relationship between the cost of the sanctions and the probability of a compromise (Caruso, 2003). The naïve theory assumes that the authority in the target country is concerned with the welfare of their

[2] The argument in the literature often assumes that sanctions are imposed by democratic countries on an undemocratic regime to promote democracy and/or punish them (Lektzian and Souva 2003, Cox and Drury 2006). It often turns out that the regime of the target country has radical and skewed policies, which attracted the sanctions in the first place.

citizens; an undemocratic regime, however, often does not consider who their policies hurt (Kaempfer and Lowenberg 1988; Lektzian and Patterson 2015; Pond 2017). This type of regime tends to hedge themselves through a range of activities, often at a major cost to their citizens. Dorussen and Mo (2001) explain that critics of sanctions argue that the targeted state often transfers the costs to their citizens and finds other ways, such as rent-seeking, trading with third parties, etc to hold on to their policy. The evidence, from the United Nations sanctions on Iraq (1995) shows that the $2 billion in Saddam Hussein's bank account, (with claims it may have been as high as $10 billion) ended up in the pockets of officials outside Iraq, whilst poverty was prevalent inside the country (Campbell, 2018).

It is plausible to argue that innovation in developing countries is partially undermined with a less market led economy and greater governmental control to satisfy the incentive and objectives of the small influential groups. How do trade restrictions create space for monopoly rent and what is innovation like under sanctions in developing countries? Sanctions reduce the competition in the target country and benefit non-frontier firms, which cannot compete with frontier firms. These non-frontier firms can be state-owned, nationalized, PLC, private (or both) led by individuals often with a strong link to the regime. The the PLCs and private firms groups of firms often benefit from monopoly rent that is not underpinned by innovation. They benefit from the favourable treatment by the ruling elite in return, for example, for the claim of job creation[3]. Favourable treatment can allow these firms to borrow at a much lower rate of interest, and tax treatment, get access to fixed-rate foreign exchange, better access to domestic banks, a stronger domestic network, better access to information, and access to a cheaper labour supply and control of the black market. For example, studies by Woods (2008) Acemoglu et al. (2013) and Acemoglu and Johnson (2023) highlight labour exploitation by the ruling elites.

Sanctions increase the demand for domestic products (Pond 2016), reduce or even tarnish foreign competition, and increase the demand for protectionist policies *e.g.* via an increase in trade tariffs post-sanctions. In addition, a recent study shows that sanctions overall slow employment growth, thereby they enhance access to cheaper labour (Moghaaddasi Kelishomi and Nistico, 2022). They argue that in the presence of trade restrictions where trade diversion is costly, domestic entrepreneurs replace imports. However, we argue this "trade replacement" brings implications for *know-how* and the *quality* of such replacements. Countries in the peripheries have lower fitness and hence firms in these countries tend to be non-frontier firms. The growth of these non-frontier firms is inversely related to the level of competition (Aghion and Howitt, 1992). Therefore, it is safe to assume 1) that most likely they replace imports with inferior products and 2) demand in the domestic market increases for these domestic firms, and they can export to less developed countries or other countries under sanctions (*e.g.* export of drones from Iran to Russia). Sanctions could benefit these firms. Hence, there is a growth in low-quality output. With these views, there is at the very least low-quality production, but on the other side of the same

[3] Yet often, there are strong suggestions of connections and nepotism within all these firms in these countries.

spectrum, one could see them taking control of black-market imports and profiting from a pure rent. Take Iran as an example, a combination of petrodollars, a multi-exchange rate system, and sanctions create an environment that motivates rent-seeking and demotivates innovation because those in power do not need to innovate to benefit. Nevertheless, many of these firms although benefitting from better control and share of the domestic market lose access to the international markets.

Trade restrictions encourage rent-seeking[4] and therefore, increases the social cost (Tullock, 1967, Appelbaum and Katz 1986, Wender, 1987). Delmorre and Snow (1990, p150) have built on Tullock's work suggesting the extent of the social cost depends on the government's involvement in subsiding such activities, and at the limit, it is "equal to the economy 's maximum potential social surplus".

3. The model

Goyal and Joshi (2006) studied strategic network formation to examine the stability of the "different free trade structure" p.749 by developing a social welfare function. They define the social welfare function as the sum of consumer surplus and profits made by firms of a country in domestic and international markets. In their study, Goyal and Joshi (2006) showed that a pairwise stable trading network is a complete network, the only other stable network has all countries in a network except a single country, an autarky. Campbell (2018) elaborates on this result, pointing out that if there are two networks each with at least two players then there is every chance a player from one of these two networks will form a free trade agreement with the other network. This later statement reflects the world reality, there are vast numbers of incomplete trading networks, and therefore trade networks are often not pairwise stable.

We take the notion of pairwise stability and focus on free-riders. We modify Goyal and Joshi's (2006) social welfare function to allow for the presence of free-riders and address the research question: can free-rider(s) reduce the social welfare function of sender countries? Let's define free-riders as players who are incentivised to maximise their benefit regardless of the cost to their trading partners within a network. With this perspective, trade restrictions on an energy producer provides space and scope for free-riders despite secondary sanctions. Some of these free-riders countries are large enough to be able to follow their interests and not the terms of any secondary sanctions imposed (*e.g.* China, India). They benefit from the positive externalities of trade sanctions on energy producers via sanction circumventing activities. For example, a player could benefit from its trade agreement with the EU members and decide to trade with Russia whilst Russia is under heavy sanctions by the EU. This section models such a scenario.

[4] The wasteful competition that takes place as business/pressure groups follow rents through influencing government policies defined as rent-seeking (Kruger 1974).

Recall that the literature divides countries into two groups; centre and peripheries, where peripheries mostly export primary products. Assume a buyer -seller network where sanctions are placed on a major primary producer, *i.e.* on a seller who belongs to the periphery group. Define $\mathcal{N} = \{1,2,\dots,n\}, n \geq 3$ as a finite set of countries. Peripheries have only one representative firm and produce a homogenous energy product with identical and constant marginal costs of production. A central country could be the sender, or a third country and third countries are subject to the secondary sanctions. The 'centre' countries could have one or two representative firms, one of which must produce advanced manufactured products and import energy as an input for its production function. We assume centre countries produce homogenous advanced manufactured products and hence, they are perfect substitute for each other. Their second firm can only be a primary producer otherwise they will only have one firm. For simplicity, we assume that there is no link in between the primary producer, regardless of their categories (*i.e.* centre or peripheries).

For a network g, the adjacency matrix $G = [g_{ij}]$ keeps track of trade links between players, this is a zero-diagonal matrix. The binary pairwise relationship between players is captured by $g_{ij} \in \{0,1\}$. If $g_{ij} = 0$ then i cannot enter j's domestic market and vice-versa because they do not have a trade link. When i and j are directly linked $g_{ij} = g_{ji} = 1$. Denote by g_c the complete network, *i.e.* a network where all members have trade links. As in the original study by Goyal and Joshi (2006) and for the sake of exposition, we assume that countries only trade with each other if there is no tariff, *i.e.* they have a FTA. $N_i(g)$ denotes the set of all countries with which i has a free-trade agreement (FTA), and $n_i(g)$ represents the number of nodes in $N_i(g)$ hence, $n_i(g) = 1 + N_i(g)$, the 1 count is for i itself (Campbell, 2018).

To derive the social welfare function for centre countries, we derive the standard price and quantity using the Cournot model of competition. In its simplest form denote the market demand function in country i as $Q_i = A - P_i$ where Q_i is the total output in country i given the price P_i. The term A is a constant where marginal cost $c < A$. To derive the price and quantity we assume there is no fixed cost and constant marginal cost as in Goyal and Joshi (2006) and Campbell (2018).

For the moment assume that all centre countries have only one representative firm producing advanced manufactured products and that they import energy; we later relax this to allow for a second representative firm that produces energy. As in Campbell (2018) denote by R the total output by all centre countries (*i.e.* energy buyers) but one, X. The firms are independent and hence do not collude. The representative firm in each country reacts to total output, R in other centre countries and produces quantity, q to maximise its own profit, hence:

$$q + R = A - P \tag{1}$$

where q is the representative firm quality, R is the total output by all countries but one, $A > P$ is a constant and P is the price, therefore:

$$q = A - R - P \tag{2}$$

and price:

$$P = A - R - q \tag{3}$$

Assuming c is the cost, then the cost of producing q units of output is cq and a firm profit turns to be $Pq - cq$ and we have*:*

$$(P - c)q = (A - R - q - c)q = (A - R - c)q - q^2 \tag{4}$$

Taking the first derivative with the respect to quantity, it results in the maximised quantity, q^*:

$$q^* = \frac{1}{2}(A - R - c) \tag{5}$$

We assumed that all firms are homogenous therefore the total output, but one firm becomes:

$$R = \frac{1}{2}(A - (n-1)q^* - c) \tag{6}$$

Solving for q^* we have:

$$q^* = \frac{A-c}{n+1} \tag{7}$$

and the total industry output:

$$Q^* = \frac{n(A-c)}{n+1} \tag{8}$$

Given $P = A - Q^*$ we have:

$$P^* = A - \frac{n(A-c)}{n+1} = \frac{A+nc}{n+1} \tag{9}$$

Hence the individual firm profit is:

$$(P^* - c)q^* = \frac{(A-c)^2}{(n+1)^2} \tag{10}$$

When the market demand function has the form $q = a - p$ the consumer surplus is equal to $\frac{1}{2}q^2$ where:

$$q = \frac{A-c}{n+1} \tag{11}$$

If we assume equal weights for consumer surplus and producer profits, then the social welfare function is the sum of consumer surplus and firm $i's$ profit in the domestic market and all foreign markets we have the social welfare function:

$$W_i = \frac{[n_i(g)(A-c)]^2}{2(n_i(g)+1)^2} + \frac{(A-c)^2}{(n_i(g)+1)^2} + \left(\frac{\sum_{i\neq j}(A-c)^2}{(n_j(g)+1)^2} - T_j^i(g)\frac{(A-c)}{n_j(g)+1}\right) + T_i^i A\frac{(A-c)}{n_i(g)+1} \quad (12)$$

where $\frac{n_i(g)(A-c)^2}{2(n_i(g)+1)^2}$ is consumer surplus, $\frac{(A-c)^2}{(n_i(g)+1)^2}$ is the profit $i's$ firm makes in the domestic market and $\frac{\sum_{i\neq j}(A-c)^2}{(n_j(g)+1)^2}$ is the profit i's firm makes in all foreign markets. The term $T_j^i(g)$ is the tariff term which is a function of total outputs. For simplicity, and without loss of generality, for the rest of this analysis, we assume that the trade link is conditional on an FTA and drop the tariff values. Therefore, the SWF in a complete network is given by:

$$W_i = \frac{[n_i(g)(A-c)]^2}{2(n_i(g)+1)^2} + \frac{n_i(g)(A-c)^2}{(n_j(g)+1)^2} \quad (13)$$

where $\frac{n_i(g)(A-c)^2}{(n_j(g)+1)^2}$ is the profit country i's firm makes in all countries that they have an FTA plus in i's domestic market.

If country i is a centre and has "two representatives" firms that for simplicity make an equal profit (13) can be written as:

$$W_i = \frac{[n_i(g)(A-c)]^2}{2(n_i(g)+1)^2} + \frac{2(A-c)^2}{(n_i(g)+1)^2} + \frac{(n_j(g)-1)(A-c)^2}{(n_j(g)+1)^2} \quad (14)$$

where $\frac{2(A-c)^2}{(n_i(g)+1)^2}$ is the total profit earned by a country $i's$ firms in its domestic market. $\frac{(n_j(g)-1)(A-c)^2}{(n_j(g)+1)^2}$ shows the profit of country i in all foreign markets, the $n_j(g)-1$ shows i export to all countries except itself. The demand for each firm remains unchanged as they are producing different products, *Ceteris Paribus*.

If country i is a centre and has "one" firm, (13) can be written as:

$$W_i = \frac{[n_i(g)(A-c)]^2}{2(n_i(g)+1)^2} + \frac{(A-c)^2}{(n_i(g)+1)^2} + \frac{(n_j(g)-1)(A-c)^2}{(n_j(g)+1)^2} \quad (15)$$

4.The impact of free-riders on the SWF in the sender and third countries

We assume that there is a complete network and i breaks its link with j, which is a periphery country and produces a primary product. Equation 14 is used if the sender has two firms, a firm that has a short position and one firm that has a long position in energy. If it is assumed the sender only has one firm and that its profits are a negative function of energy prices, we use equation 15. All countries have the same weighting, and we examine the impact of breaking the link with j on the social welfare function of i under four different scenarios for the sender. In the first case, all countries continue to trade with j except country i (*i.e*. the sender). In the second case, only two countries trade with j, in the third case no country trades with j except one country, and in the final case, no country trades with j.

4.1 Scenario 1: all countries trade with j except i (*i.e* the sender)

Once i breaks a link with a periphery the SWF for country i' (3) becomes:

$$W_i(g-ij) = \frac{[(n_i(g)-1)(A-c)]^2}{2n_i(g)^2} + \frac{2(A-c)^2}{n_i(g)^2} + \frac{(\boldsymbol{n_i(g)-2})(\boldsymbol{A-c})^2}{(\boldsymbol{n_j(g)+1})^2} \tag{16}$$

For the ease of discussion profits in international markets are presented as bold in all equations. In all scenarios the first three terms on the right-hand of the equations presented by ΔW_{ij} shows the social welfare function where there no country is eliminated, the remining terms represent the payoff for a given scenario. The notation $g-ij$ denotes the new network obtained by removing the link between ij. The number of countries that operate in country i reduces by one, this is reflected in all three terms on the right-hand side compared with equation 3. The third term shows country i will supply to $(n-2)$ international countries (subtracting itself and j from n), but trade numbers in all these remain the same, *i.e*. the denominator in the third term remains unchanged. The fact that country i might have a second firm that produces a primary good does not affect the third term, as by assumption, it does not supply primary products to a primary producer.

Mathematically, to show the overall effect of breaking the link with country j on country $i's$ SWF it is sufficient to show that the SWF is larger before breaking the trade link with country j, that is: $\Delta W_i = W_i - W_i(g-ij) > 0$ (Goyal and Joshi 2006, Campbell 2018). Here, however, we alter Goyal and Joshi's model so that there can be two firms in the domestic market instead of one. In what follows, for brevity, the subscript i and network g have been dropped.

$$\Delta W_{i1} = \frac{[n(A-c)]^2}{2(n+1)^2} + \frac{2(A-c)^2}{(n+1)^2} + \frac{(n-1)(A-c)^2}{(n+1)^2} - \frac{[(n-1)(A-c)]^2}{2n^2} - \frac{2(A-c)^2}{n^2} - \frac{(\boldsymbol{n-2})(\boldsymbol{A-c})^2}{(\boldsymbol{n+1})^2}$$

$$\Delta W_{i1} = \frac{(A-c)^2(n^2+4+2(n-1)-2(n-2)}{2(n+1)^2} - \frac{(A-c)^2(n-1)^2-4}{2n^2} \tag{17}$$

For positive n, the expression 17 is positive iff

$$\frac{[n^2+6]}{2(n+1)^2} > \frac{(n-1)^2+4}{2n^2} \tag{18}$$

If $n > 3$ this equality holds which means $W_i - W_i(g-ij) > 0$. Hence, the SWF in country i reduces once it breaks trade with country j.

4.2 Scenario 2: Two free-riders

If we assume two countries do not follow the terms of the sanctions, for example, China and India continue to buy oil from Russia, then:

$$\Delta W_{i2} = \frac{[n(A-c)]^2}{2(n+1)^2} + \frac{2(A-c)^2}{(n+1)^2} + \frac{(n-1)(A-c)^2}{(n+1)^2} - \frac{[(n-1)(A-c)]^2}{2n^2} - \frac{2(A-c)^2}{n^2} - \frac{\boldsymbol{(n-4)(A-c)^2}}{\boldsymbol{n^2}} - \frac{\boldsymbol{2(A-c)^2}}{\boldsymbol{(n+1)^2}} \tag{19}$$

The penultimate expression on the right-hand side states the profit of country i in all but three countries. Country i does not export to itself in the international market hence $n-1$, but term $n-4$ shows the subtraction of 3 more countries, one is because of breaking the link with one country, and the remaining two are stated in the final expression. The denominator shows only n^2 as supposed to $(n+1)^2$ because all countries in this fraction have broken their link with j. The final expression shows the profit in the remaining two countries (*e.g.* India and China) where all countries are supplying goods (*e.g.* Russia is supplying energy to China and India). Which simplifies to 20:

$$\frac{(A-c)^2[(n^2+2(n-1)]}{2(n+1)^2} - \frac{(A-c)^2[(n-1)^2-4-2(n-4)]}{2n^2} \tag{20}$$

For positive n, the expression 20 is positive because:

$$\frac{n^2+2n-2}{2(n+1)^2} > \frac{(n-1)^2-4+2n}{2n^2} \tag{21}$$

4.3 Scenario 3: one free-rider

If only one country does not follow the terms of the secondary sanctions, then:

$$\Delta W_{i3} = \frac{[n(A-c)]^2}{2(n+1)^2} + \frac{2(A-c)^2}{(n+1)^2} + \frac{(n-1)(A-c)^2}{(n+1)^2} - \frac{[(n-1)(A-c)]^2}{2n^2} - \frac{2(A-c)^2}{n^2} - \frac{\boldsymbol{(n-3)(A-c)^2}}{\boldsymbol{n^2}} - \frac{\boldsymbol{(A-c)^2}}{\boldsymbol{(n+1)^2}} \tag{22}$$

The sixth expression on the right-hand side shows the international profit in all countries that have eliminated their trade link with j and the seventh term shows the profit in the only country that continues

to trade with j. For example, after sanctions are imposed on Russia, assume that all countries break their link with Russia, except for India, which continues to trade with Russia. Which simplifies to (23):

$$\frac{(A-c)^2[(n^2+4+2(n-1)-2)]}{2(n+1)^2} - \frac{(A-c)^2[(n-1)^2-4-2(n-3)]}{2n^2} \quad (23)$$

For positive n, the expression 23 is positive because:

$$\frac{(n^2+2n)}{2(n+1)^2} > \frac{(n-1)^2-2+2n}{2n^2} \quad (24)$$

which means $W_i - W_i(g-ij) > 0$

4.4 Scenario 4: no free-riders

If we assume that all countries follow the terms of secondary sanctions, we have:

$$\Delta W_{i4} = \frac{[n(A-c)]^2}{2(n+1)^2} + \frac{2(A-c)^2}{(n+1)^2} + \frac{(n-1)(A-c)^2}{(n+1)^2} - \frac{[(n-1)(A-c)]^2}{2n^2} - \frac{2(A-c)^2}{n^2} - \frac{(\boldsymbol{n-2})(\boldsymbol{A-c})^{\boldsymbol{2}}}{\boldsymbol{n^2}} \quad (25)$$

which can be simplified to 926:

$$= \frac{(A-c)^2[n^2+4+2(n-1)]}{2(n+1)^2} - \frac{(A-c)^2[(n-1)^2-4-2(n-2)]}{2n^2} \quad (26)$$

$$\frac{n^2+2n+2}{2(n+1)^2} - \frac{(n-1)^2-2n}{2n^2} > 0 \quad (27)$$

Therefore, sanctions reduce the overall payoff of a country if all countries follow the terms of the secondary sanctions. To see if there is a difference between when all follow but one and when all follow, we subtract former equation by the latter equation:

$$\Delta W_i = \frac{[(n-1)(A-c)]^2}{2n^2} + \frac{2(A-c)^2}{n^2} + \frac{(n-3)(A-c)^2}{n^2} + \frac{(A-c)^2}{(n+1)^2} - \frac{[(n-1)(A-c)]^2}{2n^2} - \frac{2(A-c)^2}{n^2} - \frac{(n-2)(A-c)^2}{n^2} = -1 \quad (28)$$

This is the loss of social welfare, given the presence of a single free-rider. As the number of free-riders increases, the loss increases. Reducing the firms that operate in the domestic market to one does not alter this finding.

Mathematically we showed the SWF is a negative function of free-riders. We assumed a complete network, where the sender places sanctions on a country and breaks its link. In total, we compare five scenarios, one before sanctions (scenario zero) and four after sanctions (Scenarios 1-4). In the first scenario, no country other than the country i (*e.g.* the sender) breaks its link with the target, we show that the sender's social welfare function goes down following the breaking of a link. In the second

scenario all but two countries broke their link with the target, and the social welfare function for country i remained less compared to the situation before breaking the link, but is higher than in scenario 1, because only two countries violated the terms of the secondary sanctions. In case three only one country continues to trade with the target and the social welfare function for i remained less than before breaking its link but higher than in scenario 2. It is case 4 where all countries break their link with the target, and we showed (4.4) that if there are more than 14 countries then there is no loss in Social Welfare Function for country i. Finally, we showed the difference between the social welfare functions.

Comparing the ΔW_{i1} to ΔW_{i4} the only difference among them is country $i's$ profit function in the international market (in bold). For the moment we ignore the fact the target is an energy supplier. We examine what happens to the international profit function as the number of countries increases from 4 in all five scenarios (Figure 1). The firm's profits in the international market is greatest when there is a sanction on a target, and all follow the terms of secondary sanctions (an unlikely real-world scenario) followed by when there is no sanction. However, the differences between these two scenarios vanishes as the number countries increases to 40. This can be show as follows:

$$\frac{(n-1)(A-c)^2}{(n+1)^2} - \frac{\boldsymbol{(n-2)(A-c)^2}}{\boldsymbol{n^2}} < 0 \qquad (29)$$

When n is small, the denominator of the second expression is smaller than the first expression, which makes the fraction larger. As n increases, the difference between the denominators and numerators becomes negligible, and the two fractions become equal. Intuitively, as the number of countries increases, the impact of less competition diminishes. In all scenarios, the profit in the international market is maximized when there are 4 countries, and then it reduces. Profit in all scenarios converges as the number of countries increases.

We assumed that all countries have equal weight, but this is not the case where major economies such as China or India violate the terms of sanctions for example, when they continue to buy energy from Russia or Iran. Once sanctions are placed on a major energy producer, those who violate the terms of secondary sanctions have bargaining power and get access to cheaper energy. This makes these violators more competitive in the international market as their cost of production is lower than say country i (for example a NATO member). Assuming it is China or India that violates the terms of the sanctions along with cheaper labour in these countries their cost of production will be significantly less than in country i, and they will be able to attract foreign investments from other countries to theirs. This also allows a faster rate of technology transfer because these countries also learn by doing.

The impact of sanctions on the SWF is dependent on who is eliminated from the trade network, whether it is a major energy producer or a competitor that has been eliminated. In what follows we examine this

aspect and relax the assumption of fixed marginal costs to see what happens to the SWF of the sender countries.

5.The impact of eliminating a major energy supplier on the SWF

Separate from, but related to the above discussion, are studies on delinquency by Ballester et al. (2006). They show that the elimination of a key criminal player from a network of delinquents results in the highest aggregate reduction in delinquency. In the context of criminal activities, the elimination of a key delinquent seems to be a good strategy for the planner. Elimination of a regional/world energy producer could be equated as eliminating a key player, *i.e*. yielding the highest loss of energy supply but the question is, who pays the cost and who benefits? This study evaluates such a strategy and addresses how sanctions on a major energy producer affect the SWF of the sender and third countries?

In the previous case, we assumed that we had a complete network, and then a player was eliminated from the complete network. In this case, we assume a given network and examine what happens to the social welfare function as the number of players or marginal costs increases. We use equation 15, under two assumptions to allow to compare the general case *i.e.* when target is a competition and when a target is a supplier. This will allow us to compare the impact of increased competition (*i.e.* when the target produces the same goods as the sender) as opposed to an increase in marginal cost (*i.e.* when target is a supplier).

5.1. Consumer surplus for the sender when the target, *j* is a supplier of energy

The general model used by Goyal and Joshi (2006) shows that by eliminating a link, $g_c - ij$ consumer surplus in $i's$ market will reduce to $\frac{[(n-1)(A-c)]^2}{2n^2}$ which is less than $g_c = \frac{[n(A-c)]^2}{2(n+1)^2}$. The first- (and second-) order condition of the consumer surplus function with respect to n is positive (and negative); hence, the consumer welfare function is concave with respect to the number of firms:

$$\frac{\partial cs}{\partial n} = \frac{\partial \frac{[n_i(g)(A-c)]^2}{2(n_i(g)+1)^2}}{\partial n} = \frac{n_i(g)(c-A)^2}{(n_i(g)+1)^3} > 0 \qquad (30)$$

Proposition 1: As the number of suppliers increases, the Consumer Surplus increases.

Irrespective of the types of firms, as the number of firms in the domestic market increases the consumer surplus increases because it either increases the level of competition in the domestic market or acts as an extra supplier which reduces the cost.

Proposition 2: As the marginal cost increases the consumer surplus decreases.

If we relax the assumption of fixed marginal cost, the derivative of the consumer welfare function with respect to marginal cost is negative by assumption ($c < A$):

$$\frac{\partial cs}{\partial c_i} = \frac{\partial \frac{[n_i(g)(A-c_i)]^2}{2(n_i(g)+1)^2}}{\partial c_i} = \frac{n_i^2(g)(c_i-A)}{(n_i(g)+1)^2} < 0 \quad (31)$$

Therefore, both fewer links or an increase in marginal costs, are bound to reduce consumer surplus. In addition, $\frac{n_i^2(g)(c_i-A)}{(n_i(g)+1)^2} > \frac{n_i(g)(c-A)^2}{(n_i(g)+1)^3}$ meaning a small increase in the marginal cost reduces the consumer surplus more than reducing the number of firms by one. This is a plausible outcome. As the supply of primary goods reduces it will increase the per unit cost of production for firm i. Joshi and Mahmud (2020) address the extent of this effect through strategic complementary effects and the ease of access to other suppliers. In the presence of the secondary sanctions, this will increase the level of competition to gain access to the supply of primary goods and it is bound to reduce the strategic complementary effect, *i.e*. the ease of substitution. Consumers will end up paying the price of sanctions for the target, both in the sender country and the impact spillover onto other countries, one because of the secondary sanctions and two because of the linkages in international trade.

5.2. Profits in domestic markets when the target is a supplier of primary goods

In a general case when a competitor is eliminated from $i's$ market the profit earned by firm i increases, therefore profit is lower when there is a complete network that is:

$$\pi(g_c) - \pi(g_c - ij) = \frac{2(A-c)^2}{(n_i(g)+1)^2} - \frac{2(A-c_i)^2}{n_i^2(g)} < 0 \quad (32)$$

where $\frac{2(A-c)^2}{(n_i(g)+1)^2}$ is the profit in the complete network and $\frac{2(A-c_i)^2}{n_i^2(g)}$ is the profit once one player is eliminated from the complete network. We placed the assumption that there are two types of countries: the 'centre' and 'peripheries' and that the target is a periphery. The centre and peripheries are not competing in a Cournot competition. If the target is a competitor, then:

$$\frac{\pi(g)_i^d}{\partial n} = \frac{\partial \frac{2(A-c_i)^2}{(n_i(g)+1)^2}}{\partial n} = -\frac{2(A-c)^2}{(n_i(g)+1)^3} < 0 \quad (33)$$

The FOC of profit earned by a country $i's$ firm with respect to n is negative and the second order condition is positive given the convexity of profit and proposition 3 is readily in place:

Proposition 3: As the number of competing firms in the domestic market increases, the profits earned by domestic firms are reduced.

This result is as expected when the import from a target is extra competition. This is not the case for the firm(s) who are oil importers from the periphery.

However, if the target is a supplier:

$$\frac{\pi(g)_i^d}{\partial c_i} = \frac{\partial \frac{2(A-c_i)^2}{(n_i(g)+1)^2}}{\partial c_i} = -\frac{2(A-c_i)}{(n_i(g)+1)^2} < 0 \quad (34)$$

Proposition 4: A sanction on a major international primary producer reduces the profit for a representative firm in country i that has a short position on energy

Breaking a link with the target increases per unit costs and marginal costs for the sender across the supply chain, and so reduces profits. The value of $\frac{\pi(g)_i^d}{\partial c_i} < \frac{\pi(g)_i^d}{\partial n}$ shows that there is a larger loss resulting from an increase in marginal cost (*i.e.* when a primary producer is removed) than a decrease in the number of players.

If target is a competition, the elimination of a target benefit representative domestic firm by an amount equal to $\frac{2(A-c)^2}{(n_i(g)+1)^3}$. If a target is a supplier the elimination of a target costs representative domestic firms by an amount equal to $\frac{2(A-c)^2}{(n_i(g)+1)^2}$.

For a moment if we assume there are two firms in a country i the change in total profit is:

$$\frac{2(A-c)^2}{(n_i(g)+1)^3} - \frac{2(A-c_i)}{(n_i(g)+1)^2} = benefit - cost < 0 \quad (35)$$

There is a gain in profit by as much as $\frac{2(A-c)^2}{(n_i(g)+1)^3}$ for a firm that has a long position in oil and there is a loss in profit for a firm that has a short position in oil by an amount of $\frac{2(a-c_i)}{(n_i(g)+1)^2}$. Since $\frac{2(A-c)^2}{(n_i(g)+1)^3} < \frac{2(A-c_i)}{(n_i(g)+1)^2}$ the expression is negative. This argument does not include increases in the value of assets. For instance, for domestic oil producers, the value of their oil resources increases as the price of oil increases.

If there is only one firm in country i which has a short position on oil the loss is equal to: $\frac{2(A-c_i)}{(n_i(g)+1)^2}$ which is greater in absolute term than the case of two firms because in the case of two firms the gain for the company with a long position in oil cushions the loss in the firm that utilises the oil hence:

$$\frac{2(A-c)^2}{(n_i(g)+1)^3} - \frac{2(A-c_i)}{(n_i(g)+1)^2} < \frac{2(A-c_i)}{(n_i(g)+1)^2} \quad (36)$$

There is less loss of profit when country i is endowed with an energy-producing firm in addition to the firm that has a short position in oil. This is a function of the number of firms in the country i. For the sake of exposition if we assume that there are n firms in which $n = (n_e, n_{-e})$ where n_e stands for the

number of energy-producing firms and simplicity assumes that both energy and non-energy firms make equal profits, then the loss in profit following a sanctions on an energy producer is :

$$\Delta\pi(g)_i^d = \begin{Bmatrix} \left|\frac{n_e(A-c)^2}{(n_i(g)+1)^3} - \frac{n_{-e}(A-c_i)}{(n_i(g)+1)^2}\right| = \left|\frac{2(A-c_i)}{(n_i(g)+1)^2}\right| & if\ n_e = 0 \\ \left|\frac{n_e(A-c)^2}{(n_i(g)+1)^3} - \frac{n_{-e}(A-c_i)}{(n_i(g)+1)^2}\right| < \left|\frac{2(A-c_i)}{(n_i(g)+1)^2}\right| & if\ n_e \geq 1 \end{Bmatrix} \quad (37)$$

The inequality inside the parenthesis is the result of diversification.

The findings can be summarized as follows: If a country has a representative oil producer firm and a manufacturing goods representative firm, removing a competitor that produces energy from the market benefits the oil producer firm. However, adding an extra supplier, despite increasing competition in the domestic market, is favourable. It is important to note that these results are based on the model used in this study.

5.3 Profit in all foreign markets when the target is a supplier of primary goods

The FOC of profit in all foreign markets shows that as the number of links increases, profits decrease as the market becomes more competitive:

$$\frac{\partial \frac{n_i(g)(A-c)^2}{(n_i(g)+1)^2}}{\partial n} = -\frac{(c-A)^2(n_i(g)-1)}{(n_i(g)+1)^3} < 0 \ , c < A \quad (38)$$

Proposition 5: As the number of competing firms in the international market increases, the profits earned by domestic firms are reduced.

There is a substitution effect because of competition. Hence, as competition reduces, given the sanctions are imposed on a major energy producer, and secondary sanctions are imposed, then the profit of an oil producer firm increases because of the effect of reduced competition.

In addition, as marginal costs increase for representive domestic firm , their profits reduce as expected.

$$\frac{\partial \frac{n_i(g)(A-c)^2}{(n_i(g)+1)^2}}{\partial c_i} = \frac{2n_i(g)(c_i-A)}{(n_i(g)+1)^2} < 0 \ \ , c < A \quad (39)$$

Proposition 6: A sanction on a major international primary goods producer, reduces the profit for the firm in country i that has a short position on oil/energy in the international market

As in the domestic market, the absolute value of $\frac{\pi(g)_i^F}{\partial c_i} < \frac{\pi(g)_i^F}{\partial n}$ hence, there is a larger loss resulting from an increase in marginal cost (*i.e*. when a primary producer is removed) than the effect of a decrease in the number of players:

$$\frac{(c-A)^2(n_i(g)-1)}{(n_i(g)+1)^3} - \frac{2n_i(g)(c-A)}{(n_i(g)+1)^2} < 0 \qquad (40)$$

The derivative of the SWF shows that in the presence of sanctions, consumer surplus decreases. Profits of firms that are dependent (independent) on the imported energy from the target country decrease (increase) as the marginal price of supplies increases. The prices are dependent on the cost of the marginal supply of energy. Given the introduction of sanctions, marginal costs will go up for firms that have a short position in energy, but "all" internal marginal terms will benefit from this, *i.e*. even though an energy-producing firm might not face an increase in its marginal cost, it will increase its prices, *e.g.* fuel cost at pumps increases.

The argument for the cost ineffectiveness of the sanctions is focused on trade losses for the sender and target (Kaempfer and Lowenberg, 1988; Morgan and Schwebach, 1997). Examining the SWF, Goyal, and Joshi (2006) assumed that a government maximises the SWF when it decides to agree on a trade link. This is still true even if consumer surpluses decline, but domestic firms benefit from the higher prices. In such a case the cost will be transferred to the consumer, through cost of living rises. However, none of these derivatives suggest that there is any assurance that placing sanctions will not reduce the SWF of the sender unless there is no trade link between the sender and the target. Commandment III of Hufbauer et al. (1990) states that placing sanctions is a futile exercise if there is no link between the sender and the target. However, the presence of secondary sanctions and a multipolar world challenges Commandment III, unless the target is an autarky. Assume there is no link between the sender and the target, but the sender has hegemonic power. For the sanctions to have any bite on the target, placing secondary sanctions on other countries to not trade with the target will hurt the target and will reduce the supply of energy in this case. But this means the third countries who follow the terms of secondary sanctions experience negative externalities and could face a significant increase in their marginal costs. These third countries, that follow the terms of the sanctions, are subject to the immediate collateral damage of the sanctions. This suggests the sender's key allies, could face an increase in their marginal costs, and consequently, be the loser of a game that they did not play. The loss for the third countries is bound to have a higher impact on their economy, as one would expect the sender has a stronger economy, hence it is more buoyant to repel the loss than smaller economies.

One could argue if the sender is also a seller, they could gain by selling to third countries, and benefit by eliminating a major energy producer from the international market and weakening competition. This is even more effective if the target is an international rival to the sender (USA vs Russia). Whilst this

argument is largely sound, it ignores the spillover effect of price volatility on the sender country even if there was no trade between the sender and the target and even if the sender itself is a supplier of energy, unless the sender trades with no other country.

These findings also highlight another issue, the secondary sanctions do not often guarantee that all players follow them, particularly in the presence of a multipolar world. But even the violation of such enforcement hurts the target because those who agree to trade with the target have greater bargaining power. Whilst it is difficult to measure it accurately, it is reasonable to assume that China and India have benefited from Russia's invasion of Ukraine. In the short term, whether the benefit of purchasing cheaper energy supplies overrides any punishment by the sender depends largely on the structure of the trade between these third countries and the sender. For example, China is the largest exporter to both the USA and Europe. And is the third largest importer from the USA and second largest from Europe. This, at least in the short term, means China might not follow the Western sanctions imposed on Russia. Sanctions create two types of energy supplies: premium and not premium. This creates an arbitrage opportunity. When a market is not segmented and there are two types of oil prices, buyers buy cheap and sell expensive oil, and prices converge. In the presence of sanctions, the market is segmented, and there is no realignment of prices so prices do not converge, and free-riders can make a profit by exploiting mispricing in the market like a money machine. Arguably, the sanctions give large free-riders monopsony power to press a target, for example, Russia to drop the prices. These will have long-term effects on network structure. The sender in the long term might diversify its trading and eliminate or reduce their trade with this latter group.

Assume that there is a regional rivalry between two regional powers, both producing homogenous primary products (oil). A superpower places sanctions on one of the regional rivals, whereas the other one is a key regional ally. Imposing sanctions on the target will incentivise its regional rival and the sender can potentially transfer the cost of the sanctions to this rival. Put differently, given the complementary effect, it is expected that the other regional player will provide an extra supply of energy to ensure that prices are not increasing, at least not for the sender, hence incurring costs itself. The regional rival will increase the supply of oil into the market, but it might not be sufficient to fully eliminate price rises, incurring extra costs for all.

The findings show that there is less loss of profit and hence higher SWF in the presence of sanctions if sender countries have energy-producing firms as well as high-tech firms. This discussion cautiously highlights the fact that whilst not all countries might have an endowment of oil and gas energies other forms of energy can substitute the oil and gas energy to maximise diversity in the economy and minimises energy dependency.

6. How does monopolistic competition explain the impact of sanctions on the target?

In the previous section, we examined a buyer-seller network, where the target was the seller. It was assumed buyers compete in a Cournot game and we derived a social welfare function. We then examined the impact of sanctions on the payoff of sender and third countries, *i.e.* on their social welfare. The present section complements the previous section, we examine a buyer-seller network where now the sender(s) and third countries are the sellers and focus on consumer utility and representative firm profit in the target country. We consider a target country which belongs to the periphery and is bound to have lower economic fitness compared with advanced economies. It is perfectly plausible that the representative firm in the target country produces differentiated product to those in centre countries that are not a perfect substitute, and one could argue at much lower quality or perceived quality.

Many studies have examined the impact of sanctions on target countries (*e.g.* Hubfbauer et al. 2009; Dizaji and Bergeijk, 2013; Neuenkirch and Neumeier, 2015, Dreger et al. 2016). A large body of prominent scholars argued that sanctions are placed for their expressive rather than instrumental purposes (*e.g.* Renwick 1981, Leyton-Brown 1987, Lundborg 1987, Tsebelis 1990 in Kaempfer and Lowenberg, 2007). These studies often argue that sanctions hurt the citizens, and this study follows this argument. However, the approach in this study is innovative, we evaluate the counter-intuitive impact of sanctions and evaluate how sanctions benefit the elite in the target country. We employ the concept of monopolistic competition to assess what happens to the representative firm (the elite).

To motivate this idea, we refer to the seminal work of Kaldor (1956) and its modification (Pasinetti 1960). They proposed three sets of simultaneous equations in which national income is made up of workers' wages, and capitalist and workers profits. Pasinetti's model shows that investment is equal to the total savings. Savings are made up of workers' and capitalists' savings, where these savings are a function of worker's wages and profits and capitalists' profits. For a capitalist to earn higher, it must spend more, to spend more it must be that wages are lower, or the savings of workers are lower because investment is equal to their savings. This comes at the expense of workers' wages and profits.

Sanctions reduce real wages given that they increase inflation, which reduces the savings for most of the population to a much lower amount. It remains to be seen how a capitalist can get away from the cost of sanctions and this sets up our next argument. To do this we examine the effects of sanctions on two groups. The first group are the capitalists, to whom we refer as the elite, who set up the country's policies, own the firms, and have the capital to take over the infrastructure and superstructure left by the departure of foreign firms. Our simple analysis is based on the arguments that the target is a developing country, the regime is undemocratic and autocratic, large firms are close to the government and domestic products have no absolute advantage over imports. The second group is the worker, whom we call citizens, who are passive recipients of the policies set by the elite.

The Kaldor model shows that the national income is made up of workers' wages, and capitalist and workers profits. To systematically show how sanctions affect the capital and labour shares in the

national income this section borrows Dixit and Stiglitz's (1977) model of monopolistic competition to examine the demand in the face of reduced foreign competition.

Monopolistic competition has been employed in a vast number of economic studies particularly in international trade (Benassy, 1996, Seegmuler, 2008, in Aloi and Lloyd-Braga 2010, Le Riche et al, 2022) but not in the context of sanctions. Product diversity reduces aggregate price (Benassy, 1996). The impact of sanctions is the opposite. Sanctions impede trade, reduce the value of fiat currency, and reduce the diversity of resources, then according to this notion, reduce consumer utility. Less diversity suggests that there are fewer products for consumer demand to focus on. This will shift the power even more so to a few domestic producers (and the government), who may also be producing goods and services of lower quality than those that were being imported from the developed economies. Therefore, these effects increase inflation and reduce consumer surplus. If we assume equal weight on consumer surplus and producer profits, then lower consumer surplus leads to a lower social welfare function. This section examines how/whether the sanctions can increase the profit of the tradeable sector.

We assume the general case, with constant elasticity of substitution, CES, where the utility function is stated as:

$$u = U\left(x_0, \left[\sum_i x_i^{\rho}\right]^{1/\rho}\right) \tag{41}$$

There are two bundles of goods, the first group is assumed to be at a fixed price, numeraire, x_0 and the second bundle is the differentiated sector, x_i and $\left[\sum_i x_i^{\rho}\right]^{1/\rho}$ is a quantity index. The differentiated sector could be food in supermarkets, clothes, hotel brands, fast food, white goods, *etc.* The function $U(.)$ presents a social indifference curve or the multiple of consumer's utility, and it is assumed homothetic in its argument. It is a separable utility function; therefore, it allows for two-stage budgeting. The substitute parameter $\rho \in (0,1)$ guarantees that $U(.)$ is a concave function. We omit the derivation of the optimal quantities for each sector and the individual firm demand function, as it is elegantly derived by many authors (for this version of derivation see Foltyn, 2012). Given these assumptions for the utility function, the demand function for a firm in a differentiated sector is derived as:

$$x_i = y\left[\frac{q}{p_i}\right]^{1/(1-\rho)} \tag{42}$$

where y is a quantity index

$$y \equiv \left[\sum_i x_i^{\rho}\right]^{1/\rho} \tag{43}$$

and the price index

$$q = \left[\sum_i p_i^{\rho/\rho-1}\right]^{(\rho-1)/\rho} \quad (44)$$

Assuming there are n varieties, then, $y = xn^{1/\rho}$ and $q = pn^{(\rho-1)/\rho}$. This is possible if we assume there are many varieties where $p_i = p$ and therefore, they all produce the same quantity x.

We expect sanctions to reduce variety and increase the size of the parameter ρ. In what follows we examine the impacts of these parameters on the price index and consumers' taste for variety.

Proposition 7: As variety, n increases the price index, q decreases.

$$\frac{\partial pn^{(\rho-1)/\rho}}{\partial n} = \frac{p.n^{-\frac{1}{\rho}(\rho-1)}}{\rho} < 0 \quad (45)$$

The FOC of the price index with respect to the number of varieties is negative, because by assumption $\rho < 1$.

Proposition 8: As the substitution parameter increases, the price index increases.

$$\frac{\partial pn^{(\rho-1)/\rho}}{\partial \rho} = \frac{pn^{\frac{\rho-1}{\rho}} ln(n)}{\rho^2} > 0 \quad (46)$$

The relationship between the price index and the substitute parameter, ρ is convex, as ρ increases the price index increases non-linearly. Figure 2 visualises this relationship (44) for $p = 1$ and assuming n varieties (*i.e.* $q = pn^{(\rho-1)/\rho}$).

Assuming that there is competition between varieties, and varieties are differentiated, the notion of taste for variety argues that people's utility is a positive function of the number of varieties and scale economies result in welfare loss. We can show this directly using the quantity-index utility function.

From the first stage optimisation, the optimal quantity for the differentiated sector is:

$$y = \frac{s(q)I}{q} \quad (47)$$

where y is the quantity index for a large sub-group quantity, $s(q)$ is the share of expenditure on this sector given budget I and q is the price index as in (44).

Plugging y and q (43 and 44) into the demand function (42) faced by a single firm, it yields:

$$x = \frac{s(q)I}{nq} \quad (48)$$

Finally substituting x into $y \equiv \left[\sum_i x_i^{\rho}\right]^{1/\rho}$ we have:

$$V(n) = y = n^{1/\rho - 1}(nx) \tag{49}$$

Proposition 9: The utility function, $V(n)$ increases as varieties increase:

$$\frac{n^{1/\rho - 1}(nx)}{\partial n} = \frac{nx^{1/\rho - 1}}{\rho} > 0 \tag{50}$$

Proposition 10: The utility function, $V(n)$ decreases as $\rho \in (0,1)$ increases.

$$\frac{n^{1/\rho - 1}(nx)}{\partial \rho} = -\frac{n^{1/\rho} \ln(n)x}{\rho^2} < 0 \tag{51}$$

The derivative of the $V(n)$ function w.r.t n is positive and it is negative w.r.t ρ. Both these derivatives show that consumers prefer more variety to less. As ρ increases from just a little more than zero to just a little less than one, $V(n)$ function exponentially decreases. The size of the substitution parameter determines the degree of differentiation, the lower it is the more differentiated products are and consumers prefer more differentiated varieties. Proposition 8 also shows similar effects of the substitution parameter. The price index goes down as varieties increase or the substitute parameter decreases. Put simply the lower the variety the higher the price index, and the lower the utility function for consumers.

We now visualise what happens to domestic firms operating in the target country. For the simplicity of exposition, we assume an extreme case where many firms are operating in a country but only one of them is a domestic firm. All firms have equal demand, equal cost functions, and marginal revenue before sanctions are placed. It is assumed that there is no discriminative pricing and marginal revenue is:

$$MR = P - \frac{\Delta P}{\Delta Q} Q \tag{52}$$

where P is price and Q is the initial quantity produced by a firm. This guarantees that the MR curve is below the demand curve ($MR < P$). The cost function is made up of fixed cost, F, and fixed marginal cost, c:

$$C = F + cx \tag{53}$$

where average costs are declining as output increases, *i.e.* each firm displays an increasing return to scale (Figure 4). The demand curve is downward sloping; hence, as the price comes down demand goes up. The demand the individual domestic firm is facing before the sanction is imposed is D_1 and it produces a quantity of q_1. Where the q_1 meet D_1 is price and cost is where q_1 meet AC_1. It is clear from the curve that the domestic firm is barely surviving. Once sanctions are imposed it eliminates foreign competition from the target market and there is an autarky, one firm is now operating and facing the

total market downward sloping demand curve. Earlier it was shown that the price index is a function of the number of varieties in the differentiated sector and the substitution parameter, as the variety decreases the price index increases. We know the utility function is also equal to the optimal quantity for the differentiated sector, which is:

$$V(n) = y = \frac{s(q)I}{q} \tag{54}$$

In the context of sanctions, this is self-explanatory. Trade sanctions reduce or even eliminate international firms operating in the target country (*e.g.* departure of international firms from Russia post 2022 sanctions). The presence of sanctions that limits exports, depreciate exchange rate (Peksen, 2015; Itskhoki and Mukhin, 2022) and hence, marginal cost is endogenized dependent on the sanction. This increases the cost function for the domestic firm and reduces the budget for the mass market. At the same time, given the departure of foreign firms, the variety falls, the price index increases, and the marginal propensity to consume for a large section of society increases. Putting this differently, as the price index increases, spending power reduces, and the numerator of the quantity index (47) gets smaller, whilst the denominator, price index increases, and the whole fraction becomes much smaller, it is the quantity index-utility function that declines. They will end up buying less and the total demand will decrease. In autarky, the total demand (Figure 3) is equal to the demand for the sole domestic firm, D_2 which is greater than D_1. As expected, the sanctions increase both average and marginal costs, but it also increases profit. The red dotted rectangular area is the profit for the domestic following the sanctions. It shows that profit has increased after the sanctions despite the reduction in total demand because the domestic firm gets the total market share, which is more than what the domestic firms would get before the sanctions, given the presence of competition for higher quality products.

Even if we relax the assumption of autarky there will still be far fewer firms in the differentiated sector. The derivative of the price index shows that the price index reduces as variety increases and vice versa. Consumers end up paying more for less diverse, lower-quality products.

The domestic firms benefit from increased demand, which tends to be less price elastic in certain situations. This can occur 1) if the firms offer necessities 2) because of the increased demand for commodities (*e.g.* gold, property) as the local currency deflates and interest rates are below the inflation rate and 3) there is a shift from international holidays, given the unfavourable exchange rates, and so citizens spend more locally. When considering the social welfare function and with sanctions in the target country, in extreme cases target's firm will not be able to sell in the international market, and so whilst their profit increases in the domestic market they lose their trade in the international market. We argued that target firms have lower fitness therefore it is feasible many of these domestic firms would not have been able to compete in the international market anyway. It is plausible that even primary produce like grains, fruits, and oil may not be sold in the international market under the sanctioned

regime. Therefore, while domestic firms may benefit in domestic market, on average, there is likely a loss for domestic firms in the international market. Given equilibrium quantity and profits, and if all firms earn equal profits, the social welfare function becomes:

$$\text{Payoff for target} = \text{SWF} = n^{1/\rho - 1}(nx) + \frac{1}{\sigma} p_e x_e \quad (55)$$

Assuming there is a representative firm, this can be thought of as a payoff country. What is striking is that the key losers of sanctions are the citizens, not the capitalists who often influence policies. Overall, these results show that the economy of a country shrinks following major sanction.

There are some potential implications that are not driven logically from this model but worth further investigation. Sanctions create a multi-price system within the domestic markets and creates endless arbitrage opportunities for the elites, which is nothing other than rent distributions among a few, at the expense of most citizens. They can do this because they have access to 1) cheaper dollars 2) low-rate banking loans, below the inflation rate and 3) cheap labour as many are unemployed. Therefore, these firms lobby for harder government policy and do not compromise on the terms demanded by the sanction's sender at an additional social cost. As a further observation there is an extra benefit from the sanctions, a new industry springs up from the sanctions, the "repair industry". Sanctions generate a new market, given the increasing cost of buying new technology, those who can repair goods, benefit, such as car mechanics, computer engineers, white goods mechanics, etc. The monopoly rents in the reuse and repair economy are very different from *laissez faire* economies where innovation generates monopoly rent.

7. Discussion

This paper establishes the link between Prebisch-Singer's hypothesis (1950) and economic fitness, to demonstrate that sanctions have identifiable adverse effects. We employ the social welfare function and the monopolistic competition framework to highlight the unintended consequences of sanctions on an energy producer. The presence of free riders, or the elimination of an energy supplier can decrease social welfare in the sender and third countries. This study demonstrates how free-rider countries reduce the profits of sender firms in the international market. These effects extend beyond sender countries to third countries that adhere to international sanctions. Free riders undermine the impact of the sanctions, they violate secondary sanction terms, and trade with the target country with increased bargaining power. Sanctions create segmented markets and grant monopsony power to large free riders, at the expense of senders and of those complying with secondary sanctions. The extent of the impact on social welfare largely depends on the profits of predominantly private domestic firms in domestic and international markets. Free-riding decreases marginal costs for free-rider countries, thus enhancing their competitiveness. They attract foreign investments and expedite technology transfer at the expense of the social welfare of sender countries in the medium to long term. This could also happen at the firm

level, despite the influence that larger private firms may have on government policies, all firms' preferences may not align with those of the government, which is responsible for policy decisions. If private firms aim to maximize shareholder value, reducing costs becomes one way to achieve this and this could lead to sanction circumventing activities.

Consistent with existing literature, our findings indicate that removing a competitor brings negative consequences for consumer surplus. These results, however, contradict the general assumption that foreign firms' access to the domestic market reduces domestic firms' profits, as it depends on who is eliminated. In the case of an energy supplier, this effect is negative/positive for domestic firms with a short/long position in energy. The entry of an additional foreign firm into the domestic market adds to competition, but the impact depends on the nature of the foreign firm. If they supply domestic firms, their presence benefits these firms otherwise it counts as a competitor. Our analysis demonstrates that there is a trade-off favouring the addition of an extra supplier despite increased competition in the domestic market. This analysis highlights that a firm suffers more as its marginal costs increase, particularly when a supplier is removed from the domestic market, in comparison to when a competing firm is added. Furthermore, it shows that, given secondary sanctions, these effects are not limited to the sender country, and third countries experience similar dynamics.

To best of our knowledge this study is the first to utilize the concept of monopolistic competition to explore the impact of sanctions on the target country. The research demonstrates that monopolistic competition is a valuable tool for examining the effects of sanctions. In line with previous studies, while we acknowledge that significant sanctions do harm the target country and they are indiscriminate, our research uniquely shows that sanctions can have adverse consequences. Specifically, we argue that despite the unfavourable policies of target countries, the elite are motivated by "profit incentives" that result from the redistribution of the costs of sanctions from the government to the citizens. The elites (the capitalists) benefit from increased demand for non-frontier products and an increased availability of labour. These findings present a mixed picture and necessitate careful consideration. We assume that the target country is a developing nation with lower economic fitness, therefore, domestic firms in the target country are non-frontier. This raises an important consideration: if these firms produce manufactured products that have little opportunity to sell in the domestic market in the presence of foreign firms, then they can significantly benefit from the sanctions as they are not competitive in the international market even without the sanctions. On the other hand, primary producer firms such as energy producers, agricultural products, or skilled local handcraft products (*e.g.* rugs) suffer significant losses as they no longer benefit from exports in the international market. This is a dilemma for the democratic planner as to how they should plan sanctions to avoid such an outcome.

There are other expected effects beyond the focus of this discussion but worthy of further investigation. The sanctions reduce economic capacities and with that, they contribute to

unemployment. The middle and working classes are hit, and with this comes economic migration, both brain drain and workers who might have had a job in sectors that relied upon exporting their output, such as energy and agriculture had the sanctions not been imposed. Contrary it creates jobs in the repair and re-use industry.

8.Conclusion

The social welfare function presented in this study is based on the presence of a (complete) network. The traditional literature does not fully emphasize the importance of networks in capturing these consequences. These collateral damages are much more pronounced when a secondary sanction is placed, as the costs transmit through the network, particularly when the target is a major primary producer. The mechanism of secondary sanctions implemented by the sender brings the rest of the world into the game of sanctions involuntarily. However, the presence of a large international power brings the challenge of free riders to the sender. Given their size, they may violate the terms of secondary sanctions and receive positive externalities of the sanction on a major producer.

From a policy perspective, these results highlight several points. Eliminating a producer is costly, and dependency is a form of vulnerability. Alternative forms of energy to substitute for fossil fuel energy reduces energy dependency and allows an economy to absorb some of the shocks in energy price increases. The collateral damages discussed in this research highlight the importance of the winner-loser paradigm in examining the impact of sanctions. Sanctions as a foreign policy tool always emphasize their punishment mechanism and overlook their positive externalities. Our findings shift the paradigm and allow sanctions to be more fully scrutinized, not only as a way of punishing the target, but also to see who they benefit and at whose expense. All forms of trade restrictions limit competition and hence do not follow the sustainable development goals and challenges, practically, the assumptions around sustainability.

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Appendix A, List of Figures

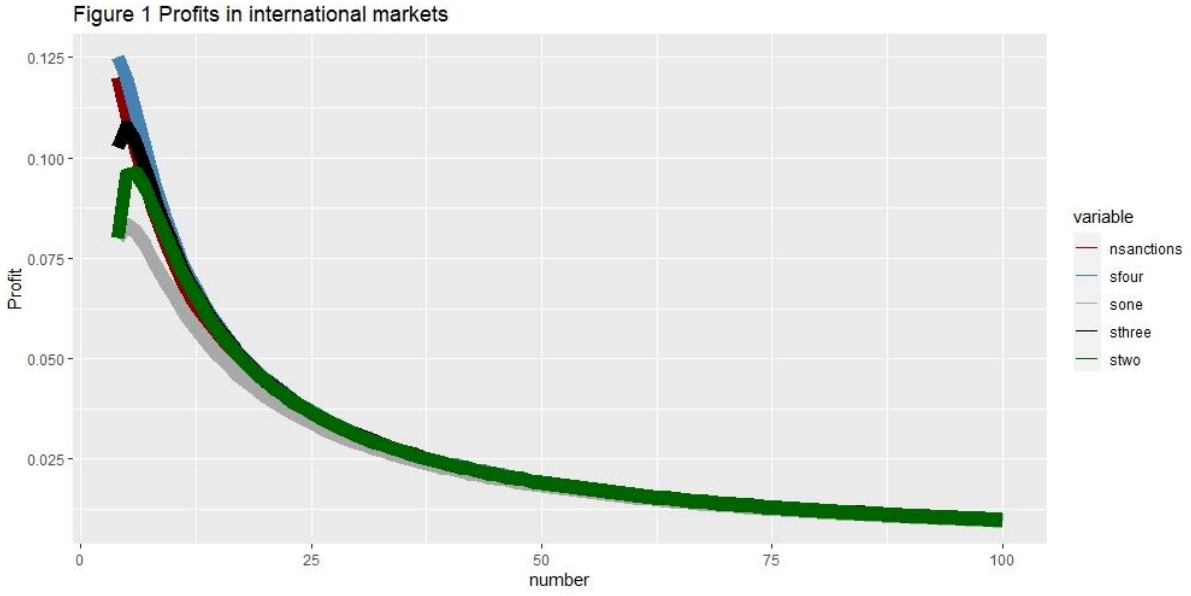

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Figure 2 Price Index

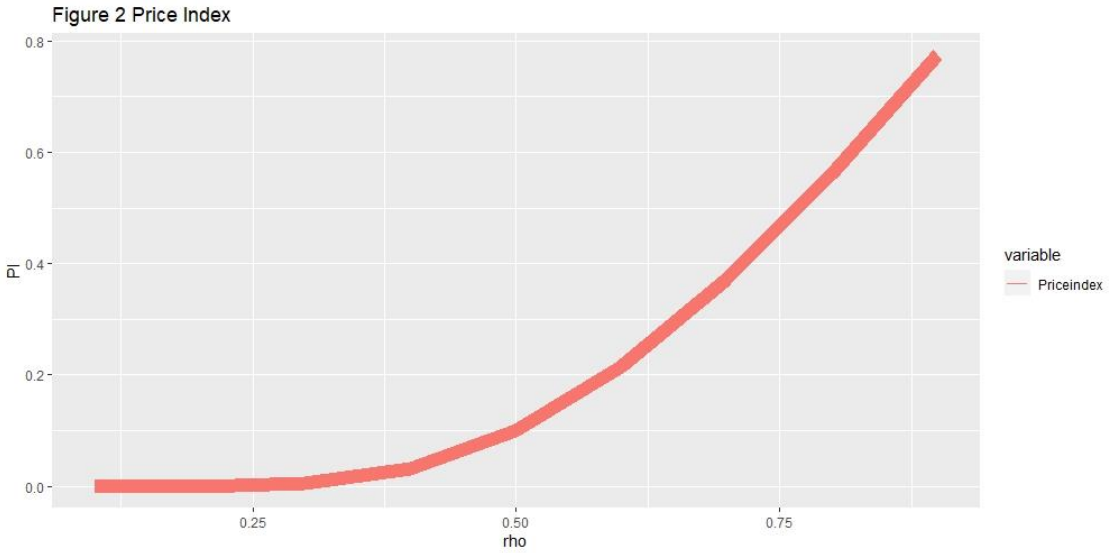
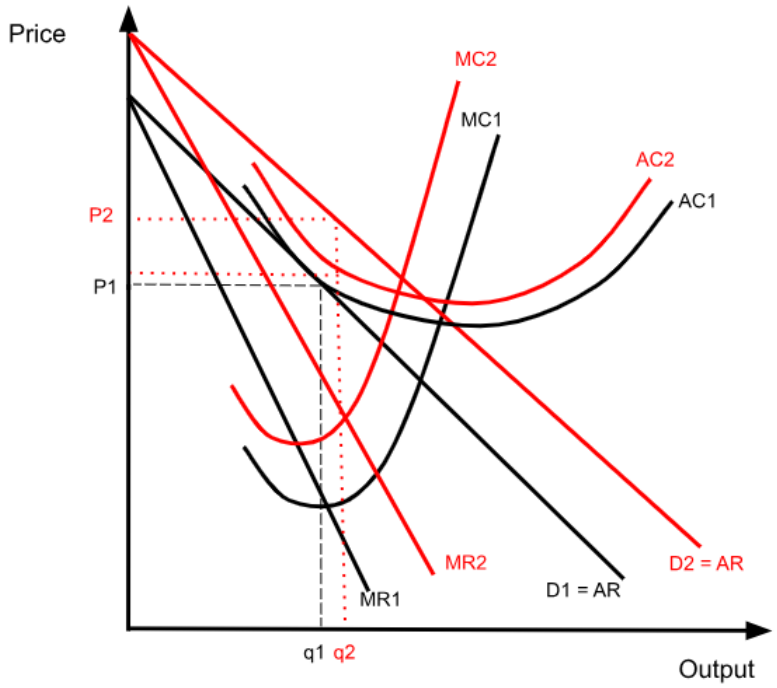


Figure 3 Monopolistic competition[5], profit for domestic firm(s) before (1) and after sanctions (2)



Price, Profit before (Black) and after sanctions (Red)

[5] this was drawn using google doc here: https://docs.google.com/drawings/d/1FqamVTB_W2IWqwOCWhj5AtXwaVicxz7T632zK-dBiew/edit?pli=1

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