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European Anti-Dumping Policy: Welfare Implications for German Consumers of Solar Glass

Honours Thesis

From

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This thesis is presented according to the *Honours Policy* of Murdoch University, Perth, Western Australia for the degree of B. Econ (Hons). The contents of this thesis are an account and representation of original research.

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Abstract

On the 26th of November 2013 the European Commission concluded that solar glass originating from the People's Republic of China had been dumped into the European market. The Commission imposed a provisional anti-dumping duty on subsequent imports. This thesis evaluates the expected and actual welfare implications for consumers in the German market after the anti-dumping duty was introduced. As Europe's largest solar energy producer, German data on solar energy production, sampled between 2011 and 2014, as well as price levels and installation rates for solar energy provides a robust framework of analysis. By way of a multiple regression analysis, it is found that the introduction of the Commission's anti-dumping duty had a statistically insignificant effect on the production of solar electricity in the German market. Through the continued growth in solar energy production, it is found that German consumers are inelastic to changes in the price of solar energy. Prior literature underlines the prevalence of consumption preferences for consumers who exhibit the 'warm-glow' effect and derive utility out of altruism towards the environment. The heightened consumption of solar energy in spite of rising prices underlines this effect. These conclusions enable further consideration for the duty's implications for market welfare in the country, and also its implications for the wider European community. It is concluded, in contrast with classical theory on industrial organisation, that European consumers were made no worse off as a result of the anti-dumping duty, and that producers benefited.

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1 Introduction

On April 27th, 2014, Germany set the world record for total solar production with a record 24.2 gigawatts at midday, despite a recent restriction on import prices of solar glass.[1] In recent years the European community has had access to solar power generating installations at steadily decreasing prices, which has been attributed to intense international competition in solar glass originating from China. The competitive pressure from China had European producers of solar glass complaining that they were unable to continue producing whilst still maintaining profitability, with many facing insolvency (p. 24, 150). Upon investigation, the European Commission found that these producers had indeed lost significant market share in the solar glass industry, and that material damage had been incurred (p. 21). As a result of these findings, the Commission decided to launch an investigation into allegations of dumping on the part of their Chinese competitors.

Dumping is defined in international trade theory as the deliberate selling of a good below its true value in a trading partners economy. This dumping instigates unfair competition and thus imposes more stringent constraints on domestic producers, who would otherwise continue selling their goods at a profit. In the short run, this negatively impacts the profits of all producers in any given market, whilst providing lower prices to consumers (or downstream distributors of the given good). In the long run firms that engage in dumping may gain a stranglehold of their target market so that they can ultimately benefit from monopolistic power. Recent decades have seen a rise of anti-dumping policy as a trade barrier used by competition regulatory authorities to counteract dumping in markets.[2] Opinions on dumping differ, with many governments having historically taken action (most notably, the European Union, the United States, Australia, Canada and South Africa) against dumping with the use of anti-dumping measures. The World Trade Organisation (WTO) does not pass judgment on dumping itself; instead it directs governments in the ways they can and cannot react to dumping.[3] A review of the literature finds that both classic and contemporary literature build a strong foundation that anti-dumping policy is, in general, welfare diminishing. Policy

[1] Fraunhofer-Institut für Solare Energiesysteme – Stromerzeugung aus Solar- und Windenergie im Jahr 2014.

[2] In Australia, matters on anti-dumping are presided over by the *Australian Government Anti-Dumping Commission*. Thus, for consistency this thesis will make use of the term 'anti-dumping' and not of the alternate form 'antidumping'.

[3] See WTO (http://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm8_e.htm) for more information.

makers act on the rationale that dumping should be prevented by a reciprocal anti-dumping duty that raises market prices and neutralises material damages to domestic firms. Although this may be the case, it is harder to justify anti-dumping policy from a consumer's perspective; consumers benefit (at least in the short run) from dumping and subsequently lowered market prices. As such, a trade-off can be observed between domestic consumer surplus and domestic producer surplus in a price dumping scenario.

This thesis provides the foundations of trade and competition policy required to analyse an anti-dumping case. It questions to what degree EU governments should seek to protect their producers at the cost of consumers, and discusses the ways consumers might respond to price changes in renewable energy. In terms of structure it examines, first of all, the foundations established by past research into consumer attitudes towards renewable energy price changes. It then explores the existing literature of international trade and competition theory, with particular attention given to definitions of dumping and anti-dumping as well as the classical model of tariff incidence (see figure 1). Afterward, the proceedings undertaken in 2013 by the EC (Commission Regulation 1205/2013) against solar glass originating from the People's Republic of China will be reviewed. Finally, an inter-temporal empirical analysis of actual solar energy production time series data is conducted to gain insight into the behaviour of consumers before and after the anti-dumping measures were established.

It is hypothesised that after the European Commission's anti-dumping measures were enforced (raising the price of solar energy installations in Europe), European consumers will, by and large, continue to invest because they are price-inelastic with respect to sustainable products. That is, that there is only a loose correlation between price and demand for renewable production, and that consumers base their decisions toward solar energy investment on aspects other than price; a belief observed in previous studies. In terms of scope, for the purposes of this thesis, Germany was selected as a representative economy of the EU for a number of reasons. Firstly, data from the The National Network Agency (Bundesnetzagentur) shows that Germany is the EU's largest producer of solar energy. Public data associated with price and energy output for Germany's solar industry is both comprehensive and extensive. Importantly, weaknesses exposed by dumping activities in the EU-China dumping case at hand were shown to have produced extensive material damage to, in particular, German producers. Indeed, the majority of EU producers who are members of the industry lobby group *EU ProSun Glass* (complainant of the EU-China dumping case) originate from Germany. The years investigated by the European Commission for the purposes of their dumping investigation were between 2009 and 2012 (inclusive). As such, price and energy production data used to evaluate consumer behaviour before and after the implementation of the anti-dumping measures was sampled from Q1 2011 through Q2 2014. Note that Germany was the European country that performed best against the backdrop of the Eurozone Crisis. The Crisis ran its course more or less on the time frame of the dumping investigation in question, so the stability of the German economy during this time minimises volatility in empirical data (relative to other European economies) that is used to test the above hypotheses. Lastly, in examining the EC proceedings it should be noted that it is not within the scope of this thesis to verify or dispute the European Commission's investigation, but instead to expand upon and draw inference from it in order to gain insight into the affairs of German consumers.

The results of this thesis show that, as expected, the enforcement of an anti-dumping tariff caused the price of solar glass to increase (EC, p.25), and the average price of complete solar rooftop installations to stabalise (see figure 6). What was unexpected however was that this tariff does not fit with the classical model of tariff incidence. Despite the anti-dumping tariff bringing an end to spiraling prices for this type of solar installation, it was found that German consumers continued to unabatedly invest in solar energy. This tendency of price inelasticity in consumers of sustainable products is attributed to Andreoni's 'warm-glow' effect. That is, investment in the renewable energy industry is derived from a decision function not just of price and individual utility, but also some altruistic mix of, for example, environmental consciousness and a simple desire to appear environmentally conscious. The empirical results of this thesis very much support the existence of the warm-glow effect. In particular, the results show that the establishment of anti-dumping measures by *Commission Regulation 1205/2013* (which stabilised falling prices for complete solar module rooftop installations) had a negative, but statistically non-significant effect on solar energy production. These findings are found after controlling for statistical biases in solar energy production, such as seasonal variation, investment incentives, and efficiency variations over time.

As a result of these findings it can be said that the anti-dumping tariff enforced by the European Commission on imports of solar glass in order to assist its domestic producers did not harm competition in the industry insofar as to deal significant harm to German consumers, and that German producers were benefited. This is a contradiction of the total-welfare diminishing predictions of the classical model of tariff incidence.

2 Literature Review

2.1 Environmental Considerations, Altruism, and the Warm-Glow Effect

This initial section 2.1 and the following section 2.2 aim to provide a review of the presiding literature and thus construct a theoretical background for this thesis. According to Vailland and Ons (2002), environmental considerations continue to play an important role in international trade decisions. In recent years, international trade agreements have increasingly featured explicit provisions that require both or all trading partners to adhere to certain environmental standards.[4] Authors have attempted to explain the 'greening of world trade' (Anderson and Blackhurst, 1992) as a result of pressure from countries seeking to impose their 'higher' and more progressive environmental standards on their trading partners. Bechtel et al. (2012) attributed this partly to a desire of policy makers to appease voters who may be hesitant of ever increasing trade-openness (p. 839). Furthermore, they found in a research survey of consumers in Switzerland, that those voters who are most supportive of the environment are also the most supportive of trade protectionism (p. 854). In particular, their research findings showed that consumers who care most for the environment stated that they strongly supported jobs-related protectionism, and that, crucially, they place more emphasis on aspects other than price when evaluating imported products. These findings appear to support what Andreoni (1990) once described as a warm-glow effect: 'clearly social pressure, guilt, sympathy, or simply a desire for a 'warm glow' may play important roles in the decisions of agents' (p. 464). In more recent work, Andreoni and Miller (2003) showed formally that the utility derived from the warm-glow effect can be expressed as a function of ones own utility and the utility provided by other players (in this case, the environment through the abatement of traditional forms of energy production). Menges et al. (2005) confirmed the existence of the 'warm-glow' effect whilst investigating willingness-to-donate for green electricity. Their findings supported impure altruism, that is, that consumers benefit from both contributing to environmental quality and its current level when opting in favour of green energy. It is this definition of a 'donation' to green energy

[4] Examples provided by Vailland and Ons (2002) include the North American Free Trade Agreement (NAFTA), as well as many bilateral agreements originating from the United States and European Union with countries such as Argentina, Brazil, Singapore and South Korea.

and the environment itself that allows us to account for the part of green energy investment which is over and above that of the expected demand when accounting purely for prices. This notion of altruistic utility maximisation was validated by Nicholson and Snyder (2008), who noted that no utility maximisation problem prevents an individual decision maker deriving satisfaction from altruism, philanthropy, or generally "doing good".

2.2 Dumping, Anti-Dumping, and Competition Policy

Dumping, as a concept, has a long history as a controversial trade practice. The first discussion of dumping in international trade was by Viner (1923) where it was defined as 'price discrimination between national markets' (p. 3). Viner compiled the earlier writings of scholars noting, most notably, a sixteenth-century English writer who accused foreign producers of selling paper in England at a loss, harming England's infant paper industry. Similarly, in the seventeenth century, Viner (p. 38) recalls the story of a group of Dutch merchants in the Baltic region who sold their produce at extremely low prices in an effort to drive out their French merchant rivals. The eighteenth century saw intense debate on the issue in the United States, with founding father Alexander Hamilton (1791) warning about foreign competitors who aim to: "...frustrate the first efforts to introduce a business into another by temporary sacrifices, recompensed, perhaps by extraordinary indemnifications of the government of such country..." (p. 299). By the nineteenth and twentieth centuries, Viner (pp. 51-66) observed that dumping had become widespread practice in both the United States and Germany, also noting (pp. 40-44) that one of the first international trade laws introduced by the United States was on dumping policy. Viner noted that, before 1914, dumping was practiced most extensively and systematically in Germany (p. 51). He attributed this to the complete organisation of industrial cartels operating within the country and abroad. He explained this was made possible as the negative effects of the dumping were disseminated amongst the members of these cartels so as to dissipate any significant losses resulting from their predatory activities. Since then, the definition of dumping has been more precisely defined by economists such as Van den Bossche (2005) to describe any situation where the firms of one nation export goods to another at a price below the value of the good (p. 42).

The case studied in this thesis, *Commission Regulation (1205/2013)*, applied anti-dumping measures on imported solar energy equipment from the People's Republic of China. In the past 100 years, policy makers have made use of anti-dumping policy in order to combat dumping in their economies, on grounds that the unfair practice of dumping causes material damage. Blonigen and Prusa (2006) defined anti-dumping as a "legal statute that allows for a remedy (typically an import duty) to offset the effects of dumped imports". Zvidza (2008) highlighted that the rationale for such policy makers makes perfect sense: "If an exporter is engaging in unfair pricing in a foreign market with the aim of driving out the incumbent producers, it should be counteracted by a reciprocal anti-dumping duty that will neutralise the effect" (p. 20). Prusa (2005) coined anti-dumping measures during their initial years of usage as a rational extension of domestic competition policy, designed to protect against foreign competitors efforts to undermine domestic competition. Whilst this is the stated intention of anti-dumping measures, economists such as Finger (1993) initially purported that anti-dumping measures are established as a form of protectionism against foreign competition (see also, for example, McGee (1996); Motta and Onida (1997), Cheng et al. (2003); Motta (2004); Prusa (2005); and Bown (2009)). In particular, Cheng et al. (2003) noted that due to the costly nature of dumping investigations, it is inherently within the national interest to implement anti-dumping measures which favourably shift the tides of competition. Motta (2005) provided further evidence of this, stating that anti-dumping laws are often simply designed to penalise efficient firms, thereby protecting an economy's own firms from competitive market forces. In turn, Prusa (2005) showed that often, especially in developed economies, the link between dumping and anti-dumping policies is tenuous. In particular, literature from Prusa champions the viewpoint that, when detached from theory, anti-dumping measures have nothing to do with the microeconomics of predatory pricing but are most often used as a measure of protectionism. Prusa claimed that anti-dumping policy is purely protectionist policy, putting the interests of producers ahead of the interests of consumers. Many economists (such as Miranda et al. (1998); Blonigen, (2003); Zanardi (2004); Prusa (2005); and Motta (2005)) believe that anti-dumping policies are a larger problem for consumers than the actual act of dumping. Even from a more recent perspective, Frankel (2013) described how anti-dumping policies, although widely touted to ensure the fostering of healthy competition across international markets, are in effect simply a means of reducing competition.

Motta and Onida (1997) and Motta (2004) stated that anti-dumping policy is directly comparable to predatory pricing (dumping being predatory pricing across international markets), and as such the wealth of microeconomic foundations, relevant legislation and literature attributable to competition policy is compatible with the current study. Furthermore, he stated that anti-dumping policy can be used to support protectionist goals (p. 29). One of the key tenets of competition policy is that policy makers should seek not to protect competitors, but competition itself. Proponents of anti-dumping such as Mastel (1998) claim that the restrictions imposed by anti-dumping measures are necessary to combat "unfair" competition. Some go insofar as to show that anti-dumping can be beneficial. Destler (1996) likened anti-dumping policy to a "safety valve", which can be later removed from a narrow range of products to provide tariff reductions in other domestic industries. Later research by Moore and Zanardi (2006) found that there was very little empirical evidence to suggest that such a relationship between anti-dumping measures and tariff reductions exists.

Importantly, economists such as Moore (1992) have noted that a standard approach throughout the literature is to assume that policy outcomes are determined through the interaction of lobbyists (acting as agents for rent-seeking domestic producers) and vote seeking politicians (who have an interest in best serving consumers). In this sense there results a "policy equilibrium" which maximises political support between both producers and consumers. The aforementioned interaction has important implications for the case at hand. Firstly, it is the lobbyists (*EU ProSun Glass*) who registered a complaint to the European Commission on behalf of domestic producers. In turn, European governments have publicly stated their opposition to the measures; German Chancellor Angela Merkel said that a tariff implementation was "not the way to solve the dispute".[5] The findings of this thesis hope to provide true insight into effects of the anti-dumping measure on both producers and consumers, which Ballero et al. (2000) described as 'winners' and 'losers', respectively. It is this point of contention that reinforces the current interest and importance of examining the welfare impacts of this type of policy on society.

The required literature framework exists to examine the effects of anti-dumping policy on

[5] http://www.theguardian.com/business/2013/jun/04/eu-tarriffs-dumping-china-solar-panels (Date accessed: 29/08/2014).

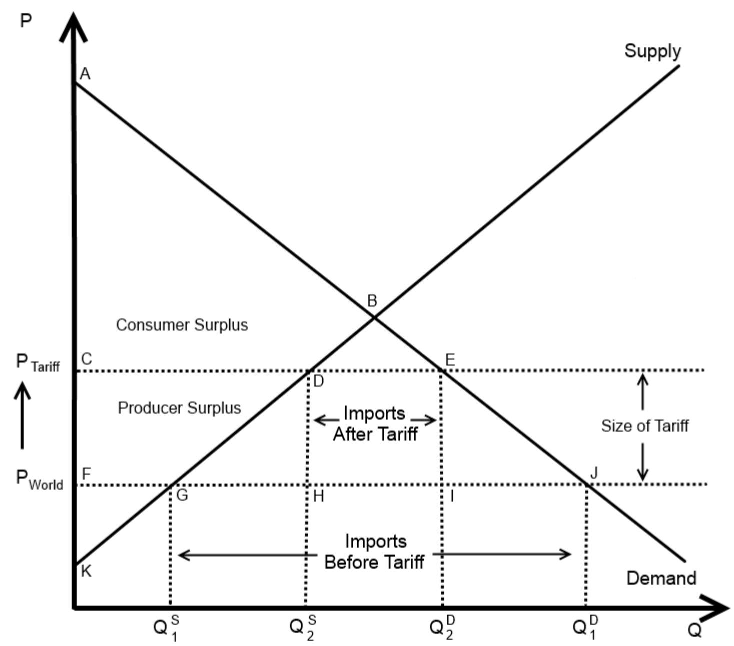
German consumers; however to the knowledge of the author, the recent *Commission Regulation 1205/2013* (European Commission, 2013) case has yet to be examined within this framework. This case is selected due to the nature of its ceteris paribus change in market conditions within the solar energy industry. It provides an uncomplicated representation of consumer behaviour ex ante and ex post of this policy. Despite the readiness of relevant data, there is a research gap in the exploration of the effects that this policy has had on actual solar energy production and, furthermore, price signals have yet to be discussed ex post of this anti-dumping measure in terms of consumer surplus. By firmly establishing the position of this case within the literature and gaining a better understanding of how European consumers are affected by this recently established barrier to trade, this thesis is able to provide further research into the existence of the warm-glow effect and tie it into the presiding literature.

3 Modeling Anti-Dumping Policy

3.1 The Classical Tariff-Incidence Model

Economic welfare is outlined by Motta (2004) as a standard concept used to measure industry performance. With respect to anti-dumping policy, Cheng et al. (2003) outlined three elements of which the welfare effects of a given anti-dumping policy is composed: (a) domestic consumer surplus, (b) domestic producer surplus, and (c) anti-dumping tariff revenue. The authors noted that the more 'protective' the anti-dumping measure, the more producers are benefited; that is, their producer surplus increases. In line with this description of the welfare outcomes of protectionism, the classic model for tariff incidence is deemed compatible with the current study. This version, adapted from Hill and Myatt (2010) where it is labelled as 'The effects of a tariff' is illustrated in Figure 1. It provides a clear illustration of the expected outcome of anti-dumping policy.

Figure 1: Classical Model of Tariff Incidence



In figure 1 the initial level of domestic consumer surplus at is area $\triangle AFJ$. This level exists because domestic consumers in an open economy are able to acquire a given product at equilibrium: the low price, P_{world}. Domestic producer surplus is low as a result of intense international competition (constrained of course by P_{world}), and found in the area $\triangle FGK$. Suppose now that a tariff is put in place for the domestic competition authorities. This would increase the price from its initial level, P_{world}, up to the tariff level, P_{tariff}. The magnitude of the tariff will change domestic consumer and producer surplus, hence overall welfare. Small tariffs may hardly shift the welfare balance, however larger tariffs have the potential to entirely eliminate international trade. If this occurs, then the P_{tariff} may rise as high as level B, which is, as logically follows, the closed economy equilibrium price. With a tariff at the level illustrated in figure 1, the implementation of the tariff diminishes consumer surplus to the area $\triangle ACE$, thus demand for the product in question; simultaneously, producer surplus increases to area $\triangle CDK$. Thus far, these changes have accounted for changes in two of the elements as predicted by Cheng et al. (2003), domestic consumer surplus and domestic producer surplus; remaining of course, is tariff revenue. This is seen as the creation of the rectangular area $DEHI$. A problem arises here in that this revenue raising has a distortionary effect on overall welfare, creating the two areas of size $\triangle DGH$ and $\triangle EIJ$ as a societal loss. Therefore, according to the classical model, the implementation of a tariff on foreign imports is inefficient in the sense that it has contributed to an overall welfare loss to the domestic economy.

3.2 Welfare Remarks

With the above, it is clear that a dilemma exists for policy makers. When implementing anti-dumping tariffs on imports, the classical model shows that policy makers are at ends between protecting the interests of producers and the interests of consumers. Here it is useful to place the ideas of domestic consumer surplus and domestic producer surplus into perspective. For consumers, when lower prices are paid, they are treated to a higher surplus. On the other side, for producers, a high surplus means larger profit margins. The difficult task of any policy maker is deciding the distribution between these two factors: market welfare. Policy makers must evaluate whether their trade policy provides benefit to consumers by way of heightened efficiency (lower prices, better quality, and a greater variety in consumption), or whether their policy is better tailored to assist the producers who supply the market. Ultimately, domestic competition policy is in place to serve the interests of consumers, however Motta (2004) stated that it is in the best interest of consumers for policy makers to target, in general, a total welfare maximising outcome when implementing policy (p. 21). In this way it is believed that competition will steer economies into delivering the goods from an efficient and innovative market.

Unfortunately the aforementioned dilemma is such that the balance of power between domestic consumers and producers is somewhat uneven. On the one hand, Motta (2004) claims that producers have concentrated market power, and are therefore able to efficiently lobby politicians for the support needed to pass measures (such as, ofcourse, anti-dumping measures) in their favour (p. 21). On the other hand, consumers are under-represented in the sense that they have scattered and disorganised interests, limiting their ability to bargain and negotiate on such policy (they have power to elect, but only on par with producers who are themselves inherently also consumers).

3.3 Criticism of Anti-Dumping Measures

Many economists (such as Miranda et al. 1998; Zanardi, 2004; and Blonigen, 2003) believe that anti-dumping policies are a larger problem for consumers than dumping in upon itself. Literature from Prusa (2005) champions the viewpoint that AD measures have nothing to do with the microeconomics of predatory pricing, but are used most often as a measure of protectionism. Prusa likened dumping to a disease and anti-dumping measures to it's medication, noting that the disease (dumping) is itself often far less harmful than the medication used to prevent it (anti-dumping measures). As such, table 1 outlines Prusa's two key criticisms of anti-dumping duties:

Table 1: Prusa (2005) Criticisms of Anti-Dumping Policy

Criticism 1. The Proliferation Problem	The level of anti-dumping measures required to correct for dumping introduces more economic inefficiency to the system than the dumping would have alone, if left without intervention.
Criticism 2. Anti-Dumping Measures as Protectionism	AD law is carefully formulated such that, in effect, it is market protectionism. This in turn lowers efficiency and competitiveness in the domestic economy.

Continuing with Prusa's medical analogy, he noted that the market 'remedy' is often administered at a level far above what is required, and that in many cases it often has nothing to do with the initial 'disease' it is supposed to be addressing; in this sense Prusa explained that AD policy is in effect, protectionist policy. Furthermore, he noted that AD measures are most often able to be implemented without issue because of the complicated processes used to calculate damages. Due to their complexity, it has been easy for regulatory agencies to claim damages under what Prusa (2005) labeled a 'highly discretionary accounting exercise'. Frankel (2013) described how anti-dumping policies, although widely touted to ensure the fostering of healthy competition across international markets, are in effect simply a means of reducing competition. In conclusion, it should be noted that the WTO has made no attempt to block or actively discourage AD measures. This has made it permissible for regulators to create for themselves large cost and price margins so as to protect their domestic industries from foreign competition.

3.4 Modeling the Warm-Glow Effect

We have seen that the predictions of the classical model of tariff-incidence are clear: surplus shifts away from consumers to producers, a tariff revenue is raised, and there is also a component of deadweight loss. As a result, the classical model of tariff incidence clearly suggests that when an anti-dumping tariff is put into effect on a product, demand for that product will decrease. Logically, this would mean that as a result of the *Commission Regulation 1205/2013* case in question, consumer demand for solar energy installations will decrease, ceteris paribus.

Andreoni and Miller (2003) suggest the existence of a so called "warm-glow effect" can offer up an alternative, in some situations, which has the potential to defy the above predictions of the classical model of tariff incidence. In particular, the warm-glow effect is demonstrated in the behaviour of those who give to charity, or consumers of sustainable goods, such as, for example, fair-trade items, organic produce and investments in renewable energy. In the latter and more relevant case, it is postulated that consumers are said to derive utility from their own outcome as well as the outcomes of others. Formally, the findings of Andreoni and Miller (2003) demonstrate that the utility derived from the warm-glow effect can be expressed as a function of ones own utility and the utility provided by other players (in this case, the environment through the abatement of traditional forms of energy production). That is, $U_i = u_i(\pi_i + \pi_{-i})$, where U_i is the end utility for decision maker i, and π_i is the payoff from the actions of i, and π_{-i} is the payoff to all other actors, and noting, crucially, that:

$$u_i(\pi_i + \pi_{-i}) > u_i(\pi_i).$$

Intuitively, one can see that the utility derived by consumers exhibiting the warm-glow effect is greater than those without, as is the case under classical assumptions. Rearranging, the warm-glow effect can be measured in terms of $u_i(\pi_{-i})$. This relationship will be empirically analysed in a later section. The next section will first examine the key findings and provisions of *Commission Regulation 1205/2013* in detail.

4 Commission Regulation 1205/2013

4.1 Investigation

On November 27 2013 the European Commission published the *Commission Regulation 1205/2013* (European Commission, 2013) to the Official Journal of the European Union. This document outlined the European Commission's inquiry and proceedings which considered a provisional anti-dumping duty on imports of certain solar glass originating from the People's Republic of China. Furthermore, the European Commission (2013, 4.6) examined the economic circumstances during the investigation period, testing these trends against a variety of macro-economic indicators. The exact product in question was denoted by the European Commission (2013, 2.1, (26)/(28)) as a component used in the production of solar energy producing modules with:

"... solar glass consisting of tempered soda-lime flat glass, with an iron content of less than 300 ppm, a solar transmittance of more than 88 %, a resistance to heat up to 250 °C , a resistance to thermal shocks of Δ 150 K and having a mechanical strength of 90 N/mm or more".

These proceedings were initiated after complaints from a body of European solar glass producers EU Pro Sun officially dating 15 January 2013. The European Commission (2013, 1.1 (2)) deemed an investigation was justified due to EU Pro Sun's prominent industry status,[6] and prima facie evidence of dumping in the market.

The European Commission used a variety of market tests amongst a sample of the four largest European solar glass producers to determine that material damages had been sustained. These four producers had a combined industry sales volume of 79 %, and were thus deemed by the European Commission (2013, 1.3.1 (10)) to reflect a representative sample of the industry. In addition, twelve Chinese solar glass producers representing 95 % of the Chinese market exporting to the European market were

[6] Its firms constituted 25% of the European solar glass industry, but also expressed representation for the broader interests of European solar glass producers.

sampled (European Commission, 2013, 1.3.1 (15)).

The European Commission (2013, 1.3.2 (25)) examined trends and performed tests relevant to the assessment of injury for the 1 January 2009 to 31 December 2012. The Commission (2013, 4.3, (81)) examined trends in overall consumption during the investigation period (see Table 2), noting that whilst overall consumption of solar glass had risen significantly from 19 440 m2 in 2009 to 29 040 m2 in 2012, it had in fact subsequently fallen between 2011 and 2012. Motta (2004) says that monopolists wish to do this, so that they can later ramp us prices. It would appear that the Chinese producers have, in capturing the market, done so. This trend appears to provide evidence of a monopolist ramping up prices after a rise in market share.

Table 2: Union Consumption of Solar Glass (1000 m2)

	2009	2010	2011	2012
Total Union Consumption	19 440	28 504	35 258	29 040
Index	*100*	*147*	*181*	*149*

The European Commission (2013, 4.4.1 (83)) also examined trends in import volume from the People's Republic of China during the investigation period. Import volume increased dramatically (see Table 3), and as a result so did the market share of Chinese producers, from a low 6.2 % to a much higher 28.8%. Motta (2004) stated that, based off case precedent, a market share above 50% can typically be deemed significant so as to dominate a particular market and single-handedly influence prices. Whilst the Chinese producers did not achieve a 50% market share in the investigation period, these figures are of interest because the increase in solar glass imports far outnumbered the increase in solar glass consumption. In line with the theoretical case of dumping, Chinese producers were artificially lowering prices by greatly increasing supply.

Table 3: PRC Import Volume (1000 m2) and Market Share

	2009	2010	2011	2012
Import Volume	1 200	2 050	6 150	8 350
Index	100	171	513	696
Market Share	6.2%	7.2%	17.4%	28.8%
Index	100	117	283	466

Solar glass pricing was also investigated by the European Commission (2013, 4.4.2 (86)). The Commission found that during the investigation period prices had fallen from 6.20 € in 2009 down to 4.38 € in 2012 (see Table 4). This 27.2 % fall in prices was purported by the European Commission to be clear evidence of Chinese price undercutting (European Commission, 2013, 4.4.2 (88)). It is worth mentioning however, that increasing technology, production methods and other efficiencies could partly explain this price fall in what is an emergent technology. Section 5.4 provides a more in-depth analysis of these changes.

Table 4: Import Prices (€/m^2)

	2009	2010	2011	2012
Price	6.02	6.10	4.96	4.38
Index	*100*	*101*	*82*	*73*

4.2 Conclusions on Injury and Causation

The European Union (2013, 5, (132)) found that its domestic producers had reduced production costs during the investigation period to the maximum extent possible, and were faced with no choice but to decrease their sales price to unprofitable levels in order to compete with the PRC's producers. As such it was determined by the European Commission (2013, 5. (133)) that European producers had suffered material injury as a result of unequivocal Chinese dumping.

4.3 Provisional Duty Imposed

Simply state the facts here: duty amounts and glass specifications. The European Union (2013, 6.6 (164)) stated that there were 'no compelling reasons' against the imposition of anti-dumping measures against the People's Republic of China. As such, the Commission (2013, 7.2 (171)) introduced anti-dumping measures against PRC imports. These consisted of a tariff markup on customs duty unpaid prices of incoming solar glass. This rate was set variably between different companies, but was predominantly set at 42.1 % (with some exceptions to a small group of PRC producers).[7]

4.4 Frankel Commentary and Discussion

Frankel (2013), a key commentator on the case, commented that "the solar energy industry is a perfect example of how trade can benefit air quality". Vigourous international trade and amicable international trading relationships facilitate the efficient allocation of resources amongst economies. As has been observed in the classical model of tariff incidence, uninhibited trade in solar glass between the EU and China served to facilitate trade in (that is, increase demand for) solar installations by delivering lower prices to the end consumer. In turn, this trade has the ability to transition energy generating capacities away from traditional fossil fuels and toward greener renewables; thus it can be said that such trade benefits air quality. Because of this relationship, merit is given to the idea that consumers may be inelastic to the aforementioned increase in price of solar glass. That is, they are motivated by the warm-glow effect, because they derive utility from factors other than their own investment profits, such as environmental quality. Indeed, Frankel (2013) also commented that western societies "should thank the Chinese panel producers for their contribution to keeping solar power viable, not penalise them through protectionist anti-dumping measures". Furthermore, Hansakul and Levinger (2014) cautioned of the precarious trade relationship between these two economies (p. 15).

Motta (2004) explained how, in the European Union, Article 81(3) allows any agreement or de-

[7] In particular, Henan Yuhua, who were found to have not participated in dumping actions so intensively. This firm was found by the European Commission (2013, 7.2, (171)) to have a 'dumping margin' of 31.9 %, in comparison to the majority of PRC producers with dumping margins as high as 86.2%.

cision by the European Commission "which contributes to improving the production or distribution of goods or to promoting technical or economic progress, *while allowing consumers a fair share of the resulting benefit*" (p. 19). This provision indicates that consumer welfare is to be given significant consideration in any Commission ruling. The next section will conduct an empirical analysis into the behaviour of German consumers after the implementation of the anti-dumping tariff outlined in *Commission Regulation (1205/2013)* and, in doing so, will test to see if the interests of consumers are indeed upheld.

5 Empirical Analysis

5.1 Time Series Regression Analysis

This section will use time series regression analysis to examine the impact of *Commission Regulation 1205/2013*'s anti-dumping measures on consumer behaviour: in particular, their investment in solar energy. Solar energy production was chosen as the best reflection of consumer behaviour before and after the introduction of the anti-dumping tariff on solar glass origination from China for two main reasons. Firstly, it is a measure of the terminal output of the consumers purchasing process. McKellar et al. (2003, p. 4) explained how this methodology for economic performance is most commonly used in health economics. Here, throughputs (for example, the number of physicians per patient, number of hospital beds, or number of MRI scanners) are ignored and instead the terminal outputs are given primary consideration (usually measured in quality adjusted life years). In much the same way, this analysis treats throughputs (namely, solar panel price, seasonality, and module efficiency) as proxies to the actual solar energy production; they are instead included in the regression model, where available. Secondly, the availability of the data is such that one is able to obtain time series data on actual solar energy production in Germany going back until 2010. This data is particularly rich, as it is available in 15 minute intervals and also updated in real time.

Assuming that the introduction of *Commission Regulation 1205/2013* affected consumers in some measurable form, Table 5 shows a number of predictions as to how they may react to a price change.

Table 5: Potential Effects of *Commission Regulation 1205/2013* on German Consumers

No Change	The introduction of the anti-dumping tariff on Chinese solar glass entering the EU has no effect on consumer demand for solar installations.
Less Solar Installations	The introduction of the anti-dumping tariff on Chinese solar glass entering the EU causes the demand for solar installations to fall.
More Solar Installations	The introduction of the anti-dumping tariff on Chinese solar glass entering the EU causes the demand for solar installations to rise.
Renewable Substitution	The introduction of the anti-dumping tariff on Chinese solar glass entering the EU causes the demand for solar installations to fall, but this investment is allocated to other renewable energy projects.

5.2 Data Acquisition

Data on German "actual solar energy production" is captured in real time by the *European Energy Exchange* (EEX) and posted to their website at 15 minute intervals.[8] Data is presented as collected from the four individual balance areas (*50Hertz*, *Ampiron*, *TenneT*, and *TransnetBW*) which account cumulatively for German nationwide inputs of solar from households to the grid. The available data can be outputted in the form of a chart, or as downloadable Excel files (.xls); each Excel file consists of a days worth of data presented in 15 minute intervals. As such, one excel file was downloaded for every day in the analysis. To compile the data, each individual days actual solar energy production was summated and inputted into one "master" Excel document. As the production of solar energy naturally follows a roughly quadratic trend (with a maximum peak around mid day, and tails in the morning and night), summating each days worth of data was necessary to eliminate serial correlation on a day on day basis. Figure demonstrates a portion of the acquired data, and the Excel functions used to compile it.

[8]For webpage see: http://www.transparency.eex.com/en/Statutory Publication Requirements of the Transmission System Operators/Power generation/Actual solar power generation

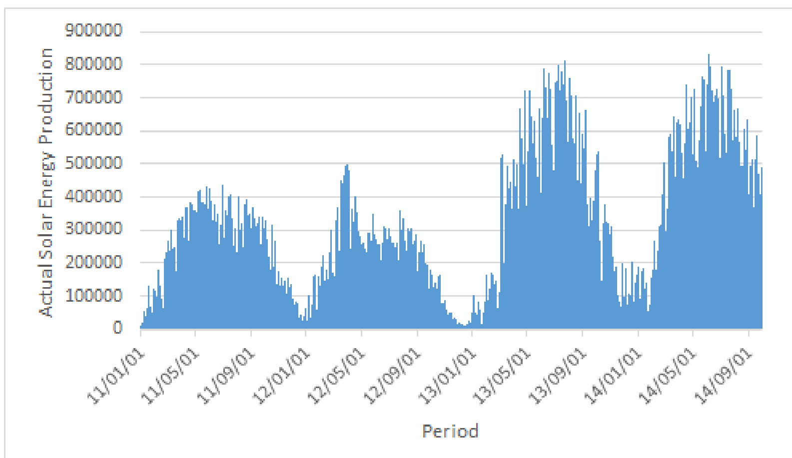
Figure 2: Sample Excel Dataset of Actual Solar Energy Production

D2 =SUM('C:\Users\Aaron\Documents_UNIVERSITY_____THESIS\Solar Energy Production DE\2011\[TEM_7solar_2011-01-01_DE_en.xls]2011-01-01'!B2:E97)

	A	B	C	D
1	Week	Date	t	Solar Energy Production (MW)
2	Week 1	01/01/2011	1	9300.4
3		02/01/2011	2	20694.2
4		03/01/2011	3	22357.1
5		04/01/2011	4	21980.6
6		05/01/2011	5	50607.1
7		06/01/2011	6	14110.6
8		07/01/2011	7	18428.3
9	Week 2	08/01/2011	8	52919.5
10		09/01/2011	9	39290.4
11		10/01/2011	10	37613.9
12		11/01/2011	11	39317.5
13		12/01/2011	12	23157.3
14		13/01/2011	13	12608.7
15		14/01/2011	14	25815.3
16	Week 3	15/01/2011	15	65693.7
17		16/01/2011	16	134216.1
18		17/01/2011	17	128933.9
19		18/01/2011	18	43681.3
20		19/01/2011	19	34362.8
21		20/01/2011	20	31496.4
22		21/01/2011	21	49852.6

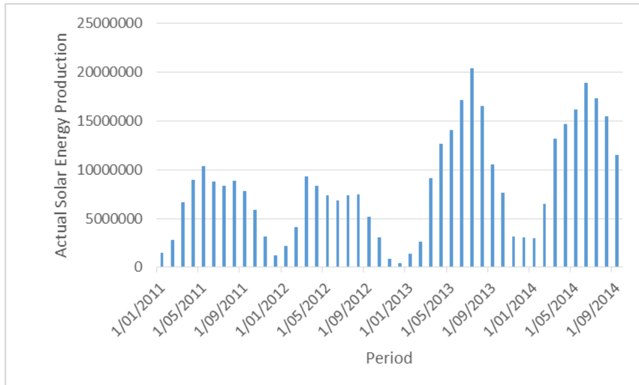
The compiled data is graphed in figure 3 (daily) and in 4 (monthly).

Figure 3: Day on Day Actual Solar Energy Production in Germany (Mw)



Source: *European Energy Exchange*

Figure 4: Month on Month Actual Solar Energy Production in Germany (Mw)



Source: *European Energy Exchange*

Figures 3 and 4 clearly show that the data is serially correlated, oscillating around the seasons. Fraunhofer (2014) says exogenous fluctuations in the data can be attributed to changes in aerosol content of the atmosphere and changes in cloud cover. Intuitively, during the European summer months, there is more sunlight hours and less cloud cover, increasing actual solar energy output. As expected, the European winter output is much lower.

5.3 Methodology

The method chosen was a time series regression analysis, as it is necessary to examine the developments of consumer investment in solar energy over time; in particular, we want to test a hypothesis that the introduction of the anti-dumping tariffs on Chinese Solar glass had no statistically significant effect on consumer demand for solar. More formally, we can state the null and alternative hypotheses as shown in Table 5.3.

Table 6: Hypotheses

Null Hypothesis (H_0)	The introduction of anti-dumping tariffs on Chinese Solar glass did not have statistically significant effect on demand for solar energy amongst German consumers.
Alternate Hypothesis (H_1)	The introduction of anti-dumping tariffs on Chinese Solar glass had a statistically significant effect on demand for solar energy amongst German consumers.

A well defined model satisfies the following assumptions outlined by Wooldridge (2013), which ensure Best Linear Unbiased Estimators (or, BLUE) for the MLR model. Achieving BLUE is vital in order to minimise variance, and therefore attain the highest explanatory power achievable. These assumptions are:

1. The population follows a model that is linear in its parameters.
2. Samples are randomly sampled from the population.
3. There is sample variation in explanatory variables ($Var(x) \neq 0, \forall x_i$).
4. There is a zero conditional mean, whereby the error u has an expected value of zero given any value of the explanatory variable, of the form $E(u_i|x = 0)$.
5. Homoskedasticity, whereby the error u must have the same variance for any value of the explanatory variable.

To test the hypotheses outlined in Table 5.3, it is necessary to run a multiple linear regression (MLR) analysis on the time series data in order to fit an ordinary least squares (OLS) trend line to the data. MLR models generally are of the format:

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + ...\beta_k x_k + u_i;$$

with k independent variables where:

Figure 5: Multiple Linear Regression Specification

y_i	dependent variable for sample i
β_0	intercept parameter
β_k	slope parameter
x_i	explanatory variable for sample i
u_i	error term

The particular model required to investigate the relationship between the tariff and production was specified as follows:

$$production_i = \beta_0 + \beta_1 t_i + \beta_2 \phi_i + \beta_3 feb_i + \beta_4 mar_i + \beta_5 apr_i + \beta_6 may_i + \beta_7 jun_i + \beta_8 july_i + \beta_9 aug_i + \beta_{10} sep_i + \beta_{11} oct_i + \beta_{12} nov_i + \beta_{13} dec_i + u_i$$

Data on “actual solar energy production” from Germany was collected and regressed on a dummy variable which signifies the period before and after the tariff introduction. In addition, other coefficients are included to control for the error which is observable in the data, most notably, serial correlation. Serial correlation itself can complicate MLR analysis. Wooldridge (2013) defines serial correlation in time series analysis as a correlation of errors between differing time periods. As such, this must be corrected for by controlling for seasonality in the model. Doing so allows for unbiased inference from the specified model. Note that as per time series data analysis conventions outlined in Wooldridge (2013) where dummy variables are used to model each period, the month of January is omitted as an explanatory variable. This is done so that January acts as a base or benchmark month, with all variances described through the other monthly explanatory variables (i.e. feb_i) relative to the month of January (the benchmark) in any given year (p. 257). Table 5.3 explains the nomenclature of the MLR model.

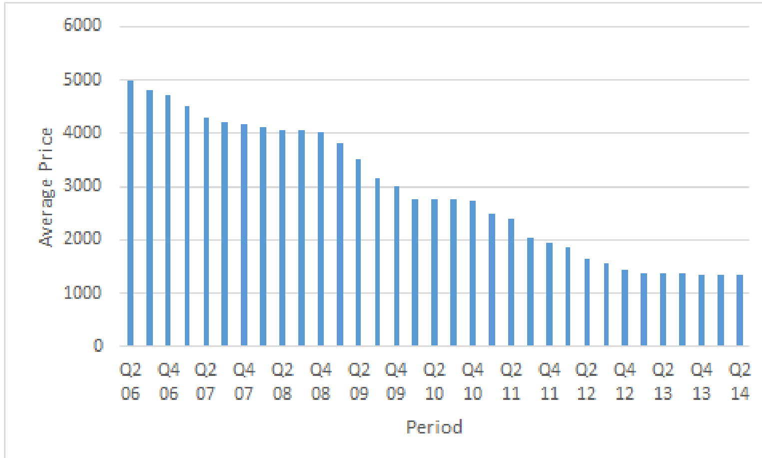
Table 7: Description of the Model

Variable	Description
$\widehat{production}$	The dependent variable conveyed by the MLR model.
t_i	Time, where $1(t)$ corresponds to one day.
ϕ_i	Tariff, a dummy variable where: 0 =No Tariff, 1 =Tariff
feb_i	February, a dummy variable where: 0 = Not February, 1 = February
mar_i	March, a dummy variable where: 0 = Not March, 1 = March
apr_i	April, a dummy variable where: 0 = Not April, 1 = April
may_i	May, a dummy variable where: 0 = Not May, 1 = May
jun_i	June, a dummy variable where: 0 = Not June, 1 = June
jul_i	July, a dummy variable where: 0 = Not July, 1 = July
aug_i	August, a dummy variable where: 0 = Not August, 1 = August
sep_i	September, a dummy variable where: 0 = Not September, 1 = September
oct	October, a dummy variable where: 0 = Not October, 1 = October
nov_i	November, a dummy variable where: 0 = Not November, 1 = November
dec_i	December, a dummy variable where: 0 = Not December, 1 = December

5.4 Secondary Data

Secondary data exists in support of the model. In particular, this data accounts for the error term, u_i and provides further context for the MLR model of actual solar energy production in Germany. In particular, Figure 6 shows the average price development of solar modules in Germany from the periods Q2 2006 until Q2 2014. As can be seen, prices prior to allegations of Chinese dumping were steadily falling. In the year 2013, the average price stabilised.

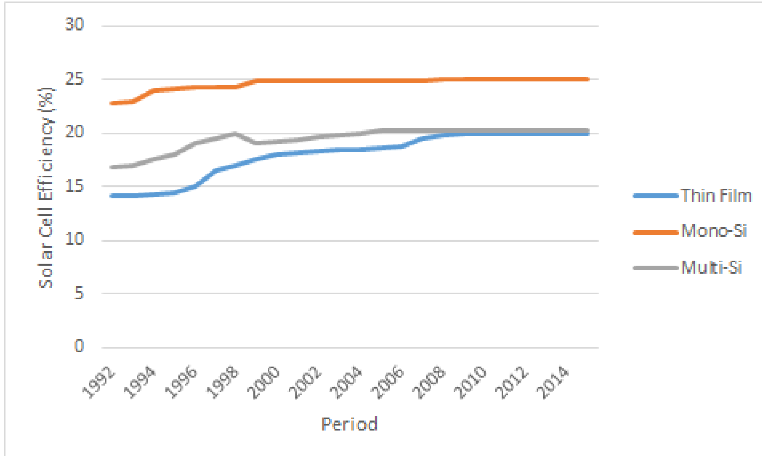
Figure 6: Average Price for a Rooftop Solar Installation in Germany (€/kw)



Source: Fraunhofer ISE (2014)

Logically, one can assume that the efficiency of solar cells would increase with technological advancement over time, t. Evidence exists to suggest that improvements in efficiency of the most commonly used solar cells in Germany over the last decade have been minimal. Figure 7 illustrates the varying efficiency increases of each of the commercialised forms of solar cells. Some forms of solar cell, such as III-V Multi-Junction Concentrator Solar Cells have seen large efficiency increases, however others such as Mono Crystalline Silicon and Multi Crystalline Silicon have seen only marginal increases in efficiency during the same time period.

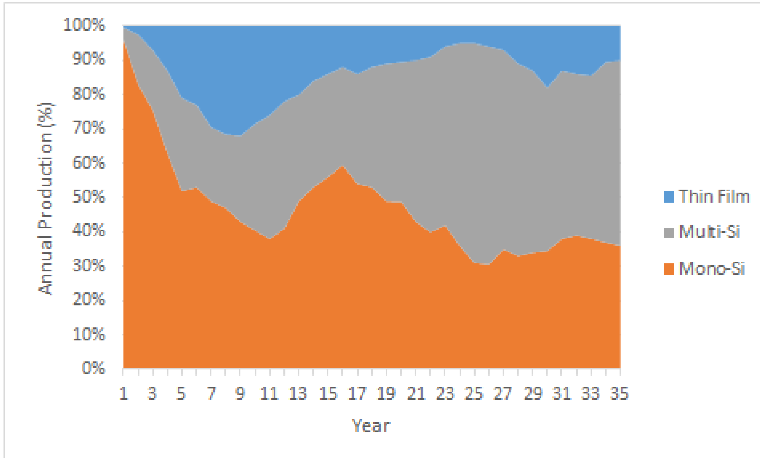
Figure 7: Solar Cell Efficiency Development Over Time



Source: Fraunhofer ISE (2014), p. 25.

Figure 8 shows the most commonly used forms of solar cell. It is clear that the solar cells which in the last decade have hardly developed in terms of efficiency, *Mono Crystalline Silicon* and *Multi Crystalline Silicon*, are also the most commonly utilised. In addition, Fraunhofer ISE (2014) stated that increases in solar efficiency in the last 10 years are in the range of 14 - 16 %. As such, there is no control for module efficiency in the MLR model; the marginal increases are captured in the error term, u_i.

Figure 8: Solar Production by Technology (% of Total Production)

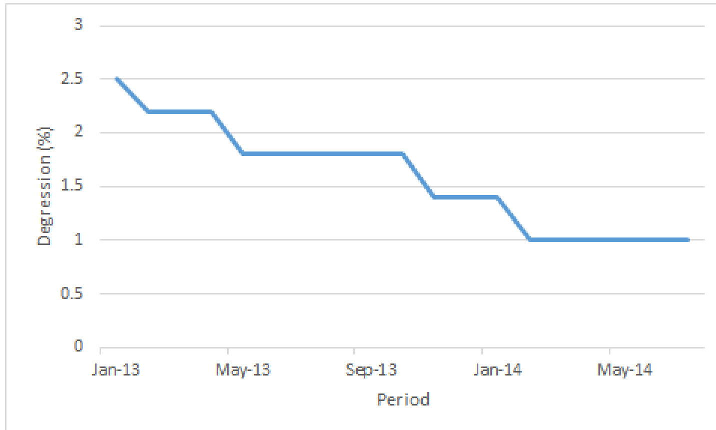


Source: Fraunhofer ISE (2004), p. 18.

Feed-in tariffs were also accounted for in the analysis. The National Network Agency (Bundesnetzagentur) in Germany maintains these statistics in the public domain.[9] Figure 5.4 shows the gradual degression in the German national feed-in tariff rate for solar energy generation since January 2013. This digression demonstrates a rise in the real price of a solar installation in Germany since this time. As there is no control for this variable in the MLR model, the error term $u_i$captures the effect of these tariffs.

[9]http://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/ErneuerbareEnergien/Photovoltaik/DatenMeldgn_EEG-VergSaetze/DatenMeldgn_EEG-VergSaetze_node.html (Date accessed: 04/07/14).

Figure 9: German Solar Energy Feed-In Tariff Degression Since January 2013 (%)



Source: National Network Agency (Bundesnetzagentur)

5.5 Results of Regression and Analysis

The multiple linear regression model detailed in this section allowed for the estimation of the effect of the anti-dumping tariff on seasonally adjusted actual solar energy production. Table 8 provides summary statistics of the dependent variable, actual solar energy production (MW). Tables 9 and 10 indicate the regression statistics that were obtained in the course of the analysis.

Table 8: Summary Statistics

Mean	272009.10
Standard Error	5281.84
Median	241078.40
Mode	313622.80
Standard Deviation	195428.20
Kurtosis	-0.22
Skewness	0.7289
Range	828393.40
Minimum	4086.40
Maximum	832479.80
Count	1369

Table 9: Regression Output A

Multiple R	0.8104
R Square	0.6568
Adjusted R Square	0.6535
Standard Error	115033.3229
Observations	1369

Table 10: Regression Output B

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-34305.5020	11489.0899	-2.9859	0.0028	-56843.8368	-11767.1670
t	167.3244	11.9698	13.9788	1.4E-41***	143.8430	190.8058
ϕ	17775.9016	11509.0371	1.5445	0.122697	-4801.5638	40353.3670
feb_i	73136.0943	14964.7546	4.8872	1.14E-06***	43779.4916	102492.6970
mar_i	234864.6692	14626.4509	16.0575	3E-53***	206171.7223	263557.6160
apr_i	293002.4551	14769.6092	19.8382	4.29E-77***	264028.6723	321976.2380
may_i	291506.1619	15737.6812	18.5228	1.87E-68***	260633.2964	322379.0270
jun_i	317450.6717	14926.3843	21.2677	7.65E-87***	288169.3406	346732.0030
jul_i	356201.2710	14089.5385	25.2812	7.7E-116***	328561.5938	383840.9480
aug_i	289621.0624	14828.5098	19.5313	4.76E-75***	260531.7333	318710.3920
sep_i	187672.6321	15014.3329	12.4995	5.21E-34***	158218.7708	217126.4930
oct_i	102691.5262	16218.8478	6.3316	3.29E-10***	70874.7483	134508.3040
nov_i	-540.5187	16439.7273	-0.03288	0.973776	-32790.5993	31709.5619
dec_i	-39877.1802	15835.5547	-2.51821	0.01191***	-70942.0458	-8812.3146

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

These regression results allow for the terminal specification of the MLR model as follows:

$$\widehat{production}_i = -34305.50201 + 167.3244752(t_i) + 17775.90161(\phi_i) + 73136.09436(feb_i) + 234864.669(mar_i)$$
$$+293002.4551(apr_i) + 291506.1619(may_i) + 317450.6717(jun_i) + 356201.271(jul_i)$$
$$+289621.0624(aug_i) + 187672.6321(sep_i) + 102691.5262(oct_i) - 540.5187098(nov_i) + 39877.1802(dec_i).$$

Overall, the specified MLR model is a relatively good fit of the population. The regression statistics indicated an adjusted R-squared value of 0.6535. With this value, it can be seen that the specified model captures, on average, 65.35 % of the variation of the dependent variable ($production_i$); this implies that 34.65% of the variation in the dependent variable is what lies in the error term, u_i. The standard error in the model of 5281.842 MW is quite low relative to the mean actual solar energy generation of 272009.1 MW. This further indicates a strong correlation of the samples relative to the linear trend line.

The variable indicating each passing day t in the specified MLR model is statistically significant at a 95% level of confidence. With a p-value of less than 0.0000, it shows that with each day that passes the dependent variable actual solar energy generation increases by, on average, 167.32 MW. The y-intercept is estimated, on average, to be -34305.5. The interpretation of this is that if all coeffcients other than the intercept were set to 0, the production in any time t would be, on average, equal to -34305.50 MW; this value is also significant at a 95% level as it has a p-value of less than 0.0000.

Crucially, the coefficient representing the anti-dumping tariff ϕ is shown to have a non-significant effect on the actual solar energy output. This is attributed to it having a p-value of 0.122697, which is not lower than the requried $p < 0.001$. This means that in the context of the specified MLR model the null hypothesis H_0 is unable to be rejected in favour of the alternate hypothesis H_1. This means that, on average, the introduction of the anti-dumping tariff by *Commission Regulation 1205/2013* had no effect, in the time from its introduction on 02/12/2013 until 30/09/2014, on the generation of solar electricity in Germany. The important inference drawn from this finding is that, given the supporting secondary data in section 5.4, there was no slow down in solar energy investment as a result of the tariff on Chinese solar glass imports.

5.6 Limitations

The predictive power of the empirical model presented in this thesis was limited by a number of factors. Firstly, it is possible that the sample size after the introduction of the anti-dumping tariff presented is not large enough to fully account for the strength of the effect. As this sample size increases, one is able to detect the perhaps subtle ceteris paribus changes of the anti-dumping tariff ϕ on the dependent variable with a greater accuracy. Secondly, it is possible that the effect of the anti-dumping tariff on consumer behaviour may be lagged; indeed, consumers may not even be immediately aware of its effect, or have made contractual agreements which make the effect of the anti-dumping tariff on the dependent variable more complicated than its binary representation in the model. Thirdly, the cost of data acquisition limited its collection in a variety of ways. For example, requests for data access to a number of German research institutes (such as *BSW*

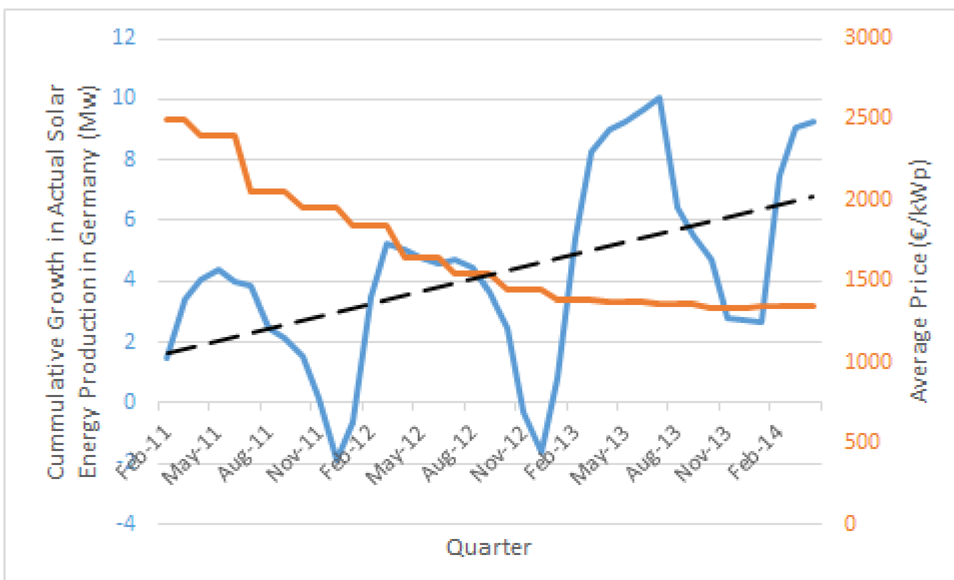
Solar, *Fraunhofer ISE* and *EEX*) were declined, on grounds of the commercial sensitivity of such information.[10]

[10]Refer to appendices 7.1 and 7.2 for sample correspondence.

6 Conclusion & Suggestions for Further Research

This thesis examined the *Commission Regulation 1205/2013* case and discovered price inelasticity amongst German consumers of solar installations. These proceedings found that German producers of solar glass had lost significant market share throughout the rapid market entrance of Chinese competition in the European solar glass market. Indeed, the *European Commission* found sufficient evidence of material damages amongst European producers of solar glass, and implemented an anti-dumping tariff to protect its domestic industry. As a result of these events, the price of a solar installation in Europe stabalised after decades of decreasing prices. Figure 10 shows the relationship between the price of an average rooftop solar installation in Germany (measured in Euro per kilowatt produced) against growth in solar energy production (measured in megawatts). Despite the average price stabilisation of rooftop solar installations in Germany, the growth rate in installations of solar in Germany continued to trend upward, as seen by the unabated growth in solar productivity.

Figure 10: Growth in Actual Solar Energy Production in Germany (trend line added) against Average Price for a Rooftop Solar Installation in Germany



The theory of the warm-glow effect is thought to in part account for this inelasticity.

Specifically, it has been shown that there exists insufficient evidence to suggest that the imposition of an anti-dumping tariff by the European Commission on the import of dumped Chinese solar glass had a significant effect on the investment in solar energy installations of German consumers. Indeed, since the tariff was introduced on 2 December 2013 actual solar energy production in Germany has continued to grow unabated. This is despite both a stabilisation in consistently falling prices for solar energy installations and a gradual degression in the solar energy feed-in tariff rate. A recent solar industry report by Fraunhofer ISE (2014) recalled that the German government has an ambitious goal of reductions in greenhouse gas emissions in 2050 by 80-95% compared to 1990. As a democratically elected majority government, it is reasonable to conclude that the ambitions of the German government are reflected and derived from its voters: German consumers. These consumers are believed to exhibit the warm-glow effect.

It is suggested that the warm-glow effect drives consumers to invest in solar energy and reap non-monetary rewards which materialise as a general satisfaction from their environmental philanthropy. In this sense, investing in solar energy is akin to a donation to the environment, and the warm-glow effect is desired for its own personal benefit and the status it imparts on oneself as a consumer in relation to other consumers. The magnitude of demand for solar by German consumers (during the period examined in this thesis) was greater than any price offsets from the anti-dumping tariff imposed by *Commission Regulation (1205/2013)*. Simply put, it is believed that, due to the warm-glow effect, German consumers of solar energy respond inelastically to changes in the price of solar energy installations.

These findings are in contrast to what is expected from the imposition of an anti-dumping tariff. The classical model of tariff incidence predicts that consumption and consumer welfare in a protected industry will fall due to the imposition of a higher price on a good. In this case, the investment in solar continued to increase, despite this prediction. Under the logical assumption that German solar glass producers benefited from the imposition of the anti-dumping tariff as a result of their lobbying, it would appear that the European Commission has devised clever policy by means of *Commission Regulation (1205/2013)*. Caballero et al. (2000) described anti-dumping as producing “winners” and “losers” from producers and consumers respectively. In the case examined it is shown that, at best, German producers and consumers both benefited by the imposition of the anti-dumping tariff and, at worst, consumers were for some reason willing to shoulder the burden of the tariff. In the case examined, it is found that policymakers were handed a win-win scenario whereby consumers who exhibited the warm-glow effect allowed the protection of the German solar energy industry without the byproduct of a significant slowdown in solar energy investment.

This thesis contributes to existing literature in a number of ways. Firstly, it provided further input into the debate over anti-dumping, which remains a point of contention amongst economists such as Finger (1993); McGee (1996); Cheng et al. (2003); Prusa (2005) and Brown (2009). Zvidza (2008) highlighted the fact that sound anti-dumping policy should perfectly counteract distortions to the competitive outcome (p. 20). The empirical findings of this thesis support this objective by the *European Commission,* and found that the Commission was able to deliver a 'win-win' outcome for policy makers, in contrast to the welfare diminishing theoretical prediction of the classical model of tariff incidence. Secondly, this thesis examined the implications of *Commission Regulation 1205/2014* on German consumers of solar glass, and is to the knowledge of the author the first academic paper to do so. Finally, it provided evidence of consumer price inelasticity in the German solar glass market. This inelasticity is attributed to what Andreoni (1990) described in a paper as the warm-glow effect, whereby consumers are likely to weigh factors other than price heavily in their purchasing or investment decisions. Andreoni and Miller (2003) and Nicholson and Snyder (2008) later showed that a given consumers' utility function can be derived from factors derived from not only their own utility, but also some portion of utility imparted on others, or in the case of solar energy, the utility imparted on the environment (and its conservation). The warm-glow effect described by Andreoni (1990) indicates a scenario where solar installations deliver proportionately lower levels of tangible utility from financial return to consumers, but instead, higher levels of intrinsic utility; a warm-glow sense of satisfaction is derived from philanthropy, or generally being observed by others to be "doing good". As such, this thesis presents further evidence of this phenomenon in recent years amongst environmentally conscious consumers in Germany who, despite an increase in the price of solar investment, continued to unabatedly invest in solar after the implementation of anti-dumping tariffs on Chinese solar glass imported into the European Union.

As time goes on, future researchers will have access to a higher number of date samples for further empirical analysis along the same lines of this study. Indeed, if the effects of the anti-dumping tariff are lagged, this will become increasingly evident in future research. Furthermore, commercial interest in the area of consumer sentiment toward renewable energies and other sustainable products may allow for increased research budgets; thus, the possibility of obtaining more comprehensive data sets which relate to, for example, factors such as prices and installation rates (which are generally considered by their stakeholders to contain market sensitive information) may be easier to obtain. Researchers who are particularly gifted in quantitative analysis may also find value in performing more vigourous testing of the findings of this thesis. Qualitative research opportunities in the area of consumer sentiment for renewable energies and other sustainable products have potential to uncover further evidence of the warm-glow effect. Potential methods include willingness to pay surveys and interviews into the real world decision making process of investors in such products. Although further analysis of German consumers would expand directly on the findings of this thesis, there is no reason why the methods and techniques that have been employed here are not compatible with other countries and markets. For example, an analysis of the warm-glow effect displayed by consumers across different economies may provide interesting opportunities for future research.

7 Appendices

7.1 Sample E-Mail Data Request[11]

Dear Herr Knaack,

Currently I am writing my thesis for the award of honours in economics, at Murdoch University in Perth, Western Australia. For my thesis, I am conducting an analysis on price elasticity in green energy markets and, as such, would like to specifically include data on historical end consumer prices for solar installations in Germany.

This data was referenced in the Fraunhofer Institute's April 2014 paper "Recent Facts about Photovoltaics in Germany". After quite extensive searching on both the English and German versions of the Bundersverband Solarwirtschaft website I am unable to find this data.

At the suggestion of a professor from my university, I would like to kindly ask for access to the data. If you are able to provide it, it would be most helpful.

Thank you for your assistance in advance,

Aaron Kosovich (B.Econ)

Honours in Economics Student

Murdoch University, Perth, Western Australia

7.2 Sample E-Mail Data Response[12]

Dear Aaron,

Thank you for your reply. If you don't find the information in our media it is not available free of charge. I am sorry for that.

Kind regards,

Jan Knaak

Senior Project Manager International Affairs & Research Policy

[11] The following email correspondence was sent 06/05/2014.
[12] The following email response was recieved 21/05/2014.

BSW - Bundesverband Solarwirtschaft e.V

- German Solar Industry Association -

[*contact details excluded*]

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