UNIVERSITY OF CAMBRIDGE
Faculty of Economics

Institute for New Economic Thinking

Cambridge-INET Institute

Cambridge-INET Working Paper Series No: 2015/24

Cambridge Working Papers in Economics: 1529

POLICY SHOCKS AND STOCK MARKET RETURNS: EVIDENCE FROM CHINESE SOLAR PANELS

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February 2019

Abstract

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JEL Codes: F12, F13, G10, G14

Keywords: Chinese exports, antidumping, solar panels, event study

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For helpful conversations and feedback, we thank Holger Breinlich, Hector Calvo Pardo, Paola Conconi, Ron Davies, Giovanni Facchini, Yi Huang, Brendan Lambe, Christoph Moser, Jose Olmo, Alejandro Riano, Eiichi Tomiura, Maurizio Zanardi, participants at the 27th NBER-TCER-CEPR Conference on "Globalization and the Welfare Impacts of International Trade," the European Trade Study Group Conference, the Nottingham-Zhejiang International Trade Conference, the International Finance and Banking Society Conference, the China Finance Review International Conference, and seminar participants at University College Dublin and the University of Southampton. Meng would like to thank the National Natural Science Fundation of China (No.71803079) for research support. Song is grateful for support from the Zhejiang Provincial Natural Science Foundation of China (LY18G030003) and the Zhejiang University Education Foundation Global Partnership Fund.

1 Introduction

How do stock markets respond to information about expected changes in the value of a firm? The relationship between the dissemination of information and its role in efficiently allocating resources across firms is fundamental to the growth and development of an economy, especially when the firms are engaged in producing innovative new products that could themselves stimulate growth in other industrial sectors.

It has been well established that the Chinese economy, in which a competitive market-based economy operates alongside a state owned sector, suffers from resource mis-allocation that manifests as lower than potential productivity. (See Hsieh and Klenow (2009) and Dollar and Wei (2007)). However, among competitive market-based firms, one might expect efficient resource allocation associated with clear dissemination of information about market conditions such as the demand for a product. In this paper, we study a unique series of policy changes that (1) threatened to dramatically reduce Chinese firms' access to the EU market, (2) temporarily restricted Chinese solar panel exports to the EU significantly, and (3) finally resulted in moderate import restrictions against Chinese solar panel products. Moreover, in addition to these negative external demand shocks, we examine domestic policy shocks intended to stimulate China's domestic demand: (1) the announcement of a domestic development plan with explicit quantitative targets for the installation of solar panels and (2) the announcement of a domestic subsidy plan that would only benefit power generators that adopted solar panels for electricity generation. Our analysis examines how stock market returns evolved for 37 Chinese solar panel firms that were publicly listed in different stock markets around the world.

Our analysis begins with event studies of cumulative abnormal returns (CAR) in three distinct stock markets - New York, Shanghai-Shenzhen and Hong Kong - in response to a series of announced policy changes regarding the importation into the European Union of solar panels manufactured in China and the consumption of solar panel products in China. We document Chinese firms' cumulative abnormal returns in response to this series of policy shocks and, importantly, how these responses varied by firm ownership and across the three different stock markets we examine.

We then examine the predictions of the Melitz (2003) model of firms engaged in international trade to explore the cross-sectional determinants of firms' abnormal returns in response to trade policy announcements. We find broad support for the Melitz model's predictions that the largest and most export-oriented firms will experience the largest proportional decline in expected future profits in response to an increase in a foreign trade restriction. We extend the analysis along a number of empirically-interesting dimensions. First, we incorporate the precise value chain position of the firm into our analysis of CARs. As the structure of global value chains has become more fragmented and complex, it has become more important to understand how a trade policy change against one output along a value chain impacts the value of firms along the chain. We find that stock market losses are largest for the more directly impacted value chain positions.

We next extend our analysis to firm ownership types and find that the stock prices of private sector firms in China are more responsive to trade and domestic policy announcements than state owned enterprises (SOEs); private sector firms are more likely to be adversely affected by trade restrictions than state owned enterprises and private sector firms gain more from domestic policy initiatives. Notably, we observe very little or no change in the cumulative abnormal returns of Chinese state owned enterprises (SOEs) to a policy change that threatened to seriously impair the firms' access to 80% of the world market for solar panels and photo-voltaic cells. At a minimum, this suggests that SOEs are largely insulated from the fundamental market forces that drive the behavior of the Chinese private sector firms that they compete against. In finding very little or no response in the stock prices of SOEs to external trade policy shocks alongside negative abnormal returns for private sector firms, we provide suggestive evidence that the mechanism of resource (mis)allocation is tied to investors' perceptions about the extent to which SOEs are invulnerable to market forces. Although the European Union's trade policy actions were intended to "level the playing field" between European and Chinese firms, the policy seems to have had the unintended consequence of tilting the playing field within China against the Chinese economy's private sector solar panel producers in favour of SOEs.

We conclude our analysis by using an instrumental variables approach to study the importance of the market in which a firm is publicly-listed. To the best our knowledge, ours is the first work to assess and compare the responses in different stock markets to the same set of events relevant to the firms listed within them. Interestingly, the prices of private sector Chinese solar panel firms listed on the US stock market are more responsive to trade and domestic policy shocks than those listed in Hong Kong or Shanghai-Shenzhen. This could perhaps be attributed to the fact that the US stock market participants are largely professional and institutional investors who use analytical tools and have real-time access to relevant market information, while in the Chinese market the majority of investors are private individuals.[1] Taken together, these findings highlight that trade policy actions which are intended to foster a fairer competitive environment in global markets can potentially exacerbate underlying distortions in markets with heavy state involvement.

The present paper contributes to three literatures: (1) the literature on firm productivity and resource mis-allocation in China (Hsieh and Klenow (2009); Hsieh and Song (2014); Dollar and Wei (2007)); (2) the event-study literature (Breinlich (2014), Moser and Rose (2014), Hartigan, Perry, and Kamma (1986); Hughes, Lenway, and Rayburn (1997); Lenway, Morck, and Yeung (1996); Guzhva and Pagiavlas (2004); Miyajima and Yafeh (2007); Kutan, Muradoglu, and Sudjana (2012); and Kosmidou, Kousenidis, and Negakis (2012)); and (3)

[1] According to U.S. Securities and Exchange Commission, in the US market institutional investors like mutual funds, pension funds, endowment fund insurance companies, hedge funds and trust investments accounted for 67% of the market capitalization in 2010. In contrast, in the Chinese market all types of institutional investors, including QFII, accounted for only 10.9% of market capitalization in 2013.

the literature on the impact of antidumping policy on exporters (Bown and Crowley (2006), Bown and Crowley (2007), Crowley, Meng, and Song (2018), Tabakis and Zanardi (2016)).

Our work builds upon a number of significant prior contributions in the event study literature. An important early study of the impact of special US import tariffs on stock market returns was conducted by Hartigan, Perry, and Kamma (1986). More recent contributions on the impact of trade policy changes on stock market value include Breinlich (2014), Breinlich (2015), and Moser and Rose (2014). Breinlich (2014) examines the impact of the North American Free Trade Agreement (NAFTA) on the value of individual Canadian firms. Moser and Rose (2014) study the impact of signing a regional trade agreement on the returns in national stock markets. Ries (1993), on Japanese autos in the 1980s, and Hughes, Lenway, and Rayburn (1997), on semiconductors, examine the impact of trade policy changes on upstream and downstream firms.

Recent contributions on evaluating externally-created policy shocks include Kutan, Muradoglu, and Sudjana (2012) and Kosmidou, Kousenidis, and Negakis (2012). Kutan, Muradoglu, and Sudjana (2012) examine the impact of IMF-related news on both financial and real sector stock returns in Indonesia during the Asian crisis, in particular, they explore the interplay between IMF actions in crisis countries and the actions and responses of local authorities. Kosmidou, Kousenidis, and Negakis (2012) test for the impact of the EU/ECB/IMF bailout programs on the financial and real sectors of the Athens Stock Exchange during the Greek sovereign crisis.

A number of prior studies on abnormal stock returns have focused on understanding the cross-sectional determinants of heterogeneous returns: Lenway, Morck, and Yeung (1996) look at the U.S. steel industry, Guzhva and Pagiavlas (2004) study U.S. airlines after the September 11th terrorist attacks, and Miyajima and Yafeh (2007) examine Japanese non-financial companies around major events associated with the Japanese banking crisis of 1995-2000.

The next section describes the history of the Chinese solar panel industry, the EU antidumping case against Chinese photo voltaic (PV) producers, and Chinese government initiatives to stimulate the solar panel industry. Section 3 describes the data. The empirical methodologies employed are discussed in section 4. Section 5 presents the main results. Section 6 concludes the paper.

2 Policy changes and the Chinese solar panel industry

In most locations around the globe, duirng the period under study, the cost of solar energy exceeded the cost of power furnished by traditional electric utilities (gas, coal, hydro, etc.), although it was widely considered to be a promising form of environmentally friendly clean energy. For example, in 2012 the average price of a kilowatt hour of electricity for households in China was about 0.5 RMB while the average cost of producing a kilowatt hour of electricity using solar panels was 1.3 RMB.[2] Because of its positive environmental impact, governmental bodies in many countries have provided economic incentives in the form of rebates, tax credits and subsidies to end users, distributors, system integrators and manufacturers of photo volataic products to promote the use of solar energy in on-grid applications. The EU has been notably generous in providing subsidies to consumption, especially in Germany and Spain.[3] Because of the heavy government support for solar product consumption, the EU has been the world's leading region in terms of cumulative installed capacity for several years; in 2011 the EU accounted for 75% of global capacity, in 2012 70% and in 2013 59%, which corresponded to a physical capacity of 81.5GW in that year.[4] Moreover, the level of European consumption has translated into a massive increase of the quantity in kW hours of solar generating capacity in Europe. For example, in Germany in 2014, installed solar capacity was 38 GW compared to 28 GW in gas, 28 GW in hard coal, and 21 GW in brown coal (Burger (2014)).

In contrast to the stated European policy objective of reducing the environmental impact of energy consumption, the Chinese government justified its engagement with the solar panel industry as part of an economic development program of cultivating "strategically important emerging industries."[5] Beginning in 2000, the Chinese government launched a series of national policies, subsidy schemes and regulations that actively promoted the solar panel industry at the R&D, production and application stages.[6] Production of photo voltaic products grew exponentially between 2000 and 2012. For example, output of PV modules, measured in terms of total energy-generating capacity, increased by a factor of about 1000, from 3 MW in 2000 to 23 GW in 2012. By 2012, Chinese firms produced 58% of the total global supply of PV modules. The coincidence of EU subsidies to consumption with Chinese subsidies to production resulted in significant exports of solar panels from China to the EU. In 2012, Chinese solar panel exports to the EU were valued at €21 billion and represented roughly 7% of *all* Chinese exports to the EU. (Yao and Li (2013)).

In the aftermath of the financial crisis of 2008-2009, European governments came under pressure to reduce solar panel subsidies as the European fiscal situation deteriorated.[7] Al-

[2]See: "Study on PV electricity cost and Grid Parity," Cuiping Ma, Dan Shi and Xiaonan Cong, *Modern Economic Science* (in Chinese), 36: 85-95 (March 2014).

[3]Germany implemented the Electricity Feed-in Act (Stromeispeisegesetz 1991-1999/2000) to provide incentives for renewable electricity generation. This was followed by the "100,000 Solar Roofs Initiative" in 1999-2003 which provided low interest rate loans for PV installation. The Renewable Energy Sources Act in 2000, and amendments in 2004 and 2009, provided photo voltaic-specific feed-in subsidies. See Grau, Huo, and Neuhoff (2012).

[4]Source: "Global Outlook for Photovoltaics 2014–2018," published by EPIA (European Photovoltaic Industry Association).

[5]On 19 December 2012, the Executive meeting of Chinese State Council convened by then Premier Wen Jiabao confirmed that the photovoltaic industry is a strategic emerging industry. Source: Xinhua News Agency, "Executive Meeting of State Council: Serious Over-capacity of Photovoltaic Industry", 19 December 2012.

[6]See Sun, Zhi, Wang, Yao, and Su (2014) on the development of China's solar panel industry.

[7]After prices of photovoltaic systems decreased dramatically in 2009 and the fiscal situation deteriorated,

though EU government support for solar panel consumption was reduced, total European consumption of solar panel modules (measured in megawatts) actually *increased* by 221% between 2009 and 2012. However, the robust growth of European consumption was not fully enjoyed by European producers; their total sales growth of only 127% over this period implied a declining market share (see table 2). Much of this declining market share was due to strong import growth from China. On 24 July 2012 SolarWorld AG (Bonn, Germany) filed a complaint with the European Commission (EC) alleging unfair pricing of solar panels by Chinese photovoltaic manufacturers. This complaint led to a full-scale EU investigation into dumping by Chinese firms which concluded on 2 December 2013. Over the course of the 18 month investigation, six distinct policy changes with market-relevant information took place. The EC has a clearly defined process punctuated by a number of steps, each of which concludes with a policy announcement. Subsequent to SolarWorlds' filing of a complaint, the EC made three separate trade policy announcements regarding the importation of solar panels from China. An aspect of this antidumping case that made it somewhat unusual was that the Chinese government made two separate industrial policy changes during this same time window.

We examine the stock market responses to six policy events: (1) the filing of the complaint by EU firms against Chinese solar panel firms, (2) the EU's preliminary ruling to impose provisional tariffs on solar panels temporarily while the investigation proceeded, (3) the initial announcement of solar industry development guidelines by the Chinese government, (4) the announcement of an amendment to the preliminary ruling that replaced provisional tariffs with a price floor agreement with most Chinese firms and that raised provisional tariffs against the remaining Chinese firms, (5) the announcement of the detailed features of the Chinese subsidy scheme by the Chinese government on Monday 30 August 2013, and (6) the EC's final decision to restrict solar panel imports through a price undertaking (i.e., price floor and quota) agreement with most Chinese firms and high import tariffs against others.[8] Our analysis focuses on policy announcements by the European Commission and official Chinese government entities as these two markets were the major consumers of solar panels over this period.[9] Table 1 outlines the development of events over

the German government decided to reduce the feed-in tariff (i.e., a subsidy) in July 2010 (Grau, Huo, and Neuhoff (2012)). Spain completely suspended its feed-in tariff (subsidy program) in January 2012. (Brown (2013)).

[8]Appendix A lists all the firms in our sample and indicates if they participated in the price undertaking negotiated for the amendment to the provisional decision, the price undertaking negotiated for the final decision, and whether or not they satisfied the Chinese government's efficiency requirements laid out in the *Development Guideline*.

[9]A similar trade policy investigation against Chinese solar panel firms took place in the US between October 2011 and November 2012. However, the quantitative importance of the the US market to Chinese firms at this time was minor. For example, in 2010 consumption of solar modules in the European Union was 12198 MW with 8606 MW being imported from China. American consumption of solar panel modules in the same year of 1035 MW was less than one-tenth of Europe's and American imports from China of 527 MW were less than one-sixteenth of Europe's. As the American market was so small, we do not

time.

Table 1: Events in the Solar Panel Market, 2012-2013

Event	Date	Demand Shock (+/−)	Description
Petition	24 Jul. 2012	(−) external	EU solar panel firms filed petition for protection against Chinese imports
Preliminary Ruling	4 Jun. 2013	(−) external	Provisional EU import duty announced
Development Guideline	15 Jul. 2013	(+) domestic	Industrial development guideline announced by the State Council of China
Amendment	2 Aug. 2013	(−) external	Provisional EU import duty amended to voluntary quota
Subsidy Scheme	30 Aug. 2013	(+) domestic	China's National Development and Reform Commission announced a solar panel subsidy
Final Ruling	2 Dec. 2013	(−) external	Application of voluntary quota & EU import tariffs

Before turning to a detailed discussion of the policy events, we briefly describe the historical developments in the EU solar panel market from 2009 through 2012. Table 2 presents a selection of statistics from 2009 through the investigation period (IP) of 2012 related to the evolution of the EU market for solar panel modules (the final product typically installed on rooftops), cells (a component of modules), and wafers (a component of cells). The first three rows of table 2 show that imports of solar panel products (measured in GW of energy-generating capacity and normalized to 100 in 2009) grew substantially over 2009-2012. Further, from rows 4-6, we see that rising imports from China led to a sizable increase in the combined market share of Chinese firms for all three products. By 2011, 80% of solar modules consumed in Europe were provided by Chinese firms. The last three rows of the table show prices of solar panel products sold in the EU were declining rapidly over this time period. The question that the EC had to examine in its antidumping investigation was: to what extent were the price declines due to factors including: (1) a decrease in the price of polysilicon, an important input, (2) increased production efficiencies, and (3) reduced manufacturing costs as a result of improving technology versus (4) anti-competitive price behavior by Chinese firms.[10] Ultimately, the EC found that Chinese firms were selling solar

analyze American trade policy actions in this paper. Data on market size and imports comes from USITC Publication 4360, "Crystalline Silicon Photovoltaic Cells and Modules from China," Nov. 2012, Table C-2 and Commission Regulation (EU) No 513/2013 of 4 June 2013 "imposing a provisional antidumping duty on imports of crystalline silicon photovoltaic modules and key components...originating in the People's Republic of China..." Table 1-a and 2-a.

[10]The 2012 annual report of China-based US-listed company CSUN emphasizes technological factors behind price declines.

panels at "dumped" prices.[11]

Table 2: Evolution of the EU solar panel market: 2009-2012

Indicator		2009	2010	2011	IP
Import volume index	Module	100	251	462	408
	Cell	100	303	554	582
	Wafer	100	551	926	748
Market share	Module	63%	71%	80%	80%
	Cell	8%	16%	22%	25%
	Wafer	6%	22%	32%	33%
Price index	Module	100	79	64	36
	Cell	100	73	70	58
	Wafer	100	73	73	60

Source: Commission Regulation (EU) No 513/2013 of 4 June 2013. This document describes the analysis performed by the EC in its preliminary investigation into the allegation of dumping by Chinese firms. Tables 1-a, 2-a, 3-a, 4-a, 5-a, and 7-a of the Commission's report display data in physical units of megawatts and €per kilowatt as well as indices based in 2009. These underlying data were collected by Europressedienst, an independent consultancy employed by the European Commission. The authors reorganized the data reported in Commission Regulation (EU) No 513/2013 to make this table.

2.1 Theoretical predictions for the response of stock prices to policy announcements

To understand the link between firm profits and trade or industrial policy announcements, we turn to the Melitz (2003) model.[12] Breinlich (2014) develops the predictions of the Melitz model for firm-level profits and stock prices in response to an announcement of

[11] With 220 European producers and 218 exporting Chinese producers operating in the European market, one might imagine that it would be difficult for a firm or group of firms to engage in predatory price-undercutting and still remain viable in the long run. The EC's findings that Chinese firms were pricing below cost hinged on a practice that is commonly used by WTO members to evaluate dumping by firms located in non-market economies, i.e., countries with significant government intervention in markets. Specifically, the prices charged by accused Chinese solar producers were compared to the solar panel production costs of third-party firms not involved in the investigation, in this case, the Indian enterprises EMVEE Photovoltaic Power Private Limited and Tata Power Solar Systems Limited. (Commission Regulation (EU) No 513/2013 of 4 June 2013). Thus, the Commission determined that Chinese firms were charging prices below the production costs of Indian firms and, thus, were guilty of dumping.

[12] The Melitz model of monopolistic competition captures two features that we think are important: the large number of producers operating in China and the EU suggests that firms have limited pricing power and, because pricing is based on the energy-generating capacity of a module, cell, or wafer, quality differentials between firms are likely to be small.

a trade liberalization. In the Melitz model, firms have heterogeneous productivity levels, are engaged in monopolistic competition, and must pay a fixed cost in order to export. This implies that only the most productive firms export; among exporters, more productive firms export larger quantities and earn higher profits. Thus, the model predicts that firms that are more productive (by labour productivity or total factor productivity), are larger (by employment or sales), and have a higher export share will experience larger expected profit gains in response to the announcement of a tariff liberalization. Interestingly, with regard to foreign exporting firms, the Melitz model predicts that moving from free trade to a restrictive import tariff has the proportionally largest negative impact on the profits of the most productive firms. That is, while all extant exporting firms would experience a reduction in profits or increase in the probability of exiting the foreign market in response to an increase in a foreign import tariff, as a fraction of intial profits, the largest proportional loss would accrue to the firms in the industry with the highest export shares and productivity.

This theoretical framework provided by the Melitz model guides our expectations about each of the policy announcements examined.

The first policy event was the filing of the antidumping petition by SolarWorld AG on 24 July 2012. This event represented an increase in the probability of future trade restrictions against Chinese firms exporting to the EU. As all firms in our sample were exporting to the EU, Melitz' theory predicts a decline in Chinese firms' market values, with larger declines in expected returns for the firms with the highest export shares, which under the assumptions of the Melitz model are also the firms with the highest productivity.

The second policy event, the announcement of a provisional antidumping duty of 11.8% on 4 June 2013 was an actual reduction in market access. The Melitz model predicts a reduction in expected future profits arising from the provisional tariff increase in the near term (approximately 6 months) and an increase in the probability of a long term (e.g. 5 year) import tariff. Again, larger declines in stock returns are predicted for more export-oriented and more productive firms.

The third policy event, on 15 July 2013, was a Chinese government issuance of new regulations for the solar panel industry. The official *Development Guideline of the State Council of China* established ambitious growth, investment and production efficiency standards. In explicitly laying out production efficiency requirements for producing firms, the *Development Guideline* created winners and losers across Chinese firms by (essentially) restricting capacity expansion to the most efficient producers and requiring firm closures and industry consolidation.[13] The *Guideline* implied a substantial increase in domestic consumption

[13] Explicit requirements for new manufacturing sites were set out in the *Guideline.* For example, to qualify for a plant expansion, a firm's existing conversion efficiency ratios had to be greater than or equal to 20% for mono-crystalline silicon and 18% for poly-crystalline silicon. In addition, the *Guideline* also stipulated that the total integrated energy consumption for the production of poly-crystalline silicon could not exceed an average of 100 kWh per kg of poly-crystalline silicon material produced. Appendix A reports in column 4

of PV products within China as the State Council set the annual growth of PV installed capacity at no less than 10GW from 2013 to 2015, with the intent of reaching 35GW of installed capacity by 2015.[14] The *Guideline* implied a large positive demand shock for solar panels. Both the Melitz model and a standard n-firm Cournot oligopoly with heterogeneous costs predict the largest profit gains for the most productive or lowest cost firms.

The fourth policy announcement of 2 August 2013 was complicated. On this date, the Commission amended its preliminary ruling by replacing the import tariff of 11.8% on all Chinese solar panels with a negotiated *price undertaking* or price floor. Starting with this announcement, the European Commission began to introduce a small amount of heterogeneity across firms in the restrictiveness of the import policy. The first dimension of heterogeneity was participation in the price undertaking agreement. Most of the firms in our sample participated in the price undertaking; Appendix A lists each firm's participation status.[15]

The second source of heterogeneity related to enforcement of the price undertaking agreement. Figure 1 illustrates the time series of the actual and threatened import duties facing the China-listed, private sector solar panel firm, TBEA Co., Ltd. Figure 1 indicates that the Commission planned to enforce the amendment's price undertaking agreement by charging an import tariff of only 1.60% if TBEA Co.'s exports satisfied the price and quantity agreement, but by raising the import tariff to 47.50%, the threat duty rate, if TBEA's exports exceeded the firm-specific quota or sold below the minimum price. Chinese firms faced a small degree of heterogeneity in the magnitude of the threat duty that they would be charged if they violated the agreement.[16] The amendment, which essentially created a collusive oligopoly among Chinese and European firms, had theoretically ambiguous effects on the future profits for a participating firm relative to a competitive market situation with a high import tariff. The price undertaking raised the expected future prices of solar panel products in Europe, but also restricted the level and expected future growth of quantities sold in Europe. Thus, the impact of the policy on stock returns would depend on how

which firms in our sample were reported by *PV Magazine* to have satisfied the Chinese government's efficiency requirements. See Meza, Edgar, "China's cull list of 109 favored companies, *PV Magazine*, January 2014.

[14]To understand how ambitious this plan is, note that prior to the announcement of the *Development Guideline*, according to the "12th five-year development plan for the photo-voltaic electricity" made by the National Energy Administration on September 12, 2012, the Chinese government's target for PV installed capacity by 2015 was only 20 GW. Further, one can compare the *Development Guideline* to the predictions in HIS (Information Handling Services)'s "Whitepaper: Predictions for Solar Industry in 2014" which claimed that *global* PV installation would be 33.1GW in 2015, with only 9.3 GW being installed within China.

[15]The *Official Journal* announcements of the amendment did not list the specific values for the minimum import price and Chinese market share, but press reports indicated that the initial minimum import price would be €560/kW for modules, with 70% of the European market to be allocated to imports from China. Allocation of the precise import volume to each Chinese firm was left to the discretion of the China Chamber of Commerce. See the Q&A Memo prepared by Mayer Brown for the SETI (Sustainable Energy Trade Initiative) Alliance at http://seti-alliance.org/en/node/271.

[16]In appendix C, we provide a summary of the policy facing each firm - overall, the pattern of trade policy changes was similar to that facing TBEA.

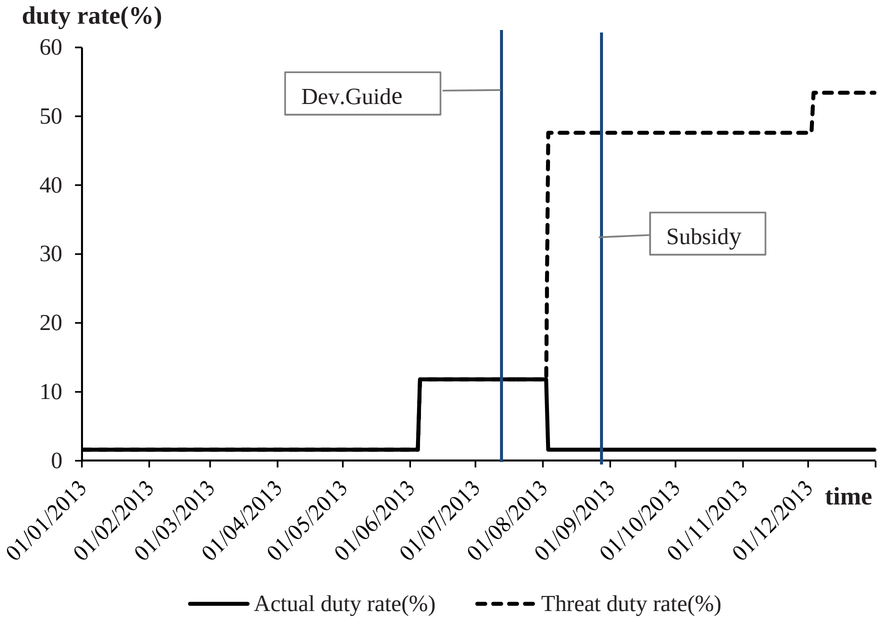


Figure 1: Evolution of EU trade policy for TBEA Co., Ltd.

markets expected future profits to evolve under managed collusion versus free competition with a high import tariff.

The fifth policy event was a Chinese government announcement of a subsidy to entities which generate power using solar panels. China's National Development and Reform Commission (NDRC) issued the "Finalized Subsidies for Distributed Generation and Ground-mounted PV Stations" on 30 August 2013.[17] This programme stipulated that starting from 1 January 2014, the subsidy for distributed generation would be set at the rate of RMB 0.42 per kWh, and the feed-in-tariff scheme for ground-mounted PV stations would be set at a rate about RMB 0.95 per kWh. These rates are considerably higher than those paid to traditional generators in China.[18] The offer of this generous subsidy to electricity generators increased their demand for solar panels. As with the *Development Guideline*, both a Melitz model and an n-firm Cournot oligopoly with heterogeneous costs predict positive stock returns, with the largest returns predicted for the most productive or lowest cost firms.

[17] The National Development and Reform Commission (NDRC) announced the subsidy scheme on August 30th 2013. This major policy change was reported by all leading media including Shanghai Securities News, the official news release outlet of China Securities Regulatory Commission (http://stock.cnstock.com/stock/smk_gszbs/201308/2720858.htm), ifeng finance (Fenghuang Caijing) (http://finance.ifeng.com/a/20130830/10568458_0.shtml), and Sina Finance (http://finance.sina.com.cn/stock/hkstock/marketalerts/20130830/135316618389.shtml).

[18] The *Want China Times* (a Taiwan-based English language newspaper) reported in "The price of power: China's confusing electricity rates" (15 May 2013) that electricity distribution rates for 2010 ranged from RMB 0.16 per kWh (State Grid) to RMB 0.2 per kWh (China Southern Power Grid).

The sixth and final policy event in our study was the final ruling in the solar panel antidumping case by the European Commission on 2 December 2013. The European Commission confirmed its decision to accept the price undertaking (i.e., the price floor and firm-specific market shares) offered by Chinese exporting producers. This decision enabled Chinese exporting producers who participated in the undertaking to be exempt from paying any antidumping duties. The final price undertaking agreement included 121 firms which represented 80% of the total volume of solar panel products imported from China. The remaining firms, which did not fully cooperate with the EC's investigation, faced AD duty rates from 47% to 64.9%. Appendix A lists each firm's participation status in the final price undertaking (UT). The expected impact of this announcement on stock returns is generally ambiguous (because it raised prices but lowered firm-level quantities).

3 Data

Our dataset comprises 37 solar panel firms whose production facilities are located in China. All of these firms are publicly-listed entities, of which 17 are publicly-listed in the Shanghai-Shenzhen stock market, 11 are listed on US markets (7 are listed in NYSE and 4 are listed in NASDAQ), and 9 are listed on the Hong Kong Stock Exchange. Together, these firms accounted for 80% of China's solar panel output in 2012.[19]

The first component of the dataset are the daily stock prices and average market returns from April 2012 through December 2013. For firms listed on the Chinese markets and the Hong Kong market, which we refer to as China-listed and Hong Kong-listed, respectively, the firms' stock returns and the market returns were obtained from Wind (www.wind.com.cn). Those for US-listed firms were obtained from Wharton Research Data Services (WRDS, wrds-web.wharton.upenn.edu) and the Center for Research on Stock Prices (CRSP, www.crsp.com).

The second component of the dataset is detailed information about the individual firms obtained from annual reports. We carefully reviewed the annual reports of all firms in our sample for two years, 2011 and 2012.[20] For each firm we extracted: (1) the total value of assets, (2) the total number of employees (in addition, for US and Chinese firms, we also collected the total number of production employees), (3) the firms' total revenues, (4) the age of the firm, (5) the firm's leverage, (6) the firm's total export share defined as total export sales divided by total revenues, and (7) the firm's R&D expenditures.

Because we are interested in understanding how a firm's position along the production chain impacted its stock market returns, we also construct one additional variable, (8) product mix. The solar panel production process consists of six clearly-cut stages along a

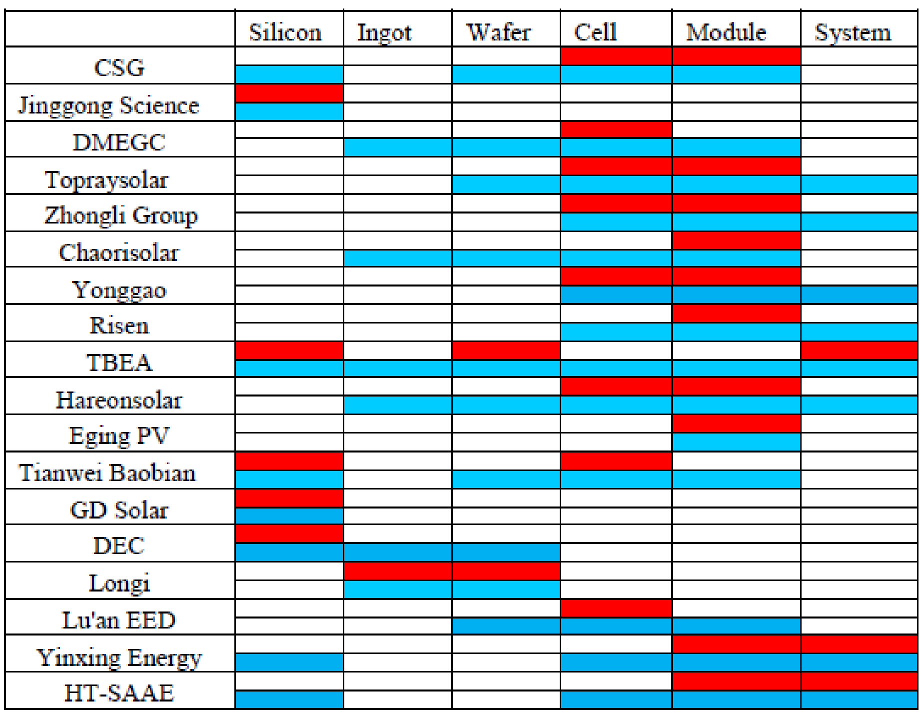
[19]The European Commission's antidumping case listed 218 entities producing solar panels in China. (See *Official Journal Commission (EU) Regulation No. 748/2013 of 2 August 2013.* 80 of these entities were subsidiaries of the 37 publicly-listed firms in our sample. See Appendix B for the list of subsidiaries.

[20]These annual reports covered all operation and financial information for the fiscal years 2011 and 2012.

value chain that correspond to six distinct products: silicon, ingot, wafer, photo voltaic cell, photo voltaic module and photo voltaic system. Along this chain, firms may be actively engaged in one or more stages. Figures 2, 3 and 4 summarize the value chain of each firm. These figures are constructed from information in the firms' annual reports and are supplemented, when necessary, with information from firms' websites. We use **main sales** to denote a firm's most important production stage(s) by sales volume and indicate these stages with red blocks in figures 2, 3 and 4 . If more than one stage have comparable sales volume shares, we record all of these stages as **main sales**. We also record **production line** activity with blue blocks in the figures if a firm reports that it engages in a stage in its annual report or website AND if the sales volume for that stage is not negligible. From the information in figures 2, 3 and 4, we construct the dummy variable which we will use in our empirical analysis: product mix. This variable is equal to one if a firm's main sales are in wafers, cells, or modules (WCM), the three products targeted by the European antidumping case.

Finally, we calculate the share of EU exports relative to the firm's total exports for each firm using the Chinese Customs Database.

Figure 2: Value chain, China-listed companies



A brief examination of figures 2, 3 and 4 reveals some basic patterns. First, most China-listed firms have their main sales in photo voltaic cells and modules with a significant share heavily engaged in silicon production. The scope of US-listed firms is similar to that of China-listed firms. However, US-listed firms tend to be most heavily involved in photo voltaic module production. Finally, firms listed in Hong Kong include both upstream and downstream production, with a large share involved in the production of photo voltaic systems.

Figure 3: Value chain, US-listed companies

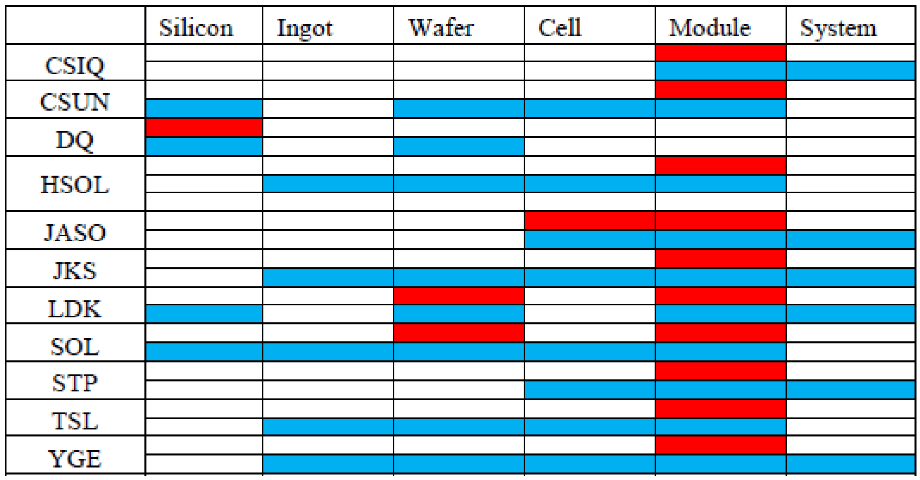
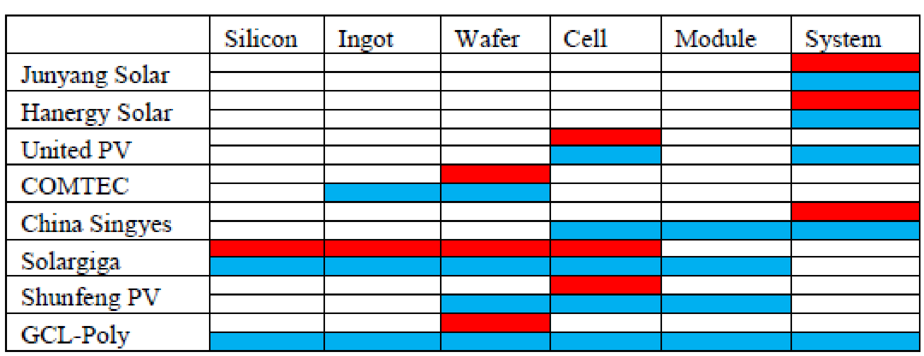


Table 3 summarizes some important characteristics of the firms in our sample. An examination of table 3 reveals some differences between firms listed in different markets. For example, US-listed companies are younger and smaller, by assets and revenues, than China-listed companies, but the US-listed firms are larger when measured by the total number of employees. In terms of leverage, the Hong Kong-listed companies are the most highly-leveraged, followed by the China-listed firms. Finally, US-listed firms are more export-dependent than firms listed in the Shanghai-Shenzhen market. As Hong Kong annual reports do not require the reporting of export sales, we cannot say anything about the export exposure of firms listed in Hong Kong. US-listed companies are less R&D intensive than China-listed companies, both in terms of R&D expenditures (reported) and R&D personnel (not reported).

Figure 4: Value chain, Hong Kong-listed companies



The third and final component of our dataset are the dates of the policy announcements

Table 3: Summary Statistics

Market	Statistics	Assets*	Emp.	Revenue*	Age	Leverage	Export Share	R&D Intensity
CN	mean	25	8170	9.8	14.2	0.589	.309	.0334
	sd	46	9747	15	6.31	0.172	.304	.0186
HK	mean	10	3018	3.7	9.25	0.504	.	.025
	sd	18	5046	6.2	5.86	0.225	.	.0277
US	mean	16	9680	7.9	8.5	0.770	.765	.0196
	sd	10	5903	4.9	3.25	0.139	.165	.0133
Total	mean	19	7475	7.9	11.4	0.622	.472	.0275
	sd	34	8200	11	6.05	0.201	.342	.0199

* in billions of Chinese renminbi

reported in the previous section. Information on the European Commission's antidumping case against Chinese solar panel producers was collected from publicly available reports in the *Official Journal of the European Union.*[21] Information on the Chinese government's announcements of its industrial policy programme was collected from various relevant Chinese governmental agencies.[22]

4 Empirical Methodology

We use the event study methodology to estimate the abnormal returns for Chinese solar panel firms that are listed in the Chinese, Hong Kong and the US stock exchange markets. According to the efficient markets hypothesis, equity market prices represent the net present value of future profits. Our analysis employs two different methodologies to estimate abnormal returns in response to a policy shock, a multivariate regression model (Binder (1985)) and an excess return model.

We begin our analysis with a multivariate regression of the returns of firm i on the relevant market return and a set of dummy variables surrounding the event date:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \sum_{s=t-2}^{t+4} \theta_{is} D_s + \epsilon_{it} \tag{1}$$

where R_{it} is the return on firm i's security , α_i is a firm-specific intercept, β_i is the systematic risk of firm i's security, R_{mt} the market return for the market in which the firm is listed, D_s denotes a series of seven 0-1 dummy variables for days surrounding the event date at $t = 0$, θ_{is} captures a firm's excess return on a given date, s, and ϵ_{it} is the error for security

[21] See Commission Regulations (EU) No 182/2013, No 513/2013, No 748/2013, No 1238/2013.

[22] A full list is available upon request.

i at t. The individual excess returns θ_{is}, are allowed to differ across firms i and date from two days prior to the policy announcement (to capture any leaking of information before the official announcement) until four days after the announcement. We estimate this model by least squares. These parameters identify how policy news materializes into stock prices over time.

Our second approach is to directly calculate the abnormal returns surrounding the event date by using a standard market model to construct the expected return on a given date. Firstly, we employ the market model to estimate how the return of firm i is related to the stock market return.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it} \tag{2}$$

where R_{it} is the return on firm i's security, α_i is a firm-specific intercept, β_i is the systematic risk of firm i's security, R_{mt} the market return for the market in which the firm is listed, and ϵ_{it} is the error for security i at t.

From this regression we obtain the expected or predicted return, $E(R_{it})$, of the individual firm i on date t. Then the abnormal return, AR_{it}, is calculated as the difference between the observed return, R_{it}, and the predicted return:

$$AR_{it} = R_{it} - E(R_{it}) \tag{3}$$

We refer to the excess return calculated from this method as the market model excess return. This abnormal return AR_{it} can also be interpreted as the difference between the return conditional on the event and expected return unconditional on the event, therefore it constitutes a direct measure of the (unexpected) change in a firm's value associated with the event. Adding up this abnormal return for individual days over a certain period of time, say from k days before the event through l days after the event, produces the cumulative abnormal return (CAR) for firm i during the event window $(-k, +l)$. The examination of the CAR is important as very often the effect of a news shock materializes around the date of the event, either because it takes time for the investors to absorb the news or there is some information leakage going on before the event.

$$CAR_i = \sum_{t=-k}^{+l} AR_{it} \tag{4}$$

After estimating abnormal returns for individual firms in response to the six policy events, we calculate the cumulative average abnormal return (CAAR) across different sets of firms in our sample. By creating subsets of the firms in our sample according to observable features (market in which the firm is listed, state-owned enterprise, etc.), we can begin to develop a picture of the salient firm characteristics that underlie the cross-sectional heterogeneity in excess returns. This is a useful analysis in addition to examining the CARs because it helps us get a sense of the average abnormal return across firms, i.e., whether the event is, on average, associated with an increase or decrease in firms' values over time window T.

$$CAAR_T = \frac{1}{N}\sum_{i=1}^{N} CAR_{iT} \tag{5}$$

The final step in our analysis is to estimate a cross-sectional model that relates excess returns to firm characteristics. The reason that abnormal returns vary cross-sectionally is that the economic effect of the events differs by firms. Such cross-sectional analyses are relevant even when the mean stock price effect of an event is zero (Kothari and Warner (2007)). Our estimating equation is:

$$CAR_i = \gamma + \mathbf{x_i'}\boldsymbol{\Omega} + \nu_\mathbf{i} \tag{6}$$

where γ is the intercept, $\mathbf{x_i'}$ is a vector of explanatory variables, Ω is a vector of estimated parameters, and ν_i is a normally distributed error term. Explanatory variables included in the model include export share, the natural log of labor productivity, operating costs per unit of revenue, and firm size. Firm-level models of international trade like Melitz (2003) imply the gains to trade liberalizations are largest for the most productive firms and the loss of market access are most costly for the most productive firms. In extensions to the model we add a firm's leverage, i.e., the use of debt in a firm's capital structure, as a proxy for the financial costs or financial fragility; a measure of R&D intensity; value chain position, dummies for ownership type, and an instrumented variable for the market in which a firm is listed.

5 Estimation Results

In this section, we report the estimates of abnormal returns from both the multivariate regression and market models. We then present cumulative average abnormal returns for different groups of firms in our sample. Finally, we report results on the cross-sectional determinants of excess returns.

5.1 First-stage estimation of abnormal returns

In this section, we describe our findings about the excess returns to Chinese firms in response to various events. Overall, we note that most firms earned negative excess returns when the European Union announced that it would impose temporary import duties on Chinese solar panels on 4 June 2013. There is a high degree of heterogeneity in the excess returns to the other five events studied. Below, we discuss the results in detail.

In table 4, we report the parameter estimates of the multivariate regression model of excess returns, by day around the event date, for each of the six policy announcements we analyze. We experimented with the length of the estimation window based on characteristics of the policy process but found similar results. In table 4, the reported parameters, θ_s are the average value of the θ_{is}'s over all the firms in our sample. Figure 8 reports the CARs for each firm from the multivariate model over a 7 day event window.

We also calculated CARs from the market model using an estimation window from 27 days before the event to 5 days before the event.[23] The estimated CARs from the market model over a 7-day (-2,+4) window are reported in figure 9.

To illustrate the main findings regarding the policy events, in figures 5, 6, and 7 we display the evolution of the CARs from the market model over the seven day event windows averaged over different groups of firms in our sample. In each figure the CAR is normalized to zero at date t=-2. Each figure displays six panels that correspond to the six different policy shocks. By constructing these figures for different subsets of our sample according to observable firm characteristics, we can identify important firm-level features that are associated with positive and negative excess returns. In section 5.3 we will more formally analyze these differences by firm characteristics.

Table 4: Multivariate Regression (MVRM) Event Study Results, All firms

	(1)	(2)	(3)	(4)	(5)	(6)
	Petition	Preliminary	Dev.Guideline	Amendment	Subsidy	Final
θ_{t-2}	-0.0105**	-0.0320***	0.00685	0.0122**	-0.00611	-0.00109
	(0.049)	(0.002)	(0.352)	(0.050)	(0.304)	(0.853)
θ_{t-1}	-0.00706	-0.0256**	-0.00406	-0.00367	-0.00421	-0.0106*
	(0.206)	(0.012)	(0.549)	(0.599)	(0.477)	(0.072)
θ_t	-0.0111**	0.000514	0.0555***	0.0114*	0.00630	-0.0257***
	(0.034)	(0.960)	(0.000)	(0.068)	(0.286)	(0.000)
θ_{t+1}	-0.00740	-0.0263***	0.0242***	0.0264***	0.0208***	0.000525
	(0.159)	(0.010)	(0.000)	(0.000)	(0.001)	(0.929)
θ_{t+2}	-0.00201	-0.0229**	-0.0241***	0.0107*	0.00579	0.0139**
	(0.703)	(0.024)	(0.000)	(0.083)	(0.357)	(0.018)
θ_{t+3}	-0.00663	-0.0234**	-0.00449	0.00475	0.00705	-0.0108*
	(0.222)	(0.021)	(0.497)	(0.337)	(0.233)	(0.067)
θ_{t+4}	-0.0420***	0.0416***	-0.0185***	0.00743	0.00485	-0.0238***
	(0.000)	(0.000)	(0.006)	(0.132)	(0.413)	(0.000)
N	851	850	850	835	843	851

p-values in parentheses,* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Beginning with figure 5, we examine the evolution of the average CAR over the seven day

[23] For two events, the amendment and subsidy announcements, the proximity of the announcement dates necessitated shorter estimation windows of 11 to 2 days before the event and 12 to 2 days before the event, respectively. As a robustness exercise, we also estimated CARs using the longest feasible estimation windows for the policy process. We took 90 days before an event to be the longest possible window and then, when policy announcements were made within a narrow time window, we shortened the estimation window to disentangle the effect of compounding events. More specifically, we choose 90 days before the event through 5 days before the event for the filing of the petition and the preliminary decision and 80 days before the event through 5 days before the event for the final decision.

event window. Each panel corresponds to one of the six policy events, with time measured in days from the policy announcement date of zero along the x-axis and the cumulative abnormal return on the y-axis. In each panel, the dashed line is the average CAR over the 31 private sector firms and the solid line is the average CAR over the six state owned enterprises (SOEs) in our dataset. The light dotted lines depict the 95% confidence intervals around each average CAR. Beginning with the left-most panel in the top row, we note that the average impact of the filing of the antidumping petition was more negative for private sector firms than for China's state owned enterprises. On average, this policy announcement was associated with differences by ownership, but the average for different groups of firms was not large. More interestingly, in the third panel of the top row and the middle panel of the bottom row, we see that the announcement of the Development Guideline and the Chinese government's subsidy plan for solar power generation both had average positive impacts on private sector firms in China, but virtually no impact on SOEs. Further, the average effect of the amendment to the provisional tariff order, i.e., the establishment of the price floor and quota system, was zero. Lastly, in the bottom right, announcement of the final decision to permanently implement a price floor and quota system, with the Chinese firms allocated a 70% market share in the EU, was clearly negative for private sector firms, but had no impact on the SOEs.

Turning to figure 6, we consider whether the differential impact of the policy announcements on average CARs is related to the firm's value chain position. As before, each panel represents the average CAR to a policy announcement. In this figure, the solid line denotes the average across firms that have their main line of business is solar wafers, cells or modules while the dashed line denotes firms at the other two extremes of the value chain - primary inputs and solar power generating systems. The main takeaway from this figure is that firms engaged in wafer, cell or module production experience more negative abnormal returns in response to European policy announcements like the initiation of the petition and the final imposition of the price floor and quota than other firms. These same producers also respond most positively to the Chinese industrial policy announcements.

Differential responses by the stock market in which a firm is listed are displayed in figure 7. In this figure, the solid line represents the average CAR across firms listed in Chinese stock markets, the dark dashed line is the average CAR across firms listed in US markets, and the lighter dashed line indicates the average CAR over firms listed on the Hong Kong Stock Exchange. Large differences in the average CAR between US-listed and Chinese-listed firms are evident in response to the filing of the antidumping petition with European Commission, in response to the announcement of the Chinese Development Guideline, in response to the EC's amendment to its preliminary tariff establishing a price floor and quota, and in response to the announcement of the subsidy program.[24]

[24] We acknowledge that one possible explanation for the difference in average responses between the Chinese and the US or Hong Kong stock markets could be that the Chinese market is less efficient at processing new information into stock prices (perhaps because the share of sophisticated market participants is substantially

While the previous figures have given us a broad picture of the evolution of abnormal returns, they obscure the interesting cross-sectional heterogeneity in firm responses. In figure 8, we present the firms' individual CARs over the seven day event window based on the multivariate regression model. Similarly, figure 9 displays firms' CARs derived from the market model (i.e., realized less predicted return from the market model). The abnormal returns presented in these two figures are those which we will examine further in section 5.3.

To read figure 8, note that each panel represents one of the six policy announcements. The vertical axis measures the 7 day cumulative abnormal return of a firm with each bar along the x-axis corresponding to a firm; bars 1-18 represent China-listed firms, bars 19-29 represent US-listed firms and bars 30-37 represent firms listed in Hong Kong. See appendix A for the correspondence between bar numbers and a firm's name. Clearly we see the policy news has heterogeneous impacts on these firms. For US-listed firms, the effects of the various EU policy announcements (petition, preliminary, amendment, and final) are

lower). If this is correct, the use of the efficient market model might not be appropriate. However, in figures 8 and 9, where we report the CARs of individual firms, the fact that many China-listed firms share the same qualitative pattern of response to policy announcement shocks, even if the magnitude is smaller, leads us to believe that the use of the efficient markets model in this context is justified.

Figure 5: Average CAR during the event window for State Owned Enterprises (SOE) and private sector firms

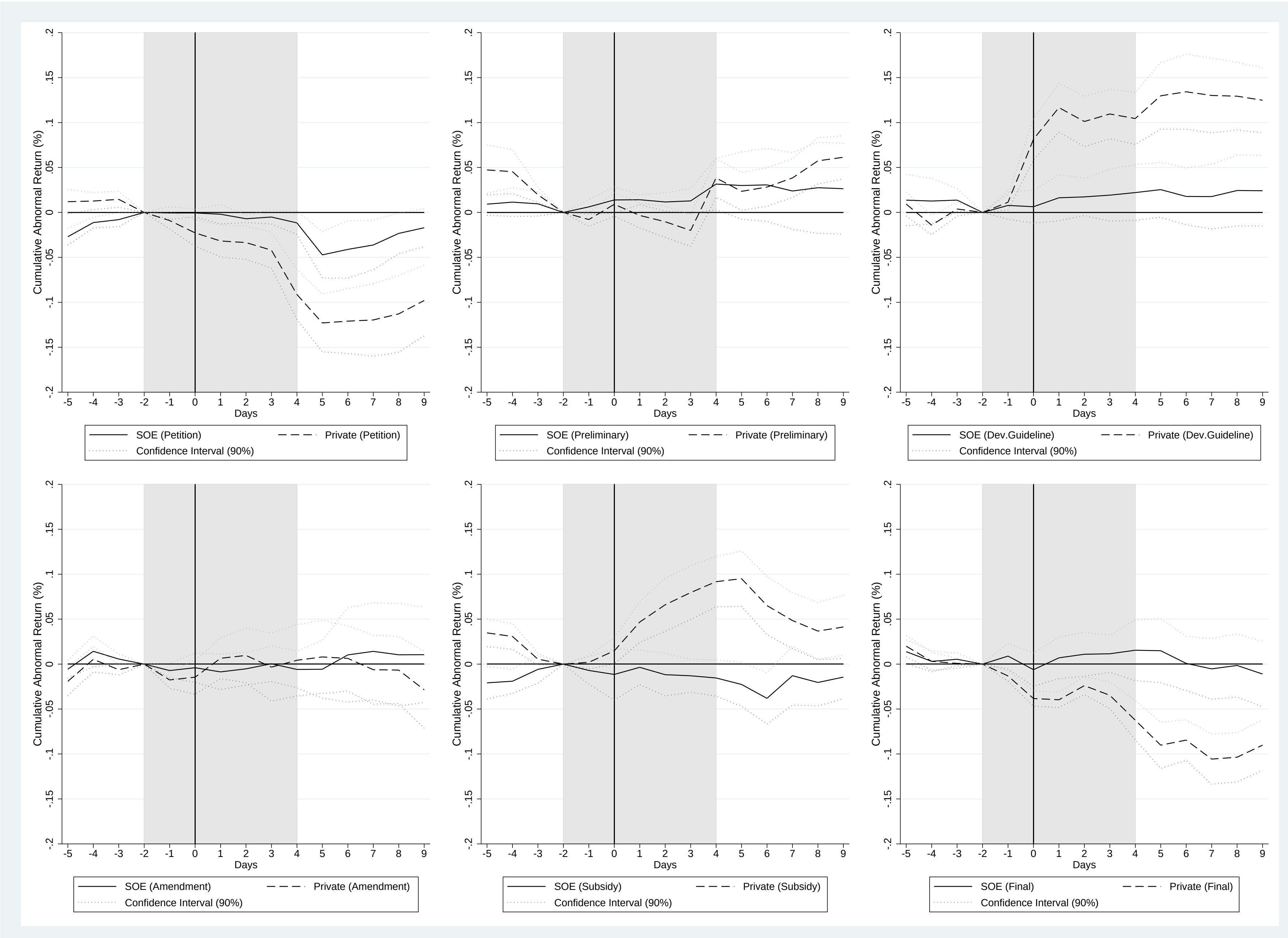


Figure 6: Average CAR during the event window for wafer-cell-module (WCM) and non-WCM firms firms

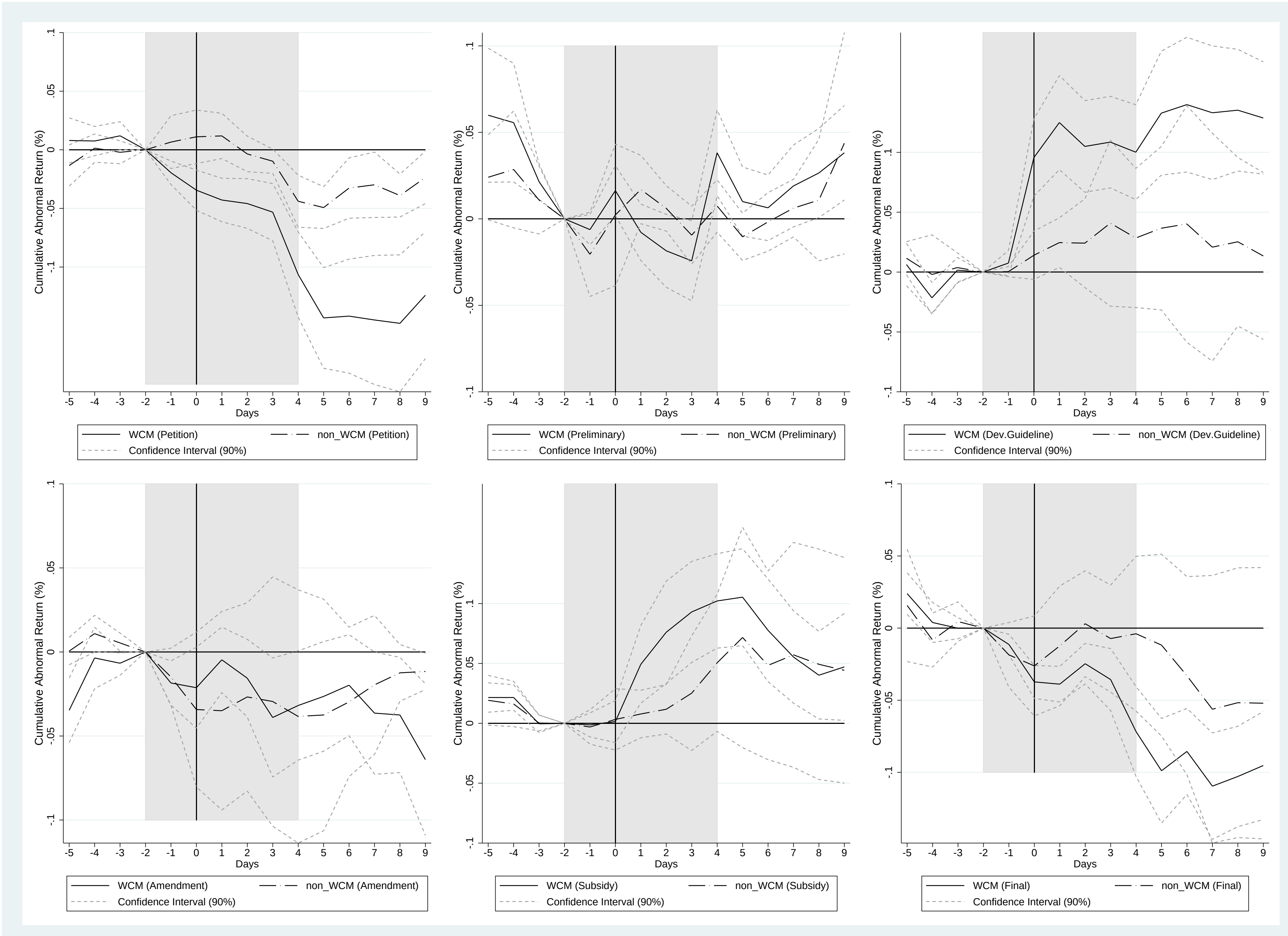
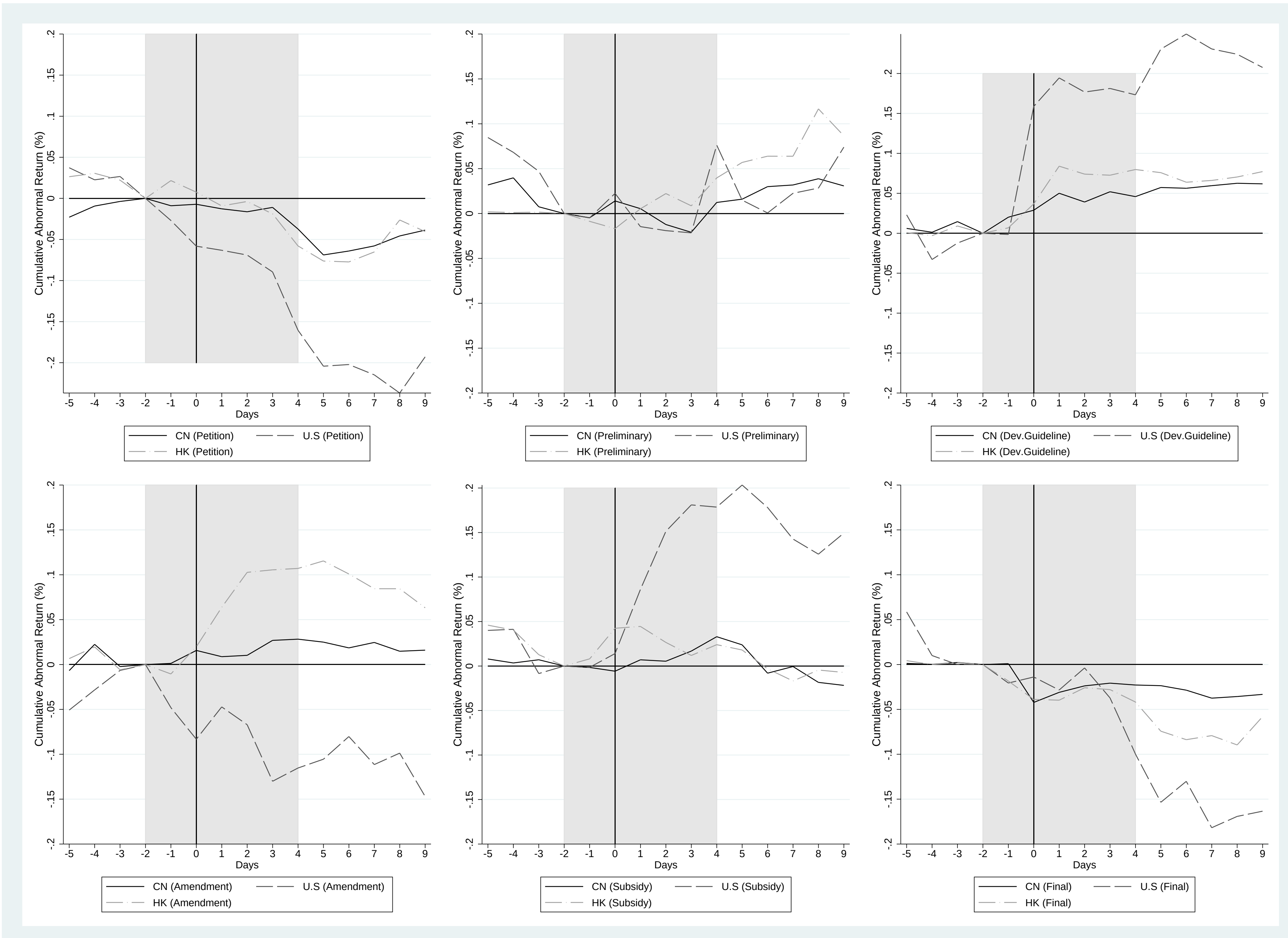


Figure 7: Average CAR for firms listed on the Chinese (CN), United States (US), and Hong Kong (HK) stock markets



overwhelmingly negative. In contrast, for the China-listed firms, the EU policy shocks come with mixed effects; they are positive or negative, depending on the firm.

Consider the firm-level responses to each event by considering each event in turn. Beginning with the panel labeled "Petition," the left-most panel in the top row, we see that of the 18 China-listed firms, all but four experienced negative CARs when Solar AG filed its complaint with the European Commission. The impact of this policy announcement was negative but modest in size; the cumulative negative abnormal return for most China-listed firms was less than 10%. In contrast, the US-listed firms experienced sizable negative CARs; three firms lost 40% or more of their value after the announcement. The Hong Kong-listed firms had mixed results, most experienced moderate negative returns, but two has positive abnormal returns. Negative abnormal returns to the petition seem quite natural as this raised the probability of a future European trade restriction.

Moving across the top row of figure 8, the middle panel, "Preliminary," depicts the almost universally negative CARs arising in response to the EC decision to impose provisional import duties. Investors clearly perceived this as a sharp blow to the future profitability of solar panel manufacturers in China. Firms listed in the US markets (bars 19-29) were hardest hit, with losses of 20-40% fairly typical. The impact on firms listed in China (bars 1-18) was the more muted, with negative CARs in the 10-20% range, although several firms had no losses or small positive returns. The impact on Hong Kong-listed firms was mixed.

Continuing across the top row of figure 8, the right most panel documents the considerable heterogeneity in responses across firms to the Chinese government's announcement of its *Development Guideline*. The *Guideline* had three main components: 1. a radical expansion of production capacity that would be restricted to those firms whose existing operations could satisfy government efficiency requirements, 2. a restructuring of the industry in China toward fewer firms, and 3. technological improvement through university collaborations. Thus, with the inherent threat that weaker, less productive firms might be shut down or merged into stronger rivals, we hypothesize that the heterogeneous returns are linked to a firm's underlying production efficiency.

In the bottom row, "Amendment" shows that US-listed firms were hardest hit by the ECs decision to amend the temporary import duties from an 11% ad valorem duty to a price floor and import quota system. Many US-listed firms experienced a negative abnormal return greater than 20%. In contrast, the Chinese and Hong Kong listed firms experienced almost no change in value (with one Hong Kong firm experiencing a large positive abnormal return). One possible explanation is that market participants believed that the allocation of firm-specific export quotas to Europe by the Chinese Chamber of Commerce would favour firms listed in China over those listed in the U.S. These negative excess returns are somewhat surprising when compared to another famous voluntary initiative to restrict exports - the US Auto VER. In that case, announcement of the VER led to substantial *increases* in the stock market value of Japanese firms subject to the import restrictions. The middle panel in the bottom row displays CARs in response to the announcement of the subsidy to distributed generators (households or firms in China that installed rooftop solar panels). The largest beneficiaries of this policy to stimulate consumer demand in China were firms listed in the US. Among firms listed in China and Hong Kong, the results were mixed, with some experiencing small positive returns while other experienced negative returns.

Lastly, the bottom right panel of figure 8 presents the CARs in response to the final decision by the European Commission that resulted in a long-term price undertaking. There is a high degree of heterogeneity in excess returns across firms. Although the final ruling was essentially a confirmation of the amendment, it expanded the list of firms entitled to participate in the negotiated price undertaking. As with the amendment to the provisional tariff, the hardest hit firms were those listed in the US. Some firms listed in China experienced sizable losses, but many experienced little or no change in value. In section 5.3 we examine the determinants of this cross-sectional heterogeneity in abnormal returns. Again, the sharply negative return across a large number of firms is in sharp contrast to the experience of Japanese automakers at the time of the US Auto VER.

We next calculate the abnormal return for individual firms using the expected return derived from the estimated market model (2). Figure 9 presents CARs over the seven day event window, but calculates the abnormal return as the difference between the actual return and the return predicted by the market model. The results are qualitatively and quantitatively similar to those of the multivariate model.

5.2 Cumulative Average Abnormal Returns

The next set of results summarizes the average effect of each of the policy announcements over a seven day window for different subsamples of our data. Table 5 shows the estimation results on CAAR across markets and across different groups of firms within the same market. Each row presents the average of the CAR from the market model over a seven day event window for the sample described in the row. In the first row, we calculate the CAAR for the full sample of 37 firms. We can see that the petition by SolarWorld AG (column 1), the preliminary decision to impose provisional import duties (column 2) and the EC's final decision to impose a permanent price undertaking (column 6) all resulted in negative abnormal returns for Chinese firms. Given that each of these events was associated with restricting access to the firms' largest market, the results are as expected. The two initiatives by the Chinese government to stimulate domestic Chinese demand for solar panels, the announcement of the Development Guideline (column 3) and the subsidy program (column 5) resulted in an increase in abnormal returns.

Figure 8: Estimated CARs over the 7 Day Event Window using the MVRM parameters

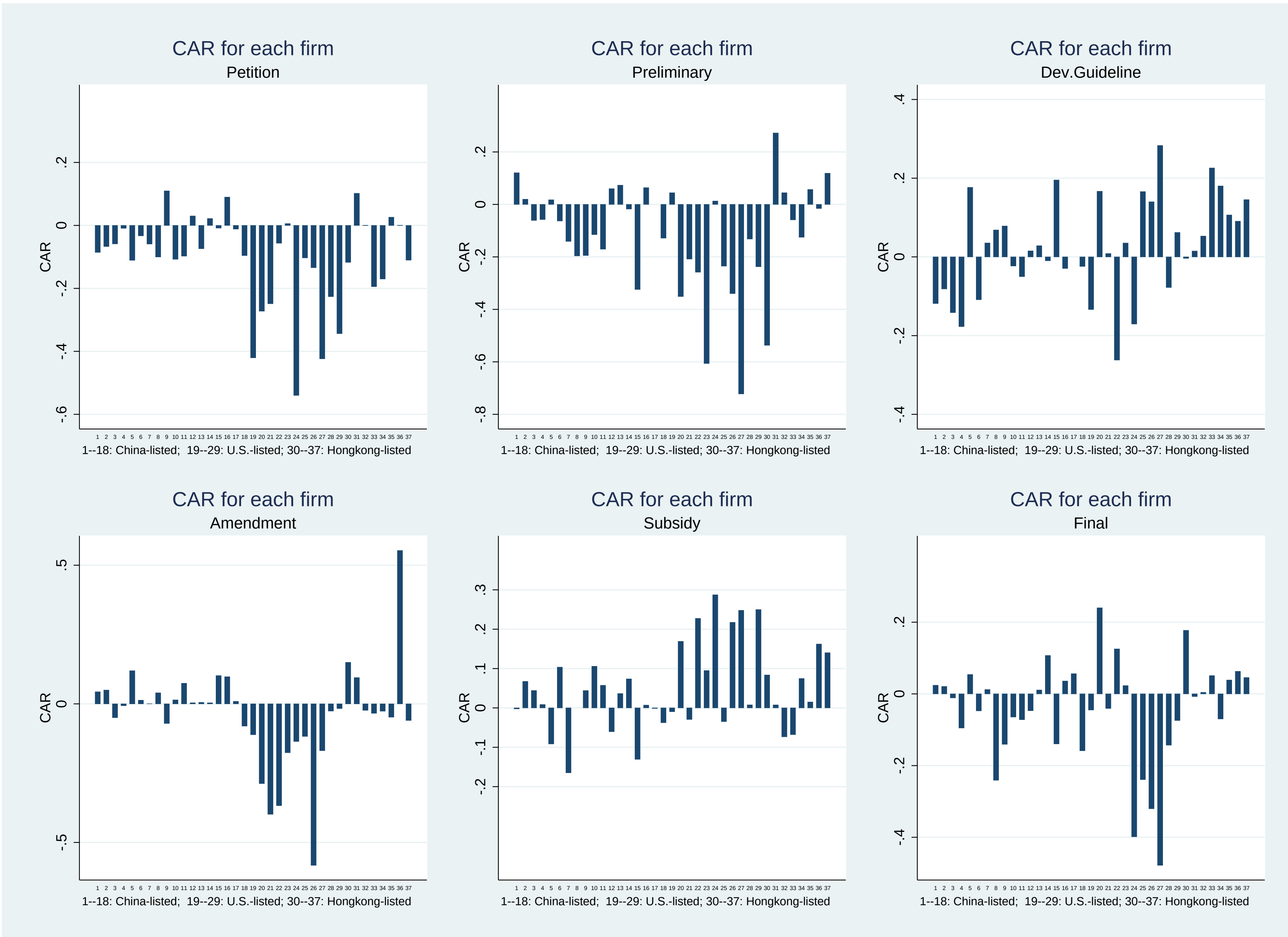


Figure 9: Estimated CARs over the 7 Day Event Window using the market model

Table 5: CAAR for Events, by subsamples of firms

	(1) Petition	(2) Prelim.	(3) DevGuide	(4) Amend.	(5) Subsidy	(6) Final
Whole	-0.0676***	-0.0560***	0.0421***	-0.0148	0.0388***	-0.0313**
(37 firms)	(-3.34)	(-3.45)	(3.39)	(-0.60)	(3.22)	(-2.20)
China	0.00470	-0.0604***	0.0173	0.0331*	0.0266*	-0.0103
(18 firms)	(0.27)	(-3.18)	(1.28)	(1.97)	(1.95)	(-0.76)
U.S	-0.201***	-0.0787***	0.0793**	-0.171***	0.0590*	-0.0627
(11 firms)	(-5.93)	(-3.23)	(2.85)	(-4.70)	(1.98)	(-1.51)
HongKong	-0.0466*	-0.0148	0.0465	0.0928	0.0384	-0.0353***
(8 firms)	(-2.06)	(-0.28)	(1.81)	(1.69)	(1.63)	(-3.62)
SOE	0.0285	-0.0102	0.0232	-0.00158	-0.0111	0.0234
(6 firms)	(1.24)	(-0.41)	(1.70)	(-0.10)	(-0.48)	(1.18)
Private	-0.0862***	-0.0648***	0.0457***	-0.0173	0.0484***	-0.0419**
(31 firms)	(-3.87)	(-3.51)	(3.14)	(-0.59)	(3.71)	(-2.63)
WCM	-0.109***	-0.0643***	0.0493**	-0.0276	0.0458***	-0.0390*
(24 firms)	(-4.25)	(-3.77)	(2.75)	(-0.78)	(2.88)	(-1.97)
non-WCM	0.00853	-0.0406	0.0288**	0.00891	0.0259	-0.0171
(13 firms)	(0.41)	(-1.18)	(2.33)	(0.34)	(1.45)	(-0.98)

t statistics in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The next three rows compare the cumulative average abnormal returns across three groups: firms listed in China, firms listed in the US, and firms listed in Hong Kong. Taking the cumulative average abnormal return over only those firms that are listed on Chinese stock markets, two things are notable. First, many events are not associated with a sizable average abnormal return. Second, the impact of the preliminary decision to impose provisional duties is negative and significant. Moving down to examine Chinese firms listed on US markets, we see that the magnitudes of the negative abnormal return in response to market access restrictions are large and statistically significant. Conversely, the US-listed firms respond very positively to the good news of policy initiatives to stimulate Chinese domestic demand. Finally, the next row shows that firms whose stock trades on the Hong Kong market lost value in response to the petition-filing and the final decision by the EU to restrict Chinese imports with a price undertaking.

The next block of rows compares the cumulative average abnormal returns of state owned enterprises with those of private sector firms. Overall, we see that SOEs do not respond to any of the news about demand for solar panels whereas private sector firms listed in China, the US and Hong Kong have the response one would expect of firms that see demand for their product contract or expand under various policy initiatives.

Lastly, the final two rows present the cumulative average abnormal returns by a firm's position on the solar panel value chain. Firms that produce wafers, cells, or modules experienced negative returns in response to policies that restricted EU market access and positive returns in response to the Chinese policies intended to stimulate demand. In contrast, the non-WCM firms that make primary inputs into solar panels or that use solar panels as part of a power-generating system had almost no response to the EU import restriction. The one exception is a small positive response to the *Development Guideline*.

5.3 Second-stage analysis: explaining the variation in CARs

In this section, we present formal statistical analysis of the cross sectional determinants of the abnormal returns associated with the six policy events we study. Tables 6 through 9 use the abnormal returns of the multivariate market model over a seven day event window as the dependent variable. In tables 10 through 12, we use the abnormal returns from the market model to examine some alternative predictions of the Melitz model. In using the CARs from the market model, we seek to demonstrate the robustness of our results to different measures of abnormal returns.

In table 6 we consider the most direct prediction of the Melitz model: firms with higher export shares will experience a larger proportional drop in expected future profits in response to an increase in the import tariff. We find broad support for the model's predictions in our estimates. Column (1) reports the abnormal returns associated with the announcement of the antidumping case. This event raised the likelihood of a future trade restriction; under the Melitz model, the greatest proportionate profit losses of a trade restriction accrue to the firms with the highest export share. We find empirical support for this prediction in the parameter of -0.225 which indicates that an increase in export share of 10 percentage points is associated with a decline in abnormal returns of 2.25%.

Turning to column (2), a preliminary import tariff of 11.8% implies larger future losses for firms with larger export shares under the Melitz model. Again, we find empirical support for the model in the parameter estimate of -0.182. The response to the development plan, which represented an outward shift in domestic demand, was predicted to be positive. However, the effect in column (3) is negative and not statistically different from zero.

In column (4), we report the response to the EU's announcement of the price-floor and quota system for some firms and punitive import tariffs for others. Recall from figures 8 and 9 that this event was associated with considerable cross-sectional heterogeneity with 7 day excess returns ranging from + 50% to -50%. Note also that those firms with the highest expected future export sales had the most to lose from a quota system that would inhibit future sales growth in Europe. The estimated parameter of -0.223 indicates that for every 10 percentage point increase in export share, the announcement reduced the firm's abnormal return by 2.2%. One interpretation is that, prior to the AD case, market participants viewed the most export-oriented firms as having the highest growth potential in Europe. The advent of the price floor and quota system locked these export-oriented firms into slower-than-anticipated growth and undermined their ability to compete on price against other Chinese manufacturers. In column (5) the announcement of the domestic subsidy to solar panel electricity generation was expected to increase abnormal returns for all solar producers. We see that a 10 percentage point increase in export share was associated with a 1.6% in a firm's abnormal return. Lastly, column (6) reports the impact of the final price undertaking agreement is negative, as predicted, but imprecisely estimated. In summary, the trade policy events examined in table 6 provide broad support for the predictions of the Melitz model. However, as firms in Hong Kong are not required to report their export sales, this analysis is limited to China and US-listed firms.

Table 6: CAR from MVRM for US and China-listed firms by export share

	(1) Petition	(2) Prelim	(3) Dev.Plan	(4) Amend	(5) Subsidy	(6) Final
Export share	-0.225***	-0.182*	-0.0848	-0.223**	0.162**	-0.0525
	(0.0696)	(0.102)	(0.0776)	(0.0896)	(0.0662)	(0.0910)
Constant	-0.00784	-0.0458	0.0293	0.0389	-0.0227	-0.0370
	(0.0433)	(0.0546)	(0.0417)	(0.0481)	(0.0355)	(0.0488)
Observations	27	26	26	26	26	26
R-squared	0.295	0.118	0.0474	0.206	0.199	0.0137

Notes: Standard error in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: CAR from MVRM for all firms by EU share in total exports

	(1) Petition	(2) Prelim	(3) Dev.Plan	(4) Amend	(5) Subsidy	(6) Final
EU share of total exports	-0.103*	0.0305	-0.0618	-0.0660	-0.0143	0.00128
	(0.0569)	(0.0534)	(0.0435)	(0.0926)	(0.0488)	(0.0512)
Constant	-0.0225	-0.0682**	0.0765***	-0.00918	-0.0368	-0.0325
	(0.0390)	(0.0324)	(0.0264)	(0.0562)	(0.0296)	(0.0311)
Observations	31	30	30	30	30	30
R-squared	0.102	0.012	0.067	0.018	0.003	0.000

Notes: Standard error in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7 uses an alternative datasource, the Chinese Customs Database, to analyse the relationship between abnormal returns and the importance of the EU for each firm's total exports. The Chinese Customs Database provides detailed information about exports by destination for 31 firms in our sample. The main impact is observed at the petition stage – an increase in the EU's share in the firm's total exports is associated with a decline in the firm's abnormal return of 1.03%.

In table 8, we examine the relationship between excess returns at the time of both EU and Chinese policy changes and the firm's underlying labour productivity. The Melitz model predicts that firms with higher productivity will earn higher profits which implies that the return of a more productive firm is higher (all else equal). Further, firms with the highest productivity have the highest export shares. A change in trade policy that reduces Chinese firms' market access in Europe would tend to imply a larger decline in the return (i.e., a more negative excess return) for the firms with the highest productivities (i.e., those with the largest shares of their profits deriving from export revenue). Table 6 found that firm's with larger export shares experienced larger declines in their abnormal returns when the EU imposed import restrictions. In the next set of estimates, we directly examine the relationship between excess stock market returns and labour productivity.

Beginning with column (1), we expected that firms with higher productivity would have higher export shares and thus, more negative returns in response to a foreign import tariff. In fact, we observe that a one percent increase in labour productivity is associated with a one percent increase in stock market returns. That is, while almost all firms had negative returns, those with the highest labour productivity had the least negative returns. One possible explanation could be this reflects quality differences in the products coming from different firms – if firms with higher productivity were also producing higher quality output, that might have sheltered their returns somewhat from the EU's policy action. [25].

However, in column (2), we find results more in line with a standard Melitz model – the firms with higher labour productivity experienced more negative abnormal returns in response to the announcement of a preliminary antidumping duty. Column 5 displays that a 10% increase in the productivity of production workers was associated with a significant 4.4% increase in the abnormal return following the announcement of the Chinese government's domestic subsidy program designed to stimulate demand for Chinese solar panels.

Table 8: CAR from MVRM for all Chinese firms by labour productivity

	(1)	(2)	(3)	(4)	(5)	(6)
	Petition	Prelim	Dev.Plan	Amend	Subsidy	Final
Ln labor productivity$_{t-1}$	0.0105*	-0.0517***	0.0186	0.0342	0.0443*	0.0221
	(0.00509)	(0.0173)	(0.0212)	(0.0379)	(0.0234)	(0.0255)
Ln labor prod'y$_{t-1}$*SOE	0.00425	0.00662***	-0.00190	0.00654	0.00215	0.00413
	(0.00340)	(0.00212)	(0.00260)	(0.00465)	(0.00288)	(0.00314)
Constant	-0.182***	0.649**	-0.221	-0.590	-0.679*	-0.359
	(0.0598)	(0.246)	(0.301)	(0.539)	(0.333)	(0.363)
Observations	24	27	27	27	27	27
R-squared	0.282	0.386	0.042	0.130	0.175	0.118

Notes: Standard error in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[25]We thank Eiichi Tomiura for suggesting this interpretation to us

Table 9 provides an alternative measure of labour productivity – revenue per scientific or technical worker. Results are not entirely robust relative to table 8, but the signs of statistically significant coefficients are consistent with the Melitz model. Turning to columns (3), the observed positive effect on the excess return of having more effective technical workers is consistent with what we would expect from a development plan that was designed to stimulate demand for solar panels. Column (4) indicates that the amendment ot the EU's restriction on solar panels from China has a more negative effect on firms with more productive technical workers. This is exactly what one would expect from the Melitz model.

Table 9: CAR from MVRM for all Chinese firms by productivity of technical workers

	(1) Petition	(2) Prelim	(3) Dev.Plan	(4) Amend	(5) Subsidy	(6) Final
Ln labor productivity$_{t-1}$	0.0102	-0.0230	0.0451***	-0.0887***	-0.0115	-0.00420
	(0.00623)	(0.0166)	(0.0159)	(0.0273)	(0.0214)	(0.0222)
Ln labor prod'y$_{t-1}$*SOE	0.00628*	0.00304	0.00184	0.00127	0.00194	0.00451
	(0.00340)	(0.00260)	(0.00248)	(0.00428)	(0.00334)	(0.00347)
Constant	-0.205**	0.300	-0.712**	1.384***	0.143	0.0240
	(0.0865)	(0.279)	(0.267)	(0.460)	(0.359)	(0.372)
Observations	23	26	26	26	26	26
R-squared	0.270	0.198	0.266	0.377	0.045	0.093

Notes: Standard error in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In table 10 we consider the impact on the abnormal returns at the petition stage, but we use the market model's CAR in lieu of the multivariate market model's CAR along with additional control variables. We focus on the abnormal returns associated with the filing of the petition because this first event likely had the greatest new information content of the six policy announcements and allowed for the use of the longest pre-event estimation window. In addition to the productivity of production workers, we add a control for leverage as a proxy for the firm's financing costs and financial fragility and find that abnormal returns were lower for more highly levered firms. Column (2) examines the special status of state owned enterprises. We see that after controlling for firm-level productivity, being a state owned enterprise is associated with approximately a 18.6% increase in the firm's abnormal returns. This is an economically meaningful difference and indicates that markets do not see state owned enterprises as subject to the same market forces that impact private market firms. This is also strong statistical support for the observations we made about figure 5.

In column (3) we return to the observation first made about figure 7. US-listed firms seemed to experience more negative abnormal returns in response to the announcement of the European antidumping case. We would like to examine the impact of stock market on abnormal returns, but the choice of the market in which a firm lists is endogenous. Thus, we take an instrumental variables approach. Our instrument is the educational history of the firm's founder, CEO, and chairman of the firm's board. We search company reports

Table 10: CAR of Petition Filing for all Chinese firms

	(1)	(2)	(3)	(4)
	Petition	Petition	Petition	Petition
Ln labor productivity	0.0427	0.0281	-0.0310	0.0189
	(0.0344)	(0.0275)	(0.0327)	(0.0283)
Leverage	-0.387**	-0.491***	-0.000425	-0.443***
	(0.157)	(0.127)	(0.159)	(0.126)
Stated Owned Firm		0.186***		
		(0.0475)		
US listed Firm IV			-0.244***	
			(0.0726)	
Product Mix				-0.173***
				(0.0456)
Constant	-0.455	-0.222	0.460	0.0499
	(0.465)	(0.373)	(0.426)	(0.395)
Observations	27	27	27	27
R-squared	0.205	0.524	0.556	0.512
First stage F-test			12.09	

Notes: Standard error in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

and the firm's webpage to learn if each of these three leaders of the firm has a degree from a university in North America, Western Europe or Australia. We then use this information to construct the variable *foreign education* which is equal to one if any of these three leaders of the firm holds a foreign degree. In column (3) we report the second stage of a 2 stage least squares model in which foreign education instruments for whether or not a firm is publicly listed on a US market. We find that listing in the US has a significant negative impact on the firm's return. Listing in the US is associated with a 24% decline in a firm's stock market return in response to the filing of the European antidumping case. The first-stage F-test of 12.09 suggests that education is a modestly strong instrument for the market in which the firm lists.[26] Finally, in column (4) we include a dummy variable called *product mix* which is equal to one if the firm's main line of sales is in wafers, cells or modules. As expected, firms that concentrate their activity in these products earned significantly greater losses.

We further explore the abnormal returns of state owned enterprises in table 11. Earlier, figure 5 demonstrated that private-sector firms earned lower abnormal returns than state owned enterprises in response to the filing of the petition and the European Commission's final decision in the antidumping case. On a more positive note, private market firms earned higher abnormal returns than SOEs in response to the announcement of the *Development Guideline* and the subsidy to electricity generators. In table 11 we formally measure the magnitude of the SOE-effect. At the same time, we consider an alternative variable implied by the Melitz model, firm size, which we measure as the log of total employment. In the Melitz model, firm size is positively correlated with productivity and export sales. Thus, larger firms are expected to earn more negative abnormal returns in response to a trade restriction.

In column (1), we observe that a 1% increase in firm employment is associated with a 2.9% decrease in abnormal returns, while being a state owned enterprise is associated with a 13.9% increase in excess returns. These findings support the Melitz model's predictions that the largest firms lose the most from a foreign trade restriction. Evidence from column (2) is consistent with column (1), but not statistically significant. In column (3), the imprecision of the estimated parameters prevents us from drawing conclusions.

Column (4) indicates that larger firms lost more from the European price undertaking. In column (5) we note that, consistent with figure 5, the abnormal returns earned by private sector firms to the subsidy announcement were 6.3% higher than those of SOEs. In column (6) we observe that, again consistent with figure 5, private sector firms earned abnormal returns 7.5% lower than SOEs at the time of the EU's final antidumping decision.

The last set of results presented in table 12 analyze the impact of abnormal returns

[26] Our inherent assumption behind the use of foreign education as an instrument for market listing is that foreign education has no direct effect on the firm's excess return, but merely increases the CEOs knowledge of foreign market institutions and practices, making foreign listing an easily to implement decision. If foreign education directly impacts productivity and the firm's returns, then the exclusion restriction would not be satisfied and foreign education would not be a valid instrument.

Table 11: CAR for all Chinese firms by size and firm type

	(1) Petition	(2) Prelim	(3) Dev.Plan	(4) Amend	(5) Subsidy	(6) Final
State Owned Firm	0.139**	0.0585	-0.0212	0.0742	-0.0635*	0.0758**
	(0.0516)	(0.0449)	(0.0330)	(0.0680)	(0.0327)	(0.0372)
Ln employment	-0.0290*	-0.00935	0.00524	-0.0354*	0.00733	-0.00569
	(0.0148)	(0.0124)	(0.00911)	(0.0188)	(0.00902)	(0.0103)
Constant	0.150	0.0148	-0.00235	0.249	-0.0131	-0.00166
	(0.122)	(0.101)	(0.0746)	(0.154)	(0.0738)	(0.0840)
Observations	37	36	36	36	36	36
R-squared	0.210	0.0546	0.0179	0.108	0.106	0.112

Standard errors in parentheses,* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

by the market in which a firm is listed. In figure 7, we observed that US-listed firms had lower abnormal returns in response to the filing of a petition, announcement of the amendment and announcement of the final decision. Conversely, US-listed firms had much larger positive excess returns than Hong Kong and China-listed firms in response to the *Development Guideline* and subsidy announcements. As in table 10, we examine these cross-market differences by instrumenting for a US-listing with information on whether or not the firm's leaders were educated outside China. The first stage F statistic of 12.09 in column (1) suggests that education is a modestly strong instrument for the market in which the firm lists. However, the lower value of the F statistic in columns (2) - (6) reveals that foreign education is a somewhat weak instrument in these regressions. We find a large negative impact of listing in the US for the petition filing and amendment announcements. Abnormal returns were 23% and 29% lower for US-listed firms for these two events.

However, the response of US-listed firms to the *Development Guideline* was strongly positive, 13% higher than China and Hong Kong-listed firms. Various interpretations of this market effect are possible. One interpretation is that the more sophisticated market participants in the US responded to these important news events fully because they grasped the importance of the events to future profitability. Alternatively, the US-listed firms might have differed from the China and Hong Kong-listed firms in some important way that was not captured by observables like firm size and this unobservable heterogeneity is the source of the market differences.

Table 12: CAR for all Chinese firms by stock market listing (IV results)

	(1) Petition	(2) Prelim	(3) Dev.Plan	(4) Amend	(5) Subsidy	(6) Final
US listed Firm IV	-0.237***	0.0504	0.131*	-0.292***	0.113	-0.0559
	(0.0654)	(0.0927)	(0.0723)	(0.0878)	(0.0755)	(0.0713)
Ln employment	0.0139	-0.0103	-0.00855	-0.00285	-0.00756	0.00460
	(0.0143)	(0.0151)	(0.0118)	(0.0143)	(0.0123)	(0.0116)
Constant	-0.112	0.0181	0.0709	0.0752	0.0671	-0.0579
	(0.108)	(0.112)	(0.0876)	(0.106)	(0.0915)	(0.0864)
Observations	37	36	36	36	36	36
R-squared	0.503	.	.	0.601	.	0.125
First stage F-test	12.09	6.99	6.99	6.99	6.99	6.99

Standard errors in parentheses,* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6 Conclusion

In this paper, we examined the stock market performance of Chinese firms in the solar panel industry in response to a series of policy announcements related to an antidumping investigation in the European market and industrial policy announcements by the Chinese government. We first documented that announcements of trade policy restrictions in Europe were associated with negative abnormal returns for most Chinese solar panel producers. However, our analysis documents considerable heterogeneity in the magnitude and, in some cases, the sign of abnormal returns. Additionally, we showed that domestic policy announcements by the Chinese government tended to induce positive abnormal returns for Chinese solar panel manufacturers.

In exploring the sources of cross-sectional heterogeneity in returns, we found, consistent with the Melitz (2003) model of firms engaged in international trade, that larger, more export-oriented firms experienced larger stock market losses in the wake of European trade restriction announcements. We further show that European trade policy has a larger negative effect on Chinese private sector firms relative to state owned enterprises. Finally, we use a two stage least squares estimation technique to show that firms listed on US markets are more responsive to news events than those listed in China and Hong Kong.

In considering our results, we note that we have identified empirical puzzles. First, the market returns of China's state owned enterprises appear to be largely unresponsive to relevant news events. It is not clear why. We speculate that this lack of responsiveness might be due to investors' perceptions that these firms are sheltered from adverse market forces by an unofficial but implied government guarantee (similar to that which propped up FANNIE MAE in the US). If correct, this line of reasoning suggests that one underlying cause of the resource mis-allocation problem in China is the belief in implicit government guarantees.

Second, we observe that firms listed in the United States are more responsive to news events than those listed in China and Hong Kong, even after controlling for observable characteristics and instrumenting for the decision to list in a foreign market. Many possible explanations exist; for example, this could be due to differences in the sophistication of investors, the functioning of the stock markets, or unaccounted-for differences in the firms in our sample. We suggest that this question warrants further research as it relates back to the deeper question of resource mis-allocation and the mechanisms necessary to improve efficiency.

Finally, our analysis points to the unexpected outcome of Europe's antidumping policy in solar panels. The intellectual origins of antidumping policy and the contemporary popular commentary surrounding it suggest that it is intended to promote a fair competitive environment for firms. However, our results highlight that publicly-listed Chinese *private sector* firms experienced the largest losses under Europe's import restrictions. Weirdly, the state owned enterprises that possibly benefit from implicit government guarantees experienced little or no adverse impact. Although EU antidumping policy is intended to foster fair competition, it seems that the net effect of policy changes in the solar panel market (European restrictions on the importation of Chinese solar panels and any officical or unofficial policies the Chinese might imposed in response) tilted the playing field against the Chinese private sector in favor of state owned enterprises.

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Appendices

Appendix A List of Chinese Photovoltaic Firms

Company Number	*Firm Name*	*Stock Market*	*Ownership*	*Development Guideline*	*Amend. Outcome*	*Final Outcome*
1	CSG PVTech	CN		efficient		UT
2	Jinggong	CN				
3	DMEGC Solar Energy	CN			UT	UT
4	Topray Solar Co.	CN			UT	UT
5	Zhongli Talesun Solar	CN			UT	UT
6	Chaori Solar	CN		efficient	UT	UT
7	Era Solar (Yonggao)	CN			UT	UT
8	Risen Energy Co.	CN			UT	UT
9	TBEA Solar	CN		efficient	UT	UT
10	Hareon Solar Technology	CN		efficient	UT	UT
11	Eging PV	CN		efficient	UT	UT
12	Tianwei Baobian	CN	SOE			UT
13	GD Solar	CN	SOE		UT	UT
14	Dongfang Electric (DEC)	CN	SOE		UT	UT
15	LONGi Silicon Materials	CN		efficient	UT	UT
16	Lu'an EED	CN	SOE	efficient		
17	Yinxing Energy	CN	SOE			
18	HT-SAAE	CN	SOE	efficient	UT	UT
19	Canadian Solar Energy	US		efficient	UT	UT
20	China Sunenergy	US		efficient	UT	UT
21	Daqo New Energy	US				UT
22	Hanwha SolarOne	US		efficient	UT	UT
23	JA Solar	US		efficient	UT	UT
24	Jinko Solar Co.	US		efficient	UT	UT
25	LDK Solar	US			UT	UT
26	Renesola	US		efficient	UT	UT
27	Suntech Power Co.	US		efficient	UT	UT
28	Trina Solar	US		efficient	UT	UT
29	Yingli Solar	US		efficient	UT	UT
30	Jun Yang Solar	HK				
31	Hanergy	HK		efficient		
32	United PV	HK				
33	Comtec	HK		efficient		
34	Singyes Solar	HK				
35	Solargiga Energy	HK		efficient	UT	UT
36	Shunfeng PV	HK			UT	UT
37	GCL-Poly Energy	HK		efficient	UT	UT

Appendix B Subsidiaries of publicly-listed Chinese Firms

Chaorisolar: Shanghai Chaori Solar Energy Science & Technology Co. Ltd, Shanghai Chaori International Trading Co. Ltd; CSG PVtech Co.Ltd: CSG PVtech Co. Ltd; CSIQ: CSI Solar Power (China) Inc., Canadian Solar Manufacturing (Changshu) Inc., Canadian Solar Manufacturing (Luoyang) Inc., CSI Cells Co. Ltd; CSUN: China Sunergy (Nanjing) Co. Ltd, CEEG Nanjing Renewable Energy Co. Ltd, CEEG (Shanghai) Solar Science Technology Co. Ltd, China Sunergy (Yangzhou) Co. Ltd, China Sunergy (Shanghai) Co. Ltd; DEC: Dongfang Electric (Yixing) MAGI Solar Power Technology Co. Ltd; DEMGC: Hengdian Group DMEGC Magnetics Co. Ltd; DQ: Nanjing Daqo New Energy Co. Ltd; EGing PV: Changzhou EGing Photovoltaic Technology Co. Ltd; GCL-Poly: Konca Solar Cell Co. Ltd, Suzhou GCL Photovoltaic Technology Co. Ltd, Jiangsu GCL Silicon Material Technology Development Co. Ltd, Jiangsu Zhongneng Polysilicon Technology Development Co. Ltd, GCL-Poly (Suzhou) Energy Limited, GCL-Poly Solar Power System Integration (Taicang) Co. Ltd, GCL Solar Power (Suzhou) Limited, GCL Solar System (Suzhou) Limited; GD Solar: GD Solar Co. Ltd; Hareonsolar: Jiangyin Hareon Power Co. Ltd, Hareon Solar Technology Co. Ltd, Taicang Hareon Solar Energy Co. Ltd; HSOL: Hanwha SolarOne (Qidong) Co. Ltd, Hanwha SolarOne Co. Ltd; HT-SAAE: Shanghai Shenzhou New Energy Development Co. Ltd, Lianyungang Shenzhou New Energy Co. Ltd; JASO: JingAo Solar Co. Ltd, Shanghai JA Solar Technology Co. Ltd, JA Solar Technology Yangzhou Co. Ltd, Hefei JA Solar Technology Co. Ltd, Shanghai JA Solar PV Technology Co. Ltd; Jinggong Science: Jinggong P-D Shaoxing Solar Energy Tech Co. Ltd; JKS: Jinko Solar Co. Ltd, Jinko Solar Import and Export Co. Ltd, Zhejiang Jinko Solar Co. Ltd, Zhejiang Jinko Solar Trading Co. Ltd; LDK: Jiangxi LDK solar Hi-Tech Co. Ltd, LDK Solar Hi-Tech (Nanchang) Co. Ltd, LDK Solar Hi-Tech (Suzhou) Co. Ltd, LDK Solar Hi-Tech (Hefei) Co. Ltd; Longi: Xi'an LONGi Silicon Materials Corp., Wuxi Longi Silicon Materials Co. Ltd; Risen: Risen Energy Co. Ltd; Shunfeng PV: Jiangsu Shunfeng Photovoltaic Technology Co. Ltd, Changzhou Shunfeng Photovoltaic Materials Co. Ltd, Jiangsu Shunfeng Photovoltaic Electronic Power Co. Ltd; SOL: Renesola Zhejiang Ltd., Renesola Jiangsu Ltd.; STP: Wuxi Suntech Power Co. Ltd, Suntech Power Co. Ltd, Wuxi Sunshine Power Co. Ltd, Luoyang Suntech Power Co. Ltd; TBEA: Xi'an SunOasis (Prime) Company Limited, TBEA Solar Co. Ltd., Xinjiang Sang'O Solar Equipment; Tianwei Baobian: Tianwei New Energy Holdings Co. Ltd, Tianwei New Energy (Chengdu) PV Module Co. Ltd; Topraysolar: Shenzhen Topray Solar Co. Ltd, Shanxi Topray Solar Co. Ltd, Leshan Topray Cell Co.

Appendix C Evolution of EU trade policy

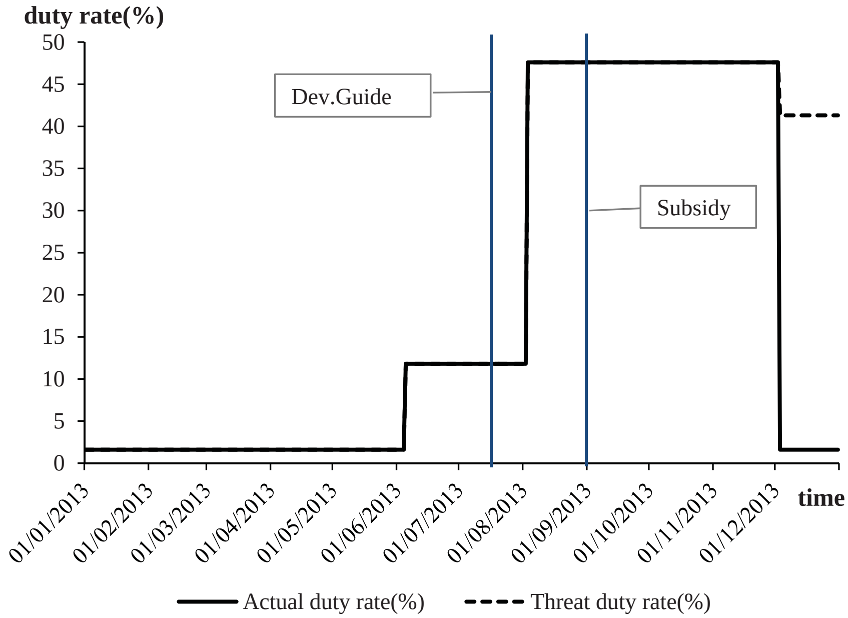

Figure C.1: Evolution of EU trade policy for Daqo New Energy Co. Ltd; Tianwei New Energy Holdings Co. Ltd; and CSG PVTech Co. Ltd

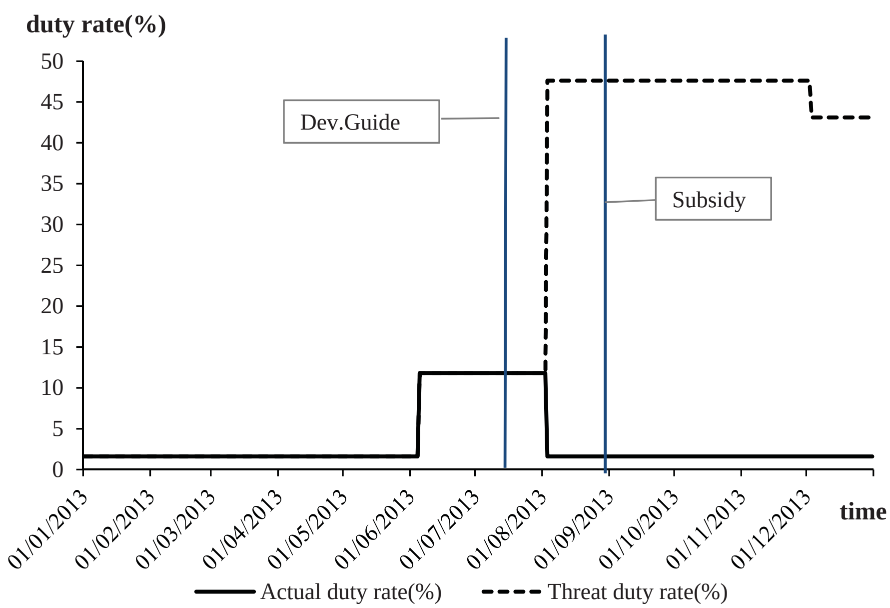

Figure C.2: Evolution of EU trade policy for Rene Solar Ltd

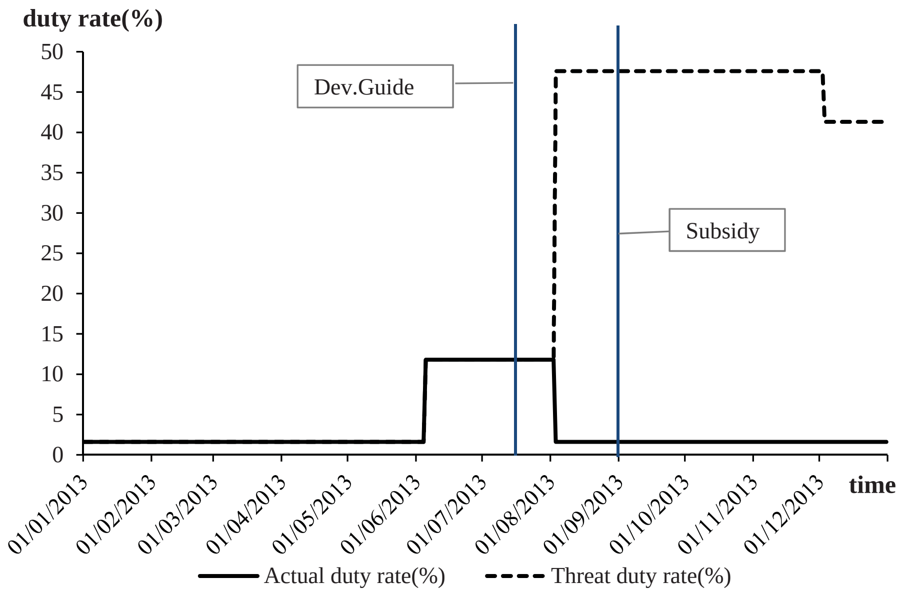

Figure C.3: Evolution of EU trade policy for 1. HAREON SOLAR Corp.; 2. Zhejiang Sunflower Light Energy Science & Technology Limited Liability Company; 3. RISEN ENERGY CO. LTD; 4. Shanghai Chaori Solar Energy Science & Technology Co. Ltd; 5. ChangZhou EGing Photovoltaic Technology Co. Ltd; 6. Hengdian Group DMEGC Magnetics Co. Ltd; 7. Shenzhen Topray Solar Co. Ltd; 8. Xi'an LONGi Silicon Materials Corp.; 9. GCL-Poly Energy Holdings Limited; 10. Shunfeng Photovoltaic International Ltd.; 11. China Sunergy (Nanjing) Co. Ltd; 12. Hanwha SolarOne (Qidong) Co. Ltd; 13. Jinko Solar Co. Ltd; 14. CSI Solar Power (China) Inc.; 15. Zhongli Sci-Tech Group Co., Ltd.

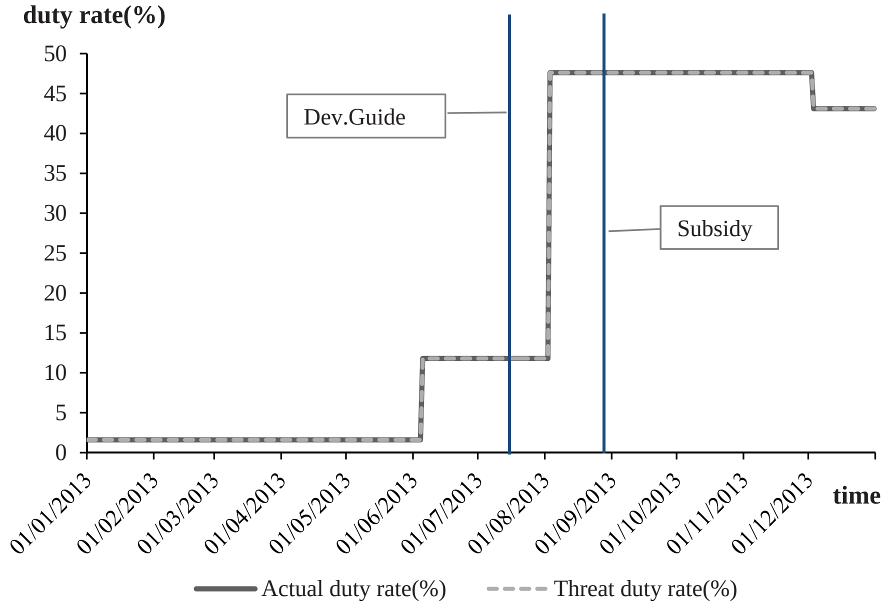

Figure C.4: Evolution of EU trade policy for Jinggong P-D Shaoxing Solar Energy Tech Co. Ltd.

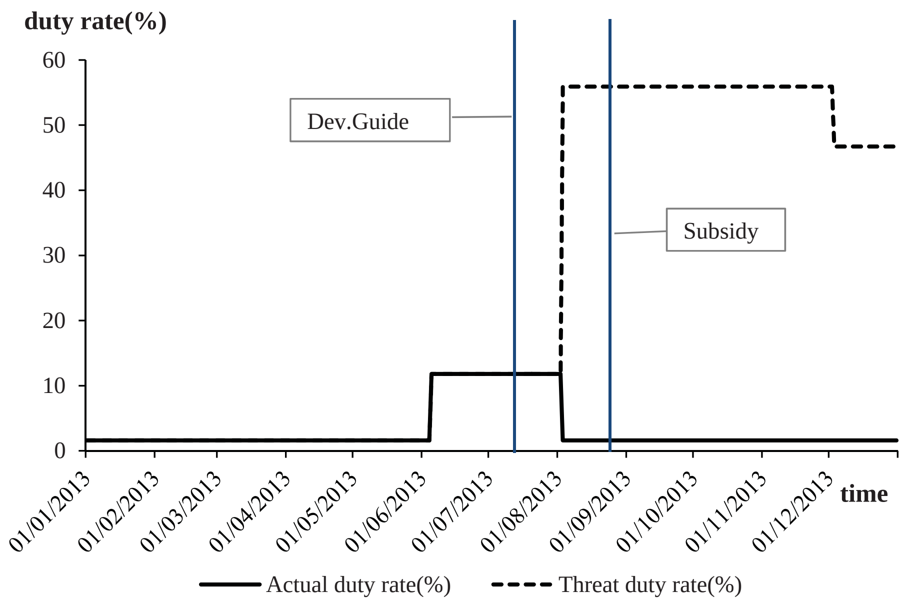

Figure C.5: Evolution of EU trade policy for Jiangxi LDK Solar Hi-Tech, Ltd.

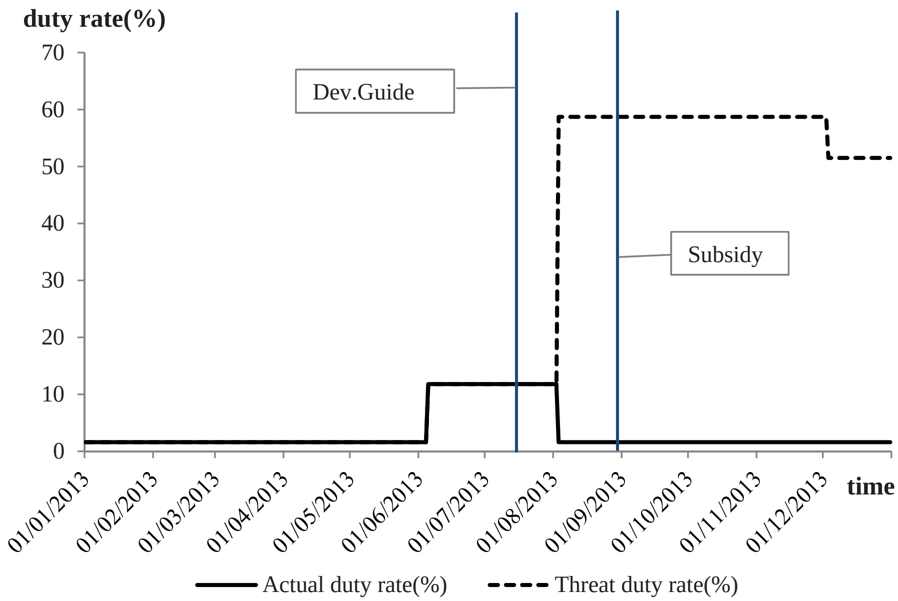

Figure C.6: Evolution of EU trade policy for JingAo Solar Co., Ltd.

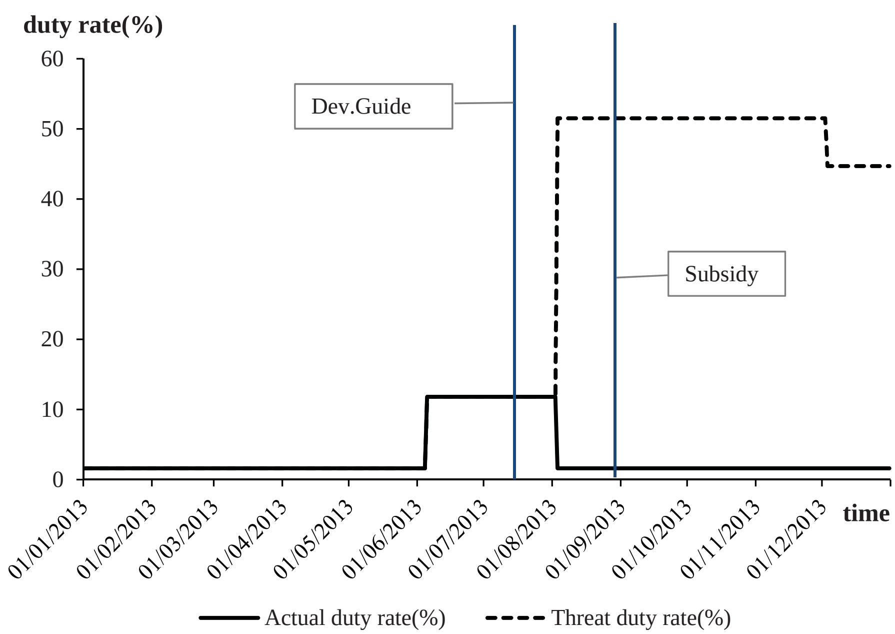

Figure C.7: Evolution of EU trade policy for Changzhou Trina Solar Energy Co. Ltd

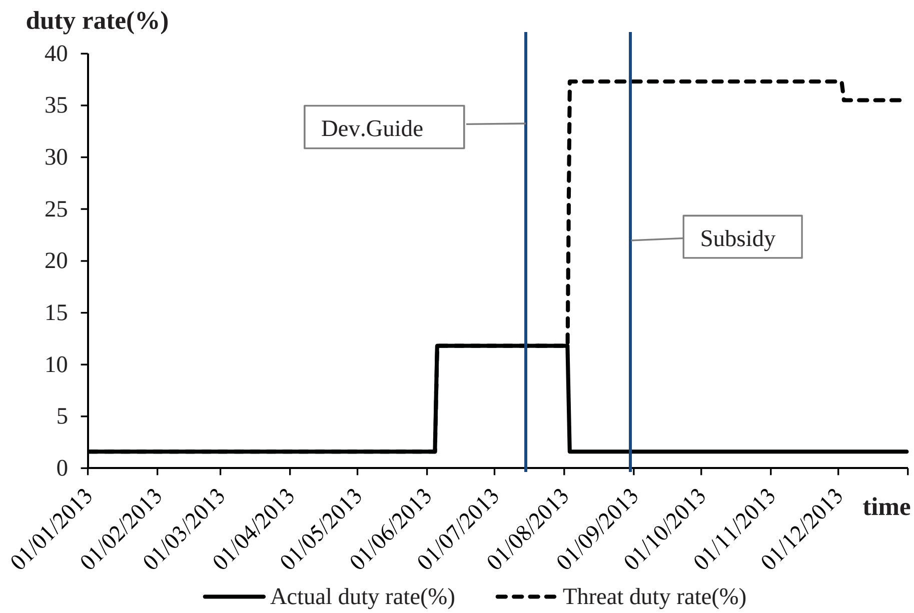

Figure C.8: Evolution of EU trade policy for Yingli Energy (China) Co. Ltd

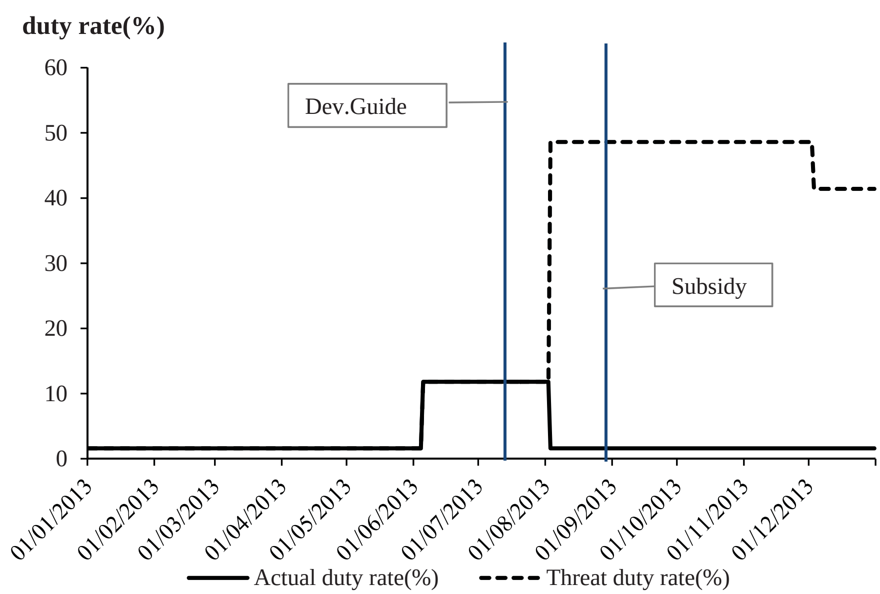

Figure C.9: Evolution of EU trade policy forWuxi Suntech Power Co. Ltd

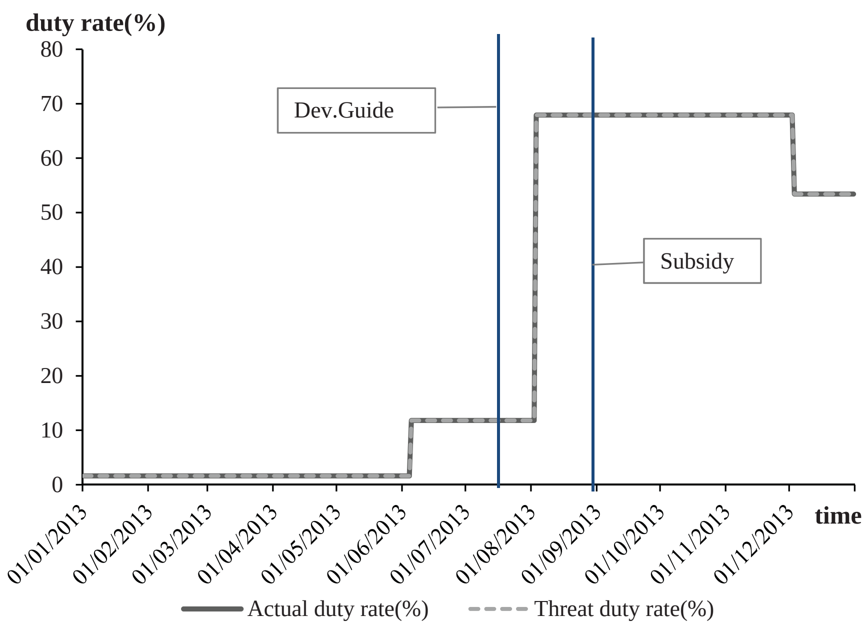

Figure C.10: Evolution of EU trade policy for 1. Grim Advanced Material Co.Ltd; 2. Ning Xia Yin Xing Energy Co., Ltd.; 3. Tianjin Zhonghuan Semiconductor Co., Ltd.; 4. Jiangsu Zongyi Co., Ltd.; 5. Hanergy Solar Group Limited; 6. Solargiga Energy Holdings Limited; 7. Comtec Solar Systems Group Limited; 8. China Singyes Solar Technologies Holdings Limited; 9. United Photovoltaics Group Limited; 10. Jun Yang Solar Power Investments Ltd.; 11. Lu’an EED.