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King Abdullah Petroleum Studies and Research Center

# The Effect of Preferential Trade Agreements on Energy Trade from Chinese and Exporters' Perspectives

Philipp Galkin, Carlo Andrea Bollino and Tarek Atalla

*April 2017/ KS-2017--DP010*

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# Key Points

During periods of supply abundance that lead to lower prices, commodity exporters strive to secure their market share with major importing economies. This paper seeks to cast light on what drives an exporter's share of Chinese imports of oil, gas and coal – and we find that the strategy behind achieving this goal need not rely on pricing policies alone.

China has been promoting a trade agenda that seeks to strengthen economic ties in the Asia-Pacific region and has been extending negotiations aimed at developing relationships worldwide. The country is a major energy import powerhouse; its trade deals have significant impact on the international energy trade and global energy markets. We explore the role of energy in China's preferential trade agreements (PTAs) and extend the trade gravity model to disaggregated trade flows, estimating the impact these agreements have on Chinese energy imports. We find that:

- Securing energy/resource imports is not the major driver of China's PTA strategy. Other considerations include: access to significant or strategically important markets, complementary economic and trade structures and extending political influence.

- The impact of PTAs on trade patterns varies across product groups. Agreement elements may include tariff reduction, scope and other specific policy arrangements.

- From China's perspective, reduced import tariff rates likely:
  - Increase the import flows of coal, crude oil and oil products – but not gas – from a partner economy to China.
  - Help an energy exporter increase its share in Chinese crude oil and oil product imports.
  - Divert a partner's exports of crude oil and oil products to China from competing importers.

- From an exporter's perspective, the presence of an operational PTA with China likely:
  - Increases the import flows of gas from a partner economy to China.
  - Helps an energy exporter increase its share of Chinese imports of coal.
  - Diverts a partner's exports of coal and gas to China from other importers.
  - Does not affect oil exports to China.

- The depth and scope of a PTA does not affect the patterns of Chinese energy imports.

# Executive Summary

Despite slowing growth during the past decade, China remains a major importer of fuels and energy products and exerts a significant influence on global markets. Since its accession to the Word Trade Organization (WTO) in 2001, Chinese foreign trade – including energy trade – has been increasingly impacted by preferential trade agreements (PTAs) negotiated on a multilateral (e.g., Association of Southeast Asian Nations) and, for the most part, on a bilateral basis. Currently, China has PTAs with 22 economies, which account for 18 percent of the country's energy imports and 34.5 percent of total Chinese imports in 2015 (World Bank 2016a), and it is negotiating with 21 more potential PTA partners. This paper seeks to provide insights into China's approach to PTAs and their effect on energy flows.

> Energy exporting economies that consider a trade agreement with China will benefit by understanding the country's approach to selecting PTA partners, its trade policy priorities and whether a PTA will help increase export values and capture a greater share in Chinese imports.

> From the Chinese perspective, its targets may include securing energy imports, diversification of trade flows and diverting its partner's exports away from other importers.

> Shifts in Chinese energy import patterns due to PTAs also impact other market participants.

China's dependence on energy imports, especially natural gas and crude oil, suggests that securing access to supply is one of the pillars of its foreign trade – and, hence, PTA – policy. However, energy and fuels account for just 13 percent of total imports. The share of energy products in imports from PTA partners is below 7 percent due to the lack of agreements with major oil exporters. Also, many existing PTA partners do not have a track record of significant energy product exports. This indicates that there are other drivers for Chinese engagement in preferential trade deals besides securing energy or raw material inputs. These drivers include gaining access to substantial or strategically important markets – either directly or through a 'hub' economy linked with key markets through PTAs – diversifying import sources and seeking complementary economic structures and trade patterns. In the past decade, especially during the development of the then U.S.-led Trans-Pacific Partnership (TPP) initiative, which has since been abandoned by President Trump, analysts identified the increasing importance of non-economic factors, such as exerting political influence and 'soft power' in the Pacific region and worldwide, in shaping Chinese foreign trade accords.

Chinese preferential trade agreements are not based on a particular template; they are drafted individually. Generally, historical record shows that China prefers to start with liberalization of trade in goods; over time, addenda covering trade in services and investments are introduced. These policy documents tend to have limited scope, primarily addressing tariff reduction and standards but leave out clauses on public procurement, competition and intellectual property protection. China's trade agreements with developed economies are usually more comprehensive than those with developing economies and result in more significant tariff cuts, which, however, can vary significantly across the product groups.

We extended the general framework of the trade gravity model to analyze the factors impacting China's energy trade flows. We disaggregate them by four major product groups under the Harmonized System classification of goods (coal, crude oil, oil products and gas/gaseous hydrocarbons). Gaseous hydrocarbons refers, for the most part, to natural gas liquids (NGLs) and so we shall use this terminology

throughout the paper. This approach allows us to assess the impact PTAs have on Chinese energy trade and isolate it from other factors, which could also potentially affect flows, including those that constitute the classic trade gravity model (countries' gross domestic product (GDP) and distances between them), as well as additional control variables (currency exchange rates and domestic energy production). Given a large degree of heterogeneity across the PTA's policy arrangements and tariff levels applied to particular product groups, traditional representation of the impact of a PTA as a dummy variable might be insufficient. Therefore, we extended the conventional trade gravity model by adding two extra variables that represent the PTA effect: the average tariff level applied to a particular product group and the depth index (DI). DI captures whether a trade agreement contains substantive provisions in the areas of services trade, investments, standards, public procurement, competition and intellectual property rights, and also whether all the tariffs would eventually be reduced to zero.

Our analysis finds that the dominant factor affecting trade flows of coal, crude oil and oil products is the average tariff level applied by China to these product groups. Its effect is less pronounced for gas/NGLs, which is more affected by policy arrangements represented by a PTA variable.

We find that an energy exporting economy which hopes to increase its share in Chinese imports should prioritize tariff reduction in the case of oil and gas/NGLs and a PTA deal in the case of coal. From a Chinese perspective, reduced tariffs for crude oil and oil products are likely to result in a partner's diverting its exports of these products to China in preference to other importers. By contrast, it is the presence of an operational PTA that drives diversion for the coal and gas product groups.

Analysis of trade intensity indices for energy product flows to China confirms the dominant effect of tariff levels. It should also be noted that the comprehensiveness or depth of a trade agreement – measured by its depth index – do not appear to be a significant variable affecting patterns of Chinese energy imports. This seems plausible, as energy products are commodities largely traded internationally. Accordingly, their imports may not require a complex and in-depth legal and institutional framework.

# Assessing the Role of PTAs in Foreign Trade and Energy Flows

Proliferation of multilateral and bilateral PTAs, which started in the early 1990s and continued into the 2000s has triggered a substantial body of literature on the subject. Predominantly, the focus of this was on the impact of PTAs on trade flows and the welfare of participating economies (see Plummer et al. 2010 for detailed review). Other studies also examined the effects of PTAs on foreign direct investment (Berger et al. 2010), demographics (Orefice 2012), policy reforms (Galal and Tohamy 1998) and other socio-economic and development indicators.

The qualitative assessment of the impact of the PTAs is usually performed by comparing the values of chosen indicators before and after the agreements came into force. For the purpose of trade flow analysis, exports and imports can be examined in natural units and monetary values, as well as the share in the partner's global exports and imports. However, this approach does not quantify the effects of PTAs nor does it isolate such effects from the impact of other factors.

The trade gravity model addresses both these issues. It estimates the trade flows and the PTA effect through an econometric equation, or set of equations. Unlike the Viner's model and its extensions (Johnson 1960, Krueger 1995) or general equilibrium models (Ciuriak 2007, Kiyota and Stern 2007), it allows for the isolation of the PTA effect on trade by introducing a set of control variables that represent other potential trade determinants. In its initial formulation, Tinbergen (1962) defines the trade flow between two countries as a function of their GDP and the geographical distance between them. Subsequently, other factors have been added to the equation including exchange rates, common borders and membership of political and economic associations.

The trade gravity model framework can also be applied to sector specific and product specific analyses of trade flows, including international trade in fuels and energy. In particular, it enables the identification of the different effects that PTAs have on the energy trade compared with other product groups (see Balassa 1967, Hakimian and Nugent 2003) and the exploration of cross-sectoral effects (Makochekanwa 2006). However, the modest number of studies that explore product specific trade flows suggests relatively limited application of the trade gravity model in this domain compared with the analyses of aggregated trade flows.

Regardless of the study scope – aggregated or sectoral trade flows – the PTA factor in the formulation of the trade gravity model is generally represented as a dummy variable, assigned the value of 1 if two or more economies are engaged in a PTA and 0, if not. This proxy method does not capture the impact of specific PTA components such as the tariff regime and a variety of institutional and policy arrangements, which significantly limits the scope of analysis. Reduction in tariff rates and its implementation schedule stipulated in PTAs usually vary significantly across product groups. Moreover, every PTA is different in terms of its scope, structure and priorities.

This study intends to contribute to the understanding of the effects of PTAs on international energy trade by disaggregating them into specific components. We modify the trade gravity model formulation by representing the PTA effect through the Average Tariff and Depth Index (see Appendix 1 and 3 for

details) variables and apply this method to explore the impact of China's bilateral and multilateral trade agreements on its energy import flows. Specifically, we examine the following questions:

- Do the PTAs have a significant impact on Chinese energy imports, or energy exports to China, and does any impact vary by particular product group?
- Is a PTA with China likely to help increase or secure a share in Chinese energy imports?
- Does a PTA with China tend to increase the Chinese share in the partner's energy exports?
- Which PTA component – tariff reduction or institutional arrangements – is more important in facilitating energy trade with China?

# Chinese PTA Strategy

Imports play an increasingly important role in China's energy balance. In 2014, the country sourced from abroad 7 percent of its coal needs. Imported natural gas and crude oil accounted for 32 percent and 60 percent of consumption, respectively (CEIC 2016). Accordingly, energy – along with other mineral resources, raw materials and agricultural products – has been one of China's foreign trade policy priorities (People's Daily 2007, Pett 2012). However, Chinese engagement in trade agreements is defined by a much broader range of economic and political motives on top of energy imports and import strategies in general. These incentives affect both the selection of potential PTA partners and the scope of resulting agreements and, hence, should not be discounted in the analysis of future Chinese energy trade flow patterns.

China has preferential trade agreements with 22 economies – most of them located in the Asia-Pacific region – and is negotiating with 21 more (see Figure 1). The economic structure and trade patterns of Chinese PTA partners suggest that Chinese engagement in trade agreements is driven not only by a desire to secure imports of energy and other natural resources. In 2015, only 11 PTA partners recorded exports exceeding $1 million for coal, $12 million for oil and $15 million for gas/NGLs (U.N. Comtrade 2016). Also, despite the presumed strategy of sustaining export growth and securing market access, China does not have PTAs with many of its top trading partners including the U.S., members of the EU, Japan, India, Brazil and Russia. PTAs with two major trading partners – Australia and Republic of Korea – only came into force in 2015.

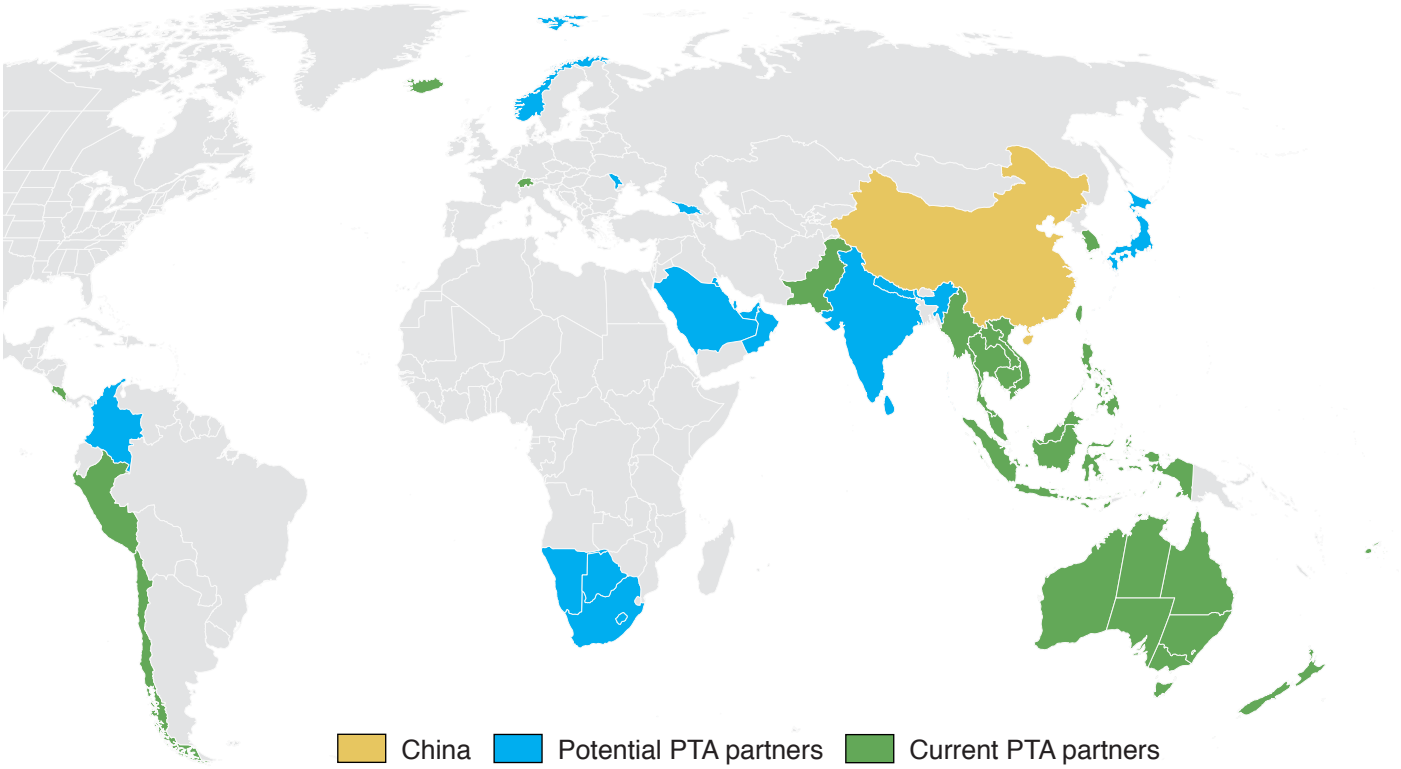



**Figure 1**. China's existing and potential PTA partners.

Source: Ministry of Commerce, People's Republic of China; Asian Development Bank.

Although some of the partner economies cannot be deemed significant in terms of their market size, they can be considered a PTA hub – that is, a gateway to strategic larger markets for China. For example, Costa Rica is a member of the Central American Common Market and has free trade agreements with Mexico, Colombia, Venezuela and the CARICOM countries; Chile has FTAs or PTAs with all major North and South American economies; and Switzerland has FTAs with the EU, a number of Eastern European countries and key economies in the Mediterranean basin.

Engaging in trade agreements with smaller economies also helps China to diversify its trade flows by reducing the share of key trade partners and gives it an edge in negotiations, especially if these economies do not negotiate as a trading block or economic union. With the notable exception of ASEAN, China prefers to negotiate bilateral PTAs.

However, recent developments suggest that Chinese foreign trade strategy has begun to shift. Song and Yuan (2012) argue that the Chinese PTA agenda is increasingly driven by political concerns. As a counter-measure to the TPP initiative, which was championed by the U.S. during the Obama Presidency, China turned its attention to negotiating trade deals with major regional economies. It signed FTAs with the Republic of Korea and Australia and started negotiations with Japan. A PTA (within the Economic Cooperation Framework Agreement) with Taiwan exemplifies another strategy. By offering economic preferences, China is attempting to exert soft power and build closer political ties. The uncertainty surrounding the TPP agreement after the Trump administration pulled out of the initiative has given China an opportunity to assume a leading role in shaping the Asia-Pacific trade landscape.

When it comes to the scope, structure ad specific clauses of trade agreements, China does not apply a particular template. The agreements are designed on an individual basis depending on the partner's trade patterns and economic development. As a rule, in the initial phase China tends to prioritize trade in goods, primarily, through tariff reduction mechanisms. Later, as relationships progress, additional agreements on trade in services and investments are likely to be signed. This approach has been criticized by a number of scholars for not being comprehensive and, hence, economically less meaningful (Nakagawa et al. 2016, Song and Yuan 2012). Recent PTAs, however, especially those with developed economies such as Australia or Korea, tend to be more comprehensive. Also, a number of addenda to existing PTAs have recently been signed to add depth and breath.

The PTA depth index (DI) introduced by Dur et al. (2014) can be applied to compare various PTAs that have Chinese participation in a consistent way. DI captures whether a trade agreement contains substantive provisions in the spheres of services trade, investments, standards, public procurement, competition and intellectual property rights, and also whether all the tariffs in the agreement are eventually planned to be reduced to zero (see detailed DI scores for existing PTAs in Appendix 2).

On average across all signed PTAs, China's DI is 4.8 out of 7, signaling that its approach to trade deals is not as superficial as some researchers suggest. However, these scores differ significantly by partner groups: average DI for Hong Kong, Macao and Taiwan is only 2.3; for developing economies it is 3.9 and 5.3 for developed ones. The most frequently applied clauses across Chinese trade agreements cover full tariff elimination and standards, whereas such issues

as public procurement, competition and intellectual property protection are generally omitted.

Chinese tariff concessions also depend heavily on the negotiating counterparty. As a rule, China commits to a greater percentage of zero-tariff products with partners that make similar commitments. As a result, Chinese trade agreements with developing economies generally have higher tariff levels than those with developed economies (see Table 1). Note that on average China commits to more significant tariff cuts than its partners from developing economies and less cuts compared to that undertaken by developed economies.

Unlike the trade agreement provisions represented by DI, which affect a broad range of bilaterally traded products, the tariff regime differs significantly not only by trading partner, but also by product group. In the next section we take a more detailed look at China's tariff regime for major energy-related product groups and their role in bilateral trade with existing PTA partners.

**Table 1.** Average tariff reduction commitments by China and its partners.

| Partner category | China's average initial 0-tariff product percentage | Partner's average initial 0-tariff product percentage | China's average target 0-tariff product percentage | Partner's average target 0-tariff product percentage |
|---|---|---|---|---|
| **Developed** | 71.5% | 88.5% | 93.3% | 97.4% |
| **Developing** | 51.0% | 44.3% | 92.3% | 90.0% |

Source: Ministry of Commerce, People's Republic of China.

# China's Energy Imports and Its Role in Foreign Trade

For the purpose of this study, we define energy imports as the volumes or values of imported goods classified under Article 27 (mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes) of the Harmonized System classification of goods (HS code). We focus our analysis on four major subgroups represented by the following articles:

- 2701: Coal; briquettes, ovoids and similar solid fuels manufactured from coal.
- 2709: Petroleum oils and oils obtained from bituminous minerals; crude.
- Minerals, not crude; preparations, containing by weight 70 percent or more of petroleum oils or oils from bituminous minerals; these being the basic constituents of the preparations; waste oils.
- 2711: Petroleum gases and other gaseous hydrocarbons (NGLs).

China's energy imports represent a substantial share of the global energy markets. Combined import value of the four HS code groups that we focus on in this study reached $184 billion, or 11 percent of global imports in 2015, while imports of coal and crude oil accounted for 18 percent and 15 percent of global imports, respectively (World Bank 2016a). This makes China one of the major players in the global energy markets and a lucrative target market for energy exporters.

Despite the country's position as a major energy consumer, its energy imports accounted for 13 percent of its total imports in 2015, declining from 17-18 percent in 2011-2014 (World Bank 2016a). If we isolate trade flows with existing PTA partners, the share of energy products drops to 7 percent of total imports from these economies. These numbers support the thesis that securing energy imports is not the exclusive motivation of China's trade deals (Figure 2).

As China increased the number of its preferential trade deals, energy imports from PTA participants also rose. This peaked at about $35.5 billion in 2015 when trade agreements with such substantial energy trade partners as Australia and the Republic of Korea came into force. However, the percentage of energy products in total import flows from PTA partners shows a declining trend, which can be attributed to the recent price reduction in global energy markets. This trend, though, would be partially reversed if China signed those PTAs that are currently being negotiated with major energy exporters such as South Africa and the Gulf Cooperation Council countries.

Disaggregation of energy imports from China's PTA partners by product group reveals a relatively balanced structure (see Figure 3 overleaf). The noticeable exception is the relatively modest value of crude oil imports, especially compared with its total imported volume. This can be explained by the fact that China does not have trade agreements with major oil exporters, nor with its oil exporting neighbors – Kazakhstan and Russia – with which it shares pipeline infrastructure.

Disparity in crude oil imports from PTA and non-PTA countries is the main factor contributing to the dominance of the latter in China's total energy imports. In 2015 only 18 percent of energy imports were sourced from PTA partners, which still represents an increase from the 8-9 percent level of the previous years. However, the dynamics of imports of other energy products – except for crude oil – are more favorable to exporters that have preferential trade agreements with China.

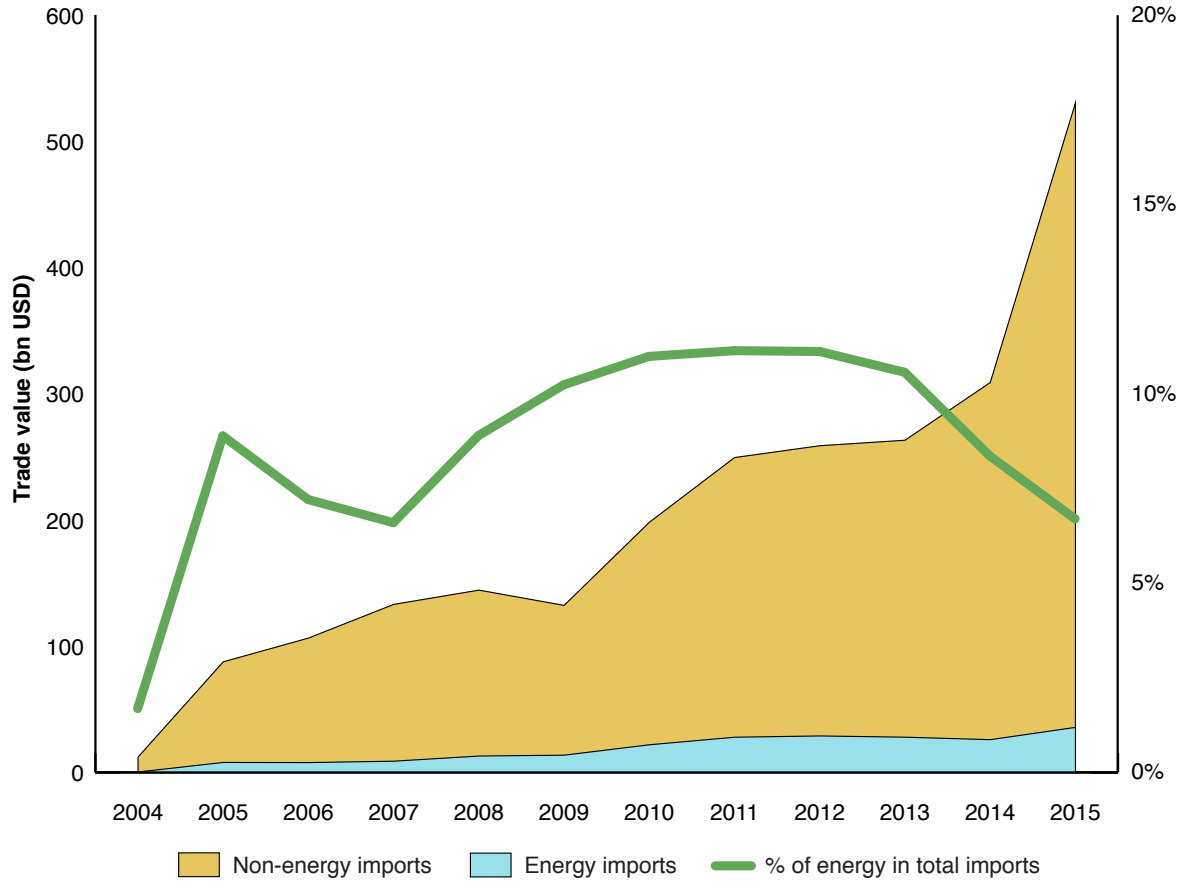
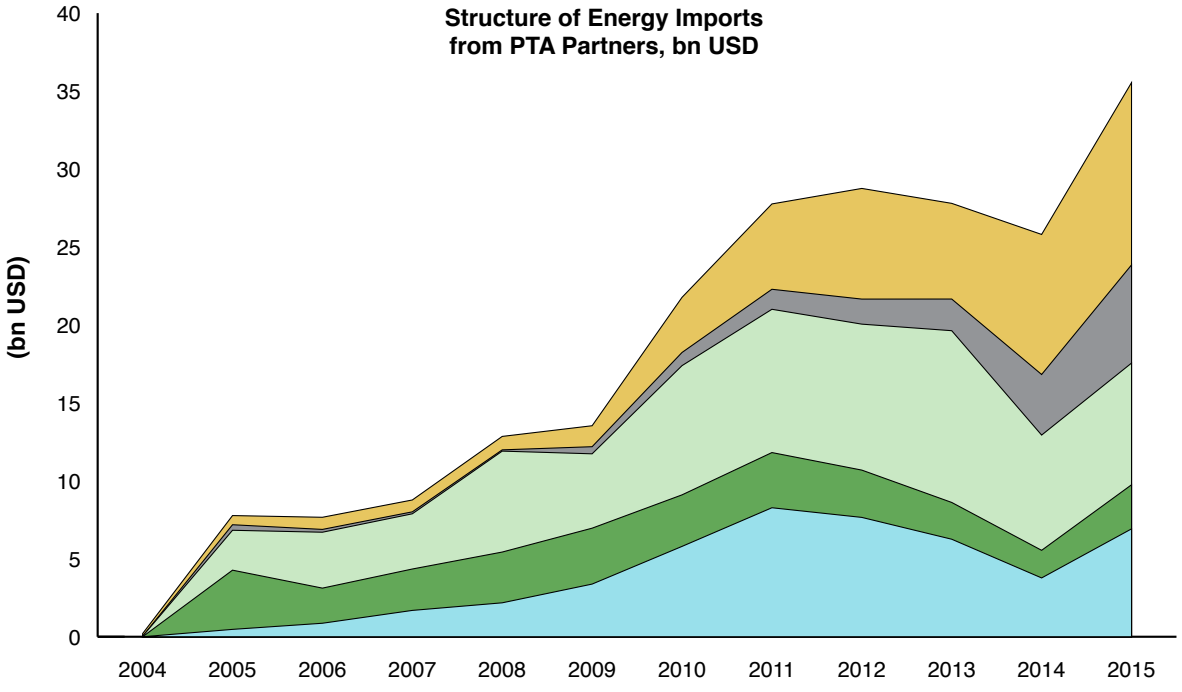



**Figure 2**. Dynamics of China's energy and non-energy imports from its PTA partners.

Source: National Bureau of Statistics of China, World Bank, ITC Trade Map.



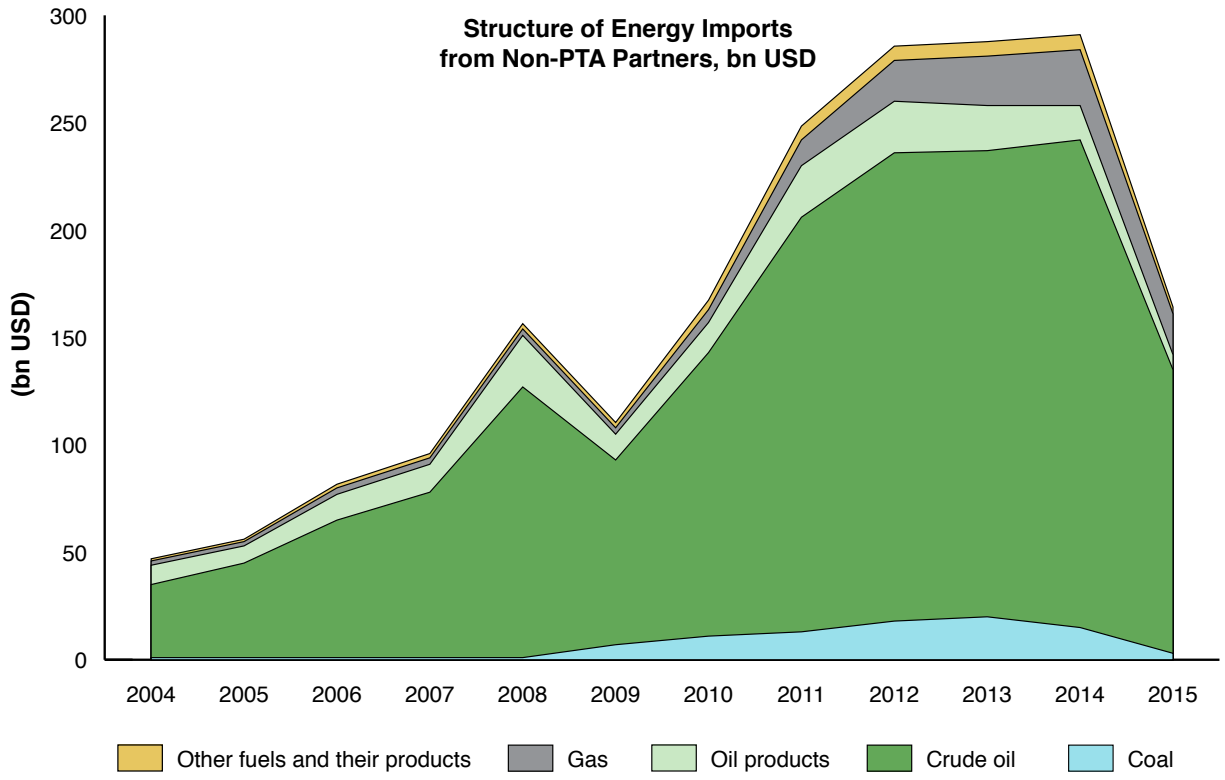



**Figure 3**. Comparison of China's energy imports structure from PTA and non-PTA partners.

Source: National Bureau of Statistics of China, World Bank, ITC Trade Map.

The import of coal (2701 HS article), oil products (2710 HS article), natural gas/NGLs (2711 HS article) and other energy products from PTA partners show an upward trend (see Figure 4). The increasing number of free trade agreements has positively affected this trend, but was this the only contributing factor? Presumably, a PTA should provide conditions favorable to the energy exporting economy, leading to increased trade flows and market share in China's total energy imports. The recent dynamics of Chinese energy imports seem to support this hypothesis. A sharp reduction in imports of the energy product groups presented in Figure 4, which occurred in 2014–2015, was mostly absorbed by non-PTA trading partners, while the economies that had a trade agreement with China kept and, in some cases, increased their market share, despite an oversupply/depressed prices in the global markets and reduced total Chinese energy imports.

One of the factors that can help explain this dynamic is the difference in tariffs that China applies to its preferential trade partners (PTA tariffs) and the most-favored nation (MFN) tariff applied to other WTO members. The difference between the average PTA and applied MFN tariffs in 2015 reached 3.4 percent for coal, 2.4 percent for oil products and 3.1 percent for gas/NGLs, (see Appendix 3 for detailed representation) which gave a competitive advantage to exporters from PTA partner economies. The notable exception is the crude oil tariff regime, which has been set – at zero level – for all importers since 2002.

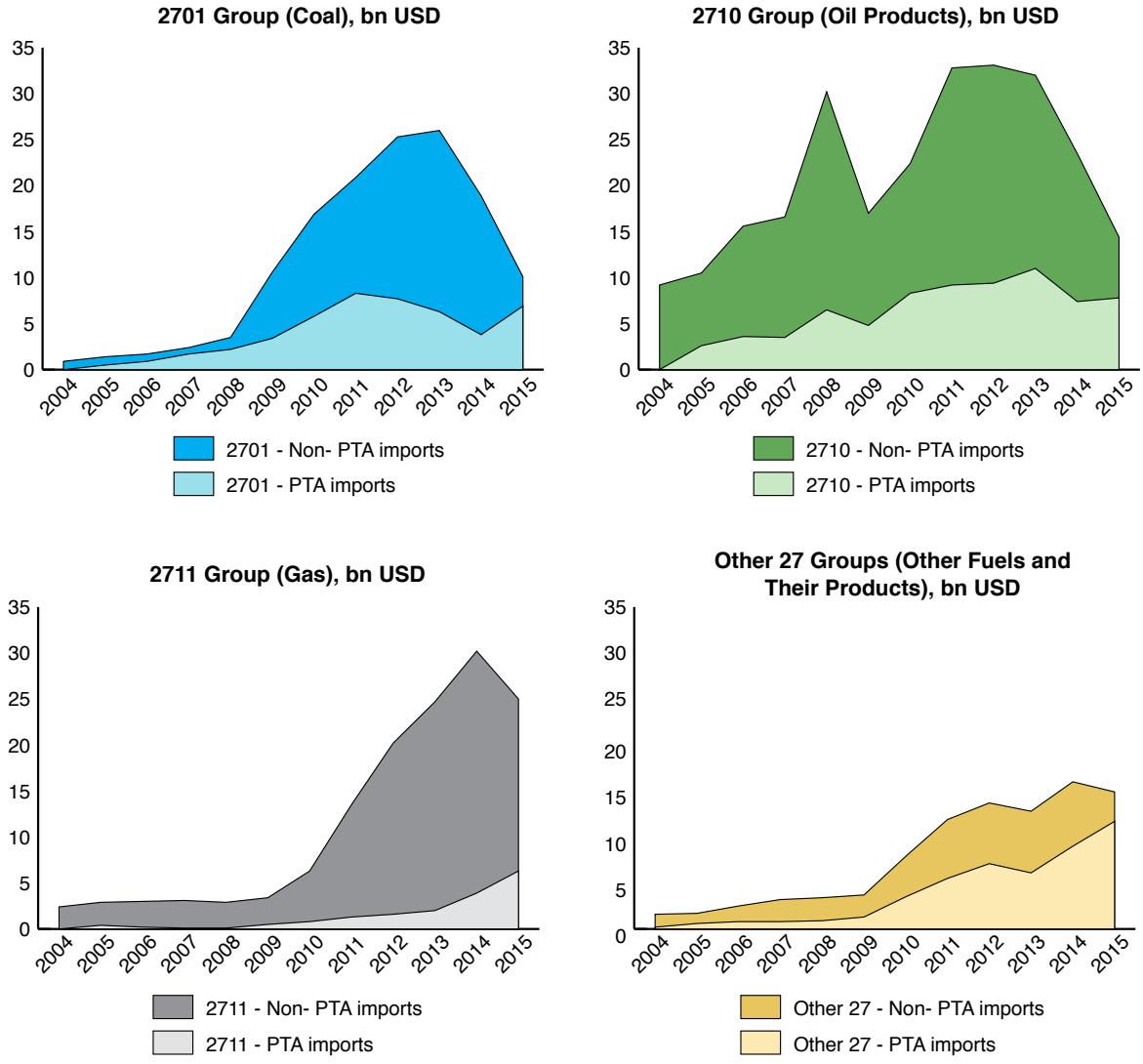



**Figure 4**. Chinese imports of specific energy products.

Source: National Bureau of Statistics of China, World Bank, ITC Trade Map.

However, it is difficult to draw conclusions on the effects of preferential tariffs based on qualitative observations alone. The institutional and policy arrangements of preferential trade agreements, such as standards, fair competition and investment facilitation clauses, can also affect energy trade flows and product market shares. Other factors, including the distance between countries, size of their economy, energy production levels, etc., can also determine energy trade patterns. In addition, each of these factors may have a different effect on various energy product groups.

In the next section we describe the framework that helps isolate the impact of PTAs with China on its energy products import flows and market shares. This approach can be used not only to understand the effect of existing PTAs, but also for evaluating the potential impact of future trade agreements from the perspective of an energy exporting economy and providing insights into China's strategy in securing foreign trade deals.

# Estimating the Effects of PTAs

## Scope, method and data

Our analysis covers China's annualized energy import flows from the 22 economies that have preferential trade agreements with it for the period 1995 – 2015. These flows are represented in volumes (Kg) and values (1,000 USD) – ImpFlUn and ImpFlVal variables – and grouped according to the articles 2701, 2709, 2710 and 2711 of the HS code. We also look at the share of these flows in total Chinese imports of their respective products (ImpShUn and ImpShVal variables). In the second phase, we approach the problem from the exporting economies' perspective, looking at the annual energy export flows to China and China's share in the economies' total energy exports (EXpFlUn, ExpFlVal, ExpShUn and ExpShVal variables). Finally, we assess the dynamics of the trade intensity indices (TII) – defined in the text box – for selected energy product flows.

For our analysis we apply the extended version of the trade gravity model. The model consists of 36 equations: each of the four product groups has nine dependent variables (ImpFlUn, ImpFlVal, ImpShUn, ImpShVal, EXpFlUn, ExpFlVal, ExpShUn, ExpShVal and TII). We assess the PTA impact through the PTA dummy variable (PTA), average import tariff rate for a particular product group (TarAvg) and depth index (DI). Exogenous control variables include the GDP of China, GDP of partner economy, exchange rate in Chinese yuan and partner's currency to USD, distance between China and partner economy and domestic production of exporting economy. Detailed model formulation is presented in Appendix 4.

The primary source for the import and export trade flow data is the World Integrated Trade Solutions (WITS) database produced by the World Bank. Where necessary, missing values were sourced from the U.N. Comtrade database, ITC Trade Map, and national statistics and customs departments. Export and import shares as well as the TII values were calculated based on the trade flow data. The texts and tariff schedules of preferential trade agreements were obtained from the Ministry of Commerce of PRC and ADB Asia

**Trade Intensity Index**

The trade intensity index (also known as Balassa Index; Balassa 1965) is used to determine whether the value of trade between two economies is greater or smaller than would be expected on the basis of their importance in world trade. In this study, it is defined as the share of an economy's energy product exports to China divided by the share of world exports to China. For a particular product flow, it is calculated as:

$$TIIi = (xi / Xit) / (xw / Xwt)$$

Where xi and xw are the values of economy i's exports and of world exports to China and where Xit and Xwt are economy i's total exports and total world exports, respectively. An index of more (less) than 1 indicates a bilateral trade flow that is larger (smaller) than expected, given the partner economy's importance in world trade.

Source: World Bank

Regional Integration Center. Depth indices were sourced from the DESTA database; where certain PTAs were missing, DI's were derived by us using the DESTA methodology. The data for control variables were obtained from a variety of sources including the World Bank, CEPII and Enerdata. Detailed descriptions of the data sources used for the model variables and their descriptive statistics are provided in Appendix 5. The complete dataset can be downloaded in Electronic Appendix 1 and the modeling output is provided in Electronic Appendix 2.

## Effects of PTA, depth index and average tariff rates on China's energy imports

The first set of models evaluates the effect of PTAs on Chinese energy imports. Table 2 shows the effect of the PTA dummy variable (PTA), depth index (DI) and average tariff rates (TarAvg) on energy import flows and corresponding import shares.

Decrease in average tariff rate has a positive effect on trade flows across all major energy product groups. This effect is more explicit when the import flows are measured in natural units. The impact on the import values is to some degree alleviated because tariff payments are included in the CIF import price reported on the Chinese border. By contrast, institutional and policy arrangements of PTAs – presented in the form of a PTA dummy variable and the depth index – have no impact on China's energy import flows. These results suggest that China does not require a policy framework to drive an increase in its energy imports. Instead, it can unilaterally reduce the average MFN tariff applied to a particular product group.

From the perspective of an energy exporting economy aiming to increase its share in Chinese imports, the strategy has to be different. A preferential tariff regime is expected to facilitate the growth in market share only for the oil products group and, to a lesser extent, for gas/NGLs. If China

**Table 2.** Effect of PTAs on China's import of energy products.

**Product Groups (HS Classification)**

| Variables | 2701 (Coal) | | | | 2709 (Crude Oil) | | | | 2710 (Oil Products) | | | | 2711 (Gas/NGLs) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ImpShVal | ImpShUn | ImpFlVal | ImpFlUn | ImpShVal | ImpShUn | ImpFlVal | ImpFlUn | ImpShVal | ImpShUn | ImpFlVal | ImpFlUn | ImpShVal | ImpShUn | ImpFlVal | ImpFlUn |
| PTA | | | (+) | + | | | | | | | | | | | | |
| DI | | | | | | | | | | | | | | | | |
| TarAvg | - | (-) | | | - | (-) | (-) | - | (-) | - | - | - | - | (-) | (-) | (-) |

+ positive effect, (+) insignificant positive effect, - negative effect, (-) insignificant negative effect.

Source: KAPSARC analysis.

decides to raise the import tariff for crude oil from the current zero level, the preferential (better than MFN) tariff terms would also probably lead to the capture of additional market share. The 2701 (coal) group stands out from the general pattern. The share in coal imports is not affected by the average tariff level, but tends to be higher if the exporting economy has a preferential trade agreement with China. The signs for DI are not statistically significant. Therefore, this variable is unlikely to have any substantial impact on shares in Chinese energy imports as a whole.

## Effects of PTA, depth index and average tariff rates on energy exports to China

The second set of models explores the behavior of two types of dependent variables: energy export flows to China and Chinese shares in PTA partners' total energy product export. The output of these models (see Table 3 below) also highlights the prevalent role of tariff reduction in increasing energy trade flows with China. For the export flow values of coal, crude oil and oil products groups, the coefficient of the TarAvg variable is negative and statistically significant. The notable exception is the 2711 (gas/NGLs) group, where an increase in exports to China is more likely to be stimulated by a preferential trade agreement represented by the PTA dummy variable.

Similar to the results of the import flow analysis, the depth index variable is not statistically significant. The insignificance of the depth index in combination with significance of the PTA dummy variable suggests that the presence of specific non-tariff clauses in a preferential trade agreement is more important for increasing energy trade with China and/or capturing respective market shares than the broader scope of such agreements. The binary structure of DI (see Appendix 1 for details) does not allow us to capture the relative effect of specific PTA clauses and identify those with the most impact.

**Table 3.** Effect of PTAs on China's import of energy products.

**Product Groups (HS Classification)**

| Variables | 2701 (Coal) | 2709 (Crude Oil) | 2710 (Oil Products) | 2711 (Gas/NGLs) |
|---|---|---|---|---|
| | ExpFlUn ExpFlVal ExpShUn ExpShVal | ExpFlUn ExpFlVal ExpShUn ExpShVal | ExpFlUn ExpFlVal ExpShUn ExpShVal | ExpFlUn ExpFlVal ExpShUn ExpShVal |
| PTA | + + | | | + + (+) (+) |
| DI | | | | |
| TarAvg | (-) - (-) | - - - - | (-) - - - | (-) (-) |

+ positive effect, (+) insignificant positive effect, - negative effect, (-) insignificant negative effect.

Source: KAPSARC analysis.

The export share variables (ExpShUn, ExpShVal) represent China's ability to capture a larger proportion of energy exports from a PTA partner economy. The model's results suggest that a reduction in the average tariff level would probably result in the export flows of crude oil and oil products being diverted to China and would have no significant effect on the other two groups. On the contrary, a PTA policy framework would likely increase China's share in its partner's exports of coal and gas/NGLs.

Assuming China is more interested in securing the share of its partner's export in natural units (ExpShUn variable) and its partner targets Chinese import share in monetary values (ImpShVal variable), preferential trade agreements tend to have a homogeneous effect on the goals of the parties. Both EXpShUn and ImpShVal tend to increase when the average import tariff is reduced for crude oil and oil products and when there is a general policy arrangement in the case of the coal trade. The 2711 group (gas/NGLs), however, displays the opposite pattern. The general effect of PTAs on the group's export and import share is weak. Moreover, this effect is heterogeneous: tariff reduction drives imports and the presence of a PTA affects exports. A similar discrepancy is observed when comparing factors that impact export and import flows for this product group. The other product groups, however, display homogenous patterns in export and import flows as well as in the factors that affect them, namely, average tariff levels. Understanding these links and potential effects could facilitate trade agreement negotiations between China and the exporters of these products.

As of 2015, China maintained significant advantage over its PTA partners in terms of export/import shares of energy product trade. On average, exports to China accounted for 7 percent of its partner's total coal exports, 4 percent of crude oil exports, 9 percent of oil products and 10 percent of gas/NGLs. However, the partner's average share in Chinese imports for these products totaled 4, 1, 3 and 1 percent, respectively. Such disparity can be explained by the size of the Chinese economy and attests to its strategy of energy import diversification. The 2015 data on shares in total exports/imports with selected PTA partners are given in the Table 4.

## Effects of PTA, depth index and average tariff rates on the intensity of bilateral energy trade with China

Finally, to confirm our findings, we assess the impact of PTAs on the trade intensity index for the selected product groups. The results presented in the Table 5 confirm the conclusions of the trade flow analysis. For all product groups studied, the average import tariff level is the only component of preferential trade deals that has significant impact on the TII. It should also be noted that the average TII values in all cases are higher than 1, ranging from 1.86 for crude oil to 10.58 for gas/NGLs. This suggests that energy export flows to China from its PTA partners are larger than expected based on the countries' share in world economy.

Detailed output of the models applied in this section is presented in Electronic Appendix 2.

**Table 4.** Shares of selected PTA partners in China's total imports and of China in partner's total exports in 2015, %.

| PTA Partners | 2701 (Coal) | | 2709 (Crude Oil) | | 2710 (Oil Products) | | 2711 (Gas/NGLs) | |
|---|---|---|---|---|---|---|---|---|
| | IMP Share | EXP Share | IMP Share | EXP Share | IMP Share | EXP Share | IMP Share | EXP Share |
| Brunei | | | 0.04% | 2.30% | | | | |
| Indonesia | 15.34% | 10.49% | 0.43% | 9.78% | 0.83% | 7.19% | 5.01% | 10.53% |
| Malaysia | 0.01% | 2.24% | 0.08% | 1.62% | 2.80% | 3.25% | 6.02% | 8.23% |
| Myanmar | | | | | | | 6.36% | 32.73% |
| Philippines | 0.02% | 89.61% | | | 0.10% | 4.67% | 0.01% | 37.47% |
| Singapore | | | | | 14.27% | 7.67% | 0.10% | 8.66% |
| Thailand | | | | | 1.55% | 3.44% | 0.14% | 17.82% |
| Australia | 52.35% | 16.70% | 0.75% | 1.57% | 0.34% | 2.72% | 6.97% | 0.46% |
| Republic of Korea | | | | | 30.46% | 10.78% | 0.46% | 44.82% |
| Peru | | | | | 0.62% | 3.31% | | |
| Switzerland | | | | | 0.02% | 3.77% | | |
| Taiwan | | | | | 2.57% | 3.35% | 0.13% | 77.51% |
| Pakistan | 0.00% | 7.10% | | | 0.00% | 11.54% | | |
| Vietnam | 0.43% | 15.83% | 0.69% | 25.42% | | | | |
| Hong Kong SAR | | | | | 0.64% | 64.29% | 0.00% | 5.04% |

Source: National Bureau of Statistics of China, World Bank, ITC Trade Map, KAPSARC analysis.

**Table 5.** Effect of PTAs on trade intensity in energy products trade with China.

| Product Groups (HS Classification) | | | | |
|---|---|---|---|---|
| Variables | 2701 (Coal) | 2709 (Crude Oil) | 2710 (Oil Products) | 2711 (Gas/NGLs) |
| PTA | | | | |
| DI | | | | |
| TarAvg | - | - | - | - |

+ positive effect, (+) insignificant positive effect, - negative effect, (-) insignificant negative effect.

Source: KAPSARC analysis.

# Conclusion

China's example illustrates that PTAs can have a significant impact on the energy trade patterns of the parties involved. They can be instrumental in increasing trade flows, capturing market shares and diverting energy exports from other importers.

Existing trade partnerships and flows as well as economic structures of partner economies suggest that China's PTA strategy is driven by a complex set of incentives that extend beyond securing supply of raw materials and mineral resources, including fuels and energy products. The range of such incentives encompasses gaining access to substantial or strategically important markets, benefiting from complementary economic and trade structures and extending political influence and 'soft power'. These drivers of Chinese foreign trade policy – seemingly unrelated to energy – nonetheless have significant impact on energy trade, since they ultimately define the selection of a PTA partner as well as the structure and content of the resulting agreement.

Analysis of Chinese energy imports requires a disaggregated approach. PTAs with China tend to be tailored individually and therefore vary greatly in terms of scope and degree of liberalization. In addition, its trade flows demonstrate varying patterns depending on the specific energy product group.

Reduced average tariff rates are instrumental in increasing trade flows of coal, crude oil and oil products. Their impact is less significant in the case of gas/NGLs imports: this group is more affected by policy arrangements (presence of an operational PTA). The comprehensiveness of a trade agreement, as measured by its depth index, does not affect Chinese energy imports. The dominant effect of the tariff component on energy trade with China is confirmed by the analysis of the trade intensity indices. The TII for every energy product group studied is higher than expected, and is significantly affected by the average tariff rate.

Besides affecting trade flows, a PTA can facilitate increasing or securing a share in Chinese energy imports or – from the Chinese perspective – diverting energy exports from other importers. Policy arrangements, represented by a PTA dummy variable, facilitate a mutual increase in export/import shares in coal trade and help China secure a larger share in its partners' gas exports. The market share of exports/imports of crude oil and oil products, on the other hand, are affected by the tariff level.

These findings indicate that the balance of power in bilateral energy trade is skewed towards China. It can increase energy imports and divert its partner's energy exports without engaging in a PTA – by merely applying unilateral tariff cuts for a particular product group. Thus PTAs can hardly be viewed as an instrument of China's energy security strategy. Energy exporters that target the Chinese market, on the other hand, would benefit from a preferential trade agreement, which gives China leverage in the negotiation process. However, the suggested strategy of focusing on import tariff reduction for the target product groups rather than on negotiating a comprehensive in-depth agreement in general, matches China's approach to developing preferential trade relationships.

Though, across the board, the tariff level has a higher impact on energy trade with China and therefore, should probably be prioritized in PTA negotiations by interested parties, the ability of institutional/ policy arrangements to facilitate the capture of a partner's market share should not be underestimated. In this regard, the insignificant effect of the depth index, which assigns similar weight to the major components of a PTA, suggests a possible area for further research: which specific clauses of a PTA have the most significant impact on energy trade?

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# Appendix 1: The Structure of the Depth Index

The Depth Index is an additive index of seven variables that represents key provisions of a preferential trade agreement:

**Table 1.1.** The Structure of the Depth Index.

| Variable | Description | Value |
|---|---|---|
| Full_fta | More than a partial scope agreement? | [0;1] |
| Services | Substantive provision on services? | [0;1] |
| Investments | Substantive provision on investments? | [0;1] |
| Standards | Substantive provision on standards? | [0;1] |
| Procurement | Substantive provision on public procurement? | [0;1] |
| Competition | Substantive provision on competition? | [0;1] |
| Iprs | Substantive provision on intellectual property rights? | [0;1] |
| **Total range** | | **[0;7]** |

Source: Dur et al. 2014.

# Appendix 2: Depth Index Scores for China's PTAs

**Table 2.1.** Depth Index scores for China's PTAs.

| Partner | Partner Code | Agreement Type | Signed | In Effect | Full fta | Iprs | Procurement | Standards | Services | Investments | Competition | DI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Iceland | 11 | Bilateral Investment Agreement | 1994 | 1997 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Hong Kong SAR | 21 | CEPA | 2003 | 2004 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| Macao SAR | 22 | CEPA | 2003 | 2004 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| Brunei | 1 | ASEAN FTA | 2004 | 2005 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| Cambodia | 19 | ASEAN FTA | 2004 | 2005 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| Indonesia | 2 | ASEAN FTA | 2004 | 2005 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| Lao PDR | 18 | ASEAN FTA | 2004 | 2005 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| Malaysia | 3 | ASEAN FTA | 2004 | 2005 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| Myanmar | 4 | ASEAN FTA | 2004 | 2005 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| Philippines | 5 | ASEAN FTA | 2004 | 2005 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| Singapore | 6 | ASEAN FTA | 2004 | 2005 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| Thailand | 7 | ASEAN FTA | 2004 | 2005 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| Vietnam | 20 | ASEAN FTA | 2004 | 2005 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| Chile | 9 | FTA | 2005 | 2006 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 3 |
| Pakistan | 17 | FTA | 2006 | 2007 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 3 |
| Brunei | 1 | ASEAN FTA Services | 2007 | 2008 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 3 |
| Cambodia | 19 | ASEAN FTA Services | 2007 | 2008 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 3 |
| Indonesia | 2 | ASEAN FTA Services | 2007 | 2008 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 3 |
| Lao PDR | 18 | ASEAN FTA Services | 2007 | 2008 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 3 |
| Malaysia | 3 | ASEAN FTA Services | 2007 | 2008 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 3 |
| Myanmar | 4 | ASEAN FTA Services | 2007 | 2008 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 3 |
| Philippines | 5 | ASEAN FTA Services | 2007 | 2008 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 3 |
| Singapore | 6 | ASEAN FTA Services | 2007 | 2008 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 3 |
| Thailand | 7 | ASEAN FTA Services | 2007 | 2008 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 3 |
| Vietnam | 20 | ASEAN FTA Services | 2007 | 2008 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 3 |
| Chile | 9 | FTA Services | 2008 | 2008 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New Zealand | 13 | FTA | 2008 | 2008 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 4 |
| Singapore | 6 | FTA | 2008 | 2009 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 4 |
| Brunei | 1 | ASEAN Investment | 2009 | 2010 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Cambodia | 19 | ASEAN Investment | 2009 | 2010 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Indonesia | 2 | ASEAN Investment | 2009 | 2010 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Lao PDR | 18 | ASEAN Investment | 2009 | 2010 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Malaysia | 3 | ASEAN Investment | 2009 | 2010 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Myanmar | 4 | ASEAN Investment | 2009 | 2010 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Pakistan | 17 | FTA Services | 2009 | 2009 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| Peru | 14 | FTA | 2009 | 2010 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 5 |
| Philippines | 5 | ASEAN Investment | 2009 | 2010 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Singapore | 6 | ASEAN Investment | 2009 | 2010 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Thailand | 7 | ASEAN Investment | 2009 | 2010 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Vietnam | 20 | ASEAN Investment | 2009 | 2010 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Costa Rica | 10 | FTA | 2010 | 2011 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 5 |
| Taiwan | 16 | ECFA | 2010 | 2010 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Chile | 9 | FTA Investment | 2012 | 2012 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Iceland | 11 | FTA | 2013 | 2014 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 5 |
| Switzerland | 15 | FTA | 2013 | 2014 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 6 |
| Taiwan | 16 | ECFA Investment | 2013 | 2013 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Australia | 8 | FTA | 2015 | 2015 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 6 |
| Republic of Korea | 12 | FTA | 2015 | 2015 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 6 |
| Macao SAR | 22 | FTA Services | 2015 | 2016 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |

Source: Dur et al. 2014, KAPSARC anaylsis.

# Appendix 3: Comparison of Chinese Average PTA and MFN Import Tariffs

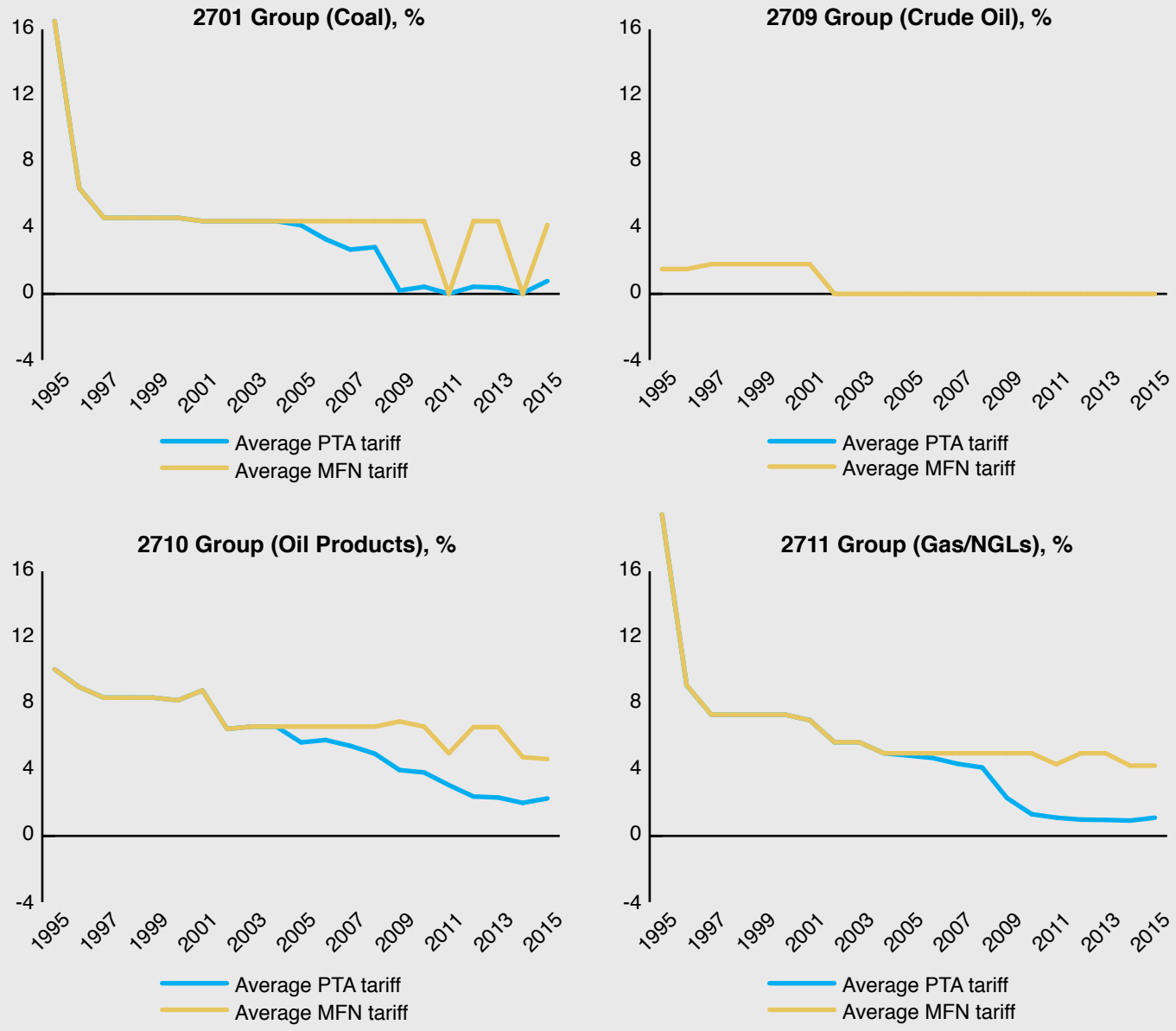


**Figure 3.1**. Comparison of Chinese average PTA and MFN import tariffs for selected product groups.

Source: World Bank 2016a.

# Appendix 4: Model Formulation

The general model that we apply to the problem is an extension of the gravity model of trade and can be represented as follows:

$$Y = Z^{*}\beta + X^{*}\alpha + \varepsilon \quad (1)$$

Where Y represents dependent variables, which are the values and volumes of import flows *(ImpFlUn, ImpFlVal)*, import shares *(ImpShUn, ImpShVal)*, export flows and shares *(ExpFlUn, ExpFlVal, ExpShUn and ExpShVal)* and the *TII* for the four categories of energy products. We estimate nine different specifications for each product for a total of 36 equations as detailed in Electronic Appendix 2.

We estimate the equation as a panel of 22 partner economies over 21 years from 1995 to 2015, including fixed effects; the error term is represented by $\varepsilon$.

The exogenous variables in each equation can be grouped into two main effects. Z is a matrix of variables capturing the effect of PTAs that includes:

- *PTA* is a dummy variable that captures whether an economy has a PTA with China.
- *TarAvg* represents simple average import tariff for a particular product group applied by China to a partner economy.
- *DI* is the value of the Depth Index that characterizes a PTA between China and partner economy. If in any given year t there was no PTA, then *DI t* = 0.

X represents a matrix of other control variables including GDP of China, GDP of partner economy, exchange rate of Chinese Yuan and partner's currency to USD, the distance between China and partner economy and domestic production of exporting economy.

The $\beta$ coefficients represent the effect of the PTA-related variables, whereas $\alpha$ coefficients represent the effect of the structural (control) variables and $\varepsilon$ represents the usual error term.

# Appendix 5: Model Variables: Data Sources and Descriptive Statistics

**Table 5.1.** Data sources: dependent variables.

| Dependent Variables | Description | Data Sources |
|---|---|---|
| ImpFlUn | Annual import of China from a PTA partner in kilograms. | World Bank 2016a, International Trade Centre 2016, CEIC 2016, UN Comtrade 2016, National Bureau of Statistics 2016. |
| ImpFlVal | Annual import of China from a PTA partner in thousand USD. | |
| ExpFlUn | Annual export to China of a PTA partner in kilograms. | |
| ExpFlVal | Annual import to China of a PTA partner in thousand USD. | |
| ImpShUn | Share of import (in kilograms) from a PTA partner in total Chinese import. | |
| ImpShVal | Share of import (in thousand USD) from a PTA partner in total Chinese import. | |
| ExpShUn | Share of export (in kilograms) to China in total export of a PTA partner. | Calculated based on the import / export flow data. |
| ExpShVal | Share of export (in thousand USD) to China in total export of a PTA partner. | |
| TII | See page 15 for explanation. | |

Source: Listed in the table.

**Table 5.2.** Data sources: independent variables.

| Independent Variables | Description | Data Sources |
|---|---|---|
| PTA | Dummy variable: whether China and its trading partner were engaged in a PTA in a given year. | Ministry of Commerce 2016, Asian Development Bank 2016. |
| TarAvg 2701<br>TarAvg 2709<br>TarAvg 2710<br>TarAvg 2711 | Aggregated tariff rate: simple average by tariff lines in a corresponding product group. | Ministry of Commerce 2016, Asian Development Bank 2016, World Bank 2016a, U.N. Comtrade 2016. |
| DI | Depth index: quantitative measure of the non-tariff clauses of a PTA. | Dur et al. 2014 |
| GDPImp | GDP of China, PPP adjusted in constant 2011 international thousand USD. | Feenstra et.al. 2015 |
| GDPPart | GDP of a PTA partner, PPP adjusted in constant 2011 international thousand USD. | |
| ExRate1 | Average yearly exchange rate of Chinese Yuan to USD. | World Bank 2016b |
| ExRate2 | Average yearly exchange rate of a PTA partner's currency to USD. | |
| Dist | Geodesic distances between China and a PTA partner – latitudes and longitudes of the most important cities/agglomerations (in terms of population). | CEPII 2016 |
| ProdUn 2701<br>ProdUn 2709<br>ProdUn 2710<br>ProdUn 2711 | Domestic production of a corresponding product group in a PTA partner economy in natural units. | IndexMundi 2016, EIA 2015, Enerdata 2016 |

Source: Listed in the table.

**Table 5.3.** Descriptive statistics of dependent variables: product group 2701.

| Dependent Variables | Mean | St. Dev. | Min | Max |
|---|---|---|---|---|
| ImpFlUn, mil t | 2.30 | 10.54 | 0.00 | 94.40 |
| ImpFlVal, mil USD | 202.05 | 1028.75 | 0.00 | 10119.75 |
| ExpFlUn, mil t | 2.45 | 11.49 | 0.00 | 93.40 |
| ExpFlVal, mil USD | 177.63 | 918.06 | 0.00 | 8775.63 |
| ImpShUn | 0.03 | 0.11 | 0.00 | 0.75 |
| ImpShVal | 0.04 | 0.11 | 0.00 | 0.75 |
| ExpShUn | 0.10 | 0.24 | 0.00 | 1.00 |
| ExpShVal | 0.07 | 0.19 | 0.00 | 0.99 |
| TII | 3.07 | 15.85 | 0.00 | 254.95 |

Source: KAPSARC analysis.

**Table 5.4.** Descriptive statistics of dependent variables: product group 2709.

| Dependent Variables | Mean | St. Dev. | Min | Max |
|---|---|---|---|---|
| ImpFlUn, mil t | 0.37 | 0.94 | 0.00 | 6.59 |
| ImpFlVal, mil USD | 145.89 | 381.58 | 0.00 | 3313.06 |
| ExpFlUn, mil t | 0.36 | 1.02 | 0.00 | 10.57 |
| ExpFlVal, mil USD | 118.65 | 312.97 | 0.00 | 2997.79 |
| ImpShUn | 0.01 | 0.02 | 0.00 | 0.31 |
| ImpShVal | 0.01 | 0.02 | 0.00 | 0.31 |
| ExpShUn | 0.04 | 0.12 | 0.00 | 1.00 |
| ExpShVal | 0.04 | 0.10 | 0.00 | 1.00 |
| TII | 1.86 | 5.97 | 0.00 | 80.40 |

Source: KAPSARC analysis.

**Table 5.5.** Descriptive statistics of dependent variables: product group 2710.

| Dependent Variables | Mean | St. Dev. | Min | Max |
|---|---|---|---|---|
| ImpFlUn, mil t | 0.81 | 2.19 | 0.00 | 11.29 |
| ImpFlVal, mil USD | 370.92 | 1190.22 | 0.00 | 10328.11 |
| ExpFlUn, mil t | 0.86 | 2.55 | 0.00 | 19.47 |
| ExpFlVal, mil USD | 335.70 | 1166.75 | 0.00 | 9983.72 |
| ImpShUn | 0.03 | 0.08 | 0.00 | 0.58 |
| ImpShVal | 0.03 | 0.08 | 0.00 | 0.55 |
| ExpShUn | 0.08 | 0.27 | 0.00 | 1.00 |
| ExpShVal | 0.09 | 0.33 | 0.00 | 1.00 |
| TII | 4.08 | 18.22 | 0.00 | 298.10 |

Source: KAPSARC analysis.

## Appendix 5: Model Variables: Data Sources and Descriptive Statistics

**Table 5.6.** Descriptive statistics of dependent variables: product group 2711.

| Dependent Variables | Mean | St. Dev. | Min | Max |
|---|---|---|---|---|
| ImpFlUn, mil t | 0.20 | 0.69 | 0.00 | 5.78 |
| ImpFlVal, mil USD | 66.27 | 220.74 | 0.00 | 1741.87 |
| ExpFlUn, mil t | 0.16 | 0.52 | 0.00 | 3.45 |
| ExpFlVal, mil USD | 61.01 | 237.72 | 0.00 | 2469.04 |
| ImpShUn | 0.02 | 0.05 | 0.00 | 0.48 |
| ImpShVal | 0.01 | 0.03 | 0.00 | 0.32 |
| ExpShUn | 0.11 | 0.23 | 0.00 | 1.00 |
| ExpShVal | 0.10 | 0.22 | 0.00 | 1.00 |
| TII | 10.58 | 28.33 | 0.00 | 247.78 |

Source: KAPSARC anaylsis.

**Table 5.7.** Descriptive statistics of independent variables.

| Independent Variables | Mean | St. Dev. | Min | Max |
|---|---|---|---|---|
| PTA | 0.40 | 0.49 | 0.00 | 1.00 |
| TarAvg 2701, % | 3.76 | 3.52 | 0.00 | 16.5 |
| TarAvg 2709, % | 0.57 | 0.81 | 0.00 | 1.80 |
| TarAvg 2710, % | 6.09 | 2.51 | 0.00 | 10.07 |
| TarAvg 2711, % | 5.37 | 4.09 | 0.00 | 19.44 |
| DI | 1.34 | 1.79 | 0.00 | 6.00 |
| GDPImp, bn USD | 8868.47 | 4828.38 | 3073.41 | 18374.71 |
| GDPPart, bn USD | 409.11 | 488.05 | 7.41 | 2674.88 |
| ExRate1 | 7.55 | 0.87 | 6.14 | 8.35 |
| ExRate2 | 1762.04 | 4110.05 | 0.89 | 21698.80 |
| Dist, km | 6005.92 | 4948.4 | 955.65 | 19079.88 |
| ProdUn 2701, mil t | 29.2 | 92.28 | 0.00 | 491.16 |
| ProdUn 2709, th.b./d | 143.99 | 285.59 | 0.00 | 1547.00 |
| ProdUn 2710, th.b./d* | 143.99 | 285.59 | 0.00 | 1547.00 |
| ProdUn 2711, bcf | 410.14 | 688.78 | 0.00 | 2841.44 |

Note: *Crude oil production is applied as a control factor.

Source: KAPSARC anaylsis.

## About the Authors

**Philipp Galkin**

Philipp is a research fellow specializing in economic and policy analysis. He holds a Ph.D. in International Economic Relations and an MBA.

**Carlo Andrea Bollino**

Carlo is a visiting fellow at KAPSARC and professor of economics at the University of Perugia, Italy, specializing in microeconomic analysis, energy economics and environmental policy. He holds a Ph.D. in Economics from the University of Pennsylvania.

**Tarek Atalla**

Tarek is a former research associate evaluating energy productivity investments, economics of energy vulnerability and the effect of climate on energy consumption patterns.

## About the project

Our goal is to understand the context of China's energy economy and underlying decision-making processes. This understanding will enable the collection of relevant and accurate data both to feed analysis and drive the interpretation of model outputs.

The project aims to analyze and assess information to obtain policy relevant insights. Its focus is on investigating the global consequences of changes to energy markets within China and China's energy policies. In line with KAPSARC's overall objectives, the aim is to produce policy relevant insights that may assist actors outside China to understand the consequences of decisions taken by actors in China.


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