


Article

# Bilateral Economic Impacts of China–Pakistan Economic Corridor

Tariq Ali <sup>1,\*</sup> , Jikun Huang <sup>2,\*</sup> and Wei Xie <sup>2</sup><sup>1</sup> School of Economics and Management, Jiangxi Agricultural University, Nanchang 330045, China<sup>2</sup> China Center for Agricultural Policy, School of Advanced Agricultural Sciences, Peking University, Beijing 100871, China; xiewei.ccap@pku.edu.cn

\* Correspondence: agri45@gmail.com (T.A.); jkhuang.ccap@pku.edu.cn (J.H.)

**Abstract:** China is making large investments in Pakistan’s transport infrastructure under the China–Pakistan Economic Corridor. This study aims to quantitatively analyze the bilateral impacts of these investments through several policy scenarios in 2025 using a global economic model. Our results show that due to transport infrastructure development, the GDP and welfare of both Pakistan and China will improve, with a maximum of 0.3% and 0.01% increase in GDP, and USD 2.6 billion USD 1.8 billion gains in welfare for Pakistan and China, respectively. Regarding mutual trade, Pakistan’s total and agricultural exports to China will increase in the range of USD 9.6–13.7 billion and USD 4.7–6.6 billion, respectively. The percentage increase in Pakistan’s net exports of agricultural commodities to China will be higher than that of non-agricultural products. Pakistan will tap into China’s import demand for fresh fruits and vegetables and other perishable food products. Due to changing trade relations, Pakistan’s production structure will undergo slight structural adjustments. For Pakistan’s agriculture sector, the rice and fruit sectors will be top gainers, with 2.1–2.6% and 1.2–1.7% output expansion, respectively. Pakistan will also experience some leveling of income due to a relatively higher increase in wages of unskilled labor than skilled labor. The output of China’s rice sector will drop the most (–1––1.3%). Overall, the effects on China’s economy are minimal. We suggest several critical policy recommendations in light of our results, especially for Pakistan.

**Citation:** Ali, T.; Huang, J.; Xie, W.

Bilateral Economic Impacts of China–Pakistan Economic Corridor.

*Agriculture* **2022**, *12*, 143.<https://doi.org/10.3390/agriculture12020143>

agriculture12020143

Academic Editor: Piotr Prus

Received: 20 December 2021

Accepted: 17 January 2022

Published: 21 January 2022

**Publisher’s Note:** MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



**Copyright:** © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

**Keywords:** China; Pakistan; economic; corridor; CGE; agriculture

## 1. Introduction

### 1.1. Background

The Belt and Road Initiative (BRI) is a global initiative for sharing benefits in trade and other fields. The idea put forward by China in 2013 was to expand the development of Eurasia and create an economic belt along the Silk Road. BRI includes the construction of international economic cooperation corridors and ports and infrastructure projects, investment and financing support to carry out these projects, and other projects related to connectivity for countries along the BRI [1,2].

Regional participation is the highest priority among all the conduits for cooperation under BRI. Pakistan was among the first few countries to pledge cooperation on BRI. To put the mutual will to expand cooperation into practice, during the latter half of 2013, China and Pakistan signed a memorandum of understanding (MoU) on a long-term plan and action plan for the China–Pakistan Economic Corridor (CPEC) [3]. CPEC is a flagship project under BRI and includes constructing a network of highways, railways, energy projects, and special economic zones (SEZs) in Pakistan. The infrastructure projects in Pakistan, stretching over 3000 km from Kashgar in far western China to Islamabad and the port cities of Karachi and Gwadar, near Pakistan’s border with Iran, are expected to strengthen trade ties between China, the Middle East, and Africa.

Currently, about 97% of USD 19.4 billion Pakistan–China trade occurs through sea routes [4]. After completing highway networks under CPEC, the bilateral trade will increase

substantially and shift towards land transportation simultaneously. It is anticipated that due to road infrastructure development under CPEC, the distance and time for transporting commodities between Pakistan and China will decrease considerably compared with the sea route. The reduction promises the high potential for increased trade of agricultural products, especially perishable products such as meats, dairy, and fruits and vegetables. The effects will reverberate beyond China, especially for Pakistan, turning the latter into a transit hub for Central Asia and the regions in the West and South.

However, much of the previous discussion on the possible effects of CPEC on Pakistan and China has been theoretical or speculative and focuses mainly on the impacts of energy and industrial projects [5–13], with little or no attention paid to the effects on agriculture. Most of the studies indicate positive effects on the economies of Pakistan and China, generally without quantitative analysis. Some have pointed toward the broader effects of CPEC on regional trade, development, and the environment [6,14,15]. There are also a few discussions on the political and defense aspects of CPEC [16,17]. Regardless of their results, almost all the studies have used anecdotal discussions to support their conclusions without much empirical evidence. No matter how insignificant, the conclusions drawn by these discussions are much less reliable for both countries' public and policymakers than the outcomes of rigorous quantitative analysis.

To fill this critical gap in the literature, we conducted this study to evaluate the impacts of improved transportation infrastructure under CPEC on Pakistan and China using a global economic model (GTAP). These impacts are measured through changes in GDP, welfare, mutual trade, and output for Pakistan and China. As both countries are among the top five most populated ones globally and have a high dependence on the agriculture sector for food and employment, we pay particular attention to the effect of CPEC on agriculture in these countries. The specific objectives of the study are: (1) to improve an existing CGE framework to incorporate the mechanism for reducing transportation cost in a context where the existing trade route (sea) will be replaced by a new route (land); (2) to estimate the future impacts of land and sea transport infrastructure improvements under CPEC on macro indicators, trade, wages, production of various sectors; (3) to suggest policy recommendations for achieving and enhancing the economic gains from these infrastructure improvements.

Before moving on to the Section 2, we highlight the context and importance of our study through a short literature review below.

### 1.2. Literature Review

The significance of infrastructure development has been discussed since the time of Adam Smith when he described the role of infrastructure in industrial development [18] (p. 18). Samuelson [19] and Mundell [20] highlighted the existence of a significant difference in trade cost between traded and non-traded commodities internationally. Many other studies have focused on incorporating transportation costs into commodity trade [21–24]. Later, several researchers have attempted to explain the relationship between infrastructure development and different indicators of the economy [25–33].

More recent studies have further highlighted that transport brings better opportunities for the poor, enhances the competitiveness of economies, and improves the global trade in goods and services. For example, farmers can increase and diversify their income by connecting to urban markets through rural roads [34]. Agricultural development and rural poverty reduction can be significantly facilitated through an efficient rural transport system [35]. Practically, a significant portion of the World Bank's lending was for transportation infrastructure projects [36].

Literature shows that transport costs can substantially affect domestic products' market prices in developing countries. Due to the poor condition of rural roads, transport costs range between 25% and 33% of domestic products' wholesale price in former Zaire. Transportation is, on average, 50% less expensive on paved roads than on bad roads [37]. There are also several studies on the impact of transportation improvement on the whole

economy and agricultural sectors. The reduction in transportation costs in the 19th century was a significant factor in the economic growth of the United States and Europe [38]. For developing countries, reductions in transport costs allow the reallocation of resources towards the more productive units within sectors and permit the more intensive use of modern intermediate inputs by the agricultural producing regions [39].

Many impact assessment studies have evaluated the role of infrastructure development on economic growth and regional development via traditional conduits of improved connectivity and accessibility of the markets [40–44]. Improved infrastructure quality has been shown to bring new firms into the market and improve existing firms' productivity [45]. Improved transport infrastructure can enhance industrial agglomeration and affect overall market demand. Chen et al. [46] showed that investment in railroad infrastructure in China promoted demand and output that led to overall economic growth in the country. Chen and Haynes [47] used a spatial panel model to find positive spillover effects on regional GDP from land transportation infrastructure in the northeast US.

Several other studies also demonstrated reductions in international trade costs and increased trade volumes due to improved transportation infrastructure [48–51]. Based on a CGE model analysis, Villafuerte et al. [52] showed that BRI countries' regional exports would rise from USD 6.5 billion to USD 135.4 billion due to infrastructure improvements. Western Asian nations and China PR would gain the highest shares in trade and welfare gains. De Soyres et al. [53] found that transport infrastructure development in BRI countries would lower shipment time (1.7–3.2%) and trade costs (1.5–2.8%).

Based on the review of literature above, we can conclude that (1) transport infrastructure plays a critical role in the development of the agriculture sector and the overall economy, (2) among various choices, CGE is one of the best approaches to assess the impacts of transport infrastructure projects, and (3) there is a dearth of rigorous empirical studies to evaluate CPEC infrastructure development on Pakistan and China's economies.

## 2. Material and Methods

Economic activity can be severely hampered by poor infrastructure, both domestically and across borders. Transport costs in many developing regions of the world are pretty high [54]. In addition to the size of the transport infrastructure, this network's quality can cause high costs for the inland movement of agricultural commodities. For example, poor infrastructure can account for 60% of predicted transport costs for coastal economies and 40% for landlocked economies. The literature shows that land transport infrastructure development reduces transport costs through several channels. They reduce vehicle operating costs, including maintenance, and prolong the asset's life. They reduce transport time, resulting in labor cost benefits. They make for better inventory management and improve overall productivity associated with transport, as the same resource base provides more services (i.e., the same truck and driver make more deliveries). Economic-wide, better transport systems lead to economies of scale, different agglomeration patterns, improved access to markets, network externalities, more efficient market clearing, and enhanced competition resulting from improved information flows (see, for example, [55,56]).

### 2.1. Model Description

Global Trade Analysis Project (GTAP) is a multi-region, multi-sector, computable general equilibrium model with perfect competition and constant returns to scale. It utilizes economic accounts for 140 countries/regions globally, with detailed industry linkages. Bilateral trade relations for all countries/regions are also covered. GTAP, similar to many other global CGE models, relies on a fully consistent framework to capture the regional and sectoral interactions. The model provides insights into the underlying data and mechanisms of economic change resulting from changes in various trade policies and other economic variables. Theoretically, the model derives from optimizing behavior by agents such as firms and households. Households maximize utility, firms minimize costs, and all agents are price takers. The model adopts the fiction of a representative agent:

the household sector consists of infinite identical infinitesimal households, an industry of infinite identical infinitesimal firms so that each sector has the budget shares or input-output ratios of its component agents. Firms produce the final output by combining five primary factors of production (land, natural resources, physical capital, and skilled and unskilled labor) with domestic and imported intermediate inputs. Differentiation between imports from different countries is maintained through the ‘Armington elasticities,’ thus allowing a different degree of substitution between imports from various regions and between domestic production and imports. In a typical exercise to simulate the effects of the transport infrastructure improvement, the model endogenously determines all the prices and quantities of marketed commodities, as well as the impacts on incomes and GDP [57]. Figure A3 (in Appendix A) contains the outline of the GTAP model, linking various agents and their respective economic flows.

The advantage of using GTAP, similar to most CGE models, is that it can encapsulate a wide range of outcomes closely resembling the economic theory. The outcomes produced by the model are also in line with our assumption about production possibilities, consumer preferences, and resource constraints [58]. This consistency with one’s view of the world helps us gain critical empirical insights mostly ignored in policy analysis [59]. The model and accompanying database have been used extensively in policy-related studies, including the impacts assessment of infrastructure [51,52,60–63], trade policy [64–67], climate change [68–71], and energy [72–75], among others.

We used a global database containing complete bilateral trade information, transport, and protection linkages with the model. The database (version 9, <https://www.gtap.agecon.purdue.edu/databases/v9/v9doco.asp>, accessed on 14 January 2022) features the 2011 reference year and 140 regions for all 57 GTAP commodities. Before analyzing the impact of infrastructure improvement under CPEC, we aggregated the data (regions, commodities, and endowments) to the desired level, ensuring that important trade and regional partners and primary agricultural commodities are present in full detail (see Appendix A.2 Table A2 for details on regional aggregation).

We also introduced a few critical changes to the database and model for this study. The original database does not contain fruits and vegetables as separate commodities. We used Horridge’s [76] sector splitting technique to split the existing sector (vegfru) for all the regions into the vegetables and fruits sectors. The procedure required a considerable amount of data with practical issues of assigning the right shares to the new sectors and balancing the whole database. The production and consumption shares were obtained from [77], and trade shares are based on [78].

We added a new variable to the model to incorporate the shocks. We aimed to introduce a reduction in effective FOB price ( $pfob$ ) for Pakistan and China’s mutual trade resulting from the transportation infrastructure development under CPEC. The existing relation in the GTAP model [57] between CIF price ( $pcif$ ) and  $pfob$  is defined in Equation (1):

$$pcif_{i,r,s} = pfob_{i,r,s} + transport_{i,r,s} \quad (1)$$

where  $transport$  = transport cost for the trade of  $i$ , from  $r$  to  $s$ ; and  $i$  is traded commodity;  $r$  is exporting region;  $s$  is importing region.

However, as the transport infrastructure under CPEC will affect the commodities’ export price ( $pfob$ ) ties, we changed the particular equation referring to the relationship between  $pfob$  and domestic price, as in Equation (2).

$$pfob_{i,r,s} = pmarket_{i,r} + tx_{i,r} + txs_{i,r,s} + ptech_{i,r,s} \quad (2)$$

where

$pmarket_{i,r}$  = domestic market price of commodity  $i$  in region  $r$ ;

$tx_{i,r}$  = destination-generic export taxes on commodity  $i$  originating from region  $r$ ;

$txs_{i,r,s}$  = destination-specific export taxes on commodity  $i$  originating from region  $r$  destined to region  $s$ ;

$ptech_{i,r,s}$  = a new variable, which captures the reduction in the export price of commodity  $i$  originating from region  $r$  destined to region  $s$ .

$ptech_{i,r,s}$  mainly acts as an export augmenting technical change for commodity  $i$  in region  $r$ . Following the standard procedure, we also added the same ( $ptech_{i,r,s}$ ) variable into the equations dealing with export quantities of each commodity  $i$  and to the equation dealing with welfare impacts of any changes in prices resulting from policy shocks to  $ptech_{i,r,s}$ . Our method has the advantage of introducing the change in export prices without changing the government's tax revenues of region  $r$  or  $s$ .

## 2.2. Scenario Design

We established two types of scenarios, i.e., baseline scenario (the business-as-usual scenario without CPEC) and policy scenarios (with CPEC's infrastructure development).

In the baseline scenario (BL), we portray the global economies in the year 2025. We accomplish this by recursively updating the national/regional economies through shocks to capital, labor, and population, which in turn meet the projected growth rates of GDP in each region. The BL scenario reflects the changes expected to occur in the world economy as closely as possible in the coming years. These changes are grouped into two areas: the first deals with each country/region's macroeconomic forecasts, and the other deals with expected policy changes. Projections were obtained for the gross domestic product, gross domestic investment, capital stocks, population, skilled labor, and unskilled labor. These projections were based on the growth estimates of [79].

In order to reflect the changes in trade relations between Pakistan and China due to CPEC's infrastructure development projects, we designed several policy scenarios. These scenarios cover three primary conduits: the increase in trade volume, the decrease in export prices of the commodities trade through the land, and a decrease in export prices of the commodities trade through the sea. The three sets of policy scenarios are described below.

### 2.2.1. Trade Expansion Scenario (TE)

We add a mutual increase in trade between Pakistan and China to the BL scenario under this scenario. This scenario captures the effects of an increase in trade that was not possible (between these two neighboring countries) due to the longer sea route and the time required to transport over that route. The CPEC infrastructure will improve this trade immediately by the land route, which was absent in the GTAP database's baseline. We had detailed interview-based discussions with experts and concluded that the export from Pakistan destined for China could increase by 5–10% of Pakistan's total export ratio to Pakistan's total production in the wake of CPEC land connections. In our model, we have introduced a 5% (a modest) shock in the following equation:

$$QX_{i1}^c = QX_{i0}^c + \left( \frac{QX_{i0}^t}{QO_{i0}^p} \right) \times 0.05 \quad (3)$$

where

$QX_{i1}^c$  = new level of export of commodity  $i$  from Pakistan to China;

$QX_{i0}^c$  = the original level of export of commodity  $i$  from Pakistan to China;

$QO_{i0}^p$  = production of export of commodity  $i$  in Pakistan;

$QX_{i0}^t$  = original level of the total export of commodity  $i$  from Pakistan to all the countries.

China's export to Pakistan will also increase, equivalent in value to the increase in Pakistan's exports  $\left\{ \left( \frac{QX_{i0}^t}{QO_{i0}^p} \right) \times 0.05 \right\}$ . However, the increase in China's export to Pakistan by each commodity is distributed according to China's comparative advantage.

### 2.2.2. Price Reduction Land Scenarios (Land)

This set of scenarios covers the price reduction due to the improved connectivity between Pakistan and China (inland and across the borders) with land infrastructure construction. We set up price reduction shocks based on a detailed literature review and consultation with experts. The literature shows different sizes of reduction in trade costs due to infrastructure development, e.g., [80] adopted a 50% reduction in railway transportation cost; [52] assumed a 25% reduction in road transport cost and 5% reduction in sea transport cost; [60] assumed a 45% lowering of land transport costs. The experts we contacted opined that transportation cost reductions would be even higher for Pakistan and China due to the shared border. Moreover, the export prices of perishable products will decrease considerably more than other commodities.

Based on the above two sources, we assume that all commodities' export prices will decrease (Table 1). For example, the export price of vegetables, fruits, meat, and food products from Pakistan to China will decrease by 18.75%, 18.75%, 15.63%, and 15.63%, respectively. The export prices of cereal grains will decrease by 12.5%, and those of industrial products and natural resources will decrease by the lowest margins, by 6.25%. As China's existing transport infrastructure is far more developed than that of Pakistan, China's export prices for Pakistan will drop by 50% of the corresponding price decrease. The effect will mainly originate from the improved connectivity in China's border regions with Pakistan and the ability of goods to move between both countries year-round without interruptions from weather elements in years to come. The existing road that connects both countries is narrow, but it also gets closed due to snow and land sliding during the winter and spring seasons.

**Table 1.** Land rout Price Shocks to Exports from Pakistan (%) \*.

Sector	Shocks	Sector	Shocks	Sector	Shocks
Rice	12.5	Milk	15.63	Textile + apparel + leather	3.75
Wheat	12.5	Wool	12.5	Ferrous products	6.25
Grains	12.5	Veg oils	12.5	Light manufacturing	6.25
Fruits	18.75	Beverage + tobacco	12.5	Chemical + rubber + plastic	6.25
Vegetables	18.75	Processed food	15.63	Petroleum + coal products	6.25
Oilseeds	12.5	Fish	15.63	Ferrous metals	6.25
Sugar	12.5	Other minerals	6.25	Non-ferrous metals	3.75
Cotton	12.5	coal	6.25	Mineral products nec	6.25
Other crops	12.5	Oil	6.25	Heavy manufacturing	6.25
Ruminants	15.63	Gas	6.25		
Other animals	15.63	Extraction	6.25		

\* China's exports shocks are half of these values.

Furthermore, while implementing the price shocks, we also consider the trade ratio via land and sea routes between Pakistan and China. A tiny part (around 3%) of overall Pakistan–China trade occurs through land transportation [4]. We anticipate that the ratio will change considerably due to the construction of land infrastructure under CPEC and thus have designed three land scenarios with 20%, 35%, and 50% trade between Pakistan and China taking place via land routes (Table 1). The rest of the trade will still go through their original routes (sea and air).

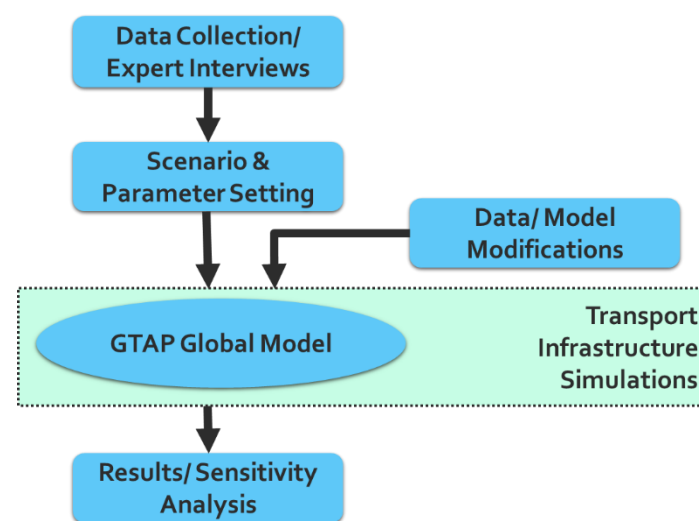
### 2.2.3. Price Reduction—Land and Sea Scenarios (LS)

These scenarios capture the combined effects of price reductions due to land infrastructure and seaport developments (e.g., developments at Gwadar port), i.e., the sea shocks are added on top of land shocks. The corridor will improve sea transportation between Pakistan and China via construction/improvement in inland infrastructure and the Gwadar port's capacity. Specifically, the export prices of commodities from Pakistan to China will decrease by one-third of the corresponding price changes under the land scenario. Like

land scenarios, we assume the same land–sea trade ratios, i.e., 20%, 35%, and 50%. The sea shocks are only applied to Pakistan’s exports to China as the infrastructure for sea transportation in China is already developed and would not affect export prices (Table 2). Figure 1 shows the overall framework for our analysis.

**Table 2.** Land/Sea Trade Ratios used for Price Shocks under Different Policy Scenarios.

Scenario	Land	Sea
Land20	20%	80%
Land35	35%	75%
Land50	50%	50%
LS20	20%	80%
LS35	35%	75%
LS50	50%	50%



**Figure 1.** Analytical framework.

We note that the economic impacts of the infrastructure cost are not analyzed here. Foreign inflows usually have short-term economic benefits through real exchange rate improvement. These benefits may diminish if the inflows are leaked through purchasing imported goods and services. There are also trade-offs related to external debt-servicing (see [81] for a detailed discussion). Our approach does not cover the possible addition of new products or markets or increase in FDI due to improved competitiveness brought by the infrastructure improvement [82].

An ideal model should allow for endogenous switching of the mode of transportation. Our model’s lack of this functionality means that we probably understate the potential gains from transport infrastructure development. Moreover, alternate pathways for impacts of the transport infrastructure developments should be implemented in the model and the scenario design. As for all CGE models, our model only traces the impact of policies through the price mechanism. Changes in transportation costs alter the costs of final goods. These affect households directly through their consumption and indirectly through their ownership of factors, for which the prices shift in response to output price changes. Changes in transfers, such as tax revenues, are also altered. Moreover, cross-border transport infrastructure development gains are not easily separable from domestic infrastructure in our approach [60]. Despite these limitations, our study is expected to offer valuable insights into a critical development issue for Pakistan and China.

### 3. Results and Discussion

In this section, we present the results of the simulations described above.

### 3.1. Impacts on Macroeconomic Indicators

Table 3 reports the macroeconomic impacts regarding projected changes for Pakistan and China, including real GDP, welfare, agricultural exports, and non-agricultural exports. The results show that Pakistan will obtain higher GDP gains under each scenario due to its relatively less-developed transport infrastructure than China. Pakistan and China's projected real GDP changes are most significant under the trade expansion (TE) scenario at around 0.191% and 0.008%, respectively. For Pakistan, the impact of higher volumes of trade with China due to land transportation infrastructure appears to be an essential driver for the GDP rise. This signifies that developing direct and faster land connectivity with a large economy such as China's would yield tremendous gains for smaller economies such as Pakistan's, mainly due to the trade's multiplier effects. Our results align with similar studies [52,61], which also found positive impacts of infrastructure improvement on the national GDP of the participating regions. For example, [61] found that due to infrastructure improvements, GDP growth rates in BRI countries would increase in the range of 0.1% and 0.7% percentage points.

**Table 3.** Effects on Macroeconomic Indicators \*.

Scenarios	Countries	GDP (%)	Welfare (Million USD)	Agricultural Exports (Million USD) **	Non-Agri. Exports (Million USD)
Trade expansion	China	0.008	1265.0	65.7	901.1
	Pakistan	0.191	2064.9	4685.4	4920.7
Land20	China	0.009	1441.0	93.4	1145.5
	Pakistan	0.235	2272.9	5191.6	5564.6
Land35	China	0.009	1579.0	115.0	1332.7
	Pakistan	0.262	2410.8	5599.4	6066.6
Land50	China	0.010	1719.0	137.5	1524.2
	Pakistan	0.287	2543.4	6033.5	6584.4
LS20	China	0.009	1585.0	95.5	1176.7
	Pakistan	0.274	2429.5	5961.7	6477.8
LS35	China	0.009	1700.5	116.8	1359.1
	Pakistan	0.291	2529.6	6257.9	6827.6
LS50	China	0.01	1817.0	138.9	1545.1
	Pakistan	0.308	2630.6	6565.4	7178.4

\* Deviation from the base in 2025. \*\* Mutual exports between Pakistan and China. Source: Simulation results.

When we add the impact of export price reduction on top of the trade expansion (TE) scenario, we see a considerable improvement in GDP gains, especially for Pakistan. For example, Pakistan and China are projected to gain 0.287% and 0.01% in their respective real GDPs under the Land50 scenario in 2025, which depicts FOB price reductions between Pakistan and China, assuming that 50% (probably the upper limit) of the mutual trade between the two nations will take place via land transportation. The impacts of lower trade ratios through land transportation are 0.262% and 0.235% on Pakistan and 0.09% and 0.09% on China, respectively, under Land35 and Land20 scenarios. The projected gains in both countries' GDP further increase if we consider the effects of land transport development and seaport improvements (the latter is considered only in Pakistan). Specifically, moving from a lower ratio of trade via land (LS20) towards a higher ratio (LS50), real GDPs are expected to increase between 0.274% and 0.308% for Pakistan and 0.009% and 0.01% for China, respectively (Table 3).

The change in economic welfare measured as the equivalent variation in income in the GTAP model is also favorable for both Pakistan and China. Under the trade expansion scenario, the combined welfare gains for both Pakistan and China are estimated to be over USD 3.3 billion, with Pakistan receiving higher gains (USD 2.0 billion) than China (1.3 billion USD). This is caused mainly by allocating resources to more productive activities due to better transportation infrastructure and improvement in terms of trade. The FOB



price reduction scenario with 50% of trade through land transport (Table 3, rows 7–8) will improve Pakistan and China's welfare by USD 2.5 billion and USD 1.7 billion, respectively. The welfare impacts of land plus sea routes on Pakistan and China are even more prominent. The welfare impacts arising from reductions in trade costs caused by investment in infrastructure are similar to those found by [61], which also found Pakistan to gain the largest welfare gains. The study by [63] also found significant positive impacts on China's welfare under infrastructure investment.

Following the reduction in trade cost, exports between both countries would increase considerably (Table 3). Pakistan, a traditional exporter of agricultural commodities to China (and the rest of the world), will see a significant increase in its agricultural exports to China under all scenarios. The same is true for China's non-agricultural exports to Pakistan. For example, Pakistan's agricultural exports to China will increase by USD 6.0 billion and USD 6.5 billion, under Land50 and LS50 scenarios, respectively. Exports of non-agricultural commodities from China to Pakistan will increase by USD 1.52 billion and USD 1.54 billion, under Land50 and LS50 scenarios, respectively. Although the price of non-agricultural commodities will decrease by much larger margins than the ones for agricultural commodities, due to a much higher base level, the exports of non-agricultural commodities from Pakistan to China will increase by relatively higher values under Land50 (USD 6.6 billion) and LS50 (USD 7.2 billion) scenarios. The exports of agricultural commodities from China to Pakistan will increase by much smaller amounts under the respective scenarios. These findings highlight the significance of reducing land and sea transportation costs for Pakistan's economy. Other studies on infrastructure development [52,60,61] also found similar results on export promotion.

### 3.2. Effects on Sectoral Output

One of the key benefits of a CGE simulation is that it also generates information on sectoral changes. Changes in the affected economy's production structure are critical because they indicate which sectors will be impacted by the proposed policy and indicate the potential degree of structural adjustment needed in the wake of such policy.

The enhanced trade due to transport infrastructure development in Pakistan and China under CPEC projects will also cause some changes in the domestic production structures, especially for Pakistan (Tables 4 and 5). Regarding agricultural output, under the trade expansion (TE) scenario, the rice, fruits, and beverage, plus tobacco, sectors of Pakistan will expand by the highest margins of 2.13%, 1.20%, and 1.04%, respectively. Wool (−3.25%), cotton (−1.31%), and other crops (−1.13%) sectors of Pakistan show the highest contractions under the trade-expansion scenario. Under the same scenario, for China, rice and fruits contract by −1.01% and −0.001%, whereas all the other sectors expand by slight margins (Table 4). In our study, China's results seem to differ from the findings of [63], which showed a contraction of agricultural output due to infrastructure investment under BRI.

As we move from land only (Land) to land plus sea (LS) scenarios, the impacts on Pakistan and China's sectoral outputs keep increasing, only with a few exceptions. For example, Pakistan's milk and processed oil sectors will contract less under the price reduction scenarios than the TE scenario. This is caused by more exports of these commodities from Pakistan to China via land routes.

**Table 4.** Effects on outputs of agricultural sectors in Pakistan and China (%).

Commodity	Trade Expansion		Land20		Land35		Land50		LS20		LS35		LS50	
	China	Pakistan	China	Pakistan	China	Pakistan	China	Pakistan	China	Pakistan	China	Pakistan	China	Pakistan
Rice	−1.009	2.133	−1.09	2.27	−1.149	2.369	−1.212	2.477	−1.202	2.452	−1.24	2.53	−1.288	2.6
Wheat	0.031	−0.022	0.03	0	0.034	0.006	0.036	0.012	0.036	0.003	0.04	0.01	0.037	0.012
Grains	0.015	0.888	0.02	0.92	0.015	0.947	0.016	0.974	0.015	0.964	0.02	0.98	0.016	1.002
Fruits	−0.001	1.203	0	1.34	−0.003	1.457	−0.004	1.578	−0.004	1.568	0	1.65	−0.005	1.737
Vegetables	0.01	0.462	0.01	0.44	0.014	0.425	0.016	0.413	0.013	0.482	0.02	0.46	0.017	0.447
Oilseeds	0.085	0.294	0.09	0.31	0.09	0.315	0.092	0.321	0.094	0.311	0.09	0.32	0.096	0.321
Sugar	0.034	0.446	0.04	0.5	0.037	0.542	0.039	0.579	0.04	0.544	0.04	0.57	0.041	0.6
Cotton	0.058	−1.312	0.06	−1.38	0.055	−1.445	0.054	−1.518	0.054	−1.501	0.05	−1.55	0.053	−1.606
Other crops	0.128	−1.133	0.19	−1.28	0.237	−1.397	0.288	−1.515	0.205	−1.437	0.25	−1.530	0.298	−1.615
Ruminants	0.007	0.0295	0	0.11	0.003	0.21	0	0.294	0.001	0.252	0	0.300	−0.003	0.366
Other animals	0.024	0.302	0.03	0.36	0.027	0.397	0.029	0.441	0.029	0.413	0.03	0.45	0.031	0.482
Milk	0.01	−0.254	0.01	−0.22	0.006	−0.198	0.004	−0.184	0.005	−0.199	0	−0.19	0	−0.18
Wool	0.168	−3.252	0.17	−3.53	0.179	−3.766	0.185	−4.013	0.189	−3.944	0.19	−4.11	0.195	−4.288
Veg oils	0.031	−0.332	0.03	−0.28	0.028	−0.238	0.027	−0.202	0.027	−0.237	0.03	−0.21	0.025	−0.178
Beverage + tobacco	0.001	1.036	0	1.08	0.003	1.113	0.003	1.143	0.003	1.116	0	1.14	0.004	1.162
Processed food	0.02	0.404	0.02	0.45	0.023	0.485	0.024	0.517	0.023	0.502	0.02	0.52	0.025	0.547
Fish	0.01	0.072	0.01	0.08	0.011	0.091	0.011	0.098	0.011	0.093	0.01	0.1	0.012	0.102

Source: Simulation results.

**Table 5.** Effects on outputs of non-agricultural sectors in Pakistan and China (%).

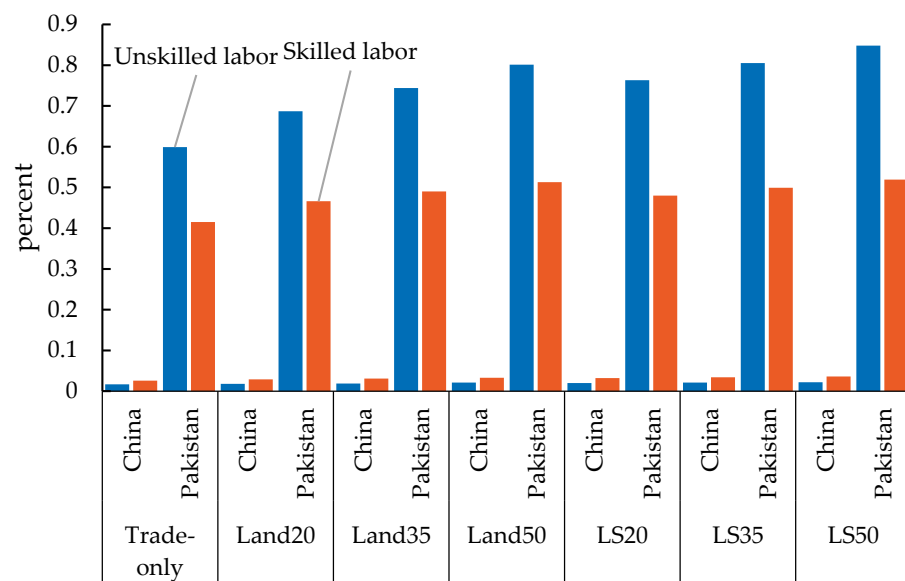
Commodity	Trade Expansion		Land20		Land35		Land50		LS20		LS35		LS50	
	China	Pakistan	China	Pakistan	China	Pakistan	China	Pakistan	China	Pakistan	China	Pakistan	China	Pakistan
Other minerals	0.007	0.242	0.01	0.28	0.007	0.314	0.007	0.345	0.007	0.337	0.01	0.36	0.007	0.38
Coal	0.004	−0.007	0	−0.01	0.005	−0.01	0.005	−0.011	0.005	−0.01	0.01	−0.01	0.005	−0.011
Oil	0.003	−0.039	0	−0.05	0.003	−0.049	0.003	−0.053	0.003	−0.051	0	−0.05	0.003	−0.057
Gas	−0.001	−0.021	0	−0.02	−0.001	−0.025	−0.002	−0.027	−0.001	−0.026	0	−0.03	−0.002	−0.029
Extraction	0.01	−0.103	0.01	−0.12	0.011	−0.129	0.011	−0.139	0.012	−0.134	0.01	−0.14	0.012	−0.149
Textile + apparel + leather	0.015	−0.932	0.01	−0.92	0.007	−0.935	0.004	−0.957	0.004	−0.953	0	−0.97	0	−0.995
Ferrous products	0.004	−0.438	0	−0.47	0.004	−0.49	0.003	−0.507	0.004	−0.491	0	−0.5	0.004	−0.509
Light manufacturing	0.011	−0.393	0.01	−0.47	0.012	−0.517	0.013	−0.569	0.013	−0.546	0.01	−0.58	0.014	−0.619
Chemical + rubber + plastic	0.016	−0.919	0.02	−1.07	0.02	−1.172	0.022	−1.281	0.02	−1.147	0.02	−1.24	0.023	−1.332
Petroleum + coal products	0.009	−0.024	0.01	−0.03	0.012	−0.041	0.014	−0.05	0.012	−0.024	0.01	−0.04	0.014	−0.047
Ferrous metals	0.01	−0.073	0.01	0.15	0.011	0.351	0.011	0.561	0.011	0.587	0.01	0.72	0.012	0.862
Non-ferrous metals	0.012	−2.045	0.01	−1.3	0.01	−0.686	0.009	−0.041	0.012	−0.168	0.01	0.27	0.01	0.679
Mineral products nec	0.011	0.683	0.01	0.62	0.013	0.581	0.014	0.537	0.013	0.671	0.01	0.62	0.015	0.567
Heavy manufacturing	0.01	−1.155	0.01	−1.2	0.009	−1.234	0.009	−1.259	0.011	−1.225	0.01	−1.24	0.01	−1.254

Source: Simulation results.

Table 5 shows that most of the non-agricultural sectors of Pakistan will shrink, and those of China will expand (though only marginally) under our simulations. Notably, in Pakistan, non-ferrous metals (−2.04%), heavy manufacturing (−1.15%), textile and apparel (−0.93%), and chemical, rubber, and plastic (−0.91%) sectors will undergo the most significant decline in their outputs under the trade expansion scenario. For China, on the other hand, non-ferrous metals, heavy manufacturing, and chemical, rubber, plastic are the leading sectors showing expansion, though the magnitudes are pretty small. The scenarios with a reduction in FOB price effects demonstrate that few sectors show different trends than those under the trade expansion scenario. For example, when compared with the trade-expansion scenario, some sectors of Pakistan either start expanding rather than shrinking (ferrous products), whereas some others, such as non-ferrous metals, at first show gradually less decline in output under the land scenarios before they start to expand under LS scenarios (Table 5). This could be explained by the relatively higher demand of these sectors (both for domestic use as intermediate inputs and for exports) due to reduced FOB prices under land plus sea transportation development scenarios. China's sectoral outputs do not show any such reversal of sign or size as we move from the trade expansion scenario to the export price reduction scenarios.

Two implications of the changes in sector outputs due to transport infrastructure development under CPEC are worth mentioning here, viz., structural adjustment costs and changes in relative wages of skilled and unskilled labor. Overall, the significant output shifts indicate that transportation infrastructure development would have a moderate to low impact on production structures and minimal adjustment costs. As expected, the production shifts are more pronounced in Pakistan due to its smaller economic size than China, and these areas may need some adjustment assistance, albeit probably minimal.

For Pakistan, the sectors with the largest expansion are also the country's largest producers and usually have high transport costs. These findings indicate a consolidation trend for Pakistan. Stone Hertel [60] also showed that some countries would experience consolidation due to transport infrastructure projects. For China, on the other hand, the structural adjustment costs will be negligible. Many of Pakistan's traditionally export-oriented agricultural sectors expand, which will induce a sizeable rise in the wages for the labor (most of which are unskilled rural labor) employed in these sectors. Predominantly, the non-agricultural sectors shrink in Pakistan, which will reduce the wage rates for the labor (mostly skilled or semi-skilled urban labor) of these sectors (Figure 2). The overall effects would be a rise in rural residents' incomes and a slight decline in the urban population's incomes. The result could be a decrease in the gap between rural-urban incomes. Moreover, the rising wages would also encourage labor movement from non-agricultural sectors to agriculture in Pakistan. The wages for unskilled labor in China would rise more than those for skilled labor. Maliszewska [61] also showed that Pakistan's unskilled wages would rise more relative to skilled. Our results for wage changes in Pakistan are opposite [60], which found a higher rise in skilled wages than unskilled wages in the Greater Mekong Subregion that would benefit the urban households more than rural ones.



**Figure 2.** Changes in wages in both countries by labor type compared to baseline. Source: Simulation results.

### 3.3. Effects on Bilateral Trade

Table 6 presents the effects of CPEC infrastructure on bilateral trade between Pakistan and China in volumetric and percentage forms. Under the policy scenarios, Pakistan's agricultural and food exports to China will grow between 8.5 to 12 times (Table 6, lower half). This translates into additional export of agricultural and food commodities from Pakistan to China between USD 4.7 billion to USD 6.6 billion (Table 6, upper half). With an additional export of over USD 3.9 billion to USD 5.1 billion, rice would be the main commodity seeing increased export from Pakistan to China. Livestock (cattle) and horticultural products will be the other significant contributors to increased exports of agricultural commodities from Pakistan to China. For horticultural crops, vegetable exports from Pakistan to China will increase 15 to 22 times under the policy scenarios. An increase in fruit exports will be on the lower side, ranging from 2.4 times to 3.9 times.

Given that Pakistan's base exports of the horticultural commodities to China are relatively low, i.e., USD 49 million for fruits and only USD 1.1 million for vegetables, the quantity effects of CPEC on these exports are moderate. Notably, the exports from Pakistan to China will increase between USD 116 million to USD 191 million for fruits and between USD 164 million to USD 240 million for vegetables. One should be reminded that these are only one-off effects, which in practice would keep on accruing over the years after CPEC transportation infrastructure is put into place. A study involving impact assessment of infrastructure improvements in BRI regions [61] demonstrates opposite effects on Pakistan's exports, i.e., due to cheaper imported inputs and higher foreign demand exports of many manufacturing sectors (processed foods and chemicals, rubber, and plastics) would increase, whereas agricultural exports would decrease. The difference is due to broader coverage of regions involved (BRI countries) in [61] than our study (Pakistan and China only) and reduction in trade tariffs with all trading partners, which are significant impediments to Pakistan's export of many non-agricultural sectors.

**Table 6.** Effects on bilateral trade between Pakistan and China.

		Agri. + Food	Extraction + Mining	Light Manufacturing	Heavy Manufacturing	Service	Total
<b>Quantitative Effects (Million USD)</b>							
Trade-only	Chn-Pak	65.7	12.6	454.0	393.5	41.1	966.8
	Pak-Chn	4685.4	10.4	2614.9	896.0	1399.4	9606.0
20%FOB + Trade	Chn-Pak	93.4	13.1	601.2	488.5	42.7	1238.9
	Pak-Chn	5191.6	17.3	3068.4	1047.0	1431.8	10,756.1
35%FOB + Trade	Chn-Pak	115.0	13.5	714.0	561.3	43.9	1447.7
	Pak-Chn	5599.4	22.6	3417.0	1169.7	1457.3	11,666.0
50%FOB + Trade	Chn-Pak	137.5	14.0	829.4	635.8	45.0	1661.7
	Pak-Chn	6033.5	27.8	3774.0	1299.6	1482.9	12,617.9
20%LS + Trade	Chn-Pak	95.5	13.2	621.2	499.2	43.1	1272.1
	Pak-Chn	5961.7	27.0	3698.0	1274.6	1478.2	12,439.5
35%LS + Trade	Chn-Pak	116.8	13.6	731.0	570.3	44.2	1475.9
	Pak-Chn	6257.9	30.5	3938.3	1363.7	1495.1	13,085.5
50%LS + Trade	Chn-Pak	138.9	14.0	842.8	643.1	45.3	1684.1
	Pak-Chn	6565.4	34.0	4174.2	1458.4	1511.8	13,743.7
<b>Percentage Effects (%)</b>							
Trade-only	Chn-Pak	16.5	78.5	10.7	16.0	44.2	13.4
	Pak-Chn	854.8	2.0	37.4	96.0	142.2	96.1
20%FOB + Trade	Chn-Pak	23.5	82.1	14.2	19.8	46.0	17.2
	Pak-Chn	947.2	3.3	43.8	112.2	145.5	107.6
35%FOB + Trade	Chn-Pak	28.9	84.8	16.9	22.8	47.2	20.1
	Pak-Chn	1021.6	4.3	48.8	125.4	148.1	116.8
50%FOB + Trade	Chn-Pak	34.6	87.5	19.6	25.8	48.5	23.1
	Pak-Chn	1100.8	5.3	53.9	139.3	150.7	126.3
20%LS + Trade	Chn-Pak	24.0	82.5	14.7	20.3	46.4	17.7
	Pak-Chn	1087.7	5.1	52.8	136.6	150.3	124.5
35%LS + Trade	Chn-Pak	29.4	85.1	17.3	23.2	47.6	20.5
	Pak-Chn	1141.7	5.8	56.3	146.1	152.0	131.0
50%LS + Trade	Chn-Pak	35.0	87.8	19.9	26.1	48.8	23.4
	Pak-Chn	1197.8	6.5	59.6	156.3	153.7	137.5

Chn-Pak = China's exports to Pakistan; Pak-Chn = Pakistan's exports to China. Source: Simulation results.

### 3.4. Sensitivity Analysis

The results of most economic simulation models depend highly on the size of shocks to exogenous variables and choices of exogenous parameters. The shock size may involve a certain degree of uncertainty, requiring us to assess whether our results depend too much on shock size. On the other hand, the exogenous parameters may be based on econometric estimations, and their size may have crucial impacts on model results [83]. For example, the GTAP model has an Armington parameter (*ESUBD*) determining substitutability between domestic and imported commodities. The 'Systematic Sensitivity Analysis' (SSA) approach demonstrates how the analyst makes explicit assumptions regarding the probability distributions of the exogenous model inputs that are not known with certainty. It provides us with statistical estimations of the probability distributions of the model results, such as means and variances (discussed in detail in [84]).

To evaluate the reliability of our GTAP-based general equilibrium simulation results, we look at two separate uncertainty checks through SSA: (1) Shocks to variable '*ptech<sub>i,r,s</sub>*' (Equation (2)), which we vary by  $\pm 10\%$  of the values used under the LS50 scenario. The results show that the welfare gains for Pakistan and China, a key variable for impact assessment, have a high degree of reliability. For Pakistan, the mean value welfare change under SSA is USD 2651.2 million (USD  $\pm 21.0$  million), which means that our result under SL50 (USD 2630.6 million) is very close to the mean value and well within the 95% confidence limit (USD 2609–2651 million). (2) We also perform a  $\pm 10\%$  check on the value of the parameter '*ESUBD*' used under the LS50 scenario. The mean change in welfare for Pakistan under this set of SSA results is USD 2633.2 million (USD  $\pm 88.9$  million), showing that our outcome (USD 2630.6 million) is almost the same as the mean value under SSA and lies within the 95% confidence interval of USD 2544.3–2733.2 million. The SSA outcomes further show that our results are more sensitive to exogenous parameter values than the size of the shock to the exogenous variable.

For China, on the other hand, the exports of agricultural and food commodities to Pakistan will grow by 16–35% under the same policy scenarios (Table 6, lower half). These

changes would be equivalent to volumetric changes between USD 66 million and USD 139 million (Table 6, upper half). China's horticultural exports to Pakistan will increase, with fruits seeing higher growth than vegetables. Specifically, China's exports to Pakistan will increase over a range of 18–39% for fruits and 5–22% for vegetables. In value terms, fruit exports from China to Pakistan will increase by USD 4.7 million to USD 10 million, whereas vegetable exports will increase by USD 5.5 million to USD 26 million. Despite the higher percentage changes in China's fruit exports to Pakistan, the exports of vegetables from China to Pakistan show a relatively higher quantity increase due to the considerable baseline export value of vegetables. Our results for China's export are different from findings by [61], which found a higher increase in agricultural exports (7.2% in 2030) under BRI infrastructure improvements than manufacturing sectors (2.7%).

#### 4. Conclusions

This study attempts to explain the relationship between infrastructure development, the overall growth of the economy, and sectoral effects in two neighboring countries with less than optimum trade integration. We use a quantitative method (CGE approach) to assess the likely impacts of the transport infrastructure of CPEC on Pakistan and China, as opposed to the qualitative discussions in earlier studies. Due to the inherent ability to track the changes in all the interlinking sectors of the economy, the model, in principle, can show all the first and second-order effects of the transport infrastructure development. The overall results are, in many ways, similar to the results of other studies in the field, such as [52,60,61,85,86].

These investments in transport infrastructure development in Pakistan and China will increase the mutual trade between Pakistan and China (as a stand-alone effect) and further decrease the export (FOB) prices of commodities traded. Our results confirm that the transport infrastructure development under CPEC has a non-trivial effect on both countries, especially Pakistan. Pakistan would enjoy relatively higher GDP and welfare gains from the transport infrastructure development under CPEC due to higher transport costs than China under the baseline. In terms of agricultural trade, our analysis shows that Pakistan can increase its export to China for more perishable commodities such as horticultural products (fruits and vegetable groups). Vegetable exports show far more considerable potential in percentage terms than fruits. This could be attributed to (1) Pakistan's higher comparative advantage in vegetable production than fruit production; (2) the opening of land connections would facilitate the vegetable exports by higher margins due to the relative perishability of vegetables compared with fruits. On the other hand, China will see more substantial increases in exports for fruits (percentage terms) to Pakistan. Thus, both countries will expand the mutual horticultural trade, with Pakistan enjoying a better deal.

Reduced regional disparities due to the leveling of wage rates among unskilled and skilled labor should be taken as an impetus to reduce extreme poverty, especially in rural areas. The policymakers need to make sure that gains from these projects also reach the smallholder farmers through equitable and inclusive policies. Pakistan needs to adopt and implement policy instruments to improve the productivity and quality of agricultural products to materialize these potential gains in agricultural exports to China fully. The modernized marketing system is another critical area to capture this export potential. Moreover, the policymakers should address the likely issues of structural adjustment costs and the wage impacts of the transport infrastructure development projects under CPEC. These adjustment costs could be considerably higher in Pakistan (a smaller economy) than in China.

The realization of potential benefits from transportation development under CPEC could also be affected by several challenges. Pakistan's security, political, regulatory, and government effectiveness and credit risk ratings could come into play. For instance, Pakistan needs to ensure risk-free security and a stable political environment to implement CPEC projects successfully. Both Pakistan and China are at different levels of economic stability, demanding a more serious effort in coordinating their economic priorities to

implement CPEC projects. Therefore, both countries should engage in an inclusive and highly consultative process to resolve any remaining issues.

**Author Contributions:** Conceptualization, T.A. and J.H.; methodology, T.A., J.H. and W.X.; software, T.A. and W.X.; validation, T.A. and J.H.; investigation, T.A. and J.H.; resources, J.H., W.X. and T.A.; writing—original draft preparation, T.A., J.H. and W.X.; writing—review and editing, T.A., W.X. and J.H.; supervision, J.H.; funding acquisition, J.H. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by the National Natural Science Foundation of China (Grant No. 71934003; No. 71873009; No. 71922002) and Australian Centre for International Agricultural Research (ACIAR) (Grant No. ADP/2014/043).

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

### *Appendix A.1. Pakistan's Agricultural Trade and CPEC*

#### Appendix A.1.1. Pakistan's Overall and Agricultural Trade

Pakistan's foreign trade has increased rapidly during the last two decades (Figure A1a). However, imports have increased much more quickly than exports during the same period. The situation has left Pakistan with an ever-increasing negative trade balance with the rest of the world. Specifically, in 2003, Pakistan's total exports of 11.9 billion USD were comparable to the total imports of 13 billion USD. However, by 2016, Pakistan's imports had risen to 47 billion USD, whereas its exports were 20.5 billion USD, resulting in a trade deficit of 26.5 billion USD. Putting in perspective, Pakistan's total trade deficit in 2016 was over 9.3% of its GDP in that year. Pakistan's significant import commodities include crude oil, chemicals, heavy manufacturing, non-ferrous metals, and edible oils. These commodities are mostly imported from (in descending order) China, Saudi Arabia, United Arab Emirates, EU, Malaysia, and Kuwait. Pakistan's major export destinations include (in descending order) the EU, USA, China, Saudi Arabia, UAE, and Afghanistan.

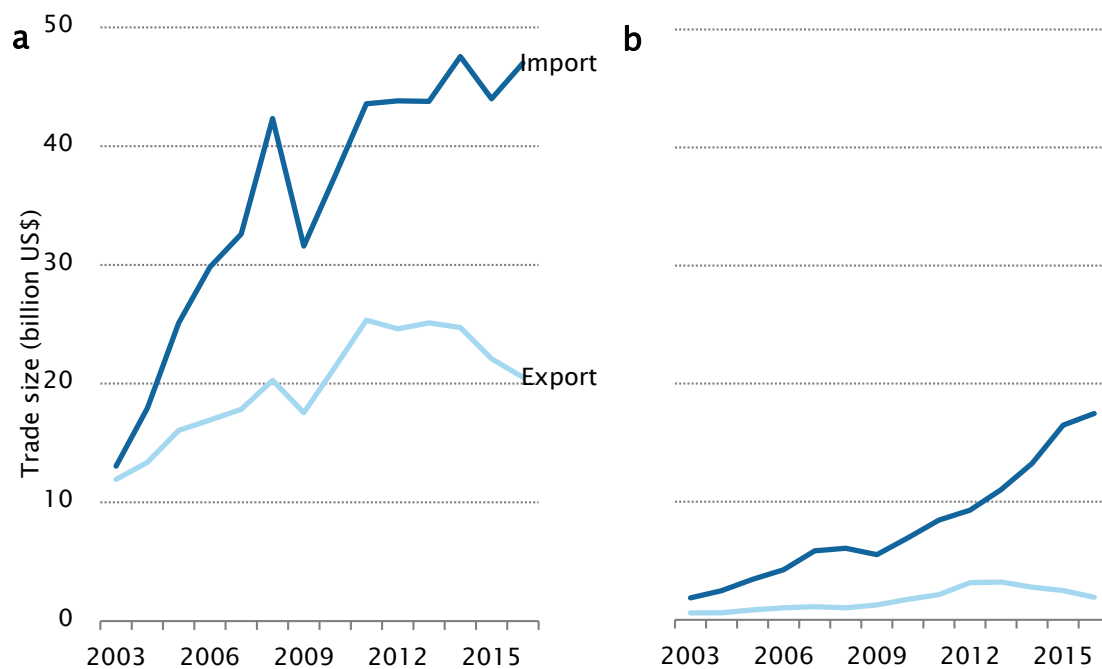
Regarding agricultural trade, the export of the major agricultural commodities from Pakistan has been increasing at a relatively slow pace since the early 2000s (Table A1). Pakistan exports high volumes of cotton (mainly to China), followed by cereals. The exports of perishable commodities, such as vegetables, fruits, and meat products, have been relatively low over the last decade. On the other hand, Pakistan has been importing large volumes of edible oils (mostly from Malaysia). Cotton, vegetables, and fruits have been other major agricultural imports by Pakistan. The imports of the agricultural commodities have shown a relatively higher rate of increase than the export commodities from Pakistan.

China—the principal partner of CPEC with Pakistan—has emerged as a significant trading partner with Pakistan in recent years, with trade balance overwhelmingly tilting towards China (Figure A1b). Pakistan's total exports to China have grown steadily over the last decade. However, the corresponding imports have increased rapidly, so much so that Pakistan's total trade deficit with China had grown from USD 1.3 billion in 2003 to over USD 15.5 billion in 2016. The trade deficit with China was about 59% of Pakistan's total trade deficit in 2016, which signifies the increasing importance of China's role in Pakistan's trade.

Pakistan's trade in agricultural commodities with China has been low and confined to a few commodities (Table A1). On the plus side, Pakistan has maintained a positive trade balance in agricultural commodities with China during 2003–2016. Cotton is the dominant export from Pakistan to China, with an average yearly export of USD 500 million to China,



reaching a maximum of USD 2173 million in 2013, before reverting to USD 1034 million in 2016. Perishable commodities such as meats, fish, vegetables, and fruits are among Pakistan’s top five agricultural exports to China. However, the export of these commodities to China has been very low compared with their total exports to the world, and has shown little or no increase over the years. Pakistan has been exporting substantial quantities of processed food, animals, and fish to the world; however, China’s share in these exports has been marginal (Table A1). During 2003–2016, Pakistan’s overall agricultural imports from China were much lower than exports but showed a higher range of commodities (Figure A1b and Table A1). Pakistan’s top agricultural imports from China include cotton (increased volumes after 2012), vegetables and fruits (relatively higher average imports over 2003–2016), and other crops (with an increasing trend).



**Figure A1.** Pakistan’s total exports and imports during 2003–2016. (a), with the world; (b), with China. Source: Authors used data from [78] to draw this figure.

**Table A1.** Pakistan’s trade in major agricultural commodities worldwide and with China during 2003–2016 (million USD).

	Global					China					
	Exports from Pakistan					Exports from Pakistan					
	2003	2007	2010	2013	2016		2003	2007	2010	2013	2016
Cotton	2532.7	3439.6	4013.4	5333.8	3497.4	Cotton	453.1	733.8	1087.8	2173.2	1033.8
Cereals	667.0	1244.1	2279.6	2181.0	1717.1	Animal Prod.	27.2	71.3	94.1	148.9	85.6
Animals	280.4	455.8	596.0	808.6	616.4	Cereals	0.0	0.2	0.4	172.4	250.6
Food	118.8	342.9	370.4	841.7	605.1	Food	0.2	9.9	46.8	53.1	36.3
Vege + Fruit	171.5	197.7	373.7	682.9	611.5	Fish	9.6	18.7	37.2	32.5	51.7
Fish	137.9	161.1	231.0	333.1	336.4	Vege + Fruit	1.1	2.3	7.3	42.5	38.7
	Imports by Pakistan					Imports by Pakistan					
Edible oils	999.0	1802.6	2480.2	2458.7	2975.9	Cotton	6.8	18.7	45.5	78.3	249.0
Cotton	418.4	981.1	1594.7	1647.0	2419.2	Vege + Fruit	21.0	69.9	125.2	43.8	119.6
Vege + Fruit	294.2	677.7	673.5	1517.0	929.5	Crops other	6.3	33.5	53.8	51.4	144.6
Crops other	318.5	917.8	830.9	1046.7	719.3	Food	14.6	31.1	67.5	51.6	75.7
Food	120.7	403.4	624.5	632.7	1282.2	Sugar	12.7	152.1	38.3	23.5	16.7
Cereals	225.9	268.2	423.5	412.4	673.0	Cereals	2.5	12.1	38.5	63.5	59.0

Source: Authors’ compilation based on data from [78].

### Appendix A.1.2. Core Components of CPEC

CPEC is a regional connectivity framework with potential benefits for Pakistan, China, and the adjoining regions [3]. With a total investment of over USD 62 billion total, the corridor will run about 3000 km from Kashgar (China) to Gwadar (Pakistan) and is expected to be completed by 2025–2030. The investment size is unprecedented and is equivalent to over 21% of Pakistan’s GDP in 2016. The connectivity projects are expected to significantly improve Pakistan’s domestic transportation and reduce transportation distance from China to the Middle East, Africa, and Europe. For China’s foreign trade to the Middle East and Europe, compared with waterborne transportation via the Strait of Malacca, CPEC will save a journey of around 10,000 km. CPEC will also boost Xinjiang’s economic development in China and North-East Pakistan (Kashgar and Gwadar, respectively) [87–90]. A detailed description of the critical components of CPEC is given below.

#### Road and Rail Projects

CPEC is mainly a corridor of economic activities. In terms of connectivity, the rail and highway network start from China’s Xinjiang province, enters Pakistan from the Khunjaberb border, and transverses through mountainous regions of northern Pakistan before entering the plains of Indus valley connecting with Gwadar port on the Arabian Sea in the south. The highway/rail network of CPEC will run through three main routes (Figure A2):

1. Western Route: (2674 km) connects the Punjab, KPK, and Baluchistan provinces with Gwadar.
2. Central Route: (2756 km) passes through KPA, southern Punjab, and Sindh provinces before reaching Gwadar.
3. Eastern Route: (2781 km) consists of three motorways (M2, M3, and M5) and connects major industrial hubs of Lahore, Multan, Sukkur, Hyderabad, and Karachi with Gwadar Port in Pakistan.

These three routes will cover the construction of new infrastructure and expansion, upgrading, and extension of several existing rail and road tracks [3].

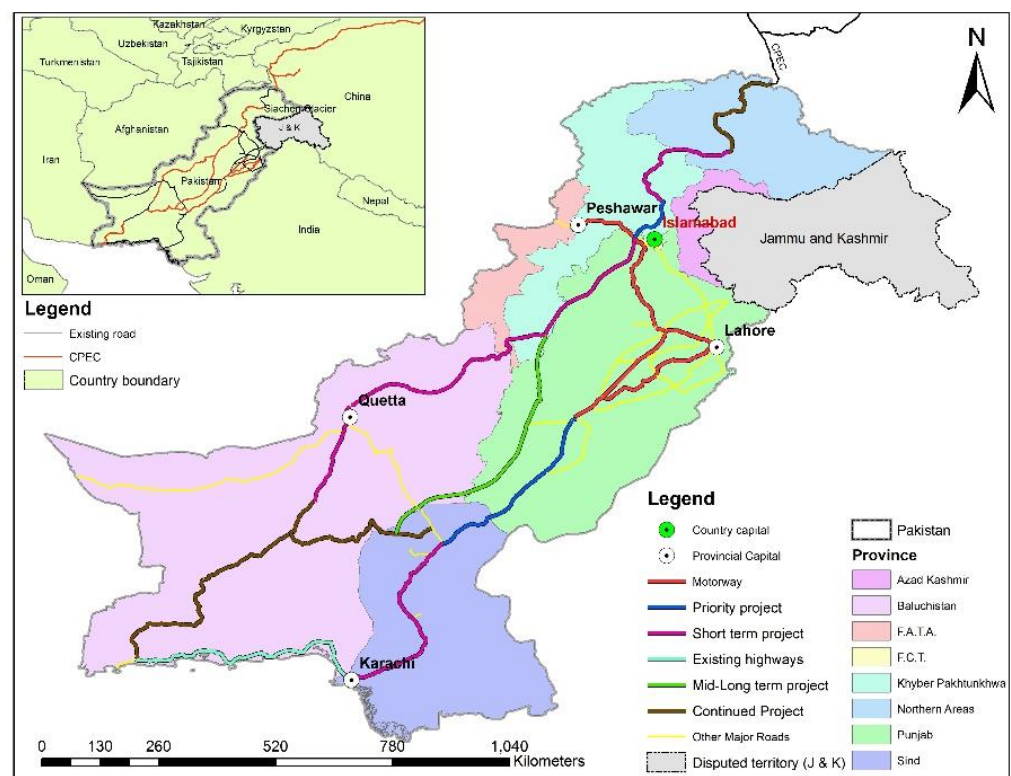


Figure A2. Highway network of CPEC. Source: Based on information from [3].

### Energy Projects

More than 50% of the CPEC's investment will be allocated to 23 energy projects costing around USD 34 billion that can help overcome the chronic electricity shortage in Pakistan. The projects will increase power production by 16,695 MW for Pakistan. There are 15 priority projects, costing USD 21.6 billion with a capacity of 10,350 MW, and were scheduled to be completed by mid-2018. Another eight projects costing USD 12 billion will improve power production capacity by 6345 MW later. Most energy projects will produce electricity using coal, whereas others include hydropower, nuclear, wind, and solar power stations. The electricity transmission and distribution system will also be improved and expanded under CPEC [3].

### Other Components of CPEC

More than nine special economic zones (SEZ) will be developed to improve the economic viability and penetration of the corridor. These SEZs will produce specific products and services based on the availability of local raw materials and other geographic factors. The highway and rail network will provide an efficient transportation system having positive multiplier effects via better accessibility to the markets, additional investments, job creation, technology transfer, boosting economic activity, social and economic development. These SEZs will further boost bilateral economic ties and expand trade cooperation between China and Pakistan.

Along with the projects mentioned above, the deep-sea port at Gwadar will also be constructed and operated under CPEC. Additionally, CPEC also covers the construction of several mass-transit projects for several metropolitans of Pakistan. Both countries have also pledged to increase people-to-people exchanges, enhance the transfer of knowledge in different sectors primarily through experts from China delivering training to human resources in Pakistan, and transfer of knowledge in the education sector by establishing a consortium of business schools [3].

### *Appendix A.2. Regional Aggregation Used in the GTAP Model*

**Table A2.** GTAP Regional Aggregation.

Sr. No.	Country/Region	Sr. No.	Country/Region
1	China	9	Australia/New Zealand
2	Pakistan	10	North America
3	India	11	South America
4	East Asia	12	EU28
5	Southeast Asia	13	Middle East
6	Rest of South Asian	14	Africa/Caribbean
7	Central Asia	15	Rest of the World
8	Russia		

Source: Authors work on the GTAP model.

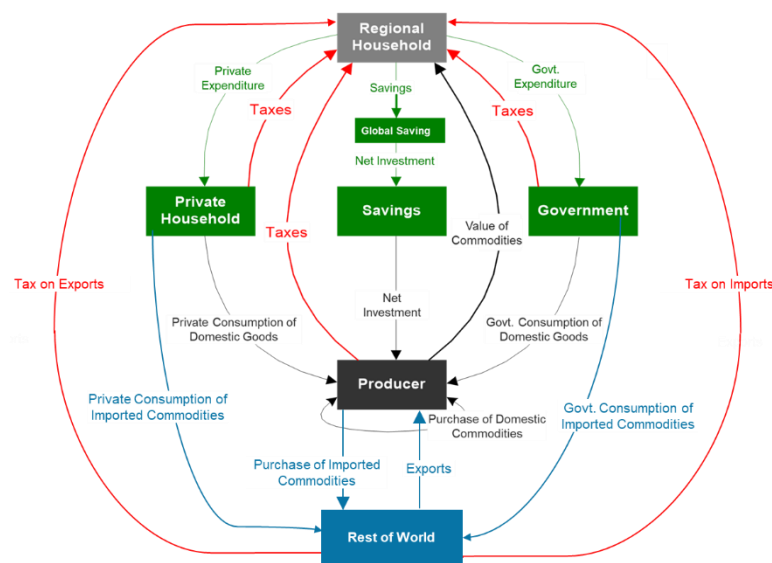


Figure A3. Outline of GTAP model. Source: Based on [91].

## References

1. State Council of the People's Republic of China. *Full Text: Action Plan on the Belt and Road Initiative*; State Council of the People's Republic of China: Beijing, China, 2015. Available online: [http://english.gov.cn/archive/publications/2015/03/30/content\\_281475080249035.htm](http://english.gov.cn/archive/publications/2015/03/30/content_281475080249035.htm) (accessed on 10 February 2021).
2. State Council of the People's Republic of China. *Silk Road Fund's 1st Investment Makes China's Words into Practice*; State Council of the People's Republic of China: Beijing, China, 2015. Available online: [http://english.gov.cn/news/top\\_news/2015/04/21/content\\_281475093213830.htm](http://english.gov.cn/news/top_news/2015/04/21/content_281475093213830.htm) (accessed on 10 February 2021).
3. GoP (Government of Pakistan). CPEC Secretariat: Ministry of Planning, Development & Reform, Pak-Secretariat: Islamabad, Pakistan. 2017. Available online: <http://www.cpec.gov.pk/faqs> (accessed on 10 October 2017).
4. KCCI. *China Pakistan Economic Corridor: Is Pakistan Ready to Surf the Tide?* Infonalysis; Research and Development Cell; Karachi Chamber of Commerce and Industry: Karachi, Pakistan, 2017. Available online: <http://www.kcci.com.pk/research/wp-content/uploads/2017/07/CPEC-Is-Pakistan-ready-to-surf-the-tide-Feb-2017.pdf> (accessed on 10 October 2017).
5. Ali, Y.; Rasheed, Z.; Muhammad, N.; Yousaf, S. Energy optimization in the wake of China Pakistan Economic Corridor (CPEC). *J. Control. Dec.* **2018**, *5*, 129–147. [[CrossRef](#)]
6. Ali, M. Pakistan's quest for coal-based energy under the China-Pakistan Economic Corridor (CPEC): Implications for the environment. *Environ. Sci. Pollut. R.* **2018**, *25*, 31935–31937. [[CrossRef](#)]
7. Garlick, J. Deconstructing the China–Pakistan economic corridor: Pipe dreams versus geopolitical realities. *J. Contemp. China* **2018**, *27*, 519–533. [[CrossRef](#)]
8. Raza, H.; Osama, A.; Hena, S. China Pakistan Economic Corridor (CPEC): The Counter Balancer of Momentous Energy Crisis in Pakistan. *Adv. Soc. Sci. Res. J.* **2018**, *5*, 172–180.
9. Ahmed, Z.S. Impact of the China–Pakistan Economic Corridor on nation-building in Pakistan. *J. Contemp. China* **2019**, *28*, 400–414. [[CrossRef](#)]
10. Alam, K.M.; Li, X.; Baig, S. Impact of transport cost and travel time on trade under China-Pakistan economic corridor (CPEC). *J. Adv. Transp.* **2019**, *2019*, 7178507. [[CrossRef](#)]
11. Khan, S.; Liu, G. The China–Pakistan Economic Corridor (CPEC): Challenges and prospects. *Area Dev. Policy* **2019**, *4*, 466–473. [[CrossRef](#)]
12. Ali, M. China–Pakistan economic corridor: Prospects and challenges. *Contemp. South Asia* **2020**, *28*, 100–112. [[CrossRef](#)]
13. Kanwal, S.; Pitafi, A.H.; Rasheed, M.I.; Pitafi, A.; Iqbal, J. Assessment of residents' perceptions and support toward development projects: A study of the China–Pakistan Economic Corridor. *Soc. Sci. J.* **2020**. [[CrossRef](#)]
14. Boyce, T. *The China-Pakistan Economic Corridor: Trade Security and Regional Implications*; Sandia Report SAND2017-0207; Sandia National Laboratories: Albuquerque, NM, USA, 2017.
15. Zhang, R.; Andam, F.; Shi, G. Environmental and social risk evaluation of overseas investment under the China-Pakistan Economic Corridor. *Environ. Monit. Assess.* **2017**, *189*, 253. [[CrossRef](#)] [[PubMed](#)]
16. Hameed, M. The politics of the China–Pakistan Economic Corridor. *Palgrave Commun.* **2018**, *4*, 64. [[CrossRef](#)]
17. Basit, S.H. Terrorizing the CPEC: Managing transnational militancy in China–Pakistan relations. *Pac. Rev.* **2019**, *32*, 694–724. [[CrossRef](#)]
18. Smith, A. *The Wealth of Nations* [1776]; Random House, Inc.: New York, NY, USA, 1937; p. 18.
19. Samuelson, P.A. The transfer problem and transport costs, II: Analysis of effects of trade impediments. *Econ. J.* **1954**, *64*, 264–289. [[CrossRef](#)]

20. Mundell, R.A. Transport costs in international trade theory. *Can. J. Econ. Political Sci.* **1957**, *23*, 331–348. [CrossRef]
21. Herberg, H. Economic Growth and International Trade with Transport Costs. *J. Inst. Theor. Econ.* **1970**, *126*, 577–600.
22. Falvey, R.E. Transport Costs in the Pure Theory of International Trade. *Econ. J.* **1976**, *86*, 536–550. [CrossRef]
23. Casas, F.R. International trade with produced transport services. *Oxf. Econ. Pap.* **1983**, *35*, 89–109. [CrossRef]
24. Bougheas, S.; Demetriades, P.O.; Morgenroth, E.L. Infrastructure, transport costs and trade. *J. Int. Econ.* **1999**, *47*, 169–189. [CrossRef]
25. Aschauer, D.A. Does public capital crowd out private capital? *J. Monet. Econ.* **1989**, *24*, 178–235. [CrossRef]
26. Aschauer, D.A. Is public expenditure productive? *J. Monet. Econ.* **1989**, *23*, 177–200. [CrossRef]
27. Aschauer, D.A. Public investment and productivity growth in the group of seven. *Econ. Perspec.* **1989**, *13*, 17–25.
28. Munnell, A.H. Policy watch, infrastructure investment and economic growth. *J. Econ. Perspec.* **1992**, *6*, 189–198. [CrossRef]
29. Holtz-Eakin, D.; Schwartz, A.E. Infrastructure in a structural model of economic growth. *Reg. Sci. Urban Econ.* **1995**, *25*, 131–151. [CrossRef]
30. Calderon, C.A.; Servén, L. *Trends in Infrastructure in Latin America, 1980–2001*; Working Paper WPS3401; The World Bank Group: Washington, DC, USA, 2004. Available online: <https://openknowledge.worldbank.org/bitstream/handle/10986/14129/WPS3401.pdf?sequence=1> (accessed on 10 April 2021).
31. Canning, D.; Bennathan, E. The Rate of Return to Transportation Infrastructure. In *European Conference of Ministers of Transport (ECMT), Transport Infrastructure Investment and Economic Productivity*; ECMT Round Tables, No. 132; OECD Publishing: Paris, France, 2007. [CrossRef]
32. Crafts, N. Transport infrastructure investment: Implications for growth and productivity. *Oxf. Rev. Econ. Policy* **2009**, *25*, 327–343. [CrossRef]
33. Sahoo, P.; Dash, R.K. Infrastructure development and economic growth in India. *J. Asia Pac. Econ.* **2009**, *14*, 351–365. [CrossRef]
34. World Bank. *To Pave or Not to Pave: Developing a Framework for Systematic Decision-Making in the Choice of Paving Technologies for Rural Roads*; Mobility and Transport Connectivity Series; The World Bank Group: Washington, DC, USA, 2021. Available online: <https://elibrary.worldbank.org/doi/epdf/10.1596/35163> (accessed on 7 January 2022).
35. Department for International Development (DFID). SLOCaT. In *Rural Transport and Agriculture Factsheet*; ReCAP: London, UK, 2015. Available online: [https://assets.publishing.service.gov.uk/media/57a0898840f0b652dd000284/61280-SloCat\\_2015\\_RuralTransportandAgriculture\\_FactSheet\\_ReCAP\\_Eng\\_v150910.pdf](https://assets.publishing.service.gov.uk/media/57a0898840f0b652dd000284/61280-SloCat_2015_RuralTransportandAgriculture_FactSheet_ReCAP_Eng_v150910.pdf) (accessed on 8 January 2022).
36. Amos, P. *Safe, Clean, and Affordable . . . Transport for Development: The World Bank Group's Transport Business Strategy for 2008–2012*; Transport Business Strategy No. 46792; The World Bank Group: Washington, DC, USA, 2008. Available online: <https://documents1.worldbank.org/curated/en/440361468175472897/pdf/467920WP0Box331usiness1Strategy1web.pdf> (accessed on 7 January 2022).
37. Minten, B.; Kyle, S. The effect of distance and road quality on food collection, marketing margins, and traders' wages: Evidence from the former Zaire. *J. Dev. Econ.* **1999**, *60*, 467–495. [CrossRef]
38. North, D. Ocean freight rates and economic development 1730–1913. *J. Econ. Hist.* **1958**, *18*, 537–555. [CrossRef]
39. Adamopoulos, T. Transportation Costs, Agricultural Productivity, And Cross-Country Income Differences. *Int. Econ. Rev.* **2011**, *52*, 489–521. [CrossRef]
40. Lall, S.V. Infrastructure and regional growth, growth dynamics and policy relevance for India. *Ann. Reg. Sci.* **2007**, *41*, 581–599. [CrossRef]
41. Patuelli, R.; Reggiani, A.; Nijkamp, P.; Bade, F.J. The evolution of the commuting network in Germany: Spatial and connectivity patterns. *J. Transp. Land Use* **2010**, *2*, 5–37. [CrossRef]
42. Francois, J.; Manchin, M. Institutions, infrastructure, and trade. *World Dev.* **2013**, *46*, 165–175. [CrossRef]
43. Parthasarathi, P. Network structure and metropolitan mobility. *J. Transp. Land Use* **2014**, *7*, 153–170. [CrossRef]
44. Chong, Z.; Qin, C.; Chen, Z. Estimating the economic benefits of high-speed rail in China: A new perspective from the connectivity improvement. *J. Transp. Land Use* **2019**, *12*, 287–302. [CrossRef]
45. Puga, D. European regional policies in light of recent location theories. *J. Econ. Geogr.* **2002**, *2*, 373–406. [CrossRef]
46. Chen, Z.; Xue, J.; Rose, A.; Haynes, K. Impact of high-speed rail investment on the economy and environment in China: A dynamic CGE analysis. *Transp. Res. Part A Policy Pract.* **2016**, *92*, 232–245. [CrossRef]
47. Chen, Z.; Haynes, K.E. Public surface transportation and regional output: A spatial panel approach. *Pap. Reg. Sci.* **2015**, *94*, 727–751. [CrossRef]
48. Limao, N.; Venables, A.J. Infrastructure, geographical disadvantage, transport costs and trade. *World Bank Econ. Rev.* **2001**, *15*, 451–479. [CrossRef]
49. Brooks, D.H. Infrastructure's role in lowering Asia's trade costs. In *Infrastructure's Role in Lowering Asia's Trade Costs: Building for Trade*; Brooks, D.H., Hummels, D., Eds.; Edward Elgar Publishing: Cheltenham, UK, 2009; pp. 1–17.
50. Donaldson, D. Railroads of the Raj: Estimating the impact of transportation infrastructure. *Am. Econ. Rev.* **2018**, *108*, 899–934. [CrossRef]
51. De Soyres, F.; Mulabdic, A.; Ruta, M. Common transport infrastructure: A quantitative model and estimates from the Belt and Road Initiative. *J. Dev. Econ.* **2020**, *143*, 102415. [CrossRef]

52. Villafuerte, J.; Corong, E.; Zhuang, J. Trade and Growth Impact of One Belt, One Road on Asia and the World. In Proceedings of the 19th Annual Conference on Global Economic Analysis, Washington, DC, USA, 15–17 June 2016. Available online: <https://www.gtap.agecon.purdue.edu/resources/download/8280.pdf> (accessed on 6 January 2022).
53. De Soyres, F.; Mulabdic, A.; Murray, S.; Rocha, N.; Ruta, M. How much will the Belt and Road Initiative reduce trade costs? *Int. Econ.* **2019**, *159*, 151–164. [[CrossRef](#)]
54. Henderson, J.V.; Shalizi, Z.; Venables, A. Geography and Development. *J. Econ. Geogr.* **2001**, *1*, 81–106. [[CrossRef](#)]
55. Jensen, R. The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector. *Q. J. Econ.* **2007**, *3*, 879–924. [[CrossRef](#)]
56. Hulten, C.R.; Bennathan, E.; Srinivasan, S. *Infrastructure, Externalities, and Economic Development: A Study of Indian Manufacturing Industry*; The World Bank Group: Washington, DC, USA, 2005.
57. Corong, L.E.; Hertel, T.W.; McDougall, R.A.; Tsigas, M.E.; Van Der Mensbrugge, D. The Standard GTAP Model, Version 7. *J. Glob. Econ. Anal.* **2017**, *2*, 1–119.
58. Berry, S. Biofuels policy and the empirical inputs to GTAP models. In *California Air Resources Board (CARB) Expert Workgroup Working Paper*; Yale University Department of Economics & Cowles Foundation and NBER: Sacramento, CA, USA, 2011. Available online: <https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.348.5774&rep=rep1&type=pdf> (accessed on 6 January 2022).
59. Hertel, T.; Keeney, R.; Ivanic, M.; Alan Winters, L. Distributional effects of WTO agricultural reforms in rich and poor countries. *Econ. Policy* **2007**, *22*, 289–337. [[CrossRef](#)]
60. Stone, S.; Strutt, A.; Hertel, T. Socio-Economic Impact of Regional Transport Infrastructure in the Greater Mekong Subregion. In *Infrastructure for Asian Connectivity*; Bhattacharya, B., Kawai, M., Nag, R., Eds.; Edward Elgar Publishing: Cheltenham, UK; Northampton, MA, USA, 2012; pp. 95–138.
61. Maliszewska, M.; van der Mensbrugge, D. *The Belt and Road Initiative: Economic, Poverty and Environmental Impacts*; World Bank Policy Research Working Paper No. 8814; The World Bank Group: Washington, DC, USA, 2019. Available online: <https://ssrn.com/abstract=3369989> (accessed on 6 January 2022).
62. Rana, P.B.; Ji, X. Potential Economic Impact of BRI: A Computable General Equilibrium Analysis. In *China's Belt and Road Initiative*; Palgrave Macmillan: Singapore, 2020; pp. 47–69. [[CrossRef](#)]
63. Yang, G.; Huang, X.; Huang, J.; Chen, H. Assessment of the effects of infrastructure investment under the belt and road initiative. *China Econ. Rev.* **2020**, *60*, 101418. [[CrossRef](#)]
64. Dixon, P.B.; Rimmer, M.; Tran, N. Creating a disaggregated CGE model for trade policy analysis: GTAP-MVH. *Foreign Trade Rev.* **2020**, *55*, 42–79. [[CrossRef](#)]
65. Walmsley, T.; Minor, P. US trade actions against China: A supply chain perspective. *Foreign Trade Rev.* **2020**, *55*, 337–371. [[CrossRef](#)]
66. Aguiar, A.; Corong, E.; van der Mensbrugge, D. *Detailed Trade Policy Simulations Using a Global General Equilibrium Model (No. 6199)*; Center for Global Trade Analysis, Department of Agricultural Economics, Purdue University: West Lafayette, IN, USA, 2021.
67. Giesecke, J.A.; Tran, N.H.; Waschik, R. Should Australia be concerned by Beijing's trade threats: Modelling the economic costs of a restriction on imports of Australian coal. *Aust. J. Agric. Resour. Econ.* **2021**, *65*, 1–22. [[CrossRef](#)]
68. Nijkamp, P.; Wang, S.; Kremers, H. Modeling the impacts of international climate change policies in a CGE context: The use of the GTAP-E model. *Econ. Model.* **2005**, *22*, 955–974. [[CrossRef](#)]
69. Calzadilla, A.; Rehdanz, K.; Betts, R.; Falloon, P.; Wiltshire, A.; Tol, R.S. Climate change impacts on global agriculture. *Clim. Chang.* **2013**, *120*, 357–374. [[CrossRef](#)]
70. Moore, F.C.; Baldos, U.; Hertel, T.; Diaz, D. New science of climate change impacts on agriculture implies higher social cost of carbon. *Nat. Commun.* **2017**, *8*, 1607. [[CrossRef](#)]
71. Xie, W.; Xiong, W.; Pan, J.; Ali, T.; Cui, Q.; Guan, D.; Meng, J.; Mueller, N.D.; Lin, E.; Davis, S.J. Decreases in global beer supply due to extreme drought and heat. *Nat. Plants* **2018**, *4*, 964–973. [[CrossRef](#)] [[PubMed](#)]
72. Dandres, T.; Gaudreault, C.; Tirado-Seco, P.; Samson, R. Assessing non-marginal variations with consequential LCA: Application to European energy sector. *Renew. Sustain. Energy Rev.* **2011**, *15*, 3121–3132. [[CrossRef](#)]
73. Golub, A.A.; Hertel, T.W. Modeling land-use change impacts of biofuels in the GTAP-BIO framework. *Clim. Chang. Econ.* **2012**, *3*, 1250015. [[CrossRef](#)]
74. Ali, T.; Huang, J.; Yang, J. Impact assessment of global and national biofuels developments on agriculture in Pakistan. *Appl. Energy* **2013**, *104*, 466–474. [[CrossRef](#)]
75. Malins, C.; Plevin, R.; Edwards, R. How robust are reductions in modeled estimates from GTAP-BIO of the indirect land use change induced by conventional biofuels? *J. Clean. Prod.* **2020**, *258*, 120716. [[CrossRef](#)]
76. Horridge, M. *SplitCom—Programs to Disaggregate a GTAP Sector*; Centre of Policy Studies, Monash University: Melbourne, Australia, 2005. Available online: [www.monash.edu.au/policy/SplitCom.htm](http://www.monash.edu.au/policy/SplitCom.htm) (accessed on 19 October 2020).
77. FAOSTAT. 2020. Available online: [www.fao.org/faostat/en/](http://www.fao.org/faostat/en/) (accessed on 10 March 2021).
78. United Nations Statistics Division (UNSD). *UN COMTRADE*; International Merchandise Trade Statistics, United Nations Statistics Division: New York, NY, USA, 2020. Available online: <http://comtrade.un.org/> (accessed on 13 September 2021).
79. Fouré, J.; Bénassy-Quéré, A.; Fontagné, L. Modelling the world economy at the 2050 horizon. *Econ. Transit* **2013**, *21*, 617–654. [[CrossRef](#)]
80. Herrero, A.G.; Xu, J. China's belt and road initiative: Can Europe expect trade gains? *China World Econ.* **2017**, *25*, 84–99. [[CrossRef](#)]

81. Panizza, U. Domestic and external public debt in developing countries. In *United Nations Conference on Trade and Development Discussion Paper (No. 188)*; United Nations Conference on Trade and Development (UNCTAD): Geneva, Switzerland, 2008. Available online: [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1147669](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1147669) (accessed on 8 January 2022).
82. Serebrisky, T. *Sustainable Infrastructure for Competitiveness and Inclusive Growth*; Inter-American Development Bank Infrastructure Strategy, Inter-American Development Bank: Washington, DC, USA, 2014. Available online: <https://publications.iadb.org/en/sustainable-infrastructure-competitiveness-and-inclusive-growth> (accessed on 11 January 2022).
83. Arndt, C.; Pearson, K.R. *How to Carry Out Systematic Sensitivity Analysis via Gaussian Quadrature and GEMPACK*; GTAP Technical Paper, 3; The Center for Global Trade Analysis, Purdue University: West Lafayette, IN, USA, 1998. Available online: <http://www.gtap.agecon.purdue.edu/resources/download/1209.pdf> (accessed on 8 January 2022).
84. Preckel, P.; Verma, M.; Hertel, T.; Martin, W. *Systematic Sensitivity Analysis for GTAP—Where We have Been and Where We Are Going*; GTAP Technical Paper; The Center for Global Trade Analysis, Purdue University: West Lafayette, IN, USA, 2011. Available online: <https://www.gtap.agecon.purdue.edu/resources/download/5307.pdf> (accessed on 9 January 2022).
85. Gilbert, J.; Banik, N. *Socioeconomic Impacts of Cross-Border Transport Infrastructure Development in South Asia*; ADBI Working Paper 211; Asian Development Bank Institute: Tokyo, Japan, 2010. Available online: <http://www.adbi.org/working-paper/2010/04/14/3655.socioeconomic.transport.infrastructure/> (accessed on 11 November 2020).
86. Portugal-Perez, A.; Wilson, J.S. Export Performance and Trade Facilitation Reform: Hard and Soft Infrastructure. *World Dev.* **2012**, *40*, 1295–1307. [[CrossRef](#)]
87. GoP (Government of Pakistan). *Pakistan and China Reaffirms Their Commitment to CPEC in a Meeting between Minister Planning & Development and Mr. Zhang Chuxian, Member of CPEC*; Ministry of Planning, Development & Reforms, Pak-Secretariat: Islamabad, Pakistan, 2015. Available online: <http://cpec.gov.pk/news/5> (accessed on 28 October 2020).
88. GoP (Government of Pakistan). *Long Term Plan for China-Pakistan Economic Corridor*; Ministry of Planning, Development & Reform, Pak-Secretariat: Islamabad, Pakistan, 2017. Available online: <http://www.cpec.gov.pk/brain/public/uploads/documents/CPEC-LTP.pdf> (accessed on 28 October 2020).
89. Chohan, U.W. *What Is One Belt One Road? A Surplus Recycling Mechanism Approach*; Discussion Paper Series: Notes on the 21st Century; University of New South Wales (UNSW) Sydney: Kensington, Australia, 2017. Available online: <https://ssrn.com/abstract=2997650> (accessed on 21 November 2021).
90. The Express Tribune. CPEC Investment Pushed from \$55b to \$62b. Available online: <https://tribune.com.pk/story/1381733/cpec-investment-pushed-55b-62b> (accessed on 18 November 2020).
91. Brockmeier, M.A. *Graphical Exposition of the GTAP Model (No. 1236-2016-101374)*; GTAP Technical Paper No. 8; The Center for Global Trade Analysis, Purdue University: West Lafayette, IN, USA, 2001. Available online: <https://www.gtap.agecon.purdue.edu/resources/download/181.pdf> (accessed on 8 January 2022).