Does the Belt and Road Initiative boost Chinese Automobile Exports? A Staggered Adoption Approach

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Abstract

We examine whether China's ambitious Belt and Road Initiative assisted its export performance in the final automobile sector, a market that has been challenging for the Chinese economy. We use the heterogeneity robust DID estimators for staggered timing. We also control for anticipation effects and potential BRI selection endogeneity using IVs. Our estimates find that China's final automobile exports to the BRI partner destination countries after these countries became signatories are almost double that of the export to non-BRI partner destinations, and the effect for net-exports is an increase of about 59%. Sub-sample analyses indicate that the positive effect is stronger for China's export to lower-income partners compared to its exports to relatively higher income destinations. The results are robust across alternate methods and specifications.

Keywords: Belt and Road Initiative, automobile exports, staggered Diff-in-Diff, heterogenous effect

JEL classification: F13; F14

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1. Introduction:

Getting a share of the finished-automobile export market has been a challenge for China- a country that has been an economic powerhouse in many other industries. In recent years China accounts for nearly 30 percent of global vehicle production, but 0.6 percent of the total international export value for cars[3]. At the current levels of production, automobile production in China contributes between 5 to 7.5 percent of China's GDP. The ability of China to make a breakthrough into the export market would have a strong impact on its own GDP, and on the overall global trade for final automobiles.

Our research investigates whether the Belt and Road Initiative (hereafter BRI) announced in 2013 by the Chinese government, involving infrastructure development and investments to improve connectivity and cooperation on a transcontinental scale (Ruta et al., 2019), has been effective in assisting China's export performance in the automobile industry. The countries and regions encompassed by the BRI make up 64% of the world population but only 30% of world GDP (Huang, 2016).

While there exists literature on the effects of BRI, there doesn't appear to be analyses about the final automobile industry, which is an important sector from the world trade perspective. Second, given that the signatories became BRI partners at different years post 2013, to the best of our knowledge, we are the first to use the heterogeneity robust staggered Diff-in-Diff estimators to study the BRI effect. Third, current research has rarely accounted for the potential endogeneity of BRI partner selection, assuming instead the selection to be random (Yu et al., 2020). We examine and control for the endogeneity of BRI country selection using instrumental variables.

Fourth, the concept of vertical differentiation (Schott, 2004) has seen widespread application in international trade research, with Hallak (2006) demonstrating that rich countries tend to import high quality goods. While the automobile industry is widely recognized as an industry with a high degree of quality differentiation (Liao, 2011), empirical research that brings the vertical differentiation aspect of automobile exports to examine heterogeneous effects across destination countries of different income levels, indicative of quality difference, is sparce. Our paper fills this gap by examining the heterogeneous effect of the BRI for countries that differ by income levels that are indicative of quality preferences.

Our estimates find that the BRI significantly helped boost China's final automobile exports,

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[3] https://www.statista.com/topics/1013/car-imports-and-exports-in-china/

with the effects being stronger in the lower income BRI-partner destination countries indicative of China's relative strength in the middle and lower end varieties of automobiles. The estimated effects for net-exports are similar in direction but smaller in size indicating that while the BRI stimulated mutual exports between China and the BRI partner countries, the effect is stronger for China, as expected.

2. Background Literature

Given that trade and investments are the two most important objectives of the BRI (Chen, 2016; Huang, 2016; Chen et al., 2018), most of the existing literature relating to the impact of BRI focuses on these two aspects. Regional cooperation, specifically ones that include China, is an aim of the BRI on the trade dimension (Yu et al., 2020).

Trade effects of the BRI may arise broadly because of two reasons: first, the direct effect of reduced transportation costs due to the improved BRI connectivity infrastructure (Herrero & Xu, 2017; Fardella & Prodi, 2017; Ramasamy & Yeung, 2019; Mao et al., 2019; De Soyres et al., 2019; Jackson & Shepotylo, 2021), and second, because of the standard reasons of specialization along with comparative advantage due to the free trade objectives of the BRI. Zhu et al. (2021) is an example of this second area of literature that focuses on the international trade and investment benefits to economies owing to the transnational division of labor, the mobility of production factors, and technology diffusion. Yu et al. (2020) add the dimension of intergovernmental cooperation helping reduce trade uncertainty and in turn lowering the transportation costs.

Most of the existing studies discussed above as well as Foo et al. (2020) and Baniya et al. (2020) are based on the BRI impacts of trade at the national aggregate level, with Chen et al. (2018) and Huang et al. (2020) being notable exceptions looking at sea-food trade and tourism impacts respectively. In the current paper, we focus on the automobile industry for the following reasons. First, as Truett & Truett (1994) and Humphrey (2003) found, since the 1990s the automobile industries of developing countries were transformed by trade and investment liberalization policies, showing that this is an industry whose development has the capability of being decisively influenced by government policies. While rich and interesting research exists on automobile trade in general (Goldberg, 1994; Feenstra et al., 1996; Knittel, 2011) and specifically for China (Harwit, 2001; Liu & Yeung, 2008; Amighini,2012; Peters, 2012; Oh, 2013; Imran et al., 2018), the effect of the BRI on automobile exports has not been examined to the best of our knowledge, though as noted above, this is an industry that is responsive to policy changes. While the Chinese automobile industry has played a significant role in China's GDP and is significant in global automobile production, the export market performance for Chinese automobiles has remained elusive (Amighini, 2012). This makes it of interest to examine if the BRI was able to provide significant improvements in Chinese automobile export performance, which would have significant implications not only for China but also for international trade in automobiles.

3. Data and Specification

China's BRI was announced in 2013, and different countries became signatories of this initiative in different years post 2013. Of these, 8 countries joined the BRI in 2013, 1 country joined in 2014, 19 countries joined in 2015, 5 countries joined in 2016, 24 countries joined in 2017, 61 countries joined in 2018 and 15 countries joined in 2019[4] as collected from the Chinese government's Belt and Road portal[5], while 52 countries that China exported automobiles to are seen not to have signed up for BRI partnership till 2019 and serve as our control group.

Table 1: Summary Statistics (Annual variables)

Variable	Interpretation	Mean	Min	Max
Auto_exp	Log of (1+Exports) of motor vehicles, with Exports in '000 $ *(Source: OECD STAN Database)*	9.902	0	16.567
BRI	BRI partner country (dummy) *(Source: Chinese Government portal)*	0.628	0	1
L_tariff	Log of tariff rate on Chinese automobile *(Source: World Integrated Trade Solutions database)*	2.35	0	5.26
L_exch	Log of exchange rate current/last *(Source: World Bank's World Development Indicators)*	.043	-.215	13.45
L_GDP	Log of GDP at constant 2015 $ *(Source: World Bank's World Development Indicators)*	24.08	17.14	30.62
Projects	Number of Chinese projects in destination country *(Source: AidData's Geocoded Global Chinese Official Finance Dataset)*	27.114	0	288
Diplo_length	Length of diplomatic relation *(Source: Ministry of Foreign Affairs of the People's Republic of China)*	35.014	0	64

Note: Total number of observations is 2947, except for the 2 variables tariff rate (2,885) and exchange rate (2,248).

Our dependent variable: China's automobile exports, comes from OECDs STAN Bilateral Trade Database by Industry and End-use category, and covers all countries that China exported automobiles to between 2005 and 2019. **Table 1** shows the summary statistics and source of the

[4] The appendix contains the names of countries and regions by their BRI joining date.
[5] https://www.yidaiyilu.gov.cn/xwzx/roll/77298.htm

dependent and explanatory variables used in our analyses.

While Athey and Imbens (2022) show that the standard DID estimation will remain unbiased under the assumption of random assignment of the adoption date, Baker et al. (2022) bring up concerns that biases may arise in more general settings in the presence of treatment effect heterogeneity. Hence, we use heterogeneity robust estimation for staggered timing as suggested by Gardner (2021), Borusyak et al (2021), Sun and Abraham (2021), Callaway and Sant'Anna (2021), Roth and Sant'Anna (2021). These models allow for *'g'* groups at time *'t'*, where a group is defined by the time period when the units are first treated, instead of the setup with two periods and two groups in the canonical DID. The overall average treatment effect τ is the average of the group-time average treatment effects $\tau_{g,t}$.

Discussion of a country's trade expansion typically looks at both the extensive and intensive margins of trade. However, the data shows that during the post-BRI period, there was only a single additional country as a destination of China's automobile exports within a total of 197 destinations. Given this, our analysis looks at whether the BRI increased the volume of Chinese automobile exports to existing trade partners.

Chinese auto exports have typically not been seen as a threat to Japanese or European auto makers internationally, given that Chinese exports were more concentrated in low-end market segments. The BRI also aimed to expand China's reach mostly to the somewhat less developed economies of Asia, Africa, Europe and Latin America. This makes it interesting to examine the effects of BRI for different income-subsamples of China's export partners. We classify the countries and regions in our analysis into High-income and Low-income destinations based on whether their average per-capita income during the sample period is above or below the median for the overall sample.

China's selection of its BRI partners reflects China's ties with these countries, and we consider two variables that capture this connection. The number of loans and projects undertaken by China in the destination country before 2013 is a strong indicator of bilateral ties between the pair of countries. These loans and projects are both Chinese-aid and non-concessional official financing, and pertain to various aspects such as health, education, infrastructure and do not directly affect automobile exports. Our second candidate for instrumental variables is the length of diplomatic ties between China and the partner countries. While 13 countries in our dataset do not report having a diplomatic relation with China, among the countries that do report having diplomatic relations with China, the average length of such relation is 33.95 years, ranging from 2 to 64 years. **Table 2** shows that these two variables have higher values for BRI partner countries, indicating that they reflect bilateral ties.

Table 2: Indicators for China's pre-2013 ties to export destinations, across BRI and non-BRI partner countries

	BRI countries	Non-BRI countries
Number of Projects	33.48	4.81
Years of Diplomatic Relation	37.43	23.67
# Observations	1278	432

4. **Estimation results**

The standard DID estimates in Column 1 of **Table 3** uncover a statistically significant effect of the BRI on auto exports of China. Due to concerns about biases in the standard DID estimates when the exposure to treatment is staggered, we use the more recent heterogeneity robust estimator, which finds (Column 2) the effect somewhat smaller than the canonical DID estimates, though still large at 128%[6]. While this method controls for country fixed effects that remain unchanged over time, for example distance, landlocked-ness, cultural and religious similarity, we next incorporate additional trade explanatory variables that vary over time, specifically GDP, the tariff rate, and changes in the exchange rate of the destination countries. Doing so reduces the predicted effect (Column 3), with the BRI being found to increase China's automobile exports by 74% compared to exports to destination countries that are not BRI partners.

We add subsequent layers of improvements to the specification. A possibility that has sometimes been mentioned for large policy changes is that if economic agents are anticipating the policy shock, this might affect their behavior in the years prior to the start of the policy. In the case of BRI, this possibility would take the form of auto exports in the pre-BRI period being affected in anticipation of the BRI. To control for this possibility, we estimate our model leaving out the year immediately prior to the joining year for each signatory country. When this is incorporated (Column 4) in the model with the trade variables, the estimated effects are stronger, indicating that considering the last year prior to BRI joining to be a pre-intervention period dampens the estimated effect of BRI. This implies that the automobile trade activity increased in anticipation of BRI partnership even before the agreement was officially signed. This is reasonable in the current context since the BRI does not represent a specific date that a specific policy change happens;

[6] exp(0.824) -1

rather it is a symbol of a promise of stronger bilateral partnership going forward and is likely to have a positive spillover effect before it is officially signed.

Freyaldenhoven et al. (2019) indicate that using instrumental variables might provide a robustness test for the strict exogeneity hypothesis of the control and treatment groups. This leads us to the next consideration: Control of BRI partner selection using instrumental variables in the first stage of the estimation that might predict a country's tendency to join the BRI[7]. Doing so (Column 5) shows that China's exports of final automobile to BRI-partners increased by 98% in the years after joining BRI. Also, given that the final automobile industry is characterized by significant intra-industry trade, we look at the average BRI effect for net-exports of automobiles (Column 6) and find that an increase of 59% indicating that while the BRI increased bidirectional trade between China and its partner countries, the effect is stronger for China.

Finally, given that China has traditionally been more successful in exporting automobiles to low-income countries, we examine how the effect of the BRI translated to destination countries of different income groups. **Table 4** shows that while the BRI increased China's automobile exports to both sets of countries, the effects are larger for lower income destinations. For example, in the specification controlling for the time varying GDP, exchange and tariff rates (Columns 5-6), the increase in exports is 94% for high-income BRI-partners and 110% to low-income BRI-partners. Control of anticipation effects and instrumentation of BRI participation finds this pattern to remain consistent. The corresponding effects for net-exports of automobile are 41% and 57% respectively for the high and low-income BRI-partner countries.

[7] The first stage results are presented in the appendix.

Table 3: Overall sample estimations

	Standard DID	Heterogeneity robust estimation for staggered timing				
		Core specification	Additional variables	Anticipation effect	BRI selection	Net-Exports
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.857***	0.824***	0.555***	0.761***	0.685***	0.465***
	[0.199]	[0.0558]	[0.0699]	[0.134]	[0.100]	[0.0883]
Observations	2852	2852	2157	1963	1681	1626
R^2	0.032					

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

Table 4: Subsample estimations

	Standard DID		Heterogeneity robust estimation for staggered timing							
			Core specification		Additional variables		BRI selection		Net-Exports	
	Upper income	Lower Income	Upper income	Lower Income	Upper income	Lower Income	Upper income	Lower Income	Upper income	Lower Income
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treatment	0.714**	0.813***	0.783***	0.863***	0.664***	0.743***	0.665***	0.670***	0.344***	0.453***
	[0.309]	[0.239]	[0.0777]	[0.0801]	[0.117]	[0.166]	[0.116]	[0.153]	[0.112]	[0.117]
# Obs.	1438	1414	1438	1414	931	1032	793	888	745	881
R^2	0.021	0.079								

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

5. Robustness Checks:

5.1. Parallel Trends

To test the assumption of parallel trends we perform what is known as a "falsification" test. For this test, we performed an additional difference-in-differences estimation using a "false" treatment period of 2009. We use the two 4-year periods 2005- 2008 and 2009-2012 to estimate difference-in-difference using the true treatment and control groups. The only exception is that there was no BRI in 2009 for any of the countries, and hence our estimation should not be picking up a significant DID effect.

Table 5: Diff-in-Diff Parallel-Trend test

	(1) Basic OLS	(2) OLS with controls	(3) FE with controls
False post-period	0.7248**	-0.8514***	1.9874***
	[0.3190]	[0.2244]	[0.2087]
BRI country	0.4533*	-0.0509	
	[0.2579]	[0.1864]	
BRI* False post-period (DID coefficient)	0.1411	0.0941	0.0015
	[0.3531]	[0.2116]	[0.1658]
Constant	8.9752***	-510.3509***	1080.7598
	[0.2327]	[51.9445]	[1736.2459]
Tariff, Exch., GDP controls	No	Yes	Yes
N	1398	1185	1185
R^2	0.028	0.612	0.500

Note: Robust standard errors in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In **Table 5**, Columns (1) and (2) report results from the pooled OLS estimation without and with the additional country specific trade variables (GDP, tariff, and exchange rates), while column (3) adds the country fixed effects. The coefficient on the false DID is not significant in all these specifications. This shows that in the absence of a real intervention in the form of BRI, the treatment and non-treatment countries exhibited a similar trend in terms of auto-exports by China. This reinforces our finding that the BRI intervention is the cause of the difference in the post-BRI effect found for the BRI countries.

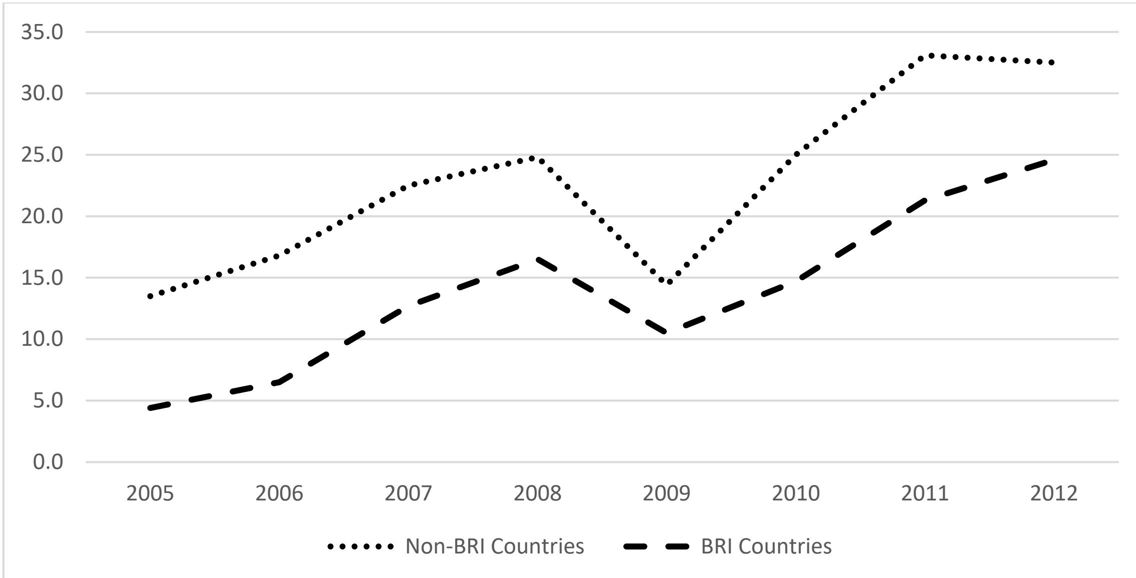

Fig. 1. Auto exports to BRI & Non-BRI countries (In Million USD)

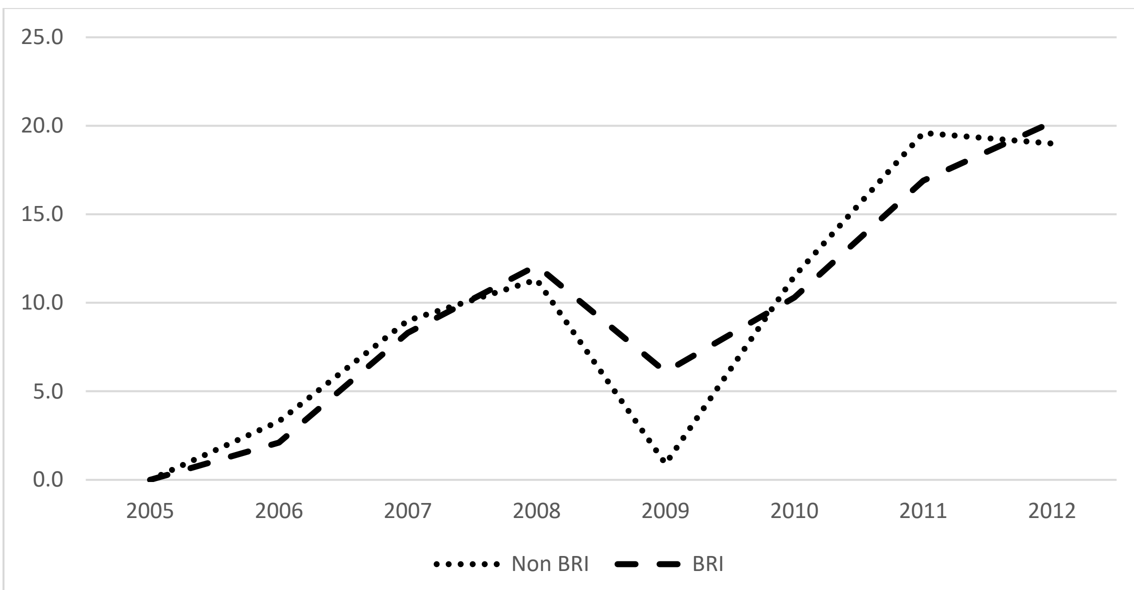

Fig. 2. Parallel Trend of Chinese Auto Export (In Million USD)

The parallel trends assumption can also be seen graphically. **Fig. 1** depicts that China's export to the BRI countries has typically been lower than the export to the non-BRI countries. This is not surprising given that the BRI countries, as noted earlier, comprise of only 30% of world GDP. However, when the difference in the intercept is removed, the BRI and non-BRI countries show parallel trends in the pre-intervention period (2005-2012) as evident in **Fig. 2**.

4.2. **Placebo Test**

If the effect that we picked up in our main estimation were truly driven by BRI connections, then such an effect should not be observed in a random group of countries, which would provide credence to our main results.

Table 6: Diff-in-Diff Placebo test

	(1) Basic OLS	(2) OLS with controls	(3) FE with controls
Fake BRI partner	0.387**	-0.0923	
	[0.153]	[0.0834]	
Post 2013	1.028***	0.504***	0.112
	[0.158]	[0.0883]	[0.111]
Fake-BRI* Post 2013 (DID coefficient)	-0.162	0.0575	0.00887
	[0.225]	[0.127]	[0.134]
Constant	9.165***	-17.55***	-60.41***
	[0.109]	[0.393]	[5.857]
Tariff, Exch., GDP controls	No	Yes	Yes
Observations	2852	2157	2157
R^2	0.026	0.754	0.268

Note: Robust standard errors in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

For this test, we randomly designate half of the countries in our data as fake BRI partners. **Table 6** depicts that no treatment effect (fake_BRI*Post period) is found in this random group of countries, reinforcing the finding that the real BRI effect is what drives the main results.

4.2. **Subsample analyses leaving out middle income countries**

We next examine the robustness of our results for the heterogenous effects of the BRI across high income and low-income partners.

Table 7: Subsample estimations leaving out middle income countries in the 40th to 60th percentiles of per-capita GDP

	Standard DID		Heterogeneity robust estimators for staggered timing							
			Core specification		Additional variables		BRI selection		Net-Exports	
	Upper income (1)	Lower income (2)	Upper income (3)	Lower Income (4)	Upper income (5)	Lower Income (6)	Upper income (7)	Lower Income (8)	Upper income (9)	Lower Income (10)
Treatment	0.878**	1.040***	0.745***	0.879***	0.732***	0.841***	0.730***	0.756***	0.307***	0.447***
	[0.357]	[0.264]	[0.0862]	[0.0861]	[0.120]	[0.225]	[0.124]	[0.217]	[0.112]	[0.117]
# Obs.	1230	1149	1230	1149	740	838	617	736	548	714
R^2	0.020	0.093								

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

While in the main analysis high- and low-income partners were classified as below and above the 50th percentile respectively in the per capital income distribution, we leave out the partner countries in the 40th to 60th in our robustness check. The patterns in **Table 7** remain consistent with our earlier findings in Table 5.

6. Conclusions

This paper examines whether the BRI has helped China make inroads into automobile exports, an international market that has remained elusive to the Chinese economy. Using the heterogeneity -robust staggered-timing Diff-in-Diff approach, the full sample estimation finds a significant positive impact. Placebo tests and the parallel trend assumption are found to be satisfied, and anticipation effects are controlled, reinforcing that the positive effects for automobile exports are truly driven by the BRI.

Extensions to the specification control for potential BRI selection endogeneity using IVs that account for the political and economic relations between China and the destination countries. While controlling for ties between China and the partner countries somewhat dampens the effects estimated initially, the results remain strong and significant. Subsample analysis reveals the effects to be heterogeneous across destination country income groups, with the lower-income destinations displaying a stronger export boost arising from the BRI, which is consistent with China's relative weakness in the high-end automobile markets.

To account for the intra-industry trade aspect of automobiles, we explore the effects of BRI on net-exports of final automobiles and find the effect to be similar in direction but smaller in size indicating that while BRI stimulated mutual exports between China and the BRI partner countries, the effect is stronger for China, indicating that China was able to make good use of the BRI to make inroads towards becoming a stronger automobile exporter.

Future directions of research should aim to understand the varieties and qualities of automobiles that underlie the Chinese exports success in the lower-income BRI destinations. Furthermore, research into why similar varieties have not done so well in the non-BRI destinations would shed light on the trade facilitating channels and connections created by the BRI within the destination countries, a lesson that will be useful to all countries aspiring to improve their export performance.

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Appendix:

Table A1: List of Countries by BRI join-year

2013	Afghanistan, Belarus, Cambodia, Kyrgyzstan, Macedonia, Moldova, Mongolia, Pakistan
2014	Thailand
2015	Armenia, Azerbaijan, Bulgaria, Cameroon, Congo, Democratic Republic of the Czech Republic, Hungary, Indonesia, Iraq, Kazakhstan, Poland, Romania, Russia, Serbia, Slovakia, Somalia, South Africa, Turkey, Uzbekistan
2016	Arab Rep. of Egypt, Georgia, Latvia, Myanmar, Papua New Guinea
2017	Albania, Bosnia and Herzegovina, Cote d'Ivoire, Croatia, East Timor, Estonia, Kenya, Lebanon, Lithuania, Madagascar, Malaysia, Maldives, Moltenegro, Morocco, Nepal, Netherlands, New Zealand, Panama, Philippines, Slovenia, Sri Lanka, Ukraine, Vietnam, Yemen
2018	Algeria, Angola, Antigua and Barbuda, Austria, Bahrain, Bolivia, Brunei, Burundi, Cape Verde, Chad, Chile, Costa Rica, Djibouti, Ecuador, El Salvador, Ethiopia (excludes Eritrea), Fiji, Gabon, Gambia, Ghana, Greece, Grenada, Guinea, Guyana, Iran, South Korea, Kuwait, Laos, Libya, Malta, Mauritania, Federated States of Micronesia, Mozambique, Namibia, Nigeria, Niue, Oman, Portugal, Rwanda, Samoa, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, South Sudan, Sudan, Suriname, Tajikistan, Tanzania, Togo, Tonga, Trinidad and Tobago, Tunisia, Uganda, United Arab Emirates, Uruguay, Vanuatu, Venezuela, Zambia, Zimbabwe
2019	Bangladesh, Barbados, Benin, Cuba, Cyprus, Equatorial Guinea, Italy, Jamaica, Lesotho, Liberia, Luxembourg, Mali, Peru, Qatar, Solomon Islands
Non-BRI partner (till 2019)	Andorra, Aruba, Australia, Bahamas, Belgium, Belize, Bermuda, Bhutan, Brazil, Canada, Colombia, Denmark, Finland, France, Germany, Greenland, Guatemala, Haiti, Honduras, Hong Kong, Iceland, India, Ireland, Israel, Japan, Jordan, North Korea, Macao, Malawi, Marshall Islands, Mauritius, Mexico, Montserrat, Nauru, Netherlands, New Caledonia, Norway, Palau, Palestine, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Spain, Swaziland, Sweden, Switzerland, Taiwan, Turkmenistan, Tuvalu, United Kingdom, United States

Table A2: First stage results for BRI partner selection

	(1)	(2)	(3)
Num. projects	0.0020***	0.0028***	
	[0.0001]	[0.0001]	
Diplo-length	0.0057***		0. 0071***
	[0.0004]		[0.0004]
Constant	0.4987***	0.6748* *	0.5058***
	[0.0177]	[0.0099]	[0.0180]
N	2852	2852	2852
R^2	0.1378	0.0792	0.0982

Robust standard errors in brackets
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$