

Structural gravity modelling: how trade wars and Belt and Road policies change trade flows in Europe and Central Asia

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Westminster Development Policy Network Virtual Seminars

July 7, 2021

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Belt and road initiative

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Key Findings

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BRI, political alliances, and political stability

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Structural gravity: history

- ▶ Gravity model of trade (Tinbergen, 1962)
- ▶ Explosion of microfoundations of gravity (Eaton and Kortum, 2002; Anderson and van Wincoop, 2003; Chaney, 2008; Helpman et al., 2008)
- ▶ Unifying theory of structural gravity (Head and Mayer, 2014; Costinot and Rodriguez-Clare, 2015)

Structural model: theory

Structural gravity is represented by

$$X_{ij} = \frac{Y_i E_j}{Y} \left(\frac{\varphi_{ij}}{\Omega_i P_j} \right)^{(1-\sigma)} \quad (1)$$

- ▶ X_{ij} is export from country i to country j
- ▶ $Y_i = \sum_j X_{ij}$ is total value added of country i
- ▶ $E_j = \sum_i X_{ij}$ is total expenditure in country j
- ▶ σ is elasticity of substitution across varieties
- ▶ Y is global output.

Multilateral resistance terms

Ω and P are multilateral resistance terms (MRT). They capture all relevant global trade factors, that influence trade of countries i and j .

- ▶ Outward MRT:

$$\Omega_i^{(1-\sigma)} = \sum_j \frac{E_j}{Y} \left(\frac{\varphi_{ij}}{P_j} \right)^{(1-\sigma)} \quad (2)$$

- ▶ Inward MRT:

$$P_j^{(1-\sigma)} = \sum_i \frac{Y_i}{Y} \left(\frac{\varphi_{ij}}{\Omega_i} \right)^{(1-\sigma)} \quad (3)$$

Trade costs

Our bilateral trade costs are given by

$$(1 - \sigma) \times \ln \varphi_{ij} = \gamma_{dist} \ln(\lambda_{ij} \times dist_{ij}) + \gamma_{FTA} FTA_{ij} + Z_{ij} \gamma_Z + u_{ij} \quad (4)$$

- ▶ To estimate the potential effect of a regional free trade agreement we introduce a variable $FTA=1$ if free trade agreement and 0 otherwise
- ▶ Reduction in transportation cost, due to improved transport infrastructure is captured by $\lambda_{ij} \leq 1$
- ▶ Z captures all additional information about bilateral trade: common language, common border, etc

Estimation of inward and outward MRT

- ▶ Estimation of inward and outward multilateral resistance terms is done by PPML (Silva and Tenreyro, 2006) with full set of exporting and importing countries fixed effects.
- ▶ This method got very popular in estimation of gravity models because
 - ▶ it performs better in dealing with no trade (so-called zeros in trade flows)
 - ▶ Fally (2015) demonstrated that if structural gravity (1) is estimated with full set of exporter and importer fixed effects, the estimated fixed effect coefficients represent a unique solution to the inward and outward multilateral resistance terms.

Welfare effect

Welfare impact of a counterfactual scenario relative to the baseline is computed according to

$$\hat{W} = 100\% \times \left(\frac{Y'_i / P'_i}{Y_i / P_i} \right) \quad (5)$$

Algorithm of counterfactual analysis with structural gravity

1. Estimate the model by PPML, using actual data
2. Recover inward and outward multilateral resistance terms and compute welfare indices
3. Modify trade policy variables according to the scenario assumptions, keeping everything else constant
4. Estimate the model by PPML with new policy variables, keeping everything else constant
5. Recover counterfactual inward and outward multilateral resistance terms and compute new welfare indices and new trade flows
6. Compare the baseline and counterfactual variables

Examples of structural gravity models

- ▶ Jackson, K. and Shepotylo, O., 2021. Belt and road: The China dream?. China Economic Review, 67, p.101604.
- ▶ Jackson, K. and Shepotylo, O., 2021. Risky business: Political stability along the Belt and Road.

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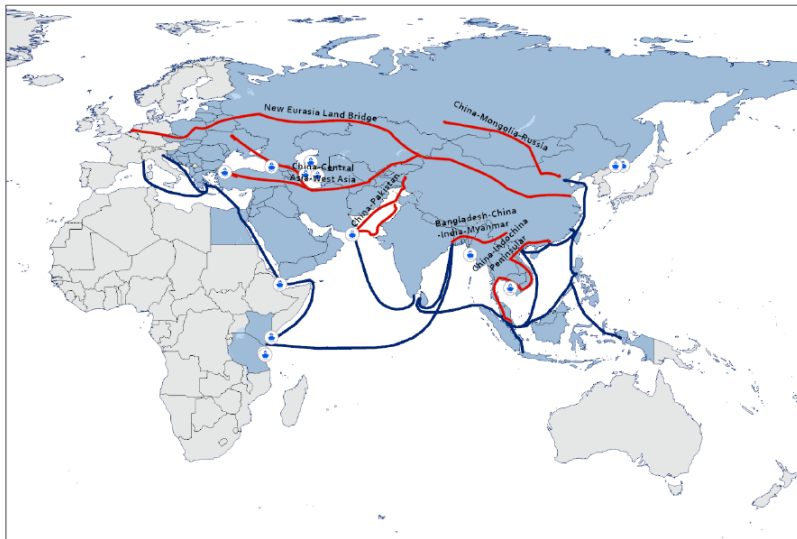
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Belt and road

- ▶ Belt and road initiative includes a third of global trade and GDP and over 60 percent of world population
- ▶ It consists of Silk Road Economic Belt and Maritime Silk Road.
- ▶ 6 transport corridors: Eurasian Bridge, Mongolia-Russia, Central Asia-Turkey, Pakistan, Indochina, Myanmar.
- ▶ Maritime routs directed towards South East Asia, Gulf countries, North Africa and Europe.
- ▶ Overall, all roads lead to Europe.

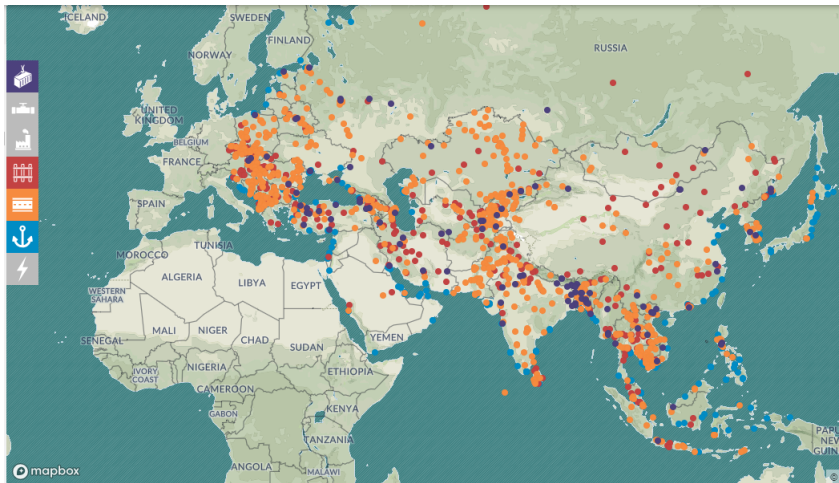
Figure 1: The Belt and the Road



Source: World Bank

The Projects

- ▶ Key issue: lack of credible information on the projects
- ▶ We use the database from the Reconnecting Asia Project at the Centre for Strategic and International Studies
- ▶ We estimate that 63 percent of the funding on BRI projects concerns (single mode) rail infrastructure
- ▶ The average cost for rail projects is the highest out of the three modes



Source: Centre for strategic and international studies

The Projects

- ▶ The translation of these projects into transport cost reductions is central to the BRI
- ▶ Cost reductions may come from traders using the same routes or changing routes/modes
- ▶ There are a number of studies exploring the impact of transport infrastructure investment
- ▶ We model a range of transport cost reductions between 15-50 percent

50 percent transport cost reduction: realistic?

- ▶ Currently, maritime route from China to Central Europe takes about 30 days.
- ▶ Railways are half that time, but freight rates are much higher. (0.03 vs 0.3 USD per tonn per kilometer)
- ▶ Reed and Trubetskoy (2019) estimate that rail and road improvement reduce freight rate at 30-50 percent
- ▶ It also involves crossing several borders along the way contributing further to time and cost of land shipments.
- ▶ Improving railway and road infrastructure, streamlining customs procedures may dramatically change time and cost of trade between China and Europe, essentially making New Silk Road a dominant mode of transportation between those two large economic regions.

Largest dry port: Khorgos in Kazakhstan



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Policy Scenarios

1. BRI
2. China-EU FTA
3. BRI and China-EU FTA
4. BRI and other integration scenarios (TPP and TTIP)

Data

1. 162 countries for the period 1960-2014
2. Trade data: IMF Direction of Trade Statistics
3. GDP data: World Development Indicators
4. Trade policy and trade costs data: CEPII

Trade policy elasticities

Table 2: Estimation of trade elasticities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	PPML	PPML	PPML	PPML	FE	PPML	PPML	FE
Dependent variable	No internal trade				Internal trade included			
	Exp_{ij}	Exp_{ij}	$Exp_{ij,t}$	$Exp_{ij,t}$	$\ln Exp_{ij,t}$	$Exp_{ij,t}$	$Exp_{ij,t}$	$\ln Exp_{ij,t}$
FTA	0.463** (0.062)	0.388** (0.085)	0.516** (0.034)	0.417** (0.046)	0.375** (0.030)	0.372** (0.075)	0.412** (0.033)	0.380** (0.030)
Ln(1+ Applied tariff)		-0.701 (1.170)		-1.087* (0.536)				
Observations	25440	14544	234378	68889	122216	25600	234466	123721
Sample	2014	2014	1960- 2014	1990- 2014	1960- 2014	2014	1960- 2014	1960- 2014
R^2					0.875			0.881

Key results: BRI

⊕

A. Mean welfare gains of reduction in transport cost due to Belt and Road Initiative (BRI) by region, percent

Region	Reduction in transport costs, %								Average
	15	20	25	30	35	40	45	50	
China	0.64	0.9	1.18	1.5	1.85	2.26	2.71	3.24	1.79
East Asia & Pacific	-0.01	-0.02	-0.02	-0.03	-0.04	-0.05	-0.05	-0.06	-0.04
Europe & Central Asia	0.06	0.08	0.11	0.13	0.16	0.2	0.23	0.27	0.16
European Union	0.3	0.42	0.55	0.69	0.85	1.03	1.22	1.45	0.81
Latin America & Caribbean	0.09	0.13	0.16	0.21	0.25	0.31	0.36	0.43	0.24
Middle East & North Africa	0.08	0.12	0.15	0.19	0.23	0.28	0.33	0.39	0.22
North America	0.09	0.12	0.16	0.2	0.24	0.29	0.35	0.41	0.23
South Asia	0	0	0.01	0.01	0.01	0.01	0.01	0.02	0.01
Sub-Saharan Africa	0.07	0.1	0.13	0.17	0.21	0.25	0.3	0.35	0.2
All	0.11	0.15	0.19	0.24	0.3	0.36	0.43	0.51	0.29

Key results: China-EU FTA

B. Mean welfare gains of signing FTA EU and China by region, %

Region	Welfare gains, %
China	2.56
East Asia & Pacific	-0.05
Europe & Central Asia	0.22
European Union	1.16
Latin America & Caribbean	0.34
Middle East & North Africa	0.31
North America	0.33
South Asia	0.01
Sub-Saharan Africa	0.28
All countries	0.41

Key results: BRI and FTA

C. Mean welfare gains of reduction in transport cost due to Belt and Road Initiative (BRI) and signing FTA EU and China by region, %

Region	Reduction in transport costs, %								Average
	15	20	25	30	35	40	45	50	
China	3.47	3.83	4.22	4.67	5.16	5.71	6.35	7.07	5.06
East Asia & Pacific	-0.07	-0.07	-0.08	-0.09	-0.1	-0.1	-0.11	-0.13	-0.09
Europe & Central Asia	0.29	0.32	0.35	0.38	0.41	0.45	0.49	0.54	0.4
European Union	1.54	1.69	1.85	2.02	2.22	2.43	2.67	2.94	2.17
Latin America & Caribbean	0.46	0.5	0.55	0.6	0.65	0.71	0.78	0.86	0.64
Middle East & North Africa	0.42	0.46	0.5	0.54	0.6	0.65	0.71	0.78	0.58
North America	0.44	0.48	0.53	0.58	0.63	0.69	0.76	0.83	0.62
South Asia	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.03
Sub-Saharan Africa	0.37	0.41	0.45	0.49	0.53	0.58	0.64	0.7	0.52
All countries	0.54	0.59	0.65	0.71	0.78	0.86	0.94	1.03	0.76

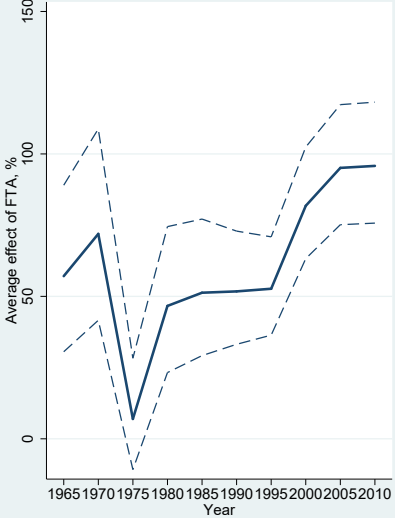
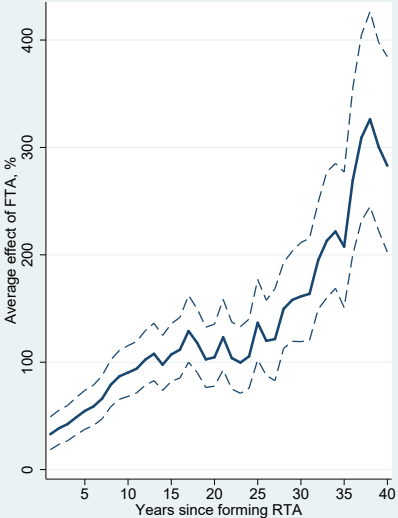
Key results: Other global initiatives

Table 6: Effect of TTIP and TPP and their interactions with transport cost reduction on welfare in China.

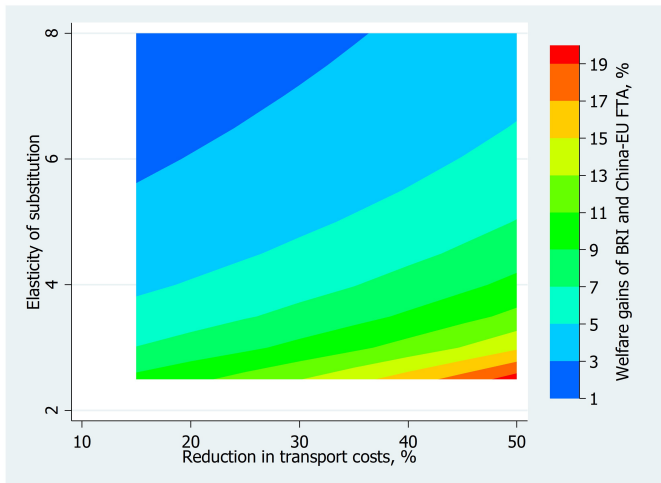
Transport cost reduction, %	TTIP	TTIP and BRI	TPP	TPP and BRI
15		0.624		-0.854
20		0.878		-0.566
25		1.159		-0.248
30	-0.01	1.472	-1.57	0.106
35		1.822		0.503
40		2.219		0.951
45		2.673		1.462
Average	-0.01	1.550	-1.57	0.193

Notes: all values are computed for elasticity of substitution equals 5

Dynamic FTA and trade formation



Chinese welfare gains of BRI and EU FTA



Key Findings

- ▶ Both China and EU countries gain under scenarios 1-3
- ▶ Signing and implementing an FTA between China and the EU is equivalent to transport cost reductions of approximately 45 percent
- ▶ Joint reduction of transportation costs (via the BRI) and signing an FTA generates welfare gains that exceed the sum of the welfare gains from the separate implementation of these policies

Key Findings

- ▶ The major gains of the China and EU FTA do not stem from tariff reductions
- ▶ Major gains come from other effects of an FTA, including lowering non-tariff measures, agreements in the services sectors and reduction of trade policy uncertainty
- ▶ If transport cost reductions exceeds 30 percent, the positive effect of the BRI on China would compensate for the potential negative effects of TPP

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Motivation and Contribution

Two particularly dominant Chinese strategic narratives that have emerged under President Xi Jinping:

- ▶ Belt and Road Initiative (BRI)
- ▶ New Type of Great Power Relations

These policies are part of a shift towards an outward focused Chinese state

Motivation and Contribution

- ▶ Research exploring the impact of politics on trade is fairly recent and growing rapidly
- ▶ The focus in much of this literature is on the impact of worsening political relations
- ▶ In a Chinese context, the modelling literature tends to focus on the negative consequences of diverging political views; e.g. 'Dalai Lama effect'
- ▶ We contribute to this body of literature by exploring the impact of positive political changes that may be generated as a result of Chinese involvement in BRI countries

Motivation and Contribution

We examine two questions:

- ▶ How do potential changes in the political environment, derived from the BRI, impact on trade and welfare?
- ▶ How do the trade and welfare impacts of reductions in trade costs compare to impact of changes in the political environment?

Identifying the key model parameters

- ▶ Production function estimation to estimate effect of political stability on productivity

$$Q_i = A_i K_i^{\alpha_K} L_i^{\alpha_L} \epsilon_i \quad (6)$$

$$\ln A_i = a_0 + a_1 hc_i + a_2 ps_i + u_i \quad (7)$$

- ▶ Gravity model to estimate effect of military alliance and political affinity on trade

$$X_{ij} = \exp(\gamma_{dist} \ln(dist_{ij}) + \gamma_{ma} ma_{ij} + \gamma_{pa} pa_{ij} + Z_{ij} \gamma_Z + \xi_i + \eta_j) + e_{ij} \quad (8)$$

- ▶ Matching techniques to estimate how trade agreements influence political affinity

$$pa_{ijt} = \gamma RTA_{ijt} + D_{it} + D_{jt} + D_{ij} + \eta_{ijt} \quad (9)$$

Data

- ▶ 160 countries for the period 1960-2018
- ▶ External trade data: IMF Direction of Trade Statistics
- ▶ Internal trade data: World Bank data (national accounts and balance of payments) and OECD estimates (share of services in GDP and value added in exports)
- ▶ Political stability data: World Bank governance indicators
- ▶ Formal bilateral political relationships data: Ideal points difference (Bailey et al., 2017)
- ▶ Formal defense alliances data: Correlates of War (COW) (Gibler, 2009).
- ▶ GDP data: World Development Indicators
- ▶ Trade policy and trade costs data: CEPII
- ▶ Capital, labor, and productivity data: Penn World Tables 9.1

Policy Scenarios

Table: Counterfactual scenarios

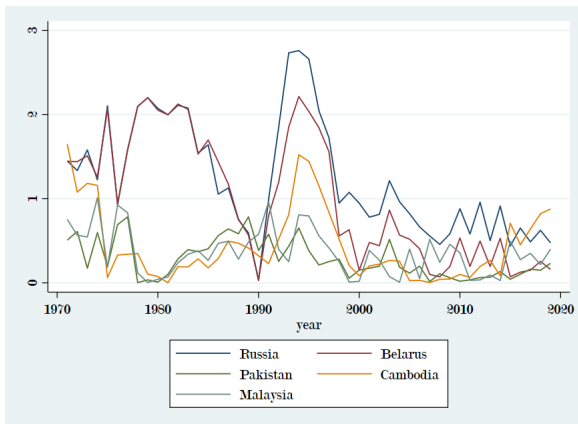
Scenario	Brief Description
BRI	Trade cost reductions of 15%
DEF	Forming a military alliance
PA	Strengthened political affinity
PS	Higher political stability

DEF: Forming a military alliance

- ▶ Alliances can be embedded within regional trade agreements
- ▶ The BRI may include the signing of new formal alliances, potentially as part of a formal bilateral trade/investment agreement
- ▶ Informal alliances may be agreed and not be made public

PA: Strengthened political affinity

Figure: UN voting alignment: ideal points estimates for selected countries, distances from China



Notes: Absolute distance between country 1 and country 2 ideal point estimates



PS: Higher political stability

Table: Average level of political stability in 2014 by region

Region	Average political stability in 2014
East Asia & Pacific	0.472
Europe & Central Asia	0.443
Latin America & Caribbean	0.244
Middle East & North Africa	-0.891
North America	0.891
South Asia	-0.752
Sub-Saharan Africa	-0.662

Source: World Bank Governance Indicators, 2014

Table: Change in export to China, percent by regions

	BRI	DA	PA	PS	Average
East Asia & Pacific	0.16	0.32	0.06	1.29	0.46
Europe & Central Asia	2.65	6.60	0.93	1.58	2.94
Latin America & Caribbean	-4.03	-9.63	-1.45	0.00	-3.78
Middle East & North Africa	3.64	8.98	1.29	4.63	4.64
North America	-4.09	-9.76	-1.47	0.00	-3.83
South Asia	6.16	14.73	2.20	9.21	8.08
Sub-Saharan Africa	-3.76	-9.01	-1.35	0.00	-3.53
Total	0.10	0.32	0.03	2.38	0.71

Some observations

- ▶ For a number of countries, the results for the political stability scenario are very small, or even zero, as they already have a stability rating equal, or exceeding, the European and Central Asian average
- ▶ The performance of the countries under the umbrella of the Cooperation between China and Central and Eastern European Countries (CEEC) group is particularly strong across the BRI, DA and PA scenarios
- ▶ The increase in exports for India, Vietnam, Philippines and Lao is among the most moderate out of the BRI countries

Table: Average change in welfare, percent by regions

	Conditional GE				Full GE			
	BRI	DA	PA	PS	BRI	DA	PA	PS
China	1.59	3.55	0.36	0	1.81	4.11	0.45	-0.49
East Asia & Pacific	0.42	0.93	0.1	0.35	0.63	1.42	0.16	1.13
Europe & Central Asia	0.36	0.79	0.08	0.4	0.57	1.27	0.14	1.4
Latin America & Caribbean	0.14	0.3	0.03	0	0.34	0.77	0.09	-0.22
Middle East & North Africa	0.36	0.79	0.08	1.24	0.57	1.28	0.14	4.12
North America	0.17	0.36	0.04	0	0.37	0.84	0.09	-0.09
South Asia	0.83	1.82	0.19	2.37	1.04	2.33	0.26	8.82
Sub-Saharan Africa	0.08	0.17	0.02	0	0.29	0.64	0.07	-0.05
Total	0.28	0.61	0.07	0.39	0.49	1.09	0.12	1.29

Our full general equilibrium results produce stronger effects, since there is positive feedback from lower trade costs to price changes as well as gains in incomes and expenditures across all countries

Further findings

Findings

Based on our full general equilibrium results:

- ▶ Military alliances between BRI countries and China are expected to have the most positive effect on welfare, with particularly positive effects on China and South Asia
- ▶ Improved political stability across BRI countries is expected to have the most beneficial impact on South Asia.

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Conclusions

- ▶ The EU can capitalize on this opportunity if they can develop stronger strategic oversight of investment flows
- ▶ China must avoid an escalation of the criticisms around their investments as well as working to timescales that allows for appropriate due diligence
- ▶ Our results also suggest that the rewards for both China and the EU can be even greater if they are also willing to commit to a FTA

Conclusion

- ▶ It is important to look beyond economic gains derived from trade cost reductions
- ▶ Politically aligning countries participating in the BRI and providing security to the countries where China invest in transport and infrastructure has the potential to deliver significant benefits

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- ▶ Jackson, K. and Shepotylo, O., 2021. Belt and road: The China dream?. China Economic Review, 67, p.101604.
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