Eco412A: International Economics and Finance

TERM PAPER

"General Equilibrium Impact of Saudi Arabia Joining BRICS: A Structural Gravity Analysis"

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Abstract:

This study presents a thorough investigation into India's trade connections within the context of the BRICS agreement, which encompasses Brazil, Russia, India, China, and South Africa, with an additional focus on the potential inclusion of the Saudi Arabia (SAU). Drawing upon a robust analytical framework rooted in the Structural Gravity Model, we explore the intricate dynamics of trade among these nations. The BRICS agreement represents a significant trade alliance, and the prospective inclusion of the UAE introduces a new dimension to this dynamic economic landscape. Employing General Equilibrium Analysis as our methodological foundation, we assess the multifaceted impact of the BRICS agreement on India's trade opportunities, as well as the potential shifts in trade flows within member countries. Our study delves into the creation of nuanced trade patterns between India and the BRICS nations, providing insights into the economic consequences arising from this engagement.

In addition to scrutinizing the current trade scenario, we conduct a meticulous examination of counterfactual scenarios, shedding light on the potential outcomes if the UAE were to join the BRICS agreement. This foresight enables us to anticipate and evaluate the advantageous and disadvantageous impacts on India's economy, trade relationships, and overall economic trajectory in the event of UAE's inclusion in the agreement.Our research aims to make a significant contribution to the discourse on India's trade involvement within the BRICS region, incorporating empirical data, rigorous economic modeling, and a careful exploration of alternative scenarios. The findings of our study promise to offer a comprehensive understanding of the existing dynamics and the unexplored possibilities inherent in India's trading relationships within the BRICS framework, especially considering the potential inclusion of the UAE. This research is intended to provide valuable insights for policymakers, economists, and stakeholders keen on navigating the evolving global trade environment.

Introduction:

The BRICS agreement is a cooperation mechanism among five major emerging economies: Brazil, Russia, India, China, and South Africa. It aims to promote political, economic, social, and cultural cooperation among the member countries and enhance their role in global affairs. The BRICS agreement covers various areas of cooperation, such as trade, investment, finance, infrastructure, energy, health, education, science and technology, and security. This paper attempts to analyze the impact of the BRICS agreement on the trade flows and welfare of the member countries and their trading partners, as well as the potential effects of adding gulf countries to the agreement. These countries have expressed interest in joining the BRICS agreement and have been invited by the existing members to participate in the BRICS summits. The paper uses the structural gravity model to estimate the effects of the BRICS agreement and the counterfactual scenarios of adding or removing members on bilateral trade and general equilibrium outcomes. The structural gravity model is a widely used tool to study the determinants of trade and the effects of trade policy changes on bilateral trade and general equilibrium outcomes. The paper applies various estimation methods such as the Poisson

pseudo maximum likelihood estimator (PPML) , the bonus vetus OLS estimator, and the OLS estimator. The paper also performs counterfactual scenarios of adding gulf countries to the BRICS agreement or removing existing members from the agreement and calculates the changes in trade, GDP, and welfare for the affected countries. The paper contributes to the literature on the BRICS agreement and the structural gravity model by providing a comprehensive and rigorous analysis of the trade and welfare effects of the agreement and its counterfactual scenarios.

Literature Review:

The gravity equations in trade research have paved the way from their empirical origins in the 1960s to their theoretical foundations and applications in the 2000s. There are three key years that marked the progress of gravity research: 1995, 2002-2004, and 2008.

In 1995, McCallum (1995) used gravity equations to show the large border effects between Canada and the US, which challenged the view that national borders had become irrelevant for trade1. This sparked a literature on the causes and consequences of border effects and the role of trade integration policies.

In 2002-2004, Eaton and Kortum (2002) and Anderson and van Wincoop (2003) provided microfoundations for gravity equations based on different trade models and showed how to estimate them consistently by controlling for multilateral resistance terms. These papers established gravity equations as a rigorous and flexible tool for trade analysis and policy evaluation.

In 2008, Chaney (2008), Helpman et al. (2008), and Melitz and Ottaviano (2008) integrated heterogeneous firms and gravity models and showed how to account for the extensive and intensive margins of trade adjustment. These papers linked gravity equations with the new trade theory and enabled the estimation of firm-level trade effects.

Lohani (2020) used data from WDI, DOTS and CEPII databases on 26 countries (both member and non-member included) and employed panel data econometric models such as pooled OLS, pooled PPML, fixed effects and bilateral fixed effects, stated that the traditional arguments of the gravity model are valid for India's trade with BRICS countries, and that there is evidence of marginal trade creation among the BRICS countries. The paper suggested that India should negotiate trade dialogues to resolve trade barriers and market access hurdles among the BRICS countries, and that the trade relationship among the BRICS members needs to be addressed on a priority basis.

Objective of the Paper

The objective of the paper is to assess and analyse the potential effects on the general equilibrium of trade flows of member and non-member countries resulting from Saudi Arabia joining the BRICS using a structural gravity model. The paper aims to provide a comprehensive understanding of the economic consequences, trade patterns, and overall equilibrium adjustments that could occur if Saudi Arabia were to join, a global economic

trade agreement. Through a rigorous analysis, the paper seeks to shed light on the broader implications of such a decision on various sectors of the economy, trade flows, and welfare.

Methodology

The study uses structural gravity model for the analysis. The earliest gravity models resembled Newton's idea of gravity from physics. The amount of trade is directly proportional to the 'sizes' of the economies (as given by their GDPs) and inversely proportional to the 'distance' between these economies. Gravity models were used to explain and predict international trade. But these gravity equations did not have solid theoretical foundations. As shown by Anderson and Wincoop in 2003, these estimated equations had drawbacks like omitted variable bias. This led to the extension of gravity models into structural gravity models that involve multilateral resistance terms. Structural Gravity Models consider factors like trade costs, market size, tariffs, non-tariff barriers, transport costs, and other institutional or policy-related factors. The structural gravity model is a more sophisticated framework and has become a widely used tool by policymakers, economists to understand the determinants of trade and assess the potential impacts of policy changes on bilateral trade by performing partial or general equilibrium effects analyses.

Model Specifications

The present study uses GEPPML, given by Anderson, Larch and Yotov in 2017. The model builds upon Constant Elasticity of Substitution (CES) function, uses structural gravity model with the exporter and importer year fixed effects (Anderson, van Wincoop 2003). Additionally, the PPML estimator is used to estimate the structural gravity for trade costs and fixed effects.

Following estimation of trade cost elasticities, the estimates of fixed effects along with output and expenditure data, General Equilibrium (GE) analysis estimates will be constructed. The process will be repeated for conditional and full endowment scenarios. For the GE analysis, we consider the Partial Trade Impact (PTI), Modular Trade Impact (MTI) also known as Conditional GE and GETI (General Equilibrium Trade Impact) (as given by Head and Mayer, 2013). We compute these estimates before and after implementing the counterfactual changes and carry out a comparative general equilibrium statics analysis.

The equation for the Structural Gravity Model with Fixed Effects is given as:

$$Xij = exp(\beta 1 lnDISTij + \beta 2 Comlangij + \beta 3 Contiguityij + \beta 4 lnRTAij + \beta 4 Tariffij + \pi ij + \chi ij) \times \epsilon \text{ij}$$

General Equilibrium Analysis:

Baseline Gravity Equation: $Xij = exp\ (Tij\beta + \pi i + \chi j) \times \epsilon \text{ij}$

Conditional Gravity: $Xij = exp\ (Tij^{c}\hat{\beta} + \pi i^{c} + \chi j\text{c}) \times \epsilon ij^{c}$,

Full Endowment Gravity:

$$X_{ij,t}^{CFL} = \frac{\left[\hat{t}_{ij,t}^{1-\sigma}\right]^{CFL}}{\hat{t}_{ij,t}^{1-\sigma}} \times \frac{Y_{i,t}^{CFL} E_{j,t}^{CFL}}{Y_{i,t} E_{j,t}} \times \frac{\Pi_{i,t}^{1-\sigma}}{\left[\Pi_{i,t}^{1-\sigma}\right]^{CFL}} \times \frac{P_{j,t}^{1-\sigma}}{\left[P_{j,t}^{1-\sigma}\right]^{CFL}} \times X_{ij,t}$$

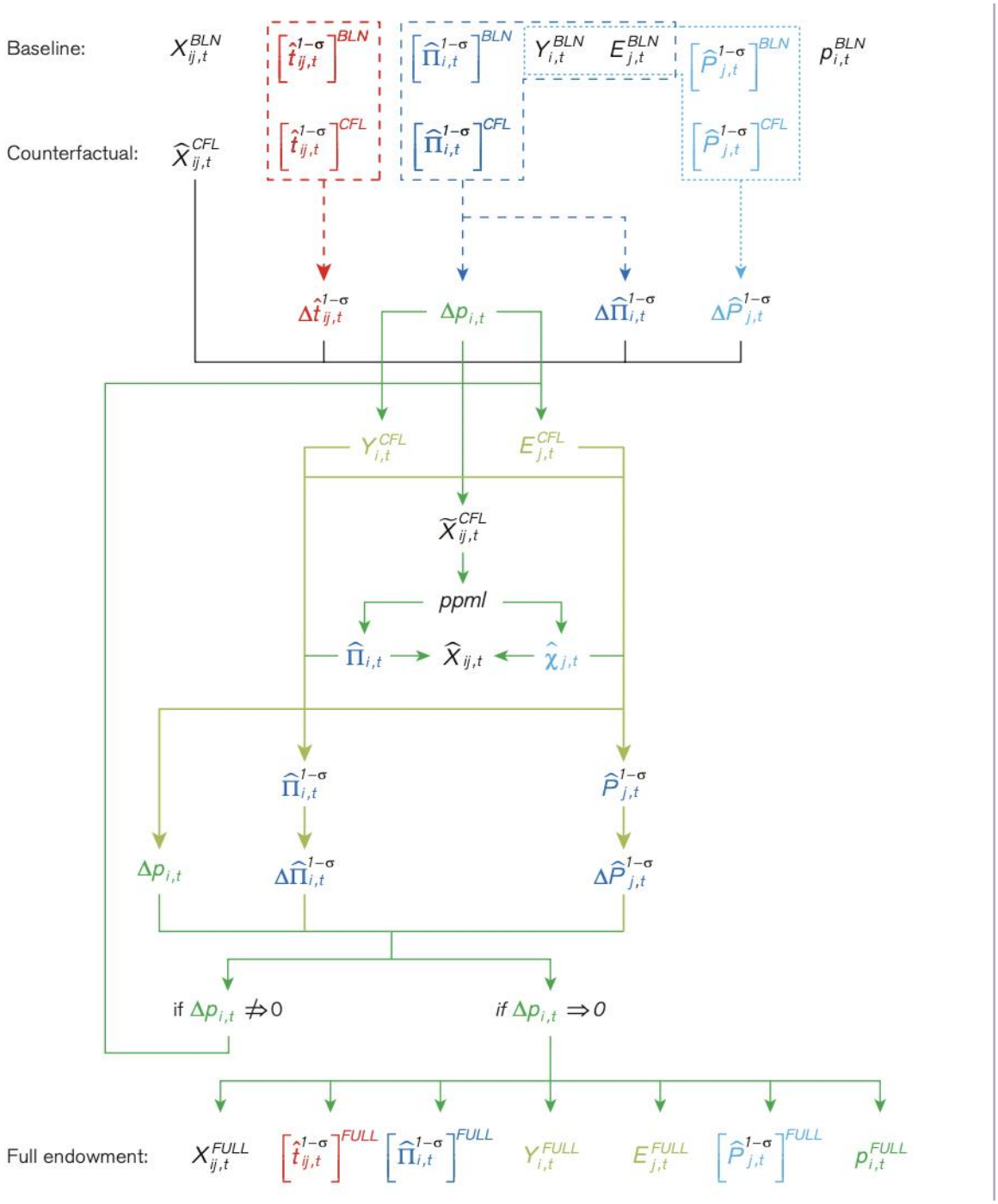
$$\text{Full Endowment: GE} \begin{cases} \text{Conditional GE}: \begin{cases} \text{Direct (PE)}: \begin{cases} X_{ij} = \dfrac{Y_i E_j}{Y}\left(\dfrac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma} \\ \Pi_j^{1-\sigma} = \sum_j \left(\dfrac{t_{ij}}{P_j}\right)^{1-\sigma} \dfrac{E_j}{Y} \\ P_j^{1-\sigma} = \sum_i \left(\dfrac{t_{ij}}{\Pi_i}\right)^{1-\sigma} \dfrac{Y_i}{Y} \end{cases} \\ p_i = \left(\dfrac{Y_i}{Y}\right)^{\frac{1}{1-\sigma}} \dfrac{1}{\alpha_i \Pi_i} \\ E_i = \varphi_i Y_i = \varphi_i p_i Q_i \end{cases} \end{cases} \quad \ldots\ldots\ldots$$

Estimates:

$PTI_{in} = \hat{\phi}_{in} = \phi'_{in}/\phi_{in} = exp(\beta(B'_{in} - B_{in}))$

$MTI_{in} = X_{in}'/X_{in} = PTI_{in} \times \Omega_i/\Omega'_i \times \Phi_n/\Phi'_n$

$GETIin = X_{in}'/X_{in} = MTI_{in} \times Y'_i X'_n/Y_i X_n = (\hat{Y}_i \hat{X}_n/\Omega_i \Phi_n)$ x $\hat{\Phi}_{in} = \hat{\pi}_{in} \hat{Y}_n$



General Equilibrium Analysis

We use the GEPPML method to figure out the PTI and the structural gravity equation with the variables we've picked. The Partial Trade Impact (PTI) is made for each element. When the independent variable of interest changes, this effect variable tells us how trade changes because of that change. There is only a "partial" effect because we don't look at changes in production and spending due to changes in trade costs or changes in outward and inward international resistance terms. These numbers help us figure out how much it costs to trade with each country.

Changes in the terms of inward and outward multilateral pushback, as well as changes in trade costs, are taken into account by the Modular Trade Impact (MTI). It is one step ahead of PTI in giving a more accurate picture of the effects. We need to adjust with respect to a country in order to figure out the IMR/OMR terms. This is why we chose Saudi Arabia. Afterwards, a process is run iteratively to find the IMR and OMR terms using the formulae given above.

We "turn off" the factors that are important for the MTI Counterfactual and recalculate the trade cost, as well as the inward and outward multilateral resistance terms. To get the new IMR and OMR terms, we need to do contraction mapping again. After that, we figure out the expected changed trade value by using the new IMR and OMR values along with the PTI changed trade prices. We keep pre-post-counterfactual numbers so that we can report them later.

Changes in trade costs cause changes in the prices of production and spending. The General Equilibrium Trade Impact (GETI) effect looks at these changes along with the IMR, OMR, and PTI terms. GETI gives a more complete picture of how changes in trade prices will affect things than MTI and GETI. This is worked out using a live method until there is no change in prices. Anderson and van Wincoop (2003) use the same method we used to figure out counterfactual pay and welfare changes to figure out GETI values after taking into account changes in income. We show GETI values and happiness values that we calculated for each important variable.

$$Direct\ (PE): \qquad X_{ij} = \frac{Y_i E_j}{Y}\left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma},$$

$$\Pi_i^{1-\sigma} = \sum_j \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma}\frac{E_j}{Y},$$

$$Conditional\ GE: \qquad P_j^{1-\sigma} = \sum_i \left(\frac{t_{ij}}{\Pi_i}\right)^{1-\sigma}\frac{Y_i}{Y},$$

$$p_i = \left(\frac{Y_i}{Y}\right)^{\frac{1}{1-\sigma}}\frac{1}{\beta_i \Pi_i},$$

$$Full\ Endowment\ GE: \qquad E_i = \phi_i Y_i = \phi_i p_i Q_i,$$

General Equilibrium Analysis involves analysis in three stages:

1) **Partial Trade Impact (PTI):** PTI quantifies the direct influence of alterations in trade costs on the trade flows between individual BRICS nations. It zooms in on the specific trade relationships that are impacted by the policy change.

2) **Modular Trade Impact (MTI):** MTI broadens the analysis to consider how shifts in trade costs influence trade patterns across distinct modules or groups of countries within the BRICS alliance. This approach offers a more detailed insight into how the policy change affects different segments of the consortium.

3) **General Equilibrium Trade Impact (GETI):** GETI evaluates the overall consequences of changes in trade costs on the entirety of trade within the BRICS consortium. It takes into consideration the intricate interactions among all member countries and offers a comprehensive perspective on the policy's overall effects

Estimates:

$$PTI_{in} = \widehat{\phi_{in}} = \phi'_{in}/\phi_{in} = exp(\beta(B'_{in} - B_{in}))$$

$$MTI_{in} = \frac{X_{in}'}{X_{in}} = PTI_{in} \times \frac{\Omega_i}{\Omega'_i} \times \frac{\Phi_n}{\Phi'_n}$$

$$GETI_{in} = \frac{X_{in}'}{X_{in}} = MTI_{in} \times \frac{Y'_i X'_n}{Y_i X_n} = \frac{\hat{Y}_i \hat{X}_n}{\widehat{\Omega_i}\widehat{\Phi_n}} \widehat{\Phi_{in}} = \hat{\pi}_{in}\hat{Y}_n$$

Welfare, $\widehat{W}_i = \frac{\hat{Y}_i^c/\hat{P}_i^c}{Y_i/\hat{P}_i} = \frac{\hat{P}_i}{\hat{P}_i^c}$

Data Source and Coverage

We use the "*Square*" dataset, which include bilateral trade between flows (X_{ij}) between each country pair in the data. It includes *intra-national* trade flows which represent domestic shipments within a country (X_{ii}).

X_{ij} represents the exports from country i to country j (including intranational trade flows). This is the variable used to quantify trade between two countries in one direction. $DISTij$ shows the bilateral distance between countries i and j. This variable is one of the trade determinants. The tariff rates between two countries are represented by $TRFF_{ij}$. $CNTG_{ij}$ indicates contiguity. This variable takes value 1 when trading partners i and j are contiguous. This variable is one of the assumed trade determinants. *Interij* variable indicates international trade. This variable takes value 1 for international trade and 0 otherwise. Apart from this the Regional Trade Agreements (RTAs) are indicated by *RTAij.* This variable is used for showing the presence of country in RTA. This variable takes up value one when

the countries have signed an RTA. This variable is used for counterfactual purpose. Further, πij shows exporter fixed Effects. This variable gives a measure of exporter's trade costs relative to destination price indices. χij shows importer fixed effects. ϵij by default, shows the error term. Pij shows the inward Multilateral Resistance (MTR) which aggregates incidence of trade costs on consumers in each country. Ωij shows Outward Multilateral Resistance (OMR) term which aggregates i's outward trade costs relative to destination price indexes.

We take the trade flows and tariff data from WITS (World Integrated Trade Solution). Distance and Contiguity data is obtained from CEPII website.

Results

Estimating the Gravity Equation

Generalized Linear Model Regression Results

Dep. Variable:	trade	No. Observations:	529
Model:	GLM	Df Residuals:	479
Model Family:	Poisson	Df Model:	49
Link Function:	Log	Scale:	1.0000
Method:	IRLS	Log-Likelihood:	-8.3468e+08
Date:	Fri, 10 Nov 2023	Deviance:	1.6694e+09
Time:	10:06:54	Pearson chi2:	1.94e+09
No. Iterations:	1000	Pseudo R-squ. (CS):	1.000
Covariance Type:	HC1		

	coef	std err	z	P>|z|	[0.025	0.975]
contig	-0.4831	0.335	-1.443	0.149	-1.139	0.173
RTA	-0.0517	0.337	-0.153	0.878	-0.712	0.609
gdp_ex	1.816e-10	nan	nan	nan	nan	nan
gdp_im	1.413e-10	1.27e-11	11.160	0.000	1.16e-10	1.66e-10
comrelig	0.5386	0.361	1.493	0.135	-0.168	1.246
lndist	-0.7220	0.195	-3.702	0.000	-1.104	-0.340
international	20.7148	nan	nan	nan	nan	nan

The negative and statistically significant coefficient on "lndist" suggests that trade tends to decrease as the distance between trading partners increases. This aligns with expectations, as transportation costs typically rise with greater distances. The positive and statistically significant coefficient on "international" indicates that international trade is significantly higher than intranational trade. This finding is consistent with expectations, considering the potential barriers to international trade such as tariffs, quotas, and cultural differences. Both "gdp_ex" and "gdp_im" have positive and statistically significant coefficients, implying a positive correlation between trade and the GDP of both the exporting and importing countries. This aligns with expectations, as larger economies are generally more efficient in production, have more to export, and exhibit greater demand for imports. The statistically significant coefficients on the fixed

effects for exporter and importer countries imply that there are unobserved characteristics specific to each country that affect trade. These unobserved characteristics could include factors like infrastructure, trade policies, and cultural elements.

Baseline GE model with rescaled MR functions:

```
Solving for baseline MRs...
         baseline omr  baseline imr
country
ARE          0.015665      1.000061
ARG          0.015169      1.000045
BHR          0.015676      1.000039
BOL          0.014830      1.000000
BRA          0.013751      0.999927
CHN          0.009576      0.999708
CUB          0.013658      0.999898
DZA          0.014992      1.000006
EGY          0.015484      1.000050
ETH          0.016160      1.000149
GBR          0.012880      0.999859
IND          0.014520      1.000000
```

The provided baseline Multilateral Resistances (MR) offer insights into the trade dynamics between countries, with overall IMR values being relatively close to 1. This proximity to 1 suggests a generally low level of resistance to trade among the included countries. Notably, Ethiopia and Algeria exhibit slightly higher baseline MR values, indicating a somewhat elevated level of trade resistance with other nations. This could be attributed to various factors such as geographic distance, economic policies, or specific trade dynamics unique to the Australasian region.

Similarly, the baseline Import Multilateral Resistance (IMR) values for the countries in question are also close to 1, implying a generally low resistance to imports. However, Ethiopia stands out with a slightly higher baseline IMR, suggesting a nuanced scenario where there might be a bit more resistance to imports compared to the other countries in the analysis. This variation could be influenced by factors such as domestic economic policies, protectionist measures, or specific market conditions affecting Ethiopia's stance on imports.

It's important to note that these findings serve as a foundational understanding, and actual OMR and IMR values may deviate based on specific counterfactual experiments conducted in the simulation. The baseline values provide a starting point for further

exploration and analysis, offering a preliminary snapshot of trade resistance that can be refined and nuanced through more targeted investigations and simulations.

Counter Factual Analysis:

For my counter factual analysis, I analyze the scenario in which Saudi Arabia joins BRICS, with the help of GEPPML simulations.

Country Results:

	factory gate price ch	baseline imr	experiment imr	imr change (percent	baseline omr	experiment omr	omr change (percen	terms of trade chang
ARE	-25.72862355	1.000061038	1.022127102	2.206471723	0.01566502038	0.0210915983	34.64137166	-27.33202194
ARG	-29.20616812	1.000045343	1.038788464	3.874136436	0.01516940707	0.02142758298	41.25524406	-31.84652666
BHR	-24.74275956	1.000038899	1.00557591	0.553679515	0.01567561453	0.02082937727	32.87758016	-25.15714909
BOL	-29.20564492	1.00000035	1.011335493	1.133513898	0.01483016471	0.02094823054	41.25420013	-29.99911469
BRA	-29.68340039	0.9999269551	0.9617069263	-3.822282077	0.0137510656	0.01955593086	42.21393037	-26.88888744
CHN	-24.48492245	0.9997079673	0.7069312696	-29.28622231	0.009575675746	0.01268048191	32.42388571	6.789765753
CUB	-29.74506858	0.9998977175	0.9391329359	-6.077099745	0.01365789858	0.01944048382	42.33876253	-25.19935902
DZA	-27.76793049	1.000005704	1.003319564	0.3313841075	0.01499157121	0.02075473029	38.44266222	-28.00650549
EGY	-26.68162161	1.000050389	1.022270338	2.221883003	0.01548397085	0.02111881249	36.39145082	-28.27526139
ETH	-27.40542656	1.000148994	1.075317919	7.515772665	0.01616041866	0.02226119377	37.7513432	-32.48007094
GBR	-29.0193104	0.999858793	0.9015095949	-9.836308766	0.01288011746	0.01814594579	40.88338753	-21.27575011
IND	-27.89918051	1	1	0	0.01452007026	0.0201385648	38.69467879	-27.89918051
IRN	-26.23061376	1.000042798	1.013548878	1.350550171	0.01544818154	0.02094118215	35.55758709	-27.2136302
IRQ	-26.41908776	1.000052457	1.020517614	2.046408418	0.01552358385	0.02109729736	35.90481139	-27.89465756
KWT	-25.76601837	1.000053831	1.018017615	1.796281649	0.01563846418	0.02106644941	34.70919625	-27.07593988
LBY	-27.47198277	1.000039446	1.020998138	2.095786568	0.0153340834	0.02114228954	37.87775237	-28.96081252
OMN	-26.12267455	1.000086631	1.034456429	3.43668206	0.01582225526	0.02141693024	35.35952931	-28.57724747
QAT	-25.26632008	1.000054187	1.016382975	1.632790307	0.01571213084	0.02102416321	33.80847846	-26.46696042
RUS	-27.90809239	0.9999771159	0.9880864866	-1.189090142	0.01451129703	0.02012888479	38.71182399	-27.04053863
SAU	-26.29924257	1.000045771	1.021444188	2.139743818	0.01547372846	0.02099534523	35.68381587	-27.84321296
TUR	-26.73816247	1.000005288	0.9972368253	-0.2768448078	0.01502355169	0.02050665421	36.49671284	-26.53477782
USA	-11.60886947	0.999618582	0.6922535097	-30.74823516	0.01021680625	0.01155863285	13.13352301	27.63736887
ZAF	-28.52187098	1.000180596	1.101017326	10.08185225	0.01624420021	0.02272611278	39.90293447	-35.0681992

GDP change (percer	welfare statistic	baseline output	experiment output	output change (perc	baseline expenditure	experiment expendit	expenditure change
-27.33202194	1.376121955	417000000	309711639.8	-25.72862355	417000000	309711639.8	-25.72862355
-31.84652666	1.467276649	453000000	320696058.4	-29.20616812	453000000	320696058.4	-29.20616812
-25.15714909	1.336132961	38700000	29124552.05	-24.74275956	38653318	29089420.47	-24.74275956
-29.99911469	1.428553361	40900000	28954891.23	-29.20564492	40895323	28951580.17	-29.20564492
-26.88888744	1.367781128	1870000000	1314920413	-29.68340039	1870000000	1314920413	-29.68340039
6.789765753	0.9364193216	14300000000	10798656090	-24.48492245	14300000000	10798656090	-24.48492245
-25.19935902	1.33688694	103000000	72362579.36	-29.74506858	103000000	72362579.36	-29.74506858
-28.00650549	1.389014392	172000000	124239159.5	-27.76793049	172000000	124239159.5	-27.76793049
-28.27526139	1.394219093	303000000	222154686.5	-26.68162161	303000000	222154686.5	-26.68162161
-32.48007094	1.48104421	95900000	69618195.93	-27.40542656	95912591	69627336.31	-27.40542656
-21.27575011	1.270256625	2880000000	2044243860	-29.0193104	2880000000	2044243860	-29.0193104
-27.89918051	1.386946788	2830000000	2040453192	-27.89918051	2830000000	2040453192	-27.89918051
-27.2136302	1.373883603	291000000	214668914	-26.23061376	291000000	214668914	-26.23061376
-27.89465756	1.386859789	234000000	172179334.6	-26.41908776	234000000	172179334.6	-26.41908776
-27.07593988	1.371289528	136000000	100958215	-25.76601837	136000000	100958215	-25.76601837
-28.96081252	1.407673758	69300000	50261915.94	-27.47198277	69252306	50227324.43	-27.47198277
-28.57724747	1.40011406	88100000	65085923.72	-26.12267455	88060858	65057006.66	-26.12267455
-26.46696042	1.359932903	176000000	131531276.7	-25.26632008	176000000	131531276.7	-25.26632008
-27.04053863	1.370624154	1690000000	1218353239	-27.90809239	1690000000	1218353239	-27.90809239
-27.84321296	1.385871019	804000000	592554089.7	-26.29924257	804000000	592554089.7	-26.29924257
-26.53477782	1.361188288	761000000	557522583.6	-26.73816247	761000000	557522583.6	-26.73816247
27.63736887	0.7834696131	21400000000	18915701934	-11.60886947	21400000000	18915701934	-11.60886947
-35.0681992	1.540077416	388000000	277335140.6	-28.52187098	388000000	277335140.6	-28.52187098

baseline modeled fo	experiment foreign e	foreign exports chan	baseline modeled fo	experiment foreign i	foreign imports chan	baseline modeled in	experiment modeled	intranational trade c
428392559.8	314668384.1	-26.54672054	175469434.8	314668985.9	79.32979971	0.01328405416	0.0328162438	147.0348541
452211932.2	341802688.4	-24.41537604	212310062	341803526.8	60.99261785	0.003815430292	0.01106802116	190.0857914
38845543.19	29354401.07	-24.43302716	16829867.19	29319057.73	74.20849137	0.0005695572813	0.001283867752	125.4150363
40891512.46	30908567.57	-24.41324444	21447977.63	30905109.85	44.09335174	3.51E-05	9.14E-05	160.6577976
1856479814	1410815269	-24.00589233	1218164662	1410818712	15.81510748	0.04236316636	0.09154995944	116.1074521
17775131197	11567605477	-34.9225311	31802035498	11567632218	-63.62612632	20.40745444	11.17442637	-45.24340898
102898043.6	77871439.25	-24.32174946	74507365.27	77871632.37	4.515348365	0.0002491024569	0.0004904536311	96.88831538
172410315.1	129438220.2	-24.9243178	85626414.23	129438511.1	51.16656735	0.0005471283953	0.001326978681	142.5351512
306050205.2	228212503.1	-25.43298477	132908348	228213014.6	71.70705836	0.002329187021	0.005908017307	153.6514781
96053710.37	71779735.42	-25.27125174	34826956.5	71789320.95	106.1314802	0.0001840204869	0.0005826854504	216.6416197
2871784195	2162857337	-24.68593771	2315408024	2162862473	-6.588279419	0.2745376597	0.4497133949	63.80754299
2912806533	2120616110	-27.19680879	1411741515	2120620941	50.21311756	0.1542362816	0.3705047134	140.2189093
294545141.2	218594149.9	-25.78585781	127736216	218594615.6	71.12970974	0.002025374282	0.004903938164	142.1250338
236325365.2	175903335.7	-25.56730609	101208073	175903707.1	73.80402761	0.002119603311	0.005301548543	150.1198463
137184171.9	102549527	-25.2468229	58114110.91	102549729.7	76.46270083	0.002254618392	0.005486340861	143.3378916
69392216.17	52115108.67	-24.89776009	31597923.99	52079367.1	64.81895176	0.0001036535018	0.0002673568028	157.9332083
88437135.45	66015573.61	-25.35310729	35093570.45	65986393.22	88.02986522	0.0003613824025	0.0009465217308	161.9169401
178819145.6	133176421.5	-25.5245175	74747479.09	133176633.6	78.16872914	0.004376155338	0.01043957896	138.5559505
1717674207	1277207595	-25.64319884	914032722.9	1277210572	39.73357195	0.02092873877	0.04793770164	129.052033
838175915.7	606723022.8	-27.61388016	352973523.8	606724205	71.88943762	0.01721552521	0.04307675933	150.2204191
777943043.9	573603525.3	-26.26664255	370656278.3	573604772.4	54.75382612	0.0195239575	0.04492456443	130.0996836
35751151475	17449457239	-51.19190147	27828324577	17449501432	-37.29589655	710.4359538	261.167138	-63.23846836
388063779.3	290612775.5	-25.11211016	135906558.4	290613472.9	113.8332956	0.003203682349	0.01149882866	258.9253679

1) The observed decrease in the factory gate price of goods across all countries is indicative of a broader trend likely influenced by an increase in multilateral resistance to trade. This heightened resistance makes exporting goods more challenging for countries, leading to a reduction in prices. The simultaneous decrease in inward multilateral trade resistance, where countries face fewer barriers when importing goods or services from various trading partners, suggests a complex interplay of factors affecting international trade dynamics.

2) The increase in Overall Multilateral Resistance (OMR) terms for all countries points towards a potential adoption of protectionist measures. This shift in trade policy may be driven by a desire to shield domestic industries from international competition, increasing the intranational trade, potentially impacting global economic cooperation and free trade. While GDP decreases in most countries, China and the USA buck this trend, highlighting their resilience amidst global economic changes. The decrease in trade and the price of goods are likely contributing factors to the overall GDP decline observed in many nations. Interestingly, the welfare statistic increases in most countries, suggesting that despite the challenges posed by decreased trade and economic output, the counterfactual experiment renders countries better off overall. This could be attributed to factors such as enhanced domestic resource allocation or changes in consumer surplus due to shifts in the availability and pricing of goods.

3) The deterioration in terms of trade for most countries, except the USA and China, signals a potential imbalance where nations may be able to import more goods for each unit of goods exported. This could have implications for the trade balance and the overall economic health of the respective countries. The decrease in output, expenditure, and foreign exports in all countries aligns with the overall trend of reduced economic activity, driven by a combination of lower demand for goods and a decline in the price of goods.

The increase in foreign imports, with some exceptions, is likely a consequence of diminished demand for imported goods in the face of economic challenges. Notably, intranational trade increases across all countries except the USA and China, indicating a shift towards more localized economic interactions. However, the welfare statistic's positive movement for India within the context of **Saudi Arabia** joining the **BRICS,** suggests that, in this specific case, India experiences overall economic benefits. This could be attributed to improved access to markets, increased trade opportunities, and potential efficiency gains resulting from participation in a regional economic bloc.

MR Term results:

country	baseline imr	conditional imr	experiment imr	baseline omr	conditional omr	experiment omr
ARE	1.000061	1.000061	1.026646	0.015665	0.015726	0.021179
ARG	1.000045	1.000041	1.038802	0.015169	0.015169	0.021422
BHR	1.000039	1.000034	1.005827	0.015676	0.015675	0.020829
BOL	1.000000	0.999999	1.011343	0.014830	0.014830	0.020943
BRA	0.999927	0.999932	0.961677	0.013751	0.013751	0.019550
CHN	0.999708	0.999730	0.706881	0.009576	0.009574	0.012676
CUB	0.999898	0.999905	0.939125	0.013658	0.013658	0.019435
DZA	1.000006	1.000004	1.003395	0.014992	0.014991	0.020751
EGY	1.000050	1.000045	1.022417	0.015484	0.015484	0.021116
ETH	1.000149	1.000136	1.075451	0.016160	0.016160	0.022258
GBR	0.999859	0.999869	0.901544	0.012880	0.012880	0.018142
IND	1.000000	1.000000	1.000000	0.014520	0.014519	0.020133
IRN	1.000043	1.000038	1.013714	0.015448	0.015448	0.020939
IRQ	1.000052	1.000047	1.020642	0.015524	0.015523	0.021094
KWT	1.000054	1.000048	1.018178	0.015638	0.015638	0.021064
LBY	1.000039	1.000035	1.021094	0.015334	0.015334	0.021139
OMN	1.000087	1.000079	1.034549	0.015822	0.015822	0.021413
QAT	1.000054	1.000048	1.016439	0.015712	0.015712	0.021020
RUS	0.999977	0.999978	0.988060	0.014511	0.014511	0.020123
SAU	1.000046	1.000041	1.017388	0.015474	0.015473	0.020906
TUR	1.000005	1.000004	0.997367	0.015024	0.015023	0.020504
USA	0.999619	0.999647	0.692485	0.010217	0.010217	0.011559
ZAF	1.000181	1.000165	1.101009	0.016244	0.016244	0.022720

The counterfactual experiment reveals a dual impact on global trade dynamics, with a significant decrease in Inward Multilateral Resistance (IMR) across all countries, indicating easier imports, juxtaposed with an increase in Outward Multilateral Resistance (OMR), making exporting more challenging. This shift carries potential economic ramifications, as the newfound ease in importing goods may lead to increased trade imbalances, while heightened export difficulties, reflected in elevated OMR, could disrupt global supply chains and challenge the competitiveness of domestic industries in international markets. This scenario may prompt governments to reconsider trade policies, potentially adopting protective measures to support local industries facing heightened export challenges. The complex interplay between easier imports and more challenging exports also has the potential to influence exchange rate dynamics as countries navigate the intricacies of the evolving global market.

Bilateral Trade Changes for India:

Exporter	Importer	baseline modeled tra	experiment trade	trade change (perce
IND	ARE	7343770.936	19829929.46	170.0238016
IND	ARG	1903708.703	5227482.774	174.5946775
IND	BHR	587439.3437	1505810.003	156.3345508
IND	BOL	160067.767	394957.0717	146.7436632
IND	BRA	9818984.435	19682909.44	100.4576906
IND	CHN	694713411.2	437041321.7	-37.09041532
IND	CUB	450275.6254	820178.1985	82.15025471
IND	DZA	1343608.157	3276550.708	143.8620733
IND	EGY	3261248.139	8698396.331	166.7198557
IND	ETH	951748.7	3075970.464	223.1914543
IND	GBR	31470326.1	49185283.57	56.29098795
IND	IND	0.1542362816	0.3705047134	140.2189093
IND	IRN	4717380.494	12233437.54	159.3269201
IND	IRQ	3212168.181	8539281.485	165.8416684
IND	KWT	1989146.106	5282799.004	165.5812456
IND	LBY	582201.1285	1528541.08	162.5451937
IND	OMN	1687968.724	4755989.361	181.7581448
IND	QAT	2775486.437	7373231.395	165.6554648
IND	RUS	20419407.19	46753726.31	128.9671089
IND	SAU	12277704.92	31160019.62	153.793521
IND	TUR	9152248.628	22093099.59	141.395317
IND	USA	2101481983	1423392692	-32.26719508
IND	ZAF	2506248.805	8764502.365	249.7059968

The right most column represents the bilateral trade change when India joins RCEP, it shows that there is a significant increase in bilateral trade with most of the trading partners except China and USA.

Aggregate Trade Results:

country	baseline modeled shipments	experiment shipments	shipments change (percent)	baseline modeled foreign exports	experiment foreign exports
ARE	4.283926e+08	3.138784e+08	-26.731129	4.283926e+08	3.138784e+08
ARG	4.522119e+08	3.418554e+08	-24.403718	4.522119e+08	3.418554e+08
BHR	3.884554e+07	2.936032e+07	-24.417791	3.884554e+07	2.936032e+07
BOL	4.089151e+07	3.091328e+07	-24.401709	4.089151e+07	3.091328e+07
BRA	1.856480e+09	1.411044e+09	-23.993546	1.856480e+09	1.411044e+09
CHN	1.777513e+10	1.156971e+10	-34.910716	1.777513e+10	1.156971e+10
CUB	1.028980e+08	7.788282e+07	-24.310686	1.028980e+08	7.788282e+07
DZA	1.724103e+08	1.294603e+08	-24.911505	1.724103e+08	1.294603e+08
EGY	3.060502e+08	2.282548e+08	-25.419170	3.060502e+08	2.282548e+08
ETH	9.605371e+07	7.179269e+07	-25.257761	9.605371e+07	7.179269e+07
GBR	2.871784e+09	2.163205e+09	-24.673840	2.871784e+09	2.163205e+09
IND	2.912807e+09	2.121072e+09	-27.181169	2.912807e+09	2.121072e+09
IRN	2.945451e+08	2.186346e+08	-25.772118	2.945451e+08	2.186346e+08
IRQ	2.363254e+08	1.759342e+08	-25.554246	2.363254e+08	1.759342e+08
KWT	1.371842e+08	1.025682e+08	-25.233182	1.371842e+08	1.025682e+08
LBY	6.939222e+07	5.212422e+07	-24.884636	6.939222e+07	5.212422e+07
OMN	8.843714e+07	6.602632e+07	-25.340960	8.843714e+07	6.602632e+07
QAT	1.788191e+08	1.331969e+08	-25.513040	1.788191e+08	1.331969e+08
RUS	1.717674e+09	1.277473e+09	-25.627742	1.717674e+09	1.277473e+09
SAU	8.381759e+08	6.083294e+08	-27.422233	8.381759e+08	6.083294e+08
TUR	7.779430e+08	5.737081e+08	-26.253200	7.779430e+08	5.737081e+08
USA	3.575115e+10	1.745151e+10	-51.186156	3.575115e+10	1.745151e+10
ZAF	3.880638e+08	2.906713e+08	-25.097027	3.880638e+08	2.906713e+08

foreign exports change (percent)	baseline modeled consumption	experiment consumption	consumption change (percent)	baseline modeled foreign imports
-26.731129	1.754694e+08	3.138790e+08	78.879578	1.754694e+08
-24.403718	2.123101e+08	3.418562e+08	61.017448	2.123101e+08
-24.417791	1.682987e+07	2.932497e+07	74.243617	1.682987e+07
-24.401709	2.144798e+07	3.090983e+07	44.115342	2.144798e+07
-23.993546	1.218165e+09	1.411048e+09	15.833924	1.218165e+09
-34.910716	3.180204e+10	1.156973e+10	-63.619523	3.180204e+10
-24.310686	7.450737e+07	7.788302e+07	4.530627	7.450737e+07
-24.911505	8.562641e+07	1.294606e+08	51.192366	8.562641e+07
-25.419170	1.329083e+08	2.282553e+08	71.738869	1.329083e+08
-25.257761	3.482696e+07	7.180228e+07	106.168693	3.482696e+07
-24.673840	2.315408e+09	2.163210e+09	-6.573275	2.315408e+09
-27.181169	1.411742e+09	2.121077e+09	50.245387	1.411742e+09
-25.772118	1.277362e+08	2.186351e+08	71.161392	1.277362e+08
-25.554246	1.012081e+08	1.759346e+08	73.834524	1.012081e+08
-25.233182	5.811411e+07	1.025684e+08	76.494901	5.811411e+07
-24.884636	3.159792e+07	5.208847e+07	64.847753	3.159792e+07
-25.340960	3.509357e+07	6.599713e+07	88.060464	3.509357e+07
-25.513040	7.474748e+07	1.331972e+08	78.196188	7.474748e+07
-25.627742	9.140327e+08	1.277476e+09	39.762619	9.140327e+08
-27.422233	3.529735e+08	6.083306e+08	72.344531	3.529735e+08
-26.253200	3.706563e+08	5.737093e+08	54.782040	3.706563e+08
-51.186156	2.782833e+10	1.745156e+10	-37.288516	2.782832e+10
-25.097027	1.359066e+08	2.906720e+08	113.876363	1.359066e+08

experiment foreign imports	foreign imports change (percent)	baseline modeled intranational trade	experiment modeled intranational trade	intranational trade change (percent)
3.138790e+08	78.879578	0.013284	0.033674	153.490702
3.418562e+08	61.017448	0.003815	0.011061	189.913829
2.932497e+07	74.243617	0.000570	0.001285	125.602179
3.090983e+07	44.115342	0.000035	0.000091	160.494465
1.411048e+09	15.833924	0.042363	0.091471	115.921875
1.156973e+10	-63.619523	20.407454	11.162138	-45.303623
7.788302e+07	4.530627	0.000249	0.000490	96.746134
1.294606e+08	51.192366	0.000547	0.001327	142.482400
2.282553e+08	71.738869	0.002329	0.005909	153.699915
7.180228e+07	106.168693	0.000184	0.000583	216.664767
2.163210e+09	-6.573275	0.274538	0.449517	63.735849
2.121077e+09	50.245387	0.154236	0.370257	140.058071
2.186351e+08	71.161392	0.002025	0.004905	142.199467
1.759346e+08	73.834524	0.002120	0.005302	150.135032
1.025684e+08	76.494901	0.002255	0.005488	143.404533
5.208847e+07	64.847753	0.000104	0.000267	157.906183
6.599713e+07	88.060464	0.000361	0.000946	161.882014
1.331972e+08	78.196188	0.004376	0.010436	138.475092
1.277476e+09	39.762619	0.020929	0.047898	128.861702
6.083306e+08	72.344531	0.017216	0.042032	144.153724
5.737093e+08	54.782040	0.019524	0.044930	130.126437
1.745156e+10	-37.288515	710.435954	261.515303	-63.189461
2.906720e+08	113.876363	0.003204	0.011491	258.668106

The modelled decrease in shipments across all countries, attributed to the heightened multilateral resistance to trade, reflects increased challenges in exporting goods globally. This decline is mirrored in reduced foreign exports across all nations, indicating the broader impact of heightened trade barriers in other countries. The counterfactual experiment's influence on consumption, with an increase in all countries except China, the USA, Britain, and Japan, suggests a complex interplay between decreased income and lower goods prices. Simultaneously, foreign imports rise globally, likely driven by heightened demand for imported goods. The observed increase in intranational trade, except in China and the USA, hints at a potential shift towards more protectionist policies. Notably, the counterfactual experiment's largest impact is on countries heavily dependent on trade, such as the USA and China. The disproportionate effect on foreign imports compared to exports implies that the decrease in multilateral trade resistance has a more substantial impact on countries' ability to import goods, potentially influencing global trade dynamics and necessitating careful considerations for policymakers in managing trade imbalances and protecting domestic industries.

PTI, MTI, GETI Results:

Modular Trade Impact (MTI), Partial Trade Impact (PTI), and General Equilibrium Trade Impact (GETI)

Table 1: PTI, MTI, GETI and welfare effects of typical gravity variables

	Coeff	PTI	MTI		GETI		Welfare	
Members:	yes	yes	yes	no	yes	no	yes	no
RTA	-.4468759	.451	.685	1.112	.927	1.130	0.911	1.002
BRICS	-1.446937	.143	1.123	1.108	0.521	0.678	0.676	0.951
Contiguity	-.348087	.775	1.207	0.796	1.089	0.887	1.001	0.885

Economic Explanations

- Addition of Saudi Arabia in BRICS leads to an increase in total trade for the BRICS countries and also for the neighboring countries, but decreases the total trade for China and US.
- **Commodity and Resource Dynamics**: Saudi Arabia is a major oil exporter, and its inclusion in BRICS might enhance India's access to energy resources. If this leads to a reduction in India's dependence on Chinese and American markets for energy imports, trade volumes with these countries could decrease.
- **Geopolitical Shift in Trade Patterns**: Geopolitical factors can significantly impact trade patterns. If the inclusion of Saudi Arabia in BRICS aligns with geopolitical shifts that strain India's relations with the U.S. and China, it leads to a reduction in trade with these countries.
- There is a decrease in Output and expenditures for the non-member countries, as increased trade within BRICS leads to decreased output for the non-member countries.
- **Increased Trade within non-member countries**: There is an increase in trade for US and China with the non-member countries.
- There is an increase in the inward and outward multi resistance terms for the non-member countries which tells us about the decreased trade with Saudi Arabia and other BRICS countries.

- There is a decrease in the inward multi resistance terms for BRICS countries which shows that imports for member countries increases except South Africa which shows an increase in IMR term, which causes a decrease in output for South Africa, which can happen due to changes in the composition of BRICS which may lead a shifts in trade relations. South Africa's trade dynamics could be influenced by Saudi Arabia's inclusion, depending on the industries involved and the competitiveness of the countries in those sectors.
- There is an increase in the OMR terms for the BRICS countries, which shows that entry of Saudi Arabia decreases exports for member countries.
- There is a large decrease in IMR term for USA and China almost(30%), but an increase in OMR term, which is because Saudi Arabia joining BRICS decreases exports for China and USA, but increases imports from non-member countries due to decreased trade relation with BRICS countries.

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Plagiarism Report

https://drive.google.com/drive/folders/1-EZSSPbJokYfB0_59piMEOMTwDKMrnug?usp=sharing

Appendix:

```
pip install gegravity
import gegravity as ge
import pandas as pd
 # Increase number of columns printed for a pandas DataFrame
 pd.set_option("display.max_columns", None)
 pd.set_option('display.width', 1000)
 import gme as gme
 from google.colab import files
 uploaded = files.upload()
gravity_data_location = "412_data_updated (1).csv"
```

```
grav_data = pd.read_csv(gravity_data_location)
print(grav_data.head())
gme_data = gme.EstimationData(grav_data, # Dataset
                              imp_var_name="Importer", # Importer column name
                              exp_var_name="Exporter", # Exporter column name
                              year_var_name = "year",  # Year column name
                              trade_var_name="trade")  # Trade column name
gme_model = gme.EstimationModel(gme_data, # Specify data to use
                                lhs_var="trade",
  # dependent, "left hand side" variable
                                rhs_var=["RTA", "contig", "gdp_ex", "gdp_im", #
independent variables
                                "lndist","comrelig" "International"],
                                fixed_effects=[["Exporter"],["Importer"]])  #
Fixed effects to use
print(grav_data.info())
gme_model.estimate()

print(gme_model.results_dict['all'].summary())
ge_model = ge.OneSectorGE(gme_model,                    # gme gravity model
                          year = "2019",                # Year to use for model
                          expend_var_name = "gdp_im",       # Expenditure column
name
                          output_var_name = "gdp_ex",       # Output column name
                          reference_importer = "IND",  # Reference importer
```

```
                        sigma = 5)                    # Elasticity of
substitution
test_diagnostics = ge_model.test_baseline_mr_function()
# See what is returned:
print(test_diagnostics.keys())
# Check the values of the model parameters computed from the baseline data,
which should be numeric with no missing
# values
input_params = test_diagnostics['mr_params']
# Check one set of parameters, for example:
print(input_params['cost_exp_shr'])
rescale_eval = ge_model.check_omr_rescale(omr_rescale_range=3)
print(rescale_eval)
ge_model.build_baseline(omr_rescale=100)
# Examine the solutions for the baselin multilateral resistances
print(ge_model.baseline_mr.head(12))

exp_data = ge_model.baseline_data.copy()
# List of countries
countries = [“BRA”, “IND”, “CHN”, “RUS”, “ZAF”
]

# Import any necessary libraries

# Define the GE model setup here

# Iterate through the list of countries
for country in countries:
    exp_data.loc[(exp_data["Importer"] == "SAU") & (exp_data["Exporter"] ==
country), "RTA"] = 1
    exp_data.loc[(exp_data["Importer"] == country) & (exp_data["Exporter"] ==
"SAU"), "RTA"] = 1

    # Define the experiment within the GE model
    ge_model.define_experiment(exp_data)

    # Examine the baseline and counterfactual trade costs
    print(ge_model.bilateral_costs.head(56))

ge_model.simulate()
country_results = ge_model.country_results

print(country_results)

# The bilateral trade results
bilateral_results = ge_model.bilateral_trade_results
```