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SUBMITTED TO -

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STRUCTURAL GRAVITY MODEL ESTIMATION USING INDIA-CPTPP TRADE DATA AND COUNTERFACTUAL ANALYSIS

SYNOPSIS

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INTRODUCTION

- CPTPP, or the Comprehensive and Progressive Agreement for Trans-Pacific Partnership, is a trade agreement among Eleven countries, including Australia, Canada, Japan, and several others in the Asia-Pacific region.
- It aims to reduce trade barriers, promote economic cooperation, and enhance investment opportunities among its members.
- We apply structural gravity model to understand trade flows between India and CPTPP countries if India joins the CPTPP in future or there is no CPTPP in future.
- General Equilibrium refers to a state in which economic forces such as supply, demand, production, and consumption are balanced and stable.
- General Equilibrium Poisson Pseudo Maximum Likelihood Estimation (GE-PPMLE) expands on this by incorporating the interactions and interdependencies between different markets.

INTRODUCTION

- In this equilibrium state, all markets in an economy, including goods and services markets as well as factor markets (like labor and capital), are simultaneously in balance.
- Structural Gravity Model serves as a tool to understand the trade patterns between various countries, considering the general equilibrium effects.
- By integrating the Structural Gravity Model into general equilibrium analysis, economists can gain insights into how changes in trade patterns influence not only individual markets but also the overall equilibrium of the entire economy.
- In Poisson Pseudo Maximum Likelihood Estimation (PPMLE), general equilibrium refers to the consideration of multiple interrelated markets and economic factors in the estimation process.

INTRODUCTION

- This paper embarks on a Gravity Estimation Analysis to delve into trade flows among the CPTPP 11 countries in the year 2020. Our study investigates the factors influencing trade patterns, potential trade expansion, and the implications of alternative trading scenarios within this regional trade bloc. To provide a comprehensive picture, we consider India as a counterfactual trading partner, alongside few other countries.
- This analysis aims to shed light on the underlying forces shaping trade within the CPTPP 11 region, particularly in the year 2020, a period marked by significant global economic events and policy changes. By isolating India as a hypothetical counterfactual trading partner, we seek to evaluate the trade dynamics and potential economic ramifications of its absence or presence within the region.

INTRODUCTION

Countries that are part of CPTPP are -

a. Australia
b. Brunei
c. Canada
d. Chile
e. Japan
f. Malaysia
g. Mexico
h. New Zealand
i. Peru
j. Singapore
k. Vietnam

LITERATURE REVIEW

- Chaney and Helpman (2008) adapted gravity models to explain firm productivity variations. Eaton and Kortum (2002) developed a Ricardian model incorporating firm differences, using gravity-like equations for trade representation.
- McCallum (1995) used the gravity model to analyze US-Canada trade. It revealed the 'Border puzzle': trade between Canadian provinces differed markedly from their trade with the US, despite Free Trade Agreement and open borders.
- Anderson and Wincoop(2003), in their landmark paper,' Gravity with Gravitas: A Solution to the Border Puzzle', introduced Multilateral Trade Resistance terms to solve the border puzzle and gave the 'Structural Gravity Model'.
- Baier and Bergstrand (2009) did the estimation of the gravity equation using Bonus Vetus OLS methodology in which there were no MTR terms but Taylor approximations of the trade cost terms.

OBJECTIVES

The objectives of this paper are –

01. Use the Structural Gravity Model to estimate the Trade flow data on India-CPTPP countries employing approach:

General Equilibrium Poisson Pseudo Maximum Likelihood estimation methodology

02. Counterfactual analysis using the estimates calculated to infer the role of the CPTPP agreement by analyzing trade flows in the case of two scenarios –
    a. If India joins the CPTPP in the future
    b. If there is no CPTPP in the future
03. To assess the potential impacts of alternative trade scenarios by utilizing India as a counterfactual trading partner, alongside five other selected countries, and evaluating the trade dynamics and dependencies within the region.

GENERAL EQUILIBRIUM PSEUDO POISSON MAXIMUM LIKELIHOOD ESTIMATION METHODOLOGY

STRUCTURAL GRAVITY BASIC SPECIFICATION

- The functional form of our model in which the dependent variable is represented as a function of independent variables is -

$$X_{ij} = F(d_{ij}, Y_j, Y_i, NTB_i, NTB_j, CPTPP, IMP_1 \ldots IMP_{12}, EXP_1 \ldots EXP_{12}, CPTPP\_TD_1, CPTPP\_TD_2, COB_{ij}, LL_{ij}, LANG_{ij}, t_{ij})$$

X_{ij} - Imports in country i from country j
Y_i – Importers GDP
Y_j – Exporters GDP

IMP_k - Importer Dummy variable which takes value 1 when country k is importer for $k \in [1,12]$

EXP_k – Exporter Dummy variable which takes value 1 when country k is exporter for $k \in [1, 12]$

d_{ij} - The bilateral distance between country i and j
NTB_i – Non-Tariff barrier of country I
NTB_j – Non-Tariff barrier of country j

LL_{ij} – Whether one of the countries i, j is Landlocked

COB_{ij} – Whether the countries have a common border

$LANG_{ij}$ – Whether the countries have common language

GENERAL EQUILIBRIUM PSEUDO POISSON MAXIMUM LIKELIHOOD ESTIMATION METHODOLOGY

- Python Codes

```
gravity_data_location = "DatasetCPTPP.csv"
grav_data = pd.read_csv(gravity_data_location)
df = pd.read_csv('DatasetCPTPP.csv')

grav_data_cleaned = grav_data.dropna()
print(grav_data_cleaned.head())

gme_data = gme.EstimationData(grav_data_cleaned, # Dataset
                              imp_var_name="importer", # Importer column
                              exp_var_name="exporter", # Exporter column
                              year_var_name = "year",  # Year column name
                              trade_var_name="Trade")  # Trade column name
```

❖ Python Codes

```
gme_model = gme.EstimationModel(gme_data,              # Specify data to use
                                lhs_var="Trade“,       # dependent, "left hand
                                rhs_var=["pta","contiguity",   # independent
                                         "lndist","international"],
                                fixed_effects=[["exporter"],["importer"]])
```

```
 # Fixed effects to use
gme_model.estimate()
print(gme_model.results_dict['all'].summary())
```

❖ Python Codes

```
ge_model = ge.OneSectorGE(gme_model,                # gme gravity model
                          year = "2020",            #Year to use for model
                          expend_var_name = "E",    # Expenditure column
                          output_var_name = "Y",    # Output column name
                          reference_importer = "IND",  # Reference importer
                          sigma = 5)                # Elasticity
test_diagnostics = ge_model.test_baseline_mr_function()
print(test_diagnostics.keys())

# Check the values of the model parameters computed from the baseline data
input_params = test_diagnostics['mr_params']
# Check one set of parameters, for example:
print(input_params['cost_exp_shr'])
```

❖ Python Codes

```
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()

# Get unique values from the "Importers" column
unique_importers = df['importer'].unique()

 # Print the unique values
for importer in unique_importers:
    print(f'"{importer}"')
```

❖ Python Codes

```
ge_model.simulate()
bilateral_results = ge_model.bilateral_trade_results
 print(bilateral_results)
agg_trade = ge_model.aggregate_trade_results
 print(agg_trade)



# country multilateral resistance (MR) terms
mr_terms = ge_model.country_mr_terms

# Get the solver diaganoistics, which is a dictionary containing many types of solver diagnostic info
solver_diagnostics = ge_model.solver_diagnostics
```

STRUCTURAL GRAVITY RESULT

Generalized Linear Model Regression Results

Dep. Variable:	Trade	No. Observations:	225
Model:	GLM	Df Residuals:	192
Model Family:	Poisson	Df Model:	32
Link Function:	Log	Scale:	1.0000
Method:	IRLS	Log-Likelihood:	-4.9087e+07
Date:	Mon, 13 Nov 2023	Deviance:	9.8170e+07
Time:	12:43:24	Pearson chi2:	1.08e+08
No. Iterations:	109	Pseudo R-squ. (CS):	1.000
Covariance Type:	HC1		

	coef	std err	z	P>|z|	[0.025	0.975]
pta	0.6910	0.330	2.094	0.036	0.044	1.338
contiguity	0.0540	0.351	0.154	0.878	-0.634	0.742
lndist	-0.9512	0.128	-7.412	0.000	-1.203	-0.700
international	43.2472	2.18e+06	1.99e-05	1.000	-4.27e+06	4.27e+06

COUNTERFACTUAL ANALYSIS

COUNTERFACTUAL ANALYSIS

Results Country including India

	factory gate price	intranational trade change (percent)	omr change (percent)	GDP change (percent)	welfare statistic	expenditure change (percent)	experiment imr
AUS	18.74687531	-4.576836718	-15.78725777	5.252167847	0.950099196	18.74687531	1.128213113
BRN	20.83510712	-29.00937565	-17.24259415	14.3219763	0.874722457	20.83510712	1.056971848
CAN	21.59074811	-41.57423363	-17.75690046	20.40168575	0.830553155	21.59074811	1.009875795
CHL	19.34911878	-14.31492625	-16.2122008	8.396864849	0.922535907	19.34911878	1.101038485
IND	39.8120755	-15.20887489	-28.47541985	39.8120755	0.715245801	39.8120755	1
JPN	18.2181083	3.628421117	-15.41059027	2.874014814	0.972062772	18.2181083	1.149154229
MEX	18.83669229	-5.616722966	-15.85090592	5.580793394	0.947141964	18.83669229	1.125552171
NZL	18.42811671	0.907920856	-15.56059255	3.652433743	0.964762682	18.42811671	1.142550261
PER	19.53548801	-18.02670926	-16.34283538	9.689168326	0.911667045	19.53548801	1.089765633
SAU	19.04816969	-8.727390869	-16.00038853	6.563788448	0.938405076	19.04816969	1.11715404
SGP	20.67668978	-27.99396059	-17.13395502	13.84209263	0.878409714	20.67668978	1.060035776

COUNTERFACTUAL ANALYSIS

Results Country including India

baseline omr	experiment omr	terms of trade change (percent)	baseline outp	experiment o	output change (percent)	baseline expe	experiment ex	baseline mod	experiment fo	foreign ex
0.00016506	0.000139	5.252167847	2512300657	2983278529	18.74687531	2512300657	2983278529	3187408198	2972348479	-6.74717
0.00015678	0.00012975	14.3219763	2512300657	3035741191	20.83510712	2512300657	3035741191	3520547483	3044752898	-13.5148
0.00015138	0.000124501	20.40168575	2512300657	3054725164	21.59074811	2512300657	3054725164	3371457964	3026955089	-10.2182
0.00016209	0.000135816	8.396864849	2512300657	2998408696	19.34911878	2512300657	2998408696	3108443405	2966490345	-4.56669
0.00017225	0.000123199	39.8120755	2512300657	3512499692	39.8120755	2512300657	3512499692	3027464610	3466561282	14.5038
0.00016734	0.000141554	2.874014814	2512300657	2969994312	18.2181083	2512300657	2969994312	3225097534	2985256037	-7.43672
0.00016493	0.000138786	5.580793394	2512300657	2985535002	18.83669229	2512300657	2985535002	3328198827	2970898741	-10.7355
0.00016673	0.000140788	3.652433743	2512300657	2975270355	18.42811671	2512300657	2975270355	3176048476	2961841467	-6.74445
0.00016115	0.000134817	9.689168326	2512300657	3003090851	19.53548801	2512300657	3003090851	3155997013	2972881232	-5.80215
0.00016387	0.000137652	6.563788448	2512300657	2990847950	19.04816969	2512300657	2990847950	3084778100	3023103230	-1.99933
0.00015746	0.000130483	13.84209263	2512300657	3031761271	20.67668978	2512300657	3031761271	3516755684	3048829219	-13.3056

RESULTS FOR INDIA'S ECONOMY

INDIA -:

- A substantial 39.81% increase in factory gate prices suggests a significant rise in production costs.
- A minor change in foreign exports.
- A substantial decrease (15.21%) in international trade among domestic firms.
- The Inward Multilateral Resistance (IMR) remained unchanged, indicating no additional import restrictions.
- The Outward Multilateral Resistance (OMR) experienced a considerable -28.48% change, suggesting a substantial depreciation of the national currency, which may affect trade competitiveness.
- The welfare statistic of 0.72 suggests a slight decline in overall well-being.
- A significant decrease (15.21%) in foreign imports.

COUNTERFACTUAL ANALYSIS

Bilateral Trade results of India with CPTPP members countries

exporter	importer	baseline modeled trade	experiment trade	trade change (percent)
IND	ARE	589557638.9	613881388.2	4.125762726
IND	AUS	137381182.1	160294904.8	16.6789384
IND	BRA	98660905.53	182062797.3	84.53388024
IND	BRN	283034648.7	258876174.7	-8.535518215
IND	CAN	121014038.6	92814077.53	-23.30304929
IND	CHL	84792313.63	90196855.89	6.373858708
IND	IND	2.97E-10	2.52E-10	-15.20887489
IND	JPN	233103888.1	291442245.2	25.02676275
IND	MEX	97169565.62	112395537.2	15.66948606
IND	NZL	113274236.6	138641407.7	22.39447543
IND	PER	85508422.61	87426668.66	2.243341641
IND	RUS	309393560.6	515591533.1	66.64585138
IND	SAU	431488955.5	485233086	12.45550548
IND	SGP	323293914.6	298750546.1	-7.591658052
IND	USA	119791338.7	138954059.9	15.99675023

RESULTS FOR INDIA'S ECONOMY

INDIA -:

- Trade with Canada (-23.30%) and Singapore (-7.59%) experienced a decline, possibly due to changing economic conditions or reduced demand.

- Trade with Australia (16.68%) and Japan (25.03%) increased, indicating a potential boost in exports to these nations

RESULTS (FOR MR TERMS)

INDIA -:

- A slight increase in Experiment IMR (1.000226) suggests a minor relaxation of import restrictions, potentially encouraging more international trade

- Baseline Official Market Rate (OMR) is extremely low (0.000172), indicating a highly devalued currency that may impact trade competitiveness

CONCLUSIONS

- The regression results using methodologies showed a positive relationship between trade values and GDPs of the trading countries
- The trade cost variables like distance, tariff rates, non-tariff barriers display a negative relationship with the import value
- In case of counterfactuals, we find that CPTPP alliance is welfare inducing
- India have significant increase in GDP in joining CPTPP

DATA SOURCE

❖ Importer Country's GDP	– World Bank
❖ Exporter Country's GDP	– World Bank
❖ Distance	– CEPII
❖ Non-tariff barriers of Importer	– UNCTAD
❖ Non-tariff barriers of Exporter	– UNCTAD
❖ Tariff Rate	– WITS TRAINS

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THANK YOU