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AN ECONOMYWIDE ANALYSIS OF POTENTIAL IMPACT OF THE NEW US SUPPLY CHAIN POLICIES

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ABSTRACT

Our present work tries to explain how the recently recommended supply chain policies of the US can impact the global supply chain. We employ the GTAP model to analyze the possible short-term effects of those policies. We aggregated different regions and sectors to get a simplified view of our analysis. The major conclusion is that even if the newly recommended policies have the potential to increase the GDP growth rate, there might be a possibility of worsening the balance of trade account due to the risk of exchange rate appreciation. However, we only consider the US supply chain policies, and the policy approaches and responses of other countries to tackle the negative effects are still unknown. This analysis implies that the US heavy industry may be highly benefited from the recommended policies, but how much this effect may be positive, significant, and long-lasting is still unknown as our analysis majorly focuses on the short-term impacts. To study the long-term effects, we have to visualize our analysis through a dynamic general equilibrium model.

Keywords: Supply chain, general equilibrium, capital inflow, depreciation, the balance of trade.

INTRODUCTION

The purpose of this analysis is to study the short-term impacts of recently announced supply chain policies with the help of a general equilibrium model. The US is one of the major drivers of the global supply chain and has the potential to influence the price of the global market. The COVID-19 crisis can be viewed as an alarm to strengthen the domestic markets for future crises. The real vulnerabilities are lying under the global supply chain, and the regional concentration of different products are the drivers for the same.

Hollnagel (2011) mentioned four components of resilience: knowing what to do, what to look for, what to expect, and what has happened. Our paper is based on these four ideas where the major focus is on the component "what to expect". Our first aim is to look upon the vulnerabilities of the USA. According to Bonnefous et al. (1997), "vulnerability is the status or the degree of fragility of a system". On the other hand, CRAIM (2007) defined vulnerabilities as "the readiness with risk". Gallopins (2006) created a model where he suggested the conceptual linkages between vulnerability and resilience. This model suggests that resilience is considered as a subset or component of a system's capacity of response for determining how vulnerable a system is. Keeping these in mind, we have analyzed the recent trade statistics of the four critical products (semiconductor manufacturing and advanced packaging, large capacity batteries, critical minerals and materials, pharmaceutical and active pharmaceutical ingredients) mentioned in the 100-days supply chain review to find out the real vulnerabilities of these sectors.

According to the Trade Statistics for International Business Development (the USA has exported around $17 billion. The major participants of this bilateral trade were Canada (14.5%), Mexico (14.40%), and China (13.60%). The trade balance of the US is continuously worsening with China, the European Union, India, and some of the other countries.

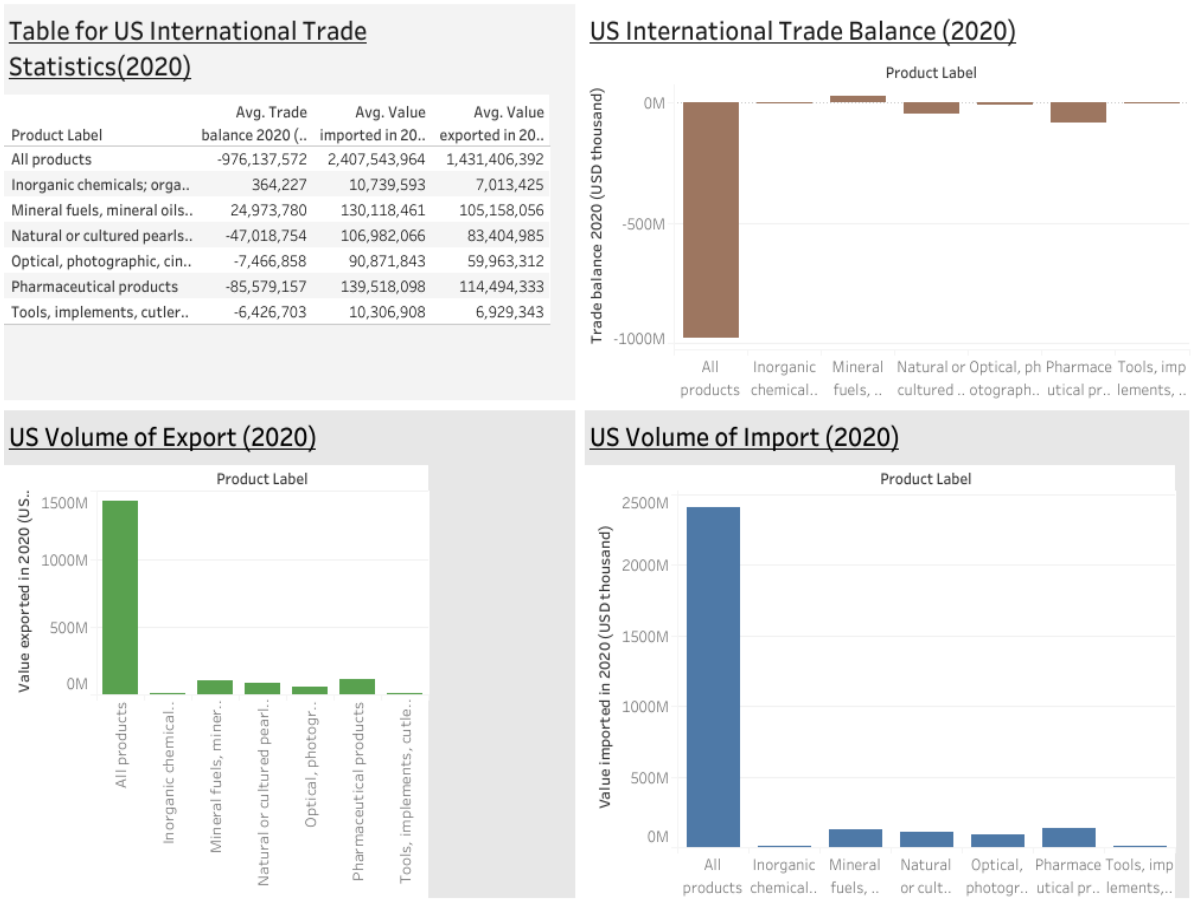
The US semiconductor industry accounts for $47 billion in export sales in 2020 (*Executive Order on America's Supply Chains,2021)*. The Semiconductor Industry Association has estimated that the global semiconductor market may reach $726 billion in annual sales by 2027 with a compound growth rate of 4.7%. The major problem lies in losing the market share of semiconductors from 37% in 1990 to only 12% in 2019. Taiwan subsidy policies towards fabrication facilities for semiconductor chips give 50% subsidy for land cost, 45% for construction and facilities, and 25% for semiconductors, in addition to R&D investments and other incentives. As a result, Taiwan (20%) accounts as the global leader in semiconductors' global installed capacity, followed by South Korea (19%), Japan (17%), and China (16%).

The estimated global nickel reserves are approximately 94 million metric tons, whereas Australia and Indonesia share around 20 million metric tons each, followed by Brazil (16Mt). The USA has a very small deposit of nickel with a volume of production of only 0.016 million metric tons in 2020. In the case of pharmaceutical products, India accounts for the largest share (29%) of active pharmaceutical ingredients (API), followed by the EU (27%) and China (16%). The USA has a huge trade deficit of $85millions with the rest of the world.

The next objective of our study is to connect those vulnerabilities with the global supply chain for the assessment of risks. The definition of the supply chain is evolving day by day as the supply chains were previously local and integrals, but nowadays, they have become global and modular (Laville, 2006). We have kept it in mind and have done our analysis from

a global perspective. Firstly, we have aggregated different regions of the world to get a simpler view of our analysis, and then we have done a risk assessment for the USA with the help of historical trade data.

Figure 1: US International Trade Statistics



Product Label	Avg. Trade balance 2020 (..	Avg. Value imported in 20..	Avg. Value exported in 20..
All products	-976,137,572	2,407,543,964	1,431,406,392
Inorganic chemicals; orga..	364,227	10,739,593	7,013,425
Mineral fuels, mineral oils..	24,973,780	130,118,461	105,158,056
Natural or cultured pearls..	-47,018,754	106,982,066	83,404,985
Optical, photographic, cin..	-7,466,858	90,871,843	59,963,312
Pharmaceutical products	-85,579,157	139,518,098	114,494,333
Tools, implements, cutler..	-6,426,703	10,306,908	6,929,343

Source: *Trade Map (US Trade Data)*

The next part of our discussion focuses on risk management policies taken by the USA to develop resilience. There are four components of the cycle of risk management: preparedness, mitigation, response, and recovery. Robustness, resources, and recovery are three key elements of resilience (Fisher et al., 2010), and the newly formed Biden administration has successfully pointed out all of these four components. Resilience can be defined as the ability of a system to return to its original state or a more favourable condition after being disturbed. It is, therefore, necessary for a nation to consider the resilience of its supply chain as a component of continuity.

Next section, our report analyzes the question “what to expect " with the help of a computable general equilibrium model. Various approaches have been taken by different studies on examining resilience for dealing with several approaches, including analytical for selection. For instance, Adtiya (2014) and Rajesh (2015) employed multicriteria methods for selecting a supplier in the context of a resilient supply chain. On the other hand, Soni et al. (2014) used graph theory interpretive structural modelling for identifying and ranking enablers of supply chain resilience. The idea is to visualize the possible impacts as a wholesome approach of an economy where all of the sectors are interlinked with each other. We introduce various

shocks as a result of different policy recommendations and analyze the impacts of those shocks with the estimated values in GTAP. Special attention to India and China has been drawn as these two economies are expected to be the potential drivers of the global supply chain in the future.

In brief, this paper is organized as follows. Section II covers a brief of the US 100-days supply chain policy review. Section III describes the methodology behind our analysis, where we discuss how we implement the CGE model with the help of GTAP for our report. Section IV analyses the findings of our research, and section V concludes.

1. 100-DAYS SUPPLY CHAIN REVIEW- A BRIEF

The comprehensive 100-days supply chain assessment critically evaluated the state of the four critical products, namely semiconductor manufacturing and advanced packaging, large capacity batteries, critical minerals and materials, pharmaceutical and active pharmaceutical ingredients (*FACT SHEET: Biden-Harris Administration Announces Supply Chain Disruptions Task Force to Address Short-Term Supply Chain Discontinuities, 2021)*. The contribution of the four different departments of the US government is as follows- the review on semiconductor manufacturing and advanced packaging has been given by the Department of Commerce. The Department of Energy reviews the sector of large-capacity batteries whereas the Department of Defense has reviewed the critical minerals and materials. pharmaceutical and active pharmaceutical ingredients have been reviewed by the Department of Health and Human Science.

The report has four different sections. The first section covers semiconductor manufacturing and advanced packaging. The US semiconductor industry accounts for nearly half of global semiconductor revenue, but the share of semiconductor manufacturing capacity on U.S. soil has fallen from 37 percent to 12 percent of global production in the last 20 years. The semiconductor supply chain has been examined through five related essential segments: (i) design; (ii) fabrication; (iii) assembly, test, and packaging (ATP) and advanced packaging; (iv) materials; and (v) manufacturing equipment where the high dependency on sales to china for continued profit growth and domestic research and development (R&D) investment, Taiwan for leading-edge logic chips, Taiwan, South Korea, and China to meet the demand for mature node chips and the concentration of lithography production sector in the Netherland and Japan has been taken into account. Eight cross-cutting risks to semiconductor supply chains, namely fragile supply chains, malicious supply chain disruptions, use of obsolete and generations-old semiconductors and related challenges for continued profitability of companies in the supply chain, customer concentration, and geopolitical factors, electronics production network effects, human capital gaps, IP theft and challenges in capturing the benefits of innovation and aligning private and public interests. The department of commerce has recommended promoting long-term US leadership by the process of full funding towards the CHIPS for America and strengthening the domestic semiconductor manufacturing sectors through the support towards key upstream—including semiconductor manufacturing equipment, materials, and gases—and downstream industries to offset high operational costs in the United States. Protection of the U.S. Technological Advantage in Semiconductor Manufacturing and Advanced Packaging by ensuring that export controls support policy has also been taken into account. The foreign collaboration and investment for semiconductor sectors have been highly welcomed in this report.

The second section of this report covers large-capacity batteries. The department of energy has developed a bunch of ideas where the major focus is on stimulating the demand for the end products using domestically manufactured high-capacity batteries and strengthening the supply chain of advanced battery minerals through investment towards nickel refining and global cooperation. Maintaining the sustainable domestic extraction of minerals and promoting sustainable domestic battery materials, cell, and pack production by catalyzing the investment and introducing supportive tax credit has also been recommended. Increased funding for R&D to expand uptake and reduce supply chain vulnerabilities is also a lucrative part of the policy recommendation. It has been estimated that EV battery recycling alone can reduce cumulative cobalt demand for global EV fleets through 2050 by 26-44 percent.

The third section of this review draws attention to critical minerals and materials by the Department of Defense. Driving a global market change towards the value of environmentally and socially responsible production has been recommended. The report has suggested establishing a new interagency task force to develop a material-by-material plan to identify specific locations of key strategic and critical materials in the United States that could be sustainably produced domestically. Deployment of DPA and other programs to incentivize production across the supply chain, including downstream, high value-added manufacturing such as new magnet capabilities and advanced electric motor designs, has also been suggested.

The last section of 100 days reviews consists of the report of pharmaceuticals and pharmaceuticals ingredients by the Department of Health and Human Services. The major focus of this section is to improve transparency and increase the economic sustainability of the U.S. and allied drug manufacturing and distribution. The report also suggested boosting local production and fostering international cooperation. In addition to this, the report recommends various investment and financial incentives to boost production.

2. METHODOLOGY

To estimate the possible short-term impacts of US supply chain policy recommendations, a standard GTAP model (Version 10) aggregated to 42 countries and 52 subsectors has been used. GTAP model is a global network of researchers conducting quantitative analysis of international policy issues. It is a multiregional, comparative-static CGE model for global trade and investment analysis. As the model is based on the theory of general equilibrium, it provides a comprehensive representation of the economy as a complete system of interdependent components like governments, investors, households, industries, exporters, and importers by capturing the economic interactions of each country or region with detailed inter-industry links. The basic assumption of this model is that the market is perfectly competitive, the industries are linearly homogenous, and the traded goods are imperfectly substitutable. The bilateral trade effects can also be captured by this model. For our analysis, we aggregated the regions as follows (see Table 1).

This analysis incorporates three known and measurable channels: (i) R&D policy and other policies that increase productivity; (ii) Resilience supply chain policy leads to an increase in tariff rate in the Biden administration; (iii) Lowering output tax in Heavy manufacturing sectors to incentivize the volume of production.

The first channel accounts for various policy measures taken by the four ministries of the US government to incentivize R&D. Investment in R&D may accelerate technological progress

in the USA. However, the size of the productivity shock is completely exogenous in our model.

The second channel arises from the approach of policy recommendations. The major focus of the report is to increase sustainability with a major concern to heavy manufacturing industries. The supply chain vulnerabilities for semiconductor manufacturing, large capacity batteries, and pharmaceutical products have been mentioned in the 100-days supply chain review. The global economy has already witnessed the increase in tariff rates of the USA, and the major burden of the tariff is expected to fall on China and India as the newly formed government is hinting towards a 25% hike in tariff rate in various products of India. The IMF has told the USA to decrease the tariff rate, but as far as sustainability is the biggest concern, the possibility for a reduction in tariff rate might be very low. However, we don't know what may be the response of other regions to tackle this problem. So, we ignore the responses of others in our analysis.

Table1: Table for Regional Aggregation in Global Trade Analysis Project(GTAP)

Regions	Countries
Oceania	Australia, New Zealand, Rest of China
East Asia	Hong Kong, Japan, Korea, Mongolia, Taiwan, Rest of East Asia
South-East Asia	Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Thailand, Vietnam, Rest of South-East Asia
China	China
South Asia	Bangladesh, Nepal, Pakistan, Srilanka, Rest of South-East Asia
India	India
North America	Canada, Mexico, Rest of North America
USA	United States of America
Latin America	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, Rest of South America, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, EI Salvador, Rest of Central America, Caribbean
European Union	Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom
MENA	Rest of Western Asia, Egypt, Morocco, Tunisia, Rest of North Africa
SSA	Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Ghana, Guinea, Nigeria, Senegal, Togo, Rest of Western Africa, Central Africa, South Central Africa, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Tanzania, Uganda, Zambia, Zimbabwe, Rest of Eastern Africa, Botswana, Namibia, South Africa, Rest of South African Customs, Rest of the World
Rest of the World	Switzerland, Norway, Rest of EFTA, Albania, Bulgaria, Belarus, Croatia, Romania, Russian Federation, Ukraine, Rest of Eastern Europe, Kazakhstan, Kyrgyzstan, Rest of Former Soviet Union, Armenia, Azerbaijan, Georgia, Bahrain, Iran, Israel, Kuwait, Oman, Qatar, Saudi Arabia, Turkey, United Arab Emirates

The third channel arises as there is a possibility for lowering the output tax to increase the volume of production. However, there might be a possibility that the other sectors may bear the extra tax burden because of these as the government has to maintain a constant amount of tax collection to stimulate the fiscal sides of an economy.

Table 2: Calibration of The Shock to Global Trade Analysis Project (GTAP)

Items	Short Term Shocks (12 Months)
R&D policy and other policies increase productivity	20% for heavy manufacturing
Resilience supply chain policy leads to an increase in tariff rate in the Biden administration	10% for China 7% for India 5%for EU 7% for East Asia
Lowering output tax in Heavy manufacturing sectors to incentivize the volume of production	By 5%

The calibration of the shocks is explained in Table 2. For this study, we also retained our standard computable general equilibrium (CGE) model - such as the perfectly competitive market, behavior of the firms, households, and the governments, along with their responses to changing resources and market conditions. Firms maximize their profit subject to budget constraints or the limited resources of an economy. The primary factors of production (land, natural resources, physical capital, and skilled and unskilled labor) are combined with intermediate inputs, including imports, to produce the final output of an economy.

3. RESULTS

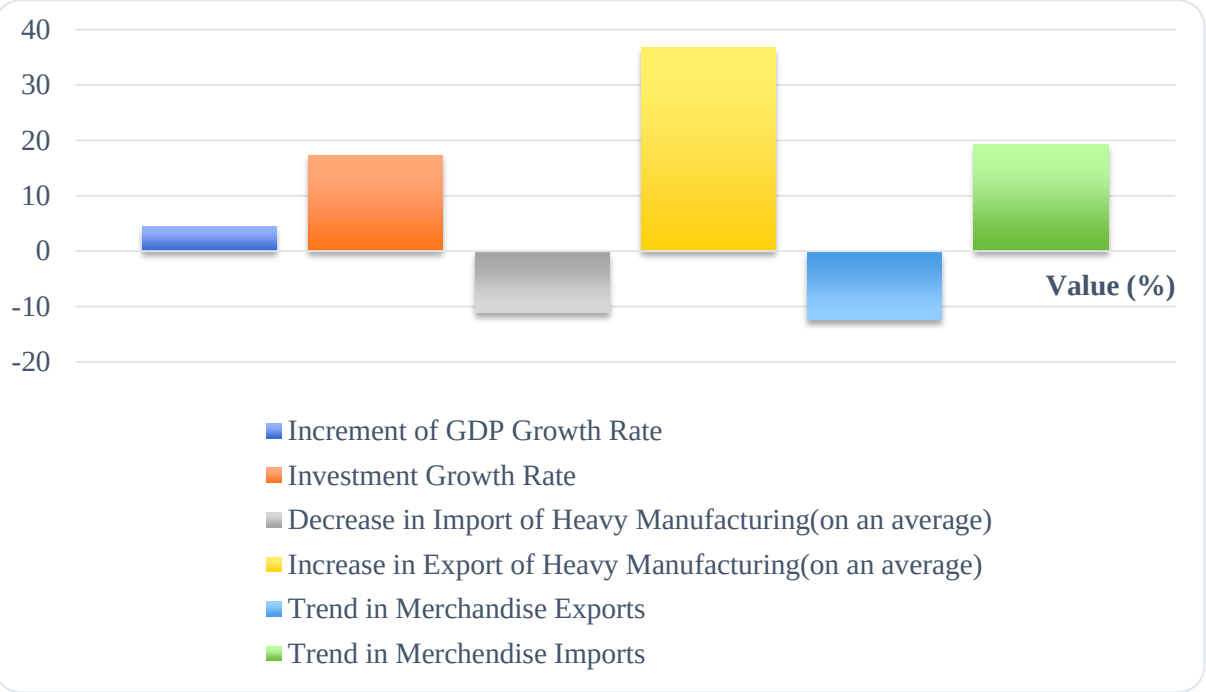
The findings of our analysis can be explained in four possible ways - (a) GDP impacts, (b) Impact on investment growth, (c) Balance of trade risk, and (d) Risk of currency appreciation. The details of our findings are as follows-

GDP impacts: Under the assumptions and given exogenous shocks of our analysis, the GDP of the USA may rise by 4.49% in the short term (1 year), which is around a 0.6 million increase from the previous GDP level. The result is pretty obvious as the increase in productivity due to the increase in investment in R&D led to an increase in production. Protectionism (protection of domestic industries to increase long-term resilience) can also be viewed as a driver of this GDP growth.

However, there may be a slightly negative impact for global economies as most of the economies' GDP growth rates may witness a negative trend ranging from -0.04 to 0.15 percent. This impact can be viewed as the capital inflow to the USA can create a negative repercussion with others.

Impact on investment growth: For the given shocks, there may be a rapid increase in investment growth as the output of capital good sectors expands around 17% for the USA. Incentivizing investment opportunities and government support to increase resilience is the major source of investment growth. Another possible reason is the increase in productivity. As productivity increases a firm's profit, investors may be willing to invest in the USA. However, the current account is already in surplus due to a rapid increase in FDI and this should be kept in mind as the amount of deficit for the capital account is continuously increasing.

Figure 2: Research Findings



Balance of trade risk: The result shows us that there may be an increase in the GDP growth rate. However, the exact mechanism of this kind of growth is quite misleading as the result is also showing that there may be negative growth of trade balance in the short term (-$457K) even if the trade balance in terms of heavy manufacturing is showing a positive trend as the net increase of trade balance accounts $285K for this sector. Terms of trade effect due to increase in tariff can be viewed as a possible reason. The existing tariff rate is already high due to the US-China trade war and other issues. The IMF has already told the Biden administration to decrease the tariff rate. However, the newly formed government is continuously ignoring the negative sides and has already announced that there may be a possibility to increase the tariff rate for some of the imported goods, which include a 25% increase in tariff for 26 items of India. The trade war always leads to a contraction of trade. As a result, the export data is showing a 12% decrease in merchandise export for the USA.

Risk of currency appreciation: One major risk for continuous increase in investment opportunities is the risk related to currency appreciation. For a 6% change in the price level of imports for US-India bilateral trade in terms of heavy manufacturing, the import of the USA has decreased around 11% for this sector. This effect may be more or less similar to the rest of the world. Similarly, for a change in price ranging from 4% to 8% throughout the world, the export of heavy manufacturing in the USA may be increased by 30 to 40%. However, we may witness the opposite impact in terms of other sectors. The given results can be viewed as follows. All of these results suggest that the summation of the elasticity of demand for exports and imports may be greater than one. As a result, the sensitivity of currency appreciation is obvious. An increase in investment opportunities leads to an increase in demand for USD, which directly accelerates the valuation of USD and leads to currency appreciation. But this kind of appreciation may create a risk in terms of the volume of trade as there may be a possibility that the exports may decrease and the import may increase.

CONCLUSION AND POLICY IMPLICATION

A lesson seems to have emerged from the recent discussions on the issue of the COVID-19 crisis. It seems that misinformation has played havoc in the global supply chain. The recently published 100-days supply chain review has mentioned how data transparency is essential to reduce supply chain risks. Our study also concludes that the suggested policies can be misleading if we don't consider the data regarding the elasticities of exports and imports for different sectors. However, our discussion doesn't include the trade misinvoicing scenarios as our preliminary assumption is that the market is perfectly competitive. Another shortcoming of our analysis is that we ignore the policies of other regions because of incomplete information. We don't know how the other regions may behave to tackle the negative effects of the US supply chain policies. Once we get a clear idea about the possible economic policies of other regions for the continuation of a positive GDP growth rate, we can advance our analysis with more accuracy.

Although our analysis has some shortcomings, the results from our study aren't negligible as the study concludes that excessive care for heavy manufacturing might hurt other sectors of the economy. A decrease in output tax rate may increase the production for heavy manufacturing, but the burden of the tax rate may be shifted to other sectors of the economy which can be viewed as a potential driver of the reduction in the production of other goods. The government has the right to increase the tariff rate. However, they can't ignore the possibility that other countries in the world may behave the same. Government has to keep this in mind for policymaking. Although our analysis doesn't answer the questions regarding the possible effects in the long-run; one has to keep in mind that short-run policies have the potential to smooth the pathway of the long run.

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