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How Reshoring Impacts Economy and Transportation Logistics – A US Perspective

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Abstract— Reshoring is a relatively new trend across the world, particularly in developed nations like the US and European countries. Its impact on the economy and transportation and logistics is expected to be significant. However, there is a lack of research on the reasons behind companies' decision to reshore, the major players involved, the economic implications, and how to align transportation for maximum benefit. To address this gap, a study was conducted using location quotients, which compare the economic composition of smaller areas to a base geographical area. Two datasets were used: the US Census Bureau's County Business Patterns employment dataset and Esri's US Business Locations dataset. Results show that location quotients greater than one indicated a more specialized economy in each industry subsector or group in a county compared to the national economy. This study also develops a Reshoring Index (RI) that can measure the readiness of outsourced products to be brought back to the US.

The study highlights the impact of reshoring on the US transportation and logistics, with a focus on the ports importing necessary commodities. Companies are expected to prioritize lowering transportation costs, resulting in a shift towards North-Eastern, South-Eastern, and Eastern ports in the US. While reshoring will reduce the burden on US ports, it may put pressure on local and regional transportation infrastructures. The findings of this research are transferable and implementable in the industry, as demonstrated by a pilot implementation at Bridgestone APM company, USA, which resulted in over \$4 million in 301 tariff savings for the company.

Keywords— Reshoring, location quotient, economic analysis, job creation

I. INTRODUCTION

Reshoring is opposite to off-shoring. In the US perspective, it is known as bringing operations back to the US. In the past few decades, numerous companies in the U.S., as well as other industrialized countries, transferred (a.k.a. offshored) manufacturing operations (or other business processes) to low labor-cost countries, mainly in Asia. This offshoring and outsourcing trend (i.e. handing a business process to an external service provider) that is based on low-cost manufacturing destinations, combined with enhanced ocean shipping and improved onshore and inland intermodal services, would constitute one of the most significant changes in manufacturing and supply chain strategy around the world. Offshoring has gradually transformed the global manufacturing environment, in which fixation on low cost labor was and most probably still is, a dominant motive for the manufacturing location or relocation

decision. This offshoring phenomenon did not only cause a decline in the U.S. manufacturing and its share in the nations' GDP, but also loss of millions of jobs in this sector (Fig. 1).

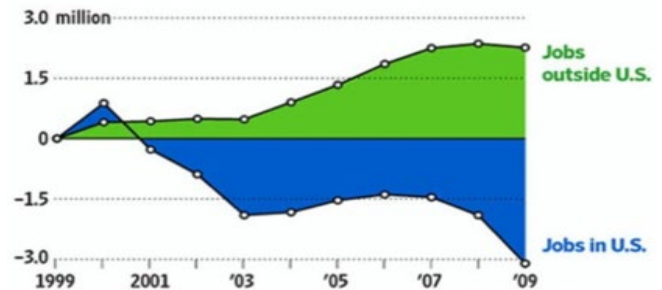


Fig. 1. Job losses in the US by US based multinational companies during 1999-2009 [1].

McCutcheon et al. published a report on the U.S. manufacturing resurgence potentials. The authors studied the driving factors that make both reshoring of manufacturing and research & development (R&D) an attractive choice; also, the study identified other set of factors that could be an obstacle for such decision [1]. Amongst those strong reshoring factors that make U.S. highly attractive for reshoring, include currency, energy, and transportation costs. At the same time, the factors which are considered as relatively attractive for reshoring include big local market demand, labor cost (especially in southern right-to-work states, combined with precipitous labor cost growth of off-shore manufacturing), and relative strength/skills of U.S. labor and availability of capital (lower cost and/or easier credit for commercial/industrial lending demand – as compared to 2009 financial crisis and after). On the other hand, taxation and regulatory climates are the main factors making the U.S. unattractive for manufacturing [2]. In the general conclusions of McCutcheon's study, it is pointed out that re-transplanting production, and in some cases R&D, back to the U.S. may not be the best choice for all industries. Reshoring will most likely be an advantageous move for heavy (energy/transportation reliant) (i.e., metals and chemicals industries) and a less persuasive strategy for light (i.e., labor reliant) manufacturers.

Nash-Hoff suggested that reshoring initiatives alone would not turn the tide. The emerging advanced manufacturing techniques (such as additive manufacturing, 3-D printing, artificial intelligence, and nanotechnology) factor heavily into the economic comeback [3]. The key factors, which are suggested to bring the manufacturing to America have been

facing drawbacks; mostly related to advanced manufacturing, quality problems, rising labor costs, intellectual property theft, rising shipping costs, long lead times for product delivery from Asia, and the cost of inventory for the larger lots need to be bought from Asia to get the cheapest prices. Industrial additive manufacturing (or 3D digital printing of polymers, metal powder, etc.) allows for building parts with very complex geometries without any sort of tools or fixtures, and without producing any waste material. Therefore, 3D printing is turning product design into reality for a fraction of the cost of past traditional manufacturing technologies. The reshoring initiative takes direct action by helping U.S. manufacturers realize that local production and sourcing often reduce their total cost of ownership of purchased parts and tooling. The initiative also trains suppliers to demonstrate to these manufacturers the economic advantages of local sourcing.

The major contribution of this paper is to assess and analyze the potential economic impact of reshoring in 15 states of the U.S. Economic impact included potential job growth, tax revenue, and GDP in those regions due to reshored instances. This research paper also analyzed and presented relevant information on the economic impact of reshored manufacturing companies and their supply chains. If manufacturers bring production back nationally, how will this affect their supply chain needs? What is the percentage of local production and how much will be imported to maintain anticipated outputs? What kind of industries will be most prominent and what ports of entry will be most affected by reshoring? This study used 15 states in the U.S. (Midwest to south, as part of CFIRE grant requirement) to evaluate the economic and supply chain impact of the sixty-three companies that reshored in that region from 2010 to 2015. This paper also generalizes the impact of reshoring on transportation & logistics so that other countries can benefit from it

II. THE REASONS BEHIND RESHORING

There are numerous reasons why companies reshore including lead time, quality, rising wages in developing countries, intellectual property, energy, freight costs, etc. [4]. Logistics cost and proximity to customers are common factors for driving the reshoring, as well as the quality factor, which vary by industry [5-7]. Arvidsson and Magnusson identified the proximity to market and customers, operational costs, and concentration of businesses as important factors [8]. A survey of manufacturers with offshore operations found a growing need to be where their customers want them to locate and the ability to expand into new markets [9]. The most likely manufacturers to return to the U.S. are those that require minimal labor, depend on natural gas, and need flexibility in production to meet changing customer needs [10]. Being close to the supply base is a driving factor. The location of suppliers is a crucial factor in realizing the benefits of reshoring [11-13]. However, for some industries in US, the supplier base, the workforce, and even the company's own internal product design capabilities have "atrophied" [14]. The initial advantage that the reshoring provides by placing the company in close reach of its designated market may be offset by the disadvantages created by the distance to suppliers [15]. It would be expected that reshoring companies would seek to locate near their remaining supply base

in the US where most of the transportation operations increase would be within the region.

Job creation in the US due to reshoring has been on rise. In 2022, there were 364,000 reshoring + FDI jobs created (see Fig. 2), up 53% from 2021's record [16]. 2022 brought the total number of job creation since 2010 to nearly 1.6 million. The ongoing upward trend in reshoring can be attributed to several factors, including supply chain gaps and the need for greater self-sufficiency. Concerns over the risks of a Taiwan-China conflict or China voluntarily decoupling have further fueled this trend. Destabilizing geopolitical and climate forces have highlighted our vulnerabilities and the urgent need to address them. To address these concerns, the White House has implemented several initiatives such as the Inflation Reduction Act, Chips Act, and Infrastructure Bill. These initiatives offer companies and industries direction and financial security to fill the gaps. While the current actions and momentum are a positive start, a true industrial policy could accelerate the trend, resulting in a 40% increase in US manufacturing and the creation of 5 million jobs. Reshoring not only reduces trade and budget deficits but also makes the US safer, more self-reliant, and resilient. Overall, the ongoing trend towards reshoring offers significant benefits for the US economy and its security.

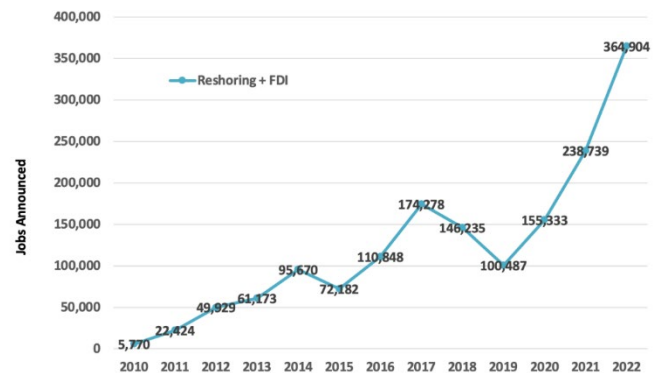


Fig. 2. Job creation in the US by US based multinational companies during 2010-2022 [16].

US increased federal manufacturing subsidies that accelerated 2022 reshoring. The US Congress also enacted several legislations including IRA and Chips acts. The new Chips law contains billions of dollars for significant manufacturing and R&D incentives to build the US semiconductor industry. Fig. 3 shows the White House map of \$1B+ factory announcements since Pres. Biden's election.



Fig. 3. US manufacturing investment since 2021 [16]

III. PROBLEM FORMULATION

The whole model consists of three major steps. First, the reshoring index is formulated and identified based on the industry NAICS code. Three factors contribute to the reshoring decision the RI, export-import deficits, and the associated logistics costs, bringing those items back to the US soil. In the second step, this research identifies the total cost of ownership (TCO) of a particular item or product group. If the second stage shows a positive result in terms of economical means. The third step finds out if it is feasible to reshore those items back.

A. Reshoring Index (RI)

Reshoring Index describes the potential of bringing manufacturing back to US soil. In the research of Sarder [20], they identified 44 subfactors, which are influencing 13 location factors related to eight reshoring factors. There are socioeconomic factors (subfactors) that influence the location decision for manufacturing. These factors (see Table I) are related to the reshoring factors that drive the reshoring decision.

TABLE I. RESHORING FACTORS WITH THEIR SUBFACTORS

SL. No.	Reshoring factors	Factors Influence Location Factors (Subfactors)
1	Labor Cost, Availability & Skill	Labor Cost Availability of skilled labor and talent
2	Availability of Natural Resources	Access to natural resources
3	Incentives	Incentives, Tax savings
4	Policy Regulation/IP Right	Government effectiveness
5	Proximity to Customers	Size of the local market
		Access to the International and Local market
		Growth of market
6	Infrastructure	Infrastructure
7	Ease of Doing Business	Follow your competitor
		Stable and business-friendly environment
		Access to capital market
8	Presence of Suppliers and Partners	Supply chain efficiency and resiliency

At this stage of this study, we would like to know which component groups are feasible for reshoring based on the RI. Earlier in this study, we identified the component with tariff issues falling under some groups representing different industries. For example, ALC (Aluminum Casting), STP (Motor Vehicle Metal Stamping), and all those different groups representing different NAICS codes. The trade deficit (the gap in export and import), and CIF (Cost, Insurance, Freight) cost also has importance in deciding to find a suitable candidate for reshoring. According to this research, though the export and import value have no direct impact on Reshoring Index, these are important for analysis. The industries with a low Reshoring Index are likely to have a high trade deficit (high import but low export). At the same time the industries that have high value (\$) of import, will have a higher impact on the economy if brought back to the United States. This research

established four steps to calculate the Reshoring Index:

Step 1: Selecting socioeconomic factors

Step 2: Reshoring factors

Step 3: Weighting the factors

Step 4: Calculating the Reshoring index

CIF cost has a big impact on the Reshoring Index. If the logistics cost is high, the Reshoring Index is likely to be high also. But there are some exceptions as well. The industries with a higher Reshoring Index have less trade deficit than industries with a comparatively low Reshoring Index. Calculating Reshoring Index and Required Formula:

Step 1: Selecting socioeconomic factors

These are well-accepted indicators of the country's socioeconomic status published by the United Nations, World Bank, World Economic Forum, KPMG, US Census, US Department of Commerce, Boston Consultancy Group Economic Intelligence Unit, etc. All the indicators were Normalized under a 1-7 scale with the Mini-Max formula.

$$Normalized\ score = 6 \times \frac{Country\ score - Minimum\ score}{Maximum\ score - Minimum\ score} + 1 \quad (1)$$

Step 2: Reshoring factors

The importance of these factors is taken from the United Nations Conference on Trade and Development (UNTCAD 2009-11). Where it explains how different factors play a role in selecting the location for different industries. For instance, skilled labor is more important in electrical equipment industries than in chemical industries.

Step 3: Weighting the factors

These factors are then weighed as follows:

The score for the United States =

$$\frac{(\sum_{j=1}^{j=m} ((\sum_{i=1}^{i=n} S_i)/n))_j \times W_j}{m} \quad (2)$$

The score for China or other Asian countries =

$$= \frac{(\sum_{j=1}^{j=m} ((\sum_{i=1}^{i=n} S_i)/n))_j \times W_j}{(1 - (L_c + mC_L))} \quad (3)$$

where S_i = subfactor from step 1; n = number of subfactors impacting the location factors; W = weight of the location factor for a particular industry from step 2; m = number of location factors; L_c = customs, insurance, Freight cost (%) paid in 2014, for importing based on NAICS code data from the US census; C_L = cost of import duties and inventory for long lead-time from China, considered as 3%.

Step 4: Reshoring index

After applying Eq. (2) for logistics cost below formula is applied to develop Reshoring Index.

Reshoring index (RI) =

$$\frac{US\ score\ from\ Eq\ (2) - Asian\ country\ score\ from\ Eq\ (3)}{Asian\ country\ score\ from\ Eq\ (3)} \times 100 \quad (4)$$

B. Total Cost of Ownership (TCO)

Generally, companies are prone to offshore, they make their decision based on the purchase price of the product, the global supply chain is also made an easy choice for them, as all the parts of the world are connected through strong infrastructure. However, making the decision solely on the purchase price is misleading [17]. Harry Moser finds out thirty-five other cost and risk factors beyond the purchase price if those cost components were taken into consideration the purchase decision might have been changed. Here in this total cost of ownership calculation, he pulled all the cost factors into six different cost buckets:

(1) Purchase Price; (2) Cost of Goods Sold (COGS); (3) Other Hard Cost Factors; (4) Risk Costs; (5) Strategic Costs; and (6) Green (Environmental/Sustainability) Cost Factors

There are many reasons for American manufacturers to reevaluate offshoring and consider reshoring. Companies are increasingly recognizing that costs, risks, and strategic impacts previously ignored are large enough to overcome the shrinking emerging market wage advantages. They are seeing the benefits of proximity, i.e., producing in the market, especially when the home market in the U.S., is still the world's largest. The top reasons that companies have reshored since 2010 include:

(1) Lead time; (2) Higher product quality and consistency; (3) Rising offshore wages; (4) Skilled workforce; (5) Local tax incentives; (6) Image of being Made in the USA; (7) Lower inventory levels, better turns; (8) Better responsiveness to changing customer demands; (9) Minimal intellectual property and regulatory compliance risks; and (10) Improved innovation and product differentiation

In the last 2 to 3 years the costs of extended supply chains have risen dramatically, especially sea and air freight and Section 301 tariffs [18, 19]. Meanwhile, the risks of supply chain disruption have increased even faster. The trade war, COVID, and Suez Canal blockage [20] have shown what can happen. Now the Ukraine/Russian war [21] and the risk of loss of Chinese or even all Asian deliveries due to an incident over Taiwan [22] further raise the value of domestic sources. Reshoring has sparked noteworthy attention in recent years, and it has had a phenomenal impact on trade and transportation across the USA. It could reshape the domestic and international business. The great economic recession in the last decade, loss of jobs, quality of the outsourced products, increasing operating costs in the out-sourced countries, social and environmental compliance, political instability, intellectual property loss, and huge trade gaps have sparked the reshoring initiatives. Even though labor cost in Asian countries is still lower than in the US but in totality, the appeal of US manufacturing is very prominent and obvious [23]. Many survey-based studies were conducted to quantify the benefit and feasibility of reshoring [23-28]. Moreover, researchers also tried to identify the forces that influence reshoring decisions and further implications. This research paper has briefly compiled with some of the important research to present the facts, figures, and forces driving the reshoring phenomena. The economic impact [29] on the overall supply chain of reshoring is presented in this research through TCO analysis and recommended for immediate reshoring for

those categories of components.

IV. IMPACT OF RESHORING

While no in-depth studies were found on the potential effect of reshoring on creating jobs, a number of studies estimated that job creation from reshoring could reach 500,000 to 6,000,000 based on different scenarios [3]. This would be a 4% to 40% increase of the approximately 14 million manufacturing jobs in the US today. According to the Reshoring Initiative [17], reshoring and related Foreign Direct Investment (FDI) trends continued strong in 2015; adding 68,000 jobs and bringing the total number of manufacturing jobs brought from offshore to over 249,000 since 2010 when the manufacturing employment was low [9]. According to the Boston Consulting Group, reshoring combined with higher U.S. exports could add 2.5 million to 5 million jobs by the end of the decade [30]. In perspective, the US outsourced 2.4 million manufacturing jobs to China between 2001 and 2013 [31].

Several industries have been identified as having the greatest potential for reshoring [7]. Reshoring is being led by manufacturers of transportation equipment; electrical equipment, appliances, and components; and computer and electronic products [32]. According to A.T. Kearney, electrical equipment, appliance and component manufacturing, transportation equipment manufacturing, and apparel manufacturing are the industries, which are reshoring [12]. Boston Consulting Group identified fabricated metals, transportation goods, appliances/electrical equipment, computers and electronics, machinery, and furniture as having the most potential for reshoring [30]. These industries differ slightly from the list of companies that have reshored and compiled by the Reshoring Initiative (see Table II). The reshoring of apparel is an area of difference [33]. Each of these industries has its own supply chain so the jobs and transportation impact will vary depending on the industry mix from a “pre-reshored” to a “post-reshored” framework.

After decades of offshoring trend, many US companies started bringing back their manufacturing i.e., reshoring. Outsourcing seems to be losing luster in the US as the majority (around 70%) of the industry seems to have had a negative experience with outsourcing, according to a survey of 25 large organizations, with a combined \$50 billion in outsourcing contracts. According to Reshoring Initiatives, more than 237 U.S. companies brought their operations back home and created significant manufacturing jobs. Table II shows some of those industries.

TABLE II. RESHORED INDUSTRIES WITH NO. OF COMPANIES AND JOBS

Industry	Jobs	Companies
Transportation Equipment	19046	30
Electrical Equipment & Appliances	12120	47
Computer/Electronic Products	6783	24
Food	2938	9
Machinery	2795	16
Apparel/Textiles	1954	37
Fabricated Metal Products	1749	25
Wood Products	1028	17

Office	810	3
Medical Equipment	628	13
Hobbies	581	22
Construction	577	4
Chemicals	300	2
Plastic/Rubber Products	298	11
Home and Kitchen	204	14
Castings	0	3
Primary Metal Products	0	3
Research and Services	0	2
Energy	0	1
Agriculture	0	1
Environmental	0	1
Tools	0	1

A sample analysis for the top 16 industries ranked by reshored instances in general focus on following sample areas with the highest combination scores of employment concentration and specialization (those in the top 1 percent). This analysis confirms with the data obtained from the US Census Bureau and Bureau of Labor Statistics, where specific industries such as fabricated metals, transportation equipment, etc. enjoy a competitive advantage in domestic markets (see Fig. 4).

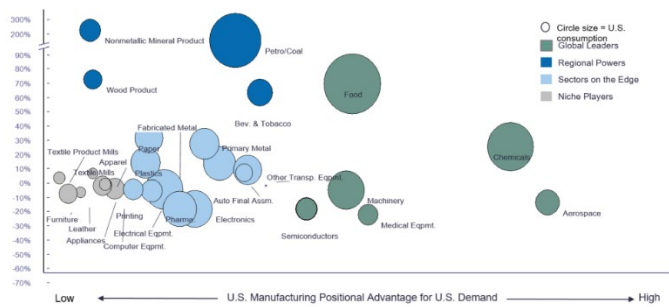


Fig. 4. US manufacturing competitiveness in domestic markets [16]

III. NUMERIC RESULTS

This research identified the important factors considered by reshored companies, and the most significant one was the transportation costs incurred from their supply chain. Using Reshoring Institutes companies' database, an extensive list with all the companies that are expecting to reshore was generated. To observe the economic impact of the manufacturing companies, the analysis took into consideration of 16 industries and focused on a region comprised of 15 US states (from Midwest to the South). An impact scenario analysis was conducted (Fig. 5), and it showed that the reshoring companies would have a total of 13,043 direct jobs. The aggregate effect on jobs amounts to 64,795 new jobs in the study region.

The analysis also showed most of their supply chain regional demand (75%) can be satisfied within the region, and the rest (25%) will be imported through nearby entry ports or states. Using data from USITC, the study showed the most significant ports importing the needed commodity and considering the companies will focus on lowering the transportation costs, the supply chain analysis will shift towards the North-Eastern,

South-Eastern, and Eastern ports, such as Detroit, MI, Chicago, IL, Laredo, TX, and respectively New York, NY. Moreover, data suggested that approximately 75% of semiconductor and other electronic component manufacturing, and 53% of electro medical and control instruments manufacturing industries are satisfied from outside the region potentially creating a ripple effect in the transportation supply chain. Out of the total regional demand for these industries, only 25% is satisfied within the region, the remainder being imported from outside.

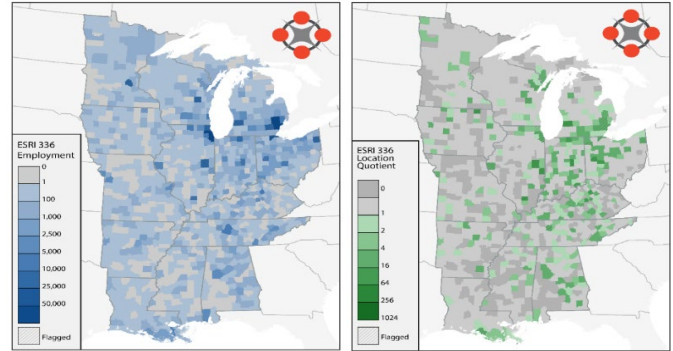


Fig. 5. a) County Employment Levels for the Transportation Equipment Manufacturing Industry Subsector (ESRI); b) County Location Quotients for the Transportation Equipment Manufacturing Industry Subsector (ESRI).

In this section, we will demonstrate the previously explained model in a real-world company, Bridgestone APM (BAPM) Co, USA. The BAPM company is rooted in innovation and provides world-class anti-vibration and foam products for the automotive industry that improve lives globally. It is importing components/parts from different countries across the world. During the eighties and late nineties, many US manufacturing companies mass-outsourced their operations overseas. The BAPM company has been thinking about doing so. This offshoring trend towards low-cost manufacturing destinations constituted one of the most significant changes in manufacturing and supply chain strategy around the world.

A. Prioritizing Components for Reshoring Using RI

To understand the company's state, (i.e., where it stands, what are its products, which all parts they are procuring, which parts should be outsourced/reshore, etc.), AS-IS analysis was conducted. It has been observed that BAPM company is paying high logistics and tariff costs for their offshore parts. From BAPM's projected spending for the fiscal year 2022, we identified that approximately 57% is overseas spending. Approximately 70% of that overseas content is from China, followed by Japan (19%), Thailand (7%), and South Korea (4%). Analysis of the tariff on parts from China highlighted four commodities – Casting products, Stamping products, Forming products, and Mounting products – accounting for most of the tariffs. In table III, we figured out the component group's NAICS code, and based on the calculation done, we pulled out the data of RI, Trade deficit, and CIF costs. So, understandably, if the RI is high, imports are greater than exports, and there are

significant logistics costs involved in that industry, that is our suitable candidate for reshoring.

TABLE III. RI %, TRADE DEFICIT, AND LOGISTICS COST % AGAINST THE 6-DIGIT NAICS CODE

Items	NAICS Code	RI %	Trade Deficit 100 K	Logistics cost %	Tariff %
Casting	331523	25	55	9	41.13
Stamping	336370	30	14	12.89	25.31
Forming	331318	23	22	7.24	16.28
Mounting	331210	26	0.37	9.43	13.92
Rubber	325212	22	-50	9.16	1.56
Mechanical	332999	20	0.009	5.25	0.90
Plastics	325211	23	-100	10.26	0.27

If we plot the table III in a chart (Fig. 6), we will be able to figure out the relation between the three major deciding factors.

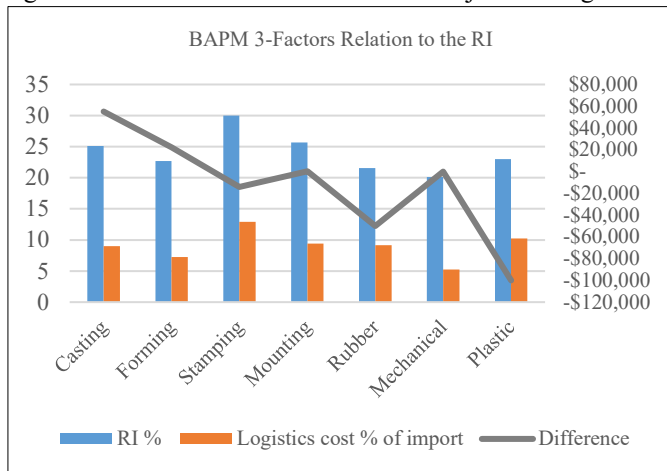


Fig. 6. BAPM 3-Factors Relation to the RI

As a part of the evaluation of components for reshoring, reshoring indices concerning trade deficits have been analyzed. The importance of different factors for a particular industry and the strength of a particular country are considered to create a 'Reshoring Index'. This Index will provide a comparative benefit if a currently outsourced product is manufactured back in the US from a particular country. The baseline for reshoring is that if the Reshoring index is high, imports are greater than exports, and there are significant logistics costs involved in that industry, which is our suitable candidate for reshoring. Also, in AS-IS analysis, those component groups are responsible for 96.64% of the total tariff cost accumulated.

B. Calculating Total Cost of Ownership (TCO) China vs US

Here in this stage of this study, we would like to calculate the Total Cost of Ownership for our top candidates. This stage requires core data from the industry, and it is specific to the individual company BAPM. The idea is every item has its price in China and US. The purchase price is lower in China, attracting

procurement managers. But, after buying those items there are costs for shipping, packaging, duty fee/custom clearance, and insurance. That cost is summed up in the cost of goods sold bucket. Similarly, in the next bucket, Other hard cost includes inventory carrying cost, in-transit carrying cost, prototype cost, and so on. Emergency air freight, quality cost, and political and economic instability costs are included in the risk cost. Product innovation's impact on distance and mass customization requirements cost is included in the strategic costs. Other sustainability issues and green costs are taken into the green cost bucket. Finally, depending on the wage increase and price inflation rate in countries, the cost is calculated on a five-year projection. The difference will tell us quantitatively if it is a suitable decision to bring those manufacturing back or not to the USA.

The casting products required in the BAPM company incurs the cost below given in table IV. As per the TCO analysis, it is apparent that although the purchase price in the USA is higher than China's purchase price by \$0.80, the total ownership cost for the USA product is decreased by \$1.65 per item. Also, after five years, the ownership cost difference will be high as \$ 2.42 per item. So, it can be inferred that just deciding solely on the purchase price is misleading. Fig. 7 shows the cumulative costs of Casting product if sourced from US vs. China. The initial purchase cost is less in China, but TCO is higher than the US cost. So, the BAPM company should think about bringing back this manufacturing and start working before losing money.

TABLE IV. THE TOTAL COST OF OWNERSHIP (TCO) OF CASTING PRODUCTS, IN CHINA VS THE US

Cost Factor	US	China
FOB price	\$ 4.46	\$ 3.66
Total COGS	\$ -	\$ 1.67
Total Other Hard Costs	\$ 0.04	\$ 0.15
Total Risk Cost	\$ -	\$ -
Total Strategic Cost	\$ -	\$ -
Total Cost Before Freight Premium	\$ 4.50	\$ 5.48
2022 Freight Premium		\$ 0.67
Grand Total Cost of Ownership	\$ 4.50	\$ 6.15
Forecast TCO (5 years)	\$ 4.70	\$ 7.12

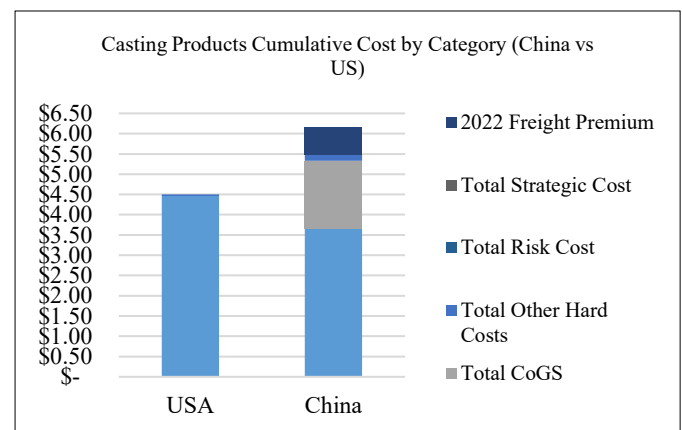


Fig. 7. Casting Products Cumulative Cost by Category (China vs the US)

The stamping product is another strong candidate for choosing domestic suppliers because of its lower total cost of ownership value when compared to China suppliers (see table V, and Fig. 8). Although the purchase price is higher, the total cost of ownership is lower for the US. Within five years, the USA suppliers will be significantly cost saving for the BAPM company (see Fig. 9). The TCO for Stamping products shows that the US suppliers are the best in terms of the purchase cost and during five years the savings will be significantly high based on the future cost trend as well.

TABLE V. TOTAL COST OF OWNERSHIP (TCO) OF STAMPING PRODUCTS, IN CHINA VS THE US

Cost Factor	US	China
FOB price	\$ 3.41	\$ 2.79
Total Other CoGS	\$ -	\$ 1.39
Total Other Hard Costs	\$ 0.03	\$ 0.11
Total Risk Cost	\$ -	\$ -
Total Strategic Cost	\$ -	\$ -
Total Cost Before Freight Premium	\$ 3.44	\$ 4.29
2022 Freight Premium		\$ 0.67
Grand Total Cost	\$ 3.44	\$ 4.96
Forecast TCO (5 years)	\$ 4.00	\$ 5.56

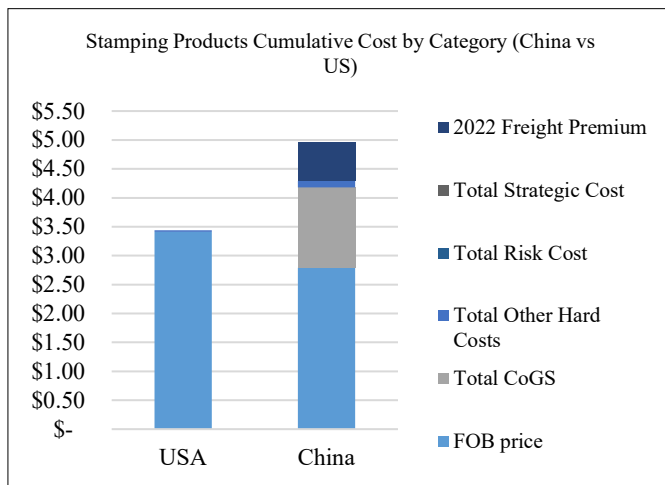


Fig. 8. Stamping Products Cumulative Cost by Category (China vs the US)

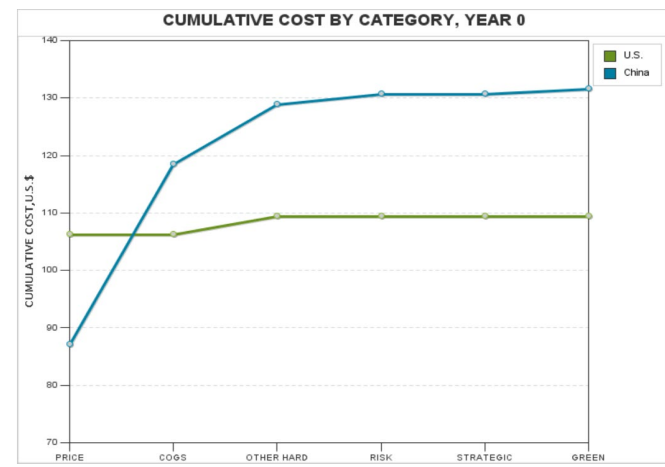


Fig. 9. Stamping Products TCO Cost Curve - next five years, China vs the US

The cost comparison below is solely taken from the purchase price and future purchase price in terms of the Total Cost of Ownership (TCO) calculation. Still, domestic production and suppliers are better for bringing jobs back to the USA, and also the company will have a chance to create JIT production systems. Not only that, the “made in the USA” tag is significantly impactful to some industries because recent surveys suggest that 70% of the buyers in the USA are willing to pay 10% more to get the product manufactured in the USA. It is also supported by the Reshoring Index that the Casting and Stamping products are best for reshoring as the TCO suggests because the RI for that industry was higher than others and, we get a better result in that TCO analysis. So, the TCO analysis is backed up by the Reshoring Index.

The above table VI shows the purchase price difference between China and US. From the TCO analysis for company BAPM, we find out that although the fob price today is lower in China market the added cost for tariff 301, transportation, and duty makes the scenario opposite to what we perceived before. That is why it is crucial to conduct the TCO analysis to find out the actual landed cost of the purchased products. The result also demonstrates that after five years with the inflated price the overseas purchase price will be a record high for the company to be competitive in the market. For example, from table VII, the casting products fob today in the Chinese market is 0.80 USD less than that of the USA market for company BAPM, but after TCO calculation it is found that the US advantage for the ownership cost of the same product today will be 1.64 USD, more than 50% less from the Chinese products. How did that happen? Well, after considering the tariff and other costs mentioned in the study, we have found that the landed cost of the products bought from Chinese markets incurs more cost during the process of getting that in-house in the US. Also, if we take the inflation rate, and wage market rise into consideration, after five years the landed cost will be 125% increased! The other components also show the same trend for the future years.

TABLE VI. PURCHASE PRICE DIFFERENCE IN CHINA VS THE USA AFTER TCO ANALYSIS

Product Name	China Advantage on FOB Present day (per unit)	US Advantage on TCO Present Day (per unit)	US Advantage on TCO after 5 years (per unit)
Casting	\$0.80	\$1.64	\$2.42
Forming	\$0.20	\$0.96	\$1.25
Stamping	\$0.62	\$1.53	\$1.56
Mounting	\$0.17	\$0.89	\$1.14

For longer-term considerations, we broke out Freight Premium which will probably come down substantially over the next few years and Section 301 tariffs may come down

eventually, but not soon. TCO favored the U.S. even without the Freight Premium. We did not quantify risk, strategic, and green/ESG costs. Given the tension over Taiwan and Chinese threats to stop shipping key automotive components if the U.S. Innovation and Competition Act is passed, the profitability advantage of shifting to U.S. sources is likely to be understated by the analysis.

In an attempt to study the economic impact of the reshoring on Bridgestone, USA components, total cost of ownership (TCO) has been analyzed and compared with that of China. Overall import cost calculation has been made on identified BAPM commodities (Aluminum casting, Stamping, Outtube and Cold Head) which all are making a big difference in procurement. It has been analyzed that if BAPM starts reshoring of these four commodities, they could save up to \$4,322,684 in the year 2022. Also, considering the same volume requirement of these four commodities for the five years, BAPM could save up to \$21,613,420. As far as individual commodity cost saving calculation is concerned for reshoring, they could save \$1,331,538 on Aluminum casting, \$7,23,904 on Cold Head, \$1,185,514 on Stamping, and \$1,081,727 on Out tube in the year 2022. Although reshoring is recommended for all four commodities but if it is not possible to adopt reshoring all together, BAPM could focus on reshoring product one by one and improve the supply chain performance. Also, there are numerous suppliers available in US with the same potential as that of China and being close to the supply base is always a driving factor for the company to select the supplier.

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