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Manufacturing Renaissance: Return of manufacturing to western countries

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ABSTRACT: Manufacturing Renaissance, i.e. return of manufacturing to west, has been recently observed. This paper analyzes the patterns observed within each of the four main drivers behind this new phenomenon and delves more deeply into the driver that centers on the new manufacturing technologies such as Additive Manufacturing (AM) and 3D Printing. Next, this paper will make the case that the location of manufacturing will be in west, relying on the established theory that has been able to explain the location of manufacturing, i.e. Product Life Cycle Model (PLC).

1. INTRODUCTION

Twenty-one percent of North American manufacturers reported bringing production back into or closer to North America in the past three months. Surveyed by manufacturing sourcing Web site MFG.com (June 2011). Thirty-eight percent planned to research such a move in the next three months. This new trend is a reverse of what had taken place in the late 60s and early 70s, i.e. western manufacturing has vastly moved to less developed countries (LDCs). The Atlantic (2012). As Norton & Rees (1979) said, the main reasons were “the low labor cost and favorable business climates of such LDC’s as South Korea and Taiwan”. Vernon (1979) made a similar statement: “Although income, market size, and factor cost patterns have converged among the more industrialized countries, a wide gap still separates such countries from many developing [LDCs] areas“. However, much has changed in recent years and the two reasons described above are less significant today than in the late 60s and early 70s. Concerning labor cost, in a recent report Boston Consultancy Group anticipates that the net manufacturing cost in China and US will converge in 2015. (Sirkin et al, 2011). Concerning the business milieu, there has been recent and recurrent complains about IPR problems in China and other Asian emerging economies. Indeed a new trend has been observed which indicates the ‘return’ of manufacturing to western countries, especially to US (Sirkin et al, 2011); (Economics, 2012); (The Atlantic, 2012).

The aim of this paper is to shed some light on the pattern observed with respect to the locational shift in western manufacturing, i.e. so-called in this paper-manufacturing renaissance. This will be per-

formed by developing arguments within the context of PLC model, while borrowing arguments from transaction cost theory and new economic geography.

The rest of the paper is organized as follows; Section 2 presents the established PLC model, section 3 demonstrates the newly observed trend in location of manufacturing —this is done by adding the additional phase to the established PLC model, and section 4 discusses the factors driving the new pattern(s). Section 5 summarizes and concludes.

2. PRODUCT LIFE CYCLE MODEL (PLC)

The product life cycle approach to international trade and investment provides a systematic explanation of how the location of manufacturing, exporting, and importing of a product changes over time. Such locational shift studied initially at international level (Vernon, 1966, 1979); (Hirsch, 1967). This was followed by studies of PLC model at the interregional level (Rees, 1979); (Norton & Rees, 1979). Vernon (1966)’s original model is presented in Figure 1.

The model proposes that location of the production (and subsequently the export and import patterns) varies based on the maturity level of the product. More specifically, Vernon (1966) argued that the production of a product in its first phase of development (i.e. new product phase) would be located in US. Firstly, this is a result of a higher level of demand for a new product in US market, among other things, due to higher average income in US in comparison with other countries. Vernon (1979). Secondly, there is a larger supply of high skilled labor. Hirsch (1967). Thirdly, swift and effective communication between the agents in the supply/value

chain (producer, customers, suppliers, competitors, etc.) exists in US. Vernon (1966). These three supply factors are essential for overcoming the uncertainty in product specification and market, which exist during the early phase of product development. Utterback & Abernathy, (1975). This early phase of product development is accompanied with higher US export.

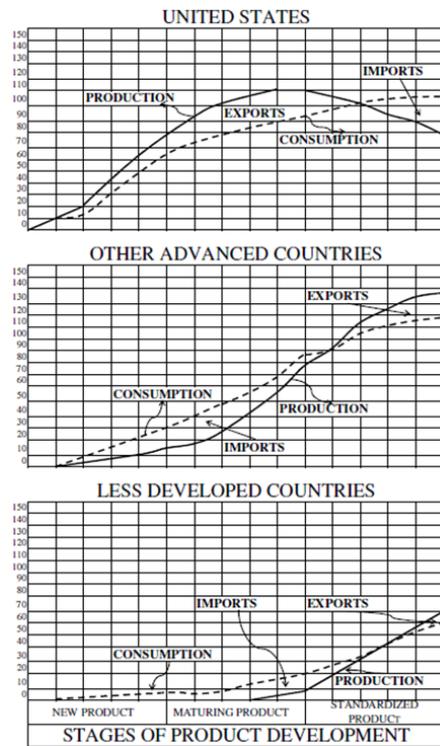


Figure 1-Original Product Life Cycle model (60s and 70s)
 Source: Vernon (1966)

The production of the second phase of product development (i.e. maturing product) would be located in other advanced countries. Vernon (1966) argued that as the demand for a product expands, a certain degree of standardization usually takes place; however, there are still efforts for product differentiations. Since there are some degrees of standardization, there would be relatively less need for externalities. Instead, there would be more orientation toward economies of scale and more concerns about production cost rather than product characteristics. This is why the manufacturing location of a product would presumably move to other developed countries. Hence, the US-made production would stagnate and the import from other developed country would start, however, US export would still be dominant on US import.

Finally, the production of third phase of product development (i.e. standardized product) would probably move to less developed countries (LDCs), since they can provide competitive advantageous for production location in this phase. Vernon (1996) provides several reasons for such claim. First, the standardized products tend to have lower uncertainty in terms of their specification (unlike new products). Hence, the need for skilled labor and externalities

(such as local knowledge) is remarkably reduced, which reduces the dependency of their location on US or other advanced countries. Second, standardized products tend to have lower uncertainty in terms of market, i.e. they have a well-articulated and easily accessible international market, so the marketing cost (from distance) is low. Third, these products are assumed to have high price elasticity of demand (unlike new products) and they are assumed to be mostly sold based on price. This would act as a motivation to take the risk of moving the production to a new location. Fourth, these products require significant labor input for their production, which is (again) an incentive for moving the production to low-cost labor countries, i.e. LDCs. Consequently, it may be wise for the international firm to shift the location of their standardized products into the LDCs, based on the notion that labor costs differences are large enough to offset transportation costs. This would be accompanied with higher import and lower export costs for US.

3. MANUFACTURING RENAISSANCE: A NEW PATTERN

This part adds an additional phase to the established model of PLC developed by Vernon (1966, 1979) and Hirsch (1967). This is not the first time a study tries to modify the original PLC model based on the observed trend. (Vernon, 1979); (Giddy, 1978). The main motives for introducing the 4th phase here is the recent changes in LDCs (emerging economies). Moreover, the impact of such changes on the behavior of US, and other advanced economies are difficult to distinguish, since they have become homogeneous in terms of various externalities over time. Vernon (1979). The new pattern of production location, import and export for three classic categories of countries is depicted in Figure 2.

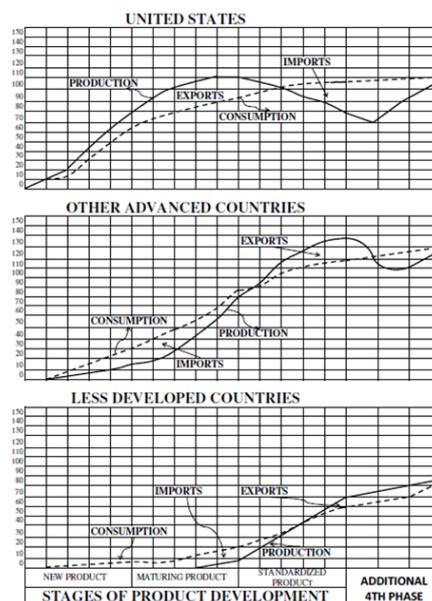


Figure 2: Extended product life cycle model
 Source: Vernon (1966)

Assuming the PLC model is valid, the first three phases of Figure 2 are identical to the original PLC model (Figure 1), while the 4th phase is an add-on. The main argument for adding the 4th phase is that some part of manufacturing production is coming back to western world, especially to US. The reason for proposing the addition of this new phase is based on newly observed pattern, briefly reviewed in introduction section. This can be explained by several driving factors, which are discussed in section 4.

4. FACTORS EXPLAINING THE “MANUFACTURING RENAISSANCE”

There are several factors driving the new pattern in location of manufacturing, i.e. manufacturing renaissance. These factors are; raising wage-levels in emerging economies, lower quality of business milieu in emerging economies (LDCs), lower importance of economies of scale for production, and motives for interacting better with customers among US companies. The discussion of each factor is presented in the following subsections.

4.1. *Rising wage-levels in emerging economies*

Wage-level has always been an important motive for outsourcing manufacturing to LDCs (Norton & Rees, 1979); (Vernon, 1979), especially if economies of scale are already, being fully exploited (Vernon, 1966). Recent evidences also suggest that the wage differential is still one of the most important drivers of outsourcing to LDCs. In examining the motives for outsourcing and offshoring, in a recent survey 50 percent of firms in Denmark, Sweden and the Netherlands state that labor cost savings is the primary reason for sourcing their business functions abroad. Statistic Denmark, (2008). Labor-intensive industries have been among the first to move to LDCs because they are most affected by increases in industrialized countries' wages relative to the rest of the manufacturing sectors. Puga & Venables (1996). In addition, weakly linked industries are also the ones who moved faster to LDCs, because they benefit less from being close to other industries in western world (they neither sell a large fraction of their output to other industries, nor spend a large share of their costs on intermediates produced by them). They are therefore the first to relocate in response to labor cost differentials, being gradually followed by more strongly linked industries. Puga & Venables (1996).

However, new reports point that the labor differential is not in place to the extent that enables the companies to move to LDCs since the 70s up to now. For instance, Boston Consultancy Group argues that wage-level in China is increasing by an average of 20 percent annually and productivity improvement is not enough to offset the labor cost. Hence, it is anticipated that the net manufacturing cost in US and China will converge in 2015. (Sirkin

et al, 2011). Such a new situation clearly violates the traditional main driver of moving the manufacturing to LDCs, i.e. labor cost differentials. Recent evidence indeed suggests that increased wages in some LDCs has reduced the US outsourcing to those countries. Swenson (2005).

One can ask why the wage-level in emerging economies has actually increased dramatically in recent years. There are at least two reasons for this. First, as (Puga & Venables, 1996) argued, outsourcing of manufacturing to a country will eventually lead to growth of related industry in that country. This implies the growth for demand in manufacturing within that country. Finally, this leads to bidding up wages in that industry and country and there will eventually be a critical mass. At this point, it is no longer profitable to stay in the home country, hence the manufacturing will move to another country. This is what has actually happened in LDCs, particularly in China. Second, there has been a new trend of what is called “brain circulation”, i.e. returning the highly educated Chinese (and some other LDCs) from US back to their home country. Saxenian, (2006). These people usually have higher salaries than ordinary employees do in LDCs. Therefore, by returning to china, they have raised the average wage.

4.2. *Lower quality of ‘business milieu’ in emerging economies*

It is shown that entry into new market inherently involves transaction costs and such transaction costs are reduced via proper institutional setting of the host country. Meyer, (2001). Proper institutional setting (business milieu) was indeed one of the reasons that manufacturing has vastly moved to less developed countries (LDCs) in late 60s and early 70s. (Norton & Rees, 1979); (Vernon, 1979). However, there have been recently recurrent complaints about IPR problems in China and other Asian emerging economies, violating the previous image about proper business milieu in these countries. It is argued that China's enforcement of its IP laws has been inadequate (e.g. lack of action against counterfeiting and piracy), although the framework of IP protection has been well established. Wang, (2004). Such lower quality of business milieu can be understood via the concept of opportunism, described by (Williamson, 1981) as dishonest behavior by competing firms. According to Transaction Cost Theory, opportunism represents a source of transaction costs. It is one of the determinants of whether firms will choose outsourcing or vertical integration. Williamson (1981) argued that vertical integration arises out of the need to safeguard against opportunism and contractual hazards.

Such contravention of IPR in (for example) China is combined with the imitation, which has been argued to be one of the factors that can explain the

boosting innovation in China. Needless to say, this is a threat to western innovation-based competitiveness. Therefore, not only lower quality of business milieu in China in recent years has blurred one of the traditional motivations to move the manufacturing to China, i.e. proper business milieu, but also their imitation skills what it is argued are a threat for innovation-based competitiveness of western companies.

4.3. Lower importance of economies of scale (due to new process innovations)

Economies of scale can reduce the total production cost. It can be achieved through the presence of a large number of suppliers in a particular region (or country). Teece (1986). Such economies of scale have actually been one of the driving factors for western companies to move their manufacturing to China and other LDCs, especially for those western companies who were followers (not first movers) in terms of outsourcing their manufacturing to China and other LDCs.

However, recent process innovations, e.g. 3D printing, degrade the importance of economies of scale. As the magazine *Economics* wrote recently:

“It [recent process innovations] will allow things to be made economically in much smaller numbers, more flexibly and with a much lower input of labor, thanks to new materials, completely new processes such as 3D printing, easy-to-use robots and new collaborative manufacturing services available online. And that in turn could bring some of the jobs back to rich countries that long ago lost them to the emerging world.” *Economics*, (April 2012).

Additive manufacturing (AM) is a relatively new manufacturing method that first came into use in late 1980's. In general, it forms 3D physical objects by solidifying the raw material layer upon layer. Depending on the technology, the solidification mechanism ranges from spraying of a liquid chemical binder, to exposure of the material to various light sources, to electron beam bombardment. The materials used are also very diverse, including various types of polymers, metals and ceramics materials, providing they be in powder or liquid form, and again depending on the technologies being used. Originally, due to its limited capacity and low resolution, the method had been used for prototyping and model making, thus the term rapid prototyping. It has since been gradually developed towards providing end-use parts or direct part production, referred to as rapid manufacturing. (Tuck et al. 2008).

As the quality of the AM fabricated products improve, the labor cost related to those products will decrease. This will create a scenario where manufacturers in regions with relatively higher labor costs are able to compete with those that have lower wages in LDC countries. In addition, combining this competitive pricing with the concept of quicker delivery will provide local suppliers with an advantage

over their foreign competitors highly competitive in their markets. Wohlers (2011).

Moreover, the rising cost of energy and its efficacy and independency are the major barriers for the future of manufacturing and play a significant role in shaping the geopolitical landscape. Taking in the consideration how AM processes are capable of producing significant waste reduction compared to conventional methods, some concepts like buy-to-fly ratios indicates how wasteful the conventional methods are. Wohlers (2011).

One major source of overall energy costs is the cost of transportation. Much more energy is needed to ship and deliver parts from a long distance than to ship them from a local or regional retailer and supplier. Studies indicates that due to problems such as communication and tool rework and transportation costs, the actual costs of offshore manufacturing is higher than is anticipated and believed in many cases. Wohlers (2011).

A key point is that the cost of producing much smaller batches of a wider variety (with each product tailored precisely to each customer's need) is falling. The factory of the future seems to have a focus on mass-customization, rather than traditional mass-production. This allows for lesser reliance on economies of scale (available through extensive availability of cheap suppliers in China), which could eventually lead to the return of manufacturing of some parts back to western countries. This is indeed what (Grossman & Helpman, 2005) argued: “disproportionate improvements in the technology for customization in a region can shift the manufacturing toward that region (here referring to US)”. Considering the trend toward production on demand, low volume, and need to increase domestic manufacturing and employment, the offshore and overseas production may not be the best choice. Wohlers (2011).

4.4. Interact better with home customers

The PLC model argues that manufacturing production will be outsourced to LDCs in the 3rd phase, assuming the strict standardization of product and lack of the need for customer interaction. This is, however, a strong assumption, especially if one considers the faster life cycle of a product in recent years. This would require close interactions with the home customer, even though a product reaches some degree of standardization. By being close to the home customer, “market-determined inducement” would ease the incremental innovation for even standardized product. Dosi (1988). In fact, the manufacturing has been outsourced to LDCs because of saving-costs forces. Vernon (1979). Now that those forces are not at play as strong as before, it is reasonable to assume that some part of manufacturing will come back to US and thus have a better interaction with the home customer *inter alia*.

Following the above reasoning (4.1 to 4.4) for occurrence of manufacturing renaissance, i.e. the 4th phase in PLC model, it is possible to illustrate the characteristics of each stages of PLC. This is illus-

trated in Table 1. This table is based on Hirsch (1967) and adds the 4th phase.

Table 1- Characteristics of the product cycles

Characteristics	Cycle phases			
	New product	Maturing product	Standardized production	Renaissance
Technology	Short run and rapidly changing	Mass-production and importance of economies of scale	Long run and stable process	Mass Customization
Physical Capital	Low	High, due to high obsolete rate	High, due to large quantity of specialized equipment	Low, due to new process innovations
Industry structure	Entry is know-how, many firms	Growing number of firms	Stagnation in number of firms	Growing number of spin offs
Human capital	Scientific and engineering	Management	Unskilled	Scientific, engineering, and unskilled
Demand structure	Seller's market, Low price elasticity of demand	Growing price-elasticity of demand	Buyer's market, High price elasticity of demand	Closer to customer, shorter technology cycles

Source: New, maturing, and standardized product characteristics are based on Hirsch (1967)

5. CONCLUSION

Manufacturing Renaissance, i.e. return of manufacturing to west, has been recently observed as a new pattern emerging in western countries, especially in US. This paper identified main drivers of this new phenomenon: (i) rising wage-levels in emerging economies (ii) lowered quality of 'business milieu' in emerging economies (iii) lower importance of economies of scale, due to new process innovations (iv) better interaction with home customers. In doing so, the paper contextualized itself within a well-established theory that explains the locational shift of manufacturing, i.e. Product Life Cycle model (PLC). The paper delves more deeply into one of the drivers that centers on the new manufacturing technologies such as Additive Manufacturing (AM) and 3D Printing.

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