

Is the era of manufacturing- led development coming to an end
due to technological change?

TABLE OF CONTENTS

SECTION 1: Introduction	5
SECTION 2: Manufacturing and Development - Historical Trajectories and Present Realities	5
2A: The historical understanding of development (Pre 1980s)	
Case 1: The First industrial revolution (1760-1860)	
Case 2: The Second Industrial revolution (1860-1945)	
Case 3: The growth of the East Asian Tigers (1970-1990)	
2B: The source of Manufacturing privileged position	
2C: Technological changes and its impacts on manufacturing	
2D: Present Realities and Development Pathways for Countries.	
Perception 1: The historically elevated position of	
manufacturing is in decline.	
Perception 2: Manufacturing has greater relevance than services	
Perception 3: Complexity due to sectoral interactions	
Section 3; Analytical Design	16
Section 4: Methodology	17
Scope	
Experimental variables	
Section 5: Research Design	19
Section 6: Results	(Currently Processing)
Section 7: Discussion	(Currently Processing)
Section 8: Conclusion	(Currently Processing)
Section 9: Tables	(Currently Processing)
Section 10: Appendix	(Currently Processing)
Section 11: References	20

Analytical Roadmap

2A: The Historical Understanding of Development

Conclusion: Manufacturing is either a driver or has strong associations with development.

Cases: The First Industrial Revolution, Second industrial Revolution and the East Asian Growth Miracles used as

Literature Review

2B: The source of Manufacturing privileged position

Conclusion: Sectoral linkage, Increasing return, and the nature of Manufactured goods as core reasons for the uniqueness of manufacturing. Peripheral reasons also exist such as unconditional convergence, the role of employment and innovation dispersion as peripheral reasons.

2C: Technological changes

Conclusion: Points to a range of technological innovations. ICT and Automation as the changes that produce the greatest impacts.

2D: Present realities of development Pathways

Conclusion: Highlights three Perceptions on the current reality of manufacturing.

Perception 1

Manufacturing is obsolete. Therefore, countries should move to new growth strategies such as services.

Perception 2

Manufacturing is still relevant but could need industrial policy to make it more effective

Perception 3

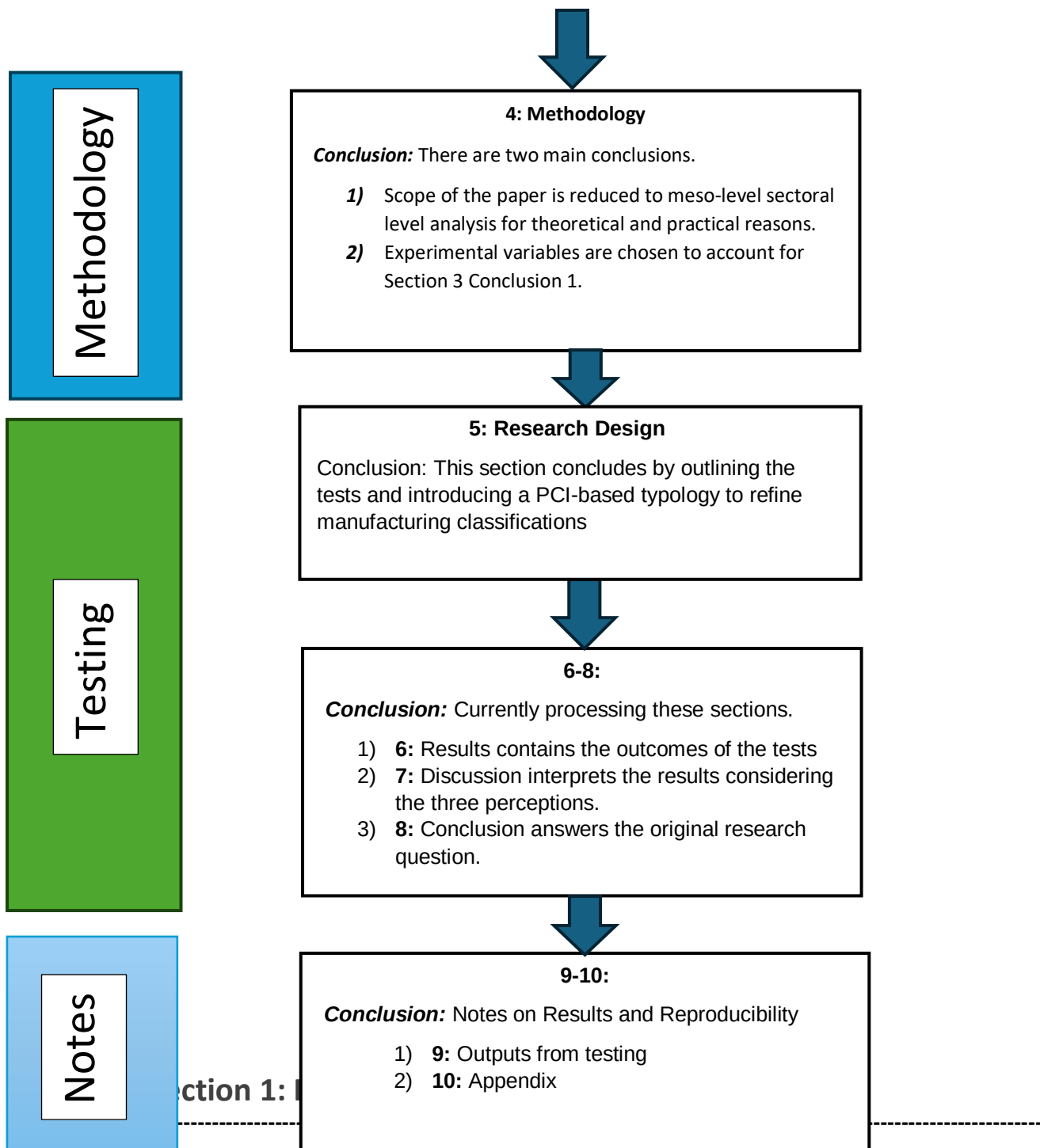
These dynamics are more complex than initially conceptualised due to the role of measurement and classification considerations.

3: Analytical Design

Conclusion: Given the three perceptions, the methods for the research will need to account for two considerations.

- 1) A sectoral understanding is required with four indicators that account for the differences in Perceptions 1, 2, and 3.
- 2) The need for a new classification system that captures the new technological reality. This would be compared to more traditional classification system (This will be addressed in Section 5)

alytical Design



Many developing economies face growing challenges in understanding and implementing the relationships between technological change and development. This leads to the disruption of the traditionally accepted development sequence - agriculture, to manufacturing, to services. In response, states have adopted three strategic responses: Catching-up, Stage skipping or Leapfrogging (Hauge, Kenward and Wightman, 2020, p. 12). To evaluate these strategies, states require a sectoral understanding of the nature of technological change. Hence, a sectoral understanding of these phenomena will be the focus of this paper.

Moreover, the core contribution of this paper is to offer a sectoral analysis related to development through two means. First, through the conventional typology of agriculture, services, and manufacturing. Second, through a new typology (PCI) that accounts for the embeddedness of manufacturing and service. Embeddedness, in this context, represents the role of technology in blurring the lines between manufacturing and other sectors. Therefore, the comparison of these typologies offers a fresh analytical lens on technological change and development.

An understanding of these dynamics has the potential to influence actors such as developing countries in resource-constrained environments, shape the historical development narrative of manufacturing-led growth, and signal a potential inflection point in the history of manufacturing itself.

Hence, to address these dynamics, the paper is structured into seven sections, each building towards a diagnostic understanding of manufacturing evolving role. Section 2 explores the historically elevated position of manufacturing. This section examines the historical, theoretical and current nature of manufacturing. The section then presents three perceptions on the current understanding of manufacturing. This leads to Section 3 which highlights the need for sectoral comparisons to development, and the need for a new typology to understand classification differences. Sections 4 and 5 establish the methodological and analytical framework for Section 6: Results. Section 7: Discussion extrapolates the key insights from the results and identifies the most robust Perception of manufacturing. Finally, Section 8: Conclusion responds to the initial research question.

SECTION 2: Manufacturing and Development - Historical Trajectories and Present Realities

This section explores the relationship between manufacturing and development across four subsections.

Section 2A establishes a relationship between manufacturing and development from 1500-1980s through three examples. **Section 2B** evaluates the key drivers for development. **Sections 2C** appraises some of the technological changes in the 1980 - 2000s that have shaped a new manufacturing reality. **Section 2D** reviews the current inflection points of the literature relative to the technological changes.

2A: The historical understanding of development (Pre 1980s)

The historical understanding of development places manufacturing at the centre of development. According to this view, manufacturing is either a strong indicator of development or is considered a driving factor for development. This perspective is rooted in a range of prominent development thinkers. Prebisch (1950, p.8) emphasises the higher productivity in manufacturing compared to services, linking manufacturing to higher living standards. Lewis (1954, pp. 163,189- 190) emphasised that manufacturing has higher prices relative to agriculture and expresses the role of employment expansion because of capital formation. Employment and capital formation are both central to the developmental process. Andreoni (2012, p.5) affirms that “industrialisation, understood as the transition from agricultural sector to the industrial sector... was synonymous with development”. Additionally, Szirmai et al (2011, p.58) emphasises the moderate impact of the manufacturing engine of growth hypothesis through a dataset ranging from 1950- 2005.

This section highlights three historical cases where manufacturing is: a strong indicator of economic development, or a direct cause of development.

The first case is the Industrial revolution from 1760-1860. The Industrial revolution signifies a break from the Malthusian trap, leading to a new era of sustained economic growth. The second case is from 1860-1945: Second Industrial Revolution. This case demonstrates that despite the heterogeneity of growth strategies - manufacturing is still central as a factor in growth. The final period to be considered is the 1945-1990: East Asian miracle. This case was chosen due to proximity and relevance to ongoing development debates.

While alternative cases such as the USSR (1920s-1970s) or Latin America's policy of import-substitution offer unique insights, they are excluded due to their failure to sustain growth to break into the High-Income Developed economies category.

In all three cases, two comparisons being made. First, GDP per capita will be compared across countries. This comparison stresses differences in GDP across countries. Secondly, a comparison of GDP per capita with the Share of industry (or manufacturing) in employment will be made. The share of Industry (or manufacturing) in employment is used as a proxy variable to emphasise the weight of manufacturing employment relative to GDP. This indicator is particularly useful given the scarcity of country-level data in earlier periods. Accordingly, this comparison is intra-country, to highlight manufacturing shares of employment correlates with GDP per capita.

Case 1: The First Industrial Revolution (1760-1860)

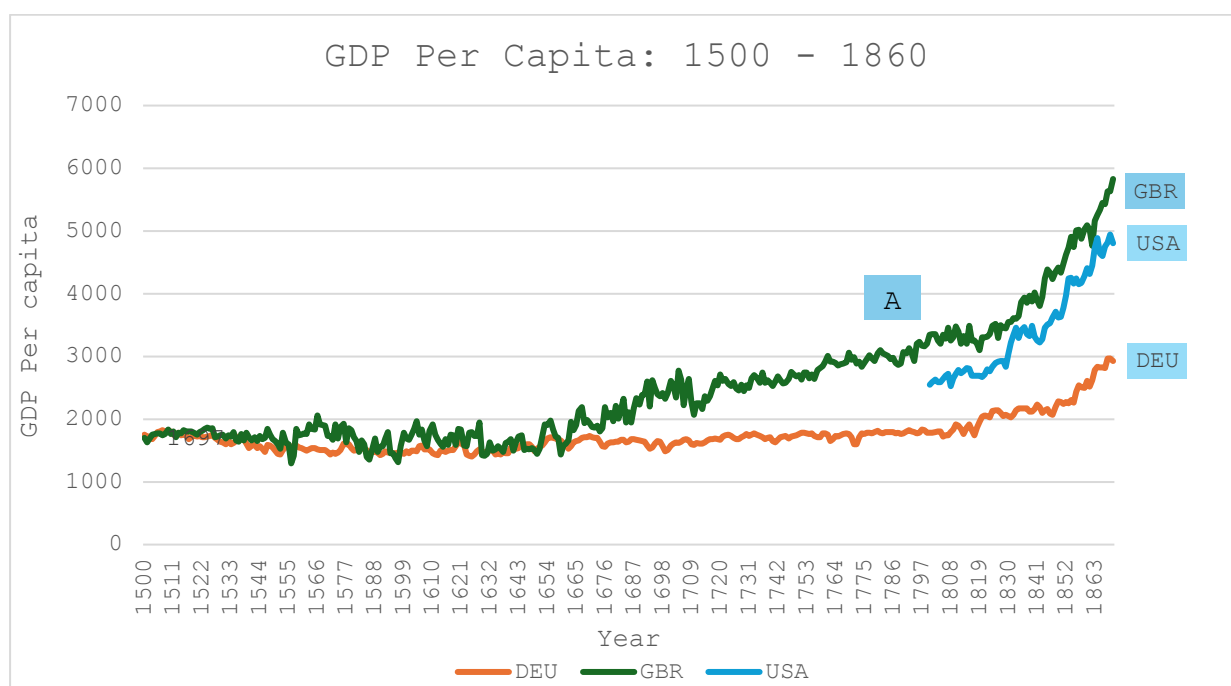


FIGURE 1: COMPARATIVE GDP PER CAPITA DATA, 1500-1860

Source: Author's graph based on data from Bolt and van Zanden (2024)

Note: Original Maddison Project dataset is filtered to produce this graph. See Section 10: Appendix for methodology.

The first major inflection point of modern economic history occurs at the Industrial Revolution (1760-1860) in the United Kingdom (GBR), marking the onset of sustained economic growth (Allen, 2011, p. 27). Figure 1 at point A (1760), marks the onset of rapid GDP growth signifying the Industrial Revolution. This rapid growth in

GDP, at point A, is deeply tied to manufacturing. In essence, labour is released from agriculture which is absorbed into industry. Prominent sectors within industry- such as cotton and textiles absorb labour to drive productivity. Therefore, leading to a rise in productivity that drives growth.

Broadberry (2015) suggests agricultural innovations from the sixteenth to the seventeenth centuries improved labour productivity (Broadberry et al., 2015, p. 368). This released “provisions, raw materials, and labour” to other sectors (Broadberry et al., 2015, p. 368). This labour is absorbed into the industrial sector. Within the industrial sector, Allen (2011, p. 32, p. 36) suggests the subsector of manufacturing, specifically cotton to be important. The cotton industry when combined with mechanisation and steam power led to dynamic labour productivity. This confluence of sectoral transformation and technological innovation led to exponential growth of GDP per capita at Point A in Figure 1.

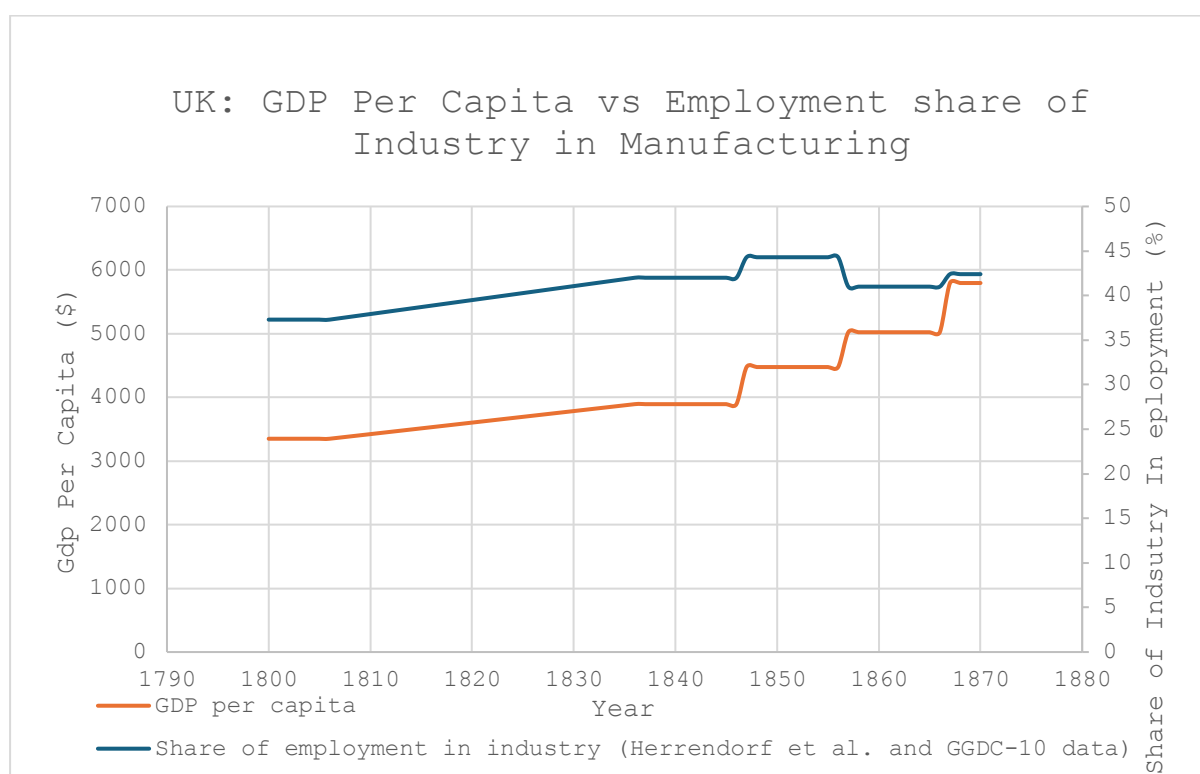


FIGURE 2: COMPARATIVE GDP PER CAPITA DATA, 1500-1860

Source: Author's graph based on data from Our World in data (2024)

Note: Original Dataset is filtered to produce this graph. See Section 10: Appendix for methodology.

Evidence suggests the prominent role of industry in GDP per capita growth. Figure 2 illustrates the parallel rise in GDP per capita and Industrial employment, between 1790-1840. Suggestive of the increasing prominence of the industrial sector. After 1840, these trends began to converge more closely. Thus, this prominence of industrial employment - combined with the literatures position on subsectors within industry, such as cotton - suggest manufacturing to be critical in development during the industrial revolution.

In conclusion, Case 1 demonstrate labour is reallocated from agriculture to industry, particularly manufacturing. Specifically, subsectors such as cotton and textiles. This reallocation of labour combined with technological change drove productivity and GDPO Growth. Therefore, manufacturing emerges as a critical driver of growth outcomes.

Case 2: The second Industrial Revolution (1860-1945)

The prominence of manufacturing in economic growth is not only confined to UK across the period of 1760-1860. During the Second Industrial Revolution (1860-1945), many countries caught up to the UK. Figure 3 highlights three insights. First, by 1945, Canada and the US surpassed the UK in terms of GDP Per Capita. Second, many other countries caught up to UK GDP per capita by 1945. Third, some economies – beginning with Japan and Spain – lay outside the upper GDP per capita range.

The growth strategies varied depending on the country within the period of 1870-1945. Gerschenkron (1962, p. 26) argues that the successful industrialisation of these countries is through a blend of imitation and adaptation to local conditions. Brooke (2014, p. 502) underlines some reasons for this diversity such as population growth, command of technology and economic demand. Consequently, creating unique strategies of growth.

Despite the uniqueness of strategies, the strong presence of manufacturing still exists. Nayyar (2020) unearths the movement of manufacturing hubs across history. Nayyar (2020) notes the predominant manufacturing hubs moved from the UK to some European countries such as Germany (Nayyar, 2020, p. 152). By the 1900s, “the share of the United States in world manufacturing production surpassed that of Britain” (Nayyar, 2020, p. 159). This period also coincides with the time when GDP per capita for the USA exceeds UK. Hence, the association suggests that manufacturing is a strong indicator of GDP pc.

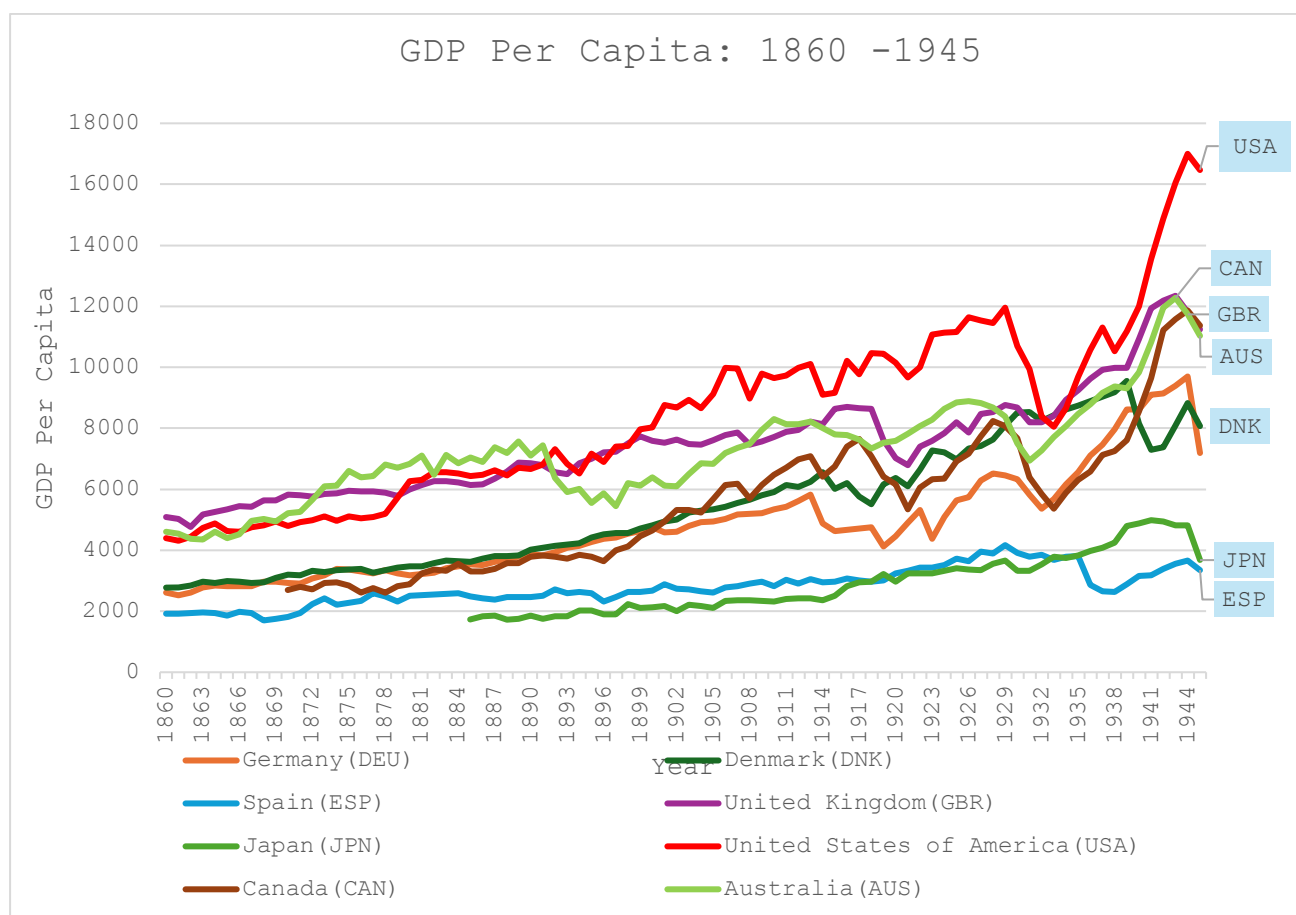
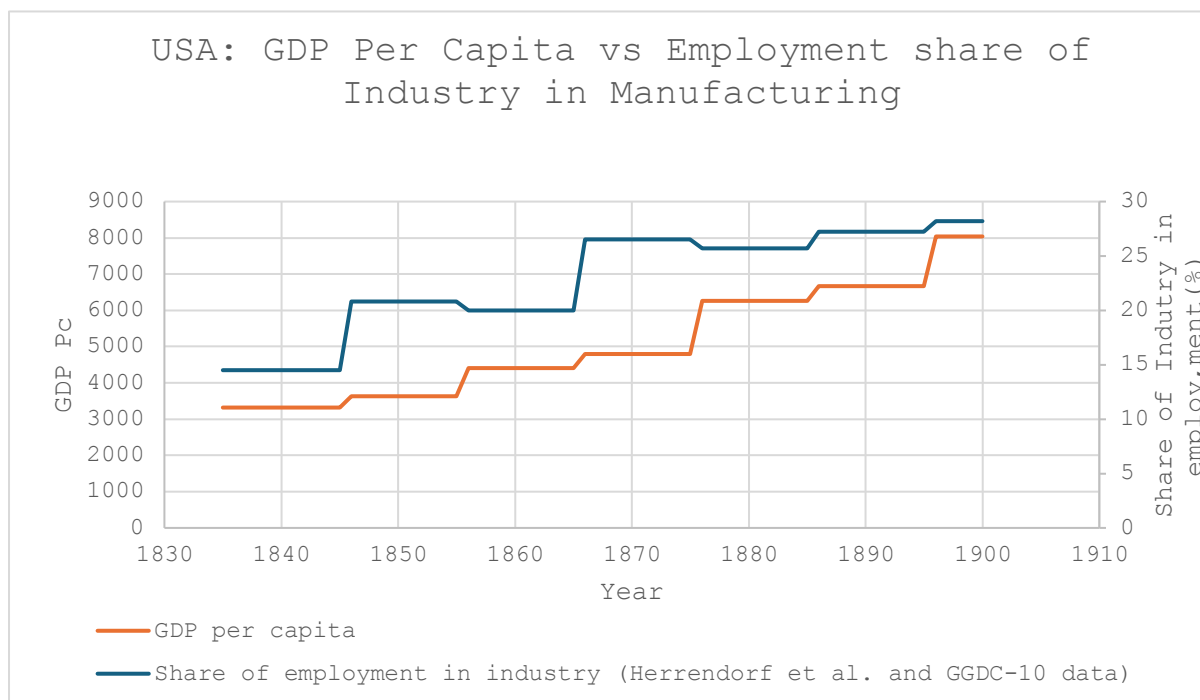


FIGURE 3: COMPARATIVE GDP PER CAPITA DATA, 1860-1945

Source: Author's graph based on data from Bolt and van Zanden (2024)

Note: Original Maddison Project dataset filtered to produce this graph. See Section 10: Appendix for methodology.

Figure 4 highlights the relationship between growing share of employment in industry and GDP pc in the USA. This positive association could be disaggregated further to highlight the specific contribution of manufacturing as a key sub-sector. Gordon (2016, p.11) identifies the Model T Ford as one of the most transformative



inventions of the period. This suggests that manufacturing as a subsector of industry could be driving the associations between industry and GDP pc. Therefore, this section has shown that industry has a prominent place within the growth of GDP pc. Moreover, manufacturing within industry is also emphasised as a driver of GDP pc.

FIGURE 4: COMPARATIVE GDP PER CAPITA DATA, 1860-1910

Source: Author's graph based on data from Our World in data (2024)

Note: Original Dataset is filtered to produce this graph. See Section 10: Appendix for methodology.

Case 3: The growth of the East Asian Tigers (1950-1990)

During the period of 1950-1990, four additional economies - Taiwan, Singapore, Hong Kong, and South Korea. - joined the list of developed nations. These countries are what we now call the East Asian Tigers. Moreover, Malaysia, Indonesia, and Thailand experienced a more modest pace to the Tigers – earning the label “The Tiger Cubs”.

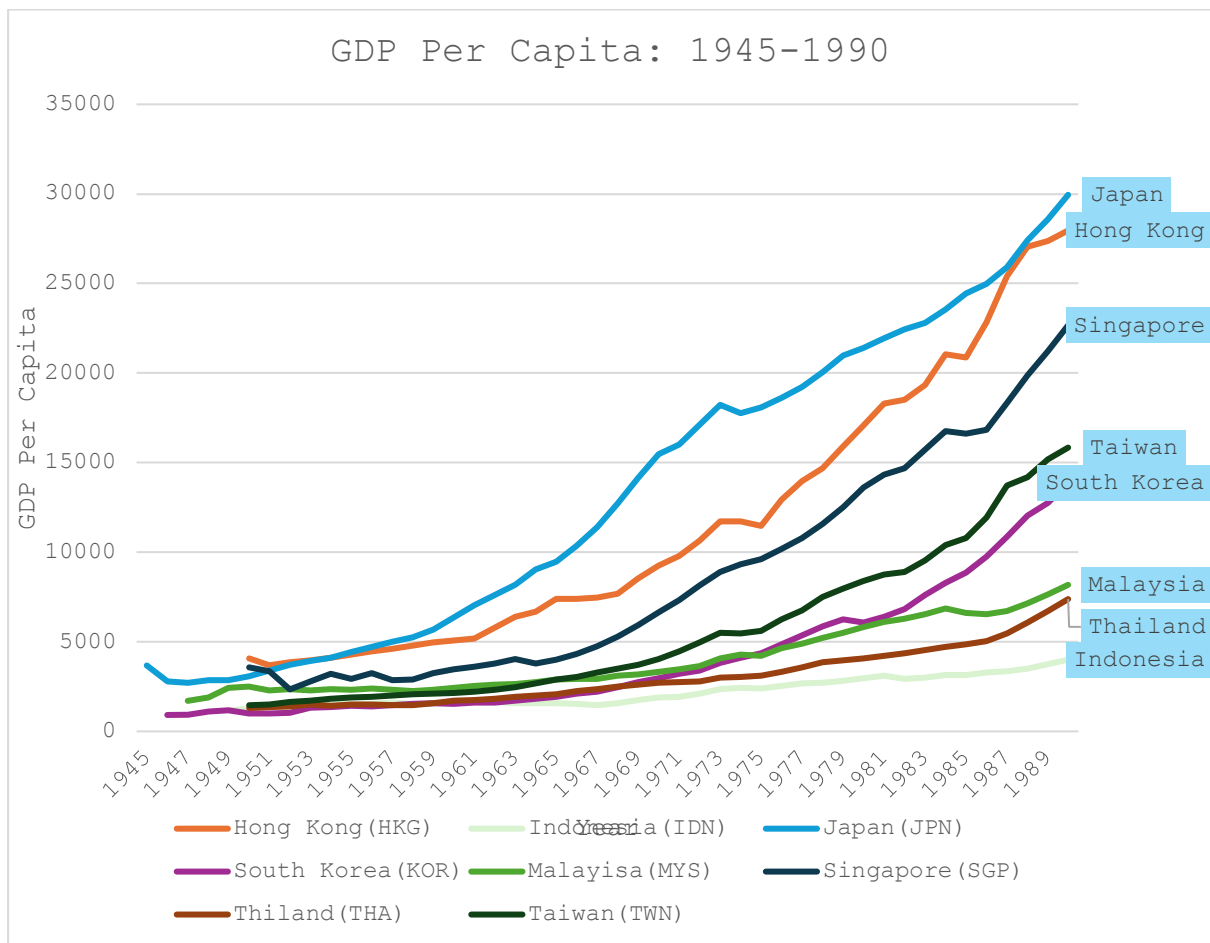


FIGURE 5: COMPARATIVE GDP PER CAPITA DATA, 1945 -1990

Source: Author's graph based on data from Bolt and van Zanden (2024)

Note: Original Maddison Project dataset filtered to produce this graph. See Section 10: Appendix for methodology.

Figure 5 shows the rapid growth in GDP for the East Asian Tigers from 1950 onwards. Manufacturing played a critical role in this growth, particularly through its contribution to the export led model.

Holistically, (Felipe, 2018, Abstract) argues the most important factor for the success of East Asia was the movement of individuals from agriculture to manufacturing, where eventually the sector “diversified and upgraded its structure” (Felipe, 2018, Abstract). This movement occurred due to the export led model which prioritised manufacturing. Key variables such as state led development, investment into infrastructure and the development of human capital - all geared towards exports of manufacturing increased productivity in the agricultural sector. This released labour into the manufacturing sector which drove productivity and exports. Weiss (2005, p.27) highlights the benefits of high exports – high profits, high savings, high investments. These benefits have the potential to create a virtuous cycle of growth and development.

There is evidence of the role of manufacturing within many of these countries. In the South Korean case, Amsden (Amsden, 1992, p. 107) directly points to the role of manufacturing productivity as the root of export success. Similarly, Wade (1990, p. 88) highlights Taiwan's growth of manufacturing as a share of GDP from 22% in 1960 to 37%, which coincides with the rapid rise in the GDP per capita.

To conclude, manufacturing drove development through productivity transformations that underpinned the export led model. Therefore, manufacturing can be perceived as a key driver of development

2B: The source of Manufacturing privileged position

The earlier section demonstrated that manufacturing is at the centre of development – either as a direct driver of development or is correlated with the growth of development.

This section explores why manufacturing occupies such as privileged position in developmental process.

Three core reasons underpin the unique presence of manufacturing in development: sectoral linkages, increasing returns, and the nature of the manufacturing good.

Firstly, manufacturing exerts strong forward and backward linkages to other sectors (Andreoni, 2012, p. 5). This conclusion stems from Hirschman (1958, p.63) work on the Unbalanced Growth Model where “growth [is] being communicated from leading sectors of the economy to the followers, from one industry to another, from one firm to another”. Andreoni (2012, p. 5) builds on Hirschman’s (1958, p.63) argument to emphasise manufacturing functions as a leading sector. In essence, manufacturing generates stronger forward and backward linkages relative to other sectors. This suggests that manufacturing is a pivotal sector for the growth of other sectors.

Park and Chan (1989, p.201) reinforce this relationship empirically to suggest growth of the service sector is contingent on the manufacturing sector. This is because services serve 13-14% of total inputs for the manufacturing (Park and Chan, 1989, p.201). This underscores manufacturing role in prompting service sector growth.

The second reason lies in manufacturing capacity for increasing returns. UNIDO (2013, p.22) notes that Kaldor (1966) built on the work of Young (1928), to highlight the role of increasing returns in manufacturing. Kaldor articulated this relationship through three empirical laws. Kaldor’s first law posits the faster the rate of manufacturing growth, the faster the rate of economic growth (UNIDO, 2013, p.22). Kaldor’s second law (also known as Verdoorn Law) highlights that the faster the rate of manufacturing output, the faster the rate of manufacturing productivity (UNIDO, 2013, p.22). Finally, Kaldor’s Third law indicates aggregate productivity is positively associated with the growth of employment in manufacturing (UNIDO, 2013, p.22). Thus, the paper submits manufacturing is special because the ‘special properties implicit in the second law triggers overall growth of the economic system (through the realisation of the first and third laws)’ (UNIDO, 2013, p.22). These feedback loops between output, productivity and employment create a virtuous cycle of growth.

Thirdly, the intrinsic characteristics of manufactured goods distinguish manufacturing from other sectors. Unlike services of agricultural goods, manufactured goods are non-perishable, exhibit higher tradability, and require less proximity in consumption. These unique traits create development advantages - increased propensity to trade, higher export earnings, and protection from external shocks (Chang, Andreoni and Kuan, 2013, p, 12). Together, these properties reinforce the reliability of manufacturing for development.

There are also peripheral reasons highlighting the impact of manufacturing to other facets of the economy. Firstly, Chang, Andreoni and Kuan (2013, p. 11) describe manufacturing as the “learning centre of capitalism”. This is because manufacturing has produced organisational innovations which have permeated to other sectors. Moreover, another peripheral reason is unconditional convergence (Rodrik, 2022, p.67). This is where manufacturing countries far from the technology frontier experience rapid productivity growth - even under resistant conditions such as adverse policies or external shocks. Finally, manufacturing enables developing countries to utilise cheap labour as a factor of production at scale. Therefore, adding employment benefits. It also optimises complementary resources such as education, institutions and capital accumulation. Therefore,

also enabling skill building efficiently. This enables less costly pathway to development through employment, and upskilling (Rodrik and Sandhu, 2025, p. 307).

In conclusion, the uniqueness of manufacturing stems from: sectorial linkages, increasing returns, and the nature of the manufactured goods. There are also peripheral reasons for the specialness of manufacturing such as unconditional convergence, employment effects, and knowledge transfers.

2C: Technological changes and its impacts on manufacturing.

The preceding sections have covered the literature's position of manufacturing until the 1980s. Thus, arguing for the specialness of manufacturing due to three reasons: sector linkages, increasing returns, and the nature of the manufactured goods.

This section identifies fundamental shifts within manufacturing post - 1980s. In other words, this section asks: are there technological evolutions that affect manufacturing after 1980? If so, what are some of their manifestations?

There is clear evidence that the manufacturing landscape has changed. O'Sullivan et al (2013, p.433) highlight five developments within global manufacturing. These being: declining share of manufacturing in OECD countries, growing competition from emerging economies, growing demand for resource- efficient manufacturing, increasing complexity and importance of manufacturing value chains, and the accelerating pace of technological change. Additionally, Chang and Andreoni (2020, p.326) also highlight financialisation and new imperialism (through changes to the rules of the global system) as newer economic realities. Furthermore, servicification is increasingly taking place in manufacturing. This is where services are increasingly being embedded into manufacturing for consumption (Crozet and Milet, 2017, p.820, p.822). Therefore, the scale and breadth of changes to manufacturing is poignant.

Despite the breadth of changes, there are two technological shifts that underpin the current manifestation of manufacturing. The most direct technological impacts are through the production process - these are ICT and Automation.

Firstly, there are technologies that affect labour in production. Andreoni and Anzolin (2019, p.10) suggest 12 key emerging technologies that augment production such as artificial intelligence and robotics, additive manufacturing among others. Automation is particularly concentrated in manufacturing with 99% of total industrial robots are being deployed in this sector (Andreoni and Anzolin, 2019, p.23). Moreover, these effects would be intensified in the future, if the use of machine learning and artificial intelligence is integrated into the production process. This would enhance labour productivity but also generate displacement concerns for low productivity labour (Urrea and Kern, 2025, Abstract, p.14). Therefore, the role of AI and industrial robots shape production process through employment and skill building effects. This reduces the peripheral benefit of employment in manufacturing stated in the earlier section.

The second change is technologies that reduce transaction or transport costs associated with trade (Rodrik, 2016, p.28). Andreoni and Anzolin (2019, p.14) highlight ICT as the source of the fragmentation of production, where ICT systems allow the integration of production across many countries. For example, tradeable services include transport services that move parts across the world, and legal and professionals' services that navigate across different regulatory paradigms with trade (Weymouth, 2017, p.935). This leads to global value chains because the advantages of local concentration decreases. Multinational firms increasingly optimise production using different countries for different aspects of the production process. This offers opportunities for emerging economies for development through attracting FDI. This dynamic enhances competition among emerging economies.

The role of ICT has more immediate consequences compared to the technologies such as automation. This is because these technologies require fewer capital requirements and have less uncertainty about technology

development and adoption. Therefore, offering greater immediate opportunities to be embedded into the global value chain.

Thus, this section has shown a range of manifestations of a changing manufacturing reality - underpinning these changes are the role of Automation and ICT.

2D: Present Realities and Development Pathways for Countries

The earlier section identified two main technological developments - automation, and ICT. The most important of which was suggested as ICT given its proximity to contemporary decision-making. Most importantly, the role of ICT and automation would be captured within the service sector classification (ISIC 4).

This section presents three competing perceptions on the role of manufacturing in development compared to services, which captures the role of ICT and Automation). Perception 1 views manufacturing as obsolete. The second perception views manufacturing as a platform. The third reflects ambiguity, acknowledging the role of classification and measurement as significant factors.

Perception 1: The historically elevated position of manufacturing is in decline.

There is a perception that technological developments erode the traditional benefits of manufacturing. This erosion challenges the historically elevated position of manufacturing in the development process. As a result, some literature argue that services represent the future of growth strategies. Thus, this section will highlight two ways automation erodes the benefits of manufacturing and highlight the importance of ICT to the present manufacturing realities.

The effects of automation on manufacturing could be envisioned in many ways. Two prominent interpretations are a reduction in employment or increase in labour capital requirement.

Firstly, automation could reduce the employment benefit of manufacturing given that labour and capital-intensive measures- such as automation – function as substitutes (Rodrik, 2022, p.70). These arguments suggest the scale of employment in manufacturing could be diminished as automation is intensified in the manufacturing process. Acemoglu and Restrepo (2020, p.2241) quantifies the effect of automation, noting that “each additional robot per thousand workers reduces the local employment-to-population ratio by 0.39 percentage points and wages by about 0.77%.”

Secondly, automation could increase the human capital requirement associated with manufacturing employment. Thereby, imposing significant cost through education - in developing countries. Rodrik (2022, p.70) argues the “displacement effect operated most strongly for the least educated workers”. Therefore, highlighting the vulnerability of low skilled work to technological substitution. As a result, automation could have dual impacts: reduction of the number of possible people employed in manufacturing, and a higher human capital requirement for those who will be employed in manufacturing.

More interestingly, technologies that reduce the transaction costs – particularly ICT- warrants closer attention. The use of ICT to synchronise research, production, and distribution have enabled a scenario where the entire world has become a factory (via Global value chains) and a marketplace (expansion of export markets). Therefore, ICT has produced many benefits: integration into world markets has increased the potential benefits of trade such as increase in forex among others.

However, the net effect could pose challenges for manufacturing. For example, the need to raise production quality to world standards is a concern. This would require capital deepening for developing countries, which may impose significant costs.

The need to meet world standards interacts with GVCs to produce differential effects within manufacturing. Diao et al (2025, p.309) highlight that large manufacturing firms exhibit strong productivity growth but limited employment effects, while smaller firms exhibit modest productivity growth but have significant employment effects. These dynamics exist because larger firms can deploy capital intensive measures to meet global

production standards, therefore, reducing labour demand. Whereas smaller firms would experience greater difficulty in attaining capital deepening, therefore, relying on labour intensive means. This creates a dual productivity system within the manufacturing sectors.

These dual productivity systems are problematic. The firms with superior productivity effectively become “more like natural resource enclaves: skill and capital intensive, disengaged with the domestic economy” (Rodrik, 2014, p.114). In essence, larger firms would become increasingly disengaged from the domestic economy due to the productivity differentials from suppliers and competitors. Therefore, large firms would be more intensely integrated with markets that are aligned with their productive potential, while being disengaged from the domestic economy. This undermines the sectoral linkage’s argument and reduces competition in the sector.

This is problematic from the perspective of political economy, if the larger company is MNC and the smaller company is a domestic developing company. Countries may be exposed to volatile world markets, which hinder long term development (if the MNC decides to move to another country abruptly).

Less productive firms -whether suppliers or competitors - could meet the global standards with targeted industrial policy. Therefore, one could ignore the effect of the sectoral linkage’s argument and the reduction in competition argument. However, the fiscal burden and technical capacity required in developing countries would make this potential unlikely. But while industrial policy can exert significant fiscal cost- history has shown them to be successful. The result of state led development in case 3(Section 2a- Case 3) could be applied here. States could actively try to pull up domestic firms that require intervention to be along the same production capital, and standards to the large productive firms. Therefore, the interventions of the state and the responses of the large productive business should also be considered when evaluating the role of sectoral linkages.

Thus, an argument can be made that the privileged position of manufacturing in development is under threat given that manufacturing is increasingly coming under pressure from new technological realities that undermine the employment, skill building and sectoral linkages benefits. Therefore, this argument highlights that countries should move to new growth strategies that do not bias manufacturing. Ghani and O’Connell (2014, p.150) argue for services to be the new avenue for growth opportunities.

Perception 2: Manufacturing has greater relevance than services

The Second perception argues manufacturing could have a central role in development due to two reasons. First, many services are embedded into manufacturing. Hence, moving away from manufacturing will dull the effects of services. Second, services productivity growth can be asymptotic compared to manufacturing.

Firstly, manufacturing is a customer of services. Hauge and Chang (2019, p.24) argue that many services are dependent on manufacturing as customers. Andreoni and Chang (2017b, p. 495) extends this argument to highlight that manufacturing is the customer of high productivity services. Andreoni and Chang (2017b, p. 495) implicitly argues that services cannot be maintained in the long run without a strong domestic manufacturing sector. If this is the case, services require manufacturing to be effective. Hence, manufacturing could be relevant for development as services growth are dependent on manufacturing growth.

However, the argument that manufacturing sector is necessary for service sector growth may warrant further analysis. One could envision a world economy where some countries are purely manufacturing sector and others are purely service sector economies. The use of technologies such as ICT would integrate these industries across countries. Therefore, enabling a pure service sector economy to grow without the input of manufacturing from the domestic economy. Thus, the developmental significance of service compared to manufacturing may be context dependent.

From an International Political Economy perspective, a purely service economy would face vulnerabilities. This is because at low levels services upgrading, exposure to competition and volatile business cycles increases.

Hence, the need to move up the value chain via process, product, or intersectoral upgrading is fundamental (WTO 2014, pp.102-108). Hence a purely producer service economy would be exposed to global market forces. Therefore, a hybrid sector of manufacturing and services may be preferable in the context of a global economy. Consequently, manufacturing could still be relevant for development.

Secondly, services are not a natural substitute to manufacturing even if the benefits of manufacturing have been reduced due to technological changes. Andreoni and Chang (2017b, p. 494) highlight that services are less responsive to productivity increases, and in some cases, productivity increase would destroy the product itself. Therefore, while manufacturing's historical capacity could be diminished, services may not be a natural substitute.

Thus, manufacturing is still central to development because manufacturing does not face the same productivity constraints that services face and the embedded formats of services and manufacturing in the domestic economy is preferable to a pure service economy.

Perception 3: Complexity due to sectoral interactions

Thirdly, some authors argue that greater complexity shapes these dynamics. This complexity warrants deeper investigation into the role of manufacturing. One important consideration is the role of classifications.

Hauge and Chang (2019) suggests that the perceived de-industrialisation within economies is because of classification changes. Firstly, Hauge and Chang (2019, p.26) argue that "the declining share of manufacturing ... is in some part due to reclassification of economic activity rather than changes in the country's productive structures". Hauge and Chang (2019, p.27) suggest that services are becoming more pronounced because these sectors have been reclassified from their manufacturing entities. Hence, creating new subsectors within the service category, as per ISIC 4.

This reclassification leads to a new economic reality due to classification changes where the embedding of services in manufacturing confounds the classical picture of manufacturing.

Section 3: Analytical Design

The previous establishes three conclusions. Firstly, 2A shows the historic understanding of manufacturing. Secondly, 2C shows how the reality of manufacturing has evolved since 1980s. This change is driven by automation and ICT technologies. Thirdly, 2D shows the literature is at an inflection point on the implications for countries, framed through three distinct perspectives.

This section identifies two key conclusions from the literature review that informs the methodological design.

Firstly, the selection of dependent variables should reflect the inflection points identified in 2D.

As the literature reveals, different perceptions on manufacturing can produce divergent strategic outcomes. For example, if Perception 1 is adopted, countries will need to look for more promising growth strategies such as services. If one adopts Perception 2, countries may choose to develop manufacturing due to benefits of manufacturing (customer of services, and service having a productivity ceiling). Finally, Perception 3, highlights the need to consider the role of classification which can shape how results are interpreted. This perception helps clarify the ambiguities related to Perception 1 and 2.

Hence, adopting one of the three perceptions is dependent on several factors. Perception 1 highlights the role of sectoral linkages and employment as key factors to question the developmental role of manufacturing. Perception 2 emphasises the role of economic opportunity from embedding effects and productivity as key indicators to choose manufacturing. Perception 3 points to the role of classification in determining results. Accordingly, the methodological design must explicitly account for these indicators- sectoral linkages,

employment, productivity dynamics, embeddness, and classification effects - to ensure analytical coherence and interpretive validity.

Secondly, multiple classification systems should be used to enable comparisons. Given the role of embedding and technological changes, traditional classification system may not fully capture the nature of manufacturing changes. Therefore, comparing a revised typology with traditional classification systems would shed light how classification systems impact sectoral understanding.

Thus, the methodology must proceed with two steps. Firstly, it must examine the role of different sectors in development. This analysis should focus on four key indicators: Sectoral linkages, Employment, Economic Opportunity and Productivity. These indicators provide the analytical basis for evaluating Perception 1 and Perception 2. Secondly, the methodology must incorporate multiple classification systems to enable comparative analysis. This comparative approach would help to capture the reality of manufacturing more fully. Therefore, offering a more layered understanding between Perception 1 and Perception 2 considering the implications of Perception 3.

Section 4: Methodology

This section will cover the scope of the research, experimental variables, role of classification systems. and hypothesis.

4A: Scope

Development processes can operate across the levels: micro, meso, and macro level factors. Macro-factors could be the role of international institutions. Micro- level factors include local powerful actors and their incentives to pursue unique types of growth strategies. Meso-level factors could be the role of state led development.

There is evidence that micro, meso and macro level variables interacting to produce unique dynamics within manufacturing. Shin and Chang (2005, p. 361) highlight the role of Global standard institutions and the role of local actors. Hauge (2020, p. 2085, 2086) highlight the tension between the integrating with transnational companies or to competing with them. Hauge (2020, p. 2089) also highlights the role of industrial policy that is relevant in shaping development outcomes.

Given the scale of these dynamics, this paper narrows its focus to a single meso-level factor: the role of economic sectors in development. This choice is both pragmatic- reducing analytical scope - and theoretical, as economic sectors serve as a bridge through which macro-level forces and micro-level incentives converge.

Thus, the use of meso level economic sectors is chosen for the pragmatic reason to reduce the size of the scope, and theoretical reasons - since economic sectors act as a bridge between micro and macro level factors.

4B: Experimental variables

This section seeks to justify the use of four dependent variables. Namely Economic growth, Economic Complexity Opportunity (ECO), Trade in Value added (TIVA) and Employment. Moreover, Sectoral value added is used as the independent variable to study economic sectoral impacts. Finally, this section outlines the rationale for controls.

Classical experimental variables on development has focused on GDP growth rates. However, this paper argues that GDP alone only captures a fraction of the full picture related to development. GDP is incomplete because it does not consider the long-term sustainability of development which is essential for low-income countries to transition to high income countries. Moreover, it fails to capture employment dynamics which are essential for individual learning and capability upgrading. Given the literature review, GDP as a standalone

measure does not capture the role of forward and backward linkages to other sectors and to other countries, which may obscure the full developmental impact of manufacturing. Moreover, trade emerges as a consistent theme across all historical periods explored in the Literature review. Hence, this paper will use a combination of variables to account for these flaws in GDP to produce a new set of dependent variables.

The dependent variables selected is inspired by the work of Andreoni and Chang (2017a, Abstract), who argues that development should also consider production as a key variable. Accordingly, the paper models development through four outcomes: productive transformation, sustainability of said transformation, the contribution of sectors to trade, and the employment effects. Productive transformation is captured through change in GDP Growth Rate data across countries overtime. Moreover, Trade in Value Added data is used to capture the role of backward and forward linkages. The specific measure of TIVA used in this paper reflects the share of Value added from sector in final exported goods which highlights backward linkages. Finally Economic Complexity Opportunity (ECO) serves as a proxy for the role of the sustainability of the country dynamism. This measure compares current productive capabilities to the proximity of more complex products. Therefore, highlighting the potential for diversifying and upgrading. Together, the combination of these dependent variables offers a multi-faceted understanding of development.

The dependent variables also address the key analytical dimensions outlined in Section 3: Sectoral linkages, Employment, Economic Opportunity and Productivity. Therefore, the dependent variables serve two purposes. First the dependent variables account for the weaknesses of GDP as a measure. Second the dependent variables drive the methods along the inflection points between the perceptions. In doing so, they enable a more precise comparison between Perceptions 1 and 2. The second conclusion from the Section 3 will be addressed in Experimental Design – Classification system.

The key independent variable will be Sectoral Value Added since it captures the net economic contribution from each sector, excluding the role of intermediate inputs. This measure offers a more accurate representation of each sector developmental contribution

Finally, this paper employs a range of control variables draw from multiple datasets. Fundamentally, this paper chose a range of controls from seven dimensions. These dimensions include Education, Institutions, Populations, Natural Resource, Trade, Infrastructure and Productivity. Accordingly, nine control variables were chosen to represent these dimensions.

Education is important since it can affect all dependent variables. Therefore, the effect of education is measured through Government Expenditure on Education (% of GDP). Higher spending on education (% of GDP) is associated with higher levels of educational attainment. Higher levels of education could produce higher productivity, increase employment prospects, and offer more avenues for economic complexity.

The role of institutions is highlighted through a composite percentile rank that constitutes a myriad of inputs (political stability, rule of law etc). Theoretically, institutions are important because they signal economic stability and prosperity. Higher levels of stability signal greater confidence for future stability which maybe be integral for considerations for long term FDI, and confidence. Hence, higher percentile rank could impact the extent of FDI and confidence. These factors drive higher economic opportunity, higher rates of productivity, employment effects.

The effect of the population is captured through population growth rates. Higher rates of population growth could expand labour force which could drive further economic growth, and economic opportunity. Natural resource as a control captures endemic Natural resource constraints (See Section 10: Appendix for classification process). Higher natural endowments interact with institutional quality to influence development strategy. Therefore, this may affect the composition of employment in services, manufacturing and agriculture.

Trade (% of GDP) captures openness to trade. Higher capacity for trade is associated with greater economic growth. Trade also affects sectoral linkages, particularly in manufacturing and services. Manufacturing tend to

benefit from trade openness and agriculture may perform better under protectionist trade policies. Infrastructure is an accelerator for development- measured by Access to Electricity (% of population). Infrastructure is an accelerator since it enhances the effects of trade, institutions, and enables some sectors more than others. For example, digital services rely heavily on the use of infrastructure such as electricity and internet access.

Finally, given the importance of productivity for development, three controls are included to reflect the different facets of productivity. Research and Development (% of GDP) is used to measure innovative capacity. FDI is used to capture technological transfer from foreign entities. Gross capital formation captures the role of domestic investment in productive capacity. Thus, the use of three control variables captures the effect of productivity more holistically.

Section 5: Research Design

This section looks at the data structure used in data analysis, describes the specifications for testing, and emphasises a new classification system (High and Low productivity Manufacturing) to be used as a comparison to classical sectoral classification.

Structure of the Data

This research would require the use of panel data for two reasons. Firstly, a range of countries is required to consider the effect of manufacturing on income levels. Secondly, the time-period begins in 2008 to capture the post-financial crisis restructuring of global production and the acceleration of ICT and automation adoption across sector. Finally, the ISIC Rev.4 classification system is adopted for its granularity and alignment with contemporary sectoral boundaries, particularly the integration of services within manufacturing processes.

Tests

This paper implements a four-stage modelling framework. Stage 1 involves an analysis of correlations between the independent and dependent variables to identify baseline associations. At Stage 2, a Breusch Pagan LM analysis will be run to specify whether a pooled OLS model is appropriate, or entity effects must be accounted for. Stage 3 is where the model is tested. If a pooled effects is validated in the earlier stage - two OLS models will be run: one model with controls, and one model without controls. (See Section 10: Appendix - Code walkthrough). If the pooled model is rejected, a Hausman Test will be run to decide between Fixed effects model or Random Effects Model. Then, the appropriate model will be executed. At Stage 4, robustness checks will be conducted. Specifically, for heteroskedasticity and multicollinearity. If heteroskedasticity exists, then robust standard errors will be applied. If multicollinearity exists, the control variables of interest are modelled in Stepwise reductions to highlight sensitivity of coefficients.

The role of classification systems

This paper proposes a dual analysis system given the conclusions of the analytical design: need to study sectoral effects, and the need to study sectoral effects relative to different classification systems. Accordingly, the empirical testing will be conducted in two papers:

1. Use conventional manufacturing sectoral classifications: manufacturing, services, and agriculture.
2. Use of a new PCI typology: high productivity manufacturing (referred to as Embedded manufacturing, low productivity manufacturing (referred to as Basic manufacturing), services and agriculture.

The hybrid typology is constructed using PCI scores from trade data as a proxy for service embeddedness in manufacturing. Embedded manufacturing is defined as a sector that has a PCI >0. A PCI >0 suggests higher embeddedness of service inputs, which produce greater productivity. Low productivity manufacturing will have PCI < 0, suggesting lesser embeddedness of service inputs, therefore, correlating with lower productivity. This will be referred to as Basic productivity manufacturing. (See Section 10: Appendix for method).

This new typology directly addresses Perception 3 - namely, the classification ambiguity regarding how to account for the embedding of manufacturing and services. This reclassification of manufacturing highlights the internal heterogeneity within manufacturing due to service embedding. Thus, offering a more nuanced view of sectoral composition.

For example, if the Embedded sector in manufacturing produces greater effects than services, agriculture, and basic manufacturing on Economic Complexity Opportunity) - this would suggest that the embedded nature of services and manufacturing would have stronger association for future economic opportunities to diversify into more complex products. Therefore, supporting argument that manufacturing should not be abandoned. Thereby, strengthening the argument for Perception 2 through a nuanced interpretation on Perception 3.

Accordingly, this paper seeks to amalgamate the conventional manufacturing classifications systems into two categories: Embedded sector and basic manufacturing. This unique strategy of reclassifying manufacturing aims to reframe the tension between Perception 1 and Perception 2, through accounting for Perception 3.

Hypothesis

So far, this section has sought to constrain the scope to sectoral effects on four development indicators with nine controls from a range of variables. This is achieved through two classification systems. This section offers two hypotheses for testing.

H1: Services value added will have the greatest positive association with Economic growth.

Reasoning: The nature of the data under-represents the effect of Manufacturing Value added. This is because sectoral classifications group services that are embedded into manufacturing into the broad service category. This classification effect may reduce the observed impact of manufacturing on growth or inflate the apparent contribution of services. As a result, the data may overstate the effect of services and understate the effect of manufacturing

H2: Embedded manufacturing will exhibit stronger with Economic Complexity compared to Conventional classification of manufacturing.

Reasoning: More complex products – those higher in the Economic Complexity Opportunity scale – typically require greater service input intensity. These characteristics are better captured by the PCI scores than conventional systems. Accordingly, the coefficient for Embedded manufacturing is expected to reflect the embedded service effects more accurately, resulting in a stronger association with Economic Complexity Opportunity.

Section 11: References

Allen, R. C. (2011) *Global economic history : a very short introduction* / Robert C. Allen. Oxford ; Oxford University Press.

Broadberry, S. et al. (2015) 'Labour productivity', in *British Economic Growth, 1270–1870*. Cambridge:

Nayyar, D. (2020) 'Industrialization, hubs, and catch-up: The world economy in historical perspective', in Oqubay, A. and Lin, J.Y. (eds) *The Oxford Handbook of Industrial Hubs and Economic Development*. Oxford: Oxford University Press. Available at: <https://doi.org/10.1093/oxfordhb/9780198850434.013.9>

Felipe, J. (2018) 'Asia's industrial transformation: The role of manufacturing and global value chains (Part 1)', *ADB Economics Working Paper Series*, No. 549. Manila: Asian Development Bank,

Available at:

<http://dx.doi.org/10.22617/WPS189457-2>

Amsden, A.H., 1992. *The Dynamics of Growth*. In: A.H. Amsden, *Asia's Next Giant: South Korea and Late Industrialization*. New York: Oxford University Press. [online] Oxford Academic. Available at: <https://doi.org/10.1093/0195076036.003.0004>

Wade, R. (1990) *Governing the Market: Economic Theory and the Role of Government in East Asian Industrialization*. Princeton, NJ: Princeton University Press. Available at: <https://doi.org/10.2307/j.ctv346sp7> (Accessed: 16 August 2025).

Gerschenkron, A., 1962. *Economic backwardness in historical perspective*. Cambridge, MA: Belknap Press of Harvard University Press. Chapter 1: Economic Backwardness in Historical Perspective.

Andreoni, A., 2012. *Productive Capabilities Indicators for Industrial Policy Design*. Vienna: United Nations Industrial Development Organization (UNIDO), Development Policy, Statistics and Research Branch. Working Paper No. 17/2011.

Park, S.-H. and Chan, K.S., 1989. *A cross-country input-output analysis of intersectoral relationships between manufacturing and services and their employment implications*. *World Development*, 17(2), pp.199–212.

UNIDO, 2013. *The Industrial Competitiveness of Nations: Looking Back, Forging Ahead*. Vienna: United Nations Industrial Development Organization.

Chang, H.-J., Andreoni, A. and Kuan, M.L., 2013. *International industrial policy experiences and the lessons for the UK*. Foresight Future of Manufacturing Project, Evidence Paper No. 4. London: Government Office for Science.

Andreoni, A. and Chang, H.-J., 2017a. Bringing production and employment back into development: Alice Amsden's legacy for a new developmentalist agenda. *Cambridge Journal of Regions, Economy and Society*, 10(1), pp.173–187

Szirmai, A. and Verspagen, B., 2011. *Manufacturing and economic growth in developing countries, 1950–2005*. UNU-MERIT Working Paper Series, No. 2011-069. Maastricht: United Nations University – Maastricht Economic and Social Research Institute on Innovation and Technology (UNU-MERIT). Available at: <https://cris.maastrichtuniversity.nl/files/858836/guid-1da67c6f-0cb2-4d2d-8844-43fd10cd0d58-ASSET1.0.pdf>

Rodrik, D. & Sandhu, R. (2025) Servicing Development: Productive Upgrading of Labor-Absorbing Services in Developing Economies. *Global policy*. [Online] 16 (2), 306–318.

O'Sullivan, E. et al. (2013) What is new in the new industrial policy? A manufacturing systems perspective. *Oxford review of economic policy*. [Online] 29 (2), 432–462.

Rodrik, D., 2016. *Premature deindustrialization*. *Journal of Economic Growth*, 21(1), pp.1–33. Available at: <https://link.springer.com/article/10.1007/s10887-015-9122-3>.

Rodrik, D., 2022. *Prospects for Global Economic Convergence Under New Technologies*. [online] Available at: <https://drodrik.scholar.harvard.edu/publications/prospects-global-economic-convergence-under-new-technologies>

Chang, H.-J. and Andreoni, A., 2020. *Industrial policy in the 21st century*. *Development and Change*, 51(2), pp.324–351. Available at: <https://doi.org/10.1111/dech.12570>

Andreoni, A. and Anzolin, G., 2019. *A revolution in the making? Challenges and opportunities of digital production technologies for developing countries*. Vienna: United Nations Industrial Development Organization (UNIDO), Inclusive and Sustainable Industrial Development Working Paper Series, WP 7/2019.

Rodrik, D., 2022. *Prospects for Global Economic Convergence Under New Technologies*. [online] Available at: <https://tinyurl.com/ydenbnrn> [Accessed 30 Aug. 2025].

Diao, X., Ellis, M., McMillan, M. & Rodrik, D., 2025. Africa's manufacturing puzzle: Evidence from Tanzanian and Ethiopian firms. *The World Bank Economic Review*, **39**(2), pp.308–340. Available at: <https://tinyurl.com/ycrw8l9p>

Rodrik, D., 2014. The past, present, and future of economic growth. In: F. Allen, J. Qian and B.K. Sheehan, eds. *Towards a Better Global Economy: Policy Implications for Citizens Worldwide in the 21st Century*. Oxford: Oxford University Press, pp.70–137. Available at: <https://doi.org/10.1093/acprof:oso/9780198723455.003.0002>

Andreoni, A. and Chang, H.J., 2017b. Industrial policy and the future of manufacturing. *Economia e Politica Industriale*, **43**(4), pp.491–502. <https://doi.org/10.1007/s40812-016-0057-2>

Hauge, J. and Chang, H.-J., 2019. The role of manufacturing versus services in economic development. In: P. Bianchi, C.R. Duran and S. Labory, eds. *Transforming Industrial Policy for the Digital Age*. Cheltenham: Edward Elgar, pp.12–36.

Shin, J.S. and Chang, H.J., 2005. Globalization and East Asian Economies: An Introduction. *Global Economic Review*, **34**(4), pp.355–362. [online] Available at: <https://doi.org/10.1080/12265080500446304>

Hauge, J., 2020. Industrial policy in the era of global value chains: Towards a developmentalist framework drawing on the industrialisation experiences of South Korea and Taiwan. *The World Economy*, **43**(8), pp.2070–2092. [online] Available at: <https://doi.org/10.1111/twec.12922>

Prebisch, R., 1950. *The economic development of Latin America and its principal problems*. New York: United Nations Department of Economic Affairs, Economic Commission for Latin America (ECLA).

Lewis, W.A., 1954. Economic development with unlimited supplies of labour. *The Manchester School*, **22**(2), pp.139–191. Available at: <https://doi.org/10.1111/j.1467-9957.1954.tb00021>.

Ghani, E. and O'Connell, S., 2014. Can services be a growth escalator in low-income countries? *World Bank Research Observer*, **29**(1), pp.1–28. <https://doi.org/10.1093/wbro/lkt007>

Chenery, H. B. et al. (1975) *Patterns of development, 1950-1970 / Hollis Chenery and Moises Syrquin / with the assistance of Hazel Elkington*. London: Oxford University Press for the World Bank.

Brooke, J.L. (2014) 'Launching Modern Growth: 1870 to 1945', in *Climate Change and the Course of Global History: A Rough Journey*. Cambridge: Cambridge University Press (Studies in Environment and History), pp. 500–528.

Weiss, J., 2005. *Export growth and industrial policy: Lessons from the East Asian miracle*. ADBI Discussion Paper No. 26. Tokyo: Asian Development Bank Institute. Available at: <https://www.adb.org/sites/default/files/publication/156779/adbi-dp26.pdf>

Crozet, M. and Milet, E., 2017. Should everybody be in services? The effect of servitization on manufacturing firm performance. *Journal of Economics & Management Strategy*, **26**(4), pp.820–841. <https://doi.org/10.1111/jems.12211>

Urrea, C. and Kern, J., 2025. *Recent advances and challenges in industrial robotics: A systematic review of technological trends and emerging applications*. *Processes*, **13**(3), p.832. <https://doi.org/10.3390/pr13030832>

Weymouth, S., 2017. Service firms in the politics of US trade policy. *International Studies Quarterly*, **61**(4), pp.935–947. <https://doi.org/10.1093/isq/sqx056>

Acemoglu, D. & Restrepo, P. Robots and jobs: Evidence from us labor markets. *Journal of Political Economy* 128, 2188–2244 (2020). <https://doi.org/10.1086/705716>.

Gordon, R.J., 2016. *The Rise and Fall of American Growth: The U.S. Standard of Living Since the Civil War*. Princeton, NJ: Princeton University Press.

World Trade Organization (WTO), 2014. *The rise of global value chains*. In: *World Trade Report 2014: Trade and Development – Recent Trends and the Role of the WTO*. Geneva: WTO, pp.78–122.

Hauge, J., Kenward, M. and Wightman, S. (2020) *The future of the manufacturing workforce*. Cambridge: University of Cambridge Engineering Department.

Hirschman, A.O., 1958. *The Strategy of Economic Development*. New Haven: Yale University Press. Cambridge University Press, pp. 340–370.

Bolt, J. and van Zanden, J.L. (2024) *Maddison Project Database 2023*. DataverseNL. Available at: <https://doi.org/10.34894/INZBF2>

Lippolis, N., 2022. *Composite dataset on growth and structural transformation*, compiled by Our World in Data. Based on: Bolt and van Zanden – Maddison Project Database (2023); HYDE (2023); Gapminder – Population v7 (2022) and Systema Globalis (2022); UN – World Population Prospects (2024); Herrendorf, B., Rogerson, R. and Valentinyi, Á. (2014); Groningen Growth and Development Centre – 10-sector database (2015). Available at: [Share of industry in employment vs. GDP per capita, 1800 to 2015](#)

World Bank, 2024. *Country classification methodology: World Development Indicators*. The World Bank Group. Available at: [How does the World Bank classify countries? – World Bank Data Help Desk](#)

World Bank, 2024. *GDP growth (annual %)*. World Development Indicators. Available at: [GDP growth \(annual %\) | Data](#)

Harvard Growth Lab, 2025. *The Atlas of Economic Complexity – Data Downloads*. Harvard University. Available at: <https://atlas.hks.harvard.edu/data-downloads>

OECD, 2023. *Trade in Value Added (TiVA) – Principal Indicators, 2023 Edition*. OECD Data Explorer. Available at: https://stats.oecd.org/Index.aspx?DataSetCode=TIVA_2023

UNIDO, 2025. *UNIDO Statistics Data Portal – Manufacturing Sector (ISIC Rev.4, Level 2)*. United Nations Industrial Development Organization. Available at: <https://stat.unido.org>

World Bank, 2025. *GDP (current LCU)*. World Development Indicators. Available at: <https://data.worldbank.org/indicator/NY.GDP.MKTP.CN>

World Bank, 2025. *Services, value added (current LCU)*. World Development Indicators. Available at: [Services, value added \(current LCU\) | Data](#)

World Bank, 2025. *Agriculture, forestry, and fishing, value added (current LCU)*. World Development Indicators. Available at: <https://data.worldbank.org/indicator/NV.AGR.TOTL.CN>

World Bank, 2025. *Government expenditure on education, total (% of government expenditure)*. World Development Indicators. Available at: <https://data.worldbank.org/indicator/SE.XPD.TOTL.GB.ZS>