SCHOOL OF
ECONOMICS AND
MANAGEMENT

Master's Programme in Economic Growth, Population and Development (Economic Development Track)

Improper Structural Transformation & Stagnant Manufacturing in Post-Independence India

The Role of Agriculture and Inter-Sectoral Linkages

by

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Abstract: India is witnessing an unconventional pattern of structural change – involving a shift to services-dominated economy at lower income per-capita than early industrialisers. Despite significant policy rhetoric on industrialisation, the sector's share in both value-added and employment has stagnated remarkably. The reform period saw a services-led growth with growing agrarian distress. Therefore, this thesis analyses India's industrial stagnation and unconventional structural change, by examining the role of agriculture-industry linkages and agricultural performance. We find that structural change in India involved a movement of workers from agriculture to other low-productive sectors such as construction and trade. Input-Output (I-O) and Ordinary Least Square (OLS) findings suggest that improving agricultural performance has the potential to improve industrial sector's performance by providing a sustained domestic demand for their goods. We find that there was an improvement in agricultural modernisation from 1965 until 1990s, indicated by the strengthened agriculture-industry linkages. However, production and demand linkages have either stagnated or declined in recent decades. Therefore, eliminating demand constraints arising out of agriculture would ensure that there is resilient domestic demand for industrial production. Improving agricultural productivity and profitability, has the potential to make farming economically viable and consequently reduce the distress-based movement of workers.

Keywords: Input-Output Matrices; Structural Transformation; Ordinary Least Squares; Agricultural Productivity; Capital Formation; Domestic-Market Linkages; Sustainable and Resilient Structural Change; Services-led growth.

EKHS21
Master's Thesis First Year (15 ECTS)
June 2022
Supervisor: Dr. Sascha Klocke
Examiner: Prof. Jonas Ljungberg
Word Count: 18127

Acknowledgements

I would like to express my sincere gratitude to my supervisor, Dr. Sascha Klocke, for your supportive feedback and constant guidance. Your suggestions helped me develop my ideas and arguments into a coherent text. I would like to thank Prof. Suresh Babu – my initial discussions with him and his support were crucial in prompting my interest in this topic. The help, support and the guidance by the faculty and staff at the Department of Economic History, LU, allowed me to work confidently with all the necessary resources at our disposal. Lastly, I would like to thank my family, friends, and comrades for bearing with me for another year. Thank you for everything.

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1 Introduction

The high growth rates that India registered in the aftermath of liberalisation reforms in the 1990s seems to have stalled since 2011-12 (Ghose 2015). Even the high growth period was largely a services-led growth that did not entail an industrial transformation. Ghose (2015) argues that a sustained increase in national income could only be achieved if India embarks on a manufacturing-led growth as was the case with the currently high-income and developed economies. Such inconsistencies can be traced in the erstwhile state-led model of development as well – wherein the planning process placed a greater emphasis on heavy industrialisation with a relative neglect of the rural economy (Rao, 1994). The title of Amartya Sen's and Jean Dreze's book "An Uncertain Glory: India and its Contradictions" applies quite aptly to its economic development process since its independence in 1947. Although Dreze and Sen's (2013, pp. 5-6) book is of the opinion that India's human and social development could not be achieved through merely improving its economic growth, this work builds on the argument that even its growth trajectory has remained inconsistent, giving rise to a phenomenon, coined by Binswanger-Mkhize (2013) as "stunted structural transformation". His contention is that India's structural transformation has 'skipped' the phase of workers moving out of agriculture into industry. According to him, the decline in the shares of agricultural output and employment was not accompanied by a commensurate increase in the shares for the industrial sector (particularly that of manufacturing industries). The singular focus on achieving high growth obfuscated the criticality of structural change in India and ignored the crucial issue of 'what is nature of growth' (Papola 2012). Therefore, we can identify that India's growth since its independence was marred with two important trends that challenges the established view of a Lewisian economic development process (Lewis, 1954). One being the lack of an industrial transformation and other being the dependence on an unsustainable growth pattern which is largely services-led. Studies have argued that a successful industrial transformation is dependent on an agrarian transformation brought about by increased productivity and profitability in the farm sector (Johnston & Mellor, 1961; Adelman, 1984). As such, the aim of this thesis is to evaluate whether poor agricultural performance and weakening agriculture-industry linkages could explain the stagnant industrial development in India, thereby generating a structural transformation that skipped the phase of industrialisation.

There is a growing body of literature attempting to analyse the differential processes of structural change in the developing countries that are defying the conventional models of economic transformation i.e shift from agriculture to industry and finally to services in terms of output and employment shares (eg: Ghani & O'Connell, 2014; Rodrik, 2016; Gollin, Jedwab & Vollrath, 2016; Sen, 2019). However, the importance of a conventional structural transformation cannot be overlooked. Evidence suggests that these unconventional patterns, which involve a direct shift from agriculture to services, could become unsustainable with low and fluctuating economic growth (Rodrik, 2016; Thorbecke & Ouyang, 2016; Ghose, 2020). Studies have also identified robust poverty reducing potential of a structural transformation (eg: Mehrotra, Parida, Sinha & Gandhi, 2014 - based on Indian experience and Frankema and Waijenburg, 2018 - using sub-Saharan Africa as a case study). Rodrik (2016) finds that several developing countries are experiencing a premature deindustrialisation, with the ascendance of advanced labour-saving manufacturing technologies. Some studies in the Indian context have discussed this issue with varying conclusions – Chakraborty and Nagraj (2020) find that despite a stagnation, Indian experience cannot yet be called a premature deindustrialisation. While Chaudhari (2015) argues that the observed trends show that India began its descent into premature deindustrialisation.

As mentioned above, the importance of a rural transformation and the role of agriculture in industrialisation was discussed by several studies starting from Lewis (1954) itself, who argued that both agriculture and industry are inter-dependent in the growth process. However, both in policy arena and in scholarly works there emerged a relative neglect of agriculture, particularly in the developing countries' context (Timmer, 1988). However, some studies have theorised this relationship in the Indian context and have argued that agriculture plays a crucial role in industrial development (Nayyar, 1978; Rao, 1994; Storm, 1995; Nagraj, 2011)

1.1 Research Questions and Aims

Given these discussions regarding the nature of structural change in developing economies and the importance of agriculture, this project aims to study the role of agriculture in India's structural change and specifically analyse the inter-sectoral linkages between agricultural and industrial sectors to examine whether the fault lines of sluggish industrialisation could be explained by considering the nature of agrarian development. Furthermore, we identify some policy implications from our analysis. While corroborating the view that structural change in India bypassed the phase of industrialisation, this thesis will argue that the underperformance of the agricultural sector and weakening of the inter-sectoral linkages could explain the lack of a full-fledged industrialisation and a sustained growth in manufacturing employment, during the entirety of the post-independence period.

Therefore, to sum up, this research has three broad aims: firstly, to examine the nature of structural change in India; secondly to identify agriculture's impact on industrial development; thirdly, to identify policy implications for improving agricultural and industrial performance. The following are the three sets of research questions to address the above objectives:

1. *What were the trends in India's structural transformation in the post-independence period? Is India witness to a "premature deindustrialisation"?*
2. *How have the inter-sectoral linkages between agriculture and industry changed over the years in India? How was agricultural performance associated with industrial performance and the extent of structural transformation?*
3. *What are the policy implications for improving agricultural performance and agriculture-industry linkages?*

In answering these questions, the thesis relies on a broad periodisation of the post-independence period. The liberalisation reforms of the mid-1980s and early 1990s have significantly altered the industrial and agricultural policy frameworks (Nagaraj, 2011; Ramakumar, 2010). Therefore, in explaining the trends for structural change and inter-sectoral linkages we make the crucial distinction between pre-reform (1950 to 1990) and post-reform period (1991-present). Although small-scale reforms were initiated in the mid-1980s, the structural adjustment policies under auspices of the International Monetary Fund and the World Bank were only announced in July 1991 (Nagaraj, 2011). Therefore, 1991 will be the year that will demarcate our periods. The post-reform period is also sometimes referred to in this thesis as the reform period because liberalisation measures were constantly expanded in scope and newer policies and changes continue to be implemented.

1.2 Thesis Outline

The rest of the thesis is organised as follows. The second chapter presents a review of previous literature on the role of agriculture, nature of structural transformation in developing economies, changes in the Indian economy since independence, and some explanations for India's sluggish industrialisation. The chapter concludes with discussions on our theoretical approach and gaps in the existing literature. The third chapter elaborates the methods that are used in the study. The fourth chapter presents the sources of data and describes in detail the different indicators that would be used for empirical analysis. The fifth chapter consists of the empirical analysis. The first section of fifth chapter discusses sectoral trends in structural change, growth and productivity. We examine some of the existing analytical frameworks on structural change in the literature and discuss their relevance to India. The second and third sections deal with agriculture-industry linkages and examines the role of agriculture in industrial development and structural change, using I-O and OLS analysis. The final section of the chapter discusses the findings and provides some implications. The last chapter discusses the main conclusions and summarises the study. Certain limitations and possibilities for future research are also addressed.

2 Theory

2.1 Previous Research

2.1.1 Role of Agriculture in Structural Transformation

Structural Transformation could broadly be understood as the change in the relative importance/dominance of different economic sectors in the economy. The debates surrounding structural transformation owe their origin to the foundational work by Arthur Lewis (1954). According to Lewis, economic development follows a dual sector model wherein the agricultural sector (referred to as subsistence sector) provides inputs in the form of cheap unskilled labour to the modern industrial sector (or capitalist sector). The movement of workers from agriculture to industry continues at subsistence wages, during which higher returns to capital are generated – which are in turn re-invested, generating growth. This framework has been further expanded to incorporate the shift from industry towards services (Ghose, 2020)

In literature following Lewis (1954) there was a relative neglect of the need for focusing policy attention on agriculture in the process of economic development, as Timmer (1988, pp. 289-289) points out. Timmer concedes that the literature viewed agriculture as a "declining sector" with its contributory role to the modernisation process restricted to the supply of "labour, food and capital". Lewis (1954:173) himself, postulates that "industrialisation is dependent upon agricultural improvement" and argues that both the "industrial and agrarian revolutions" should occur simultaneously, and that a stagnation in the latter would invariably hurt the former. Even though Lewis notes the importance of agriculture and the interdependence of agrarian and industrial transformation, as Timmer points out, later research has neglected the role of agriculture in structural change. This bias is also evident in the policy approach of the newly independent countries in the twentieth century. During the initial phases of the decolonisation, Timmer (2016, pp.86) argues that the policymakers of these economies had deliberately neglected agriculture to industrialise on a large-scale, which he says was fraught "with no understanding that agricultural productivity was linked to industrial productivity in ways that made investing in agriculture critical to overall economic growth". These policies were greatly influenced by the Prebisch-Singer hypothesis which theorised that prices and terms of trade for agricultural and primary commodities will face an eventual decline compared to the manufacturing goods (Prebisch, 1950; Singer, 1950). As a result, these third world states were reluctant to invest in modernising agriculture (Timmer (1988, pp.289).

Nonetheless, studies have also identified the crucial role played by agriculture in sustaining structural change (Johnston & Mellor, 1961; Adelman, 1984; Ravallion & Chen, 2007; Timmer, 2016; Christiaensen, Demery & Kuhl, 2011). The work of Johnston and Mellor (1961), which was one of the initial analyses on the positive role of agriculture in development, contends that low-income and developing countries should focus on simultaneous growth of both industry and agriculture. They explicate on five different roles of agriculture - one of which being agriculture as a market for industrial output. Subsequently the work of Adelman (1984) has proposed the framework in which industrialisation is led by agricultural demand, and agricultural demand in turn as a function of its growth and surplus. Therefore, improving agricultural productivity was crucial for this framework of industrialisation. Timmer (2016, pp.68) argues that agriculture has a productive role to play in the process of catching up, and that a sustainable model of structural transformation is materialised only if there is a growth in agricultural productivity "through a series of market and non-market linkages". Studies have established the significance of agricultural growth in reducing poverty and argue for greater growth inducing agricultural investments by the state (Ravallion & Chen, 2007; Christiaensen, Demery & Kuhl, 2011).

However, there is some disagreement amongst the scholars on the role of agriculture. For instance, Dercon and Gollin (2014) critiques the above-mentioned works by arguing that those studies have not analysed the relative role of agriculture in poverty reduction or economic development vis-a-vis the other sectors of the economy. They emphasise that studies have ignored cost-benefit and opportunity cost analysis of the impact of agricultural policies and investments. Nonetheless, they do not completely discredit the positive payoffs for public spending on agricultural and rural development - they conclude that heterogeneity and diverse circumstances need to be considered before devising agricultural policies.

Notwithstanding these debates surrounding the role of agriculture in structural change, there is no denying the importance of a sustainable model of structural change. For instance, Andersson, Axelsson and Palacio (2021) develop a framework of social capabilities that incorporates both structural and institutional aspects, in order to explain economies' resilience to shrinking. Structural transformation features as a crucial component of that social capabilities which captures the extent to which the economic activities of that economy are diversified beyond primary production. Despite this established view, as we will discuss in the next sub-section, structural change has followed an unconventional pattern in the newly developing economies. The section also discusses various explanations for such patterns of structural change that involved an underdevelopment of manufacturing industries.

2.1.2 Structural Change in Developing Economies

Ghose (2020: 3) identifies that all the developed and advanced capitalist countries along with late developers such as the East Asian economies have followed a similar pattern of structural change which he refers to as a "classical pattern". As is well known, this pattern refers to the shift in the relative shares of labour and output from agriculture to manufacturing/industry and finally to services. However, for the newly developing economies of Africa and South Asia structural change appears to follow an alternative path – a shift directly from agriculture to services (see Ghani & O'Connell, 2014; Rodrik 2016; Sen 2019). There are contrasting viewpoints on whether such a pattern is ideal or not - Rodrik (2016), Sen (2019), Ghose (2020) are sceptical of the sustenance of growth under this unconventional structural change, while Ghani and O'Connell (2014) suggest that these economies could benefit from this new model.

Rodrik argues that newly developing economies are experiencing premature deindustrialisation wherein these countries in the recent decades have witnessed a reduction in the manufacturing shares of employment and output at significantly lower income per-capita levels than the West. These economies, he finds, not only had lower growth, but also negative political outcomes such as a degrading democracy. Sen (2019) finds that "in structurally underdeveloped economies workers are moving directly from agriculture to non-business services, which as a sector does not have the same productivity gains observed in manufacturing". Gollin, Jedwab and Vollrath (2016) explains this phenomenon by contrasting two models of structural change: one which is based on a movement from agriculture to industry which then involves production of tradeable manufactured goods; the second model emerges, when structural change is propelled through natural resource endowments and commodity price booms. They argue that the latter scenario consists of incomes generated from resource trade to be used for consumption of urban goods and services - this scenario is termed as “urbanisation without industrialisation”. The authors claim that Africa and the Middle East followed this second model of structural change based on the natural resource boom.

Contrastingly, Ghani and O’Connell (2014) argue that these economies can pursue an alternative path, one which does not necessarily require a significant industrialisation. They argue that technological advancements and ICT revolution in the recent decades provides an opportunity for developing economies to focus on the services sector rather than on low-skill and labour-intensive manufacturing. A more neutral view is espoused by Dasgupta and Singh (2006, pp.16) who argue that premature deindustrialisation “is not necessarily a pathological phenomenon [and] it could be [either] benign or advantageous”.

2.1.3 Overview of Indian Economy Since Independence

India embarked on an ambitious state-led model of industrialisation after its independence in 1947 from the British rule, with the first five-year plan initiated in 1951. The experiences of colonisation, which ensured that industrial development remained subservient to colonial interests, had a strong imprint on economic policymaking during the initial years of independence (Rao, 1994, pp.162; Menon, 2022, pp.2). The approach of state planning and the success of industrialisation in the Soviet Union was appealing to the new rulers. The initial five-year plans (precisely from the second plan in 1956) focused on developing the industrial base of the economy with a heavy emphasis on large public sector units to undertake the task of capital goods manufacturing. The goal was “to rebuild rural India, [and] to lay the foundations of industrial progress” (Planning Commission of India, 1956, n.p). Agriculture received significant attention in the first plan in which around 45% of the total plan outlay was allocated to Agriculture & Community Development and Irrigation & Power. Despite “insufficient” allocation towards industries, the first plan called “for further expansion of basic industries, including manufacture of heavy electrical equipment and fertilisers, and for increased transport facilities required for industry and mineral development" (Planning Commission of India, 1952, n.p). However, with the second five-year plan onwards there was a reduced allocation towards irrigation, to around 8 to 10% of the plan outlay, compared to 20% in the first plan - this shift Ramakumar (2010, pp.46) argues led to the slow growth of the area of cultivation under irrigation.

These initial policies provided a structural break for the economy, growing at an average of 3.5% p.a, during the three decades since 1950, an increase from the 0.5% growth during the five decades prior to independence in 1947 (Papola, 2012). However, the growth rate decelerated since the mid-1960s, only to increase impressively beginning from early 1980s, at an average of more than 5% (Papola 2012). Another important development since the mid-1960s was the introduction of high-yielding variety (HYV) seeds and an improvement in the fertiliser technology, commonly referred to as the period of Green Revolution in India, which was prompted by the spiralling food insecurity (Ramakumar, 2010; Vakulabharanam & Motiram, 2011). This generated a significant increase in agricultural output and productivity (Bhalla, 2007 cited in Ghosh, 2010). Despite these crucial interventions, the pre-reform period was witness to a policy bias against agriculture in favour of capital-intensive manufacturing (Rao, 1994, pp.128-129).

The 1980s witnessed the initiation of liberalisation reforms with the "modernisation of the production structure with a step up in infrastructure, de-licensing of investment and output controls, and a shift in trade policy from quotas to tariff" (Nagaraj, 2011, pp.419). This period also saw: the industrial sector emerge as a top performer; a noteworthy improvement in the export of manufactures; and a high growth in agriculture (Nagaraj, 2011; Ghosh, 2010). However, this growth momentum could not be sustained. By 1980s, there emerged several critics of India's state-led model of development and argued that the economy's growth potential could only be harnessed if it is fully 'opened up' (Desai & Bhagwati, 1975; Srinivasan, 1987). It was argued that public enterprises were ineffective, and that the state control of the industrial sector in the form of the licence permit system was dampening the prospects of a robust industrial development. The "liquidity crisis in 1991" owing to the rising cost of oil imports due to the Gulf War and the collapse of USSR led the government to approach the International Monetary Fund (IMF) for credit, with its associated conditionalities (Nagaraj, 2011, pp.419). The reforms of 1991 were expected to usher in an era of “animal spirits” of capital, in the words of the then Finance Minister, Manmohan Singh. These Structural Adjustment Policies continued to be expanded in breadth and scope since 1991. These policies entailed: *firstly,* removal of compulsory licensing, investment, trade, and production controls; *secondly,* a drastic reduction of public expenditures; *thirdly,* privatisation and disinvestment of public sector companies; *fourthly,* opening up of different sectors for foreign direct investments (Nagaraj, 2011; Ramakumar, 2008).

The reform period was not characterised by any uniform trends in growth of the economy. While the growth in 90s was not higher than the 80s, the period from late 90s to 2004 witnessed a deceleration (Papola 2012). However, the subsequent five years, until 2009-10, registered the highest growth rates of the economy till date, growing at around 8 to 9% (Papola, 2012). Nonetheless, this period also witnessed a severe slowdown in employment generation with several economists coming to characterise it as a phase of ‘jobless growth’ (Kannan & Raveendran, 2009; Thomas, 2012; Papola, 2013). The reform period did not witness a turnaround in the prospects for improving manufacturing and industrial shares in output and employment (Ghose 2020). Despite this sluggish performance, there was however no dearth of policy emphasis to rejuvenate the sector - focus on the sector continues to remain a key political agenda. The National Manufacturing Policy introduced in 2011 under the United Progressive Alliance Government (2004-2014), and the Make in India project introduced in 2014 by National Democratic Alliance (2014-present), have similar objectives: to improve the share of manufacturing output to around 25% and to generate large-scale employment opportunities in the sector. However, shares of manufacturing value-added and employment have remained stagnant (Erunbam, Das, Aggarwal & Das, 2019; Ghose, 2020). Furthermore, as Mehrotra and Parida (2019) point out, there were job losses in manufacturing to the tune of 3.4 million between 2011-12 and 2017-18.

The reform period hurt the agrarian sector the most and the agrarian crisis in recent years has come to dominate the socio-political milieu of the country. The recently concluded farmers’ protest which continued for around a year is a testimony to the growing distress among the farmers with the policy approach of the state (Mashal, Schmall & Goldman, 2021). According to the data compiled by Talule (2020), more than 300,000 million farmers have died by suicide during the last two decades in India - with indebtedness, low yield and unforeseen climatic disruptions as some of the major reasons (Shetty, 2010; Reddy & Mishra, 2010) The withdrawal of state support - in the form of cheap credit, infrastructural support, minimum price guarantee (Ramakumar, 2010 & 2008) - with the onset of reforms pushed the farmers into greater distress adding to a downward pressure on the agricultural wages as well (Vakulabharanam & Motiram, 2011, pp.102). Two issues emerge from the above trends - *firstly*, the lacklustre performance of manufacturing and industry across both pre- and post-reform periods with its resultant stagnation; *secondly*, the underperformance in agriculture and the intensification of the crisis since reforms.

2.1.4 Explanations for Stagnant Industrialisation in India

As was the case with other newly developing economies, India too was witness to a sluggish performance of manufacturing and industrial sectors in terms of output and employment shares over the entire post-independence period (Rodrik, 2016; Chandrasekhar, 2018; Aggarwal, 2018; Ghose, 2020). A range of explanations have been offered, from the poor agrarian performance to the stringency of labour regulations, to account for slow growth of industrial sector (manufacturing in particular).

Some studies have identified the lack of demand from the primary sector for industrial output acting as a drag on the latter's development and its sluggish growth over the years (Nayyar, 1978; Rao, 1994, pp.162-163; Storm, 1995; Nagraj, 2011; Bhattacharyya, Abraham & D'Costa, 2013). Such a situation, they argue, was a result of the state pursuing industrialisation without an agricultural revolution involving productivity gains - as a result industrialisation was not driven by agricultural demand. Nagraj (2011) contends that public investments enhance productivity in agriculture which in turn has the capacity to generate demand for industrial goods. Bhattacharyya, Abraham and D'Costa (2013) further argues that post-independence industrialisation in India was driven by demand from urban middle classes which was largely in consumption of luxury goods and not wage goods. As such the production of these goods for middle classes was highly capital intensive, which was not suitable for absorbing the rural populace moving out of agriculture. And since industrial production has favoured the relatively smaller urban middle class at the cost of a large rural population, demand constraints emerged.

The lack of large-scale labour-intensive manufacturing in India meant that the bulk of workers moving out of agriculture could not be employed in these industries. Therefore, some studies have argued that despite liberalisation, the labour market regulations in India are stringent, which hinders private investments in manufacturing (World Bank, 2008; Panagariya, 2008, pp.287-293; Erunbam et al., 2019; Krueger, 2009). The argument is that Indian labour laws are discriminatory to large firms which forces these them to keep their regular/permanent workforce below a certain threshold to avoid labour regulations (Ramaswamy, 2013). The firms then resort to casual/contract workers to supplement their workforce. This perspective places the blame for lack of growth of manufacturing employment on the stringency of labour laws. However, studies have dismissed these arguments and have shown that implementation of labour regulations have been extremely lax in the post-reform period - with several inbuilt gaps and loopholes that would make them flexible - and that many state governments have over the years brought in provisions that could legally bypass the national regulations (Nagaraj, 2004; Sharma, 2006; Goldar, 2011; Sood, Nath & Ghosh, 2014).

Kapoor (2015), in attempting to explain the lack of labour absorption by manufacturing, finds that growth of manufacturing industries in the reform period was restricted to those large firms which could employ high-skilled workers. This coupled with an increased capital intensity in organised manufacturing in India generated low employment prospects for the sector. Corroborating this view, Kannan and Raveendran (2009) observe that during the period 1981 to 2005, largely corresponding to the reform period, the growth in manufacturing value added was not commensurate to its employment growth - while value added grew at faster pace at an average of 7% p.a, employment grew only marginally at 0.8%. Chaudhuri (2013) notes that in the reform period there was a change in the type of capital goods consumed (such as airline and telecommunication equipment), with little accompanying improvement in their domestic manufacturing capability. This he argues increased the dependence on imports and widened the manufacturing trade deficit. Falling public investments towards infrastructure and the consequent infrastructural deficit over the years are also argued to have caused the slow growth of industries (Nagraj, 2011).

2.2 Theoretical Approach

Our approach disagrees with the argument that labour market rigidities were responsible for the manufacturing sector's poor performance as it is insufficient. As noted above, there is compelling evidence that argues that reform-period was witness to significant laxities in the implementation of labour regulations and that the changes in the regional-level regulations effectively bypassed any remaining stringent national-level laws. Furthermore, labour market rigidities' perspective cannot explain why manufacturing value-added has also remained substantially lower, despite several pro-market reforms and supply-side changes that were introduced since 1991. This suggests that there are other more structural aspects that could be impacting the growth of both manufacturing output and employment.

Therefore, our overarching approach is that the crucial role of agriculture in industrialisation and structural transformation is materialised if there is sufficient policy attention to modernise agriculture, improve its productivity and increase rural incomes - as largely derived from the works of Johnston and Mellor (1961) and Timmer (1988 & 2016). Furthermore, this study will draw upon the theoretical works of demand linkages from agriculture to industry in the Indian context (Nayyar, 1978; Ahluwalia & Rangarajan, 1989; Rao, 1994; Nagraj, 2011; Bhattacharyya, Abraham & D'Costa, 2013).

Pertaining to the debates on structural change, we align with the viewpoint that conventional/classical pattern of structural transformation is essential for India, and that the unconventional pattern (i.e services-led at an early stage) that was noted is unsustainable. The significance of conventional structural change is evident in Rodrik (2011 & 2013) - who finds that developing the organised manufacturing sector holds possibilities of unconditional convergence for low-income countries. For this, he argues that these economies should pursue policies aimed at structural transformation towards industrialisation and manufacturing-led growth - involving active state interventions like the ones that manifested in the East Asian economies. This finding holds significant policy potential, particularly due to lack of evidence for unconditional convergences in the vast body of literature on cross-country regressions (see Pritchett, 1997 and Rodrik, 2014 for discussion on this). Furthermore, the services-led growth in India is generating a “dualism” with the presence of both high- and low-productive subsectors, with the latter employing a significantly higher proportion of the workforce (Aggarwal, 2012). Such a structural change is not ideal as workers are moving from one low productive sector (farming) to another low productive sector (low productive services), with little improvement in the quality of work.

The literature review presented four broad theoretical debates: *firstly*, the one which discussed the role of agriculture in development particularly for those countries which are “catching-up”; *secondly*, the nature of structural transformation process of developing economies; *thirdly*, the changes in Indian economy since independence; *fourthly*, some explanations for the stagnant industrial development in India.

Although the explanation that poor agricultural performance could be acting as a drag on Indian industrial development is not completely new, there have been fewer attempts in the literature to provide a quantitative basis to such perspectives. Furthermore, these studies which have identified these issues linking agriculture and industry, have largely been confined to the pre-reform period. The massive scale of the liberalisation reforms of the mid-1980s and early 1990s, and the consequent changes to these sectoral linkages have not been studied extensively.

3 Methods

This thesis incorporates a combination of four quantitative approaches to address the research questions. *Firstly*, we use descriptive statistics to examine the long-term trends in growth, productivity and structural change in India. These trends are then discussed in light some existing analytical debates concerning premature deindustrialisation and the implications of a services-led growth. *Secondly*, to analyse the changes in inter-sectoral linkages over the years, we calculate Sectoral Input-Output (I-O) Matrices for India from 1965 to 2014. *Thirdly*, to evaluate the association between agricultural and industrial performance, we perform a series of Ordinary Least Square (OLS) regressions. *Lastly*, we rely on a literature survey to identify the policy implications to improve agricultural productivity.

The approach to answer the research questions requires us to make critical distinctions between the different productive sectors within the broader three-sector classification. For instance, for the industrial sector, we make a distinction between manufacturing industries and the industrial sector as a whole. By doing so, as explained in latter sections in detail, we find that although there was a marginal increase in the share of value-added and employment for industrial sector in the post-reform period (i.e since late 1990s and early 2000s), it was mostly driven by non-manufacturing industries such as construction (see section 5.1.1 for more discussion). The distinction becomes essential as it allows us to examine manufacturing industries alone - the development of which is argued to offer a sustained path of structural change with possibilities of formal and high-productivity jobs for those moving out of agriculture (Rodrik 2013; Ghose 2015). Furthermore, as Ghose (2020) argues, the manufacturing sector's productivity gains are usually faster than the other sectors of the economy, making it an ideal development phase after agriculture-led growth. Therefore, by not disaggregating the industrial sector to capture manufacturing industries would provide only partial insights into the process of structural transformation. So, henceforth in this thesis, we include manufacturing as a separate category alongside industry.

3.1 Input-Output Matrices

I-O tables are quantitative depictions of the inter-sectoral/inter-industry/inter-commodity dependencies in an economy by linking the output of a sector with the inputs of the other sectors. These models, as depicted in Table 3.1 were first developed by Wassily Leontief (1936), who won the Nobel Prize in Economic Sciences for the same. The column values in the table correspond to the values of intermediate consumption of a sector 'i' (along rows) from other sectors 'j' (along the columns) including its own. The row values correspond to the final uses of the output of the sector across other sectors. While the rows present the value-added approach to measuring the gross output of the economy, the summation of columns correspond to the expenditure approach. As such, the total output along the rows and columns, corresponding to each sector, should match.

X is a vector of sectoral outputs, with X_j obtained by summing the row values along a column 'j' and X_i obtained by summing the column values along a row 'i'. For instance, the output of sector 1 i.e X_1 can be obtained by summing the values of inputs or supplies to sector 1 from sectors 1, 2 and n with that of the value added by sector 1. Or it can be derived by summing the values of intermediate consumption of sector 1's goods by sectors 1, 2 and n with the net final demand for sector 1's goods. This can be summarised as below:

$$\boldsymbol{X_j = \sum_{i=1}^{n} F_{ij} + V_i} \qquad \text{(or)} \qquad \boldsymbol{X_i = \sum_{j=1}^{n} F_{ij} + Y_i}$$

Table 3.1: Sample I-O Matrix

Supply from ith industry	**Intermediate consumption in jth industry**			**Net Final Demand**	**Total Output**
	Sector 1	**Sector 2**	**Sector n**		
Sector 1	F_{11}	F_{12}	F_{1n}	Y_1	X_1
Sector 2	F_{21}	F_{22}	F_{2n}	Y_2	X_2
Sector n	F_{n1}	F_{n1}	F_{nn}	Y_n	X_n
Value-Added	V_1	V_2	V_n		
Value of Output	X_1	X_2	X_n		

Source: Author's elaboration from Singh and Saluja (2016).
Note: Net Final Demand comprises private final consumption, net exports, gross capital formation etc.

This I-O table can be further transformed to compute Sectoral Share (or Coefficient) Matrices (or Production Linkage Matrices) and Leontief Inverse Matrices (or Demand Linkage Matrices). The production linkage matrices give the share of inputs of an ‘i’ sector in the total output of a ‘j’ sector. This can be computed by dividing each F_{ij} value (as shown below) with the corresponding column output value, X_j for the j[th] sector (Singh & Saluja, 2016). The resultant matrix (A), with ‘a_{ij}’ coefficients, is the sectoral share matrix. For instance, a_{12} is the value of inputs required from sector 1 to produce one unit of output in sector 2.

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{1n} \\ a_{21} & a_{22} & a_{2n} \\ a_{n1} & a_{n2} & a_{nn} \end{bmatrix}; \text{ where, } a_{ij} = \frac{F_{ij}}{X_j}$$

The inverse of this coefficient matrix (A) subtracted from an identity matrix (I) is called the Leontief Inverse Matrix $(I\text{-}A)^{-1}$. This matrix presents the demand linkages across sectors in an economy. This can be derived as follows: since ‘X’ is vector of all the sectoral outputs, multiplying it with the matrix of sectoral input coefficients (A) and summing it with the vector of net final consumption expenditure (Y), will give us ‘X’, output vector. Then to solve for ‘X’, we need to multiply $(I\text{-}A)^{-1}$ with ‘Y’.

$$\begin{bmatrix} X_1 \\ X_2 \\ X_n \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{1n} \\ a_{21} & a_{22} & a_{2n} \\ a_{n1} & a_{n2} & a_{nn} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_n \end{bmatrix} + \begin{bmatrix} Y_1 \\ Y_2 \\ Y_n \end{bmatrix} \text{, where X = } \begin{bmatrix} X_1 \\ X_2 \\ X_n \end{bmatrix}\text{; Y = } \begin{bmatrix} Y_1 \\ Y_2 \\ Y_n \end{bmatrix} \text{ and A=} \begin{bmatrix} a_{11} & a_{12} & a_{1n} \\ a_{21} & a_{22} & a_{2n} \\ a_{n1} & a_{n2} & a_{nn} \end{bmatrix}$$

The same can be summarised as: $X = (I - A)^{-1}\,Y$

3.2 OLS Model

For OLS regression, agricultural productivity, capital formation and growth along with a set of control variables would be incorporated as independent variables. Studies have argued that increasing agricultural productivity is essential for generating a sustainable structural change and be the basis for industrialisation (Johnston & Mellor, 1961; Timmer, 2016; Nagraj, 2011). The logarithmic values of agricultural productivity are used. Capital formation in agriculture (ACF) is indicative of the investments made in the sector. Fixed capital formation is a better proxy for our analysis, as it concerns with investments in physical assets, which for farming, can be produced industrially. However, since its data is not available for our entire time-period, we had to use gross capital formation as a proxy. ACF is the aggregate of physical assets used in the production for that year and the already existing stock of inventories (Golait & Lokare, 2008). Therefore, an increase in the capital formation indicates both higher investments, and higher consumption of physical assets. ACF is used as a proportion of agricultural GDP (AGDP).

Industrial performance and degree of structural change would be used as dependent variables. Industrial performance will be captured using productivity and growth rates. A disaggregated analysis with manufacturing industries performance as dependent variable will also be conducted. To capture the degree of structural change, we propose to use the ratio of agriculture's and industry's employment and value added. As such this research will restrict itself to the relative development of industries and manufacturing to capture structural transformation. Industrial capital formation and trade openness will also be controlled to avoid any omitted variable bias. Trade Openness is measured as the proportion of total trade (sum of imports and exports) in Gross Domestic Product (GDP). Industrial capital formation (ICF) is taken as the proportion of Industrial GDP (IGDP). Manufacturing Capital Formation (MCF) is taken as a proportion of Manufacturing GDP (MGDP)The empirical results of these regressions would only provide correlations and not causal links between agriculture and industry. Therefore, the findings from the empirical estimations will be discussed in the light of some of the theoretical and analytical works on the inter-sectoral linkages between agriculture and industry. The details of the variables used in the models are summarised in Table A.1 in Appendix A.

The model can be summarised as below:

$$structural\_change_t = \beta_{1t} + \beta_2 log\_agricultural\_productivity_t + \beta_3 (\frac{ACF}{AGDP})_t + \beta_4 CV_t + \varepsilon_t$$

$$industrial\_performance_t = \beta_{1t} + \beta_2 log\_agricultural\_productivity_t + \beta_3 (\frac{ACF}{AGDP})_t + \beta_4 CV_t + \varepsilon_t$$

Here structural change can be either the ratio of value-added of industry (or manufacturing) and agriculture, or the ratio of employment in industry (or manufacturing) and agriculture. Industrial (or manufacturing) performance is either the logarithmic values of productivity, or growth rate in value-added. '*CV*' is the set of covariates, as discussed above. ε_t is the unobserved error term. *'t'* captures the year.

4 Data

For the Input-Output (I-O) analysis, we use two datasets from Groningen Growth and Development Centre (GGDC). *Firstly*, the Long Run World Input Output Tables (WIOT), Version 1.1 for 1965 to 2000 (Woltjer, Gouma & Timmer, 2021). *Secondly*, the National Input Output Tables (NIOT) from the World Input Output Tables 2016 release for 2000 to 2014 (Timmer, Dietzenbacher, Los, Stehrer and de Vries, 2015). Since GGDC data is only until 2014, we use Asian Development Bank's (ADB) I-O data for 2015 and 2017 (Asian Development Bank (ADB), 2018). GGDC and ADB I-O databases are not three disaggregation. For instance, GGDC's I-O data for 1965-2000 presents I-O information for 23 broad sectors based International Standard Industrial Classification (ISIC) Revision 3. While the data for 2000-2014 is based on ISIC Rev. 4 and has 56 sectors. We aggregated these into four sectors – Agriculture, Industry, Manufacturing and Services. The sectoral composition is discussed in detail in Appendix A.1. Some previous I-O analyses for India have used the official I-O matrices released by the Ministry of Statistics and Programme Implementation of the Government of India (MoSPI) (eg: Ahluwalia & Rangarajan, 1989; Sastry, Singh, Bhattacharya & Unnikrishnan, 2003; Munjal, 2007; Kaur, Bordoloi & Rajesh, 2009). These tables were released for every five-year period from 1968-69 to 2007-08. Since 2007-08, only Supply-Use tables have been released and not I-O tables. Nonetheless, this thesis uses the GGDC I-O Tables, which are available continuously from 1965 to 2014, thereby allowing us to compare the changes in the inter-sectoral linkages across a longer period. Furthermore, the official I-O tables prior to 1993-94 are not available to access from the MoSPI website. For these reasons we prefer GGDC's I-O tables.

To capture the structural changes in the economy, we use the Economic Transformation Database (ETD) and the Ten Sector Database (TSD) from GGDC (de Vries, Arfelt, Drees, Godemann, Hamilton, Jessen-Thiesen, Kaya, Kruse, Mensah, & Woltjer, 2021; Timmer, de Vries, & de Vries, 2015). Both these databases provide sectoral disaggregation for gross value added and total persons engaged. ETD is available for the years 1990 to 2018 and is based on ISIC Revision 4 with data pertaining to 12 sectors of the economy. However, the data for employment is available only for 11 sectors for India (employment data for the Real Estate sector is not available). TSD, which follows the ISIC Revision 3.1, has data for ten broad sectors on value-added for 1950 to 2010 and on employment for 1960 to 2010 for India. Due to the classification differences and the changes in the National Accounts (such as change in base year for India), there are differences in the values for the overlapping years (1990 to 2012) between the two databases (as can be seen between Tables A.3 and A.4 in Appendix A). Notwithstanding this issue, the strength of GGDC data, as pointed out by Sen (2019) is that it computes the sectoral employment using population census, and then supplements the same through periodic surveys for annual estimates. By doing so, informal employment will also get captured. Furthermore, Sen (2019) argues that GGDC data is more consistent than the databases such as ILOSTAT which present employment data directly from the source without consistency checks. Lastly, GGDC datasets provide consistent data across a long-time period, which is not the case with the official databases released by MoSPI.

As there are differences in data between the datasets for the overlapping years, we do not combine the two datasets, but instead present the graphs separately. However, OLS regressions are restricted for 1950-2012 or 1960-2010 to maintain consistency. The dependent variables and the main independent variables for the OLS regressions are computed from the GGDC's TSD. Since employment data is available only from 1960, our productivity calculations are also from that year. The data for control variables are computed from Economic and Political Weekly Research Foundation's (EPWRF) India Time Series Database. EPWRF Database obtains the corresponding data from MoSPI. Therefore, all the control variables are based on officially released National Accounts Statistics. The table A.2 (Appendix A) provides a summary of all the variables used in this study.

5 Empirical Analysis

5.1 Long Run Sectoral Trends in Structural Transformation and Growth

5.1.1 India's Structural Transformation

The share of agriculture in total value-added has witnessed a steady decline over the years (Fig. 5.1&5.2) The share of services which was well below 40% prior to the 1990s, witnessed a sustained increase, in the post-reform phase, to more than 50% in recent years. The share of industries was below 30% during the entire period, except for brief period between 2005 to 2013 (Fig. 5.2). The share of manufacturing industries had never increased to a significant extent and had remained below 20%. Since 2010, there was a marginal, albeit steady, decline in the shares of industry and manufacturing.

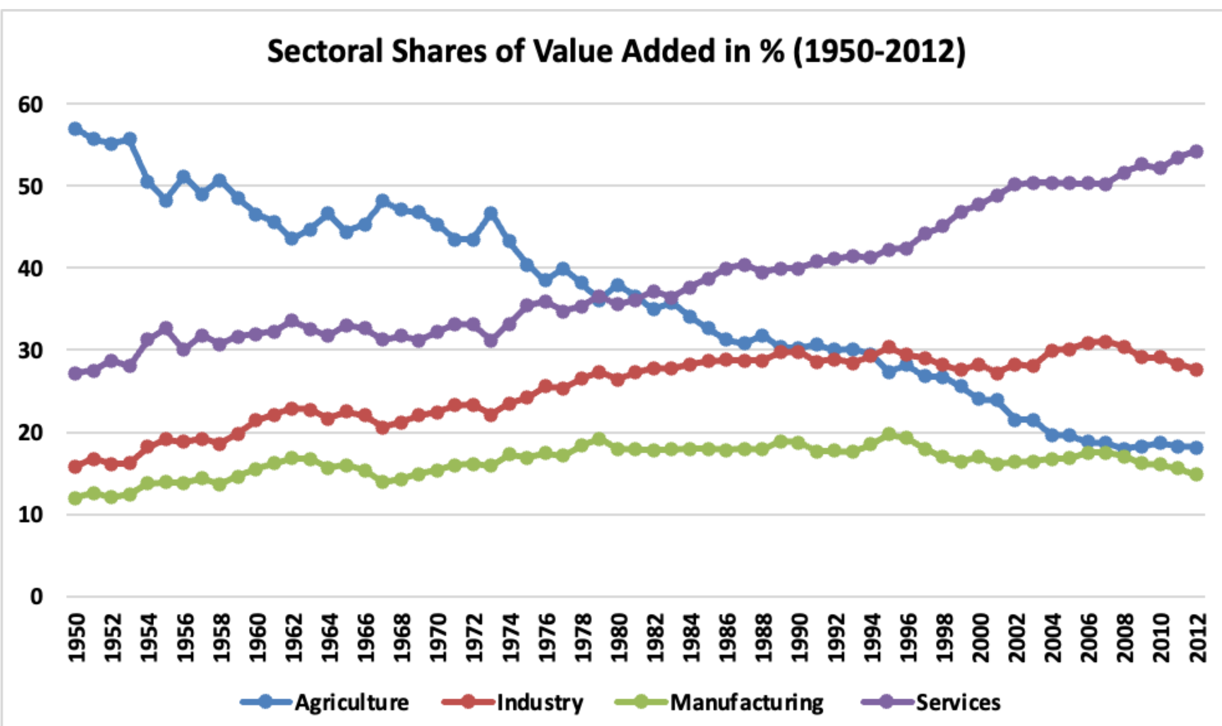

Figure 5.1: Sectoral Shares of Value-Added in India, 1950-2012.

Source: Author's calculations from GGDC's TSD. Note: Industry's share is inclusive of Manufacturing. However, since we are concerned with manufacturing performance as well, we express both.

Agriculture continues to contribute more or less the same as manufacturing to the economy, while it was not until mid-1990s that Industry contributed more than agriculture (Fig 5.1&5.2). The increase in manufacturing and industry's share largely occurred in the pre-reform period (prior to 1991). Their shares have either remained stagnant or declined in the aftermath of reform. On the other hand, services' share rose, and agriculture's share declined rapidly since 1990. A closer look at services and agriculture graphs since 1993 (when they intersect) shows that the decline in agriculture was equal to the increase in services, while industry stagnated. This suggests that structural shift, in terms of value-added, involved a transition from agricultural economy to a service based one. This presents a curious case as it runs contrary to structural transformation of currently developed economies of the West and late developers of East Asia including China (Ghose, 2020). and is similar to the pattern in other developing economies, observed by Rodrik (2016) and Sen (2019).

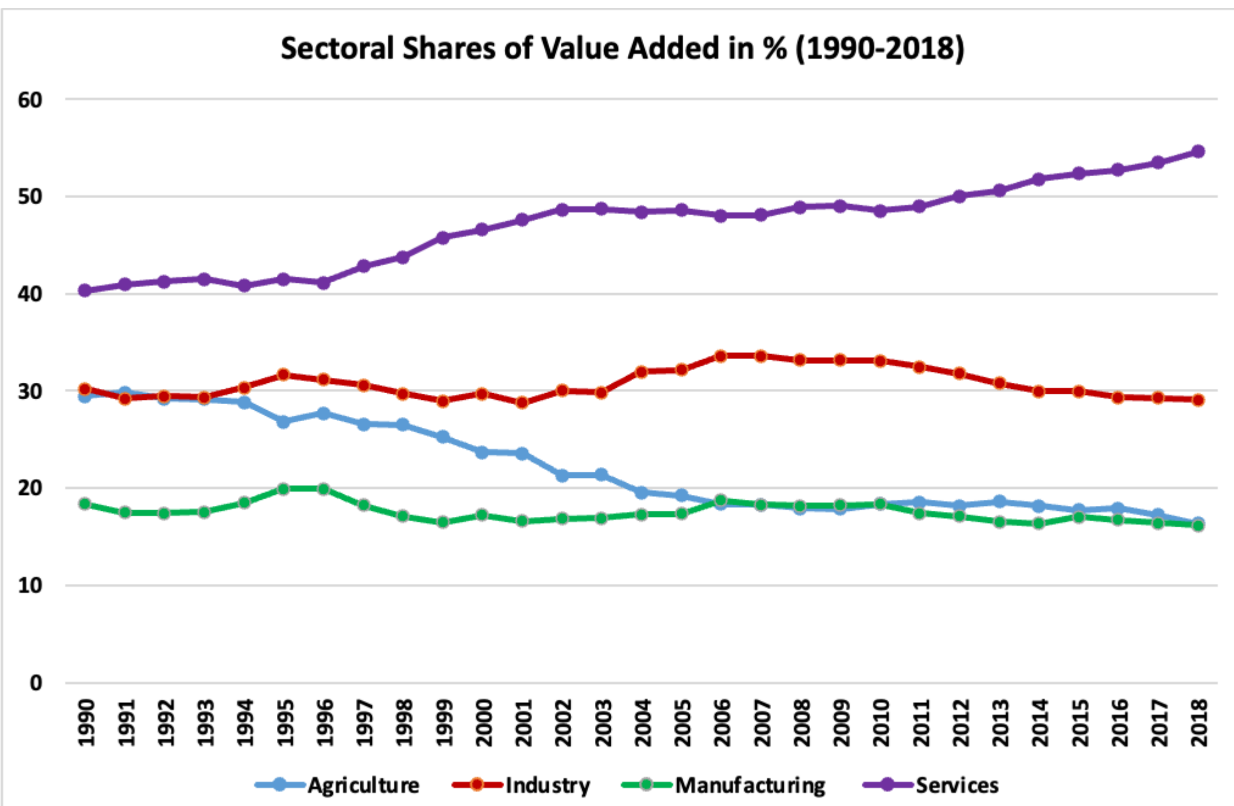

Figure 5.2: Sectoral Shares of Value-Added in India, 1990-2018.

Source: Author's calculations from GGDC's ETD.

Figures 5.3 and 5.4, provides the sectoral shares of employment between 1960-2010 and 1990-2018 respectively. Although there are differences in the shares pertaining to the overlapping period (1990-2012), the trend remains consistent across both the graphs. Post the reforms, there was a steep decline in agriculture's share of employment, accompanied by a steady increase in shares of services and industries. Unlike, value-added shares, employment shares of manufacturing and industry have remained stagnant in the period prior to reforms. It was only in the post-reform period that industry's shares started to increase, although manufacturing's continued to remain stagnant. The increase in share of industrial employment was almost exclusively on account of non-manufacturing industries i.e construction. Manufacturing employment had stagnated just around 10% during the entire period. These trends suggest that prior to reforms, labour reallocation was negligent – the shares of all the three sectors have remained strikingly stagnant prior to early 1990s. Furthermore, the reform period was witness to workers moving out of agriculture into services and construction. Much of the increase in services is in trade (Fig. 5.3 & 5.4)

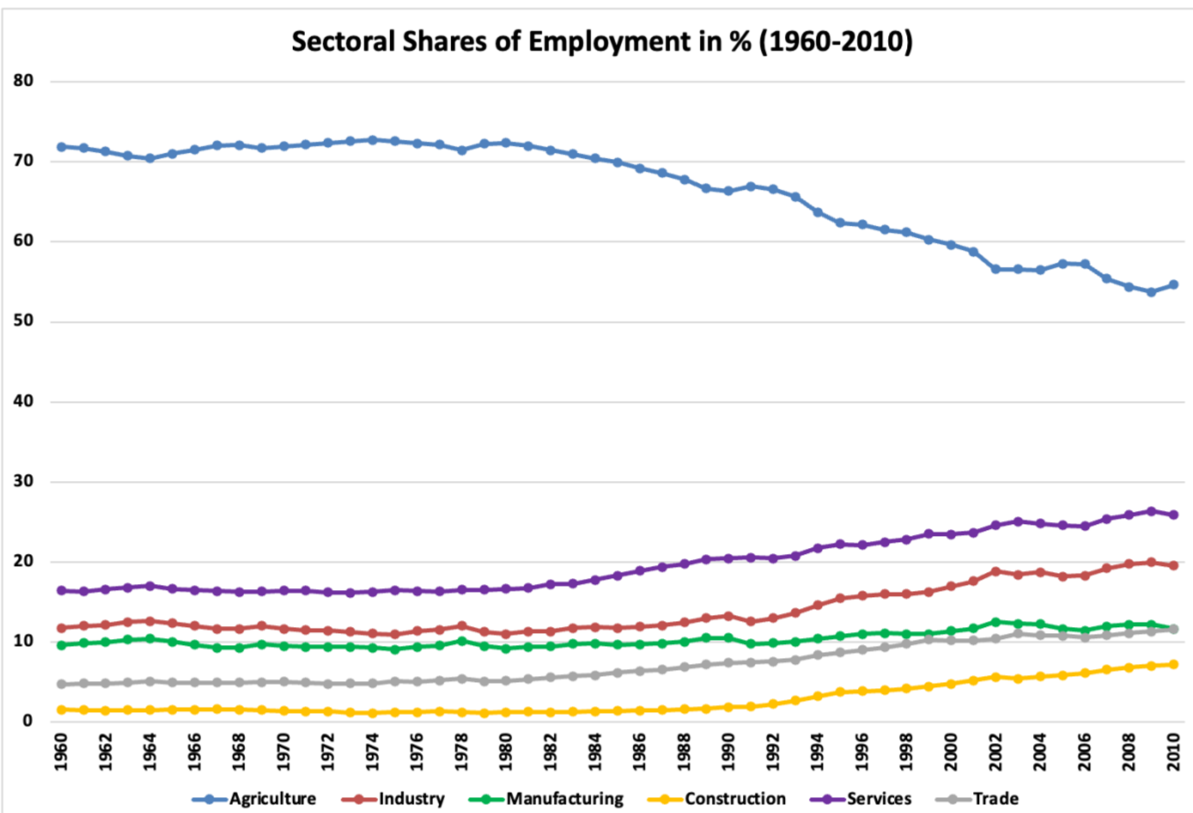

Figure 5.3: Sectoral Shares of Employment in India during 1960-2010.

Source: Author's calculations from GGDC's TSD. Note: Industry's share is inclusive of Manufacturing and Construction. While Trade is included in Services.

It is important now to synthesise both the value-added and employment trends based on a periodic analysis. As discussed in Section 2.1.3, India recorded an impressive industrial performance during 1950 to 1965 - public investments in intermediate goods industries aided in the development of capital inputs; the growth in public expenditure ensured that there was a growing aggregate demand to consume the manufactured output from the private industry (Nayyar, 1978). Value-added in industry and manufacturing grew at around 6% on average (Table 5.1). This impressive performance could also be gauged from the marginal, albeit steady, increase in value-added shares during 1950-65 (Fig. 5.1). Contrastingly, the employment shares, did not register any notable increase (Fig. 5.3) – however, this is hardly surprising as industrial policy during the first three plans (until 1965) was largely focused on heavy, capital and some intermediate goods industries (Nayyar, 1978).

From the mid-60s, Nayyar argues that, both the demand constraints due to decelerated public expenditure and the poor agricultural growth had an adverse impact on industrial performance. The growth in industry and manufacturing during 1966-80 decelerated (nearly halved and grew at around 3 to 4%) compared to the high of 6% in the three five-year periods ending 1965 (Table 5.1). Nonetheless, this period saw a slow increase in manufacturing and industry's share of value added, as agriculture's share continued to decline rapidly.

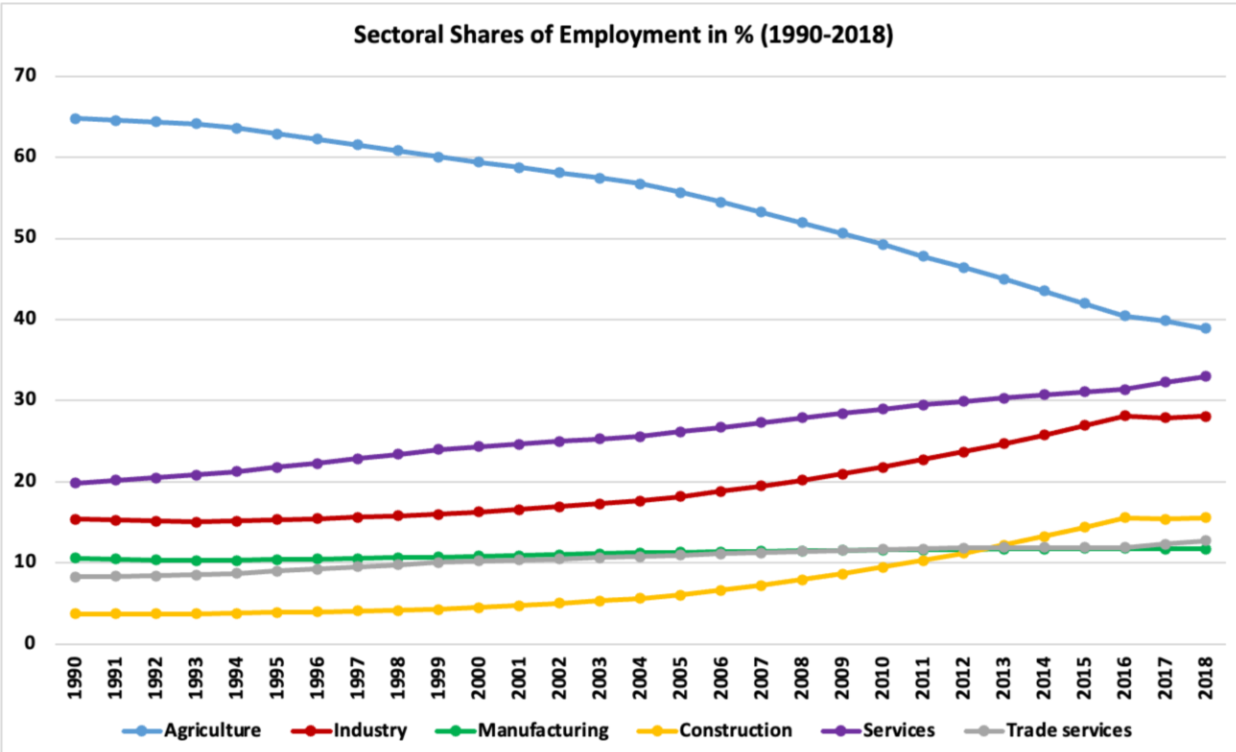

Figure 5.4: Sectoral Shares of Employment in India, 1990-2018

Source: Author's calculations from GGDC's ETD.

The crucial development in the post-reform period has been the increase in the employment shares of non-manufacturing industries (construction) and services. However, as discussed below, such a pattern signals an improper structural change which could become unsustainable (Ghose, 2015). *Firstly*, the increase in industry's share was entirely due to the boom in the construction sector. The stagnation of industry's share during 2016-18 was also due to the stagnation of the construction sector's share. The shares of employment in the construction sector are presented in the Appendix - Tables A.3 and A.4 (corresponding to Figures 5.3 and 5.4 respectively). That there was a steady decline in the share of agricultural employment only since mid to late-1980s, coinciding with the initiation of reforms, with an overall decline of 17.74 percentage points between 1980-2010 (Table A.3). At the same time, the share of industry and services increased by 8.53 and 9.22 points. However, of 8.53 points pertaining to industry, nearly 6 points accrued to the construction sector alone, with only 2.47 points corresponding to manufacturing. *Secondly*, of the

9.22-point increase in services share, 6.46 points belonged to the “trade, restaurants and hotels” services, and 2.34 points for the “transport, storage and communication” services.

The labour reallocation during 1990-2010 from agriculture was even more concentrated towards trade services and construction compared to 1980-2010 – 81% (or 9.5 percent point) of the decline in agriculture went to trade services and construction. Only 9% of the 11.7-point decline in agriculture’s share corresponds to manufacturing. Table A.4 confirms these trends even in the extended period between 1990-2018. The decline in agriculture’s employment share is accompanied by a greater increase in the share of construction sector employment (amongst industries) and in trade services (amongst services sectors). The workers moving out of agriculture, therefore, are being absorbed into low-productive and informal sectors. These trends indicate that India is witnessing a transformation away from agriculture but bypassing the phase of manufacturing, corroborating the findings of other studies (such as Binswanger-Mkhize, 2013; Sen, 2014; Aggarwal, 2018; Majid, 2019; Ghose, 2020). However, we do not completely agree with Binswanger-Mkhize (2013) who argued that workers are moving out of agriculture into rural non-farm sector jobs. We find that workers are moving from agriculture towards informal jobs such as those in construction, trade, and other informal services.

This movement towards construction and services poses several questions and appears to be unsustainable. For instance, Aggarwal (2012) argues that there is growing “dualism” in India’s services sector - the coexistence of the high-value added services which employ a fraction of the total services employment and the low-value added services which employ a large portion of service sector workers. The workers who are relocated to low productive urban informal services work for low wages and under precarious working conditions (Mehrotra & Parida, 2019). They estimate that the share of informal workers was 90.7% and 83.5% in industry and services. A study also found that the structural change towards services is largely concentrated in the urban areas with little benefit to the rural population (Unni & Naik, 2011). They argue that employment growth in the two decades of reforms in high-productive services sectors such as information technology, communications, finance and business services have not been particularly useful for the rural workers. The skill intensive nature of these jobs could be one major deterrent as these high-productive services sectors were able to absorb only the “well educated, urban middle- and upperclass youth but are unable to draw in the masses of our people" (Aggarwal, 2012, pp.122). The potential of these productive services sectors to absorb the bulk of the workers moving out of agriculture has been inadequate (Thomas, 2012; Ghose, 2020; Erunbam et al., 2019). As noted above, the construction sector, which emerged as the largest industrial sector employer, is dominated by informal and casual workers with unwritten daily wage contracts (Chandrasekhar & Ghosh, 2015). It appears that even this boom in construction employment is running out of steam – in the last three years construction employment share had plateaued around 15%, along with industry (Figure 5.4). Its potential to absorb unskilled and semi-skilled rural workforce has been declining over the last few years due to greater mechanisation and the slowdown of its output growth (Chandrasekhar & Ghosh, 2015). Abraham (2017) finds that the construction sector had a job loss of 4.2 million during 2014 to 2016. Furthermore, Erunbam et al. (2019) show that productivity growth in construction is significantly lower than manufacturing, and the growth in its average wage rate was slower than compared to agriculture. The ratio of construction to agricultural wage rates nearly halved from 1980 to 2011. From the foregoing discussion, therefore, it is evident that a more sustainable path of structural change is essential. The record of previous developers and other cross-country evidence suggests that the key is to develop manufacturing (Rodrik, 2013; Ghose, 2013).

To summarise the trends, industry/manufacturing value-added shares have not increased substantially since independence. While there have been short periods of marginal increases, there was never a sustained increase for both. Even a marginal decline in their shares can be discerned in the last decade. Agriculture's value-added share declined in the post-reform period and services' share rose rapidly. With regards to employment shares, services and construction sectors emerged as the key absorbers of workers moving away from agriculture. Although, there has been an increase in industrial employment share in the reform period, it was mostly concentrated in construction. Manufacturing employment has stagnated in the entirety of the post-independence period. Agricultural employment share has been declining in the post-reform period, but not at the pace with which its value-added has declined. Despite having around 40% of employment, agriculture accounts for less than 20% of value-added - implying low productivity. While industry share in neither output nor employment had surpassed the other two sectors at any given year, services has emerged as the dominant sector in terms of value-added share. Services now accounts for 50% of the output with just above 30% of employment. While that corresponds to high productivity for the sector as a whole, services is still marred by severe productivity differences among its subsectors (Aggarwal, 2012).

5.1.2 Trends in Sectoral Growth and Productivity

This sub-section examines the trends in sectoral growth and productivity. Table 5.1 presents the average of annual growth rates of value added and value-added per worker/productivity for five-year periods starting from 1951. The growth of agriculture value-added has remained lower than those of the other sectors across all the time periods except for 1966-70, when it emerged as the sector with the highest growth. This period also corresponds to the onset of the Green Revolution. Starting with this period, the value-added growth of industry and manufacturing began to decelerate to grow at 4% from the average of 6% in the previous three five-year periods. Nayyar (1976) argues that this slowdown in growth was due to demand constraints arising out of deceleration in public expenditure and poor agricultural performance.

After the 1991 reforms, growth in agriculture was lower than that registered during 1986-90 (Table 5.1). The reforms do not seem to have significantly improved the growth prospects of agriculture, at the same time did not also drastically lower the growth. But productivity growth seems to have improved for the last three periods. The 1980s witnessed an improvement in industrial and manufacturing growth, corresponding to the steady increase in value-added share of these sectors (Fig. 5.1 & 5.2). The 1990s saw a slowdown in value-added growth when the two sectors registered growth of around 5%, also coinciding with the plateauing of the sectoral share of value-added (Fig. 5.1 & 5.2). Similar to agriculture, the reform period did not automatically translate into sustained high growth for industry/manufacturing, except between 2006-10, when these sectors registered some of their highest growth rates comparable to the ones registered in 1986-90, just prior to the reforms. 2006-10 was also the period of high growth of Indian economy, as noted in section 2.1.3 Despite registering high growth, manufacturing's share of employment did not increase (Fig. 5.1&5.2). Industry's share rose but it was largely concentrated in construction. Services has grown impressively in the reform period, outperforming the other sectors, and as result economic growth in the recent decades as come to attributed as services-led (Ghose, 2020).

Table 5.1: Average Annual Growth Rates of Value Added & Productivity, 1951-2018 in %

	Value-Added				**Value-Added per Worker**			
	Agriculture	Industry	Manufacturing	Services	Agriculture	Industry	Manufacturing	Services
1951-55	2.88	5.95	5.84	3.94				
1956-60	3.35	6.52	6.28	5.39				
1961-65	-0.28	6.85	6.62	5.91	-0.85	4.94	4.77	4.72
1966-70	5.36	3.97	3.96	4.82	4.18	4.26	4.22	4.16
1971-75	2.33	3.06	3.33	4.48	-0.89	1.18	1.15	1.28
1976-80	1.33	4.92	4.86	4.94	-1.62	1.67	1.37	1.59
1981-85	3.13	6.01	7.04	6.29	1.08	1.81	3.06	1.51
1986-90	4.09	8.01	8.17	6.90	2.46	2.70	3.51	1.86
1991-95	2.31	6.02	7.14	6.45	1.26	0.48	4.23	2.35
1996-00	3.22	4.97	4.56	8.76	2.29	1.25	1.48	5.63
2001-05	2.85	6.91	5.97	8.74	1.09	2.99	3.17	5.24
2006-10	3.67	8.44	9.02	8.90	4.75	7.04	9.19	7.87
2011-15*	2.78	5.86	7.49	8.12	5.40	0.87	6.49	5.93
2016-18*	4.60	6.47	6.51	7.77	6.55	4.23	5.82	4.88

Source: Author's calculations based on GGDC's TSD and ETD. [*Note: The figures for 2011-15 and 2016-18 are based on ETD and have base year as 2015 prices. The other periods are 2005 base prices from TSD. Refer to Table A.5 in Appendix for all periods based on ETD.]

Productivity growth in industrial sectors on the other hand, which was higher than 4% during 1961-65 and 1966-70, was significantly lower in all subsequent periods, even after the reforms (Table 5.1). Productivity growth of services has remained consistently high in the reform period. Agricultural productivity growth in the reform period, starting from 2006-10, has improved.

Despite, an improvement in agricultural productivity growth in the recent years, the productivity gaps between agriculture and other sectors continue to remain high (Fig. 5.5). We find that productivity in agriculture increased from Rs. 16,500 in 1960 to around Rs. 29,900 in 2010 i.e by a factor of 1.8. But for the other sectors the increase was sharper by factors of 3.9, 5.7 and 5.8 for industry, manufacturing, and services respectively. The gap widened in the reform period – which is also corroborated by Binswanger-Mkhize (2013) and Kumar and Mittal (2006). Kumar and Mittal (2006) also note that there was a deceleration in the total factor productivity and output growth since the 1990s. The successes of the green revolution era could not be sustained during the next decades. This they attribute to the fall in total investment in general and public investments in particular. They also note the falling expenditure on research and extension as another reason. Therefore, despite registering higher productivity growth (in the last three five-year periods), agriculture's productivity continues to remain low, and its gap only continues to widen. The same trend can be observed in Figure A.1, in an extended period up to 2018.

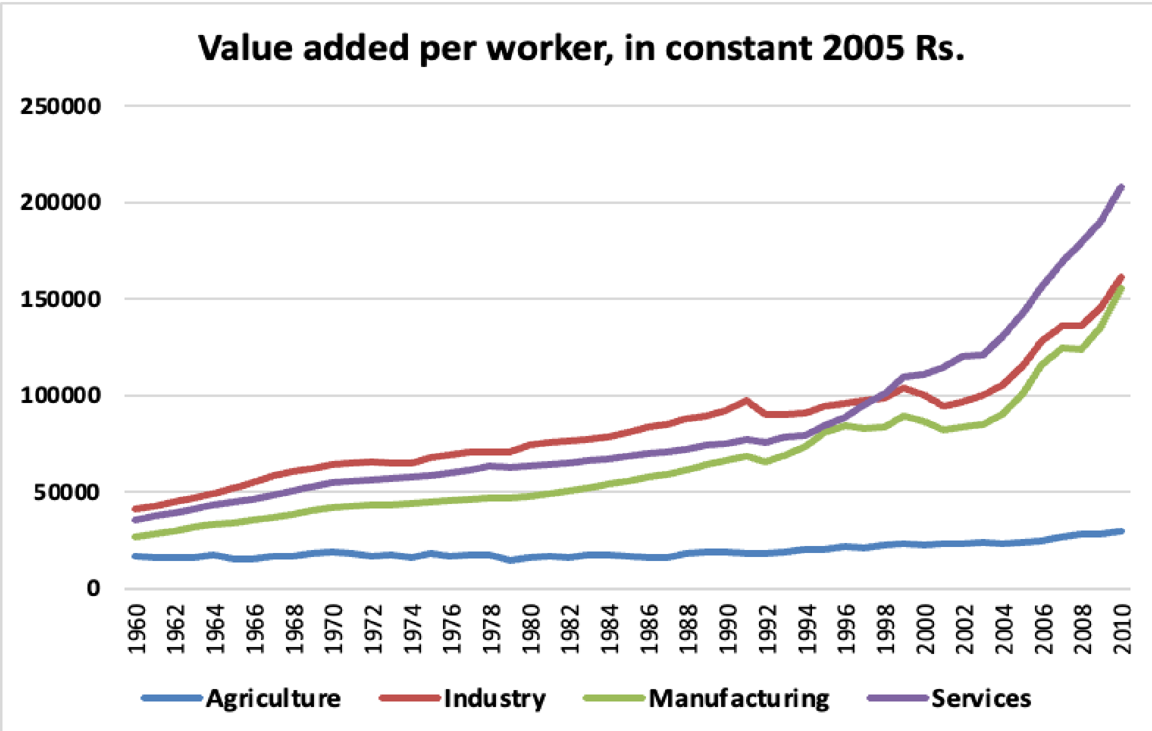

Figure 5.5: Value-Added Per Worker - Sectoral Labour Productivity (Constant 2005 Rupees), 1960-2010

Source: Author's calculations based on GGDC's TSD

Conventional logic of economic transformation suggests that the growing productivity differences between agriculture and other sectors should 'push' workers out of agriculture into other modern sectors. However, as noted by Barrett, Christiansen, Sheahan and Shimeles (2017), there are competing explanations for whether the movement of workers from agriculture to other sectors is caused by rural or urban factors. The rural factors are caused by increasing labour productivity in agriculture which frees up workers, prompting them to secure employment in other modern sectors. The urban pull effect is when the industrial development is advanced to employ a large portion of the unemployed from the farm sector. In India's case, we can see that productivity has not increased at a significant rate, while at the same time, there is a notable increase in labour reallocation away from agriculture to services and non-manufacturing industries. Such phenomenon could mean that lower profitability and productivity of the farm sector is prompting rural workers to search for off-farm jobs. But due to the low skill intensive nature of the rural workforce and lack of sufficient manufacturing jobs, those moving out of agriculture continue to be absorbed into low productive sectors of the urban economy (Ghose, 2020). In addition to widening productivity gaps, we have seen in the previous sub-section that agriculture now accounts for a much lower share of value-added at less than 20%, despite employing around 40%. Therefore, these productivity trends requires focusing attention on two fronts: *firstly*, to improve farm incomes and productivity. This would make farming profitable and lower the distress-based movement of workers. *Secondly*, to increase the skill level of the rural workforce by spending generously on education. However, the latter approach by itself cannot guarantee high-productive jobs for rural workers because the issue is also that the manufacturing sector is unable to generate sufficient jobs and has stagnated in the recent years (Kannan & Raveendran, 2009; Kapoor, 2015). On the other hand, the former approach can make agriculture profitable and, as we will discuss in more detail below, also provide a basis for industrial and manufacturing development. Therefore, it is essential to study the underperformance of manufacturing in conjunction with the agrarian crisis.

To conclude, the discussion on sectoral growth and structural transformation suggests that India's growth in the reform period was services-led. However, we do not argue that it has prematurely deindustrialised as Rodrik (2016) and Ghose (2020) define it. Although, there was stagnation, no substantial decline in the employment shares of manufacturing and industry in the recent years could be discerned (Fig. 5.3&5.4). The value-added share of manufacturing and industry has declined marginally in the last decade, however, that cannot be viewed as deindustrialisation as such. Nonetheless, this declining trend in the last few years, albeit being marginal, is concerning and could very well move into the phase of deindustrialisation. Therefore, incorporating an extended period of analysis, we corroborate the findings of Chakraborty and Nagraj (2020). We disagree with Chaudhari (2015) that India has prematurely deindustrialised. India's potential for industrial development is yet to be harnessed and although there have been fluctuations in growth rates accompanied by cycles of increase and stagnations in sectoral shares, a secular decline is yet to take place. Furthermore, we have seen that there were periods of high growth for these sectors but did not necessarily translate into a structural transformation via improved sectoral shares. This suggests that the growth has not sustained over a longer time for structural shifts to take place, which requires us to probe whether agricultural performance had a role in shaping this. We have also established that the agrarian dominated economy (in terms of value-added share) has shifted to services dominated one since mid-1980s (Fig.5.1), without industry ever coming to acquire the major share. And that services-led growth offers little potential for a sustained transformation is clear and was succinctly argued by Ghose (2020) when he says that service-led growth has not translated into services-led development. Therefore, Ghani and O'Connell's (2014) prescriptions that currently developing countries could focus on services and ICT for their structural transformation seems improbable due to the prevalence of low levels of education and lack of advanced skills for a vast majority of the population. The subsequent sections will provide some explanations for these trends from the point of view of agriculture-industry linkages.

5.2 Input-Output Analysis

Input-Output (I-O) tables allow us to analyse the dependence across the sectors in an economy by linking the output of a sector with the inputs of the other sectors. Such an analysis enables us to evaluate the changes in industry's/manufacturing's linkages with agriculture over the years - as suppliers of inputs and as consumers of final goods of the other sector. Our aim is to observe whether agriculture has lessened its dependence on industries for inputs and whether it has come to demand lesser industrial goods.

Table: 5.2: Sectoral Coefficient Matrices and Growth Rates

	Production Linkages			
	Agriculture	Industry	Manufacturing	Services
1965				
Agriculture	0.169	0.159	0.196	0.023
Industry	0.024	0.295	0.299	0.126
Manufacturing	0.018	0.211	0.244	0.093
Services	0.032	0.165	0.154	0.143
1970				
Agriculture	0.170	0.158	0.199	0.025
Industry	0.025	0.295	0.299	0.130
Manufacturing	0.019	0.204	0.239	0.092
Services	0.030	0.171	0.157	0.140
1975				
Agriculture	0.174	0.141	0.172	0.025
Industry	0.035	0.330	0.335	0.134
Manufacturing	0.029	0.244	0.275	0.102
Services	0.036	0.186	0.178	0.141
1980				
Agriculture	0.200	0.120	0.144	0.024
Industry	0.055	0.415	0.421	0.162
Manufacturing	0.047	0.312	0.357	0.131
Services	0.043	0.174	0.176	0.118
1985				
Agriculture	0.177	0.094	0.118	0.024
Industry	0.055	0.435	0.444	0.164
Manufacturing	0.047	0.311	0.350	0.129
Services	0.047	0.181	0.187	0.120
1990				
Agriculture	0.161	0.088	0.110	0.020
Industry	0.054	0.448	0.458	0.159
Manufacturing	0.045	0.333	0.371	0.122
Services	0.045	0.187	0.190	0.114

	Agriculture	Industry	Manufacturing	Services
1995				
Agriculture	0.145	0.079	0.099	0.019
Industry	0.058	0.444	0.452	0.155
Manufacturing	0.049	0.326	0.370	0.119
Services	0.052	0.201	0.205	0.123
2000				
Agriculture	0.151	0.067	0.087	0.018
Industry	0.062	0.456	0.472	0.114
Manufacturing	0.045	0.323	0.359	0.089
Services	0.054	0.162	0.173	0.114
2005				
Agriculture	0.146	0.059	0.076	0.017
Industry	0.064	0.451	0.478	0.119
Manufacturing	0.049	0.343	0.387	0.097
Services	0.061	0.189	0.202	0.126
2010				
Agriculture	0.127	0.057	0.072	0.015
Industry	0.059	0.481	0.512	0.118
Manufacturing	0.046	0.350	0.387	0.096
Services	0.057	0.173	0.183	0.117
2014				
Agriculture	0.117	0.050	0.064	0.013
Industry	0.062	0.471	0.494	0.105
Manufacturing	0.047	0.328	0.359	0.083
Services	0.071	0.187	0.200	0.118
2015				
Agriculture	0.126	0.053	0.066	0.014
Industry	0.060	0.454	0.479	0.098
Manufacturing	0.047	0.323	0.353	0.079
Services	0.072	0.209	0.218	0.121
2017				
Agriculture	0.122	0.050	0.062	0.013
Industry	0.059	0.449	0.477	0.094
Manufacturing	0.047	0.321	0.349	0.078
Services	0.075	0.210	0.220	0.121

Source: Author's calculations based on GGDC I-O Database. Calculations for 2015 and 2017 are based on ADB Database. [Note: The respective growth rates are presented in Table A.6 in Appendix A)

A detailed discussion on the construction of I-O matrices is presented in the section 3.1. In the Indian context, the works of Ahluwalia and Rangarajan (1989); Sastry, Singh, Bhattacharya and Unnikrishnan (2003); and Kaur, Bordoloi and Rajesh (2009) have analysed the trends in inter-sectoral production and demand linkages based on an I-O framework. Based on earlier period than the one in this study, those works found that industry-agriculture linkages were strengthened over time. However, in the longer run, covering the period until 2017, we find that there has been a noticeable weakening of inter-sectoral production linkages for industrial/manufacturing inputs as evidenced by the decreasing share of inputs in the output of agriculture and services. Table 5.2 presents the production linkages, as sectoral coefficients, and the respective growth rates are presented in Table A.6 in Appendix A for every five years from 1965 to 2010, and for 2014, 2015 and 2017. Each value in the production linkage matrix represents the value of inputs required from a sector to produce a unit output in another sector. For instance, in 1965, to produce a unit output in agriculture 0.169, 0.024, 0.018 and 0.032 units of inputs were required from agriculture, industry, manufacturing and services sectors respectively. These figures can also be understood as proportions i.e., in 1965, 16.9%, 2.4%, 1.8% and 3.2% of the total output of agriculture came as inputs from agriculture, industry, manufacturing and services.

There has been a steady increase of industrial and manufacturing inputs in agricultural sector output in the pre-reform period i.e. until 1985, increasing from 0.024 to 0.055 units for industrial inputs and from 0.018 to 0.047 for manufacturing inputs (Table 5.2). This is similar to the findings from other works on I-O based on official matrices (Ahluwalia & Rangarajan, 1989; Sastry et al., 2003). The increase in the share of industrial inputs indicates a trend towards modernisation of the agrarian sector in the form of increased usage of machinery, fertilisers, and other modern farming techniques (Ahluwalia & Rangarajan, 1989, pp.228; Sastry et al., 2003). Contrastingly, a relative stagnation and slow growth can be witnessed beginning from 1990 until 2017. The input requirements in 2017, were as much as they were in 1995 for industry and were marginally lower than 1995 for manufacturing (Table 5.2). The picture becomes clearer if growth rates are compared across these two broad time frames. Until 1985, growth for industrial and manufacturing inputs in agriculture was positive and double-digit rates were also registered. However, the growth has slowed down remarkably in post-reform phase, with negative growth being recorded for several years. For instance, 2005 to 2010, as understood from previous sections, was a period of high growth for both the economy and the industrial sectors as well. However, there was a decrease of industrial/manufacturing inputs in agriculture from 2005 to 2010 by 8.9% and 6.3% respectively (Table A.6 – Appendix A). Although, the value of agricultural inputs required for a unit of its own output has declined over the years, it still accounts for a significant share – which indicates that there is still scope to increase the sector’s consumption of modern industrial goods. Services inputs continue to be higher than industrial inputs for agriculture and there has not been any decline in the value of services inputs in the recent years. Industrial/manufacturing inputs in services output has also followed a pattern similar the industrial input in agriculture in the pre- and post-reform period. It increased from 0.126 units in 1965 to 0.164 units in 1985 but has declined since. In 2017, to produce a unit services output, only 0.094 input from industry was required. Similar was the trend with manufacturing as well. On the other hand, the inputs from agriculture to industry have witnessed a secular decline from 1965 (Table 5.2), which indicates a broad-based growth and diversification of industries (Sastry et al., 2003). Overall, the reform period witnessed a weakening of the production linkages, with a decreasing input dependence of sectors –the fall in dependence on industrial inputs by agriculture and services has been pertinent. As agriculture and services witnessed a decline in input consumption from industrial and manufacturing sectors, industry's and manufacturing's consumption of their own inputs has remained high (but stagnant) at around 45% and 35% in the recent years (Table A.6 – Appendix A). Chandrasekhar (2007, pp.66) argues that, based on the observed decrease in the agricultural input-dependence of industry and services, the reform period "has changed the pattern of growth in a way that has resulted in structural shifts in the nature of intersectoral linkages".

Table 5.3: Inverse Matrices and Growth Rates

	Inverse Matrices: Demand Linkage			
	Agriculture	Industry	Manufacturing	Services
1965				
Agriculture	1.236	0.478	0.543	0.163
Industry	0.080	1.750	0.783	0.344
Manufacturing	0.062	0.555	1.610	0.258
Services	0.073	0.455	0.460	1.286
1970				
Agriculture	1.238	0.476	0.545	0.166
Industry	0.083	1.748	0.782	0.350
Manufacturing	0.062	0.535	1.592	0.253
Services	0.071	0.461	0.466	1.285
1975				
Agriculture	1.263	0.536	0.594	0.192
Industry	0.144	2.047	1.092	0.453
Manufacturing	0.114	0.800	1.862	0.349
Services	0.108	0.632	0.647	1.342
1980				
Agriculture	1.394	0.942	1.030	0.364
Industry	0.466	3.596	2.759	1.083
Manufacturing	0.377	2.054	3.225	0.867
Services	0.234	1.163	1.236	1.537

	Agriculture	Industry	Manufacturing	Services
1985				
Agriculture	1.340	0.817	0.894	0.319
Industry	0.521	4.001	3.184	1.224
Manufacturing	0.399	2.241	3.411	0.927
Services	0.264	1.345	1.430	1.603
1990				
Agriculture	1.327	0.945	1.024	0.340
Industry	0.617	4.888	4.111	1.457
Manufacturing	0.481	2.994	4.197	1.126
Services	0.301	1.722	1.821	1.696
1995				
Agriculture	1.290	0.791	0.862	0.285
Industry	0.621	4.659	3.882	1.363
Manufacturing	0.484	2.806	4.016	1.051
Services	0.332	1.770	1.878	1.714
2000				
Agriculture	1.267	0.592	0.651	0.166
Industry	0.541	4.176	3.384	0.884
Manufacturing	0.396	2.317	3.494	0.654
Services	0.253	1.249	1.337	1.428
2005				
Agriculture	1.280	0.681	0.756	0.202
Industry	0.730	5.116	4.476	1.210
Manufacturing	0.572	3.219	4.526	0.954
Services	0.379	1.893	2.062	1.639
2010				
Agriculture	1.264	0.832	0.912	0.232
Industry	0.889	6.767	6.235	1.596
Manufacturing	0.665	4.285	5.647	1.197
Services	0.395	2.270	2.454	1.709
2014				
Agriculture	1.206	0.498	0.544	0.129
Industry	0.631	4.831	4.090	0.971
Manufacturing	0.455	2.729	3.928	0.703
Services	0.333	1.680	1.799	1.509
2015				
Agriculture	1.211	0.456	0.500	0.115
Industry	0.539	4.218	3.443	0.788
Manufacturing	0.396	2.334	3.510	0.583
Services	0.326	1.619	1.730	1.479
2017				
Agriculture	1.199	0.410	0.450	0.102
Industry	0.509	4.033	3.252	0.727
Manufacturing	0.376	2.206	3.374	0.541
Services	0.317	1.547	1.657	1.454

Source: Author's calculations based on GGDC I-O Database. Calculations for 2015 and 2017 are based on ADB Database. [Note: The respective growth rates are presented in Table A.7 in Appendix A)

The foregoing discussion was based on production linkages via the consumption of goods from other sectors as inputs in the production process. On the other hand, Table 5.3 presents the demand linkages and its growth rates from 1965 to 2017. Demand linkages indicate the impact of rise or fall of incomes in a sector on the demand for other the sector's goods (Sastry et al., 2003). Ahluwalia and Rangarajan (1989, pp.228) note that the demand linkages from industry to agriculture have been more clearly established than agriculture to industry. They argue that the impact of urban income changes on agricultural products particularly food and food products has been studied more, than the impact of agricultural incomes on the demand for industrial goods. In this thesis, we are interested in understanding the latter relationship.

There was a steady increase in the demand linkage for industry and manufacturing emanating from agriculture in the pre-reform period. In 1965, one unit increase in the demand for agricultural goods resulted in an increase of industrial output/demand for industrial goods by 0.080 units and manufacturing goods by 0.062 units (Table 5.3). This has increased to 0.621 and 0.484 units by 1995. However, in the reform period, they began to decline to reach 0.509 and 0.376 units in 2017. The demand linkages weakened since the initiation of reforms in 1991. The earlier works on India's I-O analysis have not been able to capture these declining trends as they were restricted to period before 2003-04.

The demand linkage of agriculture with services has been weaker compared to agriculture with industry. An increase in agricultural demand increased industrial output by a greater margin than it had increased the services output for entire period. Same is true for manufacturing as well, which had a stronger demand linkage with agriculture than services. Kaur, Bordoloi and Rajesh (2009, pp.42) argue that during the period of increased demand linkages between agriculture and industry, "a rise in the income of agricultural households had made a positive impact on industrial and services sectors through the demand channel". On the other hand, for services a unit increase in its demand increased the demand for industrial goods by 0.344 units and for manufacturing by 0.258 units. This has increased to 0.727 and 0.541 units. However, a clear difference in trend cannot be observed with the onset of reforms – there were periods of substantial increase and decline.

The I-O analysis has shown that the demand and production linkages between agriculture and industry/manufacturing have weakened in the recent years. After increasing for an initial period, these linkages started to weaken in the reform period. There has been an overall stagnation. The finding adds credence to the hypothesis that poor agricultural performance explains the lack of a manufacturing/industrial-led growth in India giving rise to a stunted pattern of structural change. As noted above, agricultural modernisation occurs due to an increasing consumption of industrial inputs. This in turn has the potential to increase productivity. However, with the stagnation and decline in consumption of industrial inputs, agriculture's productivity would have been hit.

5.3 OLS Findings

While the I-O analysis has shown that the agriculture-industry linkages weakened in the reform period, it does not provide us with the information on how agricultural and industrial performance were correlated in the long run. They only enable us to examine the dependence in a given year. As a result, we are only able to analyse the changes and observe the trends. Therefore, to further evaluate the association between agricultural and industrial performance and between agricultural performance and the extent of structural change over the entire period, a series of OLS regressions are performed. We perform specification tests which are presented in Appendix B.1.

A total of eight dependent variables are used. The primary independent variables, i.e. those capturing agricultural performance, for the analysis are agricultural productivity, agricultural gross capital formation (as a proportion of agricultural GDP) and agricultural growth rate. Additionally, the models control for trade (as a proportion of GDP) and industrial (or manufacturing) gross capital formation (as a proportion of the corresponding sector's GDP). To maintain consistency, only the data pertaining to the 10-Sector Database (TSD) from GGDC was considered. Therefore, most estimations are for the period 1960-2010. For those equations (such as column 2 in Table 5.4) which do not incorporate employment figures neither in the form of productivity nor as shares of employment, the period is 1950-2012.

Table B.1 in Appendix B presents the descriptive statistics. In this section, we present only the results of those equations which have manufacturing in the dependent variable. OLS results for those equations with industry in the dependent variable are presented in Appendix B.

Table 5.4: OLS Regressions with Ratio of Manufacturing & Agriculture Value-Added as Dependent Variable

	(1) 1960-2010	(2) 1950-2012	(3) 1960-2010	(4) 1960-2010	(5) 1960-2010
Log Agricultural Productivity	0.9135***		0.4955***	-0.0274	0.1781*
	(0.08)		(0.11)	(0.12)	(0.10)
Ratio of ACF & AGDP		5.1589***	2.7927***	1.6844***	2.7588***
		(0.33)	(0.60)	(0.56)	(0.47)
Trade Openness				0.6956***	
				(0.23)	
Ratio of MCF & MGDP				0.3348***	0.4862***
				(0.09)	(0.09)
Constant	-8.45***	0.07**	-4.58***	0.36	-1.6968*
	(0.77)	(0.03)	(1.06)	(1.13)	(0.97)
Observations	51	63	51	51	51
R-squared	0.737	0.801	0.818	0.909	0.890

Source: Author's Calculations.

[Note: Standard errors in parentheses. ***, **, & * indicate significance at 1%, 5% & 10% levels respectively.]

Table 5.4 presents the OLS results with ratio of manufacturing and agriculture value-added as a proxy for the extent of structural transformation and as the dependent variable. In (1) as percent increase in agricultural productivity is associated with an increase in the value-added ratio by 0.0091 points, while other independent variables remain constant. Nonetheless, agricultural productivity is no longer significant when trade and industrial capital formation are controlled for in (4). In (5) we exclude trade openness as it correlates very strongly with other independent variables (check Appendix B.7). After excluding trade, and including only capital formation ratio as a control, agricultural productivity become significant at 10% level. A percent increase in agricultural productivity is correlated with an increase of 0.0018 points of manufacturing to agricultural value-added, while MCF and ACF are constant. While this increase seems miniscule, a percent change in agricultural productivity, measured in rupees, is also extremely small. For instance, the mean agricultural productivity is Rs. 19,453 – 1% increase of this equals to a rise of Rs. 195. This is an extremely small change in productivity compared to the standard deviation (SD) of Rs. 3703. Hence, the increase in value-added ratio seems miniscule. Instead, if we increase productivity by one SD from its mean, i.e 19%, then value-added ratio is associated with an increase of 0.03 points i.e 16% of value-added ratio's SD, others being constant.

Ratio of Agricultural capital formation (ACF) to agricultural GDP (AGDP) has remained significant across all the equations, although its magnitude reduced after incorporating control variables. A point increase in the ratio of ACF to AGDP, is correlated with 2.8-point increase in the ratio of manufacturing to agriculture value-added. A more suitable comparison, considering that the variables are expressed in ratios, would be that a 0.1 increase in (ACF/AGDP), is correlated with an increase of 0.28 points in (5) which is 1.3 times the SD of value-added ratios. Manufacturing capital formation (MCF) remains statistically and economically significant throughout. The trends are similar if the dependent variable is taken as industry to agricultural value-added (Table B.2 in Appendix B - detailed discussion is presented in Appendix section B.1).

Table 5.5: OLS Regressions with Ratio of Manufacturing & Agricultural Employment as Dependent Variable

	(1) 1960-2010	(2) 1950-2012	(3) 1960-2010	(4) 1960-2010	(5) 1960-2010
Log Agricultural Productivity	0.1698***		0.1406***	0.1057***	0.1330***
	(0.01)		(0.02)	(0.23)	(0.02)
Ratio of ACF & AGDP		0.8106***	0.1951**	-0.0512	0.1943**
		(0.08)	(0.08)	(0.10)	(0.08)
Trade Openness				0.0927**	
				(0.04)	
Ratio of MCF & MGDP				-0.0086	0.0116
				(0.02)	(0.02)
Constant	-1.52***	0.08***	-1.25***	-1.90***	-1.1780***
	(0.09)	(0.01)	(0.14)	(0.20)	(0.17)
Observations	51	51	51	51	51
R-squared	0.872	0.679	0.885	0.896	0.887

Source: Author's Calculations.
[Note: Standard errors in parentheses. ***, **, & * indicate significance at 1%, 5% & 10% levels respectively.]

We found that ACF and agricultural productivity have positive and significant correlation with the extent of structural transformation as measured by the ratio of industrial and manufacturing value-added. We proceed to find its association with structural change when it is measured as ratios of employment. Agricultural productivity exhibits a strong positive correlation with employment ratios and remains significant even after controlling for trade and MCF, while ratio of ACF and AGDP is insignificant in (4). In (5), when trade is excluded (as it is highly correlated), we find that both productivity and ACF are significant, with MCF being insignificant. This is not surprising, as capital formation has more impact on value-added than the employment in manufacturing. Capital formation signals investment and as mentioned previously, the dominance of capital-intensive investments in India were high, while labour-intensive manufacturing was lacking. A percent increase in agricultural productivity was correlated with an increase in employment ratio by 0.0013 points (column 5), or a 20% increase was correlated with an increase of 0.026 units or 81% of employment ratio's SD, while others remain constant. 0.1 increase in ratio of ACF to AGDP is associated with an increase of 0.019 units of employment ratio i.e. nearly 59% of its SD. These relationships hold when industry to agricultural employment ratios are considered (Table B.3-Appendix B)

Table 5.6: OLS Regressions with Manufacturing Productivity and Growth Rate as Dependent Variables

	Productivity				Growth Rate
	(1)	(2)	(3)	(4)	(4)
	1960-2010	1960-2010	1960-2010	1960-2010	1950-2012
Log Agricultural Productivity	2.1802***		1.4746***	0.8353***	
	(0.16)		(0.24)	(0.23)	
Ratio of ACF & AGDP		11.1667***	4.7135***	4.6453***	
		(1.00)	(1.28)	(1.03)	
Ratio of MCF & MGDP				0.9793***	
				(0.19)	
Agricultural Growth					0.1251
					(0.09)
Constant	-10.52***	9.96***	-3.99*	1.8247	5.59***
	(1.54)	(0.10)	(2.24)	(2.13)	(0.55)
Observations	51	51	51	51	62
R-squared	0.800	0.718	0.844	0.900	0.034

Source: Author's Calculations.

[Note: Standard errors in parentheses. ***, **, & * indicate significance at 1%, 5% & 10% levels respectively.]

From Table 5.6, we find that agricultural productivity and capital formation continued to remain positively and significantly correlated with manufacturing productivity. The association of agricultural productivity with manufacturing productivity (column (4) in Table 5.6) is higher than the former's association with industrial productivity (column (4) in Table B.4 – Appendix B). A percent increase in agricultural productivity was correlated with an increase of 0.84% of manufacturing productivity, and only 0.47% increase in industrial productivity. 20% increase in agriculture productivity (nearly one SD increase from its mean), is associated with an increase of 1.68% in manufacturing productivity. This trend holds for ratio of ACF and AGDP as well. A point increase in ACF/AGDP is correlated with an increase of Rs. 10,309.46 in manufacturing productivity. However, coefficient for agricultural growth rates with manufacturing growth as dependent variable, though positive was insignificant.

Table 5.7: Robustness Checks

	(1)	(2)	(3)	(4)	(5)	(6)
	Ratio of Manufacturing to Agri Value Added (using reforms dummy)	Ratio of Manufacturing to Agri Employment (using reforms dummy)	Manufacturing Productivity (using reforms dummy)	Share of Manufacturing Employment	Ratio of Manufacturing to Agri Value Added (excluding drought years)	Manufacturing Productivity (excluding drought years)
Log Agricultural Productivity	-0.0355	0.0995***	0.3618	4.3092***	0.2782**	0.8033**
	(0.12)	(0.02)	(0.25)	(0.76)	(0.12)	(0.35)
Ratio of ACF & AGDP	2.8999***	0.2165***	4.9580***	4.6658	2.1604***	3.7937***
	(0.43)	(0.08)	(0.95)	(3.43)	(0.46)	(1.30)
Ratio of MCF & MGDP	0.4153***	0.0004	0.8222***	-0.0324	0.4606***	1.1067***
	(0.08)	(0.01)	(0.18)	(0.63)	(0.10)	(0.29)
Reform*Agri Productivity	0.0102***	0.0016***	0.0226***			
	(0.00)	(0.00)	(0.01)			
Constant	0.3920	-0.8494***	6.4551***	-32.5978***	-2.6028**	2.1490
	(1.10)	(0.20)	(2.40)	(7.09)	(1.14)	(3.24)
Observations	51	51	51	51	34	34
R-squared	0.911	0.904	0.919	0.793	0.912	0.873

Source: Author's Calculations. [Note: Standard errors in parentheses. Columns (1) to (4) are for the period 1960-2010. Columns (5) and (6) are after excluding 17 drought years during 1960 to 2010. The list of the years are in table B.5 in Appendix B. Reforms dummy is given the value 1 if the year is greater or equal to 1991, 0 otherwise. Columns (1) to (3) consist of the interaction between the reform dummy and the log of agricultural productivity. ***, **, & * indicate significance at 1%, 5% & 10% levels respectively.]

To confirm if our results were robust, we proceed to examine the relationship between manufacturing performance, and agriculture (Table 5.7). All the equations in Table 5.7 have only MCF as control. Trade Openness was excluded due to its high correlation. Firstly, we include a dummy variable for differentiating between pre- and post-reform periods. And we interact that with agricultural productivity to analyse whether agriculture had greater impact on manufacturing, post-reforms, compared to the pre-reform period (Columns 1 to 3 in Table 5.7). We can see that the interaction term is positive and significant, indicating that in the reform period agriculture and manufacturing, and agriculture and extent of structural change (proxied by value-added and employment ratios) were more closely associated than in the pre-reform period. In (4) share of manufacturing in total employment as proxies for structural transformation and as dependent variable. We find that agricultural productivity is significantly and positively correlated, indicating that improving agricultural productivity leads to a sustained increase in manufacturing employment share through rural-urban migration by freeing up workers in farm sector. However, ACF and MCF remained insignificant. In (5) and (6) we exclude the 17 drought years (based on

Mishra, 2020). Impact of droughts on agricultural production is severe in India and as Mishra (2020, pp.1) points out “more than 80% of total annual precipitation occurs in India during the monsoon (June to September) season”. Any variation in this will significantly impact the crop sector. Therefore, to avoid the impact of such extreme conditions, we exclude drought years (refer to Table B.5 in Appendix B for full list of years). The results continue to remain consistent with agricultural productivity and ACF being positively and significantly associated with both value-added ratio and manufacturing productivity.

From the above-mentioned results it is clear that agricultural performance (expressed via productivity and capital formation) were crucially associated with manufacturing/industrial performance and the extent of structural change towards manufacturing/industry. Agricultural productivity and capital formation were more correlated with manufacturing productivity than with industrial productivity. And increase in agricultural productivity was more important for increasing manufacturing employment (as a ratio with agriculture employment and as a share of total employment), while ACF was insignificant for achieving same. However, ACF was crucially linked to increase in ratio of manufacturing and agriculture value-added and manufacturing productivity. Therefore, agricultural productivity and capital formation hold potential for improving the performance of manufacturing sector. In the next section, to strengthen the OLS findings, we use existing theories to explain the ways in which agriculture impacts or generates a growth momentum in manufacturing/industry.

5.4 Discussion

5.4.1 Domestic Market Linkages

The results of the OLS estimates indicate that there were strong positive correlations between agriculture and industry’s performance, and between agriculture and structural transformation. This implies that a decline in the agricultural growth/productivity/capital formation would mean a decline in the industrial productivity/growth and a slowdown in the process of structural transformation. This, in addition, with our finding that agriculture-industry (or manufacturing) linkages have weakening in the recent years suggests that it could potentially explain the lack of an industrial-led growth. Examining an earlier period, with the use of simulation, Ahluwalia and Rangarajan (1986, pp.246) find that an increase in the agriculture value-added led to an increase in the growth of industrial value-added for both consumer and heavy industries. However, they caution against deliberately shifting terms of trade in favour of food crops to increase farm incomes. They find that such an approach, although it had a positive effect on heavy industries, ended up negatively impacting the consumer goods industries – with no net impact on the sector as a whole. Similarly, Storm (1995, pp.771) runs policy simulations to observe the impacts of "industry-led investment strategy" and find that neglecting agricultural growth could reduce the former's scope. Storm argues that if agriculture is not adequately focused, there would be an increase in food prices (caused by a relatively smaller supply in comparison to their demand). This in turn would mean that that the demand for non-agricultural goods would be lessened, as food demand is rather less elastic – thereby hurting non-agricultural sectors such as industry/manufacturing.

Our findings, coupled with the existing explanations, suggest that increases in productivity and capital formation in agriculture can be the surest way to both drive a shift of workers from agriculture to more productive sectors, and ensure the basis for a rapid manufacturing development. Capital formation invariably requires capital investments in inputs such as agricultural machinery, fertilisers etc. Demand for these goods from agriculture have a direct impact on the industries producing them. Furthermore, these goods are specific to the local agrarian and farming needs – development and manufacture of fertilisers are closely related to type of soil and other geographical features of the region. Increased demand for these goods naturally advantages domestic production. As Frankema and Waijenburg (2018, pp. 565) argue, these "domestic market linkages" are especially crucial for those goods and services which are inherently favourable to be produced under local conditions, and thereby offer some "natural degree of protection against foreign imports". Furthermore, domestic integration offers great potential for productivity spill overs and ensures that inter-sectoral linkages are enhanced. These, they argue, have been the sources of historical growth, and these market integrations hold the potential in the case of Africa to move to a labour intensive path of manufacturing – which in our analysis seems appropriate for India as well

Our findings suggest that a 20% increase in agricultural productivity could lead to an increase in manufacturing productivity by 1.68%, if the relationship is causal – while others are constant. Agricultural productivity was more crucial in explaining manufacturing than industrial productivity – therefore, improving agriculture allows a more resilient transformation with the growth of manufacturing industries, than the informal and low-productive industrial sectors such as construction. Timmer (2016, pp.80) argues that, in addition, to viewing agriculture has the supplier of factor inputs, that government interventions are necessary to correct the linkages between "growth in agricultural productivity and growth in rest of the economy". Borrowing from the work of Lipton (1977), Timmer argues that growth in agricultural productivity helps in reducing urban bias in both policymaking and capital formation. The disproportionate allocation of public investments to urban economy would change. Furthermore, Timmer (2016, pp.81) points out that increased agricultural profitability generates household surplus that would be reinvested to enhance the human capital, contributing to the increase in skilling process and thereby aiding to the "rural-urban migration". Both these channels of linkages are crucial for India with the presence of urban bias in policymaking and the low levels of rural human capital. During the period of central planning, Rao (1994) argues that "investment priorities within industry assumed far greater significance than that of priorities within agriculture". While the planning process envisioned a dominance of public capital over private capital in the industry, Rao argues that no such emphasis was laid for the agrarian sector, which was allowed to run under the aegis of private interests. We have also noted that the low education levels of rural workers meant that the bulk of those migrating to urban areas are being absorbed into low-productive jobs (Aggarwal, 2012). Therefore, these two channels of linkages are crucial. Increased agricultural productivity would lead to greater assertion by the rural economy and can demand a greater policy attention towards the rural areas. Greater surplus from farming would be reinvested by the households to aid in the human capital development. We see in the next subsections the relevance of different policies which could in turn develop and modernise the agrarian sector.

5.4.2 Improving Productivity and Modernising Agriculture

Another finding of ours which warrants discussion is that agricultural productivity, was more closely associated with structural transformation when it was proxied as ratio of manufacturing/industrial to agricultural employment, than with value-added ratio. As discussed in section 5.2, productivity differentials are the main source of labour reallocation. But in India, despite services and industries having much higher productivity than agriculture, are unable to absorb the bulk of the workforce in their most-productive jobs. For services and industrial sectors, a "duality" of sorts has emerged with the coexistence of high and low-productive sectors. A large proportion of the workers moving out of agriculture are being absorbed into low productive and low wage jobs such as those in trade services. And only a small proportion of the services employment is concentrated in the highly skilled and educated workforce. For industries, workers are moving towards construction which again is a sector dominated by insecure and informal jobs. Workers are not moving to these sectors due to better working conditions or higher pay, but rather due to the inability of the manufacturing sector to absorb them. But why would the workers move from agriculture to urban services or construction, despite the poor quality of jobs in these sectors? As noted previously, agrarian crisis in India has been debilitating for farmers, particularly small and marginal farmers. They are being pushed (rather than pulled) to search for alternative livelihoods to supplement their farm incomes and a vast majority of them are not completely exiting agriculture (Thomas, 2014). They engage in farming during the peak of sowing and harvest seasons, and temporarily seek casual employment either as daily wage workers or on very short-term contracts in the intervening period (Binswanger-Mkhize, 2013; Thomas, 2012 & 2014). Construction sector both in rural and urban areas has absorbed a significant portion of the workers seeking non-agricultural employment (Thomas, 2012). The initiation of the rural employment guarantee scheme was particularly important to those seeking additional employment (Thomas, 2012). However, such a scenario cannot completely compensate the necessity for a structural shift towards organised manufacturing. Therefore, improving agriculture's viability is important for raising farm incomes, which would naturally reduce the need for seeking 'distress employment'. And improving its viability by increasing its productivity and capital formation, generates positive spillovers for the industries as well through strengthened domestic linkages, and consequently has the potential to develop a strong base for manufacturing. This will be further explored in detail below.

Weakening agricultural-industry linkages suggests that modernisation in Indian agriculture has remained below-par – this is despite an increase in the industrial inputs since the implementation of Green Revolution strategies in mid-1960s until the 1990s (Table 5.2). Bhalla and Singh (2010) note that there were wide disparities in the usage of modern inputs such as fertilisers across India – low yielding states have consumed far less inputs per hectare than the high-yielding states. Kakarlapudi (2012) also argues that the continued reliance on traditional inputs has resulted in a slow growth of crop output in the reform period. This evidence suggests that there is still a large scope for adoption of modern industrial inputs in farming. The question then remains is how to improve the usage of modern industrial inputs in farming. The steady increase in the industrial input share in agriculture period between 1965 to mid-1990s suggests that Green Revolution strategies would have aided in increasing the industrial inputs. Ramakumar (2010) highlights four key aspects of government interventions that followed the green revolution: "price support, credit support, input subsidy support and marketing support" (pp. 47). Public expenditure on agriculture was meant to support technological transformation in farming to incentivise the farmers to adopt the new agricultural strategies (Vakulabharanam & Motiram, 2011, pp.102). They note that public expenditure was seen as a moderate substitute for the earlier promise of radical land redistribution. These strategies improved the yield and productivity of the sector (Ramakumar, 2010). Expenditure on agricultural research was particularly beneficial in resolving the issues of low yield faced by different crops, by identifying the necessary technological solutions such as improved seeds, better fertilisers etc (Ramakumar, 2012). Ramakumar notes that spending on agricultural research was considered as a public good. Since it was directly linked to identifying solutions for crop inputs, it paved the basis for demand for industrially produced HYV seeds, chemical fertilisers etc.

The reform period on the other hand was witness a slow growth in output and productivity compared to the 1980s (Chandrasekhar, 2007; Balakrishnan, Golait & Kumar, 2008; Bhalla & Singh, 2009; Ghosh, 2010; Ramakumar, 2010). This was also the period when consumption of industrial inputs has begun to slowdown (Table 5.2). With the onset of reforms, public investments in agriculture as a share of agricultural GDP declined (Ramakumar, 2012, pp.60). There has been a stagnation of public expenditure in agriculture with declining trends observed for spending on agricultural research (Ramakumar, 2012; Balakrishnan, Golait & Kumar, 2008). Ramakumar argues that these trends generated a tendency of reduced profitability and productivity in the sector. Balakrishnan, Golait and Kumar (2008) point out that a slowdown in irrigation expansion and a stagnation of public investment, particularly on Agriculture Research and Extension, wherein there was a decline in real terms since 1990, could explain the slow growth in agriculture in the reform period. At the same time, they contend that improving the bureaucratic and governance structures associated with government spending is equally crucial. Their overarching argument is that structural issues concerning the supply side of the farm sector have been detrimental to its performance and that policy approach towards the sector should aim at increasing its profitability and economic viability as an occupation. On the other hand, Chand (2010) argues that the decline in the growth of public investments in agriculture began in the 1980s itself. The fall in public capital formation, accompanying the rising input prices in the reform period, led to an increase in public spending on input subsidies. However, as Chand argues, public capital formation is more productive and has longer-term benefits for the sector. With a singular focus on price incentives, policy making even in the reform period has remained biased against the agriculture sector (Chand, 2010).

From the foregoing discussion, it is evident that increasing agricultural productivity results from increasing usage of modern industrial inputs and technology in agriculture, which in turns depends on increasing public expenditure and public capital formation that have positive spill over effects. In particular, the spending on research, irrigation, input subsidies (for modern inputs) etc have potential to modernise the sector. By generating a sustained demand for industrial inputs, these strategies can also be the foundation for a sustained domestic demand for industrial and manufacturing sectors. And although manufacturing grew at impressive rates during various occasions, such as between 1951 to 1965, 1981 to 1990, and 2001-10 (Table 5.1), it did not translate into a sustained increase in shares of value-added and employment. The presence of favourable short-term international and domestic conditions would have generated the high-growth for that shorter period of time. For instance, Nagraj (2013) finds that the high-growth period in 2000s was largely a cyclical boom which was generated by a significant increase in corporate debt and foreign investments necessitated by favourable global factors (such as increase in trade and improvement in communications, and information technology). And the growth in India ended as soon as the global markets faced severe uncertainty due to the financial meltdown in 2008. Therefore, a long-term sustenance of growth in manufacturing value-added and productivity is dependent on structural issues of production and demand linkages with agriculture.

And as Johnston and Mellor (1961) argue, the assumption that industrial sector is constrained only due to the lack of capital is faulty. “Increased rural net cash incomes [acts] as a stimulus for industrialization” as “investment decisions may in fact be influenced not only by the availability of capital but also by demand conditions” (Johnston & Mellor, 1961, pp.580). Therefore, eliminating the demand constraints that emerged in the India’s largest sector in terms of number of people engaged (Bhattacharyya, Abraham & D’Costa, 2013), is crucial for sustained development of domestic industrial and manufacturing capabilities. It relieves the pressure for the industries to be dependent on exports and favourable global conditions.

5.4.3 Relevance of Land Reforms

Another avenue for policy to improve productivity and incentivise the usage of modern inputs is the initiation of land reforms/redistribution aimed at breaking the extreme rural land inequality. Rural land redistribution was a crucial policy instrument which has been studied extensively, and with the success of East Asian transformation, it has come to be discussed as a viable option to generate agricultural revolution before embarking on industrialisation (see Adelman, 1984 & 1999, pp.291-295; Dorner & Thiesenhusen, 1990). With land redistribution being pushed to the margins of policy making and planning, structural changes in the sector could not be implemented (Rao, 1994, pp.128). There is no denying that Green Revolution strategies improved the farm productivity and yield, and arrested the import dependence for food (Ramakumar, 2010). However, these policies were implemented without significant changes in the rural property relations and therefore had unequal pay offs across different classes and regions, with big landowning classes receiving disproportionately higher payoffs (Patnaik, 1975). The persistence of land inequality also determined the socio-political power relations in the countryside, and substantially hindered the access to other productive inputs for small and marginal farmers thereby productivity, capital formation and technological advancements amongst the vast sections of the rural population (Kohli, 2012; Ramakumar, 2010; Dev, 2017). Our OLS findings suggest that agricultural productivity and capital formation are the key to sustain high industrial performance, and the experience of some of the late developers in East Asia shows that land redistribution has the ability transform the rural economy. Additionally, land reforms would also help in the evening out of the benefits of agricultural support policies, across regions and classes. Adoption of modern technology has been constrained by unequal landholding (Patnaik, 1975) and any attempt at evening the agricultural productivity gaps across regions should take into account the relevance of land redistribution. Evidence also suggests that there are several efficiency and productivity gains from reducing land concentration, and that cultivation by land owners is more productive than sharecroppers and tenants (Bardhan, 1973; Bell, 1977; Binswanger-Mkhize, Deininger & Feder, 1995). As such, empirical evidence favours land reforms as possible policy intervention to make agriculture productive.

6 Conclusion

6.1 Summary

In this thesis we have analysed the structural transformation process in India with an emphasis on the role of agriculture. We find that India witnessed a transformation directly from agriculture to services. The post-reform period saw a sharp increase in the share of services value-added and employment. Industrial sector shares saw a marginal increase in the reform period. However, there was a stagnation of manufacturing in the entirety of the post-independence period, barring some marginal growth episodes. Manufacturing employment share remained around 10%, while that of value-added remained below 20% for the entire period. Much of the increase in industry's employment was due to the construction sector. And along with low-productive service sectors (such as trade), construction emerged as the absorbers of the workers from agriculture. These trends suggest that structural change is being concentrated among the low-productive sectors of both industry and services. This presents an unsustainable pattern, as these sectors have lower productivity gains than manufacturing. Furthermore, these sectors are characterised by insecure and informal working conditions and the workers remain vulnerable.

In India, policy emphasis on agriculture has remained biased, and it could not provide the required structural shifts. The declining public investments and expenditure in the sector in the post-reform period exacerbated the problems faced, with agriculture becoming unprofitable and economically unviable. With agriculture still being the sector with the highest share of employment, the demand generated from this sector both as final and intermediate consumer of industrial goods, is crucial for the development of industry. Several studies have pointed out that both the planning and the subsequent neoliberal framework ignored this important link. Therefore, using these studies as theoretical background, we embarked on analysing the role agriculture and industry linkages played in determining the latter's underdevelopment. Using I-O matrices at the sectoral level, we find that both the production and demand linkages have weakened after improving initially. The growth in these linkages decelerated in the post-reform period, and have been declined. The share of industrial inputs in agricultural output has fallen in recent years. Subsequently, our OLS estimations revealed that agricultural and industrial/manufacturing performance were closely linked. Agricultural productivity and capital formation were associated positively and significantly with both the industrial/manufacturing performance and the extent of structural change. While these estimates are not causal in nature, they at least provide us with an understanding about the extent to which these two sectors were related. Also, there is sufficient evidence, in the form of theoretical discussions on how agriculture and industry are linked, to reasonably confirm that the poor agrarian sector is unsustainable for industrialisation. The concept of domestic market linkages, put forth by Frankema and Waijenberg (2018), is particularly useful for our analysis. Improving the linkages between the two sectors will be especially beneficial for domestic industries which have an advantage in manufacturing for domestic agricultural needs. Specific local conditions require specific manufacturing interventions that could be provided by local industries.

Despite the stagnation of manufacturing and industries, we do not argue that India is already witnessing a premature deindustrialisation. There has not yet been a substantial decline in the employment and value-added shares of these sectors, although we do not rule out such a possibility in the future. Therefore, immediate policy attention is required to overcome these issues. However, much of the policy framework, in both pre- and post-reform periods was focused singularly on manufacturing and industrial sectors - in the form of capital support during the pre-reform period, and in terms of incentives in the post-reform period. But our analysis suggests that a deeper structural issue is the underperformance of agriculture preventing sustainable structural transformation into higher productivity sectors. And as argued by Johnston and Mellor (1961) & Timmer (2016), an agricultural transformation is essential for industrial development. The necessity of eliminating demand constraints in agriculture is clear – particularly in the light of the evidence that the high growth periods in manufacturing/industry, as was seen in 2000s, was largely due to favourable global market conditions, and not due to improvements in structural constraints (Nagraj, 2013) – and as a result these growth periods were short lived.

Furthermore, as seen earlier, workers moving out of agriculture are driven by distress factors in that sector and are unable to find adequate manufacturing sector jobs only to get absorbed into low-productive services and construction sectors. Therefore, correcting the issues in agriculture is essential for industrial development: *firstly*, by making agriculture productive and *secondly*, by aiding the development of industry, which in turn would generate more productive jobs, and could become an avenue for the workers freed up in agriculture due to productivity improvements. We argue that policies such as improving productive government expenditure and investments along with land redistribution have the potential to improve farm productivity and to arrest the agrarian crisis. Productive expenditure such as towards subsidies for modern inputs and technologies and towards agricultural research and development ought to be strengthened. The Indian state in the early years of independence had a firm policy commitment to land reforms. However, as mentioned above, the successive regimes saw this official rhetoric pushed to the margins. The experience of successful industrialisers from Asia and evidence from prior studies suggest that breaking land inequality can transform the economic relations of the rural areas laying the ground for productivity improvements and thereby ensuring a sustainable structural transformation with industrial development.

6.2 Limitations and Scope for Future Research

Despite some significant findings and considerable evidence to suggest that weakening agriculture-industry linkages, and the underperformance of the agrarian sector generated a structural change that did not consist of a large-scale industrialisation in India, the study suffers from a few limitations.

Firstly, the presence of significant inter-state variations were not addressed as we have taken sectoral aggregation at the country level. We have observed that industrial and manufacturing sectors have stagnated their shares of value-added and employment, and we even observe a marginal decline in recent years. Services sector has come to contribute the highest to the total value-added, with agriculture contributing the least. However, there are considerable variations among Indian states in terms of their pattern of structural change. For instance, India's agriculture's contribution to value-added in 2018 has been a little over 15%, states such as Andhra Pradesh, Madhya Pradesh, Arunachal Pradesh, Bihar and Uttar Pradesh continue to have higher shares of agriculture (Table C.1). Gujarat's manufacturing and industrial shares are higher than their services share. Similar variations exist for other sectors across states. Gujarat, Maharashtra and Tamil Nadu have emerged as the industrial hubs in the country, and have a considerably higher share of the country's manufacturing output. These three states alone account for 43% of India's manufacturing value-added in 2018 (Table C.2). By aggregating the sectors at the country-level we have not been able to capture the state-level changes. And studying these regional differences could be important when designing local policies aimed at a more sustainable structural transformation. Future studies could examine the role of agriculture at state-levels in a panel analysis. By being panel in nature, such an analysis would have more data points and the association between agriculture and industrial performance can be better captured. And since some states have performed better in manufacturing and industrial sectors, it would allow us to check the nature of their agriculture and industry linkages and either confirm or disprove the conclusion reached in this study.

Secondly, the unavailability of data prior to 1965 for I-O tables, and the lack of a continuous series on sectoral compositions of value-added and employment up to the recent years for OLS, restricted our time period of analysis. All of our I-O matrices are available only from 1965, and the data for the first fifteen years since the inception of economic planning is unavailable - this period is also marked by a substantial improvement in the industrial and manufacturing sectors with a steady growth in output and productivity, and an improvement in their sectoral shares (Fig. 5.1&5.3; Table 5.1). So observing the demand and production linkages, during those fifteen years, between agriculture and industry/manufacturing, would have given us some insights into how the trends in these linkages were associated with the observed growth. And would have allowed us to evaluate whether such linkages were present during other growth periods.

Thirdly, in analysing the role of agriculture, we have restricted ourselves to discussing the production and demand linkages only. The other crucial linkages across sectors pertain to investment and savings (Ahluwalia & Rangarajan, 1989). They argue that these linkages determine the level of government spending and corporate investments. However, these are difficult to capture, and as such the lack of data precluded our analysis on this front. Additionally, future research could also quantitatively analyse the impact of the persistence of rural land inequality, and the failure of land reform policies on the stagnation of manufacturing. While we have argued that reducing land concentration is crucial, based on a theoretical understanding and from the experiences of some Asian economies, providing quantitative evidence would add more credence to attract policy attention.

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Appendix A

Table A.1: List of Variables for OLS regressions

Category	Variable	Type
Industrial Performance	Log of Productivity	Dependent
	Growth Rate	Dependent
Manufacturing Performance	Log of Productivity	Dependent
	Growth Rate	Dependent
Extent of structural transformation	Ratio of Manufacturing and Agriculture Value Added	Dependent
	Ratio of Industry and Agriculture Value Added	Dependent
	Ratio of Manufacturing and Agriculture Employment	Dependent
	Ratio of Industry and Agriculture Employment	Dependent
Agricultural Performances	Log of Productivity	Independent
	GCF as Proportion of Output	Independent
	Growth Rate	Independent
Control Variables	Trade as Proportion of GDP	Independent
	Industry GCF as Proportion of Industry Output	Independent
	Manufacturing GCF as Proportion of Manufacturing Output	Independent

Source: Author's elaboration

A.1 Sectoral Composition

In this thesis we have relied on three and four sector disaggregation of the Indian economy – Agriculture, Industry, Manufacturing, and Services. Agriculture consists of the Primary sector, which includes all economic activities from Agriculture, Fishing and Forestry. Industrial sector in India broadly consists of Mining, Manufacturing, Construction, and Utilities. Utilities consist of electricity generation, water, and other basic amenity industries. Manufacturing sector is a sub-sector of industrial sector. In this thesis, the trends and data for Industry and Manufacturing are both presented, and the former is inclusive of the latter. But since we are particularly concerned about manufacturing, we present both. Services is inclusive of all government and non-governmental services, such as trade, communication, financial, government, community, and other services. The GGDC I-O tables give data at a more disaggregated level, which we aggregated to the four broad sectors of Agriculture, Industry, Manufacturing and Services. The details of the sectoral composition for I-O tables are as below. For instance, Agriculture (using GGDC's NIOT) is the summation of Crop & animal production, hunting & related service activities, Forestry & logging, and Fishing & Aquaculture. Similarly for other sectors.

Agriculture	
GGDC’s Long Run WIOT (1965-2000)	GGDC’s NIOT (2000-2014)
Agriculture, Hunting, Forestry and Fishing	Crop & animal production, hunting & related service activities
	Forestry & logging
	Fishing & aquaculture

Industry	
GGDC’s Long Run WIOT (1965-2000)	GGDC’s NIOT (2000-2014)
Mining and Quarrying	Mining & quarrying
Food, Beverages and Tobacco	Manufacture of food products, beverages & tobacco products
Textiles, Textile, Leather and Footwear	Manufacture of textiles, wearing apparel & leather products
Pulp, Paper, Paper, Printing and Publishing	Manufacture of wood & of products of wood
Coke, Refined Petroleum and Nuclear Fuel	Manufacture of paper & paper products
Chemicals and Chemical Products	Printing & reproduction of recorded media
Rubber and Plastics	Manufacture of coke & refined petroleum products
Other Non-Metallic Mineral	Manufacture of chemicals & chemical products
Basic Metals and Fabricated Metal	Manufacture of basic pharmaceutical products & pharmaceutical preparations
Machinery, Nec	Manufacture of rubber & plastic products
Electrical and Optical Equipment	Manufacture of other non-metallic mineral products
Transport Equipment	Manufacture of basic metals
Manufacturing, Nec; Recycling	Manufacture of fabricated metal products, except machinery & equipment
Electricity, Gas and Water Supply	Manufacture of computer, electronic & optical products
Construction	Manufacture of electrical equipment
	Manufacture of machinery & equipment n.e.c.
	Manufacture of motor vehicles, trailers & semi-trailers
	Manufacture of other transport equipment
	Manufacture of furniture; other manufacturing
	Repair & installation of machinery & equipment
	Electricity, gas, steam & air conditioning supply
	Water collection, treatment & supply
	Sewerage; waste collection, treatment & disposal activities
	Construction

Manufacturing	
GGDC’s Long Run WIOT (1965-2000)	GGDC’s NIOT (2000-2014)
Food, Beverages & Tobacco	Manufacture of food products, beverages & tobacco products
Textiles, Textile, Leather & Footwear	Manufacture of textiles, wearing apparel & leather products
Pulp, Paper, Paper, Printing & Publishing	Manufacture of wood & of products of wood
Coke, Refined Petroleum & Nuclear Fuel	Manufacture of paper & paper products
Chemicals & Chemical Products	Printing & reproduction of recorded media

Rubber & Plastics	Manufacture of coke & refined petroleum products
Other Non-Metallic Mineral	Manufacture of chemicals & chemical products
Basic Metals & Fabricated Metal	Manufacture of basic pharmaceutical products & pharmaceutical preparations
Machinery, Nec	Manufacture of rubber & plastic products
Electrical & Optical Equipment	Manufacture of other non-metallic mineral products
Transport Equipment	Manufacture of basic metals
Manufacturing, Nec; Recycling	Manufacture of fabricated metal products, except machinery & equipment
	Manufacture of computer, electronic & optical products
	Manufacture of electrical equipment
	Manufacture of machinery & equipment n.e.c.
	Manufacture of motor vehicles, trailers & semi-trailers
	Manufacture of other transport equipment
	Manufacture of furniture; other manufacturing
	Repair & installation of machinery & equipment

Services	
GGDC’s Long Run WIOT (1965-2000)	GGDC’s NIOT (2000-2014)
Wholesale and Retail Trade	Wholesale & retail trade & repair of motor vehicles & motorcycles
Hotels and Restaurants	Wholesale trade, except of motor vehicles & motorcycles
Transport and Storage	Retail trade, except of motor vehicles & motorcycles
Post and Telecommunications	L& transport & transport via pipelines
Financial Intermediation	Water transport
Real Estate, Renting and Business Activities	Air transport
Community Social and Personal Services	Warehousing & support activities for transportation
	Postal & courier activities
	Accommodation & food service activities
	Publishing activities
	Motion picture, video & television programme production, sound recording etc
	Telecommunications
	Computer programming, consultancy & related activities; information service activities
	Financial service activities, except insurance & pension funding
	Insurance, reinsurance & pension funding, except compulsory social security
	Activities auxiliary to financial services & insurance activities
	Real estate activities
	Legal & accounting activities; activities of head offices; management consultancy activities
	Architectural & engineering activities; technical testing & analysis
	Scientific research & development
	Advertising & market research
	Other professional, scientific & technical activities; veterinary activities

	Administrative & support service activities Public administration & defence; compulsory social security Education Human health & social work activities Other service activities Activities of households as employers etc Activities of extraterritorial organizations & bodies

Table A.2: Summary of Data Sources and Time Period

Variable	Disaggregation	Source	Period	Notes (if any)
Value Added	Agriculture	GGDC's TSD & ETD	1950-2018	Available as Current Rs. and Constant 2005 Rs.
	Industry	GGDC's TSD & ETD	1950-2018	
	Manufacturing	GGDC's TSD & ETD	1950-2018	
	Services	GGDC's TSD & ETD	1950-2018	
Total Persons Engaged	Agriculture	GGDC's TSD & ETD	1950-2018	
	Industry	GGDC's TSD & ETD	1950-2018	
	Manufacturing	GGDC's TSD & ETD	1950-2018	
	Services	GGDC's TSD & ETD	1950-2018	
Value added per worker/Productivity*	Agriculture	GGDC's TSD & ETD	1950-2018	
	Industry	GGDC's TSD & ETD	1950-2018	
	Manufacturing	GGDC's TSD & ETD	1950-2018	
	Services	GGDC's TSD & ETD	1950-2018	
GCF as Proportion of Gross Output*	Agriculture	EPWRF	1950-2012	GCF and Gross Output at Factor Cost in Current Rs.
	Industry	EPWRF	1950-2012	
	Manufacturing	EPWRF	1950-2012	
Total Trade as Proportion of GDP*		EPWRF	1950-2012	Value of Trade (imports+exports) and GDP at Factor Cost in Current Rs.
I-O Matrices*	Production Linkages	GGDC's NIOT and Long Run WIOT	1965-2014	
	Demand Linkages	GGDC's NIOT and Long Run WIOT	1965-2014	

Source: Author's elaboration.

(*Not available directly from the source and are based on author's calculations from the source database.)

Table A.3: Sectoral Shares of Employment 1960-2010 (Corresponding to Figure 5.3 in the text)

Year	**Agriculture**	**Mining**	**Manufacturing**	**Utilities**	**Construction**	**All Industries**	**Trade, restaurants & hotels**	**Transport, storage & communication**	**Finance, insurance, real estate & business services**	**Government services**	**Community, social & personal services**	**All Services**
1960	71.88	0.51	9.59	0.15	1.49	11.74	4.69	1.74	0.23	7.77	1.95	16.38
1961	71.73	0.52	9.86	0.16	1.44	11.98	4.78	1.82	0.25	7.42	2.01	16.29
1962	71.32	0.56	9.98	0.17	1.40	12.11	4.81	1.91	0.27	7.50	2.08	16.57
1963	70.75	0.55	10.28	0.19	1.46	12.48	4.92	1.98	0.28	7.45	2.14	16.76
1964	70.43	0.53	10.38	0.20	1.48	12.59	5.05	2.02	0.30	7.39	2.21	16.97
1965	71.07	0.58	10.03	0.22	1.50	12.32	4.92	2.10	0.32	6.95	2.32	16.62
1966	71.55	0.57	9.65	0.23	1.53	11.99	4.88	2.14	0.34	6.70	2.40	16.46
1967	72.04	0.57	9.25	0.25	1.55	11.63	4.89	2.24	0.37	6.34	2.50	16.33
1968	72.12	0.57	9.28	0.27	1.51	11.63	4.91	2.31	0.40	6.06	2.57	16.25
1969	71.72	0.57	9.69	0.28	1.46	12.00	4.94	2.37	0.43	5.90	2.64	16.28
1970	71.97	0.51	9.44	0.29	1.37	11.62	5.02	2.42	0.47	5.78	2.73	16.41
1971	72.16	0.49	9.36	0.29	1.32	11.46	4.93	2.36	0.46	5.89	2.74	16.38
1972	72.40	0.48	9.35	0.29	1.29	11.41	4.76	2.39	0.45	5.82	2.76	16.19
1973	72.62	0.45	9.37	0.28	1.16	11.26	4.78	2.36	0.44	5.82	2.72	16.12
1974	72.74	0.44	9.25	0.27	1.07	11.04	4.81	2.45	0.41	5.75	2.79	16.22
1975	72.59	0.46	9.03	0.29	1.17	10.94	5.05	2.49	0.41	5.73	2.78	16.46
1976	72.35	0.44	9.37	0.30	1.22	11.33	5.00	2.51	0.42	5.66	2.74	16.32
1977	72.19	0.42	9.51	0.30	1.28	11.50	5.19	2.42	0.41	5.59	2.70	16.31
1978	71.49	0.39	10.13	0.31	1.18	12.01	5.37	2.42	0.41	5.65	2.65	16.50
1979	72.27	0.37	9.49	0.30	1.08	11.24	5.04	2.44	0.40	5.81	2.80	16.49
1980	72.40	0.39	9.12	0.29	1.17	10.97	5.10	2.46	0.38	5.90	2.79	16.63
1981	72.00	0.42	9.33	0.29	1.24	11.28	5.34	2.46	0.38	5.71	2.84	16.72
1982	71.50	0.45	9.39	0.29	1.18	11.31	5.52	2.43	0.38	5.97	2.89	17.20
1983	71.00	0.45	9.75	0.28	1.26	11.74	5.69	2.46	0.39	5.84	2.89	17.26
1984	70.45	0.44	9.79	0.29	1.30	11.83	5.81	2.54	0.39	6.07	2.91	17.72
1985	69.97	0.45	9.62	0.29	1.37	11.73	6.16	2.62	0.39	6.18	2.94	18.30
1986	69.22	0.49	9.69	0.29	1.43	11.90	6.37	2.64	0.40	6.40	3.07	18.88
1987	68.61	0.49	9.80	0.29	1.47	12.05	6.51	2.71	0.40	6.66	3.06	19.34
1988	67.83	0.54	10.02	0.29	1.58	12.43	6.82	2.72	0.41	6.68	3.10	19.74
1989	66.71	0.55	10.47	0.30	1.64	12.96	7.13	2.77	0.43	6.79	3.21	20.33
1990	66.37	0.59	10.51	0.29	1.83	13.22	7.37	2.76	0.43	6.50	3.34	20.41
1991	66.97	0.60	9.71	0.30	1.90	12.51	7.41	2.80	0.46	6.39	3.46	20.52
1992	66.58	0.61	9.83	0.30	2.23	12.97	7.54	2.87	0.57	5.99	3.48	20.45
1993	65.68	0.63	10.00	0.31	2.64	13.59	7.72	2.96	0.72	5.75	3.58	20.73
1994	63.74	0.68	10.37	0.33	3.17	14.55	8.31	3.14	0.91	5.61	3.74	21.71
1995	62.39	0.70	10.72	0.33	3.69	15.44	8.67	3.20	1.16	5.34	3.81	22.18
1996	62.16	0.65	10.97	0.31	3.81	15.74	8.97	3.24	1.15	5.11	3.62	22.09
1997	61.56	0.62	11.10	0.29	3.95	15.96	9.33	3.36	1.18	5.07	3.55	22.49
1998	61.21	0.58	11.00	0.27	4.14	15.99	9.74	3.48	1.20	4.94	3.43	22.80
1999	60.28	0.57	10.99	0.26	4.40	16.22	10.26	3.67	1.24	4.93	3.39	23.49
2000	59.64	0.54	11.37	0.26	4.75	16.91	10.16	3.77	1.28	4.87	3.36	23.45
2001	58.78	0.50	11.67	0.26	5.15	17.59	10.19	3.86	1.32	4.88	3.38	23.63
2002	56.58	0.50	12.46	0.27	5.59	18.83	10.39	4.15	1.41	5.09	3.55	24.59
2003	56.61	0.47	12.27	0.27	5.36	18.36	11.03	4.07	1.58	4.91	3.43	25.03
2004	56.49	0.56	12.21	0.26	5.68	18.70	10.83	4.06	1.70	4.82	3.39	24.80
2005	57.28	0.51	11.60	0.25	5.81	18.17	10.76	4.08	1.68	4.72	3.31	24.55
2006	57.25	0.54	11.42	0.25	6.08	18.29	10.57	4.16	1.73	4.72	3.29	24.46
2007	55.39	0.51	11.93	0.26	6.52	19.22	10.83	4.43	1.92	4.85	3.37	25.39
2008	54.41	0.52	12.16	0.26	6.79	19.73	11.07	4.56	2.02	4.85	3.36	25.86
2009	53.72	0.52	12.14	0.26	7.02	19.95	11.30	4.71	2.13	4.84	3.35	26.33
2010	54.66	0.49	11.59	0.25	7.16	19.50	11.56	4.80	2.23	4.14	3.12	25.84
2010-1980	**-17.74**	0.10	2.47	-0.04	5.99	**8.53**	6.46	2.34	1.85	-1.76	0.33	**9.22**
2010-1990	**-11.71**	-0.10	1.08	-0.04	5.33	**6.27**	4.19	2.04	1.79	-2.37	-0.22	**5.44**

Source: Author's calculation from GGDC's TSD. [Note: All Industries comprises of Mining, Manufacturing, Utilities and Construction. All Services is the aggregation of Trade, restaurants & hotels, Transport, storage & communication, Finance, insurance, real estate and business services, Government services and Community, social & personal services].

Table A.4: Sectoral Shares of Employment 1990-2018 (Corresponding to Figure 5.4 in the text)

	Agriculture	Mining	Manufacturing	Utilities	Construction	All Industries	Trade services	Transport services	Business services	Financial services	Govt services	Other services	All Services
1990	64.78	0.71	10.62	0.32	3.74	15.39	8.27	2.58	0.48	0.51	4.84	3.15	19.84
1991	64.57	0.70	10.49	0.32	3.74	15.26	8.36	2.60	0.50	0.53	4.87	3.31	20.17
1992	64.35	0.70	10.39	0.32	3.75	15.15	8.45	2.62	0.52	0.56	4.86	3.49	20.50
1993	64.11	0.70	10.28	0.31	3.76	15.05	8.53	2.64	0.55	0.58	4.86	3.67	20.83
1994	63.56	0.69	10.32	0.31	3.83	15.15	8.74	2.72	0.59	0.58	4.92	3.74	21.29
1995	62.90	0.68	10.42	0.31	3.91	15.32	8.99	2.82	0.64	0.58	4.99	3.76	21.78
1996	62.23	0.68	10.49	0.31	4.00	15.47	9.25	2.93	0.70	0.57	5.05	3.79	22.30
1997	61.52	0.67	10.56	0.31	4.09	15.62	9.52	3.04	0.77	0.57	5.15	3.82	22.86
1998	60.79	0.66	10.66	0.30	4.18	15.80	9.81	3.15	0.83	0.56	5.21	3.84	23.40
1999	60.04	0.65	10.74	0.30	4.28	15.98	10.10	3.27	0.91	0.55	5.28	3.87	23.98
2000	59.37	0.64	10.83	0.29	4.53	16.29	10.26	3.34	0.98	0.57	5.32	3.87	24.34
2001	58.74	0.62	10.92	0.28	4.78	16.60	10.38	3.40	1.06	0.59	5.37	3.85	24.66
2002	58.09	0.61	11.02	0.27	5.04	16.94	10.51	3.47	1.14	0.62	5.40	3.84	24.97
2003	57.41	0.59	11.13	0.26	5.32	17.30	10.65	3.53	1.22	0.65	5.43	3.82	25.29
2004	56.72	0.58	11.25	0.24	5.61	17.68	10.79	3.59	1.32	0.67	5.42	3.81	25.60
2005	55.65	0.57	11.30	0.24	6.08	18.19	10.95	3.67	1.40	0.71	5.52	3.91	26.16
2006	54.46	0.57	11.36	0.23	6.64	18.81	11.12	3.76	1.48	0.75	5.62	4.01	26.74
2007	53.22	0.57	11.41	0.23	7.26	19.47	11.28	3.84	1.57	0.78	5.72	4.11	27.31
2008	51.95	0.56	11.47	0.22	7.93	20.18	11.43	3.92	1.67	0.82	5.81	4.22	27.87
2009	50.62	0.56	11.53	0.23	8.66	20.98	11.55	3.99	1.77	0.87	5.89	4.33	28.40
2010	49.24	0.55	11.59	0.23	9.45	21.83	11.66	4.06	1.88	0.91	6.00	4.44	28.94
2011	47.81	0.55	11.64	0.23	10.32	22.73	11.74	4.12	2.00	0.95	6.11	4.55	29.46
2012	46.41	0.54	11.67	0.23	11.22	23.67	11.82	4.17	2.12	0.99	6.16	4.67	29.92
2013	44.97	0.53	11.71	0.24	12.20	24.68	11.88	4.22	2.24	1.03	6.19	4.78	30.35
2014	43.50	0.53	11.74	0.24	13.26	25.77	11.92	4.26	2.38	1.07	6.21	4.90	30.74
2015	41.99	0.52	11.77	0.25	14.40	26.93	11.93	4.29	2.52	1.11	6.22	5.02	31.08
2016	40.47	0.51	11.80	0.25	15.57	28.12	11.93	4.32	2.66	1.15	6.23	5.13	31.41
2017	39.82	0.50	11.71	0.25	15.41	27.88	12.31	4.32	2.68	1.12	6.54	5.33	32.30
2018	38.90	0.48	11.75	0.26	15.61	28.09	12.71	4.37	2.64	1.14	6.69	5.45	33.01
2018-1990	**-25.88**	-0.23	1.13	-0.06	11.87	**12.70**	4.44	1.79	2.16	0.63	1.85	2.30	**13.17**

Source: Author's calculations from GGDC's ETD. [Note: All Industries comprises of Mining, Manufacturing, Utilities and Construction. All Services is the aggregation of Trade, Transport, Business, Financial, Government and Other Services].

Table A.5: Average Annual Growth Rates of Value Added and Productivity, 1990-2018 in % (2015 Rupees)

	Value Added				Value Added Per Worker			
	Agriculture	Industry	Manufacturing	Services	Agriculture	Industry	Manufacturing	Services
1991-95	2.41	6.38	8.26	6.43	0.97	4.37	6.50	2.40
1996-00	3.27	5.55	5.62	7.60	3.03	2.82	3.35	3.78
2001-05	2.69	7.03	5.95	7.49	1.74	2.39	2.75	3.61
2006-10	3.22	8.91	10.62	7.66	5.34	4.58	9.60	5.06
2011-15	2.78	5.86	7.49	8.12	5.40	0.87	6.49	5.93
2016-18	4.60	6.47	6.51	7.77	6.55	4.23	5.82	4.88

Source: Author's calculations from GGDC's ETD

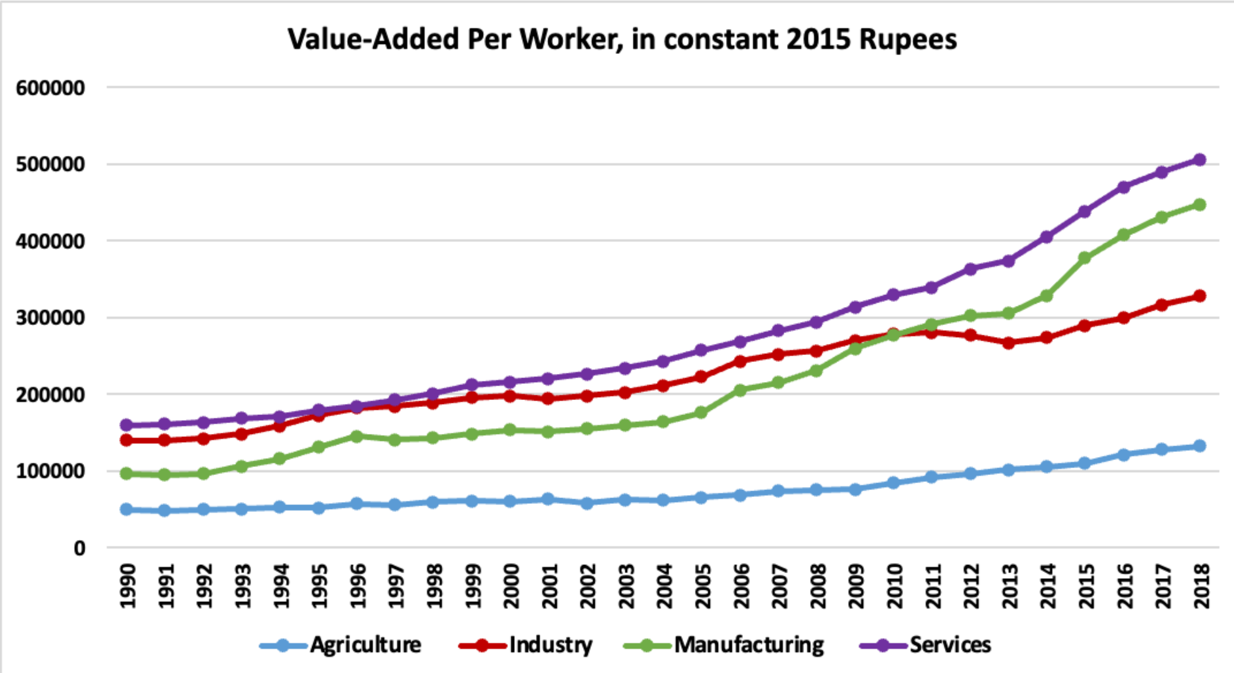

Figure A.1: Value-Added Per Worker – Sectoral Labour Productivity (Constant 2015 Rupees), 1990-2018

Source: Author's calculations from GGDC's ETD

Table: A.6: Growth Rates of Sectoral Share Coefficients or Production Linkages (corresponds to Table 5.2)

	Growth Rates (%)			
	Agriculture	Industry	Manufacturing	Services
1965				
Agriculture				
Industry				
Manufacturing				
Services				
1970				
Agriculture	0.6	-0.1	1.4	5.9
Industry	5.1	0.2	0.2	3.4
Manufacturing	3.9	-3.4	-2.2	-1.3
Services	-6.8	3.3	2.5	-1.9
1975				
Agriculture	2.4	-11.0	-13.5	2.3
Industry	39.6	11.8	12.0	3.0
Manufacturing	50.5	19.9	15.2	11.2
Services	19.9	9.3	12.8	0.3
1980				
Agriculture	14.4	-15.2	-16.2	-5.2
Industry	58.6	25.5	25.6	20.9
Manufacturing	63.2	27.9	30.0	28.7
Services	18.3	-6.8	-0.8	-16.5
1985				
Agriculture	-11.2	-21.3	-18.2	-1.6
Industry	1.1	4.9	5.5	1.0
Manufacturing	-0.4	-0.4	-2.0	-2.0
Services	10.8	4.3	6.3	2.3

1990				
Agriculture	-9.0	-6.5	-6.8	-16.6
Industry	-2.1	3.1	3.1	-2.9
Manufacturing	-3.2	7.2	5.9	-5.3
Services	-4.5	3.1	1.7	-4.9
1995				
Agriculture	-9.8	-10.6	-10.3	-3.2
Industry	6.1	-0.9	-1.3	-2.3
Manufacturing	8.3	-2.2	-0.4	-2.6
Services	15.8	7.8	7.5	7.1
2000				
Agriculture	4.1	-14.7	-12.2	-8.7
Industry	8.4	2.6	4.3	-26.8
Manufacturing	-9.0	-1.0	-2.9	-25.5
Services	3.0	-19.7	-15.7	-6.6
2005				
Agriculture	-3.8	-11.3	-12.3	-0.7
Industry	3.2	-1.0	1.3	4.8
Manufacturing	10.1	6.2	7.9	10.1
Services	13.9	16.7	16.9	10.0
2010				
Agriculture	-12.9	-4.6	-5.6	-11.2
Industry	-8.9	6.6	7.2	-1.1
Manufacturing	-6.3	2.2	-0.1	-1.5
Services	-6.3	-8.3	-9.0	-6.7
2014				
Agriculture	-8.1	-11.2	-11.1	-12.8
Industry	5.0	-2.1	-3.5	-10.8
Manufacturing	1.5	-6.3	-7.2	-13.3
Services	23.1	8.0	8.9	0.6
2015				
Agriculture	7.8	4.3	3.6	2.7
Industry	-2.5	-3.6	-3.1	-7.1
Manufacturing	-0.5	-1.8	-1.7	-4.5
Services	2.4	11.8	9.3	2.5
2017				
Agriculture	-3.0	-4.8	-5.8	-2.4
Industry	-1.1	-1.1	-0.4	-3.8
Manufacturing	1.0	-0.4	-1.0	-1.8
Services	3.2	0.4	0.7	-0.3

Source: Author's calculations based on GGDC I-O Database. Calculations for 2015 and 2017 are based on ADB Database.

Table A.7: Growth Rates of Inverse Matrices (Demand Linkages) – corresponds to Table 5.3

	Growth Rates (%)			
	Agriculture	Industry	Manufacturing	Services
1965				
Agriculture				
Industry				
Manufacturing				
Services				
1970				
Agriculture	0.2	-0.5	0.4	1.9
Industry	3.2	-0.1	-0.1	1.8
Manufacturing	0.6	-3.6	-1.1	-2.0
Services	-2.7	1.5	1.3	-0.1
1975				

Agriculture	2.0	12.5	9.0	15.4
Industry	73.3	17.1	39.7	29.4
Manufacturing	83.8	49.4	16.9	38.1
Services	51.4	37.0	38.9	4.5
1980				
Agriculture	10.4	75.8	73.3	90.2
Industry	224.5	75.6	152.6	139.0
Manufacturing	231.0	156.9	73.2	148.3
Services	117.6	84.1	91.2	14.5
1985				
Agriculture	-3.9	-13.3	-13.2	-12.5
Industry	11.8	11.3	15.4	13.0
Manufacturing	5.8	9.1	5.8	6.9
Services	12.7	15.6	15.6	4.3
1990				
Agriculture	-0.9	15.7	14.5	6.7
Industry	18.4	22.2	29.1	19.0
Manufacturing	20.8	33.6	23.0	21.5
Services	14.0	28.1	27.4	5.8
1995				
Agriculture	-2.8	-16.3	-15.8	-16.3
Industry	0.6	-4.7	-5.6	-6.4
Manufacturing	0.6	-6.3	-4.3	-6.7
Services	10.2	2.8	3.1	1.1
2000				
Agriculture	-1.8	-25.2	-24.5	-41.7
Industry	-12.8	-10.4	-12.8	-35.1
Manufacturing	-18.2	-17.4	-13.0	-37.7
Services	-23.9	-29.4	-28.8	-16.7
2005				
Agriculture	1.0	15.0	16.1	21.9
Industry	34.9	22.5	32.3	36.8
Manufacturing	44.4	38.9	29.5	45.8
Services	49.9	51.6	54.2	14.8
2010				
Agriculture	-1.2	22.2	20.7	14.8
Industry	21.7	32.3	39.3	31.9
Manufacturing	16.3	33.1	24.8	25.5
Services	4.1	19.9	19.0	4.3
2014				
Agriculture	-4.6	-40.1	-40.3	-44.4
Industry	-29.0	-28.6	-34.4	-39.1
Manufacturing	-31.6	-36.3	-30.4	-41.3
Services	-15.5	-26.0	-26.7	-11.7
2015				
Agriculture	0.4	-8.6	-8.2	-11.1
Industry	-14.7	-12.7	-15.8	-18.9
Manufacturing	-13.0	-14.5	-10.6	-17.1
Services	-2.2	-3.7	-3.8	-2.0
2017				
Agriculture	-1.0	-10.0	-9.9	-11.0
Industry	-5.5	-4.4	-5.5	-7.7
Manufacturing	-5.0	-5.5	-3.9	-7.2
Services	-2.7	-4.4	-4.3	-1.7

Source: Author’s calculations based on GGDC I-O Database. Calculations for 2015 and 2017 are based on ADB Database.

Appendix B

Table B.1: Descriptive Statistics

VARIABLES	Obs	Mean	Std.dev	Minimum	Maximum
Ratio of Manufacturing to Agriculture Value Added	63	0.519	0.210	0.210	0.948
Ratio of Industry to Agriculture Value Added	63	0.826	0.413	0.278	1.695
Agriculture Growth Rate	62	2.851	5.773	-12.775	16.324
Industrial Growth Rate	62	5.882	3.255	-3.141	12.095
Manufacturing Growth Rate	62	5.944	3.891	-3.700	14.900
Ratio of Manufacturing to Agriculture Employment	51	0.158	0.032	0.124	0.226
Ratio of Industrial to Agriculture Employment	51	0.214	0.070	0.151	0.371
Agricultural Productivity	51	19,452.923	3,702.726	14,843.820	29,912.420
Industrial Productivity	51	83,669.650	26,476.042	41,101.781	161,518.234
Manufacturing GDP	51	64,431.810	29,514.118	27,232.410	155,390.188
Ratio of ACF to AGDP	63	0.087	0.036	0.040	0.170
Trade Openness	63	0.207	0.137	0.081	0.590
Ratio of MCF to MGDP	63	0.471	0.170	0.140	0.938
Ratio of ICF to IGDP	63	0.430	0.121	0.141	0.748

Source: Author's calculations.[Note: Growth rates are in %. Productivity values are in Rupees.]

B.1 OLS Findings with Industry in Dependent Variable

Table B.2 presents the OLS results with Industry and Agriculture Value-Added as Dependent Variable. In (1) and (5) a percent increase in agricultural productivity is correlated with an increase in the ratio of value-added by 0.018 units, all else remaining constant. However, agricultural productivity is no longer significant when trade and industrial capital formation are controlled for in (4). A point increase in the ratio of ACF to AGDP, is correlated with an increase in the ratio of value-added by 3.1 points for industry in (4). A more suitable comparison, considering that the variables are expressed in ratios, would be that a 0.1 increase in (ACF/AGDP), is correlated with an increase of 0.31 and 0.17 points. Nonetheless, since trade openness is highly correlated (see Table B.7), we exclude that in column (5). In (5), a percent increase in agricultural productivity is associated with an increase of 0.0068 points in the ratio of industry to agriculture value-added. A 20% increase in agricultural productivity (almost equal to 1 SD increase from its mean) is correlated with an increase of 0.0136 points or 3.3% of SD for value-added ratio. Similarly, a 0.1 increase in ratio of ACF & AGDP is associated with an increase of 0.48 points of value-added ratio.

Table B.2: OLS regressions with Ratio of Industry to Agriculture Value-Added as Dependent Variable

	(1) 1960-2010	(2) 1950-2012	(3) 1960-2010	(4) 1960-2010	(5) 1960-2010
Log Agriculture Productivity	1.8726***		1.0442***	0.2525	0.6814***
	(0.14)		(0.20)	(0.19)	(0.15)
Ratio of ACF & AGDP		10.3571***	5.5343***	3.1079***	4.7914***
		(0.59)	(1.06)	(0.85)	(0.75)
Trade Openness				1.2128***	
				(0.36)	
Ratio of ICF & IGDP				0.9599***	1.3332***
				(0.20)	(0.19)
Constant	-17.57***	-0.08	-9.91***	-2.57	-6.8795***
	(1.41)	(0.06)	(1.86)	(1.80)	(1.37)
Observations	51	63	51	51	51
R-squared	0.778	0.835	0.858	0.945	0.931

Source: Author's Calculations. [Note: Standard errors in parentheses. ***, **, & * indicate significance at 1%, 5% & 10% levels respectively.]

While Table B.2 used value-added ratios as proxy for structural transformation, Table B.3 used employment ratio between industry and agriculture as dependent variable to capture structural transformation towards industry. We find that in (5) productivity in agriculture and ACF/AGDP ratio are positively and significantly correlated. A percent increase in productivity is associated with an increase of 0.0031 points of employment ratios or a 20% increase is associated with 0.062 points or nearly 89% of employment ratio's SD - all else remaining constant. Similarly, a 0.1 unit increase in ACF/AGDP is correlated with an increase of 0.038 units or 54% of employment ratio's SD.

Table B.3: OLS regressions with Ratio of Industry to Agriculture Employment as Dependent Variable

	(1) 1960-2010	(2) 1950-2012	(3) 1960-2010	(4) 1960-2010	(5) 1960-2010
Log Agriculture Productivity	0.3783***		0.3196***	0.2066***	0.3121***
	(0.02)		(0.03)	(0.03)	(0.03)
Ratio of ACF & AGDP		1.7910***	0.3923**	-0.0372	0.3768**
		(0.17)	(0.15)	(0.16)	(0.15)
Trade Openness				0.2982***	
				(0.07)	
Ratio of ICF & IGDP				-0.0641*	0.0277
				(0.04)	(0.04)
Constant	-3.52***	0.05***	-2.97***	-1.85***	-2.9104***
	(0.17)	(0.02)	(0.26)	(0.33)	(0.27)
Observations	51	51	51	51	51
R-squared	0.910	0.697	0.921	0.945	0.922

Source: Author's Calculations. Note: Standard errors in parentheses. ***, **, & * indicate significance at 1%, 5% & 10% levels respectively

Table B.4 presents OLS estimates of the relationship between industrial performance (proxied through productivity and growth rate) and agricultural performance (proxied through productivity, ACF/AGDP and growth rate). Columns (1) to (3) show that for industrial productivity, agricultural productivity and ACF/AGDP are strongly and positively correlated. In (3) we can find that a percent increase in agricultural productivity was associated with an increase in industrial productivity of 0.80%. And a point increase in ACF/AGDP is correlated with an increase in industrial productivity by Rs. 9728.78 i.e nearly 37% of its SD. In (4) after we control for capital formation in industry, a percent increase in agricultural productivity was associated with an increase of 0.47% in industrial productivity. Or a 20% increase (nearly one SD increase from its mean) in agriculture productivity is associated with of 9.4% increase in industrial productivity, while others are constant. And a point increase in ACF to AGDP ratio is associated with an increase of Rs. 4924.95 in industrial productivity i.e. nearly 19% of its SD. Agricultural growth was also positively and significantly correlated with industrial growth, a percentage point increase in agriculture growth was associated with an increase 0.16 percentage point increase in industrial growth, while others are constant.

Table B.4: OLS Regressions with Industrial Productivity and Growth Rate as Dependent Variables

	Log Industrial Productivity				Industry Growth Rate
	(1) 1960-2010	(2) 1960-2010	(3) 1960-2010	(4) 1960-2010	(5) 1950-2012
Log Agricultural Productivity	1.4856***		0.7988***	0.4713***	
	(0.14)		(0.21)	(0.17)	
Ratio of ACF & AGDP		8.0838***	4.5879***	3.9170***	
		(0.74)	(1.11)	(0.89)	
Ratio of ICF & IGDP				1.2038***	
				(0.22)	
Agriculture Growth Rate					0.1581**
					(0.07)
Constant	-3.36**	10.55***	2.99		5.43***
	(1.37)	(0.07)	(1.95)		(0.45)
Observations	51	51	51		62
R-squared	0.700	0.708	0.778		0.079

Source: Author's Calculations. Note: Standard errors in parentheses. ***, **, & * indicate significance at 1%, 5% & 10% levels respectively

The OLS estimations with Industry in dependent variable presents us with similar pattern, as we have seen earlier in section 5.4 with manufacturing in dependent variable. At the same time, we also found that agricultural productivity and capital formation was more crucial for manufacturing than industrial productivity

Table B.5: List of Drought Years in India Between 1960 and 2010

1965	1966	1967	1968	1969	1970	1972	1973
1986	1987	1988	2000	2001	2002	2003	2009
2010							

Source: Mishra 2020

B.1 Specification Tests

We performed the tests to determine whether our OLS estimates are Best Linear Unbiased Estimates. The results, shown below suggest that our estimates are robust to the problems of non-Normality of residuals, Multicollinearity of independent variables and Heteroskedasticity of unobserved error terms. We only present the results for one model which has manufacturing productivity (as a proxy for manufacturing performance) as the dependent variable (corresponding Column 4 in Table 5.6). The independent variables are log of agricultural productivity, ratio of ACF and AGDP and ratio of MCF and MGDP. We exclude Trade Openness as it correlates strongly with the other explanatory variables as can be seen in Panel 2 of Table B.7

Normality:

Figure B.1 presents the histogram of the error terms, and it can be seen that they largely follow a normal distribution.

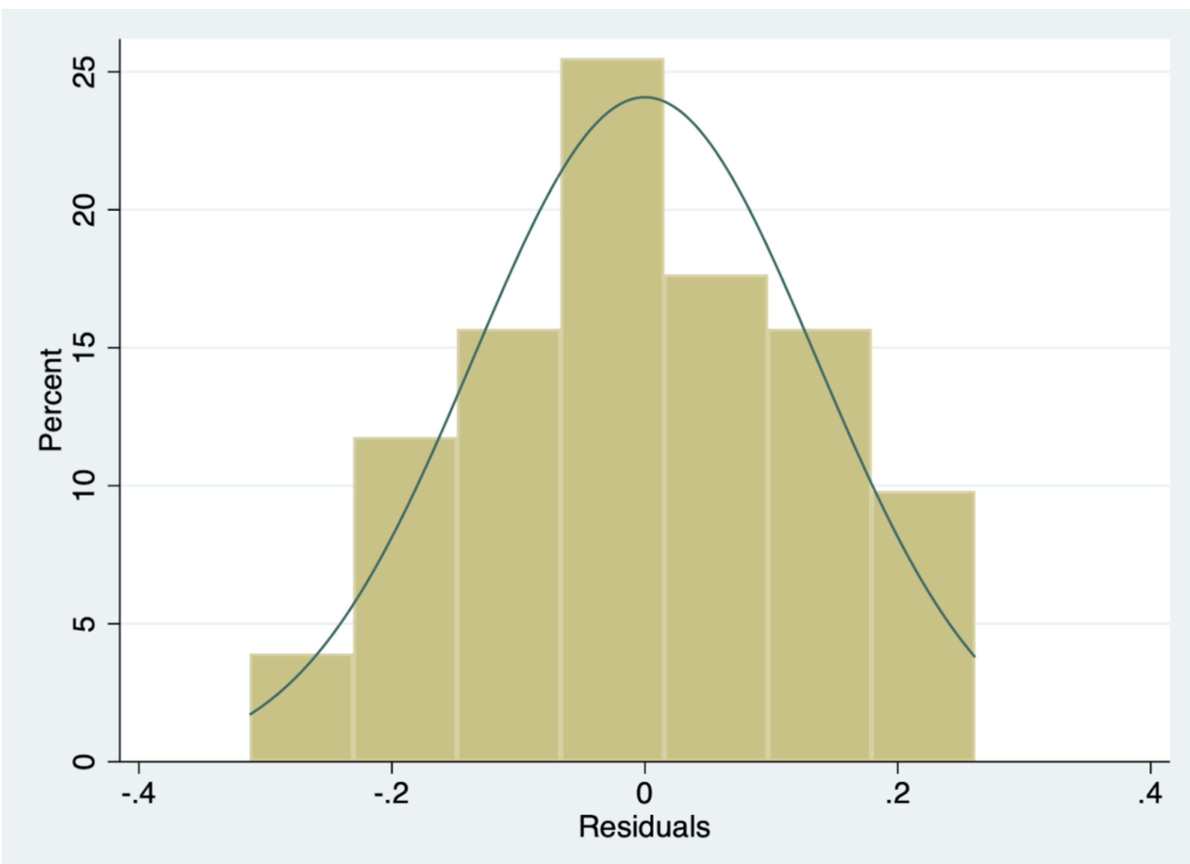

Figure B.1: Normal Distribution of Error Terms

Source: Author's calculations

To confirm that the residuals are normally distributed, we perform the skewness and kurtosis test and the results are presented in Table B.6. Since the probability value is insignificant, we cannot reject the null hypothesis that the residuals are normally distributed.

Table B.6: Test for Normality

	Observations	Pr(skewness)	Pr(kurtosis)	Adj chi^2	Prob> chi^2
Error terms	51	0.8419	0.5227	0.46	0.7954

Source: Author's calculations

Multicollinearity:

We check for collinearity or the correlation among the explanatory variables using the Variance Inflation Factor (VIF). Pane 2 of Table B.7 consists of VIF for all our explanatory variables used in the study, and it can be seen that Trade Openness has a value greater than 10, showing high correlation. Hence, we run our regressions excluding that as well – all the tables with OLS findings have an equation without Trade Openness. Excluding it doesn't alter the results, as its variation is captured by other explanatory in any case. VIF for the explanatory variables excluding Trade, shows that all the variables are less correlated with a value less than 5. Hence, we can conclude that our explanatory variables are uncorrelated.

Table B.7: Variance Inflation Factor

PANEL 1		
Variables	**VIF**	**1/VIF**
Log Agriculture Productivity	4.12	0.242445
Ratio of ACF & AGDP	2.90	0.344829
Ratio of MCF & MGDP	2.26	0.441554
Mean VIF	3.10	
PANEL 2		
Variables	**VIF**	**1/VIF**
Trade Openness	12.79	0.078214
Log Agriculture Productivity	6.20	0.161267
Ratio of ACF & AGDP	4.84	0.206548
Ratio of MCF & MGDP	3.15	0.317218
Mean VIF	6.75	

Source: Author's calculations

Heteroskedasticity:

To obtain a best linear unbiased estimator the variance of the error terms from the fitted values should be constant.

Breusch-Pagan Test: To check for that, we conduct a Breusch-Pagan test for heteroskedasticity, which has "Constant Variance" as its null hypothesis. The results of the test are shown below, and it can be seen that we cannot reject the null hypothesis as the 'p' is insignificant.

Assumption: Normal error terms

Variable: Fitted values of Log of Productivity of Manufacturing

H0: Constant variance

chi2(1) = 0.39

Prob > chi2 = 0.5346

White's Test: We confirm these results by conducting White's Test for heteroskedasticity, which shows similar results. The null hypothesis for White's test is homoskedasticity and since the p value is insignificant, we cannot reject the null hypothesis.

H0: Homoskedasticity

Ha: Unrestricted heteroskedasticity

chi2(9) = 12.90

Prob > chi2 = 0.1673

Appendix C

Table C.1: State-Wise Sectoral Shares of Value-Added (%), 2018

	Agriculture	Industry	Manufacturing	Services
ANDAMAN & NICOBAR	12	16	1	64
ANDHRA PRADESH	32	22	9	38
ARUNACHAL PRADESH	36	20	1	39
ASSAM	16	33	12	42
BIHAR	22	17	7	58
CHANDIGARH	1	10	4	83
CHHATTISGARH	19	40	13	34
DELHI	0	13	4	74
GOA	6	49	38	35
GUJARAT	13	44	32	31
HARYANA	17	29	17	43
HIMACHAL PRADESH	12	42	30	39
JAMMU AND KASHMIR	17	20	7	57
JHARKHAND	16	36	20	39
KARNATAKA	10	22	14	59
KERALA	10	22	9	57
MADHYA PRADESH	36	25	9	34
MAHARASHTRA	9	27	17	52
MANIPUR	27	9	2	60
MEGHALAYA	19	18	9	57
MIZORAM	26	26	1	44
NAGALAND	29	12	1	57
ODISHA	18	38	21	34
PUDUCHERRY	4	47	27	41
PUNJAB	26	23	13	42
RAJASTHAN	24	25	10	45
SIKKIM	10	60	43	26
TAMIL NADU	11	32	19	49
TELANGANA	13	21	11	56
TRIPURA	31	22	3	43
UTTAR PRADESH	22	25	12	44
UTTARAKHAND	9	46	35	38
WEST BENGAL	21	22	13	50

Source: Author's calculation from Reserve Bank of India (2021)

Table C.2: State-Wise Share of Manufacturing in India's Manufacturing Value-Added (%), 2018

ANDAMAN & NICOBAR	0.0
ANDHRA PRADESH	2.7
ARUNACHAL PRADESH	0.0
ASSAM	1.3
BIHAR	1.2
CHANDIGARH	0.0
CHHATTISGARH	1.4
DELHI	1.2
GOA	0.9
GUJARAT	**16.7**
HARYANA	4.1
HIMACHAL PRADESH	1.5
JAMMU AND KASHMIR	0.4
JHARKHAND	2.1
KARNATAKA	7.2
KERALA	2.5
MADHYA PRADESH	2.4
MAHARASHTRA	**15.3**
MANIPUR	0.0
MEGHALAYA	0.1
MIZORAM	0.0
NAGALAND	0.0
ODISHA	3.6
PUDUCHERRY	0.3
PUNJAB	2.3
RAJASTHAN	3.1
SIKKIM	0.4
TAMIL NADU	**11.0**
TELANGANA	3.4
TRIPURA	0.0
UTTAR PRADESH	6.7
UTTARAKHAND	2.9
WEST BENGAL	4.9

Source: Author's calculation from Reserve Bank of India (2021)