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Mdutyana, Liso

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The Effect of Technological Changes on Work Restructuring: A Comparative Analysis of the South African and Brazilian Automotive Manufacturing Industries

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by

Name: **Liso Mdutyana**
Student No:
1929902

Supervised by Dr Sibulele Nkunzi & Prof. Alexis Saludijan

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I. Introduction

Manufacturing industries have through the history of twentieth and twenty first century development economics occupied a central role in discussions on economic development. Rosenstein-Rodan (1943) argued that the alleviation of unemployment and underdevelopment in 1940s Eastern-Europe could be brought about by a government-funded establishment of complementary manufacturing industries. Lewis (1954) posited that unemployment in developing countries can be drastically reduced with a transfer of unskilled labour from the agricultural to the more productive industrial sector. Meanwhile, the Global Value Chain (GVC) literature emerging in the 1990s and 2000s touted the possibility of development through attachment of local firms to the production networks of technologically superior 'lead firms', wherein they could 'upgrade' into more valuable products, processes, or sectors (Gereffi, 2019). Underlying the advocacy for manufacturing sectors have been economic growth models wherein the primary factor determining economic growth is the accumulation and or the increased capability of physical capital (Harrod, 1939; Solow, 1956). With concerns over the lack of convergence in the economic growth rates of 'developed' and 'developing' countries, later scholars mainly attributed long-run economic growth to investments in human, rather than just physical capital (Romer, 1989).

Scholars from many disciplines have attempted to grapple with the effect of technology on work. On one hand, Marx (1867), Braverman (1975), and Burawoy (1979), view the expansion in the use of physical capital in industry as a method to increase efficiency, increase management control of the labour process, and to deskill the workforce. On the other, Ames & Rosenberg (1965) associate technological progress with an increase in worker skill. The concern over the effects of technology on work have grown louder with governments of low-income countries wielding the manufacturing industries to be the anchor of the drive towards economic development. In the past century, one method favoured by countries hoping to industrialize is attracting multinational corporations, where it is hoped that their superior level of technology will filter into the rest of the economy and lead to technological upgrading. With manufacturing and especially the automotive

industry playing a central role in government policies to bring about growth and employment, it is imperative to look at how production in these sectors relates to workers.

The automobile industry has especially been a target for developing countries, due to its possession of backwards and forward linkages to the rest of the economy. Elsewhere in the developed world – primarily consisting of much of North America, Western Europe, and Japan – a crisis in the profitability of industry (Albo, 2009, pp. 119-122) is said to have motivated the relocation of some stages of production to regions that are relatively low cost, and the installation of labour-saving technologies (Moody, 1997, pp. 81-83). Beneficiaries of this relocation and extensions of multinational corporations have been the likes of South Africa and Brazil (Oberhauser, 1993, pp. 99-100), which are the subject of our investigation. The automotive industry has formed part of the bedrock of both countries' quest for industrial and economic development since the 1950s (Shapiro, 1988, p. 60; Lamprecht et al., 2011, pp. 57-58). Moreover, the industry has been put through significant technological transformations. It is therefore an ideal candidate through which we can evaluate the effect of technological change on work restructuring.

At least two factors make the countries warrant a comparison. South Africa and Brazil's automotive manufacturing industries are both overwhelmingly dominated by multinational corporations from the developed world (NAAMSA, n.d. A; ANFAVEA, n.d.). Both countries' economies underwent liberalization in the 1990s, affecting capital-labour relations as extensive restructuring took place (Zilbovicius et al., pp. 11-12, 2002) Using the framework of 'Varieties of Capitalisms', we will look at the impact of technological changes on three aspects of work: employment levels, skills, and occupation. This dissertation will primarily focus on the 1990–1999 period when computerization and robotization first took hold in the countries, and there will be a secondary focus on the periods since. This study is unique in that it will be the first in the South African literature that approaches the topic through the framework of Varieties of Capitalisms.

The two guiding research questions are:

1. In Brazil and South Africa, respectively, what have been the effects of technological changes on the volume of employment, skill demands, and occupations, in the automotive manufacturing industry?
2. How does the effect of technological change on volume of employment, skill demands and occupations compare across the two countries? What accounts for the differences and similarities?

We find that with respect to skills and occupations, Brazil and South Africa have been similarly affected by technological changes. In both countries, there has been an increased emphasis on training and multi-skilling, and a relative decline in the importance of manual work. This can be attributed to the presence of a sectorial system of vocational training and education in both countries, which generates workers whose profile fits the industry's needs. With employment, we find that because of union strength and government alignment with unions, the South African industry has been relatively stable. By contrast, in Brazil employment levels in the industry have fluctuated due to the weakness of the relationship between government and trade unions. The rest of the paper will feature the sections in this order: **II.** Theoretical Framework; **III.** Literature Review; **IV**. Data and Methodology; **V**. History of Automobile Industry; **VI**. History & Background, **VII**. Results and Discussion; **VIII.** Comparative Analysis and Discussion; **IX**. Recommendations and Conclusion

II. Theoretical Framework

2.1. Varieties of Capitalism

Description of the Basic Model

Varieties of capitalism is a framework for "understanding the institutional differences and similarities" among developed and developing countries (Hall & Soskice, 2001, pp. 1-2). By 'institutions', Hall & Soskice (2001, p. 9). denote "a set of rules, formal or informal, that actors generally follow, whether for normative, cognitive, or material reasons". Whereas by 'organizations', they mean "durable entities with formally recognized members". This conception of institutions and organizations is rooted in the work of Douglass North (North, 1990, pp. 3-5) and other works in the 'New Economics of Organization' literature (Hall & Soskice, 2001, p. 14; Padayachee, 2013, pp. 11-12). The unit of analysis of the varieties of capitalism framework is the national political economy. The political economy is conceived by Hall & Soskice (2001, p. 6) as an arena of actors, each of whom seeks to advance their self-interest in a "rational" manner and in "strategic interaction" with other actors. Strategic interaction involves decision making by an actor that is considerate of how another actor may decide (Jehle & Reny, 2011, pp. 305-306).

The key actor in the capitalist economy is the firm (Hall & Soskice, 2001, p. 6). The firm, Hall & Soskice (Hall & Soskice, 2001, pp. 6) propose, is interested in maintaining "core competencies" and creating

“dynamic capabilities". In its quest to achieve that, it encounters coordination problems in at least five spheres (Hall & Soskice, 2001, pp. 6-7):

- Industrial relations – how the firm negotiates the wages, working conditions and productivity levels with its work force.
- Vocational training and education – how the firm ensures its workforce is adequately skilled meanwhile workers ‘choose' their skill levels.
- Corporate governance – concerns how the firm finances its operations as investors look for good returns on investment.
- Inter-firm relations – relationships the firm forms with other firms to sell or buy products or collaborate on projects.
- Employees – concerns ensuring cooperation among workers, and boosting their competencies while being wary of workers’ capability to withhold effort.

A national political economy then is categorized according to how firms go about dealing with the coordination problems found in the five spheres (Hall & Soskice, 2001, p. 8). From this, Hall & Soskice (2001, p. 8) distinguish among ‘Liberal Market Economies’ (LMEs) and ‘Coordinated Market Economies' (CMEs) - which lie on opposite poles - and some hybrid of the two which lie within the spectrum. In LMEs, firms rely on hierarchies and markets to coordinate their activities. Meanwhile in CMEs, firms rely not *only* on market but also lean heavily on non-market avenues to coordinate their activities (Hall & Soskice, 2001, p. 8). Essentially, outcomes in LMEs are market-determined (i.e., supply and demand), while in CMEs, they involve a great deal of negotiation between the relevant partners.

In CMEs, other than markets, firms are said to make extensive use of non-market mechanisms to coordinate their activities. As these economies are characterized by negotiation between actors to achieve an end, the institutions that need to be present are those that allow for, the exchange of information, the monitoring of behaviour, and the punishing of defection (Hall & Soskice, 2001, p. 10). Exchange of information can be good as one party may hold information – that is not available anywhere else – which could help the other party, or in fact be allow for a more desirable outcome to be achieved. Exchange of information can also be important for reasons of fairness

(and therefore industrial peace) as it could allow another party to adequately prepare, for example, a counteroffer, and not feel as though they are caught off guard. For the latter reasons, the exchange of information in some instances may be undesirable, for example, if one party is unwilling or unable to carry out their end of the deal but still want the benefits from the deal. Thus, it is important to have means to ensure that people carry out the end of their deal, through monitoring and punishing them. Punishment is also important because it sets a precedent that if the other party violates the terms of the agreement again, the consequences will be dire (e.g., grim strategy). In a coordinated market economy therefore, there should be institutions which ensure that parties stick to their agreements and are immediately sanctions if they fail to do so.

2.1.1. *Institutions*

The role of institutions in the varieties of capitalism framework is that they must have the capacity to allow the actors to overcome the factors that hinder cooperation in their relationship. For Hall & Soskice, institutions support the relationships that firms form to overcome coordination problems (Hall & Soskice, 2001, p. 9).

Hall and Soskice (2001, p. 9) mention markets as one kind of institution found in capitalist economies, that can underpin relationships characterized by "arm's length relations and high levels of competition". Hayek (1945) provides a classic example of how markets support arm's length-type transactions. Essentially, Hayek (1945) argues that in a society where there is a countless amount of interdependent economic actors, each of which is facing unique circumstances, it would be impossible for any single entity - such as an individual or a state - to gather all information on those actors. This is because such information is not limited to codifiable information, for example, how much a certain producer produced in a day. Rather, such information includes "knowledge of particular circumstances of time and place", which is never found "concentrated or integrated", but is dispersed widely among all individuals (Hayek, 1945). Thus, the market, through the price system, allows an individual to have all the information they need to transact, without having had to expend much time or effort.

2.2. *Critiques and Extensions of the basic model*

Above we have described the original articulation of the most basic Varieties of Capitalism model. But over the years, the basic framework has been subject to critiques and subsequent extensions.

Padayachee identifies at least three variants of the approach. First is the institutionalist variant, which we have just described above, and whose original iteration featured only a binary (rather than a spectrum) classification of national political economies as either LMEs or CMEs (Padayachee, 2013, p. 6). Second is the 'structuralist' variant, which abstracts from country case studies to classify countries into different national models of capitalism, such as Anglo-American or Anglo-Saxon models (Padayachee, 2013, p. 7). The main difference between these two variants is methodology. Whereas the institutionalist variant attempts to fit countries into a binary or a spectrum depending on how well that countries' relevant features (e.g., institutions for wage determination, or relations between business and state) align with some idealized conception of what the features of a 'liberal' or 'coordinated' are, the 'structuralist' variant categorizes countries by abstracting from the relevant features and putting countries that are broadly similar with regards those features into one category. A third variant is the 'Marxist' strand, which "places particular national capitalisms in a larger global picture to explore issues of stability and performance through the lens of class competition" [(Coates, 2005, p. 23), quoted in Padayachee, 2013, p. 9). In this Marxist variant, capitalism is recognized for its adaptability in different social and national settings (Padayachee, 2013, p. 9). National capitalisms here can be distinguished by features including but not limited to the labour process, and the extent of integration into global markets (Padayachee, 2013, pp. 9-10).

One critique of the varieties of capitalism is that national capitalisms are so tied up into the "structural imperatives of global accumulation" as to make any Varieties of Capitalism lens – which it is claimed treats national capitalisms as "analytically distinct from, and not constitutive of, the imperatives that emerge from the world market" – futile (Bond, 2013, p. 180). Indeed, as demonstrated by Bond (2013, pp. 185-202), the South African economy, from the infiltration of British capital in the mining sector in the 19th century, to the rise in foreign debt during the 2000s, has been under the subjugation of global accumulation regimes**.** Albo (2005) spells out the implications of taking this analytical stance. "Technological change is not being driven by supra-market processes of rationality, but by the imperatives of value production. This certainly means not only examining the new intensive accumulation in terms of the extent of yield of higher output per unit of labour input from the addition of new technologies to the capital stock, but also the squeezing of more surplus labour out of labour power in terms of the extension of work hours, work intensification, and the smaller share of new value-added being taken by workers. Explaining

these

developments as failures of institutional adjustment of training capacities, or collective bargaining demands, leaves unexplained the generality of the processes of austerity across different models of capitalism (Coates 1999)" (Albo, 2005, p. 73). To this we argue that the analytical distinction between national capitalisms can be useful because we do indeed find that within the global capitalist system, there has been different distributional outcomes.

A more striking criticism of the varieties of capitalism model comes from Hay (2005). Hay (2005, pp. 106-107) argues that when the framework tends to rest on a "micro-foundations-based rationalist variant of the new institutionalism", it becomes incapable of dealing with matters such as "complex institutional change over time". Consequently, Hay (2005, p. 107) it tends towards "agentless and apolitical conception of institutional adaptation to largely exogenous challenges and imperatives" and a reliance on "mechanistic understanding of 'bifurcation' or 'dual convergence' amongst models of capitalism in response to globalisation". As Nattrass (2014, pp. 57-58) points out, this problem can be overcome through "highlighting the political processes shaping the nature of institutional configurations and co-ordination"

2.3. *Alternative Theoretical Frameworks*

Another framework, labour process theory (LPT), seems appropriate to deal with the issue of technological changes and its effects on labour. Labour process theory which posits that one of the primary motives of the introduction of new machinery and new methods is to "dissolve labour process as a process conducted by the worker and to reconstitute it as a process conducted by management" (Braverman, 1998, p. 118). The implication being that technological change serves the function of tilting the balance of power in the workplace away from the workers – where they might attain greater control of the process and more bargaining power – and towards management, who presumably as agents of the owners, will do all that is necessary to make the firm more profitable and competitive. Some of the key studies on work restructuring in the South African automobile industry, such as Mashilo (2010) and Masondo (2010), have made use of the labour process theory framework. No studies in South Africa on technological change and work restructuring have made use of the varieties of capitalism framework. We do not reject the LPT framework. In fact, despite having different theoretical backgrounds, we view these frameworks as complementary. Where labour process theory tries to understand capitalist control over the labour process as a manifestation of the need to extract greater surplus value from worker in order to

maintain or increase profitability, the Varieties of Capitalism aims to understand how that conflict is shaped by the institutional structure in which the firm exists. Consequently, it is able to contribute in explaining why countries, regions, or societies that are broadly capitalist may have different outcomes with regards to gains for workers, firms, and the state.

III. Literature Review

3.1 Technology and Technological Changes

3.1.1 The Meaning of Technology

Technology, as conceived of in this paper refers to product technology and process technology. Product technology entails how a product is, for example, its design and features, while process technology entails how that product is produced, for instance, what machines are used or what role each worker plays in constructing the product (Anderson & Tushman, 1990, p. 607). The primary focus of our study is changes in process technology.

3.1.2 Technological Change

In their evolutionary theory of technological change, Anderson & Tushman (1990, pp. 604-606) posit that technology moves between phases of incremental changes and discontinuity, followed by a scramble to produce a dominant design (a variant of the discontinuity). They found evidence for their theory in the cement; glass; and minicomputer industries. Furthermore, they proposed that a technological discontinuity can be competence-enhancing, that is, it "builds on know-how embodied in the technology that is replaces" (Anderson & Tushman, 1990, p. 609). On the other hand, a discontinuity can be competence-destroying when it "renders obsolete the expertise required to master the technology that it replaces" (Anderson & Tushman, 1990, p. 609). The concepts of 'competence-enhancing' and 'competence-destroying' are useful for our discussion.

Bright enumerates some of the reasons behind the mechanization of tasks: cost of labour; cost of machinery; nature of materials; product design standards; new inventions; availability of capital; changes in demand (Bright, 1958, pp. 15-16). Furthermore, Friedman (1990, p. 1999), posits that the entire process of technological change, from what technology is developed, to what technology gets widespread use is not random. Rather, it "depends on market conditions, particular management strategies being pursued and their interaction with worker resistance" (Friedman, 1990, p. 199). In the automotive industry Ford's introduction of the division of labour appears to have been a key step towards introduction of further automation of the assembly process. Young (1928, p. 530) argues that the division of labour allows for the fragmentation of complex processes, "some of which, at least, lend themselves to the use of machinery".

3.2. Factors that Determine the Adoption of Technology

3.2.1. The Relative Cost of Labour

In economic theory, the choice of technology is evaluated through the relative price of inputs. These are often labour and capital. But a neglected aspect is that a technology might be a substitute to one type of labour yet a complement to another. The consensus in the literature on relative prices of inputs is that high unit costs of labour encourage the use of labour-saving technology.

Downey (2021) uncovers this aspect of technological change in their study of the influence of minimum wages on the adoption of computers. Downey notes that the adoption of computers comes with the one-time cost of setting them up and the recurring cost of operating them. Significantly however, with computers subsuming much of what a worker previously had to do manually, the same activity can now be done with a worker of lesser skill. Thus, computers often not only replace higher-skilled workers but also introduce lower-skilled workers (Downey, 2021, pp. 1-3). Using the state variation in minimum wages in the United States, Downey finds that a $1 decrease in the minimum wage (price of lower skilled labour) increases I.T. worker employment (a proxy for computer adoption) on average by 30% (Downey, 2021, p. 14). This means that once lower skilled workers become cheaper (lower minimum wage), firms replace high skilled workers with low skilled workers. Fan et al. (2021, p. 608) also use variation in minimum wages in within China to look at the causal impact of higher labour costs on Chinese firms' adoption of robots. For the 2004-2007 period there is an insignificant impact. However, there is a statistically significant impact in the 2008-2012 period, with a 10% increase in the minimum wage increasing a firm's probability of adopting robots (compared to firms in other cities) by 0.11 percentage points (Fan et al., 2021, p. 617).

In sum, the presence of technologies that are complementary to one type of labour while being substitutes to another can affect the skills composition of a workforce when firms react to a change in market conditions. Hence, the effect a technology change has on the skill demands of workers depends on the capabilities of that technology.

3.2.2 Multinational Corporations and Foreign Direct Investment

The prevailing views on technology within multinational corporations centre on the potential exposure of technology to rival firms. One view, exemplified by Morita & Nguyen (2021, pp. 3-

6) argues that when an a technologically superior foreign firm starts to produce alongside technologically inferior local firms, it will strategically reduce the quality of its products (and therefore processes), to avoid technological spill overs. The second view claims that rather than outright concealing its superior technology, the incoming foreign firm will use production processes that rely more on tacit knowledge, which are harder to imitate (Thoenig & Verdier, 2003, pp. 710-719). Baranson (1970) meanwhile investigates the factors that determines whether a

subsidiary receives technology transfer by licensing or by foreign direct investment. Among the factors noted include the nature of technology transferred; technology transfer environments in the countries of the donor and recipient firms; absorptive capacities of the recipient firm; and the transfer capability and strategy of donor firms (Baranson, 1970, pp. 435-436). The type of technology available within the subsidiary firm, as we will see, influences the type of labour demanded, and is therefore crucial to understanding work restructuring.

Integration within the production network of multinational corporations has been associated with the use of advanced technologies. Leone (2023) using Spanish manufacturing data for the period 1990-2017, found that ownership by multinational corporation increases a local firms' likelihood to adopt robots. Precisely, following acquisition by an MNC, the probability of adopting robots increased by 17 percentage points (Leone, 2023, p. 19). The only explanatory variable to have statistical significance in explaining why acquired firms adopt robots is "ability to export via the parental network" (Leone, 2023, p. 22). This explanation suggests robot adoption is more likely if the subsidiary will exploit opportunities to export via the parent company's network. Anzolin et al. (2022) look at the drivers of robot adoption in the automotive value chain. Specifically, they look at whether FDI leads to robot adoption. The authors correctly postulate that FDI by itself does not lead to robot adoption, but only does so when in combination with factors such as innovation and a capacity to export (Anzolin et al., 2022, p. 8).

3.3. Work Restructuring

Work restructuring is a contemporary trend which concerns the introduction of new forms of work worldwide, especially since the advent of the neoliberal era as the post-World War Two economic boom waned. The issue has been dealt with extensively by writers in the classical political economy - e.g., Marxists – tradition. The underlying ethos behind work restructuring is the search for ever- more efficient ways of producing (Webster & Omar, 2003, p. 195), thus, it has been characterized by cost-cutting methods such as downsizing of the workforce (Webster et al., 2008, p. 204) and resorting to cheap labour pools (Albo, 2009, p. 122). Work restructuring has also been associated with the flexibilization of employment (Lewchuk & Robertson, 1997, pp. 37-38). Thus, the prevailing story of work restructuring has been that of increased job insecurity for workers.

Within the automotive industry, the global spread of the lean production system has been credited with bringing about restructuring. Silver details the original form of this system, which featured a

multi-

layered subcontracting system with a core work force guaranteed employment while simultaneously obtaining low-cost inputs and flexibility from non-core areas of the supply network has been credited (Silver, 2003, p. 42). Albo (2009, p. 123) and Lewchuk & Robertson (1997, pp. 37-38) have further pointed to the co-optation of labour in partnering with management to fulfil the firm imperative of increasing competitiveness as a characteristic of work arrangements as the lean production system came to dominate. Webster & Omar (2003) look at how work restructuring has transpired post-apartheid South Africa. With restructuring brought on by shocks such as financial deregulation, privatization, and trade liberalization, the industries are characterized matters ranging from massive retrenchments to introduction of teamwork (Webster & Omar, 2003, p. 209).

3.4. Worker Participation

Worker participation is about the "the degree of influence or voice employees have in decisions about their work, their employment conditions, and the management of their organization" (Boxall & Purcell, 2010, p. 32). Haipeter (2019, p. 150) notes that in a capitalist context, it is the owners of the means of production ('capitalists') – or their delegate, the manager – who makes decisions about production, investments, and organization. Worker participation in those affairs then would appear to be 'invasive', as it trespasses into areas considered the prerogative of capitalists and managers. Perspectives on Worker Participation include the 'Human Resources Management' (HRM) perspective (Boxall & Purcell, 2010, pp. 29-51), Labour Process and Marxist perspectives (Lucio, 2010, pp. 105-130). Further worker participation may be categorized into two types: individual and collective or rather indirect/representative and direct. Examples of collective/representative worker participation include works councils; factory committees; and bodies of union representatives meanwhile individual worker participation can be exemplified by profit and capital sharing schemes (Pries, 2019, p. 43; Furstenburg, 1993, pp. 53-55).

Boxall & Purcell (2010, p. 33) give the following typology on worker participation:

	Power-centred	Ownership-centred	Task-centred
Indirect involvement	- Worker directors - Works' councils/ Employee Forums/ Joint Consultative Committees (JCCs) - Collective Bargaining - Joint Partnership Committees	- ESOP (Employee Share Ownership Plans) where shares are held by trustees directly elected by employees - Worker cooperatives	- Employee representatives
Direct involvement	- Attitude surveys - Newsletters/email/intranet - 'town hall' meetings	- Share option (purchase schemes) giving employees 'votes as shareholders	- Job enrichment (voice in how the job is done) - Semi-autonomous teams - team briefing - problem-solving groups (quality circles/ Kaizen team/ continuous

			improvement group) - Suggestion schemes

According to Haipeter (2019, p. 156), some scholars such as Blumberg view direct worker involvement in the economic affairs of a plant as essential to participation, and consequently reject representative forms as institutions of participation. Masondo (2010, p. 25) quotes Mandel (1973) and Burawoy (1979), both of whom see worker participation as a way to bring about a more 'subtle' form of domination by capital and coercion of labour. This is perception of worker participation is more in line with 'management-initiated participation'. Management-initiated participation is a form of participation based on 'participatory managerial ideologies'. That form is regarded as 'task-centred' rather than 'power centred', and as being inclined towards 'consultative rather than participative institutions as it conceives of the firm as a unitary organization (Haipeter, 2019, p. 157). Boxall & Purcell distinguish between normal consultation and 'meaningful' consultation. They describe meaningful consultation as the kind that involves procedures where workers are given comprehensive information, adequate time to craft and deliver responses, and where workers' proposals are seriously considered (Boxall & Purcell, 2010, p. 37). By contrast, there is a variant of participation – the kind preferred by many managements in the Anglo-American world – where there is some information-sharing and discussion between management and workers, but where there is no real threat to managerial interests (Boxall & Purcell, 2010, p. 37).

Worker participation highlights the potential agency that workers have in shaping production processes. Worker participation offers an organized way by which capital and labour contest what the nature of technological changes and their implication for how work may be restructured. Within our Varieties of Capitalism framework, worker participation – depending on its nature, as outlined above – touches on three of the five spheres that firms encounter coordination problems. These are

industrial relations, vocational training and education, and employees. Varieties of Capitalism framework highlights that the mere form taken by worker participation will not dictate the degree that workers are able to affect the way in which technological change affects work restructuring. Rather, we must also consider how the firm solves its coordination problem.

3.4.1. Worker Participation in Multinational Corporations

Warner & Peccei (1977) shine a light on the importance of the institutional structure of firms in affecting the possibility and the scope for worker's participation. They argue that neglecting the structure of decision making within an organization makes any discussion on worker participation redundant (Warner & Peccei, 1977, p. 8). Focusing on multinational corporations, they assume

that there is a “strong tendency for headquarters to centralize decisions” (Werner & Peccei, 1997, p. 9). However, the degree of centralization in decision making exhibited by any MNC will depend on the practicality and possibility of such centralization as well as the headquarters’ assessment of the risk of giving more autonomy to a subsidiary (Werner & Peccei, 1997, p. 9).

3.5 Technological Change and Work

3.5.1. Technological Change and Employment

Some scholars have argued that increasing use of more complex mechanisms, that is, those mechanisms that incorporate more and more of the tasks previously performed by human labour, threatens to gradually expunge the worker from some areas of production (Marx, 1976 (1867), p. 497; Bright, 1958, p. 41; Braverman, 1975, pp. 129-131). More provocatively, they suggested that adoption of these kinds of mechanisms (e.g., machines) functioned to subject the labour process to less worker control and more managerial control (Braverman, 1975, pp. 133-134; Thompson, 1989, p. 50; Gartman, 1979, pp. 196-198). Furthermore, this school of thought proposes that use of evermore complex mechanisms leads to some tasks to be doable by a considerably less ‘skilled' worker (Thompson, 1989, pp. 50-51), in a phenomenon known as ‘deskilling' (Thompson, 1989, p. 91).

But workers are not equally susceptible to replacement. Autor (2015) posits that the nature of a job affects a worker’s vulnerability to be replaced by a machine. Autor focuses their attention on ‘routine tasks’. Routine tasks are the types of tasks that “follow precise, well-understood procedures” making them codifiable and thus lends them to be automated (Autor, 2015, p. 11). Fu et al. (2021, p. 675) finds that the stock of robots is positively related to aggregate employment in developed countries, while there appears to be no relation between the two in developing countries.

2.4.1. Technological Change and Skill and Occupation

Ames & Rosenberg (1965) argue that technological change which increases the complexity of machinery leads to the increased importance of more educated/trained workers. The method of assessment by Ames and Rosenberg is linked to the concept of specialization. Specialization can be thought of as a ratio which denotes the number of doers of an activity to the number of activities done (Ames & Rosenberg, 1965, p. 367). Thus, an ‘unspecialized’ or ‘skilled’ worker or ‘sophisticated’ machine is one that performs numerous activities, while a worker with ‘complete

specialization' or a machine that is simple/unsophisticated would be one that performs only one activity.

Using the Varieties of Capitalism framework, Cody (2015) investigated the importance of the institutional structure of the political economy in determining the outcomes of labour amid technological changes in the automotive industry. Cody (2015) demonstrated how even though both German and U.S auto workers faced the same kinds of pressures; the German workers were comparatively more successful in conserving employment and building a skilled workforce as a result of having a coordinated market economy.

IV. History and Developments in the Automobile Industry

In this passage, we situate technological changes in automotive manufacturing within the evolution of automotive production systems. This is done to the end of reviewing the relationship between technology and production systems.

4.1. Craft Production

The craft production system constitutes the first production system of automobiles. Technologically, it was characterized by the use of general-purpose hand and machine tools, the latter which were used to drill and grind on wood and metal. The workforce in craft production plants was heterogenous with 40% of the workforce featuring highly skilled craftspeople like iron moulders and machinists whose extensive training ensured they understood mechanical principles

and were capable labourers. These skilled workers supervised their own work. Alongside them were semi-skilled workers who could partially do the job of the highly skilled, with the unskilled workers performing 'menial' work such as carrying work-pieces for the skilled. The latter two groups made up roughly 30% of the workforce, in the years prior to the 1910s (Wormack et al., 1990, pp. 22-31; Meyer, 2004)

4.2. Mass Production

The interchangeability of parts, eliminating processes like filing, ushered in the age of the mass production system, around the 1910s. Technologically, the system was characterized by the introduction of highly specialized or single-purpose machinery and the use of power tools. Workstations were placed alongside each other according to the sequence of tasks and were connected by work slides and roll ways. This lay-out allowed for a great deal of worker's supervision as workers were rooted to one spot. Workers were often highly specialized, performing one or two simple tasks such as the manual insertion of parts. This allowed for the elimination of skilled positions such as fitters, and drastically lowered the skills requirement for workers. The division of labour and use of the assembly line allowed for huge leaps in productivity, leading to a reduction in the size of the workforce (Wormack et al., 1990, pp. 27-28; Gartman, 1979, pp. 196-199; Smith, 1976/1776, p. 21; Bright, 1958, pp. 196-202).

4.3. Lean Production

Workers under this system are organized into teams, led by team leaders (Wormack et al., 1990, p. 56) and continuously "redefine the job content and continuously add fragments of additional work" (Meyer, 2004). Workers are further tasked to have a greater input in the workplace, through giving suggestions on how best the tasks performed can be improved. This is done in what are called 'quality circles' (Wormack et al., 1990, p. 56). While there are no defining technologies associated with the lean production system, the spread of the production system coincided with the increase in automation within the automobile plant (Bright, 1958, p. 16) as industrial robots became widespread.

A Summary of Technology and Labour use in Automotive Production Systems

	Craft	**Mass**	**Lean**
Mechanisms	Multi-purpose mechanical tools	Power/electric tools, Conveyor	Robots
Worker skill set	Multi-skilled, complete knowledge of parts and entire Vehicle	Highly specialized, low skilled	Multi-skilled, surface-level knowledge of entire vehicle
Worker role	Complete assembly of automobile, self-monitoring, and supervising	Manual installation of a single part/component	Monitoring, supervisory

Importantly, there was a great deal of overlap between these production systems. We find for example that technology which was present under the mass production system, namely power tools, is still present under the lean production system. Similarly, supervisory work can be found in both the mass and lean production system. Thus, the fundamental difference between these three production systems – outside of the volume and quality of vehicles produced – is relative concentration of different types of technologies, skills and occupations. Moreover, as we show, the relative concentrations of different types of technologies, skills and occupations can vary across different countries which use the same production system. This, we will show, is heavily influenced by the institutional setting which a firm finds itself.

V. Data and Methodology

5.1. Nature of Study

"The selection of a research question is based on the nature of the research problem…or issue being addressed" (Cresswell, 2014, p. 3). The research problem at hand is the effect of technological changes on the form that work restructuring took. Whereas some a variable like employment may be easily quantified, technological changes skills and occupations cannot. In addition to the quantitative data on employment, it is necessary to collect qualitative data, which will be descriptive in nature, for the other variables. Hence, the paper will adopt a mixed methods approach in which both quantitative and qualitative data is collected and integrated (Cresswell, 2014, p. 4). In terms of design, the research will follow a convergent parallel mixed methods design. This design is involves collecting qualitative and quantitative data at the same time, and integration of the quantitative and qualitative forms, which may help uncover contradictions which may be explained further (Cresswell, 2014, p. 15).

5.2. Sampling Technique

Purposeful sampling will be used in the qualitative portion of the research. The investigation question at hand is about technological changes in the automotive industry and how these have affected work restructuring. As such, to uncover what technological changes have taken place, it is imperative to consult entities that would have knowledge of this. This calls for purposeful sampling. In purposive sampling, the study "focuses on selecting information-rich cases whose study will illuminate the questions under study" (Patton, 2002, p. 230). Our first problem with selecting information rich cases is choosing what entities should be part of the study. This depends

on our unit of analysis. Patton notes that the "key issue in selecting and making decisions about the appropriate unit of analysis is to decide what it is you want to be able to say something about at the end of the study" (Patton, 2002, p. 229). The objective of the study is to see how technological changes affected work restructuring and whether those effects differed across the two countries under investigation. Therefore, we want to look at the general trends (if such exists) at the industrial level in these countries. Other studies that sought to understand work restructuring and technological change, for example Hlatshwayo & Buhlungu (2017), were conducted at firm level. Similarly, in a paper assessing the technological capabilities of the auto industries in the countries of Brazil, South Africa and India, Rasiah (2011) undertook their study at firm level. Lastly, Masondo's (2010) report on labour responses to work restructuring in the automotive industry, comparing South Africa to Germany, was done at the firm-level. While a firm-level study may also be informative, the limited time we had to conduct this research meant that conducting a full-scale firm-level study in two different countries would be impossible. Rather, we will rely on industry-level data, but will highlight a firm level study in the case of South Africa. We were not able to conduct a firm-level study for the case of Brazil. This effectively means that we will be severely restricted in our ability to draw a comparison about the state of production at a micro (firm) level. Instead, we will have to rely on industry-level data.

A heterogeneous sampling strategy is the most appropriate purposive sampling strategy in this case. This strategy attempts to capture and describe the "central themes that cut across a great deal of variation" (Patton, 2002, pp. 234-235). A great deal of the literature on work restructuring stresses the political nature of the phenomenon. As such, it is likely that some sources (e.g., interviewees) may distort or refuse to divulge some information. Obtaining information from varied sources may then be a remedy to this problem. A further aid to this problem will be the use of triangulation, which we will expand on below.

Because of their knowledge on technological changes and workplace changes, our sample should include shop-stewards, managers, and industry officials and analysts. Due to time and place constraints, it was not possible to get into contact with shop-stewards and managers. However, for these sources, we have used secondary data. In South Africa, as in other countries, changes in technology in the auto industry are not solely driven by management's sentiments but are also affected by government policies. For example, the Automotive Investment Scheme (AIS), designed and overseen by the Department of Trade, Industry, and Competition (DTIC), seeks to

incentivise investment in “models and components” in the auto value chain (Department of Trade, Industry & Competition,

n.d.). Thus, officials at the DTIC should be a valuable source of information. While we visited Brazil in February 2023, our visit was mistimed as shop stewards, managers and other potential sources were unavailable during that period. We have therefore used secondary data (i.e., where they have been interviewed in other scholarly works).

5.3. Data Collection and Preservation Techniques

Data from these subjects is collected via interviews. Interviews help us elicit information on events or behaviours that could otherwise not be known were it not for the presence of an observer (Patton, 2002, p. 341). Our approach to the design of the interview will be a 'Standardized Open- Ended Interview' due to demands of comparability. As our study is a comparison between phenomena in the plants of different countries, we need the responses of the different interviewees to be comparable. Hence, it is vital that they get asked the same set of questions in the same sequence. The 'Standardized Open-Ended Interview' allows for this as the wording and sequencing of questions are set in advance and are the same for a given type of interviewee (Patton, 2002, p. 346).

The interviewees responses will be captured in audio format on our cellphone. This audio will then be transferred and stored on a Google drive account (a cloud service) to ensure safety. The responses will then be transcribed onto a document. Following Hlatshwayo (2017, p. 104), whose work centred on union response to technological change, the interview responses will be analysed using thematic coding. This technique involves "reading each transcript and document and identifying patterns relating to a research question" (Hlatshwayo, 2017, p. 104). Patterns will be identified manually, wherein we will highlight phrases or words that appear to share the same sentiment or are consistent for our different interviewees.

5.4. Robustness Checks

Triangulation will be used to make our data more reliable. Patton (2002, p. 248) warns that studies that rely on one method are more "vulnerable to errors linked to that particular method". As we already explained, work restructuring tends to be political (i.e., be a vie to obtain greater power in

the workplace), so untrue responses could be obtained at interviews. To alleviate this problem, we will combine interview responses with documentation. Documentary data is vital in the first instance because it can reveal "detailed technical and historical information" (Masondo, 2010, p. 6). As such, our data will not only depend on the recollection of our subjects. We ensure consistency through comparisons of documentary data from different sources of information (Patton, 2002, p. 248). Documentary evidence will especially be vital on the Brazilian side of the study, considering the potential language barrier for interviews.

Documentary evidence will provide precise values of different variables of interest. This will compose the quantitative section of our research. Variables sought from documentary evidence from the plants and from labour unions include, a time series of: number of workers employed at plant; total number of workers in different occupations in the plant; number of workers in different sections of plant; average level of skill (i.e., years of training/education) of different occupations. In addition to this data from labour unions and plants, we will make use of publicly available documentation from the institutions: NAAMSA, NUMSA, NAACAM, the DTIC, ANFAVEA (National Association of Automotive Vehicle Manufacturers), CUT (Central Única dos Trabalhadores), etc., to collect data on variables including vehicle production and export volumes; industry employment, wages, and conditions; government support programmes; etc.

VI. History and Background

6.1 South African Model of Capitalism

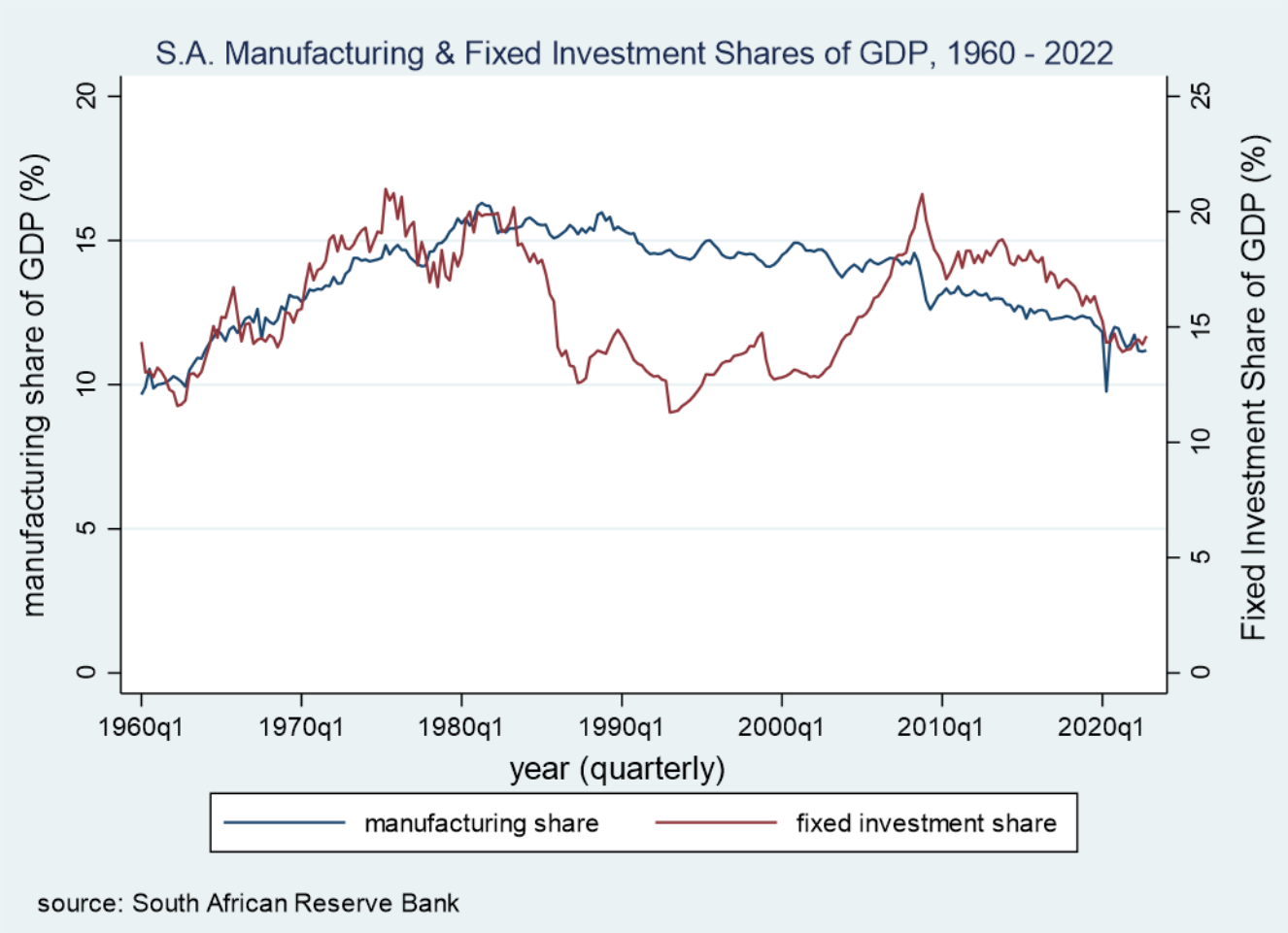
From the establishment of the Union of South Africa in 1910, up to the dawn of democracy in 1994, the political economy of South Africa was defined by the collaboration of the state and business (both domestic and foreign capital), in the exploitation of black labour power (Wolpe, 1972, pp. 431-435; Forrest, 2005, p. 26) and mineral resources (Roberts & Rustomjee, 2010, p. 51; Wolpe, 1972, p. 430), to enact a capitalist development favouring whites. Through the migrant labour system, state played the role of securing black labour supply at cheap wages for white business. Meanwhile compliance of black labour was ensured with the labour rights for black workers (Jordaan & Ukpere, 2011, p. 1094; Budlender, 1979, pp. 68-74). White workers benefitted from job reservation policies (Nattrass, 2014, p. 63). Business meanwhile was supported by state-provision of key inputs such as electricity and steel (Roberts & Rustomjee, 2010, p. 51). The oppression of black labour ranged from denial of labour rights to cheap wages, to denial of rights to undertake skilled labour positions (Nattrass, 1990, pp. 2-4; Webster et al., 2019, p. 538). Sandwiched between 1910 and 1994 were the Colonial and Apartheid systems of oppression. While the colonial economy was based around mining. the post-World War 2 period / Apartheid system was characterized by a shift in the country's growth engine, from mining – especially gold

mining – towards manufacturing industries that were however still entangled in the mining industry, in what has been described as the 'Minerals-Energy Complex' (MEC) (Hart & Padayachee, 2013, p. 58). The peak of economic performance during the apartheid period (1948 – 1994) occurred in the period 1948 – 1955, which saw GDP growth average of 4.6% per year, while manufacturing GDP grew at 7.7% per year (Nattrass, 1990, p. 6).

Schneider (2013, p. 5) categorizes the South African economy under the umbrella of 'Hierarchical Market Economies' (HME). These are economies that, Schneider expands, are characterized by "multinational corporations (MNCs), diversified business groups, low skills, and segmented labor markets" (Schneider, 2013, p. 4). Moreover, in another characterization, Schneider (2009) highlights that HMEs feature vertically integrated dominant firms and weak trade unions. Nattrass (2014, p. 61) disputes the latter characterization, arguing that that political economy was more apparent in pre-1994 South Africa. Around the mid-1990s, the government in South Africa began pursuing what was considered a neoliberal path to growth, which entailed the liberalisation of trade, regulated flexibilization of labour markets and the reliance on private capital for investment (Nattrass, 2014, p. 66). Before that, there was seemingly an attempt to co-determine the direction of the economy alongside business and labour. In 1990, for example, COSATU (a union federation) "entered the government's National Manpower Commission, a tripartite (business, labour, government) institution in order to negotiate labour market policy" (Forrest, 2005, p. 315). However, the shift towards a neoliberal model of growth was unilaterally done by the government (Nattrass, 2014, p. 66). There is a great deal of collaboration between businesses, who are often grouped into business associations. An example of which is NAAMSA in the automotive manufacturing sector (NAAMSA, n.d.). While there is a presence of trade unions in nearly all industries, the degree of their power, as measured for example by unionization rates, differ, although a general decline in unionization rates in all sectors can be observed (Department of Employment and Labour, 2021). In that sense, the South African political economy, since 1990, features a decline in worker organization, a presence of multinational corporations; a neoliberal growth regime; an extremely high level of unemployment. Figure 6.1 below illustrates this high level of unemployment:



The figure 6.2 below illustrates the importance of the manufacturing sector to the South African economy (left hand side) and the share of fixed investment, as measured by gross capital formation, in income. While the share of fixed investment has fluctuated since the 1980s, manufacturing has been trending downwards. In a country with such high levels of unemployment, this is a worrying pattern. Developments in the automotive industries have been related to both these variables as the industry, at different points, has been seen by the government as an engine for growth (Department of Trade, Industry, and Competition, 2018, **p. 3**).



6.2. The Development and Performance of the Automotive Industry

The impetus for the development of the South African automotive industry was the intense competition for customers within the 'core' or advanced countries (Oberhauser, 1993, p. 104). By expanding, multinational corporations could grab a piece of an untapped market, especially given the high tariffs that discouraged exporting (Oberhauser, 1993, p. 103). As noted by Rogerson (1991, p. 356), the growth model of South Africa was Import-Substitution Industrialization. Specifically in South Africa, there were high tariffs placed on Completely built-up Units (CBU's), that is, vehicles that are imported/exported as fully assembled cars. This encouraged several companies to build assembly plants inside the country (Black, 2001, p. 781). There were cost advantages (labour and other costs) to undertaking production in the semi-peripheral countries (Oberhauser, 1993, p. 104). South Africa was equally ideal due to the availability of cheap black labour (Rogerson, 1991, p. 356). Assessing the state of the production facilities reacquired by Original Equipment Manufacturers (OEMs) following the democratic elections of 1994, Mashilo

(2019, p. 10) says that the “technical

organizations of production (including work methods and technological capabilities)" were lacking in many "productive and international aspects". Mashilo attributed that partly to the disinvestment by Transnational Corporation (TNC) OEMs, following sanctions made against the country's apartheid regime (Mashilo, 2019, pp. 9-10). The auto firms' "levels of productivity, quality and innovation" were well below international best practice (Lorentzen et al., 2005, p. 7). Trade liberalization in the sector came with the Uruguay rounds of General Agreement on Tarrifs and Trade (GATT), where the South African government removed quotas and decreased tariffs (Lorentzen et al., 2005, p. 8). But wary of deindustrialization, the government put in place the Motor Industry Development Programme (MIDP) (Lorentzen et al., 2005, p. 8). The MIDP incentivised domestic producers to export vehicles (as they stood to gain import rebates) (Black, 2009, p. 490). That, coupled with a small domestic consumer market, led export growth to be high (Black, 2009, p. 492). Integration in global networks through exporting, Black (2009, pp. 487-488) claims, would allow firms to "operate at a large scale with more advanced technology". Large scale production would enable a plant to justify investments in sophisticated technology. Hence, investments from OEMS became larger (Robbins et al., 2008, p. 9), although there remained some reluctance from multinational corporation to undertake much greater investment (Black, 2009, p. 507).

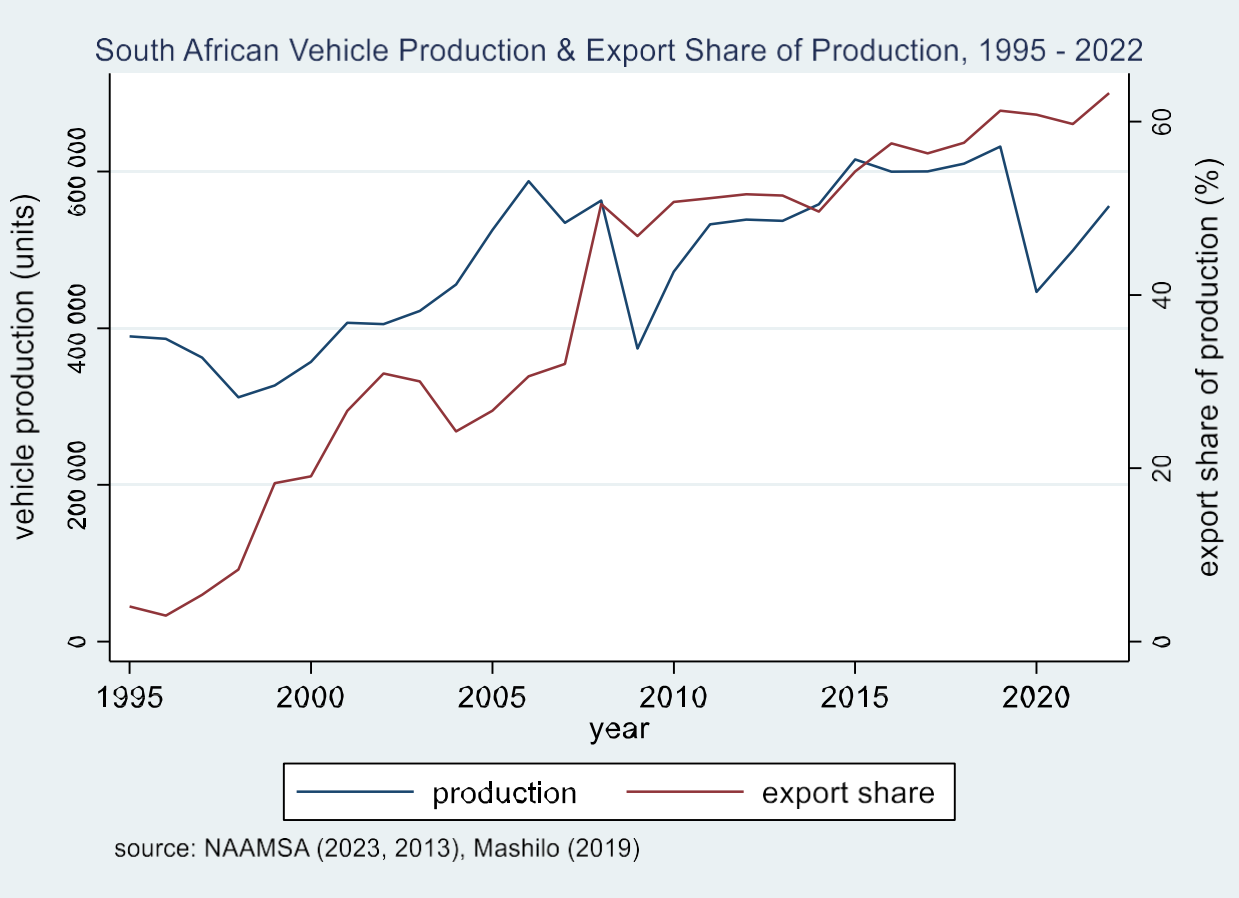


Figure 6.3: The Distribution of Passenger Vehicle OEMs across South Africa (in 2021)

Image source: NAAMSA, 2021, ‘Local Manufacturing OEM Plants by Region’

As illustrated by figure 6.3, in terms of the spatial distribution of automotive manufacturing plants, South Africa is characterized by clustering within the three provinces: Gauteng (Automotive Industry Development Centre, 2017, p. 52), Eastern Cape (Makuwaza, 2001, pp. 142-144), and Kwazulu-Natal (Lorentzen et al., 2005, p. 11). Moreover, these automotive assemblers are in all cases surrounded by component suppliers (Barnes & Hartogh, 2009, p. 41).

Figure 6.4 below illustrates the performance of the industry with regards to production volumes and exporting. The two variables have generally followed each other, with higher levels of production resulting in higher export share of production. This indicates that the accumulation regime of the local firms is very dependent on export demand.



VII. Technology Change and Work Restructuring in South Africa

7.1. Technological Changes in the South African Automotive Manufacturing Industry

Table **7.1,** Investment in Plant and Equipment by Vehicle Manufacturers, 1990 – 1998:

Year	amount (in US$ millions)
1990	330
1991	332
1992	390
1993	181
1994	214
1995	338
1996	354
1997	324
1998	516

Source: Hartzenberg & Muradzikwa (2002, P. 8); original data in NAAMSA (1999)

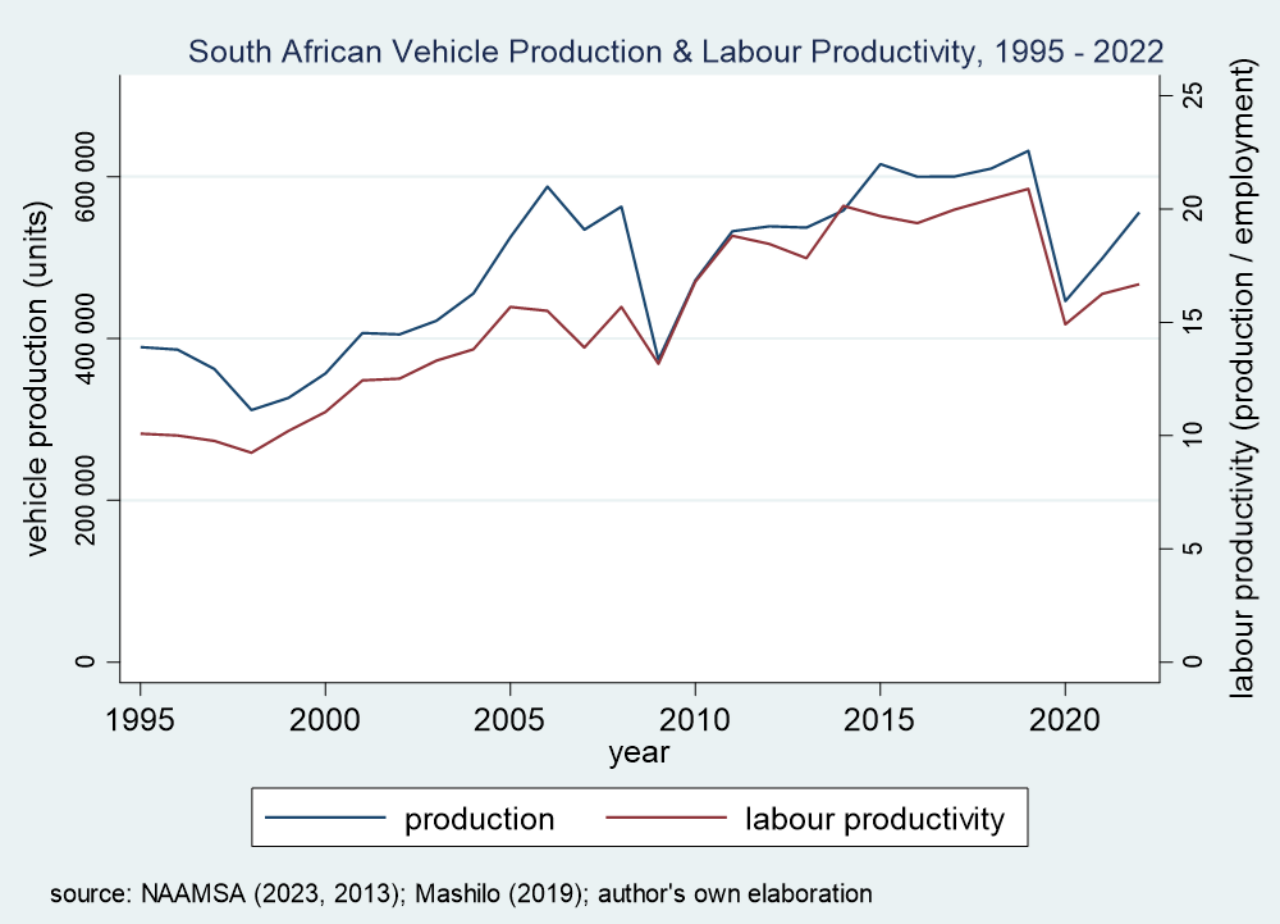
Table **7.1** above illustrates the investment outlay into the assembly plants in South Africa during much of the 1990s. This investment, note Hartzenberg & Muradzikwa (2002, p. 8), has been associated with transfer of technologies - much of which were previously unavailable to South Africa – such as relevant machinery. Forrest notes that the industry was characterized by the automated assembly line, which had been introduced in three auto companies by 1948 (Forrest, 2005, p. 48). Prior to the economy-wide liberalization of trade in the 1990s, investment into the assembly sector was made towards "model specific tooling", with the industry being characterized by "limited automation and low productivity" (Black, 2007, p. 120). Even well into the 1990s, South African assembly plants were characterized by low levels of automation and compared poorly to those of other countries (Hirschsohn 1995, p. 32; Barnes & Hartogh, 2009, p. 58). For Interviewee 5 (an academic with a history of research into South Africa's auto industry), the low levels of technological sophistication were attributable to the minimal investments made by OEMs prior to South Africa's reintegration into global markets in 1994 (Interviewee 5, 2023, 10:00)

There was initially a reluctance to the introduce robots in some of South Africa's assembly plants. Toyota South Africa in the early 1990s only used robots in instances where "jobs are too dangerous

or consistent quality cannot be achieved by humans" (Hirschsohn, 1995, p. 23). VW South Africa meanwhile by the early 1990s had only deployed 15 robots for the purposes of "quality and complexity" and would only expand the use of robots in response to wage pressures (Hirschsohn,

1995, p. 32). However, technological changes were coming in in small pockets, even though it would take until the 2000s for them to be widespread. A VW shop steward in 1984 observed the following "There has been some automation in the body shop with work on the new Audi and a little on the assembly line. Recently we have conceded the need for robotic welding of rear axles. Six guys jobs are affected here. But manual welding could not guarantee a consistently high quality... We had to allow this change in order to maintain quality" (Gomomo, VW shopsteward, quoted in Forrest, 2005, p. 467). Eventually, assembly plant productivity, as measured by output per employee, improved by 68% between 1990 and 2005, owing to a reduction in models, higher levels of automation, and an integration of lean production (Barnes & Hartogh, 2009, p. 59).

Figure **7.2.** Vehicle Production and Labour Productivity



Fixed investment in the assembly sector increased from R492 million in 1994 to R1.511 million in 1999 (Black, 2001, p. 789). Black observes that while the automotive industry experiences a large inflow of FDI relative to other manufacturing industries since 1994, this has primarily gone

to the purchases of stakes in OEMs (Black, 2001, p. 789). Further, Black (2001, p. 789) opined that the investment made in the plants paled in comparison to those made to fellow emerging countries such as Brazil, Thailand, and Argentina, in the preceding few years.

The returns to the increase in fixed investment and in the infiltration of automation in automotive plants can be seen in Figure 7.2. The effect of the MIDP on production and productivity was not immediate. In fact, as we can observe in Figure 7.2, there was a slight drop-off in both variables between 1995 and 1998.

The technological sophistication of South African plants is said to be comparable to any other plant in the world, that is, it is of international standard (Interviewee 3, 2022, 15:30). However, an academic with a long history of research within the automotive industry ('Interviewee 5') moderates this claim. Interviewee 5 notes that the production processes within the subsidiaries of OEMs are well-developed as there is a global model for production system (Interviewee 5, 2023, 00:20 – 01:20). However, while developed, subsidiary OEMs are not on the cutting-edge of technology. This, Interviewee 5 argues is because much of the research and development (R&D) that precedes the introduction of new machines or processes is conducted in parent companies or at the more advanced countries (Interviewee 5, 2023, 6:40-7:20).

What differs however, one official of an automotive companies' association claims, is the capital intensity of the industry, with South Africa having less robots (though of the same quality) and more employment than countries which produce larger volumes of vehicles (Interviewee 3, 2022, 15:30). The relatively more labour intensive nature of the South African industry is by no means an accident. As we will discuss in later section 7.3, workers – through strikes, negotiation, and a favourable balance of power in the auto industry – fought to ensure that they are not left behind in technological change. Their struggles manifested not only in training programmes to upskill them, but also included government intervention. As noted by one government official ('Interviewee 7'), throughout its industrial policies, the government has been deliberate in insuring that employment levels remain considerable. The official outlines that the incentives provided to firms for the purposes of capital expenditure (for example equipment) requires that beneficiary firms maintain or create a certain number of jobs (Interviewee 7, 23:00 – 26:00, 2022)

Below we can look at the 'robot per 100 workers' and 'robot productivity' of South Africa in comparison to other country, to understand the technological state of the industry in recent times.

We have put South Africa alongside countries that produce around the same amount of vehicles per year. Conditional on the availability of data, a country was selected if annual vehicles produced in the year under evaluation, 2016, was 150 000 units within that produced in South Africa. Therefore, our range was 450 000 – 750 000 units.

- Robot per 100 workers – the number of robots in the assembly sector divided by the number of workers employed in the assembly sector, times 100
- Robot productivity – the number of vehicles produced divided by the number of robots in the assembly sector

Table **7.3**

	South Africa	Malaysia	Poland	Argentina	Hungary
Vehicles	599 004	545 333	681 837	472 776	475 500
Robots	7 822	409	8 505	5 112	7 654
Employment	30 953	23 830*	180 000	25 000**	-
Robots per 100 Workers	25.27	1.72	4.73	20.45	-
Robot Productivity	76.58	1333.33	80.17	92.48	62.12

Source: International Federation of Robotics (2020)

Source: (Polski Zwiqzek Przemyslu Motorzacyjnego, 2017, p. 182)

*employment data is for 2020, source: Statista (2023); *

Table **7.3,** when putting aside the outlier (Malaysia), indicates that robot productivity, which we use to measure the concentration / extent of use of robots in the sector, in South Africa is at levels which are comparable to countries which produce at roughly the same scale. This vindicates the opinion of a Production Manager in one of the South Africa's OEMs who said: "we are pretty much at the peak of robot technology, any further robot technology would require massive investment, and they have to produce a lot of cars to justify that investment" (Production Manager, quoted in Chigbu & Nekhwevha, 2020, p. 12). Thus, assuming a stability in the prices of robots and of labour, a significant growth in the use of robots in the assembly sector of South Africa will be unlocked by greater levels of production. As we will explore in the following section, the stagnation in vehicle production levels partly explains the relative stability in the employment levels in the sector. Technological changes did not just come in the way of robotics. By 1992, computerization had begun in the auto plants of South Africa. Masondo report's on NUMSA's observations that there was already "the use of computers at various stages of production" (Masondo, 2010, p. 53).

7.1.1. Firm-level case studies

Volkswagen

I visited the Volkswagen Plant in Kariega, Eastern Cape, South Africa. The following is a description of the state of technology of the plant. The plant houses four assembly units: the press shop; the body shop; the paint shop; and the final assembly. I was not allowed to visit two of these

units, the paint shop and the press shop. The restriction on the paint shop was because visitors could possibly contaminate the area. My observations were as follows:

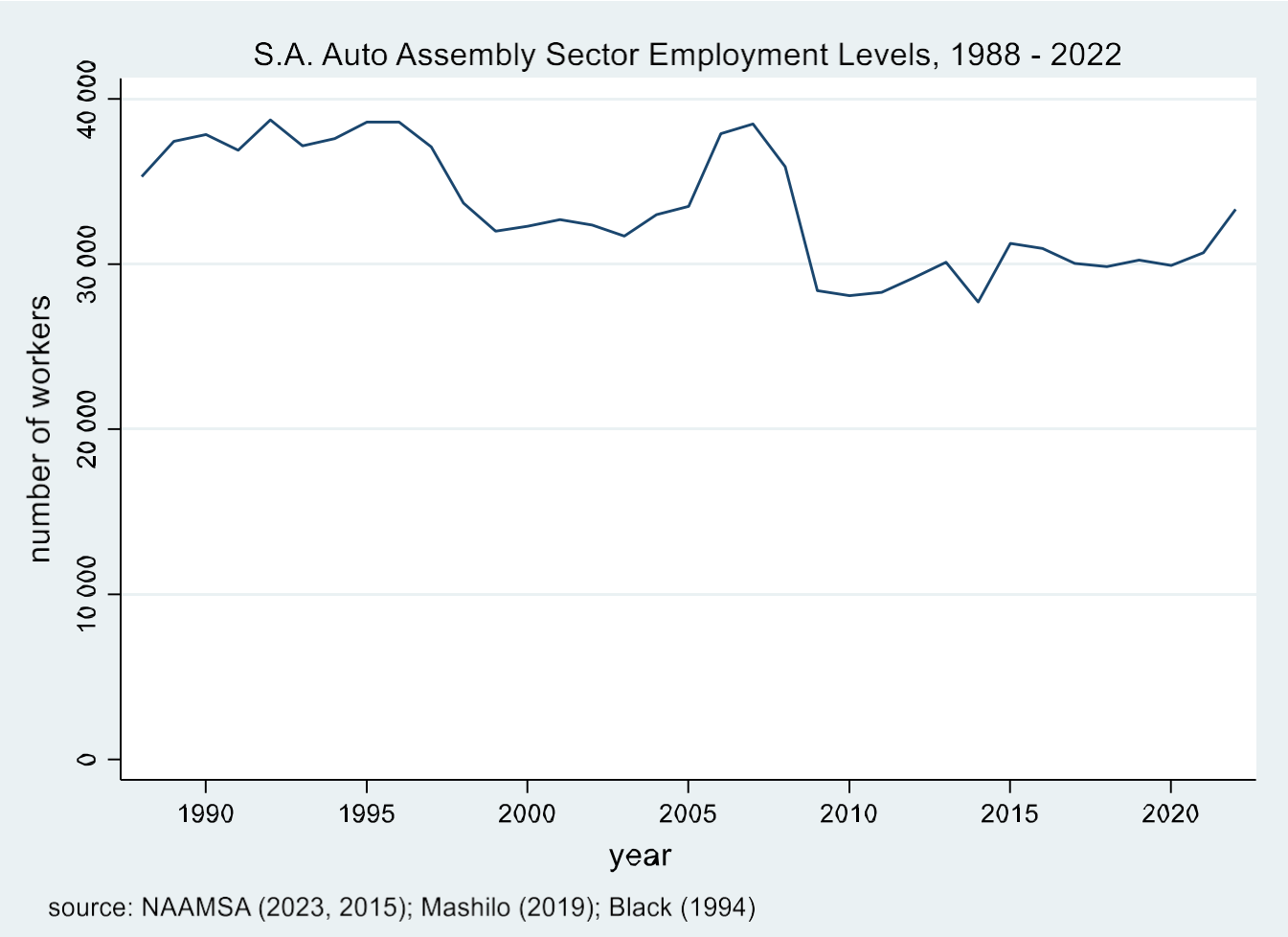
Inside the body shop, there is a division of activity into multiple lines. A couple of the lines in the body shop feature small gatherings of about 3 to 6 workers, using large power/electrical hand-held tools mounted on panels, to work on a part or parts which are passed through by a conveyor. In another section of the body shop, we find 1 or 2 workers tinkering with an internal combustion engine using common mechanical hand-tools such as wrenches. However, in tightening some connectors we have workers using power tools. For each of these lines, there is a target amount of time after which the task must be completed. Elsewhere, we have lines which exclusively feature robots that are enclosed in cages. In these lines, the robots perform the function of precision drilling on the parts as well as welding the car's parts together. Overall, within the body shop we find a fair distribution between fully automated tasks such as drilling and welding of car body parts, and tasks that require the use of mounted and bulky power tools, smaller hand-held power tools, and common mechanical tools, with the latter being the least used by some distance. The body shop featured a portion of some 330 robots which had recently been brought into the plant. (VW Kariega Assembly Plant Visit, 2023)

In the final assembly area, we also find a fairly even distribution between areas that are fully automated and those that feature workers. Incidentally, there are no areas that feature collaboration between workers and robots. Along the conveyor, we find the manual installation of the vehicle's cockpit by about 2-3 workers on each vehicle. Insertion of the dashboard takes about 3 minutes and requires 2 workers working with power tools. The wheels of the vehicle are also inserted manually by a small group of about 4 workers along the conveyor. The electric checks for vehicle are performed by a manipulator, which is a device that uses robotic arms. Then we have a line where a process called ‘marriage' – where the chassis of the car is combined with the rest of the body – happens. The process of marriage is done autonomously. The installation of components such as car mirrors is manually performed by workers. The installation of the internal combustion engine is mostly a manual process, aided by a crane hanging above (VW Kariega Plant Visit, 2023). By contrast, in this same process, at BMW Spartanburg in the United States, is fully automated (BMW, n.d.). Lastly, there is an engine built up area where we find about 2 workers per engine using common hand tools.

7.2. Work Restructuring in the South African Automotive Manufacturing Industry

7.2.2. Employment

Figure **7.4**. The level of employment in the South African Automotive Manufacturing / Assembly Sector



Employment levels in the sector remained relatively stable, hovering around 38 000 workers between 1990 and 1995, which as we will discuss, coincided with the initial period of the National Bargaining Framework (NBF) agreements. Employment levels take a steep dive from 1995 to around 1998, coinciding with the start of the first iteration of the MIDP programme. In general, since the peak of employment levels in the late 1980s, prior to widespread automation, employment levels have gently declined, with sharp drops coming in the late 1990s, in 2008, and in 2020

Forecasting the impact of electric vehicles taking on a greater share of vehicle production in South Africa, it is anticipated that there will be a "substantial reduction in employment" in the assembly sector (Interviewee 1, 2022, 9:10; Interviewee 2, 2022, 4:20). Interviewee 1 and Interviewee 2 (both representing an association for automotive component manufacturers) say this is because of the relatively simpler process of assembling an electric vehicle than an internal combustion engine car (Interviewee 1, 2022, 10:15; Interviewee 2, 2022, 4:20). Stagnation in employment levels has also been attributed to stagnation of production levels (Interviewee 3, 2022, 22:25).

7.2.3. Skills and Occupations

Specifically for the components sector, there has been upskilling of workers. A representative an association for automotive component manufacturers gave the example of a machine operator, claiming that their job is no longer restricted to moving apart from one machine to another, rather the machine operator will be doing "inspections, maintenance, quality checks, etc." (Interviewee 1, 2022, 3:30). At my visit to the VW plant in Kariega, Eastern Cape, one of the striking observations was that there were no tasks that required a worker to have a great deal of physical strength. All lifting or tilting of heavy parts was performed by machines. An industry representative of the assembly sector argues that as the manufactures became more technological sophisticated, it became necessary for workers to upskill to 'keep up' (Interviewee 3, 2022, 5:02). Moreover, they posited that the industry in South Africa does not compete on wages but on skill, as evinced by the gargantuan amounts spent by the firms on in- house training, and on the relatively high remuneration of workers (Interviewee 3, 2022, 5:15). Indeed, my observations at one of the OEM training facilities were indicative of the salience of skills in the assembly sector.

The knowledge of workers in the assembly sector is incredibly broad, on both a theoretical and practical level. The visit to the on-site training centre at the VW plant in Kariega, Eastern Cape was highly illuminating. Any person who works inside the assembly plant, from a fitter to an electrician, goes through the training centre. The centre is divided two main sections, the mechanical and electrical section. The mechanical section teaches the recruit on the most elementary, mechanical activities like grafting and filing (each designed to instil an ethos of precision) to more mechatronic tasks like programming for a robot. The electrical section's with regards to activities ranges from basic household wiring to circuit building for a car. Before the recruits can enter any of the stations in the two sections, there are small classrooms on sight where

along with the recruits, the stations' supervisor first discusses the theory behind the tasks are about to be undertaken. Thus, the structure of the training at this VW training site fulfils NUMSA's vision of a training that allows workers to have "a deep understanding of the world of work and production...and technical, analytical, logical and organizational skills to operate more creatively and independently…[as] problem-solving skills…are best developed in the context of providing a general education" (COSATU, quoted in Hirschsohn, 1998, p. 9).

Mashilo (2019, p. 44) details the distribution of skill levels in the assembly sector, Table **7.5**:

Skill level / category	**Number of workers**
Level 1	16
Level 2	4047
Level 3	1519
Level 4	8348
Level 5	173
Level 6	11
Team leaders	1779
Artisans	937
Technicians	285

Source: Mashilo (2019)

Forecasting the impact of the transition away from Internal Combustion Engine (ICE) vehicles to Electric vehicles, an official from an association of automotive companies ('Interviewee 3') claimed that the skills requirement to assembly the latter are "completely different" than those for the former (Interviewee 3, 2022, 5:50). Indeed the sentiment that electric vehicle production will necessitate a different skillset from workers is echoed in the government's green paper on 'new energy vehicles' (Department of Trade, Industry, and Competition, 2021, p. 14).

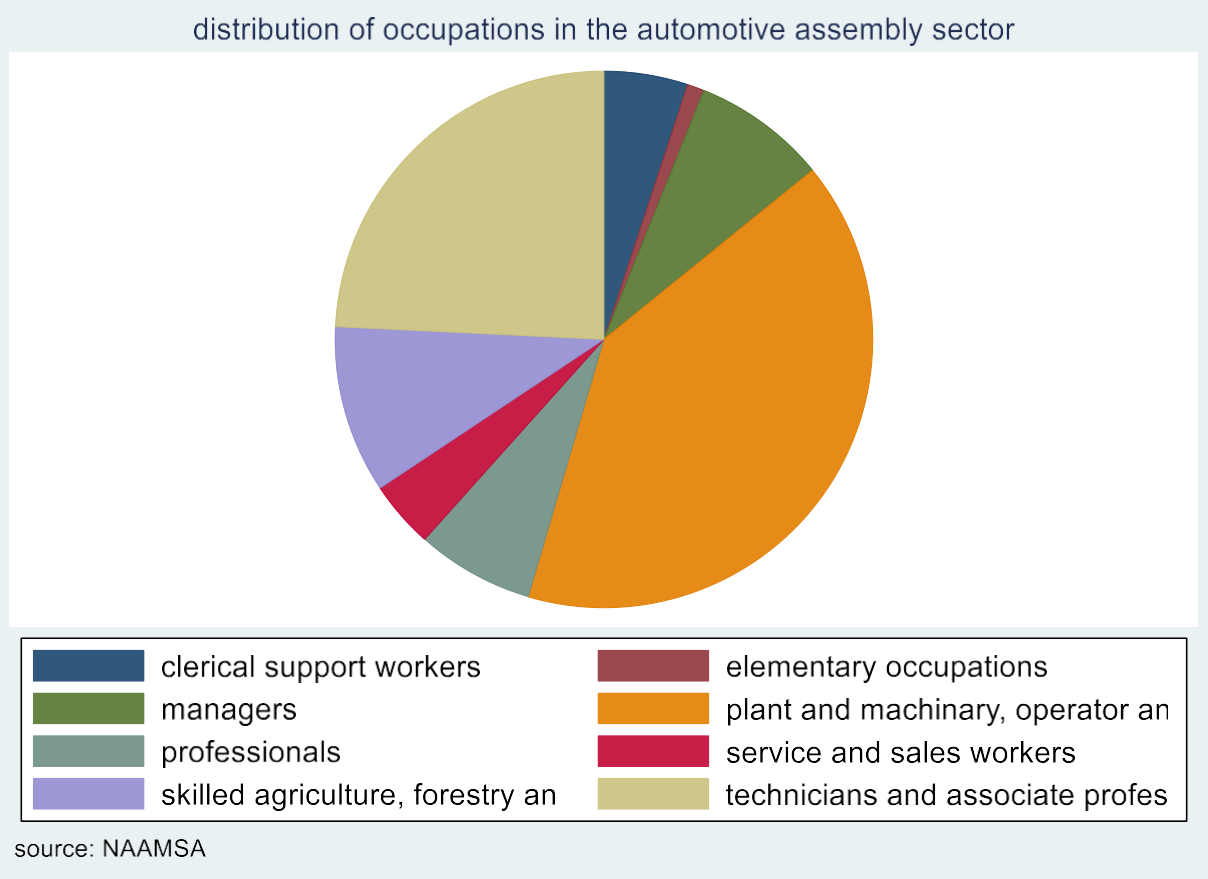


Figure 7.6., Source: NAAMSA

However, upon my visit to the mechanical area of VW training centre, I was informed by my tour guide – an employee who has worked at the firm for over 15 years – that some of the activities being trained for at the training facility have been rendered redundant through outsourcing of those activities. An example given was the training area for milling and grinding. The tour guide noted that in previous decades, if a bolt or nut was damaged, a machinist would create that nut or bolt from scratch. However due to the demands of lower time cycles, the company prefers to have spares on hand, which can be retrieved much faster than a machinist can create a new one. Thus, the trade of the machinist, while progressively dying in other OEMs, has completely ceased at VW (VW Kariega Training Centre Visit, 2023).

An observation we made during the visit to the VW assembly plant was that use of general-purpose machine tools to perform functions such as grinding and drilling on metals – which characterized the craft production system – is totally absent. The task of drilling and grinding itself and general-purpose machine tools are all still available, but they have been transformed. Drilling and grinding

has been taken over in its entirety by robots. Even the job of feeding each part to a mechanism (e.g., a robot), has been eradicated as the robot can pick up parts which only need to be placed appropriately. General purpose tools meanwhile are available but are nearly exclusively used by workers when some operation requires the nimbleness of the human hand such as the work done on internal combustion engines (VW Kariega Assembly Plant Visit, 2023).

The infiltration of advanced technologies in the factory has not led to the displacement of labour in totality, but has displaced a type of labour. Boxall & Purcell (2010, p. 39) note that robotics, computer-aided design (CAD), computer numerical control (CNC) machine tools, all of which are found in the assembly sector of South Africa, "depend for their effectiveness on astute and timely decision making by workers". A notable addition to the workforce in the assembly shops are the highly technical computer-based jobs. Since the robots are caged with no worker in sight when operational (VW Kariega Assembly Plant Visit, 2023), it masks the work done behind the scenes. At the VW training facility, recruits who are specialists in computer software are trained to use the PLC (which the supervisor of the robotics area described as the "brain" of the robot) to code instructions about the movement of the parts of the robot when it encounters different parts, over a certain time period (VW Kariega Training Centre Visit, 2023).

In the assembly sector, the usefulness of the concept of 'occupation' or 'job type' is increasingly becoming questionable. As we established, one of the premises of the Toyota production system is the multi-skilling of workers and engaging in shifting, such that each worker performs a variety of tasks. As advocated by NUMSA, and first won in the 1993 National Bargaining Framework Agreement (Hirschsohn, 1998, p. 9), workers in the assembly are graded not on skills used but skills acquired (Mashilo, 2019, p. 43). Training for work in the assembly sector is based on "a multi-skilling model that allows workers to move horizontally between job functions in their respective plants" (Mashilo, 2019, p. 43).

Ames & Rosenberg (1965, p. 370) found that for the United States, as industrialization progressed, the importance of maintenance workers (who are presumed to be highly trained) rises relative to that of productive workers. With the rise of lean production, and a focus on multi-skilling, which has meant that a shopfloor worker carries out tasks that would previously be distributed among different occupations, it is difficult to quantify how important maintenance work is relative to 'productive' work. However, a representative of an association within auto components sector

has pointed out that tasks carried out by workers in the automotive industry are largely in the monitoring aspect – such as production tracking and less so in manual tasks (Interviewee 2, 2023, 8:00). In the figure **7.6** above, 'production' workers still occupy the greatest share of the workforce. However, as we have established, the distinction between 'production' workers and 'maintenance' workers has gradually been evaporated by the employment of the Toyota production system. As expected, the category of 'technicians and associated professionals' has come to occupy significant share of the workforce

Technological changes, however, are not the only factor determining the types of jobs in the assembly sector. The degree of vertical integration of the firm also plays a role. An interesting trend pointed out by two industry representatives of the component sector is that rather than vertical disintegration – 'outsourcing' – of the firms in the assembly sector, we have more integration, with some activities that were previously outsourced now being performed in house. For example, the stamping of the body-in-white, has moved from the components sector into being performed by the OEMs themselves (Interviewee 1, 2022, 13:30). The recent expenditure by Ford on a stamping plant at its Silverton, Pretoria facilities appears to confirm this trend (Ford Media Center, 2022**)**. One of the seven assemblers has recently taken up some spray painting, an activity which had been traditionally done by suppliers (Interviewee 2, 2022, 14:30). This trend of more vertical integration is not slowing down. As the industry turns towards New Energy Vehicles – with already two of the seven assemblers making soft hybrid vehicles - the competitive advantage of the OEMs is expected to lie at who has the longest lasting battery (Interviewee 2, 2022, 4:25). Thus, we are likely to find OEMs moving into that part of the value chain (Interviewee 2, 2022, 5:00). Ford in the United States, for example, recently invested US$5.8 billion to build a battery manufacturing plant (Ford, 2021). Assuming that the kinds of tasks being insourced use human labour, this insourcing is likely to result in a reallocation of workers from the components to the assembly sector, with an unclear net effect for automotive industry employment.

7.3. Discussion

7.3.1. Industrial Relations

The NBF, 1989-1994

In this section, we argue that the response of employment to technological change was conditioned by the change in the institution of bargaining between workers and firms, which itself was a response to a shift in government strategy. As government shifted towards a neoliberal model of economic growth, whereby the state provides the guarantee of a good business environment and in turn foreign capital pours in investments to domestic industries, it became necessary for the state to play a bigger role in strategic industries, especially where it was necessary to mediate the relationship between labour and capital. Because the automotive manufacturing industry was identified as a strategically important industry, given its capacity to stabilize balance of payments, provide employment and act as an engine of growth, government interventions were necessary. By inserting itself into talks over the restructuring of the industry – to ensure that its interests would be represented or would prevail - the state undermined the considerable institutional power built by labour in the automotive manufacturing industry. In doing so, it pushed labour into a bargaining framework underpinned by the dominance of firm interests, the latter which the government effectively took as being good for the economy. In position of bargaining strength, firms were thus able to navigate the matter of employment and technological change to ensure industrial peace, for the sake of continued viability of the subsidiaries within the global production network of its parent companies.

Despite legislative restriction to worker organization and especially black worker organization in South Africa, by the 1970s, trade unions had started to covertly appear in the automotive manufacturing industry (Forrest, 2005, pp. 51-53). Open resistance and struggle for wages and better working conditions, started in the 1970s. By the late 1970s, black worker representation in the form of trade unions had found recognition in the firms Ford, VW, and General Motors (Forrest, 2005, p. 53). By the 1980s, even with small technological changes, there had been retrenchments that had been carried out unilaterally by the firms (Masondo, 2010, p. 54). On the other hand, by the 1980s, there had also been fierce worker resistance in the form of strikes. And on the back of a decade of these crippling strikes (Forrest, 2005, p. p. 54; p. 150; p. 226; Desai & Habib, 1997, p. 12), firms wanted a way to institutionalize conflict (Desai & Habib, p. 506). Workers wanted to have a voice in matters of planning (restructuring) and production (new technology) in the industry (Masondo, 2010, p. 57; Forrest, 2005, p. 301). NUMSA/MAWU set about establishing a centralized, national form of bargaining in the automotive assembly sector, which employers resisted, fearing concentrating union power (Forrest, 2005, pp. 306-307), and

rather preferring plant-level bargaining. Unions however, we able to use the considerable institutional power they built, with occasional demonstration of that power such as the union members' strike towards firms reluctant to get into national bargaining, to establish the National Bargaining Forum (NBF) in 1989 (Forrest, 2005, p. 307).

In this business-union agreement, workers wielded a great deal of power, and used it in many instances to achieve their ends. This was demonstrated in the use of highly costly industry-wide strike to force employers to acquiesce to wage demands in the first NBF agreement (Forrest, 2005, pp. 307-308). In general, there was considerable tension, antagonism and ill-will between workers and the firms throughout the auto assembly industry (Desai & Habib, 1997, p. 506; Forrest, 2005, p. 457).). The imperative of industrial peace towards the end of achieving the government's goal of national building was put to the test as NUMSA embarked on an industry-level strike in 1994 on the back of stalling wage negotiations as employers refused to pay up the 12% demanded by the union (Forrest, 2005, p. 459). Forrest reports that as workers took industrial action, 'comrades' in the government and in the community accused NUMSA of "disloyalty to the new government and of destroying the economy instead of reconstructing it" (Forrest, 2005, p. 459). Ultimately, with the union not budging even amid the pressure from government, employers unwillingly settled at 10.5% wage increase (Forrest, 2005, p. 460). We argue, in this industrial relations system -- where the workers demanded for an unconditionally (Forrest, 2005, p. 315) moratorium on layoffs, higher wages, and a voice in matters of production, buttressed by the union's organizational power which spanned nationally, and was demonstrated at every turn -- help conserve the employment level to be stable in the period 1990-1994, despite there already being technological changes and a rise in labour productivity.

With the balance of power in the automotive industry skewed towards labour, technological change had little to no effect on employment levels. We recall that in the VoC framework, one of the defining features of the political economy is how firms solve their coordination problems in the sphere of industrial relations and employees. In the 1989 to 1994 period, firms were compelled to solve these coordination problems in the NBF, an institution which was formed by labour. The NBF was an institution for collective bargaining, a form of worker participation which Boxall & Purcell (REF) classify as power-centred. The source of labour's power within this bargaining institution was their demonstrated ability to coordinate and execute financially costly strikes. Thus, firms were unable to unilaterally restructure the industry as they had done in the preceding years.

Worker interests at the time, which were mainly higher wage demands as well as a moratorium on lay-offs were as a result able to prevail. In turn, workers maintained industrial peace. This is demonstrated by the stable employment level for 1990 to 1994, which can be seen in Figure 7.4

The MITG, 1992-1995

Intersecting the debates at the NBF was the establishment of the Motor Industry Task Group (MITG) in 1992. This was a body established to address the problems of "inefficiencies in the industry, oversupply in the market, rising vehicle prices, the decline in market sales, productivity issues and the increase in job losses" (Forrest, 2005, p. 462). It was founded and headed by the government via the Ministry of Trade and Industry. In 1992, the MITG was tasked to, among other things, make recommendations to the Minister of Trade and Industry on job maintenance and creation in the industry (Forrest, 2005, p. 462). From that instant, the government had a vested

interest in the affairs of the automotive manufacturing industry. The MITG's meetings in 1993 "noted the industry's potential for economic growth, employment creation and human resources development and its potential impact on South Africa's balance of payments" (Forrest, 2005, p. 462). In addition to this, Forrest further notes that the automotive firms accepted the legitimacy of the government as leader in restructuring the industry (Forrest, 2005, p. 466).

Besides the government taking the reins, the issue of employment was being removed from the sphere where unions wielded a great degree of power, to where their entrance was premised on toning down their demands for the sake of the government projects. The MITG, argue Desai & Habib (1997, p. 508) became the institutional expression of corporatism: wherein business, unions and the government would 'co-determine' the direction of the industry for the foreseeable future. In 1994, amid a workers' strike automotive employers voiced their view that "the best method of restructuring the industry was to lower production costs by lowering wages" (Forrest, 2005, p. 461). The 1995 NBF agreement saw the reinstatement of the importance of plant-level bargaining, with the NBF also seen as the sphere where a general framework could be developed which would then be customized for implementation at plant-level (Forrest, 2005, p. 466). This played into the demands of employers, made much earlier and in a much tenser negotiating environment in the late 1980s. By 1995 therefore, the matter of employment was being gradually taken out of industry level bargaining. Thus, even with the stipulation in the 1995 agreement that productivity increases not interfere with employment levels, as the issue of employment was now largely confined to the plant-level, employers had sufficient bargaining power to enact retrenchments at a large scale following 1995. From then on, much of the industry's employment path, can be explained by variations in the level of vehicle production in the country (NAAMSA, 2023).

The balance of power in the automotive manufacturing sector shifted away from workers such that firms, with support from government, were able to implement a wholesale restructuring of the industry. The set of key actors (represented in ovals) and interests (represented in rectangles) and interaction thereof (arrows) in the automotive industry at the point of the 1995 NBF is illustrated in the diagram below. In lieu of the unilateralism by firms in the 1980s, as well as the change in the industry's production system, workers – in addition to usual demands of higher wages and better working conditions – wanted to co-determine the industry's direction. With government and figures in government using their institutional (through COSATU, a federation which NUMSA was then part of) and personal proximity to labour to persuade them, labour was forced to make

greater concessions, such as allowing for plant-level as opposed to industry-level bargaining on issues of employment and production. Thus, the spheres of industrial relations and employees, whilst still nominally co-determined by firms and labour, was moved to plant-level, an arena where firms had considerably more power. This was because labour would no longer execute industry-wide strikes on matters of employment. Furthermore, at plant-level, where workers – isolated from fellow auto workers – historically had lesser power. Thus, even as the political economy could be characterized as a co-ordinated market economy, the platform for worker participation meant that labour (at the industry level) was in a weaker negotiating position. Following this move in 1995, a wave of retrenchments followed.

7.3.2. Vocational Training and Education

In this section, we argue that the response of skills and occupations to technological changes in the industry was partly determined by coalition of institutional factors, these included the corporatist arrangement making it imperative for government and business to make some concessions to labour as well as allowing for the exchange of information, to the government-led sectorial vocational training and education system and its demand and supply-conscious incentive system. We argue that because of the proximity and information-sharing through the multi- stakeholder institutions which had been set up (NEDLAC, NBF, MITG), it was possible for labour and employers to have a better idea of the nature of the skills needed. We argue that by making the vocational training and education system in the country sectorial, it allowed for a fulfilment of the need for higher skilled labour. And lastly, we argue that that very proximity between labour, the state and business acted to ensure each party

Workers, years before the liberalisation of trade were wary of the direction the automotive industry was heading towards. As Hirshsohn reports (1998, p. 6), NUMSA in 1993, asserted that employment growth in the sector would hinge on a "world class industry" that had "skill formation and quality measures". In the early 1990s, NUMSA identified that around 70% of operators in the assembly plants were illiterate. This matter of illiteracy would potentially be more detrimental to people whose work had been or would be taken over by robots, such as welders. But because not all jobs are equally vulnerable to being overtaken by mechanisms (Autor, 2015), if workers were left to decide on their own to train, there might potentially be a skewed distribution of skills, with those fearing being overtaken by technology becoming devoting more to training than those who perceive themselves as non-vulnerable to technological change. NUMSA then pushed for the implementation of Adult Basic Education (ABE), which would give all illiterate workers a schooling equivalent to nine years (Hirschsohn, 1998, p. 9).

Automotive producers also wanted an industry with "more productive workers" (Forrest, 2005, p. 461). The source of possible contestation despite agreements on the need for skills development in the industry was the pace under which this would happen. With the implementation of the MIDP in September 1995 coming with an immediate tariff phase down (Lampretch, et al., 2011, p. 69), it was not going to be long before the previously protected industry was subject to international

competition. Thus, upskilling needed to be immediate. A further potential impediment is that there was a variation in the need of a highly skilled workforce within the firms in the assembly sector (Forrest, 2005, p. 465). As such, workers in these firms might fall vulnerable to having only firm-specific skills, or potentially an outdated skillset, which would severely limit their mobility in the labour market as they might find it hard to apply their skills elsewhere. Thus, it was necessary for the structure of the training programme to include all workers, regardless of the skills need of the firms they work for. In recognition of this conundrum, an agreement was inked that guaranteed that "that every employee would be entitled to four modules (160 hours) of training by 1996" (Forrest, 2005, p. 465). The 1991 National Bargaining Framework laid the foundation for competency-based modular training at the firm-level (OEM-level), but which imbued workers with a skillset so broad that they could be employed in a variety of industries (Hirschsohn, 1998, p. 9). That set-in motion a practice that remains more than twenty years later. In my visit at the VW Training Centre, I encountered workers from a wide range of industrial firms receiving the same training that the assembly workers in the plant undergo (VW Kariega Training Centre, 2023). This is a far cry from the profile of workers in the 1990s. At Toyota in 1992, for example, Hirschsohn (1995, p. 26) reported that "multi-skilling is practically non-existent". Moreover, the modules were envisioned to "lay the basis for career-long learning to enable workers to keep pace with technological change" (Hirschsohn, 1998, p. 9).

Because the skills development programme is sector-wise, administered by the authority merSETA, firms are no longer disincentivised to provide training. Th provision of training to a worker comes with the risk that the worker may defect to another firm, while the firm loses the money it sank into training the worker. But because the training is standardized across all facilities, from TVETs to in-house training, many firms will be encouraged to train workers because they would know that even if a worker defects to another company, there may be other workers on the market with the same skillset.

On the demand side for training, there are two factors which incentivise workers to acquire more skills. On one hand, workers may be fearful of the effect of technological change, thus they may invest in skills that are less likely to be vulnerable to technological change. One reaction to this may be multi-skilling, where essentially a worker develops deep competencies in a wider array of areas, in effect 'diversifying' to protect against the downside risk of their jobs being obsolete. The

second incentive lies with the payment structure for skills. NUMSA, was able to negotiate that workers should be paid for skills acquired not skills used. Ordinarily, acquiring a new skill would come with the risk that the worker would be wasting time and effort into something that will not be matched in the job market. But this system ensures that regardless of whether the worker is deployed in an area that calls for that skill, they will be paid for the skills that they have acquired (Forrest, 2005, p. 465). Interviewee 5 notes that the upskilling strategy was employed so as to protect the South African industry from international competition (Interviewee 5, 2023, 19:35). NUMSA's strategy was to align workers' skillset to the direction in which the industry was going (Interviewee 5, 2023, 19:58).

On the supply side of training, a government official ('Interviewee 7') notes that the deployment of millions towards training by OEMs has been encouraged by the grant reception wherein the firms make a headcount of who they trained and are able to claim a share of the training costs they incurred (Interviewee 7, 2022). If therefore there are gains to be made by firms, then they will be encouraged to provide training. A firm would assess the decision to train workers. It would be rational for the firm to train a worker if the marginal profit from an extra 'unit' (e.g., year) of training equals the yearly cost of training that worker. Thus, the firm would train only those workers whose marginal return from training equals cost. Moreover, there is the risk that a worker will defect to another firm and use their skills there (Baria & Klasen, 2016, p. 75). Thus, there will be an undersupply of training. But with the skills fund, there is a reduction in cost for each worker trained.

Lastly, the corporatist arrangement, whereby all parties moderated their interests for the sake of the national development project, had already seen workers severely moderate their interests including not resisting technological changes, agreeing to settle some issues at plant level (as the employers had desired) and placing a moratorium on industrial action (as both government and employers wished). Thus, if firms and government did not hold their end of the bargain, which in this case was the provision of skills to ensure that they survive in the industry. This give-and-take between the three parties was already apparent as the 1995 agreements saw firms exchanging a commitment to lower the wage differential between skill levels (wage compression), for a guarantee from workers that there would be industrial peace so long as all matters settled in the agreement are not violated (Forrest, 2005, pp. 464-465).

7.4. The Brazilian Model of Capitalism



source: International Monetary Fund (2022)

Figure **7.7**. The Annual Growth Rate of GDP in Brazil 1980-2022

7.4.1. The Brazilian Economy – 1950s – 1990s

In this section, we look at the Brazilian model of capitalism from the late 1980s to the late 1990s. First, some context is in order. In the early post-WWII period, Brazil embarked on a strategy of import-substituting industrialization. This period is characterised by heavy protection of the manufacturing industry, whereby the early 1960s, the nominal protection averaged 165 percent over import prices (Colistete, 2009, p. 7). Colistete illustrates that the strategy was associated with high growth of labour productivity in ‘modern' industries like chemical and pharmaceutical products (at 7.2%) but with lower growth in other ‘modern' and ‘skill-intensive' industries such as machinery (at 4.9%), over the 1945-1979 period (Colistete, 2009, pp. 9-10). With regards to

domestic learning and innovative capabilities – a measure gauged by the export structure of a country (Colistete, 2009, p. 14) – Brazilian firms and industries showed marked improvement in ‘medium technology manufactures', rising from 2.6% to 19.1% of manufacturing exports between 1962 and 1979. Medium technology manufactures are regarded as intensive in “capital, technology, and labour skill", and feature the likes of motor vehicles and parts (Colistete, 2009, p. 15).

But from the 1980s onwards, the country experienced economic crisis, marked by phenomena such as hyperinflation (Riethof, 2019). The crisis led workers to be in a precarious position of actual and threats of job losses, wage freezes or losses, and a loss of power to bargain with employers. (Riethof, 2019). To halt the economic crisis, the incoming administration planned to institute economic liberalization and stabilization packages. It however still wanted to bring labour onto the table to participate in the formulation of those policies. Regardless, the package and deepening economic crisis initially prompted protests, but those protests were gradually losing power with less workers being mobilized. This is because there were internal conflicts in the labour movement (CUT), with some factions being anti-statist and thus opposed to any negotiations (with such tactics having been successful in the previous years) and another faction being more moderate (e.g., demanding job protection). Notably, there was a close and uneasy tie between a powerful political party (PT) and *the* union movement (CUT), and the union and the ruling government. For the working class, the 1990s attempt at stabilizing the economy was characterized by the difficulties in the labour movement mobilizing workers for mass action despite worsening economic conditions of unemployment, hyperinflation, job losses, and the unpopular privatization problem; the inability of labour movements to influence policy favourably despite being called on to the negotiation table (Riethof, 2019). Following more economic strife, unions other than the CUT came to the fore and espoused more moderation and pragmatism in response to the economic crisis (Riethof, 2019**).** the country experienced waves of privatization which were resisted by some unions. The privatization predictably came with proposed reductions to the workforce, as well as abolishment of benefits such as wage increases to make the company attractive for potential investors. Privatization severely affected union power as it reduced both members and funds. Unions were however largely unsuccessful in opposing privatization (Riethof, 2019).

Figure 7.8 The unemployment rate in Brazil since 1991



7.4.2. Characterizing The Brazilian Model of Capitalism

Within the institutionalist variant of the varieties of capitalism perspective, Brazil can be grouped alongside other Latin American under the category of Hierarchical Market Economies (Schneider, 2013, p. 5). These political economies, Schneider posits, are characterized by "multinational corporations (MNCs), diversified business groups, low skills, and segmented labour markets" (Schneider, 2013, p. 4). Moreover, Brazil is characterized by moderate rates of unemployment (as illustrated by figure 7.8). There is a generally a weak relationship between labour and the state, but as we will see below, this has not always been the case. There is a strong union presence in the industrial sector. Workers are also represented by factory committees at the plant level.

Roughly in the 1950s to 1960s period, when the ISI took off in the country, labour was subject to a state-corporatism. The period saw the imposition of a labour relations system which was effectively controlled by the government via the Ministry of Labour and was designed to enable the government to mediate relations between industrial workers and employers, to assure stable labour-capital relations in the quest for capitalist development. The military junta of the 1960s saw further repression of labour, and with the government getting evermore control through implementation of highly restrictive trade union system (Ramalho, 2019, pp. 264; Melo, 2018, p. 4; Barros, 1999, p. 17). Dissatisfaction with the government-arranged industrial relations system inspired the worker resistance through strikes in the late 1970s (Melo, 2018, p. 15; Barros, 1999, pp. 27-28) and establishment of independent forms of worker representation. Emerging in the industrialized region of Greater Sao Paolo ('ABC' region) during 1980s were PT and CUT, the latter of which sought to democratize workplaces through factory committees and the national expansion of these factory committees (Ramalho, 2019, pp. 265-271). Workers struggle culminated into the enshrinement of labour rights in Brazil's 1988 Constitution, including provisions that allowed for independent forms of worker representation (Ramalho, 2019, p. 269; Barros, 1999, p. 8).

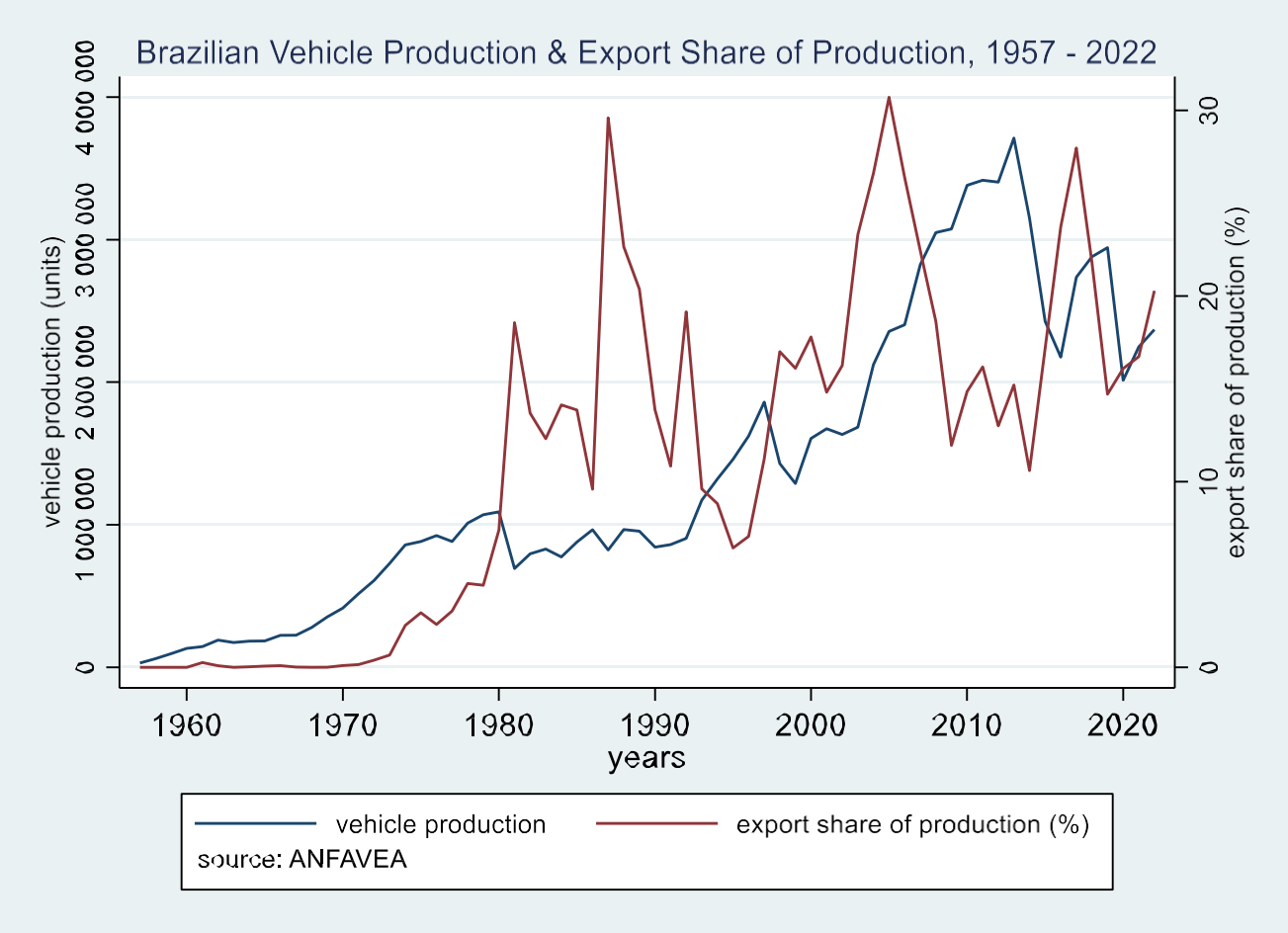
7.4.3. The Development and Performance of the Brazilian Automotive Industry

The initial efforts towards developing a domestic car manufacturing industry however lay in the balance-of-payment problems experienced by the country in the post-world war two period. An import boom, partly driven by the purchase of foreign vehicles, had ensued in the mid to late 1940s resulting in balance of payment deficits by 1947. Temporary respite followed with import cuts, but these were relaxed by 1951, which again led to balance of payments concerns with car imports being one of the primary drivers (Shapiro, 1994, pp. 29-33). Part of the reason why the assembly of motor vehicles became so attractive and so central to Brazil's plan to industrialize was because – upon visits to the then motor-vehicle dominated United States – government officials realized that it was an industry that had a lot of backward linkages and would thus prompt the "development of complementary industries" (Shapiro, 1994, p. 29)**.** To encourage the development of these complementary industries, the government enforced a strict 95% local content requirement for passenger cars (Ibusuki et al., 2015, p. 68) By the 1970s, the main objective of the government was to contain or reduce the trade deficit, hence the implementation of the export-incentive scheme

(Luedemann, 2003, p. 113-114). This was known as the Biefex programme, and it also made provisions for regional integration with Argentina (Ibusuki et al., 2015, p. 68). BIEFEX (Beneficios Fiscais a Programas Especiais de Exportacao) was not specific to the automotive sector but applied to a host of industrial goods (Shapiro, 1994, p. 223). As increased exporting was linked to exemption from taxes on imported capital goods, among other imports, the government aimed to "avoid any import constraint to investment and economic growth" (Shapiro, 1994, p. 223). By 1960, the industry had eleven assemblers, a group which included Scania, Ford, VW, and Toyota (Luedemann, 2003, p. 101)

The full impact of the debt crisis had materialized by the 1980s, leading to a dampening of the expectations on domestic vehicle demand (Shapiro, 1994, p. 226). With the industry having been previously focused on the domestic market, the only other outlet for vehicles sales was exports. With lacklustre domestic demand the vehicle export gradually rose, with the export share of domestic passenger vehicle production peaking at 41% in 1987 (Shapiro, 1994, p. 226). But due to an overvalued currency these exports had fallen to 18% by 1990 (Shapiro, 1994, p. 226). In the 1990s, auto manufacturers – with the aid of much government incentives - established new plants in areas where worker organization was weaker than the ABC industrial belt (Bicev, 2022, p. 215). The trade liberalization which took place in the early 1990s took car assemblers by shock (Ibusuki et al., 2015, p. 68). Trade liberalization brought on much more competition for the domestic market from foreign auto makers, making it an imperative to upgrade technological levels to keep up (Ibusuki et al., 2015, p. 68). Indeed, investments in the 1990s amounted to US$16.6 Billion compared to US$5.4 Billion in the 1980s, much of which was driven by already-present producers upgrading their plants (Ibusuki et al., 2015, p. 68).

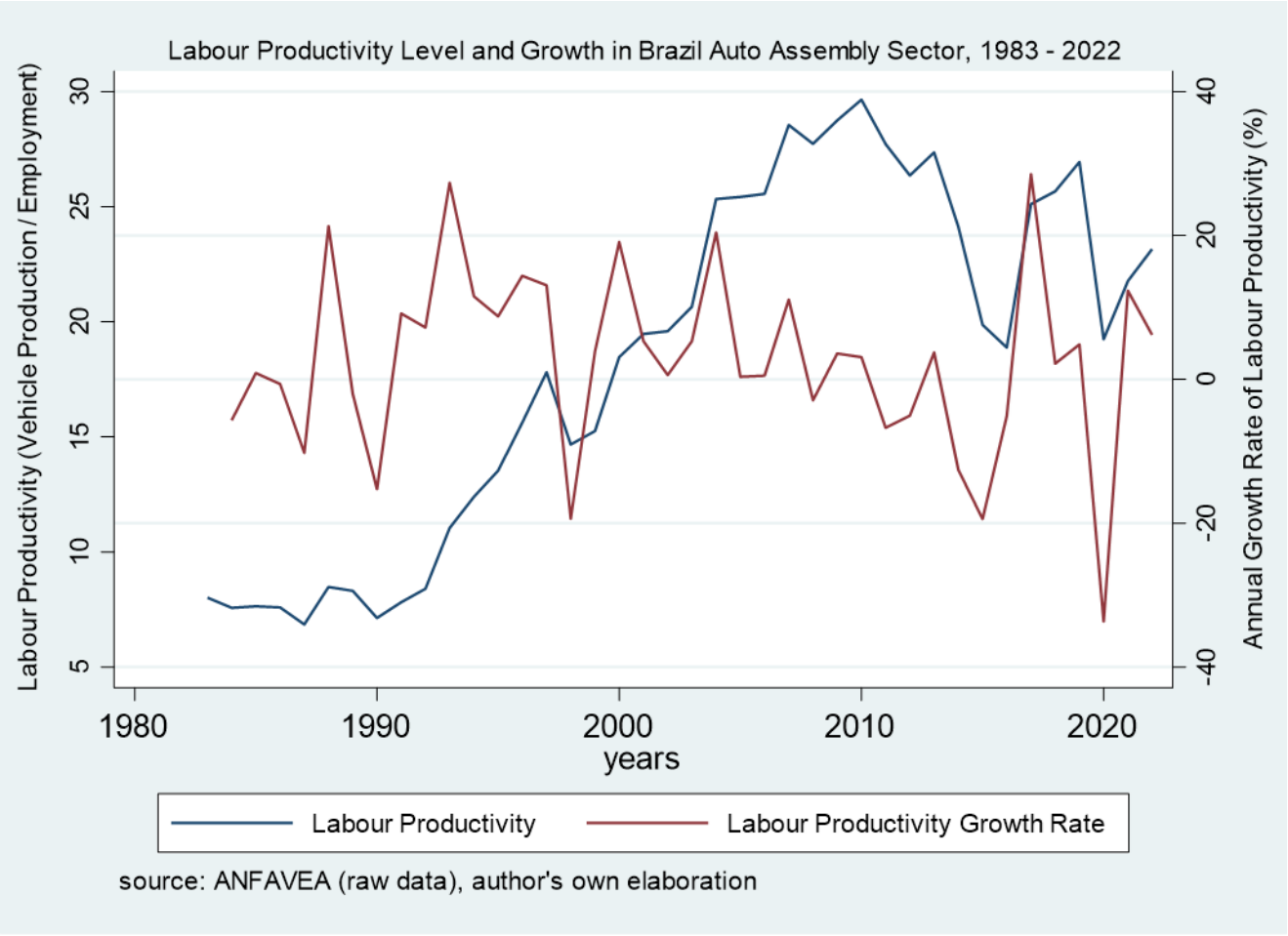
Figure **7.9.** The Performance of the Brazilian Automotive Industry: Production Levels, and Export Share of Production. While vehicle production has trended upwards, with particularly huge growth in the 2000s decade, the export share of production has fluctuated, peaking at around 30% in the mid-2000s


Brazilian Vehicle Production & Export Share of Production, 1957 - 2022
vehicle production (units)
0
1 000 000
2 000 000
3 000 000
4 000 000
export share of production (%)
0
10
20
30
1960
1970
1980
1990
2000
2010
2020
years
vehicle production
export share of production (%)
source: ANFAVEA

7.5 RESULTS AND DISCUSSION

7.5.1. Technological Changes into Brazil automotive manufacturing plants

Figure **7.10** Labour Productivity levels and growth



During the 1990s, the government provided incentives for automotive manufacturers to establish new production facilities away from the heavily industrialized 'ABC' region in and around Sao Paulo (Luedemann, 2003, p. 200).

However, this was not to the neglect of old factories as new investments reigned in. Companies including Ford, Volkswagen (VW), DaimlerChrysler, General Motors (GM), and Fiat put up billions of dollars into restructuring its old plants in places like Sao Bernardo do Campo for the period 1995-1996, with some investments extending to the year 2002 (Luedemann, 2002, pp. 202-203). For the 1995-1996 period, Ford put up US$850 million for its plant in Sao Bernardo do Campo. In Sao Bernardo, VW invested two billion Brazilian reais to implement the Polo assembly

line. For 1998-2002, GM put up US$3 billion, some of which went into the restructuring of its plants in Sao Caetano do Sul and Sao Jose dos Campos. DaimlerChrysler promised investments of US$1.1 billion for its Mercedes-Benz in Juiz de For and Sao Bernardo do Campo. Additionally, for the period 1995-1996, US$113 million went into their plant in Sao Bernardo. Fiat meanwhile lay out US$1.1. billion in its Betim plant for the 1995-1996 period (Luedemann, 2003, pp. 202-203).

In 2002, with the launch of the New Polo, VW invested R$2 billion into completely overhauling its old Anchieta factory in Sao Bernardo do Campo. This entailed the implementation of "the latest in state-of-the-art technology in equipment, tooling and the production process" (Pereira et al., 2003, p. 7). The assembly line was completely computerized, boasting 400 robots which are "welded and checked by a laser system" (Pereira et al., 2003, p. 7). There are innovations such as the use of a single assembly, known as 'Fahrwerk', to join the lower part of the car which comprises components such as the engine (Pereira et al., 2003, p. 8). In 1999, VW invested R$1.2 billion to open a new factory in Sao Jose dos Pinhais, Parana to produce the Golf and the Audi A3 (Pereira et al., 2003, p. 9). The plant uses advanced technologies such as laser welding and water-based painting. Laser welding is an "advanced process to join materials with a laser beam of high-power and high density", capable of effectively joining either plastics or metals of extreme levels of thin and thickness (Katayama, pp. 3-4). This process can lend itself to robotization, and consequently enables the reduction of manpower and achievement of full automation in a production line (Katayama, 2003, p. 4). Ford's plant in Sao Bernardo do Campo produced the Fiesta and a variety of pickup truck models (Bicev, 2022, p. 218). These include the Cargo; EscoSport; Ranger (Ford, n.d.). On the back of decreased demand for trucks in the Brazilian market, Ford reduced their production of trucks (Bicev, 2022, pp. 217-218). The Fiesta line was implemented in 2011 (Bicev, 2022, p. 218). Production of the Fiesta ran from 1996 to 2019 (Ford, n.d.). In the 1990s Ford built a new plant in Camacari, Bahia, and closed its plant in Sao Paulo (Melo, 2018)

For Brazil, we regarded comparable countries as those that are 25% within the production volume hit by Brazil in the year under evaluation. Given production levels of around 2 156 000 units, our range for selecting comparable countries is 1 616 000 – 2 700 000 units. Our selection procedure yielded the following countries: France, United Kingdom, Canada, Thailand. This is illustrated in Table **7.11**

	Brazil	France	United Kingdom	Thailand
Vehicles	2 156 356	2 090 279	1 816 622	1 944 417
Robots	25 246	138 895	62 340	82
Employment	115 279	112 000	225 000	-
Robots per 100 workers	22	124	27	-
Robot productivity	85.41	15.05	29.14	23 712

Source: International Federation of Robotics (2020)

7.5.2. Work Restructuring in Brazilian Automotive Manufacturing Industry

7.5.2.1. Employment

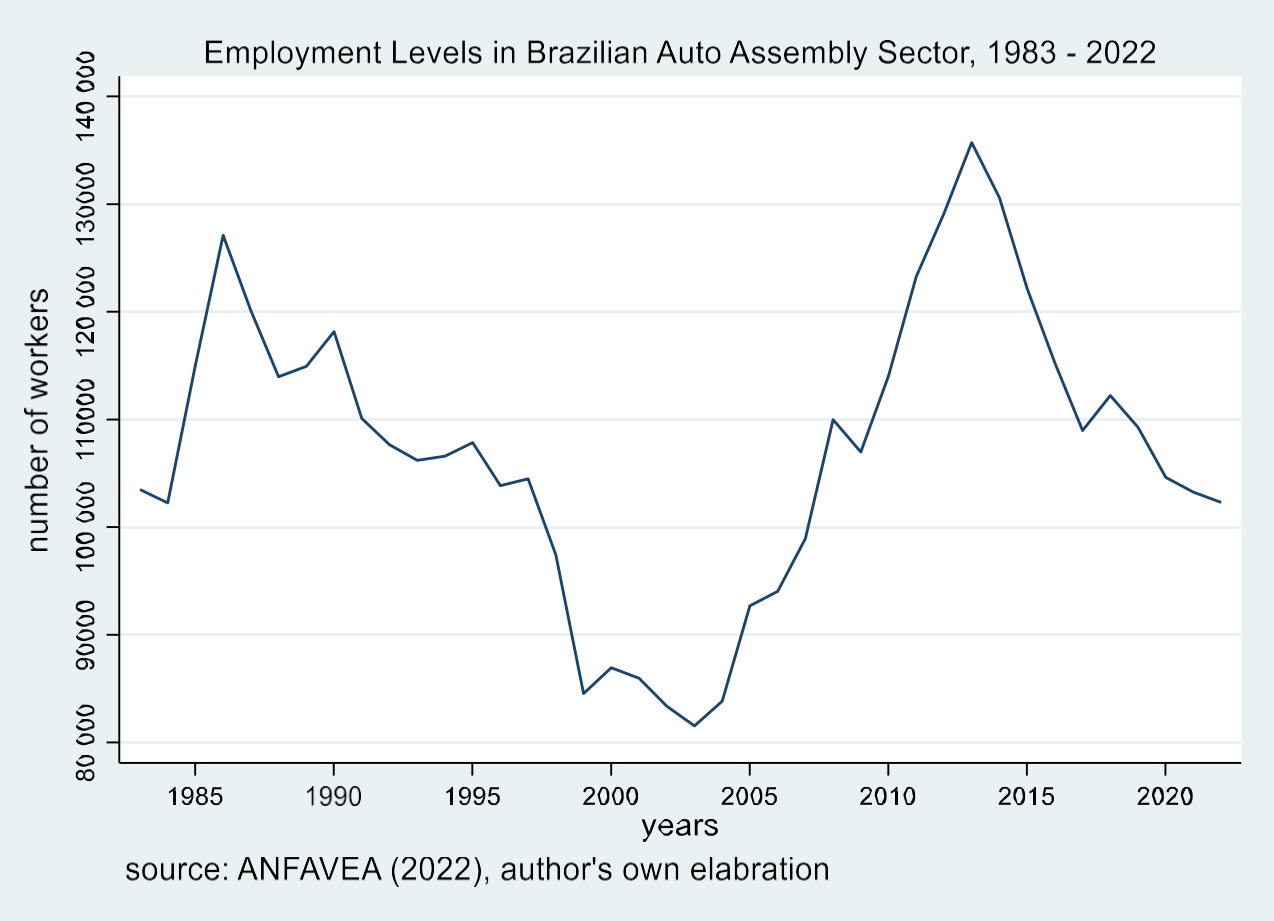


Figure **7.12.** The Level of Employment in Brazil's Automotive Assembly Sector, 1983-2022

In the sectorial chamber period, from May 1991 to December 1994 (Luedemann, 2003, p. 144), there was stabilization in the assembly sector employment levels, with an average annual growth of -0.9%. Luedemann opines that sectorial chamber period reflected the "phase of re-articulation of nationalist forces within the government, to the detriment of neoliberal policies" (Luedemann, 2003, p. 144). Dividing the automotive manufacturing industries' State of Sao Paulo employees among four groups – administrative and technical; service professions; production workers; and non-production workers, it was noted that the 16 705 employees dismissed in the period 1990 – 1992 were mostly accounted for by production workers at 65.4% (10 925 people) of the dismissals (Luedemann, 2003, p. 145). Yet, the majority of the workers hired in the 1992 – 1993 period were administrative and technical staff (51.4%), with production workers following closely at (47%) (Luedemann, 2003, p. 145). Thus, we see a restructuring of occupations over the sectorial chamber period, as more administrative and technical workers were hired, while the was a net negative change in the number of production workers as the number of dismissed exceed the number hired.

But from 1990 onwards, two trends emerge. From 1995, employment levels start to decline, with the most rapid decline happening in the period January 1998 to December 1998, where employment fell from 103 385 to 83 049 workers, a whopping 19.67% decline in the assembly workforce within a space of 12 months. The onset of the decline in employment in 1995 coincides with the 1995-1996 period we identified in the previous section where many of the OEMs committed investments amount to billions of dollars to either upgrading existing production facilities or setting up new ones. Strangely however, as illustrated by figure **7.10,** the steep upward trend in labour productivity started in 1990 following a period of stagnation dating back to the 1980s. This was on the back of rises in production and stability in employment. From 7.8 vehicles per worker in 1991 to 12.4 cars per worker in 1994, labour productivity had ballooned by 59% during the period, with little consequence for employment, because of the sectorial chamber agreement.

7.5.2.2. Skills and Occupations

Occupations	**2001 (%)**	**2006 (%)**	**2011 (%)**	**2016 (%)**

Mechanical adjusters, assemblers and mechanics of machines, vehicles and precision instruments	107,37	126.61	138.27	118.46
Metalworking laborers	92,55	62,40	47,57	38,48
Plumbers, welders, planers, boilers and assemblers of metal structures	105,01	85,24	82,33	55,61
Technicians, technical designers and similar Laborers	120,06	79,7	60,7	75,03
Painters	108,79	99,65	106,75	78,50
Electricians, electronics and similar laborers	44,53	35,33	44,06	58,16
Masters, foremen, supervisors of production and industrial maintenance and similar laborers	82,04	67,64	93,24	115,30
Laborers who handle the transport and manipulation of goods and materials	83,45	70,51	77,08	97,82
Engineers, architects and similar laborers	124,28	168,15	183,16	207,12
Economists, administrators, accountants, managers and similar workers	135,76	184,47	189,51	246,63
Production line feeder	-	100,00	150,68	442,05
Quality inspector	-	100,00	96,39	96,09

Source: Extracted from Cunha et al. (2021); Raw data from the Ministry of Labor and Employment (MTE, 2020)

Note: Variation in the proportion of professions in relation to the total amount of workforce in the assembly of vehicles considering 1996 as the base year (1996 = 100). As of 2002, the method of categorizing professions has been modified by IBGE. Thus, in 2006, new professions with a high number of workers were verified, such as a production line feeder and quality inspector. (Cunha et., 2021, p. 492).

As can be observed in the table, with technological change intensifying in the 1990s, the early to mid-2000s saw a churning out of workers whose roles either could be partially or fully mechanized. These included: Plumbers, welders, planers, boilers and assemblers of metal structures, as well as painters. Since the tasks of painters and welders is can be easily mechanized through robots – similar to our observation in the South African plant – these trends are unsuprising. The trajectory of the relatively more skilled and non-manual labour during this period is also informative. In line

with Luedemann's (2003) observation, the occupations, "Economists, administrators, accountants, managers and similar workers" and "Engineers, architects and similar laborers" saw a positive increase over the 1996 to 2006 period. These movements implied that the workforce increased in the concentration of non-manual and higher skilled workers relative to manual, lower skilled workers. In conjunction with the increase in robotization, labourers – which as we observed in the case of the plant in South Africa – which are complementary to robots such as production line feeders saw a sharp increase, especially after 2006.

7.6. Discussion

7.6.1. Industrial Relations

Our main argument is that the changes in employment levels in the Brazil in response to technological changes were conditioned by the lack of cooperation between the state and labour

as well as atomistic organization of the workers in the automotive sector. In turn, these were the results of the structure of the form of worker representation in the industry. The Sectorial Chamber was not an expression of worker power but of worker interest. Traditionally, dating back to years of the government suppressing labour, the relationship between labour and state was antagonistic. The same was true of workers and firms. Workers were only present in discussions of restructuring upon invitation and wielded no power over employees. When technological changes came, driven by the quest to combat international producers, employers simply ignored the calls of workers – despite agreements – and proceeded to retrench them. With bargaining continuing at plant level, workers held low bargaining power and thus employment fell drastically, then was left mostly to market forces thereafter.

Sectorial Chambers came about as a response to the economic crisis following the failure of President Collor's plans to mitigate the economic crisis in the 1980s (Luedemann, 2003, p. 143). It brought together the assembly, components, and retail sector of the automotive industry, along with trade unions and the government (Luedemann, 2003, p. 143). Auto industry workers were represented by the metalworkers unions of Sao Bernardo do Campo, Sao Paulo and Betim (Melo, 2018, p. 33). Among the goals of the Sectorial Chambers in 1991 was the increase of worker participation (Luedemann, 2003, p. 143). The first agreement came in 1991 and was extended to 1992. The second Sectorial Chamber of the Automotive Complex, signed in 1992, agreement was to be effective from 1993 onwards (Melo, 2018, p. 33). Considering the previously antagonistic stance the ABC metalworkers union had taken towards government and firms (Melo, 2018, pp. 27-28) – which had been fuelled by decades of repression by the latter two as the country industrialized – the Sectorial Chamber agreements represented a willingness by workers to collaborate in the interest of stemming the crisis. As established, employment preservation was carried out during this period. Although the first agreement was seen essentially as an emergency response to a crisis, the Sectorial Chamber became ingrained in the industry, and allowed for the expression of more ambitious objectives on all parties involved (Carvalho, 2003, p. 184).

Luedemann (2003, p. 144) notes that with the incoming of Vice President Itamar Frnaco in 1992, the Sectorial Chamber became seen as a stage for negotiations in the industry. Institutions for deliberation, according to Hall & Soskice (2001, p. 11) are characteristic of coordinated market economies and are crucial as they can facilitate for cooperation and trust given that actors will get

an avenue to share information such as interests and beliefs. Moreover, in the event of a shock, deliberative institutions can allow actors, through information sharing, to pursue strategies that find common agreement (Hall & Soskice, 2001, p. 12). In the 1992 Agreement, the assembly firms wanted to maintain or increase vehicle sales, while the unions wanted to preserve employment levels by putting a stop to layoffs (Melo, 2018, p. 33). The signing of the 1993 agreement saw the establishing of vehicle production targets, that of 2 million vehicles by the year 2000, and the target of creating of 90 000 jobs up to 1995 (Carvalho, 2003, pp. 184-185). But with labour productivity accelerating since 1990 (see figure **7.10**), the prospect for increasing jobs in the sector were highly doubtful. Labour productivity growth means that there is increasing output for a given level of inputs. Furthermore, as workers themselves had been invited to the Sectorial Chamber, which was founded and controlled by the government, they wielded no power.

Following the trade liberalization in the mid-1990s, however, which took the employers by surprise, it became an imperative to modernize the plants. The primary form of worker representation in Brazil automotive industry were worker-ran factory committees (Melo, 2018, p. 28). These factory committees, at plant-level, became the primary means by which workers were able to negotiate employment levels, as this was now taken out of the industry-level sphere. The following examples serve to illustrate this phenomenon. Bicev (2022, p. 213) argues that since the end of the 1990s metalworkers' unions in the ABC have been integral in ensuring the continued outlay of investment into the modernization of the automotive plants and the attraction of new vehicle platforms. The union Sindicato dos Metalurgi cos do ABC (SMABC) is said to have paired traditional strategies such as strikes with less conventional strategies such as “direct negotiation between union members and global management of the companies" (Bicev, 2022, p. 213). Ford is illustrative of worker involvement in restructuring. Bicev (2022, pp. 218-219) reports of the Ford workers union in Sao Bernardo do Campo – through a Collective Bargaining Agreement – avoiding layoffs amid a decline in the sales of the car it produces. Moreover, this workers union attempted, unsuccessfully, to negotiate the implementation of a new line to preserve employment levels at the factory (Bicev, 2022, p. 219; Melo, 2018, p. 16). These negotiations involved the factory committee (Melo, 2018, p. 16). Workers were therefore relegated to battling for employment levels at the plant level. As the technological changes pledged by most of the OEMs starting in 1995 came to the fore, it was thus unsurprising when mass retrenchments ensued, and with employment levels fell sharply from 1995 to 1999 (figure **7.12)**

7.6.2. Vocational Training and Education

In this section, we argue that the institutional structure of the national vocational system does not favour an industry-wide acquisition of skill because it does not adequately consider the incentives to supply or demand training. The Servico Nacional de Aprendizagem Industrial (SENAI) is a national vocational training system for the training of industrial workers. It was established in 1942, in response to the need of skilled workers as Brazil embarked on a 'big push' to industrialize (Baria & Klasen, 2016, p. 75). While initially devised to be a privately-ran industry-led institutions with training to be done in firms and institutions, it gradually became a stand-alone institution of training, where upon qualification, a worker will still need to go and find a job (Baria & Klasen, 2016, p. 75).

Baria & Klasen focus on the financing structure of the SENAI, arguing that it has an impact on the nature of training provided. They claim that when SENAI was solely funded by levy's from all industrial firms, while it provided a reliable income stream, it tended to encourage the provision of a standardized training programme, to the detriment of shopfloor and informal workers (Baria & Klasen, 2016, pp. 75-76). But the SENAI grew to include the sale of training to firms, it also allowed for the provision of "ad-hoc training courses" (Baria & Klasen, 2016, p. 76). Baria & Klasen (2016) investigate the productivity, wage and employability effects of undergoing training in the SENAI and vocational training in general. They find a higher trainings premium from going into the S-system (which includes the SENAI) compared to other training institutions (a premium of 28.3% for the former and 10.4% for the latter) (Brian & Klasen, 2016, p. 79). Vocational training in general is found to lead to higher levels of employment in the formal sector and of employability. The S-system is also notable for its matching abilities with as their graduates are "30 percent more likely to work in an occupation related to their training areas" (Baria & Klasen, 2016, p. 80).

The government has made some interventions on the supply side of training. 1975 saw the passing of legislation designed to encourage the training of workers. This was done via a financial incentive wherein companies could discount training costs from labour tax (Guibert & Romiszowski, 1980, p. 219). Moreover, the government – via the Ministry of Labour – took to coordinate the activities of organizations involved in the "development of human resources for the labour market." (Guibert & Romiszowski, 1980, p. 219). But such interventions are likely to have a weak effect in stimulating demand for training. In accounting terms, discounting training costs from labour tax

will be positive for the company's finances, given that labour tax would have been paid regardless of training. But for the firm the costs of on-the-job training are not limited to investment costs (e.g., paying someone to supervise the workers in training) but extend to opportunity costs (Mincer, 1962, pp. 51-52), which include reduced output due to a portion of the workers being dedicated to training or supervising training of other workers. Thus, unless it can be ascertained that the future increased profits due to the workers dedicating more time to training will exceed the current accounting and economic costs of providing on the job training.

VIII. A Comparative Analysis of the effect of Technological Change on Work Restructuring in Brazil and South Africa

Country	Technological Changes	Employment	Skills	Occupations
South Africa	*Pace:* **phased-in; anticipated** *Sophistication:* **below world technological frontier** *Extent:* **Around 25 robots per 100 workers**	**Stable; minor fluctuations; downward trend since 1990s**	**Increased concentration of higher skilled workers relative to low skill workers; near elimination of low skill Workers**	**Increased concentration of managerial/supervisory positions; artisans and professionals; decline in elementary occupations**
Brazil	*Pace:* **sudden; unanticipated** *Sophistication:* **below world technological frontier** *Extent:* **Around 22 robots per 100 workers**	**Volatile; considerable fluctuations; no discernible pattern since 1990s**	**Increased concentration of high skilled workers; lower skilled worked**	**Increased concentration of managerial/supervisory positions, professionals and of elementary occupations; decline in Artisans**

Within the institutionalist variant of the varieties of capitalism (VoC) framework, Schneider claims that while neither South Africa nor Brazil perfectly fit the mould of the Hierarchical Market Economy (HME), they can both be approximately classified under this category (Schneider, 2013, p. 5). Indeed, both countries share the main characteristics of this type of political economy. However, the problem with the institutionalist approach is that it brushes over much of what goes a long way in determining the distributional outcomes of a society. For example, Morgan et al. (2021) extends the basic institutionalist variant of VoC with considerations of two factors: the growth regime and social bloc of a country. Morgan et al. (2021, pp. 13-24) then demonstrate how through the interaction between those factors, Brazil remains locked into outcomes such as a low skill base.

8.1. Industrial Relation Systems

In the period under evaluation, 1990-1999, The national organization of the auto workers, mostly under one union (NUMSA) in South Africa, gives the workers much greater bargaining power, whereas in Brazil, with the primary form of worker representation within the plants are factory committees, it ensures a dispersal of worker resistance, giving the workers much less bargaining power. The plant level representation by one union in South Africa allowed them to build bargaining power nationwide, as strikes could be called immediately, even if a few assembly plants were affected by some dispute. The union used the strength it had built to force assemblers to preserve jobs. A reputable sanctioning system had by then been already established, with nation-wide strikes, even in cooperating plants costing the auto makers hundreds of units of production.

The weakness of the worker representation structure in Brazil was shown most clearly with the relocation of Brazilian firms from regions of union-strongholds in the Greater Sao Paolo region to regions of comparatively less unionization. A fundamental difference between the investments and restructurings in Brazil and South Africa during the 1990s was that in Brazil, it partially involved the construction of new plants in different regions than where the industry had concentrated. Whereas in South Africa, reinvestments were made into old factories. As such, firms potentially faced different kinds of conflict. In South Africa, firms had to deal with an experienced workforce that had industry and firm knowledge and that was at that point well-organized. In Brazil, firms chose their workforce and faced grievances from workers in old factories. As it turns out, the selection of new plant location in Brazil was not random. It appears – according to the VW Resende

and Ford Camacari cases (Abreu et al., 2000) – that the firms chose locations with low unionization rate that had little history with organizing in the automotive sector. Because the form of representation of workers in Brazil was plant-based, there was no scope to combat or even negotiate in the new regions.

Additionally, when South Africa's industry initially transitioned, there were tight relations between workers and government. Thus while the government wanted to have an industry that was highly competitive by international standards, the government, recognizing the potential for labour to create an environment that was unhospitable to investment, the government was able to convince labour to forego immediate demands for job creation, and rather understand that job creation needed to hinge on the performance of the industry, and more specifically, on firm-level performance (Forrest, 2005, p. 467-468). In the 1990s, there was an attempt to seemingly institutionalize worker's rights to participation through the establishment of workplace forums. This was seen even by the government as key to industrial restructuring, especially in light of restructuring becoming an imperative following South Africa's reintegration into the global economy (Webster et al., 2019, p. 540). However, the establishment of these forums never took off. This could mainly be attributed to trade unions fearing that it will undermine their power and that these forums would operate as they did during the apartheid era (Webster et al., 2019, pp. 542-544). Rather, they thought that any workplace forum should work within existing trade union structures (Webster et al., 2019, p. 544).

In all, our analysis has implications on the theory and on practice for countries. First, for theory, our analysis reveals the lack of depth in the purely institutionalist variant of the varieties of capitalism framework. We say this because, in many senses, all of the institutions (a sectorial bargaining forum) and actors (multinational corporations, a government espousing neoliberal principles, and powerful and prominent organized labour) that were present in Brazil as the economy transitioned in the 1990s were present in South Africa. In fact, Brazil's and South Africa's industries were subject to the same shock, that of trade liberalisation. Thus, a pure institutionalist analysis of the two industries during the period under review would have predicted similar outcomes for variables such as employment. However, once we consider the historical relationship between the actors, the actor-driven evolution of the institutions that bind the actors

together, and most importantly, the growth model of the economy, we start to see why there may be divergences in the economic outcomes of political economies that appear broadly similar.

8.2. Vocational Training and Education System

The key distinguishing factor in the sectoral vocational training and education systems in the countries are the incentive systems around the supply and demand of training. In South Africa, a worker drastically reduced the risk of spending time and effort in training because they will get paid for the skills, they have attained rather than those they use. In Brazil however, there are no provisions for such an arrangement. Thus, the demand for training by workers is likely to be much less as they have to take into account the risk of no skill matches.

Ultimately, even in the construction of these skills development institution, South African workers were at the forefront and were demanding the kind of education and training that would be beneficial for the lowest to the highest skilled, as exemplified by the advocacy by NUMSA od Adult Basic Education. Meanwhile in Brazil, because the skills development institutions were put in place by the government to serve industry with adequately skilled workers, it is unlikely that considerations have been made on the capacity of the lowest skilled to be retrained and be able to attain higher levels of skill. Lastly, the Brazilian vocational training and education system makes more extensive use of market forces, through the provision of tailored training programme via SENAI. Hence, it is a hybrid system as it also has programmes that are standardized. Compared to its South African counterpart, which features standardization throughout, the system in Brazil is more likely to produce skill mismatches as workers may be trained in firm-specific skills, giving them less mobility in the industry.

IX. Recommendations and Conclusion

Our results, which demonstrate the capacity of two capitalist systems to deal with technological change, during the period of economic transition in the 1990s. It offers several lessons. Firstly, in phenomena that affect an industry its totality – i.e., are not firm specific, for there to be a good articulation of the interests of all parties, it is imperative for deliberations to be carried out at an industry-level. Secondly, our results show the importance of all organizations and actors involved having the capacity to conduct their own research on the trajectory of the industry and be able to communicate and share with other actors, so that all interests are represented well.

In this paper, we have looked at the effects of technological change on work restructuring in the Brazilian and South African automotive manufacturing industries, through the lens of the structuralist approach to Varieties of Capitalism. We see that the restructuring of the automotive industry in South Africa featured a greater deal of co-determination by firms, the state and workers, although this too eventually faltered as the interests of the workers were made subservient to those of the firm. However, we still found that in contrast to Brazil, where there was a weak tie of labour to the state, and where labour was quickly overlooked by the government in structures of planning, labour in South Africa wielded considerably more power in planning. As expected of an economy that more approximates co-ordination (CME) than being liberal (LME), there was a better response to technological changes, allowing for an industry-wide retraining of workers, and employment for the most part has been stable, with only dips in the periods of economic crisis (e.g., 2008; 2020). In Brazil however, as the technological change was largely expected, and labour's voice was restricted in arenas of deliberation, there tended to be huge fluctuations in employment and less industry-wide retraining of workers, resulting in mass losses in employment, and comparatively lower skill levels than in South Africa.

From the point of view of conserving the employment levels in the automotive manufacturing sector there are two implications. First, it is salient that workers have full knowledge about the nature of the process technology that will be used in the making of electric vehicles. This will allow them to anticipate the kinds of changes firms will likely want to make within the car plants, and to potentially contest them effectively. Secondly, it implies that in a bid to protect their jobs, workers must exercise their power. However, this is made difficult by the fact that decisions on the production process are largely deliberated and concluded in the headquarters of the multinational, rather than at the subsidiary level. Thus, the strengthening of relations between workers' organization across international borders might be a one avenue of increasing worker power.

By contrast, from the point of view of industrial stability and growth, it will be necessary for the government to ensure that the workers are fully integrated in the decision making processes as the industry transitions towards electric vehicles. Given the current terrain in South Africa, where employment levels and production processes are decided at firm level, it is likely that the shedding of workers to allow for technological change will bring about instability. If workers are able to organize themselves across firms, then the resulting instability will threaten industrial growth.

Hence, the proper way would be to use the industry-level forum, National Bargaining Forum, to bring together firms, worker organizations and the state. Vitally -- as outlined in the Green Paper on Electric Vehicles (Department of Trade, Industry, and Competition, 2021, p. 10) – the transition from ICE vehicles will require much government support. This implies that the government can use this support to extract concessions from firms, ensuring that employees are protected through upskilling or reskilling which may involve redeployment into other parts of the automotive value chain. Prospects for conserving employment – regardless of industrial growth – are likely to be much tougher in Brazil. Since the platforms for coordination between the state, firms, and workers are less institutionalized, and firms have greater power to unilaterally determine production processes, workers will have to resort to more combative ways to bring firms to the negotiation table. In spite of the present animosity, for Brazil's automotive industry to prosper, it will be necessary to secure industrial peace. Thus, a stable bargaining platform – rather than a market-centric coordination -- which will allow workers and firms to come to a common agreement.

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Interviews – MAKE ANONYMOUS

Interviewee 1 – Beth Dealtry, NAACAM

Interviewee 2 – Shivani Singh, NAACAM

Interviewee 3 – Norman Lampretch, NAAMSA

Interviewee 4 – Edward Webster, Southern Centre of Inequality Studies (SCIS) – University of the Witwatersrand

Interviewee 5 – Philipp Hirschsohn, University of the Western Cape

Interviewee 6 – Jose Ramalho, Federal University of Rio de Janeiro

Interviewee 7 – Mzwakhe Mbatha, Department of Trade, Industry and Competition

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UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG | SEF SCHOOL OF ECONOMICS AND FINANCE

The Effect of Technological Changes on Work Restructuring: A Comparative Analysis of the South African and Brazilian Automotive Manufacturing Industries

A Research Report submitted in partial fulfilment of the Degree of Master of Commerce (Applied Development Economics) in the School of Economics and Finance, University of the Witwatersrand

by

Name: **Liso Mdutyana**
Student No: **1929902**

Supervised by Dr Sibulele Nkunzi & Prof. Alexis Saludjian

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INVESTIGATOR	Mr Liso Mdutyana
SCHOOL/DEPARTMENT OF INVESTIGATOR	School of Economics and Finance
DATE CONSIDERED	24 January 2023
DECISION OF THE COMMITTEE	Approved Unconditionally
RISK LEVEL	Minimal Risk
EXPIRY DATE	31 December 2026

ISSUE DATE OF CERTIFICATE 30 January 2023 **CHAIRPERSON** _____
(Dr Sibulele Nkunzi)

cc: Supervisor: Dr Sibulele Nkunzi

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am are authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

_____ **30/01/2023**

Signature **Date**

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

APPENDIX 2

UNIVERSITY CLEARANCE CERTIFICATE[5]

Name: Sibulele Nkunzi candidate for the degree of Mcom Applied Development Economics has today submitted her/his thesis/dissertation/research report/project for examination.

a) Has this thesis/dissertation/research report/project been submitted with the consent of the supervisor?	**YES** (X)	**NO**
b) To the best of your knowledge are you able to confirm that the candidate has acknowledged all information used in the thesis, dissertation or research report/project?	**YES** (X)	**NO**
c) To the best of your knowledge are you able to confirm that the candidate has not used any confidential information without the required permission in the thesis, dissertation or research report/project? If **No**, please provide an explanation in the supervisor's report.	**YES** (X)	**NO**
d) Did the candidate's research involve any engagement with people, animals, or the environment?	**YES** (X)	**NO**
e) If **Yes**, did the candidate obtain ethical clearance by the relevant, approved ethics committee of the University before the research was conducted?	**YES** (X)	**NO**

f) If **Yes**, please state the ethics certificate number

Please See Ethical Clearance Certificate

(If **No**, the degree may not be awarded.)

Name of Supervisor Sibulele Nkunzi

Signature of the Supervisor .....

Date 03/04/2023

[5] This form is applicable to all Faculties within the University.

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

WITS FACULTY OF COMMERCE, LAW & MANAGEMENT

SUPERVISOR REPORT

on submission of a thesis, dissertation or research report for examination

Senate Standing Orders on Higher Degrees require that all thesis, dissertations and research reports that are submitted must be accompanied by a Supervisor's report (see A.20). This report is not an examiner's report – it will be used by the Faculty Graduate Studies Committee for the quality assurance of supervision, and for insight into the relationship between the Supervisor's assessment and that of the examiners. This report will not be seen by the examiners but it will be given to the student along with the examiners' reports, once the examination process is complete.

Name of Supervisor: SIBULELE NKUNDI **Contact email:** Sibulele.Nkundi@wits.ac.za

School: SEF **Department:** ECONOMICS

Signature: [signature] **Date:** 03/04/20

Student Name: Liso Mdutyona **Student number:**

Degree registered for: MCOM ADE

Title of submitted thesis/dissertation/research report: The effects of Technological Changes on work restructuring: A Comparative Analysis of the S.African & Brazilian Automotive Manufacturing Industries

1. **Please Comment on the Supervision Process:**

   Frequency of meetings: twice Monthly

   Number of drafts reviewed for proposal: 2

   Extent of assistance with data collection/analysis: fair

   Number of drafts reviewed for first submission (to Faculty): fair

   Have you requested progress reports from the student? If yes, how often? NO

   Any difficulties in the relationship: None

   Other comments: Student could have done better with timely submission of drafts

2. **Please comment on the student's ability to work independently during supervision process:**

   Selection of topic: fair

   Proposal development: Good

   Literature Review: Good

   Data collection: fair

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   Thesis/dissertation/research report write up: fair

Ability to meet deadlines: Weak

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3. **Please list conferences attended by student:**

N/A

4. **Please list publications emanating from student's work** (include each authors role in the case of joint publications):

N/A

5. **Please comment on the quality of the submitted thesis, dissertation or research report:**

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Contribution the research makes to knowledge in the field: Good

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6. **Kindly advise of any personal difficulties experienced by the student** (death in the family, illness etc):

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Private Bag 3 Wits, 2050
Fax:
Tel:

Reference: Mr Tshepo Mohlakoane
E-mail: Tshepo.mohlakoane@wits.ac.za

06 January 2023
Person No: 1929902
PAG

Mr L Mdutyana
78 Crawford Street
Mount Croix
6001
South Africa

Dear Mr Liso Mdutyana

Master of Commerce: Approval of Title

We have pleasure in advising that your proposal entitled *The effect of technological changes on work restructuring: a comparative analysis of the South African and Brazilian automotive manufacturing industries* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Marike Bosman
Faculty Registrar
Faculty of Commerce, Law and Management