Received: 6 February 2023 | Revised: 25 May 2023 | Accepted: 11 August 2023

DOI: 10.1111/twec.13491

ORIGINAL ARTICLE

The World Economy WILEY

FDI, production networks and firm behaviour: Evidence from the South African automotive industry

Yuki Higuchi[1] | **Justin Barnes**[2] | **Anthony Black**[3] | **Keijiro Otsuka**[4]

[1]Faculty of Economics, Sophia University, Tokyo, Japan

[2]Gordon Institute of Business Science, University of Pretoria, Pretoria, South Africa

[3]School of Economics, University of Cape Town, Cape Town, South Africa

[4]Graduate School of Economics, Kobe University, Kobe, Japan

Correspondence
Yuki Higuchi, Faculty of Economics, Sophia University, 7-1 Kioicho, Chiyoda-city, Tokyo 102-8554, Japan.
Email: higuchi@sophia.ac.jp

Funding information
Japan Society for the Promotion of Science, Grant/Award Number: 18H00850 and 21H00714; Murata Science Foundation

Abstract

Firms in developing countries can learn advanced technology and management know-how through foreign direct investment (FDI). The extent (or the lack) of transmission of technology and knowledge depends on the structure of production networks. In the automotive industry, networks consist of vehicle assemblers and their layers of parts suppliers. We used the South African automotive industry as a case study to examine how the behaviour of assemblers and parts suppliers is linked. Based on statistical analysis using the original firm-level data, we found that the first-tier suppliers significantly increased their production with the regional expansion of automotive production. However, such growth linkages were not observed among lower-tier suppliers. Further, we obtained the suggestive evidence that only multinational (and not local) first-tier firms improved their production efficiency, indicating the importance of production networks among multinationals in transmitting technology.

KEYWORDS

backward linkage, foreign direct investment, global value chain, local content, South Africa

1 | INTRODUCTION

The manufacturing sector in Africa has been stagnant. While there has been a recent discussion on the possibility of service-led growth enabling the bypassing of manufacturing (Hallward-Driemeier & Nayyar, 2017; Nayyar et al., 2021), the youthful population in Africa constitutes an opportunity as well as a threat to the African economy and society (Aryeetey & Baffour, 2022). In the service sector, the employment absorption capacity of unskilled or semi-skilled labour is limited, and the unemployment of youth will result in widening inequality and social tension. Hence, job creation through manufacturing growth is important for equitable and sustainable growth in Africa. For manufacturing growth, firms play a critical role. However, firms in developing countries, particularly in Africa, have been unproductive and unsuccessful in upgrading partly because of a lack of learning from advanced firms (Verhoogen, 2023).

Foreign direct investment (FDI) is considered an important channel for local firms in the developing world to learn advanced technology and management know-how. Javorcik's (2004) pioneering work on the spillovers resulting from FDI found significant technology transmission from downstream multinationals to local upstream firms in Lithuania. Many subsequent studies observed similar vertical transmission from multinationals to local firms in different countries and periods (see the surveys by Havranek & Irsova, 2011; Rojec & Knell, 2018; Smeets, 2008).

We hypothesise that the benefits of technology transmission for local firms are not automatic, and the extent (or the lack) of technology transmission crucially depends on the structure of production networks. If the contractual relationships between foreign assemblers and local parts suppliers are long-term and relational, then the former has incentives to provide useful production and management information to the latter (Murakami & Otsuka, 2020).[1] Such information provision is not information spillovers in the strict sense of the word because it is not an externality but a part of conscious contractual transactions. Since we cannot empirically distinguish between informational externality and information provision, we use the term information 'transmission' to refer to the flows of useful information from one firm to another. If foreign assemblers and foreign parts suppliers dominate the production networks, local parts suppliers may fail to take advantage of such information transmission and fail to develop.

This paper uses the South African automotive industry as a case study to examine how the behaviour of assemblers and parts suppliers is linked. The automotive sector has an extensive network of supporting industries and is expected to have enormous potential for job creation and learning from FDI. Because of such anticipated benefits, many governments in developing countries have used various policy tools to attract automotive FDI (Alfaro & Charlton, 2009; Schrank, 2017). The automotive sector in South Africa consists of three geographically distinct clusters, and this structure provides a unique opportunity to examine the role of production networks in technology transmission from FDI. We examined how the vehicle production in each cluster was linked to the behaviour of foreign and local parts suppliers in the same cluster. This analysis sheds light on the degree of production linkage and information transmission in the production networks.

To do so, we used our original firm-level data collected by the South African Automotive Benchmarking Club (SAABC). The SAABC is a privately funded non-profit organisation aiming to assist the development of the automotive industry. It started collecting firm-level data in 1999 and has continued the annual data collection until the present. The core questionnaire module

[1]Although statistical data are hard to come by, we heard through informal interviews that assemblers often charge 'technical assistance fees' to key parts suppliers.

has remained unchanged, and detailed information on business performance and production management has been collected. Since the second author of this paper is the founder of SAABC, the data became newly available for our statistical analyses. Importantly, the data contain information on the location, foreign ownership and tier level of the sample firms. The first-tier suppliers, which supply intermediate products directly to assemblers, consist of foreign-owned firms, joint ventures and some purely local firms. In contrast, the lower-tier firms, which deliver their products to first or second-tier parts suppliers, are mostly local.

We regressed the performance of layers of parts suppliers on vehicle production at the cluster level. The results showed that the first-tier suppliers significantly increased their production when regional automotive production increased, while such growth was not observed among the lower-tier suppliers. We also find that the first-tier suppliers expanded production by importing parts and materials, thereby reducing their reliance on local lower-tier suppliers. These findings suggest that the first-tier firms benefitted from production linkages but not lower-tier firms. To examine whether such production linkages brought technology transmission, we regressed the parts supplier's management practice variables on the cluster-level vehicle production. We found that only the multinational first-tier firms improved their management, and such improvement was not observed among the local first-tier or lower-tier firms. This pattern indicates that the information transmission from FDI was primarily limited to the multinational first-tier firms.

To supplement the correlational analysis, we adopted an instrument variable (IV) strategy. The parent companies of the vehicle assemblers operating in South Africa strategically determine their global production level across various locations, and the share of South African production is generally a tiny fraction of global output. Thus, South African parts suppliers' local economic and business environments are unlikely to influence the parent companies' global strategy. We use the parent companies' global total production (less those in South Africa) as instruments for South African production. Our IV estimation suggests that the first-tier firms indeed increased their production in response to the expansion of vehicle production in the same cluster, while the lower-tier firms did not (or have even decreased their production).

This study contributes to the literature on FDI spillovers in two ways. First, we shed light on the importance of production networks in determining the extent of technology transmission from FDI (or FDI spillovers in the FDI literature). Existing studies found that the degree of FDI spillovers depends on various conditions of host countries. For instance, it depends on the absorptive capacity of the host country measured by schooling (Borensztein et al., 1998), prior R&D expenditure (Blalock & Gertler, 2008; Chudnovsky et al., 2008; Mancusi, 2008) or labour market restrictions (Tan & Tusha, 2023). It also depends on financial market development (Alfaro et al., 2010; Hermes & Lensink, 2003; Otchere et al., 2016) or technological incompatibilities (Carluccio & Fally, 2013). We used the original firm-level panel data and found that the technology transmission reached the first-tier multinationals but did not reach the second or third-tier firms. This finding indicates that FDI brought not information spillovers that can be enjoyed by any firm but information transmission that benefits only selected firms.

Second, we used novel data that include information on the tier level of the firms. Empirical studies of FDI spillovers conventionally relied on the industry or location-level variations in the presence of multinationals. They regressed local firms' productivity measures (such as total factor productivity: TFP) on the presence of multinational firms in the same, upstream or downstream industry or the same region. Recent empirical studies used matched firm data of suppliers and customers. Alfaro-Ureña et al. (2022) used tax data tracking firm-to-firm transactions and found that the firm productivity significantly increased once the transaction with a multinational firm began. Kee (2015) and Newman et al. (2015) used firm data with

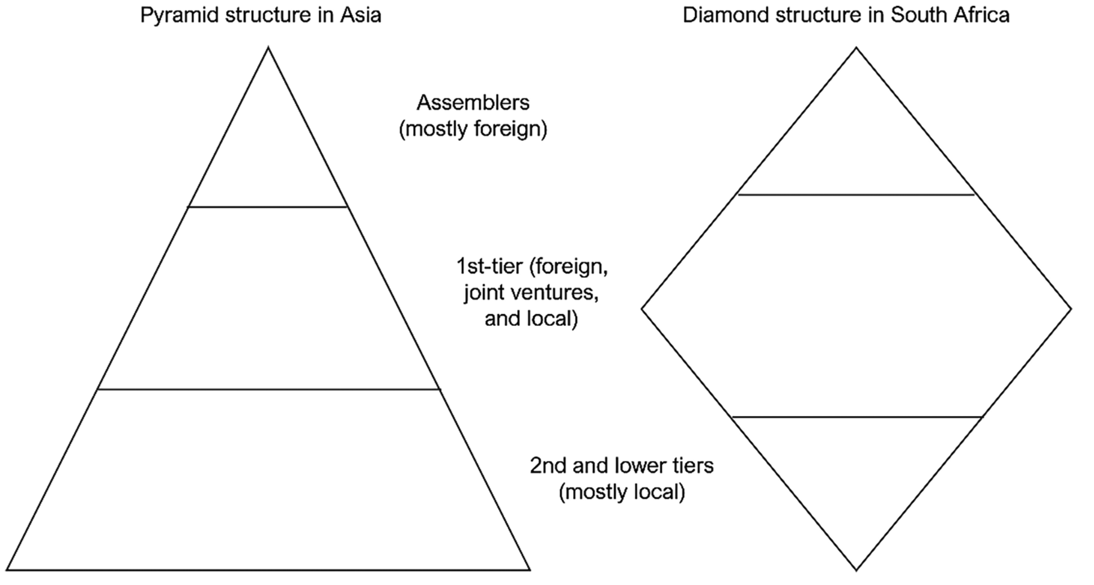

FIGURE 1 Illustration of Asian and South African automotive industry.

information on the supplier–customer relationships and found evidence of technology transmission from a multinational to a contracted local firm. While we cannot directly observe firm-level transactions, all the parts suppliers in the sample were directly or indirectly connected to a multinational in the same cluster. Our finding of heterogeneous FDI impacts by tiers of part suppliers highlights the importance of vertically structured production networks in analysing FDI's impacts.

This paper also speaks to the empirical studies of the automotive industry. Barnes et al. (2021) and Black (2009) argued that the South African automotive industry is characterised by a diamond shape, where the layers of the lower-tier suppliers are thin. This shape is in a sharp contrast to the pyramid-shaped structure developed in emerging Asian economies, such as Thailand and India (Barnes et al., 2017; Furuta et al., 2020; Natsuda & Thoburn, 2013). Figure 1 illustrates these contrasting patterns. In Asian countries, several, mainly foreign,[2] assemblers are situated at the apex of the pyramid. They procure parts largely from domestic first-tier suppliers, who procure parts from a larger number of second-tier suppliers. Further, the second-tier suppliers procure parts from an even greater number of third-tier suppliers. Second and lower-tier suppliers are mostly local and typically create extensive employment opportunities because of their labour-intensive production activities. We found that such layers are weak in South Africa because the first-tier suppliers are dominated by multinationals who rely mainly on imported parts and materials, and production linkages and technology transmission do not reach the local second or lower-tier firms.

The remaining part of this paper is organised as follows. Section 2 provides an overview of the South African automotive industry, and Section 3 explains our data and presents the descriptive statistics. Section 4 introduces the econometrics specification and shows the estimated results. Section 5 concludes with the implications of our findings.

[2]Tata and Mahindra are major local automobile assemblers in India.

2 | THE SOUTH AFRICAN AUTOMOTIVE INDUSTRY

South Africa has the largest automotive sector in Africa. It produced 631,000 vehicles in 2019 and ranked 22nd in world vehicle production. According to the International Organization of Motor Vehicle Manufacturers (OICA)'s production statistics, South African production is equivalent to a quarter of Brazil's (the largest producer in South America) and a third of Thailand's (the largest producer in Southeast Asia). This section provides an overview of the South African automotive industry while the historical details are in Appendix A.

2.1 | Brief history

The genesis of the South African automotive industry extends back to the 1920s, with the establishment of General Motors and Ford plants. While South Africa was one of the earliest developing countries to start the assembly of motor vehicles, the industry developed slowly with the dominance of low-level and low-value vehicle assembly (Barnes et al., 2004). The industry started to develop more rapidly after the introduction of import substitution policies in 1961. High tariffs on vehicles, imposition of import permits and high local content requirements were used to protect the automotive industry, and thus, local parts suppliers developed rapidly (Barnes, 2013; Black, 2001).

The protectionist policy shifted to a more export-oriented one in 1989. This policy shift was accelerated after 1995 when South Africa became a member of the World Trade Organization following the first democratic elections in 1994. The Motor Industry Development Programme (MIDP) was adopted in 1995, which drastically reduced vehicle tariffs and relaxed the local content requirement. In addition, exports were incentivised by a provision which allowed exports of parts and vehicles to earn import credits which could offset import duties on automotive imports. The result was a rapid expansion in the export of vehicles and parts as well as a rapid increase in imports, including parts and materials by first-tier suppliers (Black, 2009). We empirically examine the behaviour of firms during these transitions.

2.2 | Overview of automotive production and local content after 1995

Figure 2 presents data for the production, exports, and imports of automobiles in South Africa after 1995, when comparable data are available. Since 95% of South Africa's automotive production comprises light vehicles (LV), which consist of passenger cars and light commercial vehicles (mostly pickup trucks), this paper focuses only on LV production. In 1995, the automobile industry in South Africa manufactured approximately 400,000 vehicles, with the majority of these being sold within the country's domestic market. However, since then, there has been a notable rise in the production of automobiles, with some annual fluctuations due to the 2008 global financial crisis as well as other changes in economic condition and exchange rate volatility. The production reached 600,000 in 2019. This increase is primarily attributed to the growth in exports, which account for about half of the production in recent years. At the same time, the imports of automobiles into South Africa have also experienced an upswing, indicating that the total domestic sales have risen as well.

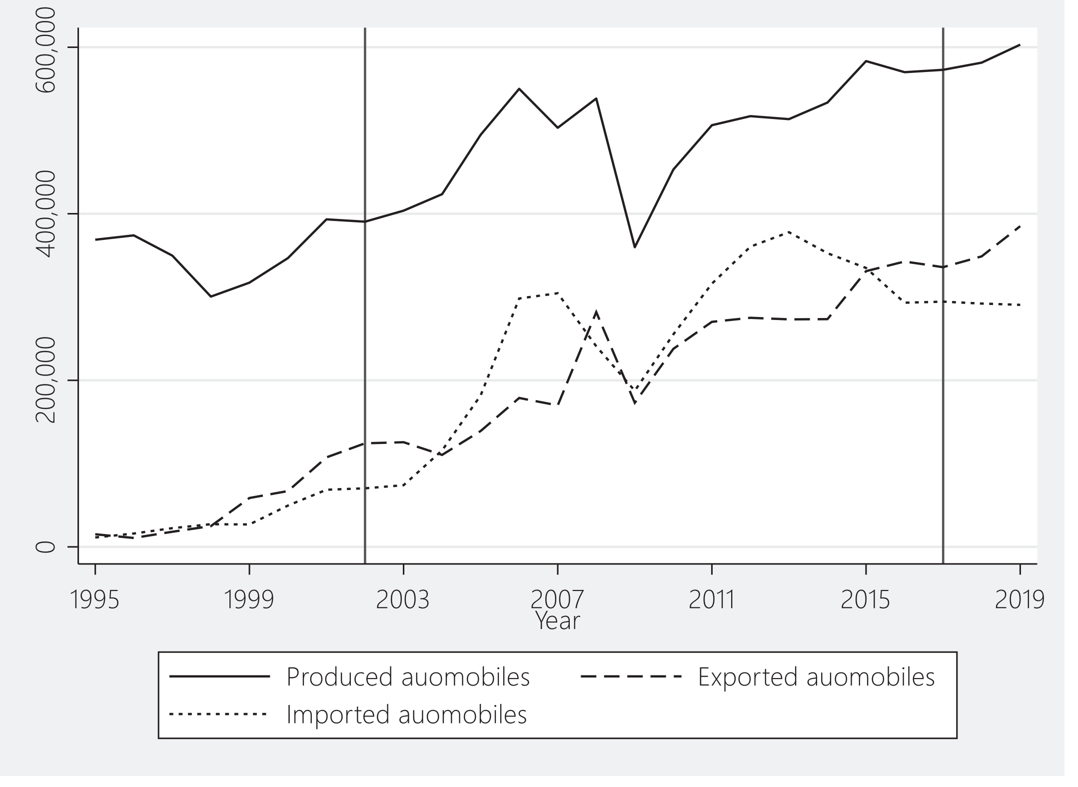

FIGURE 2 Changes in the production, exports, and imports of automobiles in South Africa (1995–2019). *Source*: The National Association of Automotive Assemblers of South Africa (NAAMSA) and AutoStats.

South Africa has seven major LV assemblers.[3] Our empirical analyses focus on these seven LV assemblers, all of whom are subsidiaries (i.e. the Original Equipment Manufacturer: OEM) of foreign automotive producers. They are clustered in three provinces: KwaZulu-Natal, Eastern Cape and Gauteng. Durban in KwaZulu-Natal is home to Toyota, the largest automotive assembler in South Africa. Eastern Cape is home to Isuzu, Mercedes-Benz and Volkswagen. Gauteng is home to BMW, Ford and Nissan. Lamprecht (2009), OICA (various years) and AutoStats provided the assembler-level production information, which we have aggregated to construct cluster-level data.[4]

Figure 3 presents the changes in the number of automobiles produced by the three clusters. In 1995, production was about 150,000 vehicles in the Eastern Cape and about 100,000 each in Gauteng and KwaZulu-Natal, and the production in all three provinces has gradually increased. The production expansion may appear to suggest that the MIDP schemes have successfully expanded automotive assembly. Comparator countries such as Thailand, however, have outperformed South Africa. From a base similar to South Africa

[3]Hyundai, Beijing Automobile Works and Mahindra have recently started assembling in South Africa. However, they operate semi-knocked-down assembly, and their share in South African vehicle production is atmost a few percent. Further, their production data were only partially available; thus, we excluded these small assemblers from the scope of this paper.

[4]AutoStats is a private consultancy company that manages the data on behalf of the National Association of Automotive Assemblers of South Africa (NAAMSA), the industry's official representative body.

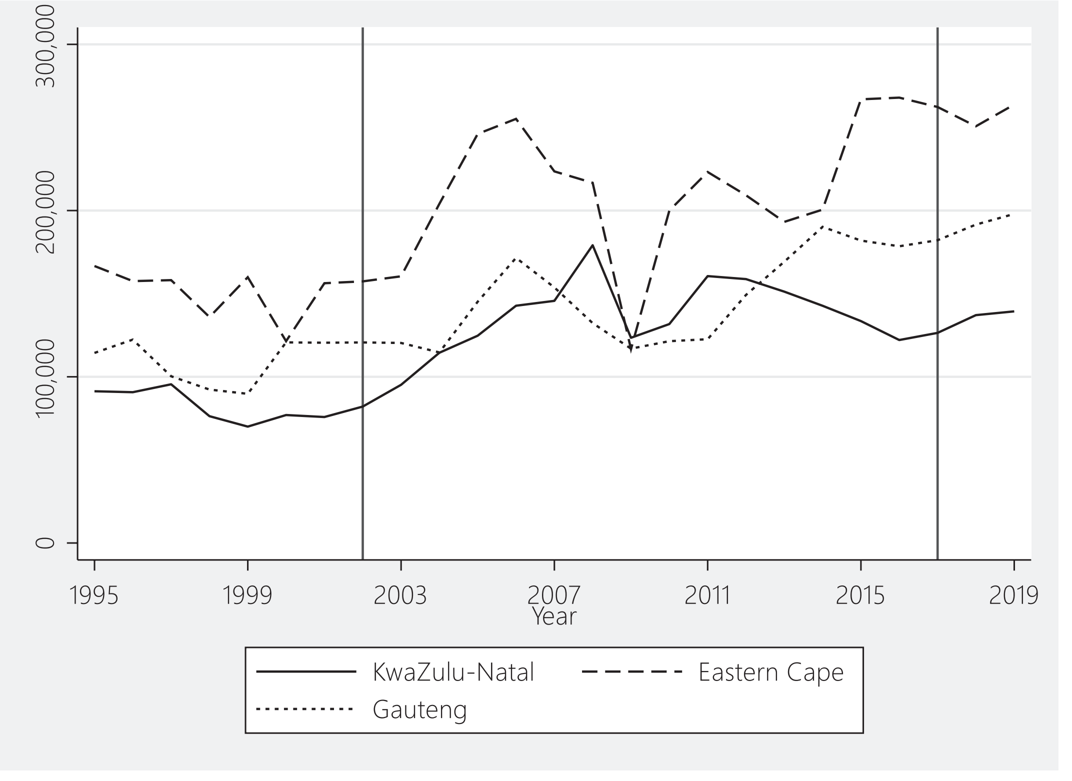

FIGURE 3 Changes in regional automobile production (1995–2019). *Source*: Lamprecht (2009), OICA (various years), and AutoStats. *Note*: KwaZulu-Natal: Toyota; Eastern Cape: Mercedes-Benz, Isuzu, Volkswagen, General Motors (until 2017); Gauteng: BMW, Ford and Nissan.

before 2000, Thai vehicle production climbed to over 2 million vehicles in 2019. Apart from having a more dynamic economy, Thailand was a more competitive location and became a favoured export hub for foreign (mainly Japanese) assemblers. It also retained high tariffs on imported vehicles, and local content levels remained relatively high (Barnes et al., 2017; Natsuda & Thoburn, 2013).

In South Africa, the level of local content has declined. Figure 4 plots the changes in the local content ratio from 1996 to 2018. Local content is computed as the wholesale vehicle value less the value of all imported materials and parts as a percentage of the wholesale vehicle value. Although no comparable data were available before 1996 due to differences in the definition of local content,[5] Black (2009) argues that the local content level started to decline with the amendment of the import-substitution industrialisation policy in 1989. With the current low local content level of about 40%, domestically produced parts comprise mainly simple products, such as wheels, exhaust components, interior and exterior trim components, body panels, batteries and glass. Overall, the aggregated data show that while automotive production has expanded since 1995, local content levels have continued to decline.

[5]Local content is difficult to measure, and the definition of local content has been a major issue of debate between the government and the various industry associations in the South African automotive sector. Each definition is subject to measurement difficulties, and the level of local content is subject to the vagaries of changes in the exchange rate.

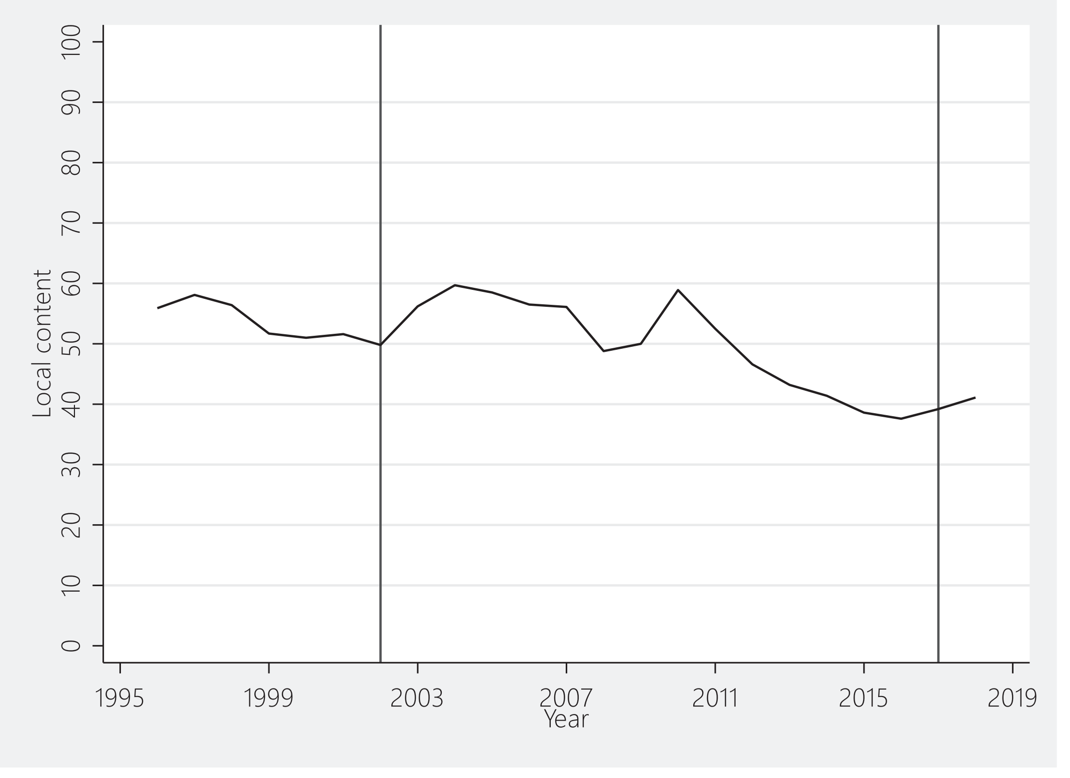

FIGURE 4 Changes in local content level (1996–2018). *Source*: NAAMSA. *Note*: Local content is defined as the average value of production less average import content.

3 | DATA

This section describes the firm-level data collected by the SAABC and provides descriptive statistics.

3.1 | SAABC

The SAABC is a privately funded non-profit organisation aiming to assist the development of the automotive industry. Its predecessor was established in 1997 in KwaZulu-Natal, and similar organisations were established in the Eastern Cape in 1999 and Gauteng in 2001. The SAABC was formed by merging these three organisations in 2002. Any automotive parts manufacturing firm with operations in South Africa can be a member of SAABC by paying an annual membership fee of 30,000 South African Rand (ZAR; equivalent to about USD 2000). The objective of the SAABC is to collect data from its member firms so that each member can objectively assess its operations, compare itself against other firms and identify operational areas requiring improvement. The club operates as a learning network and aims to enhance the growth and international competitiveness of the South African automotive industry.

SAABC data have been collected basically using the same questionnaire module. The collected data include business performance indicators, such as sales revenue, employment size, the value of imported inputs and detailed performance indicators of factory operations and production management. Each member firm provides information by responding to a structured questionnaire. Data are then verified by SAABC staff site visits and interviews. After the data collection, the SAABC analyses data from the member firms and provides a comprehensive firm-level report to each member. While these data were not based on random sampling, it comprises a novel long-term panel dataset of automotive firms.

3.2 | Sample firms

The original data contain 1407 firm-year observations from 209 firms. We excluded assemblers and firms whose main product is not automotive parts to focus on automotive parts suppliers. Thus, the number of observations was reduced to 1370 from 202 firms. We then excluded the suppliers located outside the three main clusters; the number of observations was reduced to 1301 from 194 firms. Although our data contain observations from 1999 to 2019, the data from 1999 to 2001 only include a subset of SAABC members; thus, we excluded the years 1999–2001 from our analyses. In addition, the data for 2019 were still being collected when we compiled the data, and the assembler-level global production data (which we used as our instruments) were only available until 2017. Thus, we excluded the observations from 2018 and 2019. Thus, the number of observations was reduced to 1023 from 185 firms. We concentrated our analyses on the firm-year observations that had both the sales revenue and the employment data available because these were our major outcome variables, which further reduced the number of observations to 949 from 179 firms. Lastly, since our regression analyses adopt a firm-level fixed effect model, firms with only one observation were dropped from the regressions and were excluded from the analysis. Our final dataset consists of 932 firm-year observations from 162 firms covering the years 2002–2017. The main analysis period is indicated by two vertical lines in Figures 2–4.

Table 1 shows the annual number of observations. In our analysis period of 2002–2017, the number ranges from 42 to 73 (see column 1). The number of observations was smallest in 2009–2010, when firms had a difficult time adjusting to and recovering from the global financial crisis. We define the 62 firms observed in 2002 as the SAABC 'original' firms. Many of these original firms remained members and provided data every year, while some firms participated intermittently. Further, we define the 80 firms that joined SAABC in the year 2006 or earlier as 'broadly defined original' firms. This subset accounts for half of sample firms used in the analysis.

It is difficult to define the population of automotive suppliers because they are composed of firms specialising in automotive parts and those also producing other products. The number of specialised automotive parts suppliers is about 200 (Barnes et al., 2021), and the SAABC covers a fairly large proportion of them. This, however, does not guarantee that the SAABC sample firms represent the entire South African population of automotive parts suppliers. To consider the issue of sample selection, we analysed three sets of sample firms. The first set is all the firms observed each year, which comprise a larger number but suffers from the bias arising mainly from 'entry.' Since any firm in this industry can be a member of SAABC, high-performing or promising firms, as well as struggling firms, are presumably more likely to become members. The second set is the subset consisting of only the 2002 original firms. Although entry is not a source of bias for this subset of firms, 'exit' may be an issue because poorly performing firms may not have the capacity to pay a membership fee or may have closed. The third set consists of the broadly defined original firms which became SAABC members in 2006 or earlier. The number of this subset is greater than that of the 2002 original firms, but it accounts for only half of the sample firms.

TABLE 1 Number of sample firms.

	(1)	(2)	(3)	(4)	(5)	(6)
		Breakdown			No. with available import information	
Year	No. of sample firms	(Multinational)	(Local tier 1)	(Local tier 2)		Analysis period
1999	28	10	15	3	0	No
2000	37	15	18	4	0	No
2001	38	14	20	4	12	No
2002	62	26	25	11	28	Yes
2003	63	27	25	11	34	Yes
2004	66	28	26	12	34	Yes
2005	66	30	26	10	46	Yes
2006	62	27	26	9	42	Yes
2007	52	22	24	6	37	Yes
2008	51	23	23	5	33	Yes
2009	47	21	22	4	29	Yes
2010	42	19	19	4	21	Yes
2011	50	21	19	10	32	Yes
2012	57	23	23	11	39	Yes
2013	65	27	25	13	45	Yes
2014	57	24	18	15	36	Yes
2015	60	19	18	23	35	Yes
2016	73	23	22	28	56	Yes
2017	59	18	18	23	45	Yes
2018	44	13	13	18	41	No
2019	28	7	9	12	26	No

Note: The sample from 1999 to 2001 includes only members of the organisation that preceded SAABC. In 2002, the SAABC was formed. In 2018–2019, SAABC data were still being collected, and the data on assembler-level global production data were unavailable after 2018.

Source: SAABC data.

To compare the behaviour of firms by their tier level and ownership status, we split the firms into multinational (MN), local first-tier ($L1$) and local second or third-tier firms ($L2/3$). MNs are firms with more than half of their shares held by non-South African individuals or organisations and include joint ventures. Most MNs are first-tier firms directly supplying parts to assemblers. Other firms were local firms, and they were split into two groups depending on their major customer. When the major customer is an assembler, the firm is categorised as $L1$, and when the major customer is a first or lower-tier supplier, the firm is categorised as $L2/3$. $L1$s directly supply parts to assemblers, while $L2/3$s indirectly do so. The tier and ownership information was not collected in the SAABC original questionnaire and was constructed specifically for this study based on available information at the time of the data construction in 2020. Hence, this information is time-invariant for each sample firm. However, automotive firms seldom change their tier, and a drastic change in ownership status is rare. To our knowledge, no lower-tier firms in the sample became first-tier firms, and vice versa since 1999, and only a few sample firms changed their ownership status due to mergers and acquisitions.

Columns 2–4 of Table 1 show the breakdown of sample firms. In the 2002 original sample, 42% of firms were MNs, 40% were *L*1s and 18% were *L*2/3. The share remained at similar levels before the global financial crisis. In 2009–2010, the number of observations was particularly small for *L*2/3 because they were typically small with limited cashflow management to cope with the crisis. After the crisis, the share of *L*2/3 increased, presumably because the established recognition of the SAABC started to attract an increasing number of smaller *L*2/3s. Regarding geographical location, roughly a third of the sample firms were located in each of the three clusters throughout the observation periods. The sample firms engaged in the production of trim components account for 22%, followed by pressings (17%), metal fabrication (15%), sub-assembly (13%) and foundry components (9%).

3.3 | Business characteristics in terms of the firms' category

Table 2 shows the descriptive statistics based on the pooled data covering our entire analysis period of 2002–2017. It indicates that MNs had the largest sales revenue, followed by *L*1s and *L*2/3s. The sales revenue is presented in real terms by using the consumer price index as a deflator. The high cost share of labour among *L*2/3s indicates that their production is labour-intensive. Among MNs, the mean cost share of labour was 10.0% of their costs, while it was 12.7% for *L*1s and 19.5% for *L*2/3s.

The real import amount (deflated by the consumer price index) among MNs was the largest among the three groups. The import value accounts for about a third of their sales revenue. In contrast, the import amount was minimal among *L*2/3s whose median value was almost zero. These observations suggest that MNs largely relied on sophisticated imported inputs, while local firms relied more on simple locally produced inputs. We note that the sample size is smaller for import (as well as for some other variables) because not all sample firms reported such data to SAABC. Since the import value is one of our key outcome variables, we conducted statistical analyses based on a full sample and a subset of firms with available import information (see column 5 in Table 1 for the annual number of observations). The data on sales share of export, whose median value is almost zero for all three firms, suggest that the South African parts suppliers sold most of their products to domestic downstream firms. MNs had the highest profit margin because they typically supplied higher-valued parts to assemblers.

3.4 | Changes in business performance and management indicators

We examined the changes in business performance and the production management indicators in Table 3. For readability, we split our sample period into four phases. The first is the year 2002, when only the original members were observed. The second phase covers 2003–2007, when the industry experienced rapid growth under the MIDP regime (see Figure 2). The third phase covers 2008–2012, when production declined because of the 2008 financial crisis but gradually recovered. The fourth phase covers 2013–2017.

Since we are more interested in changes over time than the cross-sectional variation here, we focused only on the original firms in Table 3. The mean real sales revenue among MNs continued to increase, those among *L*1s remained more or less constant, and those among *L*2s tended

TABLE 2 Business characteristics by firm category (2002–2017 pooled, all firms).

	(1) Multinational (MN)	(2) Local tier 1 (*L*1)	(3) Local tier 2/3 (*L*2/3)
Real sales revenue (ZAR million)			
Mean	349.9	223.8	75.3
Median	218.3	133.5	37.0
N	378	359	195
Number of workers			
Mean	302.0	365.8	145.5
Median	212.0	223.0	100.0
N	378	359	195
Cost-share of labour (%)			
Mean	10.0	12.7	19.5
Median	8.6	11.3	16.7
N	331	318	167
Real import value (ZAR million)			
Mean	129.7	68.0	6.4
Median	58.5	15.6	0.3
N	241	250	101
Sales share of export (%)			
Mean	14.7	12.3	16.0
Median	0.4	1.0	1.0
N	207	227	104
Operating profit as a percentage of sales (%)			
Mean	8.3	6.5	1.6
Median	7.6	6.8	3.5
N	344	337	181

Note: Sales revenue, import value, and value-added are deflated by the consumer price index taken from the World Bank's *World Development Indicators* and presented in 2010 real prices. ZAR 1 million was equivalent to about USD 150,000 as of 2010.

Source: SAABC data.

to decline. The growing business performance among MNs is consistent with the increase in automotive production. On the contrary, the lower-tier local firms did not expand their business even though we focused only on the surviving original firms. The changes in real import value suggest that the first-tier suppliers, particularly MNs, became more reliant on imported inputs as regional production expanded.

The SAABC collected data on numerous factory operation and production management indicators, but the most important indicators include cost control and flexibility (Morris & Barnes, 2006). Cost control is measured by the days of work-in-progress (WIP) and finished goods inventory held by the firm. Flexibility is measured by the domestic lead time, defined as the average response days from domestic customer orders to the delivery of the product when the product is out of stock.

TABLE 3 Changes in business performance and management indicators (original firms only).

	(1)	(2)	(3)
	Multinational mean	**Local tier 1 mean**	**Local tier 2/3 mean**
Real sales revenue (ZAR million)			
2002 original	260.7	231.7	73.4
2003–2007	346.8	276.6	83.8
2008–2012	414.7	259.0	41.1
2013–2017	570.7	268.5	42.8
Number of workers			
2002 original	263.2	383.6	162.0
2003–2007	285.2	454.7	178.5
2008–2012	342.9	462.2	109.4
2013–2017	283.2	538.0	118.0
Real import value (ZAR million)			
2002 original	60.2	27.3	4.9
2003–2007	123.8	84.3	3.2
2008–2012	145.3	104.2	3.5
2013–2017	251.4	78.1	0.1
Work-in-progress (WIP) inventory (days)			
2002 original	6.6	7.6	5.8
2003–2007	6.5	8.4	6.2
2008–2012	2.7	6.3	3.4
2013–2017	1.6	6.9	3.7
Finished goods inventory (days)			
2002 original	11.2	12.3	10.8
2003–2007	8.8	11.8	9.6
2008–2012	3.8	7.8	9.0
2013–2017	3.3	13.1	14.4
Lead time (days)			
2002 original	—	—	—
2003–2007	8.6	10.7	10.4
2008–2012	6.5	8.3	15.9
2013–2017	7.6	12.5	15.7

Note: Sales revenue, import value and value-added are deflated by the consumer price index.

Source: SAABC data.

We use these indicators as measures of production efficiency in our context. TFP is conventionally used in the FDI literature to measure productivity. However, the data on capital were only partially available in our data. Furthermore, we heard through informal interviews that assemblers often provided or lent machines and equipment to key part suppliers. If these machines and equipment were not included in the computation of capital, TFP would be overestimated.

Since the principle of lean manufacturing adopted in the automotive industry is to minimise the inventory level and shorten lead time (Liker, 2020; Morris & Barnes, 2006), these are relevant and important indicators of production efficiency.

Table 3 presents the changes in these indicators over time. The striking pattern is that they tended to decline among MNs but not much among the local firms. Both WIP and finished goods inventory holding were reduced to about a quarter of their 2002 value by the latest phase (2013–2017) among MNs. It seems reasonable to hypothesise that since MNs are close partners of assemblers, the latter have incentives to provide improved management and business know-how to improve their efficiency. While an alternative interpretation is that MNs have greater capacity than local firms, this cannot explain the nearly equal performance of MNs and $L1$s during the early periods. The fact that local firms did not improve their performance as significantly as the MNs suggests that improved technology either failed to reach the local firms or they proved incapable of absorbing the know-how. In other words, the degree of information and knowledge transmission in the local automotive supply chain seems limited.

4 | REGRESSION ANALYSIS

We conducted regression analysis to examine the relationship between regional vehicle production and the behaviour of parts suppliers. The relationship illustrates how multinational and local suppliers responded to the expansion of regional automotive production. It also suggests the presence (or the lack) of transmission of technology and knowledge from foreign assemblers. To our knowledge, this is a novel analysis regarding the FDI spillovers from vehicle assemblers to layers of multinational and local suppliers.

4.1 | Econometric specification

We estimated the following regression model by combining the SAABC data and the regional-level production data presented in Figure 3:

$$y_{i,j,t} = \beta_0\, x_{j,t}\, \mathrm{MN}_i + \beta_1\, x_{j,t}\, L1_i + \beta_2\, x_{j,t}\, L2/3_i + \alpha_i + \alpha_t + \alpha_j t + \varepsilon_{i,j,t} \quad (1)$$

where $y_{i,j,t}$ indicates an outcome variable of firm i, which is located in cluster j, in year t. The outcome variables include the real sales, the number of workers, the real import value and the three production efficiency indicators (i.e. WIP and finished goods inventories and lead time). $x_{j,t}$ is the number of vehicles produced in cluster j in year t.[6] All the $y_{i,j,t}$ and $x_{j,t}$ variables are converted to an inverse hyperbolic sine form, $\{y+(y^2+1)^{0.5}\}$ following Burbidge et al. (1988). This conversion mitigates the influence of the left-skewed distribution and keeps the observations with zero values. The interpretation is essentially the same as the logarithm, and we call the transformed variables log variables.

[6]The automotive assemblers try to minimise inventories, and thus, nearly all parts are assembled within the year that they are produced. Table 3 illustrates that the days of inventory holding were short even among our sample parts suppliers, and the inventory of finished goods was only a few days among the multinational first-tier suppliers in recent years.

MN_i, $L1_i$ and $L2/3_i$ are the dummy variables that take the value of 1 if a firm i is a multinational, local first-tier or local lower-tier firm, respectively. α_i and α_t is a set of firm and year fixed effects, respectively, to control any time-invariant, firm-level and year-level characteristics. $\alpha_j t$ represents a set of cluster-specific time trends to flexibly control for the development trajectory of the three automotive clusters. An error term, $\varepsilon_{i,j,t}$, is clustered at the cluster-year level because the variation of our main right-hand-side variables occurs at this level.

We first estimated this equation with ordinary least squares (OLS) to obtain β_0, β_1 and β_2 that indicate how the firm's business performance and management indicators are associated with regional vehicle production among the three groups of firms. There is a possibility that the firms procure parts from other South African clusters, but the three clusters are geographically distant, and such volumes are limited. When the outcome variable is a business performance variable, the coefficient indicates the extent of production linkage between assemblers and parts suppliers. When the outcome variable is a management variable, the coefficient indicates the extent of technology transmission.

To further investigate the causal relationship, we adopted an IV strategy. The production of the seven assemblers in South African is assumed to be determined by their parent companies' global strategy. On the other hand, South African production is at most a few percent of the global production. Thus, South African suppliers' local economic and business environments are unlikely to unduly influence the parent companies' global strategy. We aggregated parent-level global production by each cluster and used this as an instrument for the domestic cluster-level production, $x_{j,t}$. For instance, the total global production by BMW, Ford and Nissan (less the South African production) in year t is used as an IV for the production in Gauteng in year t. We tested the relevance condition, and we argue that the exclusion restriction holds. This is because, conditional on the firm and year fixed effects and the cluster-specific time trends, it is unlikely that parent-level global production directly affects the performance of South African local parts suppliers.

4.2 | Results for production linkage

Table 4 presents our main results on business performance. Panel A shows OLS results, and Panel B shows IV results. Further, columns 1 and 2 are based on the full sample, while columns 3–5 are based only on the firms with available import information. An overall pattern is that the coefficient for MNs and $L1$s (i.e. β_0 and β_1) is positive and significant, while it is negative and insignificant for $L2/3$s (i.e., β_2). Since we adopted the log–log specification, the estimated coefficient can be interpreted as an elasticity.

Column 3 in Panel A shows that MNs and $L1$s increased their sales (equivalently, production) by 0.50% and 0.65%, respectively, in response to a 1% increase in regional vehicle production. The p-values reported towards the bottom show that we cannot reject the equality of coefficients between MNs and $L1$s while we can reject between MNs and $L2/3$s and between $L1$s and $L2/3$s. Hence, the first and lower-tier suppliers responded differently to the expansion of the regional automotive production. Column 4 on the number of workers shows the positive and significant coefficient only for $L1$s. They increased their employment by 0.31% in response to a 1% increase in regional production. The impact on employment is limited for MNs probably because their production is less labour-intensive, and they expanded their production by investing in capital.

Column 5 shows that both MNs and $L1$s increased their imports by more than 1% in response to a 1% increase in regional production. While we cannot reject the null hypothesis that the

TABLE 4 Regression results for production linkage (all firms).

	(1)	(2)	(3)	(4)	(5)
Sample	**Full**	**Full**	**Only firms w/ available import data**	**Only firms w/ available import data**	**Only firms w/ available import data**
Outcome (all presented in log form)	**Real sales**	**# Workers**	**Real sales**	**# Workers**	**Real import**
Panel A: OLS estimation					
(A) Ln (regional production)	0.25*	0.025	0.50**	0.0057	1.20***
* Multinational dummy	(0.14)	(0.095)	(0.23)	(0.16)	(0.43)
(B) Ln (regional production)	0.33***	0.27**	0.65***	0.31**	1.06***
* Local Tier 1 dummy	(0.12)	(0.11)	(0.17)	(0.12)	(0.37)
(C) Ln (regional production)	−0.21	−0.0035	−0.27	−0.15	−0.34
* Local Tier 2/3 dummy	(0.16)	(0.10)	(0.18)	(0.16)	(0.69)
p-Value (A) = (B)	.62	.07	.57	.14	.81
p-Value (A) = (C)	.00	.80	.01	.46	.08
p-Value (B) = (C)	.00	.06	.00	.02	.08
N	932	932	592	592	592
Panel B: IV estimation					
(A) Ln (regional production)	0.26	−0.039	0.45	0.052	1.57***
* Multinational dummy	(0.21)	(0.15)	(0.35)	(0.18)	(0.58)
(B) Ln (regional production)	0.46**	0.37**	0.72***	0.55***	1.87***
* Local Tier 1 dummy	(0.18)	(0.17)	(0.24)	(0.18)	(0.48)
(C) Ln (regional production)	−0.17	−0.081	−0.70*	−0.49**	−1.89
* Local Tier 2/3 dummy	(0.26)	(0.16)	(0.37)	(0.22)	(1.23)
p-Value (A) = (B)	.44	.06	.41	.06	.70
p-Value (A) = (C)	.04	.82	.01	.04	.01
p-Value (B) = (C)	.03	.02	.00	.00	.00
Cragg-Donald *F* statistic	92.3	92.3	61.4	61.4	61.4
N	932	932	592	592	592

Note: Numbers in parentheses are standard errors clustered at the region-year level, and ***, ** and * indicate 1%, 5% and 10% significance level, respectively. Firm fixed effects, year fixed effects and region-specific time trends are controlled, but their coefficients are not reported.

Source: SAABC data, Lamprecht (2009), OICA (various years), and AutoStats.

import elasticity is unity among MNs and *L*1s, we found that the sales elasticities are significantly less than unity (test statistics not reported). This pattern indicates that MNs and *L*1s increased their imports more than their sales. In summary, Panel A suggests the presence of production linkages between assemblers and MNs and between assemblers and local first-tier suppliers, and that these suppliers increased imported inputs to expand their production.

In contrast, the coefficient for $L2/3$s is insignificant (and even negative) in all the columns. If the first-tier firms, including multinationals, did not increase their imports of materials and parts, their orders placed with lower-tier suppliers should increase. In this case, we expect that when assemblers expanded their production, local lower-tier suppliers expanded their production. On the other hand, if the first-tier firms increased their imports without increasing orders to local lower-tier suppliers, the relationship between vehicle assemblers and lower-tier suppliers would be disconnected. We observed such a disconnected relationship, implying that the performance of $L2/3$s did not correspond with the regional production expansion, unlike MNs and $L1$s.

Panel B reports the IV results. We first discuss the relevance of our IV. Figure 5 shows how each assembler's global production (less the South African production) is associated with their production in South Africa. It suggests that South African production increased with their parent company's global production, although the degree of dependence differs among the assemblers. Since we have three endogenous variables: the interaction of the cluster-level production (i.e., $x_{j,t}$) with MNs, $L1$s and $L2/3$s dummies, respectively, we interacted the parent-level production with these three dummy variables to construct three IVs. The first-stage F-statistics reported at the bottom of each panel are all above the conventionally accepted level

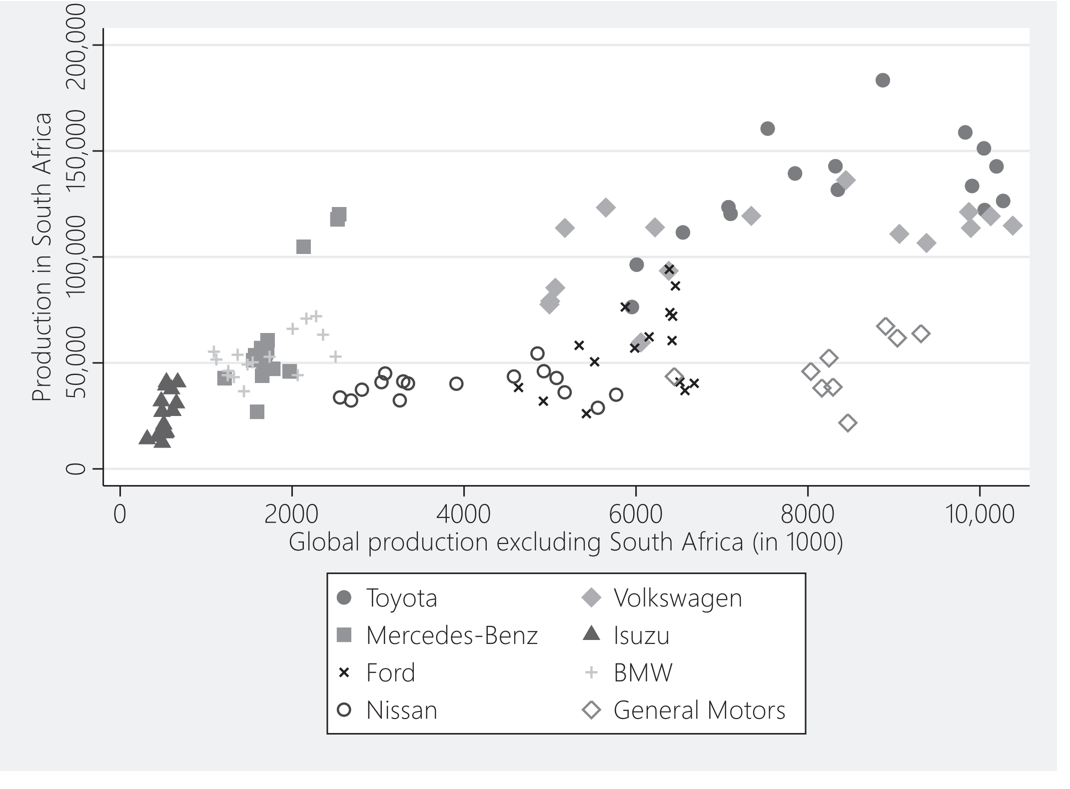

FIGURE 5 Illustration of the IV strategy: Relationship between parent companies' global production and production in South Africa (2002–2017).
Source: Lamprecht (2009), OICA (various years), and AutoStats.

of 20.[7] Further, as discussed in Section 4.1, these IVs are unlikely to directly affect the performance of South African local parts suppliers conditional on various fixed effects, and we believe that the exclusion restriction holds.

Compared to the OLS results, the coefficients based on IV estimation were larger in absolute magnitude and weaker in statistical significance because of larger standard errors. There are three points to note. First, *L*1s significantly increased their sales, employment and imports in response to the regional production expansion, and our IV results confirmed our findings from the OLS estimates. Second, while a similar pattern to *L*1s is observed among MNs, the IV estimates are noisier. With such statistical insignificance, we need to be cautious about the causal interpretation. Yet, the sign of the coefficients is basically consistent with the OLS estimates, and importantly, the coefficient on imports is positive, large and significant. Third, the *L*2/3s even decreased their sales with increases in regional production. These IV results suggest that the imports of the first-tier firms indeed replaced the lower-tier parts suppliers, who failed to take advantage of the regional development of the automotive industry.

To examine whether the observed pattern in Table 4 is sensitive to the selection of sample firms, Table A1 presents the OLS results based only on the original sample, and Table A2 presents those based only on the broadly defined original firms. Some differences in the point estimates and the statistical significance are observed, but the qualitative pattern is similar. Most importantly, the coefficients are positive and significant for sales and imports only among MNs and *L*1s, and the *p*-values show that their coefficients are statistically different from that of *L*2/3s. Therefore, even if we limit our attention to the original firms, MNs and *L*1s expanded their production and strengthened their reliance on imports in response to the regional production growth, while such a pattern was not observed among *L*2/3s.[8]

4.3 | Results for production efficiency

Table 5 reports the estimation results of Equation (1), with the outcome variable representing production efficiency indicators. The coefficients for the inventory holding of finished goods are consistently negative and significant for the MNs in columns 2 and 5 in both OLS and IV estimations. In most cases, multinational firms producing parts for multinational vehicle assemblers were invited by the latter to undertake local production. Thus, their contractual relationships and mutual trust would have been firmly established at a parent company level. Therefore, when assemblers expanded their production, they requested their dependable multinational suppliers to improve the quality and efficiency of the production. For this purpose, assemblers most likely provide production and management instructions to multinationals, which is likely to be conducive to improving the production efficiency of multinationals. Such an improvement, however, was not observed on other efficiency indicators. We interpret this as multinational parts suppliers benefiting from the knowledge and information

[7]We performed a placebo test for the IV strategy by assigning each firm to a 'wrong' cluster so that the global production does not match the location of South African producers. In this test, and the first-stage Cragg–Donald *F*-statistic became 7.06 for columns 1 and 2 and 0.32 for columns 3–5, which were smaller than the conventional level of 20. This exercise supports the validity of our IV strategy.

[8]The qualitatively same patterns were also obtained when we excluded the region-specific trends or used natural log transformation instead of the Burbidge transformation. Since as many as 15% of the estimation sample had no imports, we replaced zero values with the smallest value greater than zero in the log estimation.

TABLE 5 Regression results for production efficiency measures (all firms).

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	**Full**	**Full**	**Full**	**Only firms w/ available import data**	**Only firms w/ available import data**	**Only firms w/ available import data**
Outcome (all presented in the log)	**WIP inventory**	**Finished goods inventory**	**Lead time**	**WIP inventory**	**Finished goods inventory**	**Delivery failure**
Panel A: OLS estimation						
(A) Ln (regional production)	−0.29	−0.65***	−0.55*	−0.17	−0.72***	−0.42
* Multinational dummy	(0.20)	(0.19)	(0.29)	(0.25)	(0.24)	(0.35)
(B) Ln (regional production)	−0.12	−0.25	−0.20	−0.041	−0.19	−0.24
* Local Tier 1 dummy	(0.24)	(0.20)	(0.25)	(0.29)	(0.26)	(0.28)
(C) Ln (regional production)	−0.37	−0.21	−0.035	−0.54	−0.10	−0.057
* Local Tier 2/3 dummy	(0.36)	(0.28)	(0.61)	(0.45)	(0.41)	(0.86)
p-Value (A) = (B)	.48	.10	.14	.60	.09	.56
p-Value (A) = (C)	.80	.16	.46	.35	.15	.71
p-Value (B) = (C)	.51	.91	.81	.16	.87	.84
N	757	759	538	543	547	446
Panel B: IV estimation						
(A) Ln (regional production)	0.23	−1.26***	0.051	0.49	−1.59***	0.51
* Multinational dummy	(0.35)	(0.41)	(0.46)	(0.43)	(0.51)	(0.52)
(B) Ln (regional production)	0.60	−0.52	0.077	0.76	−0.57	0.081

(Continues)

TABLE 5 (Continued)

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	**Full**	**Full**	**Full**	**Only firms w/ available import data**	**Only firms w/ available import data**	**Only firms w/ available import data**
Outcome (all presented in the log)	**WIP inventory**	**Finished goods inventory**	**Lead time**	**WIP inventory**	**Finished goods inventory**	**Delivery failure**
* Local Tier 1 dummy	(0.42)	(0.35)	(0.41)	(0.48)	(0.41)	(0.43)
(C) Ln (regional production)	0.71	−0.18	−1.52	0.49	−0.56	−1.83
* Local Tier 2/3 dummy	(0.52)	(0.61)	(1.39)	(0.50)	(0.57)	(1.71)
p-Value (A) = (B)	.25	.18	.95	.39	.08	.46
p-Value (A) = (C)	.33	.08	.28	1.00	.10	.19
p-Value (B) = (C)	.83	.56	.27	.56	.97	.28
Cragg-Donald *F* statistic	62.7	61.5	31.9	58.7	57.7	31.0
N	757	759	538	543	547	446

Note: Numbers in parentheses are standard errors clustered at the region-year level, and ***, ** and * indicate 1, 5 and 10 significance level, respectively. Firm fixed effects, year fixed effects and region-specific time trends are controlled, but their coefficients are not reported.

Source: SAABC data, Lamprecht (2009), OICA (various years), and AutoStats.

transmission, but that the benefit was not comprehensive. They were only able to improve certain dimensions of their production efficiency.

In contrast, while $L1$s increased their sales and employment (as evident in Table 4), they did not significantly improve in any of these production efficiency indicators. When assemblers expanded their production, they were likely to order simple parts to local first-tier parts suppliers. Since their production is relatively simple and the contractual relationship is not tight or 'captive,' to use the term of Gereffi et al. (2005), assemblers will not provide much production and management instructions to local suppliers. Hence, the local first-tier suppliers benefitted from production orders but not much in terms of technology transmission to improve their production efficiency. The technology transmission to $L2/3$s was also limited because the relationship between vehicle assemblers and lower-tier suppliers is weak, and the downstream firms have limited incentives to improve the production efficiency of the upstream firms by providing technical support or information.

Panel B in Tables A1 and A2 presents the results based on the original firms and broadly defined original firms, respectively. Although the relationship was somewhat weaker among the narrowly defined original firms, the major previous finding that the increased regional production was only related to the improved production efficiency among the multinational suppliers remains unchanged. These results confirm the patterns observed in Table 5 that the local suppliers failed to improve their production efficiency through knowledge and information transmission.[9]

5 | CONCLUSION

This paper combines newly available SAABC panel data with vehicle production data to examine the impact of foreign assemblers' production on the production and management efficiency of various tiers of parts suppliers. Based on regression analyses, we found that the benefits of technology transmission for local firms are not automatic and dependent on the structure of production networks. This finding adds to the large (and still expanding) literature on FDI spillovers.

Our study of the South African automotive industry also showcased that the lack of production linkages and FDI spillovers created a diamond shape structure because of the diminishing share of tier 2 and tier 3 parts suppliers. While their industrial policies might have aimed to increase the local content, they enabled downstream firms, including foreign assemblers and first-tier suppliers, to replace locally produced parts with imported ones. Such policies have resulted in a missed opportunity for employment creation as the production of parts suppliers in the lower tiers is labour-intensive. Instead, industrial policies in developing countries should be more focused on helping local firms learn advanced technology and know-how to improve their productivity and expand their businesses for job creation. Such policies include building the capacity of local suppliers and appropriate incentives for lead firms in the value chain to procure more content locally. However, such policies should not discourage FDI, and thus, the government should simultaneously ensure a favourable economic environment for foreign investment.

[9]The qualitatively same patterns were also obtained when we excluded the region-specific trends or used natural log transformation instead of the Burbidge transformation.

ACKNOWLEDGEMENTS

This study was conducted as a part of a project entitled *Impact Assessment of Kaizen in the Automotive Industry in South Africa* undertaken at the Japan International Cooperation Agency (JICA). We would like to thank Shinya Adachi, Nkumbuzi Ben-Mazwi and Kimiaki Jin for their active research collaboration, Avril DG Madrid for excellent English edit and Keisaku Higashida and Tetsushi Sonobe for their valuable comments. This work was supported by the Japan Society for the Promotion of Science (JSPS) KAKENHI [grant numbers 18H00850, 21H00714] and Murata Science Foundation. We have no declarations of interest. All errors are our own.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DATA AVAILABILITY STATEMENT

The data underlying this article were provided by the South African Automotive Benchmarking Club (SAABC) by permission. Data will be shared on request to the corresponding author with permission of the South African Automotive Benchmarking Club (SAABC).

ORCID

Yuki Higuchi https://orcid.org/0000-0002-6433-5390

REFERENCES

Alfaro, L., Chanda, A., Kalemli-Ozcan, S., & Sayek, S. (2010). Does foreign direct investment promote growth? Exploring the role of financial markets on linkages. *Journal of Development Economics*, *91*(2), 242–256. https://doi.org/10.1016/j.jdeveco.2009.09.004

Alfaro, L., & Charlton, A. (2009). Intra-industry foreign direct investment. *American Economic Review*, *99*(5), 2096–2119. https://doi.org/10.1257/aer.99.5.2096

Alfaro-Ureña, A., Manelici, I., & Vasquez, J. P. (2022). The effects of joining multinational supply chains: New evidence from firm-to-firm linkages. *Quarterly Journal of Economics*, *137*(3), 1495–1552. https://doi.org/10.1093/qje/qjac006

Aryeetey, E., & Baffour, P. T. (2022). African competitiveness and the business environment: Does manufacturing still have a role to play? *Journal of African Economies*, *31*(Supplement_1), i33–i58. https://doi.org/10.1093/jae/ejac019

Barnes, J. (2013). Capital structure of the south African automotive industry: Historical perspectives and development implications. *Transformation*, *81*(82), 236–259. https://doi.org/10.1353/trn.2013.0003

Barnes, J., Black, A., & Monaco, L. (2021). Government policy in multinational-dominated global value chains: Structural transformation within the south African automotive industry. In *Structural transformation in South Africa: The challenges of inclusive industrial development in a middle-income country*. Oxford University Press.

Barnes, J., Black, A., & Techakanont, K. (2017). Industrial policy, multinational strategy and domestic capability: A comparative analysis of the development of South Africa's and Thailand's automotive industries. *European Journal of Development Research*, *29*(1), 37–53. https://doi.org/10.1057/ejdr.2015.63

Barnes, J., Kaplinsky, R., & Morris, M. (2004). Industrial policy in developing economies: Developing dynamic comparative advantage in the south African automobile sector. *Competition and Change*, *8*(2), 153–172. https://doi.org/10.1080/1024529042000271416

Black, A. (2001). Globalization and restructuring in the south African automotive industry. *Journal of International Development*, *13*(6), 779–796. https://doi.org/10.1002/jid.812

Black, A. (2009). Location, automotive policy, and multinational strategy: The position of South Africa in the global industry since 1995. *Growth and Change*, *40*(3), 483–512. https://doi.org/10.1111/j.1468-2257.2009.00491.x

Blalock, G., & Gertler, P. J. (2008). Welfare gains from foreign direct investment through technology transfer to local suppliers. *Journal of International Economics*, *74*(2), 402–421. https://doi.org/10.1016/j.jinteco.2007.05.011

Borensztein, E., De Gregorio, J., & Lee, J.-W. (1998). How does foreign direct investment affect economic growth? *Journal of International Economics*, *45*(1), 115–135. https://doi.org/10.1016/S0022-1996(97)00033-0

Burbidge, J. B., Magee, L., & Robb, A. L. (1988). Alternative transformations to handle extreme values of the dependent variable. *Journal of the American Statistical Association*, *83*(401), 123–127.

Carluccio, J., & Fally, T. (2013). Foreign entry and spillovers with technological incompatibilities in the supply chain. *Journal of International Economics*, *90*(1), 123–135. https://doi.org/10.1016/j.jinteco.2012.08.004

Chudnovsky, D., López, A., & Rossi, G. (2008). Foreign direct investment spillovers and the absorptive capabilities of domestic firms in the Argentine manufacturing sector (1992–2001). *Journal of Development Studies*, *44*(5), 645–677. https://doi.org/10.1080/00220380802009159

Furuta, M., Sato, T., & Otsuka, K. (2020). *Impacts of FDI on the development of local part-supplying Industries in the Automobile Industry in India, 2000–2008*. Mimeo.

Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. *Review of International Political Economy*, *12*(1), 78–104. https://doi.org/10.1080/09692290500049805

Hallward-Driemeier, M., & Nayyar, G. (2017). *Trouble in the making?: The future of manufacturing-led development*. World Bank. https://doi.org/10.1596/978-1-4648-1174-6

Havranek, T., & Irsova, Z. (2011). Estimating vertical spillovers from FDI: Why results vary and what the true effect is. *Journal of International Economics*, *85*(2), 234–244. https://doi.org/10.1016/j.jinteco.2011.07.004

Hermes, N., & Lensink, R. (2003). Foreign direct investment, financial development and economic growth. *Journal of Development Studies*, *40*(1), 142–163. https://doi.org/10.1080/00220380412331293707

Javorcik, B. S. (2004). Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. *American Economic Review*, *94*(3), 39–627.

Kee, H. L. (2015). Local intermediate inputs and the shared supplier spillovers of foreign direct investment. *Journal of Development Economics*, *112*, 56–71. https://doi.org/10.1016/j.jdeveco.2014.09.007

Lamprecht, N. (2009). The impact of the motor industry development Programme (MIDP) on the export strategies of the South African light motor vehicle manufacturers (1995–2008). *Dissertation* Submitted University of South Africa.

Liker, J. (2020). *The Toyota way, second edition: 14 management principles from the World's greatest manufacturer*. McGraw Hill.

Mancusi, M. L. (2008). International spillovers and absorptive capacity: A cross-country cross-sector analysis based on patents and citations. *Journal of International Economics*, *76*(2), 155–165. https://doi.org/10.1016/j.jinteco.2008.06.007

Morris, M., & Barnes, J. (2006). Organising cluster cooperation and learning networks in South Africa. *African Studies*, *65*(1), 79–104. https://doi.org/10.1080/00020180600771790

Murakami, Y., & Otsuka, K. (2020). Governance, information spillovers, and productivity of local firms: Toward an integrated approach to foreign direct investment and global value chains. *The Developing Economies*, *58*(2), 134–174. https://doi.org/10.1111/deve.12232

Natsuda, K., & Thoburn, J. (2013). Industrial policy and the development of the automotive industry in Thailand. *Journal of the Asia Pacific Economy*, *18*(3), 413–437. https://doi.org/10.1080/13547860.2012.742690

Nayyar, G., Hallward-Driemeier, M., & Davies, E. (2021). *At your service?: The promise of services-led development*. World Bank. https://doi.org/10.1596/978-1-4648-1671-0

Newman, C., Page, J. M., Rand, J., Shimeles, A., Söderbom, M., & Tarp, F. (2016). *Made in Africa: Learning to compete in industry*. Brookings Institution Press.

Newman, C., Rand, J., Talbot, T., & Tarp, F. (2015). Technology transfers, foreign investment and productivity spillovers. *European Economic Review*, *76*, 168–187. https://doi.org/10.1016/j.euroecorev.2015.02.005

Otchere, I., Soumaré, I., & Yourougou, P. (2016). FDI and financial market development in Africa. *The World Economy*, *39*(5), 651–678. https://doi.org/10.1111/twec.12277

Rojec, M., & Knell, M. (2018). Why is there a lack of evidence on knowledge spillovers from foreign direct investment? *Journal of Economic Surveys*, *32*(3), 579–612. https://doi.org/10.1111/joes.12207

Schrank, A. (2017). The political economy of performance standards: Automotive industrial policy in comparative historical perspective. *Journal of Development Studies*, *53*(12), 2029–2049. https://doi.org/10.1080/00220388.2016.1228879

Smeets, R. (2008). Collecting the pieces of the FDI knowledge spillovers puzzle. *World Bank Research Observer*, *23*(2), 107–138. https://doi.org/10.1093/wbro/lkn003

Tan, S. W., & Tusha, D. (2023). Foreign firm characteristics, labour market restrictions and FDI spillovers: Evidence from Moldova. *The World Economy*, *46*(1), 85–119. https://doi.org/10.1111/twec.13315

Verhoogen, E. (2023). Firm-level upgrading in developing countries. *Journal of Economic Literature*, forthcoming. https://www.aeaweb.org/articles?id=10.1257/jel.20221633&from=f

How to cite this article: Higuchi, Y., Barnes, J., Black, A., & Otsuka, K. (2023). FDI, production networks and firm behaviour: Evidence from the South African automotive industry. *The World Economy*, *00*, 1–27. https://doi.org/10.1111/twec.13491

APPENDIX A

History of the South African automotive industry

The genesis of the South African automotive industry extends back to the 1920s, with the establishment of General Motors and Ford plants. These early FDIs were attracted by the promotion of the local steel industry and the anticipation of tariff protection. While South Africa was one of the earliest developing countries to start the assembly of motor vehicles, the industry developed slowly with the dominance of low-level and low-value vehicle assembly (Barnes et al., 2004).

The industry started to develop more rapidly after the introduction of the first of six local content programmes in 1961. In the 1950s and 1960s, many developing countries in Africa, Asia and Latin America adopted import substitution policies to develop their automotive sectors (Newman et al., 2016), and South Africa was no exception. High tariffs on vehicles, import permits and local content requirements were used to protect local parts suppliers. The policy was also driven by the balance of payment challenges at the national level, and each subsequent phase of the local content program gradually increased local content requirements until 1989. The local parts suppliers developed rapidly during these four decades (Barnes, 2013; Black, 2001).

A major policy shift occurred in 1989. Local content was initially measured by weight, which encouraged the localization of body parts and heavy structural components instead of electronics or other increasingly high-value componentry. This was remedied in the final (sixth) phase of the local content programme, which ran from 1989 to 1995. Under this phase, the computation of local content shifted from mass-based to value-based. Further, firms were able to include the value of exports in their local content calculations while a minimum average level of net local content of 50% had to be maintained. Domestic market protection remained high, with the vehicle tariffs set at 115%.

Although the local content requirement was high, the provision that the value of exports could be subtracted from the net local content calculations gradually reduced incentives to increase local content. The shift from mass-based to value-based local content computation also gave the automotive assemblers much greater flexibility in their sourcing strategies. Consequently, sub-assemblers, especially those at the second-tier, came under threat because the shift gave foreign assemblers and the first-tier suppliers the ability to import semi-assembled parts. While

TABLE A1 Regression results for original firms only.

	(1)	(2)	(3)	(4)	(5)
Sample	**Full**	**Full**	**Only firms w/ available import data**	**Only firms w/ available import data**	**Only firms w/ available import data**
Outcome (all presented in log form)	**Real sales**	**# Workers**	**Real sales**	**# Workers**	**Real import**
Panel A: Production linkage (OLS estimation)					
(A) Ln (regional production)	0.47***	−0.019	0.47*	−0.12	1.20**
* Multinational dummy	(0.16)	(0.11)	(0.26)	(0.17)	(0.54)
(B) Ln (regional production)	0.52***	0.29**	0.72***	0.34**	0.62
* Local Tier 1 dummy	(0.15)	(0.14)	(0.22)	(0.16)	(0.43)
(C) Ln (regional production)	−0.071	0.00079	−0.052	−0.071	−1.06
* Local Tier 2/3 dummy	(0.18)	(0.13)	(0.21)	(0.19)	(0.76)
p-Value (A) = (B)	.80	.06	.43	.05	.33
p-Value (A) = (C)	.01	.88	.08	.84	.02
p-Value (B) = (C)	.00	.05	.00	.10	.05
N	483	483	350	350	350
Outcome (all presented in log form)	WIP inventory	Finished goods inventory	Lead time	WIP inventory	Finished goods inventory
Panel B: Production efficiency measures (OLS estimation)					
(A) Ln (regional production)	−0.029	−0.31	−0.64	−0.24	−0.27
* Multinational dummy	(0.25)	(0.19)	(0.39)	(0.31)	(0.23)
(B) Ln (regional production)	0.047	0.094	−0.53	−0.13	−0.011
* Local Tier 1 dummy	(0.28)	(0.21)	(0.33)	(0.33)	(0.26)
(C) Ln (regional production)	0.0089	−0.14	−0.24	−0.23	−0.038
* Local Tier 2/3 dummy	(0.39)	(0.27)	(0.75)	(0.46)	(0.42)
p-Value (A) = (B)	.76	.14	.74	.64	.42
p-Value (A) = (C)	.92	.58	.63	.98	.58
p-Value (B) = (C)	.92	.44	.73	.78	.96
N	431	428	304	333	331

Note: Numbers in parentheses are standard errors clustered at the region-year level, and ***, ** and * indicate 1%, 5% and 10% significance level, respectively. Firm fixed effects, year fixed effects and region-specific time trends are controlled, but their coefficients are not reported.

Source: SAABC data, Lamprecht (2009), OICA (various years), and AutoStats.

TABLE A2 Regression results for broadly defined original firms only.

	(1)	(2)	(3)	(4)	(5)
Sample	**Full**	**Full**	**Only firms w/ available import data**	**Only firms w/ available import data**	**Only firms w/ available import data**
Outcome (all presented in log form)	**Real sales**	**# Workers**	**Real sales**	**# Workers**	**Real import**
Panel A: Production linkage (OLS estimation)					
(A) Ln (regional production)	0.41***	−0.082	0.48*	−0.060	1.15**
* Multinational dummy	(0.15)	(0.11)	(0.25)	(0.17)	(0.46)
(B) Ln (regional production)	0.56***	0.32**	0.72***	0.37**	0.69*
* Local Tier 1 dummy	(0.14)	(0.13)	(0.21)	(0.15)	(0.38)
(C) Ln (regional production)	−0.060	−0.037	−0.059	−0.059	−1.05
* Local Tier 2/3 dummy	(0.17)	(0.14)	(0.20)	(0.19)	(0.76)
p-Value (A) = (B)	.35	.16	.42	.06	.38
p-Value (A) = (C)	.02	.77	.05	.99	.02
p-Value (B) = (C)	.00	.03	.00	.09	.04
N	571	571	390	390	390
Outcome (all presented in log form)	WIP inventory	Finished goods inventory	Lead time	WIP inventory	Finished goods inventory
Panel B: Production efficiency measures (OLS estimation)					
(A) Ln (regional production)	−0.060	−0.72***	−0.80**	−0.12	−0.67***
* Multinational dummy	(0.21)-	(0.21)	(0.35)	(0.28)	(0.25)
(B) Ln (regional production)	0.013	−0.19	−0.49	−0.074	−0.21
* Local Tier 1 dummy	(0.26)	(0.23)	(0.30)	(0.28)	(0.28)
(C) Ln (regional production)	−0.0040	−0.32	−0.40	−0.21	−0.29
* Local Tier 2/3 dummy	(0.36)	(0.27)	(0.75)	(0.43)	(0.40)
p-Value (A) = (B)	.75	.05	.16	.83	.15
p-Value (A) = (C)	.86	.21	.63	.79	.37
p-Value (B) = (C)	.96	.69	.91	.69	.88
N	498	495	361	368	366

Note: Numbers in parentheses are standard errors clustered at the region-year level, and ***, ** and * indicate 1%, 5% and 10% significance level, respectively. Firm fixed effects, year fixed effects and region-specific time trends are controlled, but their coefficients are not reported.

Source: SAABC data, Lamprecht (2009), OICA (various years), and AutoStats.

this move simplified assembly operations and limited the problems of local re-engineering and any quality or supply chain deficiencies (Black, 2001), increased foreign sourcing, however, was not the expected result of the 1989 reform. The parts suppliers association, the National Association of Automotive Component and Allied Manufacturers (NAACAM), initially welcomed the reform, expecting a substantial increase in local content. They also expected to receive a large increase in requests for quotations, but orders did not materialise (Barnes et al., 2004).

Immediately after the transition to democracy and South Africa's accession to the WTO, the final phase of the local content programme was replaced with the Motor Industry Development Programme (MIDP) in 1995. Vehicle tariffs were significantly reduced (initially to 65%). At the same time, stronger export incentives came into effect via an import–export complementation mechanism under which import credits could be earned by exporting vehicles or parts. This resulted in minimal actual duties being payable on imported parts. In 2012, when the MIDP was withdrawn, vehicle and component import tariffs also gradually declined annually, reaching 25% and 20%, respectively (Barnes, 2013).

Under the MIDP regime, the protection of the component sector was systematically reduced. Local content requirements were abolished. The MIDP aimed to encourage a degree of specialisation and to increase production volumes so that local parts suppliers enjoy scale economies and enhance their global competitiveness in the presence of tariff liberalisation. The consequence, however, was that some local parts suppliers were gradually replaced by imports, particularly when new vehicle models were introduced. This was accelerated by FDI from first-tier multinational suppliers. They established greenfield operations and acquired local firms, but these new firms engaged mainly in the sub-assembly of imported parts, not locally procured parts (Barnes et al., 2004). Consequently, the introduction of the MIDP resulted in the rapid growth of vehicle exports and a large increase in the imports of parts and materials by first-tier suppliers (Black, 2009).

As a result of pressure from the WTO, the MIDP was withdrawn at the end of 2012 and replaced with the Automotive Production Development Programme (APDP). The major shift in policy that occurred removed incentives for exporting and introducing market-neutral assembly and production incentives. However, since the introduction of the APDP, there has been a further decline in local content. Much of this has been due to reduced purchases from second and third-tier suppliers located in South Africa. Most South African vehicle assemblers have now secured major ongoing vehicle export contracts and have invested accordingly to upgrade their assembly plants. Furthermore, the shift towards the assembly of higher-value vehicles has been associated with increased imports of parts, thereby lowering local content levels. The APDP was originally set to run until 2020, but as part of the South African Automotive Masterplan (SAAM), the programme has been extended to 2026. In response to declining local content levels, one major adjustment to the programme relates to incentives focused only on local value addition. However, it may take time for such an adjustment to have an effect.