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The Spatial Distribution of Manufacturing in South Africa 1970-1996, its Determinants and Policy Implications

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The Spatial Distribution of Manufacturing in South Africa 1970-1996, its Determinants and Policy Implications

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Abstract

This paper researches the change in regional specialisation and industry concentration in South African (SA) manufacturing 1970-96, and evaluates possible determinants of industry location. No evident trend towards greater regional specialisation or despecialisation emerges over most of the period if we take the economic weight of the regions into account. However, between 1993 and 1996, the period of international reintegration, all provinces but one became more specialised. Industry concentration also does not show a clear trend if we account for industry size, although industries of the same rank were more concentrated in the early 1990s than the beginning of the 1970s and 1980s. Drawing on predictions from trade and economic geography models, we find that high plant-internal scale economies, intensity in the use of human capital and high industry-specific productivity gradients between locations are associated with greater geographical concentration of an industry. Scale economies are the most important pro-concentration force. A greater deviation of labour intensity of production from the mean, and strong interfirm linkages, are associated with low geographical concentration. The latter results can be explained within the economic geography framework. Linkages are the most important determinant of industry geography.

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1 Introduction

South Africa is an interesting case study of the spatial distribution of manufacturing activity and its determinants. Theoretical work on the location of manufacturers identifies among others linkages to markets – upstream supply markets as well as downstream customer markets – as a cause of agglomeration,

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and spatial differences in labour supply together with low mobility of workers as a force towards dispersion. In short, when workers and / or firms are mobile and firms have an advantage from centralising their production, a few manufacturing hubs might emerge to the detriment of the periphery, transportation cost permitting. The transition of South Africa from an inward-looking segregated apartheid state to a relatively open and more racially integrated economy makes the country something like a natural experiment for different theoretical explanations of industrial geography. Removal of international sanctions and lower tariffs should have lessened the importance of large national markets and the consequent agglomeration drive. On the other hand, greater labour mobility after abolition of the apartheid pass laws in the mid-1980s should have strengthened agglomeration. The net effect is unclear a priori. The Census of Manufacturing Activity in South Africa provides us with a fairly coherent database, covering 26 years. We are thus able to add an emerging economy study to the empirical literature on industry location, which has mostly been applied to European countries and the US.

Questions surrounding the spatial distribution of economic activity are also relevant to South African policy makers, in the context of high regional income inequality and social tension around income redistribution. Gradients in provincial incomes are closely associated with gradients in the regional density of production. A "capital city premium" common for emerging economies (Krugman, 1994; Te Velde and Morrissay, 2002) is a reality in South Africa, where manufacturing workers in Gauteng earned around twenty percent above the South African (SA) average in 1970-96, while manufacturing wages in Limpopo were less than fifty-five percent and wages in Northern Cape less than forty percent of the national average. This by itself need not be worrisome to policymakers provided economic dispersion forces level regional incomes sufficiently fast. It is of concern if spatial inequalities become entrenched and weaken the incomes of those South Africans who are not so geographically mobile and / or mobile across occupations. The absolute economic size of a manufacturing location influences total employment opportunities outside the primary sector. The degree and type of relative regional specialisation creates (or cushions) vulnerability to industry-specific shocks.

The spatial pattern of agglomeration and specialisation also has implications for longer term economic growth. Specialised regions offer firms better cost and production functions, because of natural or historic comparative advantages, and because of lower innovation and transaction cost in specialised input and labour markets. On the other hand, there is evidence that individual industries grow faster in more diverse metropolitan areas due to the cross-pollination of ideas (Glaeser et al., 1992). Henderson et al. (1995) argue that historically specialised medium-sized cities without the diseconomies of big cities attract mature sectors, while young dynamic industries seek the urbanisation economies from diversity in the metropoles.[1]

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[1] This may be relevant for South Africa, where the location of manufacturing concentrates around the four major South African cities: Johannesburg-Pretoria, Durban, Cape Town,

We digitalised the Census of Manufacturing Activity for the period 1970-96 in order to see whether regions equivalent to today's nine provinces have become more or less specialised over time, and correspondingly, whether industries have become more or less spatially concentrated. To our knowledge, we are the first to exploit such a lengthy panel on industry location in South Africa.[2] A further innovation to the literature in general is the use of a dynamic estimator. Inertia in the adjustment of industry location to new circumstances is likely, and in estimation is best accounted for by a dynamic estimation technique.

The paper proceeds as follows: Part 0 sketches the theoretical background and previous empirical work. Part 0 discusses the data. Part 0 introduces the indices which measure regional specialisation and geographical industry concentration, and traces them over the 1970-96 period. Part 0 specifies the econometric model and explains the Pooled Mean Group Estimator. Part 0 reports the estimation results. It is followed by our conclusions.

2 Explanations and evidence for an unequal spatial distribution of manufacturing

2.1 Theoretical contributions on the spatial distribution of manufacturing

Locational choice is one of the set of strategies that firms use to secure maximum profits. It balances access to customers, access to factor inputs, access to infrastructure, and possible economies and diseconomies associated with the agglomeration of firms. Much of recent empirical work on economic geography has drawn on trade theory, since goods can be more mobile than factors of production, the location of a large market or other location-bound advantages; hence, trade becomes a substitute for in-situ production. Intellectual ancestors of geography models are the location-theoretic models by Von Thünen, Weber, Lösch and Christaller, and the non-linear processes qualitatively analysed by regional development economics (Krugman, 1998).[3]

Firms and the types of activities they perform may be distributed unevenly across space because space is itself unequal. Some locations may attract firms above other locations due to their Ricardian-type natural or technological advantages, or their Heckscher-Ohlin-type abundance in a relevant factor of production that is less mobile than finished goods. A simplifying assumption of

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Port Elizabeth.

[2] Naude and Krugell (2006) present evidence based on geographically disaggregated data for South Africa. They use a commercial data base for regional GDP in order to do so. We examined this data for use in the present paper, but rejected it on quality grounds. The data is generated from aggregate GDP figures on the basis of a static algorithm, and is therefore not suitable for dynamic analysis.

[3] Several reviews of the theory and initial empirical evidence are available. On the theory, see for example Ottaviano and Puga (1998), Neary (2001) and Fujita et al. (1999). On empirical work, see for example Amiti (1997, 1998), Bruelhart (1998), Combes and Overmann (2004), as well as the literature review in Paluzie et al. (2001).

these theories is the assumption of constant returns to scale. If production can be scaled to the size of the proximate market, industrial geography would simply follow human geography. There would be spatial differences in production owing to "first nature" differences in climate, topography, resource availability etc.[4] But because industrial and human geography do not interact in a cumulative way, these differences would be smaller than the spatial differences we actually observe (Fujita et al., 1999: 2).

New trade theory shows that even when there are no first-nature differences between regions, but production is subject to plant-internal economies of scale, regions will specialise in the production of some goods (Krugman, 1979). Trade in differentiated products subsequently increases the range of choice and thereby the welfare of the citizens, since division of labour is limited by the size of the market. Market size under autarky depends on the size of the population, but increases with trade. The model determines the economic size of the trading regions and the volume of trade, but the types of products which are produced in the respective locations and the direction of trade are indeterminate. Krugman (1980) amends the model and shows that with differentiated consumer tastes and transportation costs, the country with the larger home market for a particular good will be the location of an over-proportionate share of its production. By producing in the larger market and exporting to the smaller market, firms combine the exploitation of scale economies with saving on transportation costs. In the extreme case, each country will specialise completely in the production of one type of good. Incomplete specialisation is a more likely scenario as transport costs rise and where economies of scale are less important (Krugman, 1980: 957).

In both the neoclassical and new trade theories, the regional endowment of labour – and consequently, the size of the regional market – is exogenously given. New economic geography theory allows for inter-regional mobility of workers and firms and analyses how mobility interacts with scale economies and trade costs[5] to generate a self-perpetuating process of agglomeration. The underlying assumption is that the manufacturing sector is sufficiently large such that the agglomeration of footloose firms can create a sizeable market, which in turn attracts more mobile firms and workers. Krugman (1991b) and Fujita et al. (1999, chapters 4 and 5) analyse regional agglomeration driven by labour mobility. Firms in the larger market can pay higher real wages, which attracts an inflow of workers from the periphery. Nominal wages are higher because they are an increasing function of manufacturing employment.[6] In addition, manufactured goods are cheaper in the core, due to greater competition and because the desired goods basket is subject to fewer transportation costs. Rising

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[4] "First nature" is the term by which Krugman (1991a) summarises truly natural advantages of a location such as a natural port, proximity to a navigable river, a sheltered valley or similar characteristics. "Second nature" refers to locational advantages that evolve from the concentration of population and production in a self-propelling way such as innovativeness, thick markets etc. Krugman (1993) attributes the terminology to Cronon (1991).

[5] "Trade costs" summarises all transaction costs relating to trade.

[6] This is the home market effect already sketched in Krugman (1980). Nominal wages would be the same if labour supply was perfectly elastic.

real manufacturing incomes in turn increase the size of the core market and make it an even more attractive location for firms.

Venables (1996) and Fujita et al. (1999, chapters 14 and 15) analyse agglomeration processes in the absence of labour mobility, but given interdependence of intermediate and final goods suppliers.[7] Final goods suppliers have better cost functions and are more competitive when they are close to a wide variety of intermediate producers. Intermediate suppliers in the core region have an edge over suppliers from the periphery due to the absence of transport costs. Competition ensures that price advantages are passed on to customers, which in turn, with price-elastic demand, enlarges the market size. The final spatial distribution of manufacturing firms depends on three key parameters: scale economies, share of intermediates in manufacturing output and trade costs. The more important gains from scale, and the larger the intermediates' share, the greater the tendency towards agglomeration at all levels of trade cost. Considering a range of trade costs, agglomeration forces are strongest when costs are at an intermediate level. High costs tie firms to their scattered consumers, while low costs diminish the cost advantage in intermediate purchases and the price advantage in final sales, and make firms more sensitive to inter-regional wage differentials.

The previous model simplifies by treating intermediates and final goods as varieties of the same type of product. Venables (1996) suggests interpreting intermediates' shares as different degrees of maturity of the final goods industry. Young industries depend more on specialised inputs than mature industries, where inputs have matured and become standardised as well. The attractiveness of the core location may therefore vary over the life-cycle of an industry.

Krugman and Venables (1996) analyse a model with two distinct industries, in which linkages to firms within the same industry are more important than inter-industry linkages. Imperfect inter-industry mobility of workers can lead to wage and expenditure differentials between industries. They show that at intermediate levels of transport cost, regions may specialise completely, and at low levels they will specialise according to the size of the home market.[8]

New trade and geography models focus on one agglomeration and one dispersion force: market-size (linkage) effects and immobile factors of production. As a final point we note that other drivers of agglomeration are the thick labour markets in the economic core, and pure external economies; other dispersion forces are differentials in land rents and pure external diseconomies (Krugman, 1998).[9]

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[7] Puga (1999) develops a general model that combines the agglomeration processes from factor mobility and linkages.

[8] If proximity to firms of the other industry (inter-industry linkages) was more important, each region would always host both industries.

[9] Examples for pure external economies are knowledge spillovers. Examples for pure external diseconomies are diseconomies of congestion, a higher crime rate and pollution in densely populated places. Pure external economies may not be interesting in cross-national empirical studies of industry geography, but are likely to be relevant in regional studies such as ours. Nevertheless, following preceding work on the US and Spain, these determinants are not explicitly considered.

2.2 Empirical work on the spatial distribution of manufacturing and the determinants of industry location

Several empirical contributions have provided a qualitative description of the spatial distribution of manufacturing in Europe and the US, as well as an econometric assessment of the various explanations discussed above. Amiti (1997, 1999), Haaland et al. (1999), Brülhart (2000) and Middelfart-Knarvik et al. (2000) use European countries as the geographic unit; Kim (1995) and Paluzie et al. (1999) study patterns of regional specialisation within the US and Spain, respectively.[10] We distinguish international and regional studies because of the difference in factor mobility between the two cases. Common to the papers is the use of disaggregated production or employment data for direct evidence on national or regional specialisation and industry concentration. The same observed spatial distribution is usually compatible with more than one location theory (Brülhart, 2000). These studies are thus best seen as indicators of the extent to which any one explanation has played a role in its specific context.[11]

Another common feature of earlier studies is the use of static estimators. Kim (1995), Amiti (1997, 1999) and Brülhart (2000) take a global perspective on the determinants of industry concentration, and regress on pooled data with industry and time fixed effects. Other papers treat selected years as separate cross-sections.[12] They ask whether the fall in trade cost resulting from European integration diminished or increased the importance of the various determinants, but obtain contradictory results.

Despite the diversity of regions, periods and industries covered in the various studies, as well as differences in the specialisation and concentration indices, there is robust evidence that regions in the US are highly specialised – and industries concomitantly spatially concentrated – but have become despecialised during the second half of the twentieth century (Kim, 1995).[13] Specialisation in European countries on the other hand has increased recently (Amiti, 1997; 1999; Haaland et al., 1999) but is still lower than in comparable US regions (Krugman, 1991a; Krugman and Venables, 1996). The process towards greater industry concentration in Europe has slowed in the implementation phase of the single market since 1986 except in those sectors where remaining non-tariff barriers (NTBs) were relatively high where concentration accelerated (Brülhart, 2000).

Evidence on the most important determinants of industry location is ambiguous, making it difficult to draw inferences from prior empirical work for

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[10] Earlier work on Europe is reviewed in Amiti (1997).

[11] Trade data do permit a clear distinction of the neo-classical and the new trade theories: the country with strong domestic demand for a particular good tends to be a net importer of the good under decreasing returns, and a net exporter under increasing returns (Krugman, 1980). Davis and Weinstein (1996, 1997, 1998) test this prediction and find evidence for the home market effect. See Brülhart (2000) for references and a critical discussion.

For example, the papers by Haaland et al. (1999) and Paluzie et al. (2001).

[12] For example, the papers by Haaland et al. (1999) and Paluzie et al. (2001).

[13] Glaeser et al. (1997) develop a more sophisticated theoretical concept of spatial concentration and argue that localisation is ubiquitous but slight in most industries.

the South African case. South Africa's provinces certainly vary regarding their first nature advantages in terms of climate, rainfall, maritime harbours and natural resource deposits, and factors of production were by the 1970s spatially unevenly distributed. According to Ricardian and Heckscher-Ohlin models – which ignore trade costs and increasing returns – industries that are most dependent on natural locational advantages or on the availability of inexpensive labour or capital should be most concentrated in the locations that offer these benefits. This is borne out by the spatial concentration of resource-intensive industries found by Brülhart (2000) and Kim (1995), and with qualification by Amiti (1997, 1999).[14] We expect resource-ties to be important in South Africa as well, where manufacturing has been significantly geared towards resource processing and providing inputs to the mining industry. South Africa's chemicals sector, for example, developed in response to the burgeoning demand for mining explosives since the 1890s (Gerrans, 1999), while 80% of non-tyre rubber mixed in Gauteng is consumed by the mining sector for wear and corrosion prevention (Tyrer, 2006).[15]

There is much weaker support for the expected spatial concentration of labour-intensive industries, evidence for which is reported only by Brülhart (2000). By contrast Amiti (1997, 1999), Haaland et al. (1999) and Paluzie et al. (1999) find labour-intensity irrelevant for spatial concentration. The variation of labour cost between locations is possibly greater in South Africa than between EU countries or Spanish regions. A priori, it is therefore plausible for South African low-tech labour-intensive industries to be dispersed outside the urban economic centres and close to the former black homelands. However, the increased mobility of workers after abolition of the pass laws in the mid-1980s should have served counteract the spatial dispersion of labour-intensive sectors. Conversely, given the serious skills shortage in South Africa over the entire period (Feinstein, 2005), we expect human capital intensive industries to be concentrated where trained workers concentrate, in the economic centres, especially Gauteng.

Increasing returns industries would also primarily seek Ricardian or Heckscher-Ohlin-type locational advantages as long as trade costs are low. If trade costs are intermediate or high, proximity to the biggest market is an important consideration, and new trade and geography models might dominate the classical predictions. Consumer industries with very high trade costs might exhibit little relative spatial concentration if firms follow the spatial distribution of income in the population. Empirical evidence for the relevance of new trade and geography models is mixed. Kim (1995), Amiti (1997, 1999) and Paluzie et al. (2001), using the same employment-based scale measure, detect a significant positive effect of scale-intensity on geographical industry concentration. Haa-

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[14] Kim's (1995) measure of resource intensity is the same as Amiti's (1997, 1999) and Paluzie's (2001) measure of linkages. The latter authors emphasise the wider "linkage" interpretation. Paluzie et al. find that interlinked firms are less concentrated. Because Spain is not rich in resources, this refers to manufacturing linkages proper.

[15] In 1988, non-tyre rubber accounted for around one-third of the SA rubber sector, in 1996 for 28 percent.

land et al. (1999) and Brülhart (2000), using different measures, find that scale intensive-sectors, other things equal, are not particularly concentrated – indeed, they may be deconcentrated. Evidence on the role of industry linkages is also mixed. Amiti (1997, 1999) and Haaland et al. (1999) find that linkage-intensity corresponds with greater spatial concentration, while Paluzie et al. (2001) observe a negative association pre 1986 and a positive association in 1992.[16] In the closed economy that South Africa was for most of the period studied, we would a priory expect that the main local markets played an important role for industry location (Krugman, 1994). The economic inland hub of Gauteng is certainly an example of overwhelming second nature locational advantages from agglomeration, including the developed financial services sector. In the smaller centres of Cape Town, Durban and Port Elizabeth – all maritime ports – Ricardian and agglomeration advantages mingle. The reintegration of South Africa into the international economy might have weakened linkages to local suppliers and customers and strengthened the importance of international linkages.

3   Compilation of the 1970 − 1996 panel and measurement issues

Information on regional specialisation in South Africa can be extracted from the Census of Manufacturing, which was conducted and published by Statistics South Africa (henceforth Stats SA) in mostly tri-annual intervals (1970, 1972, 1976, 1979, 1982, 1985, 1988, 1993, 1996). We use the following principal statistics: number of firms, number of salaried employees, gross output, cost of materials, and net output. Principal statistics are available for three geographical strata: the level of the major economic region (pre 1993) or province (post 1993); the level of the statistical region; and the level of the magisterial district. The maximum degree of detail on industrial sectors is the five-digit SIC class, although panel compilation required us to work with the three-digit class.

The basic unit of data collection is an establishment, which can be thought of as a plant or profit center. The theoretical literature on firms' locational choice does not distinguish between the economic entity of an establishment and the legal entity of a firm; but at its heart, the literature is concerned with the location of production, not administration. For the purpose of this study, the establishment is therefore a useful entity.

Compilation of the panel had to confront a number of difficulties, which cause a degree of measurement error in our final data set, both in the dependent and in the explanatory variables. Geographical units were rezoned; repeated revision of the industrial classifications made industries not strictly comparable across all years; information in current prices had to be converted into constant prices; and missing values due to Stats SA's confidentiality clause had to be addressed.[17]

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[16] The linkage effect in Haaland et al. (1999) is insignificant. Paluzie et al. (2001) observe a consistently insignificant negative association for some, and specification specific results for other regions.

[17] A detailed discussion of the data compilation issues can be found in Wollnik (2006).

The former TVBC[18] states were excluded because of too much missing data.

Under consideration of data issues we were able to construct a balanced panel of 22 industries: Food, Beverages, Clothing, Textiles, Footwear, Leather, Wood, Furniture, Paper, Printing, Chemicals, Rubber, Plastics, Iron & Steel, Metal Products, Non-ferrous Metals, Non-metallic Mineral Products, Pottery, Machinery, Electrical Machinery, Motor, Scientific Equipment.

4 Measurement of regional specialization and industry concentration

4.1 Industry Location in South Africa

Manufacturing value added in South Africa is overwhelmingly dominated by Gauteng, where 49 percent of manufacturing value added on average was produced in the 1970s, 45 percent in the 1980s and 42 percent in the first half of the 1990s. Apart from Gauteng, the economically strongest regions are located along the coast, while the weakest provinces stretch along the interior northern borders (Figure 1).

Above all Mpumalanga, but also the North-West and Limpopo provinces have achieved some catching up. Manufacturing value added in Mpumalanga in 1996 was around 3.5 times the size of 1970, while it was around 2.5 times its former size in the North West and Limpopo. Growth in these three provinces occurred from a low base. A remarkable development is KwaZulu-Natal where the manufacturing sector increased by 80 percent over the 26 years covered by our panel. Manufacturing value added in Gauteng grew from Rands 18.5 billion in 1970 to 35.9 billion in 1982, and thereafter consistently declined back to 21.8 billion in 1996. This distinct U-shape is in contrast to KwaZulu-Natal and the Western Cape, which also experienced a peak in 1982 but retained their previous gains to a greater extent. Iron and steel, machinery and metal products – the three largest sectors in Gauteng – accounted for one-third of the rise, but for more than half of the subsequent decline in net value added.

4.2   Regional Specialisation

The summary index of regional specialisation most commonly used is the Gini coefficient of specialisation, based on the Hoover-Balassa index (HBI) of comparative advantage. The HBI measures the size of manufacturing sector s in province p, compared to the size of the total sector in South Africa.

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[18]TVBC is the abbreviation for the four former black homelands Transkei, Venda, Bophuthatswana and Ciskei. These homelands had accepted "independence" from white South Africa between 1976 and 1981 and were dropped from the census. Exclusion of these regions is unlikely to distort the analysis, since the TBVC states consistently had a low manufacturing base, and in any event had peculiar policy distortions affecting industry location. They are therefore best left excluded.

$$HBI_{sp} = \frac{VA_{sp}}{VA_p} \bigg/ \frac{VA_{sSA}}{VA_{SA}} \equiv \frac{VA_{sp}}{VA_{sSA}} \bigg/ \frac{VA_p}{VA_{SA}}, 0 \leq HBI_{sp} \leq \frac{VA_{SA}}{VA_p} \qquad (1)$$

where VA_{sp} denotes value added in sector s and province p, and VA_{sSA} symmetrically for the SA national average. There is no measured specialisation in sector s, if the relative size of sector s in province p is the same as in South Africa as a whole, such that $HBI_{sp} = 1$. If the sector is of over-proportionate size, $HBI > 1$, with upper bound VA_{SA}/VA_p;[19] if sector s is of under-proportionate size, the $HBI < 1$, with lower bound zero.

We use value added at constant prices as the indicator of size (as do Amiti, 1997; Paluzie et al., 2001), although employment (Kim, 1995; Brülhart, 2000), gross output (Haaland et al., 1999; Midelfart-Knarvik et al., 2000) or trade data (Brülhart, 2000) could also be used.

The Gini coefficient of provincial specialisation is obtained from the HBI measure. If all sectors have an HBI of one, the province is simply a scaled version of the average spatial distribution of manufacturing in South Africa, and the Gini coefficient of specialisation is zero. The more the provincial composition of manufacturing value added deviates from the average SA make-up, the more specialised the province will appear.[20]

We find that the weighted average of measured regional specialisation in South Africa is not very high – with an average Gini of approximately 0.35. This results from the overwhelming importance of Gauteng; the least specialised region also has the greatest weight (Figure 2 and Table 1).[21] If we consider the unweighted average, the specialisation Gini rises to 0.50. No consistent trend towards greater regional specialisation or despecialisation in South Africa is evident from the weighted average Gini, while the unweighted Gini shows a gradual declined over most of the period. Both averages indicate an increase in

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[19] See De Benedictis et al. (2001). The upper bound tends towards ∞ for a province of immaterial size relative to South Africa as a whole.

[20] As noted by De Benedictis et al., (2001), even if value added is of equal size in all sectors of a province, but sectors are not balanced in South Africa as a whole, the province will appear specialised compared to the average industry structure in SA. The sources of change in the Gini coefficient are not easy to track. Formally:

$$HBI_{sp} = \frac{q_p}{q_{SA}(q_p)}$$

where q is the share of sector s in province p or South Africa, respectively. q_{SA} is a function of q_p. Hence

$$\frac{d}{dq_p}(HBI_{sp}) = \frac{1}{q_{SA}^2}\left[q_{SA}dq_p - q_p\frac{dq_{SA}}{dq_P}\right]$$

. Whether the HBI increases or decreases with expansion of sector s in province p depends on the sign of the term in [·]. In addition, the Gini places greater implicit value on the middle parts of the distribution. Changes in the relative size of sectors which are close to the South African average will therefore be given greater weight in the Gini of provincial specialisation than changes at either end of the distribution (Amiti, 1997).

[21] See De Benedictis et al. (2001) for comparing degrees of specialisation across sectors, space and time. He argues that the measured degree of specialisation according to the HBI relative to the upper bound of HBI should be taken into consideration.

regional specialisation between 1993 and 1996, as would be expected with an opening of the economy, though the note is restricted to a single observation.

At a regional level we find that Gauteng has a stable degree of low measured specialisation. Trends were different in KwaZulu-Natal and the Western Cape. KwaZulu-Natal despecialised until the mid-1980s, and has become more specialised since. Western Cape increased specialisation in the 1970s, despecialised in the 1980s, and became more specialised again in the 1990s. Because of their economic weight in South Africa, developments in Gauteng, KwaZulu-Natal and the Western Cape largely determine overall measured specialisation. Full Gini coefficients of provincial specialisation in the survey years are reported in Table 1, together with the economic weight of the province.

Data for the economically smallest regions Northern Cape, Limpopo and the North West – their weights in value added are around 0.5 percent, one percent and two percent, respectively – are the least reliable before 1985. Focussing therefore on the Free State, Mpumalanga and the Eastern Cape, it appears that observed specialisation in these provinces was comparatively stable until 1982. Subsequently regions despecialised, but apart from Mpumalanga, all became more specialised after 1993.

4.3   Industry Concentration Indices

The complementary observation to regional specialisation is the relative concentration of industry by location. We measure geographic concentration by means of the Gini coefficient of industry concentration, the locational Gini. The Gini coefficient of industry concentration is zero, if in each province value added in sector s perfectly corresponds to the economic weight of the province. The more the geographic distribution of the industry deviates from the average size of its host locations, the more concentrated the industry will appear.[22]

We divide the 22 manufacturing sectors of the data set into the five most concentrated in 1970, the five least concentrated, and the eleven sectors with intermediate concentration, and compare the classification with 1996.[23] Our cut-off Gini for the top-concentrated industries is 0.40; by 1996, this class includes nine instead of six industries. Our cut-off Gini for the least concentrated industries is 0.25; the number of industries in this class remained unchanged. The results are summarised in Table 2.

The most concentrated industries apart from Iron & Steel and Motor tend to be smaller industries. The Spearman rank correlation coefficient between industry size and concentration Gini in 1996 is -0.30, significant at the 10 percent level of significance.

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[22] Ellison and Glaeser (1997) have pointed out that the correct measure of industry concentration is indeed excess concentration after accounting for inter-industry differences in the distribution of plant-size. Since the measure requires data on industry-specific plant-size distributions, we are unable to compute it for the present study.

[23] The full industry characterization is available from the authors on request.

5 Econometric estimation of the determinants of geographical concentration of industry

5.1 Specification of regressors

In order to estimate econometrically why some industries in South Africa are more geo-graphically concentrated than others, we construct explanatory variables that proxy for the determinants of location identified by the various strands of theory. We proxy for Heckscher-Ohlin factor intensities, Ricardian technological advantages, and new trade and geography concentration benefits in scale-intensive and interlinked industries.

The Heckscher-Ohlin trade model predicts that industries with above-average needs in the use of a factor of production should concentrate in the region where this factor is abundant. We proxy for intensity in the use of labour and the use of human capital; intensity in the use of physical capital as the remaining factor of production is thereby implicitly covered as well.

Human capital intensity of production in sector s is measured by the industry-specific wage, following Haaland et al. (1999). We expect that workers with better human capital command above-average wages. Hence we assume that industries which deviate in their wage from the SA mean generally deviate in their human-capital needs of production. Industries with above-average human capital needs should be concentrated in locations with ample supply of needed skills. But industries with below-average human capital needs may have an above average use in either labour or physical capital, which explains why these too might be more concentrated than the average industry, in locations where those factors are abundant. The index of human capital intensity therefore is measured as the *absolute* deviation of the industry-specific wage per employee from the SA average wage across all industries:

$$HCAP_s = \left| \frac{\Sigma_p W_{sp}}{\Sigma_p E_{sp}} - \frac{\Sigma_s \Sigma_p W_{sp}}{\Sigma_s \Sigma_p E_{ps}} \right| \tag{2}$$

where W_{sp} denotes the wage bill of sector s in province p and E_{sp} symmetrically for the number of employees.

For labour intensity of production in sector s, we employ three indices to allow for a sensitivity check of results to alternative measures of labour intensity proposed in the literature. Our primary measure is the average number of workers required per unit of value added, approximating by using the number of salaried manufacturing employees, and net output at basic prices.[24] The first labour intensity index thus measures the deviation of the industry-specific labour intensity, from the SA average labour intensity across all industries:

$$LAB1_S = \left| \frac{\Sigma_P E_{sp}}{\Sigma_P VA_{sp}} - \frac{\Sigma_s \Sigma_p E_{sp}}{\Sigma_s \Sigma_p VA_{sp}} \right| \tag{3}$$

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[24]Ideally we would use data on production workers and value added at factor cost (Amiti, 1997), but these are not available from the Census of Manufacturing.

Given the use of SIC-3 level data, aggregation problems may render the average number of workers per value added a poor measure of central tendency in the sector. We test for sensitivity of results by employing the median in the labour intensity measure instead:

$$LAB3_s = \left| Median\left(\frac{E}{VA}\right)_{sp} - Median\left(\frac{E}{VA}\right)_{sSA} \right| \tag{4}$$

Finally, previous empirical studies (Amiti, 1997 and 1999; Paluzie et al., 2001) have used an index of average unit labour cost, which does not separate labour and human capital-intensity. In this spirit we use share of value added that goes to workers as a third measure of labour intensity:

$$LAB2_s = \left(\frac{\Sigma_p W_{sp}}{\Sigma_p VA_{sp}} - \frac{\Sigma_s}{\Sigma_s}\frac{\Sigma_p W_{sp}}{\Sigma_p VA_{sp}}\right)^2 \tag{5}$$

Note that the LAB2 measure is a composite measure of labour and human capital intensity, and thus should not be used in conjunction with HCAP. For all three measures, the Heckscher-Ohlin prior is that the further an industry deviates from average labour intensity, the more we expect its geographical distribution to deviate from the SA average, giving a positive sign expectation as prior.

According to the Ricardian model of trade, industries should locate their production in the region that offers them the best conditions for production. Given the value added per employee measure of labour productivity, one measure of locational advantage of industry s in region p, is provided by the deviation of industry s labour productivity in region p relative to average labour productivity for industry s across all regions, from average labour productivity for region p across all industries relative to average total labour productivity. Haaland et al. (1999) therefore suggest the following proxy for different technological opportunities offered by different locations:

$$TD_s = \sqrt{\frac{1}{c}\Sigma_p\left[\frac{VA_{sp}}{E_{sp}} \middle/ \left(\frac{1}{d}\Sigma_p\frac{VA_{sp}}{E_{sp}}\right) - \left(\Sigma_s\frac{VA_{sp}}{\Sigma_{sp}}\right) \middle/ \left(\frac{1}{c}\Sigma_s\Sigma_p\frac{VA_{sp}}{E_{sp}}\right)\right]^2} \tag{6}$$

where c denotes the total number of provinces and d the number of provinces where industry s is located.

Central to new trade theory and economic geography models is the prediction that industries with substantial scale economies in production locate over-proportionately near their largest markets. In the absence of data on inter-provincial trade, we measure plant-specific scale economies in sector s with the average number of employees per establishment.[25] Our measure associates bigger plants with greater scale economies, and we expect that sectors with greater scale intensity of production are more geographically concentrated. Thus:

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[25] The spirit of the theory is perhaps best captured by an expenditure variable, such as in Haaland et al. (1999) who identify industry-specific expenditure as the most important determinant of geographical concentration. We lack the requisite data.

$$SCALE_s = \frac{E_s}{\text{Number of establishments in industry } s} \qquad (7)$$

Care must be taken in the interpretation of this variable, however, since while the measure is plausible in cross-sectional comparison, in an inter-temporal comparison the interpretation is ambiguous. A drop in SCALE due to substitution of capital for labour (smaller numerator) would be associated with an increase in plant-specific scale economies, while a drop due to the advent of smaller-scale decentralised production methods (larger denominator) would be associated with a decrease.[26]

Finally, macro-economies of scale resulting from the market-mediated interaction of inter-linked industries also favour a concentration of industries, according to economic geography models. Numerous backward linkages from downstream firms form the market for upstream producers and enable efficiency gains. Resulting input price decreases render downstream firms more competitive and perpetually widen their markets as long as demand is price-elastic and diseconomies from agglomeration are not too strong. We proxy the linkage-dependency of an industry by the share of intermediate inputs in total output:

$$LINKS_s = \frac{P_s Q_s - VA_s}{P_s Q_s} \qquad (8)$$

where $P_s Q_s$ = gross output of sector s at basic prices. The measure has four weaknesses: first, it cannot distinguish between inter- and intra-industry linkages even though the latter are believed to be more important; second, it includes links to raw material producers, which are immobile, or at least less footloose than manufacturers, and represent a force towards dispersion, if transport costs exceed those for final products; third, and crucially, it asymmetrically evaluates the importance of forward and backward linkages, isolating the impact of input supplies rather than concentration of onward sales; and fourth, materials include inputs that are produced intra-regionally as well as inter-regionally and internationally, yet the first are the most relevant for the agglomeration mechanism we wish to assess (Amiti, 1998).[27]

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[26] In South Africa, the number of employees per establishment significantly trended downward in most industries, an exception being the beverage industry, and the iron and steel sector in the 1990s. Iron and steel is an outlier due to its exceptionally large scale of production, followed by non-ferrous basic metal products. Sectors with very low-scale production on the other hand are furniture, printing, scientific equipment, metal products and machinery.

[27] The mean materials share persisted at a level of 0.56 in eight surveyed years, with a standard deviation of 0.09. 1996 saw a strong increase in LINKSs to a mean of 0.68, caused by a significant increase in the cost of materials over and above the general increase in gross value added, possibly due to outsourcing and/or the accelerated depreciation of the Rand in 1996. However, the pervasive increase in materials costs is also observed in sectors with low content of imported materials such as non-metallic mineral products and printing. The standard deviation narrowed to 0.05.

5.2　　　Econometric technique

It is plausible, due to information and adjustment costs that industry concentration responds only with inertia to changes in its determinants. We therefore deviate from the static estimators of the literature reviewed, and employ the dynamic pooled mean group (PMG) estimator suggested by Pesaran et al. (1999). Additional detail on the econometric technique can be found in Fedderke (2004).[28]

6　　　Results

We estimate the model in log-linear form, where the long-run specification given by:

$$LGINI_{s,t} = \theta_1' LLAB1_{s,t} + \theta_2' LHCAP_{s,t} + \theta_3' LSCALE1_{s,t} + \quad (9)$$
$$\theta_4' LLINKS_{s,t} + \theta_5' LTD + \eta_{s,t}$$

where L indicates the natural-log transformation of the variables.[29]

The results for the long-run θs and the error-correction coefficient, denoted ϕ, are presented in Table 4 below. Models (1)-(3) test for sensitivity in the specification of the LAB variable, model (4) tests for sensitivity regarding lag-length, while models (5)-(6) test for sensitivity due to outliers and measurement error.[30] The absolute effects of scale, linkages and technology on spatial concentration increase when average labour and human capital intensity are measured by the unit labour cost index LAB2, and the coefficients on labour intensity and

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[28] An additional concern may be the presence of endogeneity between market size and industry concentration, or agglomeration of physical and human capital, due to the cumulative processes at work. Evidence on endogeneity in the literature is mixed: Haaland et al. (1999:18) cannot reject the null of no contemporaneous correlation, while Paluzie et al. (2001) report a problem with 1992 data, and to a lesser degree in the earlier periods. In the present context we pursue the general approach adopted in the literature of not explicitly pursuing the endogeneity problem.

[29] Given the use of the PMGE, recall that the long run specification is embedded in the unrestricted error correction ARDL (p, q) representation:

$$\Delta y_{it} = \phi_i y_{i,t-1} + \beta_i' x_{i,t-1} + \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}' \Delta x_{i,t-j} + \mu_i + \varepsilon_{it}$$

where $i = 1, 2, ..., N$, stand for the cross-section units, and $t = 1, 2, ..., T$, indicate time periods. Here y_{it} is a scalar dependent variable, $x_{it}(kx1)$ is the vector of (weakly exogenous) regressors for group i, μ_i represent the fixed effects, ϕ_i is a scalar coefficient on the lagged dependent variable, β_i is the $kx1$ vector of coefficients on explanatory variables, $\lambda_{ij}' s$ are scalar coefficients on lagged first-differences of dependent variables, and $\delta_{ij}' s$ are $kx1$ coefficient vectors on first-differences of explanatory variables and their lagged values.

[30] The iron and steel sector is an outlier regarding its very large scale but intermediate geographical concentration. Data for the chemicals sector may be subject to particular measurement error, due to the secrecy around South Africa's state-led oil from coal industry in particular, SA coke and refinery activities in general, and the price index problem in converting chemical industry data of Mpumalanga, particularly 1985.

scale are slightly sensitive to lag length. A comparison between models (1) and (5) with respect to (6) suggests that our results are robust regarding outliers and measurement error. We will therefore not consider these two sensitivities further. In no case do signs reverse. All results are statistically coherent, given adjustment to long-run equilibrium. The magnitude of the error-correction coefficient in the range of 0.1-0.2 indicates that adjustment is slow, as would be expected for spatial relocation of industry. However, the finding suggests that dynamics are important in the estimation of spatial effects to industry location. Long-run equilibrium relationships are homogeneous across industries, as demonstrated by the Hausman test coefficient. The most important determinant of spatial industry concentration in South Africa proves to be linkages, though the surprise is that firms with strong linkages are *less* spatially concentrated. The strongest pro-concentration effects emerge from scale economies.

We begin our interpretation of results with the effect of human capital requirements on the geographical location of production. Human capital intensity is measured as the absolute deviation of the industry-specific wage per worker from the SA mean. A greater deviation favours regional specialisation in South Africa. This result fits with Heckscher-Ohlin factor-abundance arguments as well as economic geography theory, which expects agglomeration of industries with specialised inputs needs (Venables, 1996). The geographical concentration of human capital intensive industries reflects the skills shortage in South African manufacturing during the last two decades of apartheid (Feinstein, 2005: 191, chapter 10). Concentration reports an elasticity of 0.09 to deviations of human capital intensity from its mean (model 1). The impact is not sensitive to the use of deviations from the median (model 3), or to restrictions on the lag-length in response to all types of shocks (model 4). In the surveyed literature, only Haaland et al. (1999) separate the impact of labour and human capital intensity; they find impacts of a similar order of magnitude, with elasticities of 0.14 and 0.08 in 1985 and 1992 respectively for their European cross-country comparison.

For labour intensity, we find that industries with a greater distance from the mean are on average less geographically concentrated. The coefficients of the LAB variables in models (1)-(3) show that this negative relationship is robust, independent of which particular labour-intensity index is used, but becomes insignificant when it is measured as deviation from the median (model 3) rather than the mean (model 1). The magnitude of the elasticity is small. A one percent increase in the deviation from mean number of employees per unit of value added decreases the Gini of geographical concentration by approximately 0.02 percent. Figure 3 summarizes the findings.

The finding on labour intensity contradicts the Heckscher-Ohlin prior. Moreover, in comparison, European industries with a large deviation of labour intensity from mean tended towards greater concentration - see the combined results of Haaland's (1999) cross-European country study and Paluzie's regional study of Spain (2001).

What accounts for this perverse finding in the South African case? The answer lies in the fact that in South Africa, the presence of restrictions on labour mobility due to Apartheid laws would favour dispersion of any industry that

was labour intensive, given the relative concentration of the labour resource in the homeland areas.[31] Conversely, industries with low labour intensity, hence capital intensity, are most strongly located in industries that are based in resource extraction. Again, resource extractive industry faces a lack of mobility of the inputs into its production, and relatively strong geographical dispersion of the resource base, given the relatively diverse natural resource base of the South African economy.[32]

In effect, therefore, the evidence implies that the South African economy, either due to policy intervention in the labour market, or due to its reliance on natural resource extraction that is geographically dispersed, has faced low degrees of factor concentration. As a consequence, Heckscher-Ohlin based forces for industry concentration have therefore been weak (restricted to human capital), such that *both* labour intensive *and* capital intensive industry have been unable to realise agglomeration benefits.

New trade and geography theory predict that larger internal scale economies encourage geographical industry concentration. The pro-concentration effect is confirmed in South Africa, where scale economies are the most important factor working towards concentration. The locational Gini responded on average with an elasticity of 0.19 percent to a one percent increase in scale economies (model 1).[33] In Figure 4, we use our LAB2 specification (model 2) to compare our estimated coefficient on SCALE with the literature, because neither Paluzie et al. (2001) nor Amiti (1997, 1999) separate labour and human capital intensity. The effect of scale economies on industry concentration appears to be smaller across both Spanish and US regions, and larger between European countries, than between South African provinces. Common throughout all studies is the expected positive significant effect of firm-specific scale economies on relative geographical industry concentration.

Turning to linkage intensity, industries with a high share of materials use in gross output tend to be least concentrated on average. The elasticities are large, and identify linkages as the most important determinant of industrial geography in South Africa. A one percent increase in the materials share decreases the industry Gini by around two-thirds of a percent (-0.63) in our base case model (1). If we control for labour and human capital intensity jointly by the deviation of unit labour cost from the mean (model 2), the elasticity rises further to 0.77 percent.

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[31] This would have been further strengthened by the existence of tax rebates and subsidy programmes favouring industry relocation toward the borders of homelands. On the other hand, the generally acknowledged failure of such decentralization schemes would serve to explain the weakness of the negative correlation between labour intensity and spatial concentration. Furthermore, the legal anti-migratory bias was never successfully enforced, such that labour was not scarce in the economic centres, and the price of simple labour sufficiently moderate to meliorate the decentralizing bias of labour intensity.

[32] Note that this interpretation is confirmed by the finding on the LINKS variable below.

[33] The magnitude of the elasticity is somewhat sensitive to model specification. If labour intensity is measured by the deviation from mean unit labour cost (model 2), we estimate an elasticity of 0.31 percent, possibly picking up some of the effect that human capital has on concentration. If we restrict the lag-length to one on all variables, the elasticity drops to half its value at 0.09 percent.

The finding contradicts the theoretical prior on this measure, and differs from the international findings on the US, and Europe, though it is similar to that found fro Spanish regions. See Figure 5. In a resource-intensive economy, strong linkages make firms less mobile by tying them to the potentially scattered locations of resource supplies. It is therefore plausible that linkages should have different implications in South Africa, or resource-based economies in general, than they have in the diversified industrial countries of the north. South African industry evolved from two legs: the production of fairly basic consumer goods, and mining supplies such as explosives as well as processing of mineral resources. Heavy industry emerged after foundation of ISCOR in 1928, which had been located in proximity to the supply of high-grade iron ore as well as the principal markets on the Witwatersrand (Feinstein, 2005: 115, 120). Similarly Sasol, in producing oil from coal was located in close proximity to its coal inputs. It is possible that high transportation costs subsequently locked-in the spatial pattern of this early industrial stage. Consumer goods industries would have located close to their consumers; and resource-linked industries with high materials-intensity would have located near resource deposits, or near resource growth areas in the case of processed agricultural and forestry products. Evidence that high cost of doing trade, including the cost, reliability and speed of freight handling as well as telecommunications, represent a significant obstacle to manufacturing operations in South Africa, is for example tabled in Edwards and Alves (2005).[34]

Finally, Ricardian regional technology differences have the expected positive effect on industry concentration. Industries with the largest gradients in productivity between locations tend to be more geographically concentrated. The elasticity of the geographical Gini in response to a one percent increase in industry-specific productivity advantages in some locations is 0.06 if we control for labour intensity and human capital intensity separately (models 1, 3), and is twice as large if we measure them jointly with unit labour cost (model 2).

In Europe, on the other hand, industries with stronger productivity gradients between locations are not particularly concentrated or deconcentrated. Paluzie's study of Spain estimates negative coefficients in the years 1979 and 1986 – industries with stronger productivity gradients are the least concentrated on average – and a positive co-efficient in 1992, all of them insignificant (Figure 6). Haaland et al. (1999) estimate an elasticity of 0.0079 for 1985 and -0.0026 for 1992, but they use a different measure of industry concentration than we do. It may be the case that productivity gradients in Europe are simply not that large, by nature or because technology diffuses at a fast rate.

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[34] As already noted, Spanish industries with a high share of intermediate inputs, too, were less concentrated (Paluzie et al., 2001). The negative association deepened with progressing integration of Spain into Europe (Figure 5). Following Krugman (1994) and Krugman and Livas (1996), Paluzie et al. attribute their observation to a diminishing importance of local suppliers as economic openness increased. Since South Africa had a strong inward focus over much of the period studied, this explanation does not appear applicable in our case.

7 Conclucions and Policy Implications

We consider a panel of the regional distribution of manufacturing in South Africa 1970-96 in order to evaluate possible determinants of the spatial structure of manufacturing production. We find considerable regional specialisation on average measured by the unweighted specialisation Gini, but moderate specialisation if we take the economic weight of the provinces into account. The reason is the overwhelming weight of Gauteng in SA manufacturing value added, such that the province with the greatest weight shows little specialisation. There has been no obvious trend towards greater specialisation or de - specialisation in South Africa as a whole. Provinces became more dissimilar from the hypothetical average SA province between 1993 and 1996 as would be expected with opening the economy, but this is represented by only one data point.

Corresponding to the picture of provincial specialisation, we find no evident trend towards greater spatial industry concentration based on the weighted average location Gini, although industries of the same rank were more concentrated in the early 1990s than the beginning of the 1970s and 1980s. The unweighted average spatial concentration increased. Comparing industry ranking in 1970 and 1996, the top ranked industries in both years were rubber, footwear, pottery, motor and basic iron and steel; clothing, non-ferrous metals, leather and textiles producers were also ranked among the top nine in 1996. A consistently deconcentrated industry is furniture; metal products, non-metallic mineral products, plastic and printing were among the least concentrated in 1970 but left the group by 1996. Food, beverages and chemicals, on the other hand, by 1996 were ranked among the most dispersed. Our data show that Gauteng was been unable to retain the strong increases in value added of the 1970s and early 1980s, and was by 1996 only slightly bigger than in 1970. KZN on the other hand continually gained weight.

Drawing on predictions from trade and economic geography models, we find that high plant-internal scale economies, intensity in the use of human capital and high industry-specific productivity gradients between locations are associated with greater geographical concentration of an industry. Scale economies are the most important pro-concentration force. A greater deviation of labour-intensity from the mean is associated with greater geographical dispersion. Industries with strong inter-firm-linkages are also less concentrated. Linkages are in fact the most important determinant of industry geography.

Regarding the low concentration of labour-intensive industries, we hypothesize that legal limitations on migration and tax incentives created a tendency toward lower industry concentration. Conversely, the limited success of influx control measures meant that apartheid policies did not prevent the creation of a sufficient supply of cheap labour to the economic centres, keeping the decentralization tendency within bounds. Thus the role of labour-intensity for locational choice has remained minimal.

As regards the low concentration of industries with strong forward linkages, we hypothesise that high transportation cost play a role, which tie resource beneficiaries and mining suppliers to the locations of resource production, and some

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consumer goods producers with very high transportation cost to the location of their customers.

Table 5 summarizes the evidence.

What are the policy implications that emerge from these findings for an emerging economy that has faced a history of poor industrial and labour market policy, much of which endures, combined with a high degree of natural resource dependence?

In the long run development will require the deepening and diversification of the manufacturing base of the economy. For most emerging markets the domestic economy is simply too small to render feasible autonomous trajectories of development. Reliance on export markets is therefore an essential ingredient of long term success.

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Table 1: Gini coefficients of regional specialisation

	G70	w	G72	w	G76	w	G79	w	G82	w	G85	w	G88	w	G93	w	G96	w
Northern Cape (NC)	0.69	0.00	0.68	0.00	0.62	0.00	0.66	0.00	0.67	0.00	0.71	0.00	0.72	0.00	0.70	0.00	0.72	0.00
Limpopo (LMP)	0.63	0.01	0.61	0.01	0.51	0.01	0.53	0.01	0.60	0.01	0.58	0.01	0.56	0.01	0.56	0.01	0.63	0.01
Free State (FS)	0.62	0.04	0.61	0.04	0.62	0.04	0.63	0.05	0.63	0.04	0.53	0.04	0.58	0.04	0.44	0.03	0.58	0.03
Mpumalanga (MP)	0.67	0.03	0.65	0.03	0.65	0.04	0.64	0.04	0.61	0.04	0.63	0.11	0.59	0.08	0.58	0.07	0.56	0.07
Eastern Cape (EC)	0.56	0.10	0.54	0.08	0.55	0.08	0.55	0.08	0.56	0.08	0.53	0.07	0.51	0.07	0.50	0.07	0.55	0.08
North West (NW)	0.57	0.01	0.54	0.02	0.49	0.02	0.43	0.02	0.46	0.02	0.53	0.02	0.51	0.02	0.50	0.02	0.52	0.03
Westtern Cape (WC)	0.37	0.15	0.38	0.14	0.41	0.13	0.42	0.12	0.38	0.13	0.35	0.13	0.32	0.14	0.35	0.15	0.36	0.15
KwaZulu Natal (KZN)	0.38	0.17	0.34	0.19	0.33	0.19	0.33	0.19	0.31	0.19	0.28	0.19	0.30	0.20	0.31	0.22	0.31	0.23
Gauteng (G)	0.26	0.50	0.25	0.50	0.25	0.49	0.25	0.49	0.25	0.49	0.28	0.42	0.26	0.42	0.25	0.43	0.25	0.41
Weighted Average	0.36		0.35		0.35		0.35		0.34		0.36		0.34		0.34		0.35	
Unweighted. Average	0.53		0.51		0.49		0.49		0.50		0.49		0.48		0.47		0.50	

G_t is the specialisation Gini in year t and w is the economic weight of the province in net output

Table 2:   Changes to the class of most and least concentrated sectors 1970 versus 1996

Concentrated industries that have remained concentrated	*Concentrated industries that have become less concentrated*	*Intermediate industries that are now most concentrated*
Rubber		Non-ferrous metal products
Footwear		Clothing
Pottery		Leather
Motor		Textiles
Basic iron and steel		
Dispersed industries that have remained dispersed	*Dispersed industries that have become more concentrated*	*Intermediate industries that are now dispersed*
Furniture	Metal products	Food
	Non-metallic mineral products	Beverages
	Plastic	Chemicals
	Printing	Scientific equipment
Residual group		
Paper		
Wood		
Machinery		
Electrical machinery		

Table 3:   Geographical concentration of industry across South Africa's nine provinces SIC-3

	(1)	(2)	(3)	(4)	(5)	(6)
Estimator	PMGE	PMGE	PMGE	PMGE	PMGE	PMGE
Sample	22 sectors	22 sectors	22 sectors	22 sectors	20 sectors#	21 sectors##
Info Criterion	AIC(1)	AIC(1)	AIC(1)	ARDL(1,1,1,1,1,1)	AIC(1)	AIC(1)
Dep. Variable	LGINI	LGINI	LGINI	LGINI	LGINI	LGINI
LHCAP	0.090*		0.079*	0.084*	0.090*	0.090*
	(0.016)		(0.017)	(0.025)	(0.016)	(0.016)
LLAB1	-0.022*			-0.042*	-0.022*	-0.021*
	(0.007)			(0.012)	(0.007)	(0.008)
LLAB2		-0.010*				
		(0.004)				
LLAB3			-0.005			
			(0.009)			
LSCALE1	0.190*	0.311*	0.195*	0.086*	0.191*	0.194*
	(0.016)	(0.028)	(0.021)	(0.025)	(0.016)	(0.021)
LLINKS	-0.630*	-0.768*	-0.629*	-0.653*	-0.620*	-0.625*
	(0.058)	(0.137)	(0.077)	(0.087)	(0.058)	(0.071)
LTD	0.064*	0.123*	0.064*	0.052*	0.065*	0.065*
	(0.013)	(0.024)	(0.012)	(0.015)	(0.013)	(0.014)
ϕ	-0.204*	-0.116*	-0.099*	-0.100*	-0.177*	-0.166*
	(0.066)	(0.031)	(0.041)	(0.033)	(0.059)	(0.057)
h-test	8.10 [0.15]	7.18 [0.13]	4.15 [0.53]	8.15 [0.15]	6.24 [0.28]	7.94 [0.16]
LR	694.55 [0.00]	429.21 [0.00]	548.53 [0.00]	512.32 [0.00]	585.68 [0.00]	612.70 [0.00]
RLL	1058.53	1056.70	1092.12	1163.50	1017.41	1026.24
ULL	1405.81	1271.31	1366.39	1419.66	1310.25	1332.59

 # excluding iron & steel

excluding chemicals

Standard errors reported in (·)

*Probabilities reported in [·] * indicates coefficient significant at the 5% level*

Table 4: Summary of Theoretical Priors and Empirical South African Findings.

Figures report Elasticities.

		HCAP	LAB	TD	SCALE	LINKS
Heckscher-Ohlin	prior	>0	>0			
	actual	+0.09	-0.02			
Ricardian	prior			>0		
	actual			+0.06		
New Trade	prior				>0	
	actual				+0.19	
Economic Geography	prior	>0			>0	>0
	actual	+0.09			+0.19	-0.63

Figure 1:   Total manufacturing value added by province
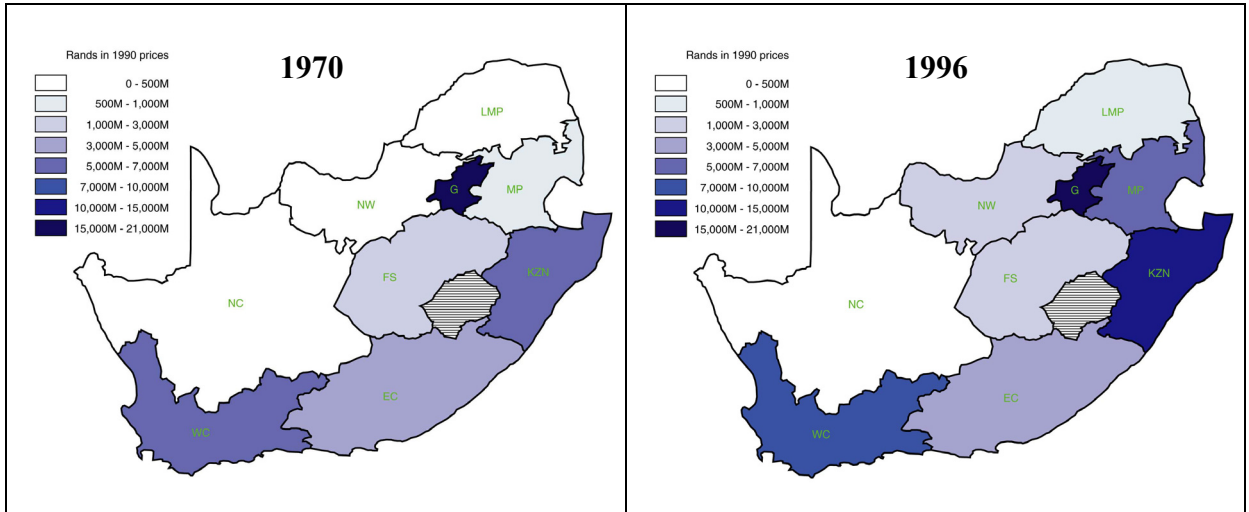
Our data exclude the former TVBC states. LMP=Limpopo; NW=North-West; G=Gauteng; MP=Mpumalanga; NC=Northern Cape; FS=Free State; KZN=KwaZulu-Natal; WC=Western Cape; EC=Eastern Cape.

Figure 2:   Gini coefficients of regional specialisation of the three economically largest provinces with shares > 10% in SA net output, and SA average Ginis
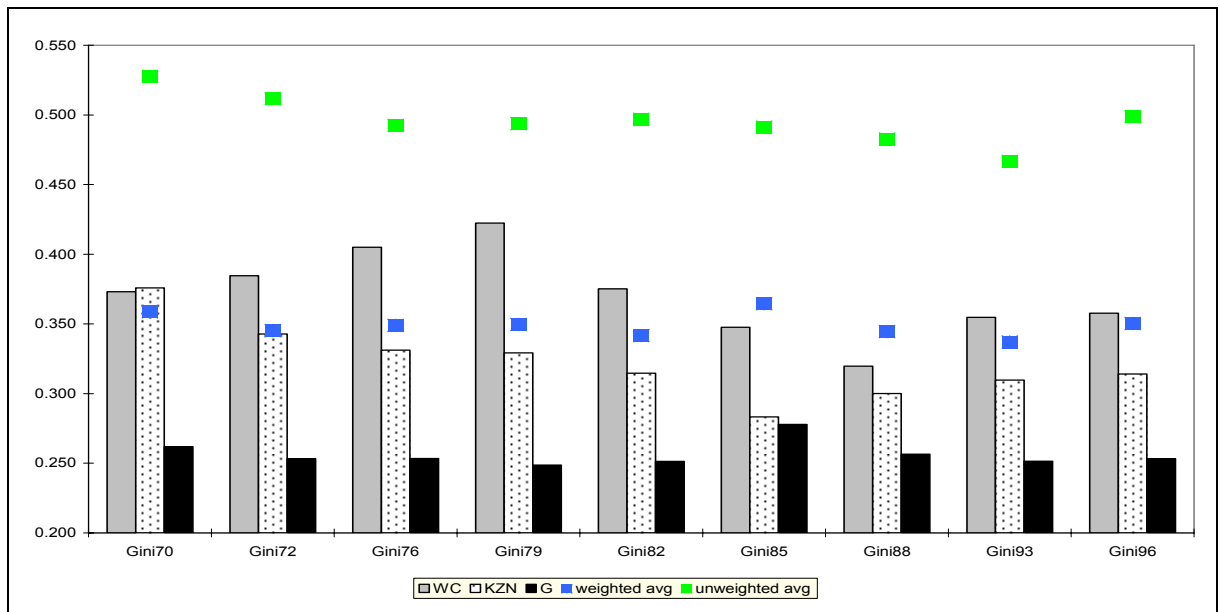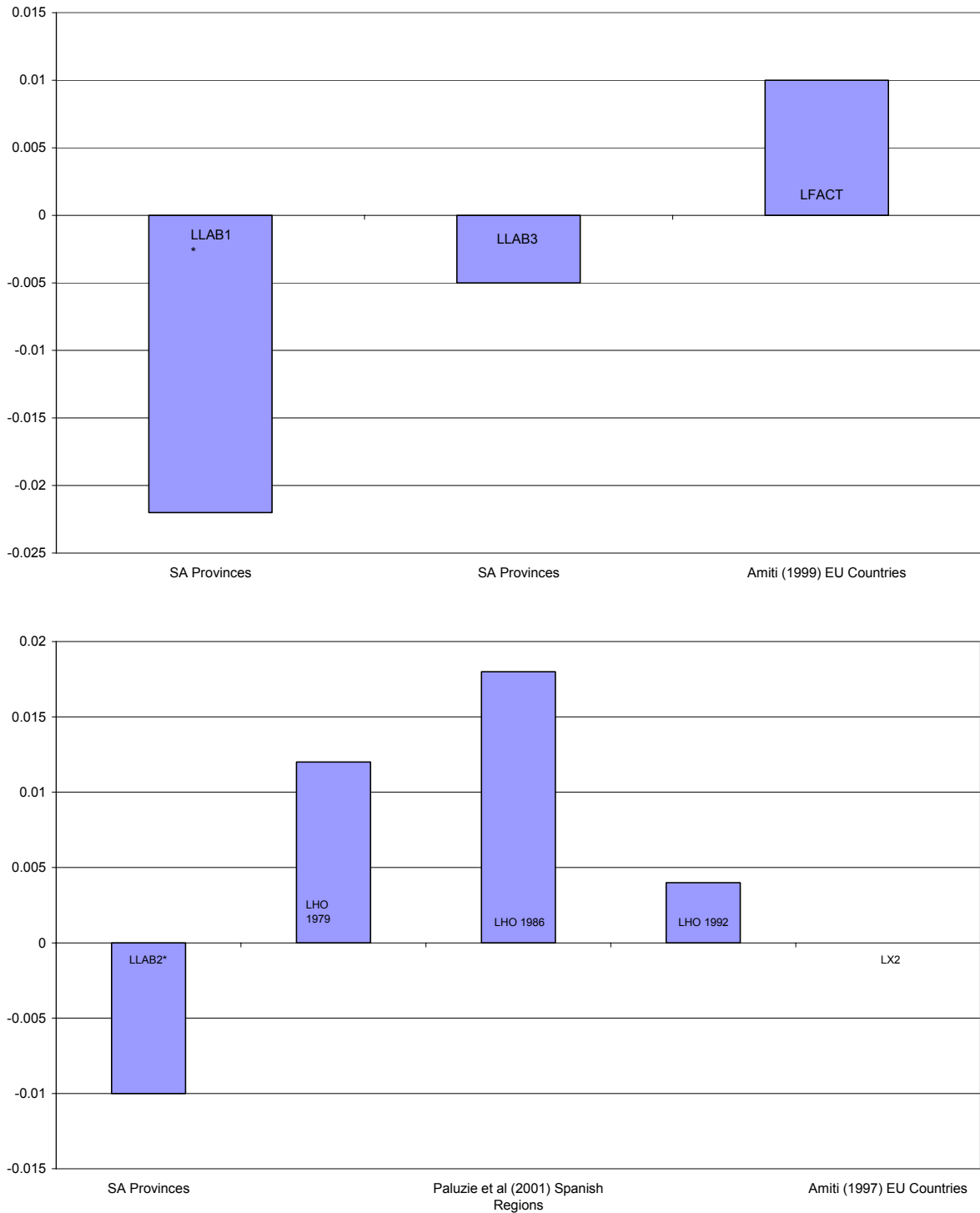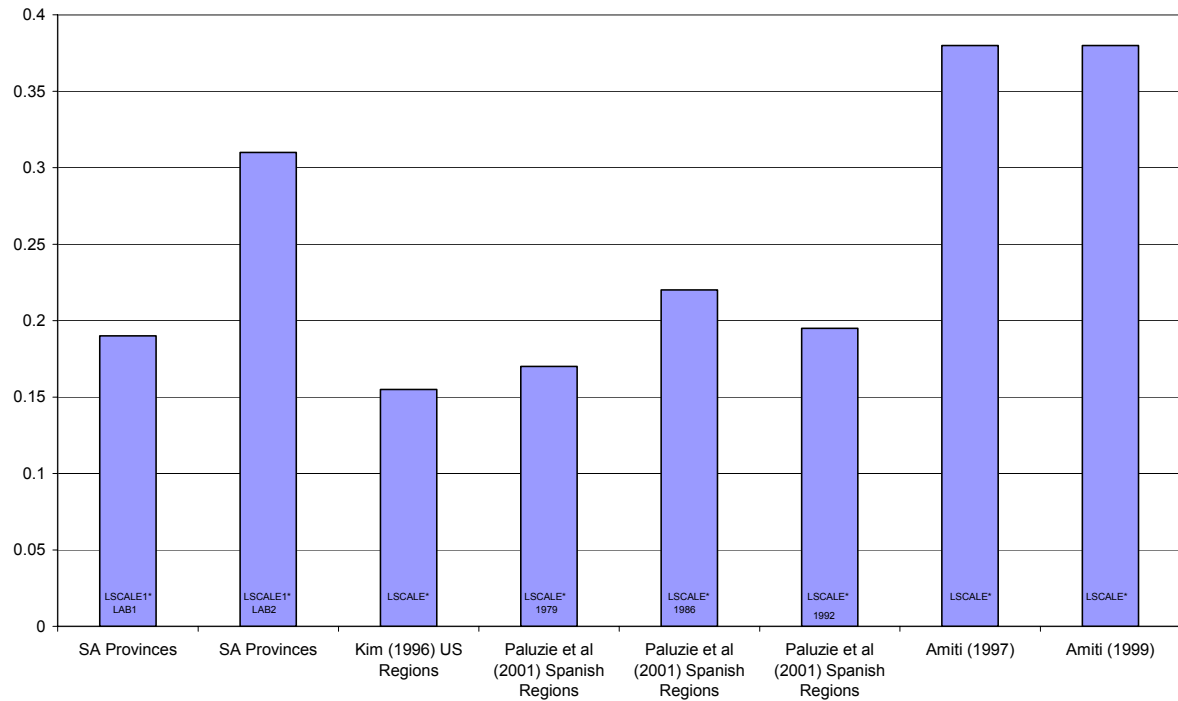
Figure 3: The effect of labour intensity on industry concentration: Elasticities of the geographical Gini in response to a 1% increase in absolute (top) and squared (bottom) deviation of labour-intensity from mean / median

* indicates statistical significance at the 5% level

Results from Haaland et al. (1999) are not included because they use a different index of geographical concentration. LFACT is not strictly comparable with LAB1 and LAB3; it is defined as the absolute deviation of unit labour cost, and not employment per value added, from its mean. From Paluzie et al. (2001) we report coefficients of the 2SLS estimates for NUTS1 regional data. NUTSI is the level of broadest regional aggregation in the European data, therefore most comparable to the SA provinces.
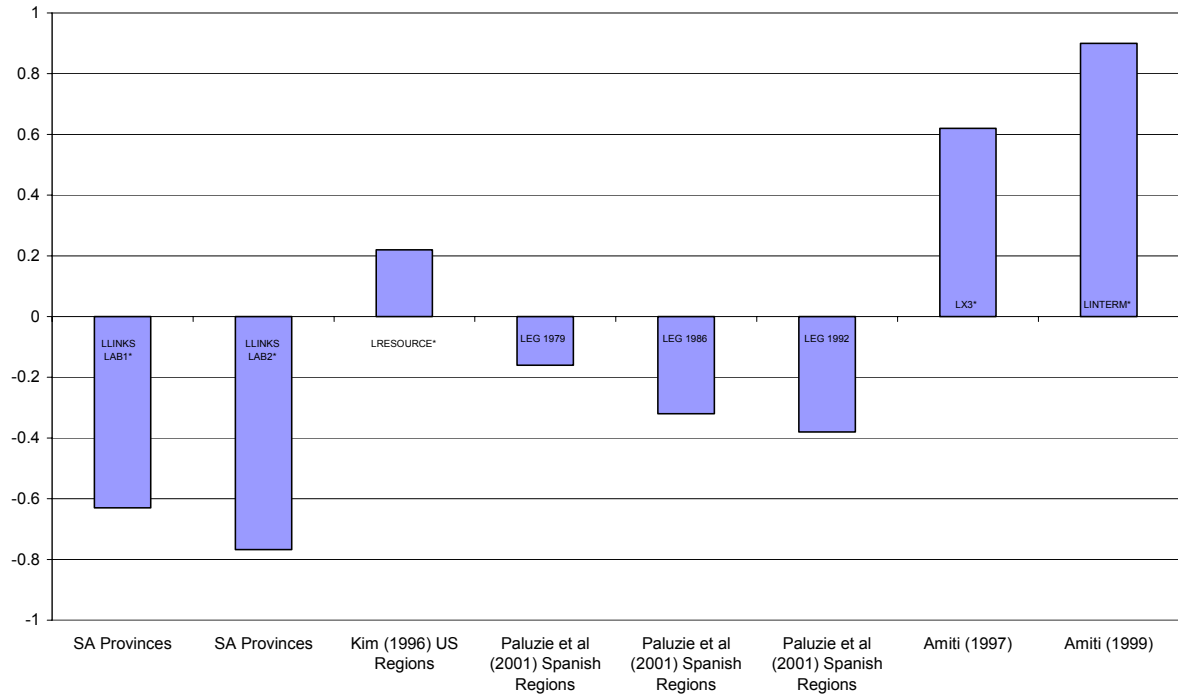
Figure 4: *The effect of scale economies on industry concentration: Elasticities of the geographical Gini in response to a 1% increase in firm-specific internal scale economies*

* indicates statistical significance at the 5% level

Results from Haaland et al. (1999) are not included because they use a different index of geographical concentration. Kim (1996) and Paluzie et al. (1999) divided their measure of scale economies by 10^3, while we divide it by 10^2 and Amiti (1997, 1999) uses the straightforward logged measure. Kim (1996: 901) in fact estimates an unlogged model, but reports an elasticity at the mean of 0.159. From Paluzie et al. (2001) we report coefficients of the 2SLS estimates for NUTS1 regional data.

Figure 5: *The effect of linkages on industry concentration: Elasticities of the geographical Gini in response to a 1% increase in the intensity of intermediate use*

* indicates statistical significance at the 5% level

Results from Haaland et al. (1999) are not included because they use a different index of geographical concentration. Kim (1996: 901) estimates an unlogged model, but reports an elasticity at the mean of 0.223. From Paluzie et al. (2001) we report coefficients of the 2SLS estimates for NUTS1 regional data.

Figure 6:   The effect of technology differences on industry concentration: Elasticities of the geographical Gini in response to a 1% increase in the industry-specific locational productivity advantage
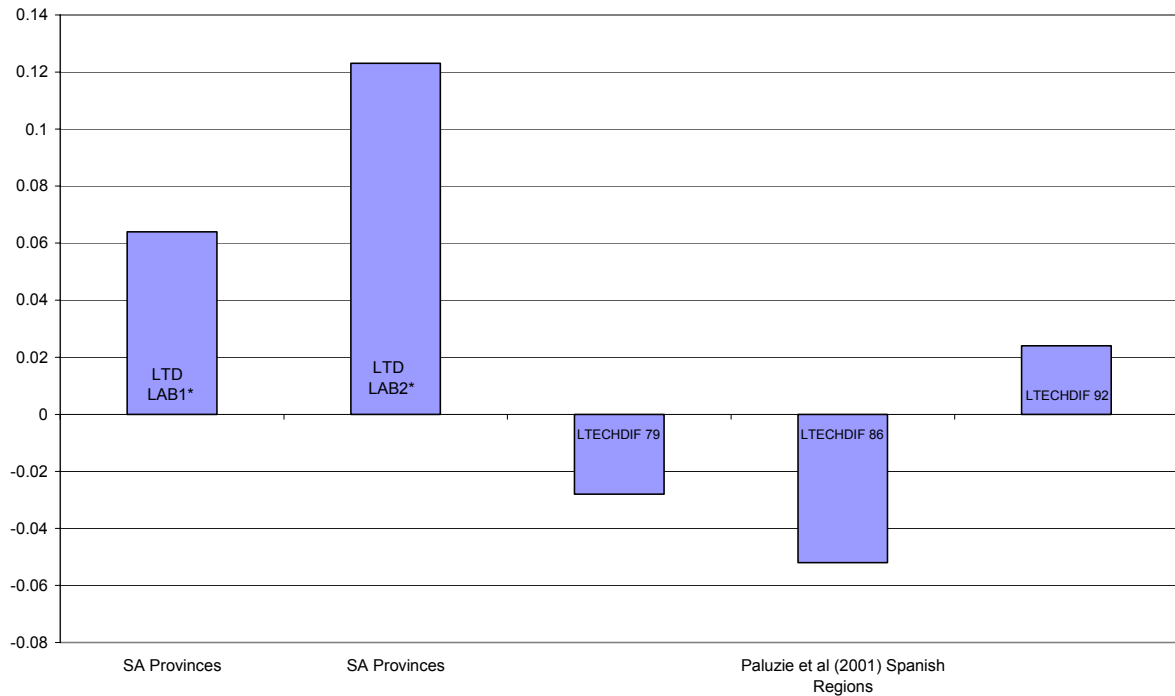
* indicates statistical significance at the 5% level

Results from Haaland et al. (1999) are not included because they use a different index of geographical concentration. From Paluzie et al. (2001) we report coefficients of the 2SLS estimates for NUTS1 regional data.