Productive knowledge, poverty and the entrepreneurial challenges of South African towns

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Stagnant exports per capita and growing poverty in South Africa necessitated an examination of the links between the levels of productive knowledge (measured as enterprise richness), poverty (measured as Enterprise Dependency Indices) and entrepreneurial development (measured as the number of enterprises) in 188 South African towns. Two statistically significant relationships were used to examine groups of towns with different poverty levels: a linear relationship of population size and enterprise numbers, and a power law relationship of population size and enterprise richness. Increased poverty levels severely impact current and future enterprise development, despite the fact that entrepreneurial space develops similarly in wealthy and poor towns. Two broad types of entrepreneurial opportunities were discerned: starting more enterprises of types that are already present in towns, and starting enterprises of types that have not been present before. The latter requires the expansion of productive knowledge. Doubling of productive knowledge (measured as enterprise richness) more than doubles the number of enterprises in towns. The economic growth of towns always requires additional enterprises of types not yet present. This requirement is more stringent in towns with fewer than 100 enterprises, but even in large towns, enterprise growth has a Pareto-like requirement of 20% of new enterprise types. There is evidence of a 'catch-22'-like poverty trap for poor towns: they lack productive knowledge, yet to overcome poverty they need to have productive knowledge. Escaping this trap will be extremely difficult and development plans and policies should heed these findings.

Significance:

- The link between productive knowledge and the wealth/poverty status of South African towns is quantified.
- There is a 'catch-22'-like poverty trap that is difficult to escape in poorer towns.
- These findings can assist in plans to combat poverty.

Introduction

By the end of the 20th century there was a need to address growing levels of urban poverty in Africa, Latin America and much of Asia.[1] South Africa's high aggregate level of income inequality increased between 1993 and 2008, and the same is true of inequality within each of South Africa's four major racial groups. Income poverty had fallen slightly in the aggregate but it persisted at acute levels for the black African and coloured racial groups.[2] Poverty in urban areas had increased.

For more than 50 years, poverty measures in South Africa have taken distributional issues and the causes and implications of deprivation into account.[3] Most South African analyses of poverty have recognised and incorporated its multidimensional nature. Quantitative absolute measurements rely on surveys of income and consumption and on international thresholds, such as one or two dollars per day, which enable cross-country comparisons. However, poverty has also been seen as being relative and the poor as lacking the resources with which to attain a socially acceptable quality of life.[3] A quantitative link between demographic and entrepreneurial characteristics has not been used to study poverty in South African towns.

A range of regularities, which have been interpreted in terms of entrepreneurship, have been recorded in the enterprise dynamics of South African towns.[4-16] These include statistically significant linear regressions between the population and total enterprise numbers in South African towns[4-10] and can be stated as:

$$Enterprises = b(population) + C \qquad \text{Equation 1}$$

The regression coefficient b is:

$$b = \frac{Enterprises}{Population} \qquad \text{Equation 2}$$

Based on an analysis of Eastern Cape Karoo towns, Toerien[13] suggested that the inverse of the regression coefficient, $(1/b)$, which relates to how many persons are associated with the average enterprise in a group of towns (linearly correlated) is a measure of the wealth/poverty status of the group of towns. It is called the Enterprise Dependency Index (EDI):

$$\frac{1}{b} = EDI = \frac{Population}{Enterprises} \qquad \text{Equation 3}$$

More persons per enterprise in a town indicates more poverty, and fewer persons per enterprise, wealthier conditions.

Equation 3 can be restated as:

$$Enterprises = \frac{Population}{EDI} \quad \text{Equation 4}$$

The enterprises in towns are thus related to the magnitude of their populations as well as their wealth/poverty status (indicated by EDI).

Changes in the population of towns are the result of the net growth rate (birth rate minus death rate), in-migration and out-migration. By the time of the first post-apartheid census in 1996, just over half of the South African population lived in urban areas; this number grew to 57.5% by 2001 as there was a movement of people to cities experiencing economic growth.[17] However, in the Gauteng Province, South Africa's dominant migration destination, some 70% of the population growth between 1996 and 2001 was the consequence of natural increases.[18] Natural processes and migration have influenced the population dynamics of South African towns.

The enormous income gaps between rich and poor nations are an expression of the vast differences in productive knowledge amassed by different nations.[19] The differences are expressed in the diversity and sophistication of the products of each of these nations. The social accumulation of productive knowledge has not been a universal phenomenon. It has taken place in some parts of the world, but not in others. Where it has happened, it has underpinned an incredible increase in living standards. Where it has not, living standards resemble those of centuries past.[19] If the level of the productive knowledge of countries determines the economic fates of the countries and their populations, the same should be true for local economies and populations of towns.

A statistically significant log-log relationship (hereafter called a power law) has been recorded between the total enterprise numbers and the number of enterprise types (referred to as enterprise richness, ER) in a large group of South African towns.[15] This relationship has endured over approximately 70 years in a selection of Karoo towns.[16] The economic growth of any South African town, small or large, is therefore dependent on new business ideas and the start-up of enterprise types not yet present in (i.e. new to) the town (Figure 1). As towns grow, a Pareto-like (80:20) division is reached between enterprise types already present and new enterprise types not yet been present in the towns.[15,16]

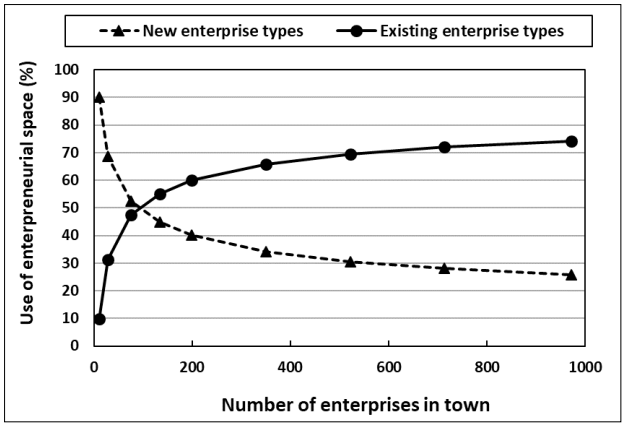

Figure 1: The use of entrepreneurial space in 188 South African towns by two groups of entrepreneurs: those founding new enterprise types and those founding more of existing enterprise types.

An increased ER in a town is, therefore, a direct indication of a higher level of productive knowledge among its residents, and hence its 'entrepreneurial capacity'. Schumpeter[20] said about 'creative destruction':

> [T]*he same process of industrial mutation – if I may use that biological term – that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one.*

Hausmann and Klinger[21] argued that producing new things is quite different from producing more of the same. Florida[22] remarked:

> *Human creativity is the ultimate economic resource. The ability to come up with new ideas and better ways of doing things is ultimately what raises productivity and thus living standards.*

The entrepreneurial well-being of South African towns is clearly connected to the ability to conceive and deliver new products and/or services. ER may serve as a proxy measure of productive knowledge.

The ER relationship can now be restated as:

$$ER = A(Enterprises)^e \quad \text{Equation 5}$$

where A is a constant and e is a coefficient.

Incorporating Equation 4 into Equation 5 results in:

$$ER = A(Population/EDI)^e \quad \text{Equation 6}$$

The reduction of poverty and inequality remain significant problems in South Africa. According to Equation 6, ER is related to the population size of towns and their wealth/poverty status. Based on the ideas of Hausmann et al.[19], higher levels of productive knowledge should, therefore, be quantitatively related to wealthier towns (lower EDIs) and lower levels to poorer towns (higher EDIs). Quantification of the impacts of poverty on entrepreneurial development in South African towns would provide a new way of analysing the poverty problem.

The prime purpose of this contribution is, therefore, to investigate the quantitative links between productive knowledge (measured as ER) and the wealth/poverty status of South African towns (measured as EDIs). In the process, future scenarios of the entrepreneurial evolution of towns of different wealth/poverty status are used to sketch the debilitating impacts of poverty.

Productive knowledge

Wealth and development are related to the complexity that emerges from the interactions between the increasing number of individual activities that constitute an economy.[23] Based on these ideas, Hausmann and co-workers produced the *Harvard MIT Atlas of Economic Complexity and Maps of Paths to Prosperity*.[19] It is based on data extracted from 128 countries representing 99% of world trade. A central tenet of their conclusions is that the differential accumulation of productive knowledge distinguishes between rich and poor countries. These differences are expressed in the diversity and sophistication of the things that each of these nations makes, or in other words, their abilities to produce products and services that have uniqueness. They concluded that productive knowledge to create new products or services is key to economic success and wealth.

Productive knowledge is not available in books or on the Internet but is embedded in brains and human networks. It is tacit and hard to transmit and acquire. It comes more from years of experience than from years of schooling.[19] Hausmann and Klinger[21] suggested that South Africa's stagnant exports per capita over the past 40 years is a consequence in part of the peripheral nature of its productive capabilities: the country is specialised in sectors intensive in highly specific factors of production that cannot be easily redeployed to other activities.[1] In other words, South Africa lacks in productive knowledge.

It is argued here that: (1) the entrepreneurial well-being of South African towns is clearly connected to the abilities of their residents to conceive and deliver new products and/or services, or in other words, connected to the levels of their productive knowledge, (2) ER can be used as a proxy measurement of productive knowledge, and (3) the concepts of ER and productive knowledge provide new ways to examine the socio-economic dynamics of South African towns.

Methods

Experimental design

The links between poverty, productive knowledge and entrepreneurship in South Africa, and internationally, are poorly studied. It is, therefore, necessary to describe how such an investigation was approached in this study. Almost 200 South African towns for which the necessary data were available were selected for the study. The presence of a statistically significant power law between ER and enterprise numbers (see Equation 5) for the total group was confirmed to ensure that the data would support this line of investigation. The resulting power law provided a reference line to examine the entrepreneurial impacts of different poverty levels. The towns were then ranked on the basis of their EDIs and divided into five groups. For the towns in each group it was confirmed that: (1) there was a statistically significant linear relationship between population numbers and enterprise numbers (see Equation 1), (2) the distribution of the EDIs of the towns in each group was not skewed and an average EDI could represent the group, and (3) there was a statistically significant power law relationship between ER and population numbers (according to Equation 6). It was previously shown that the power law relationship between total enterprises and ER has endured over almost 70 years.[16] The possibility that poverty might influence the characteristics of the power law relationship between enterprises and ER (according to Equation 5) was also investigated. Finally, different population growth scenarios were used to sketch the impacts of wealth and poverty on towns.

Selection of towns

A selection of 188 towns was used in this investigation (Tables 1 and 2). The selected towns represent all of the towns with at least 10 enterprises (as recorded in a database) at the time of writing this contribution and represent a broad range of South African towns including towns from most provinces, towns of the former homelands, towns from strong agricultural areas, towns from mining areas, etc. A range of town sizes is also represented (Table 2) but villages with fewer than 10 enterprises were excluded to avoid potential distortions in the analysis.

The towns were ranked on the basis of their EDIs and based on the magnitude of their EDI divided into five groups representing different levels of wealth/poverty. Four groups were about the same in number. The fifth group, representing the poorest towns, had only 19 towns. The groups are: Group 1 – EDIs from 10 to 80 (wealthiest towns); Group 2 – EDIs between 80 and 140; Group 3 – EDIs from 140 to 200; Group 4 – EDIs between 200 and 300; Group 5 – EDIs $\geq$ 300 (poorest towns).

Each of the groups had a spread of population sizes as judged by their minimum and maximum population numbers (Table 2). This spread ruled out the possibility that differences in EDIs might be solely a function of population size. Population sizes had reasonably skewed distributions as judged by the differences between average and median values. This was not the case as far as EDIs were concerned. The average and median EDI values were fairly close, suggesting that the EDIs within groups had reasonably normal distributions. The average EDI could therefore be used to represent each group.

Table 1: Groups and towns analysed

EDI = 10–80, *n* = 45		EDI = 80–140, *n* = 45		EDI = 140–200, *n* = 39		EDI = 200–300, *n* = 41		EDI ≥300, *n* = 19
Albertinia	Montagu	Aliwal North	Merweville	Aberdeen	Hopetown	Barkly West	Memel	Allanridge
Barrydale	Mtubatuba	Augrabies	Middelburg (EC)	Ashton	Jacobsdal	Bloemhof	Noupoort	Arlington
Bethlehem	Napier	Brandvlei	Mookgophong	Badplaas	Kenhardt	Boshof	Oranjeville	Botshabelo
Bonnievale	Nieu Bethesda	Calvinia	Parys	Beaufort West	Komga	Bultfontein	Pearston	Dealesville
Bredasdorp	Nieuwoudtville	Carnarvon	Philippolis	Bethal	Murraysburg	Clocolan	Petrusburg	Dewetsdorp
Caledon	Orania	Colesberg	Phuthaditjhaba	Bethulie	Postmasburg	Deneysville	Phalaborwa	Edenville
Calitzdorp	Oudtshoorn	Cradock	Pofadder	Bothaville	Prieska	Edenburg	Philipstown	Excelsior
Clarens	Porterville	De Aar	Richmond	Brandfort	Reddersburg	Fort Beaufort	Rouxville	Hertzogville
De Rust	Prince Albert	Fraserburg	Robertson	Britstown	Reitz	Fouriesburg	Taung	Lindley
Dullstroom	Queenstown	Garies	Sannieshof	Burgersdorp	Schweizer-Reneke	Griekwastad	Theunissen	Odendaalsrus
Gansbaai	Riversdale	Graaff Reinet	Sasolburg	Christiana	Senekal	Hanover	Tweespruit	Paul Roux
Gariepdam	Riviersonderend	Groblershoop	Somerset East	Daniëlskuil	Smithfield	Hennenman	Ventersburg	Petrus Steyn
Great Brak River	Still Bay	Heidelberg	Steytlerville	Douglas	Springfontein	Jagersfontein	Venterstad	Petrusville
Greyton	Struis Bay	Hotazel	Thabazimbi	Fauresmith	Steynsburg	Jan Kempdorp	Viljoenskroon	Rosendal
Harrismith	Sutherland	Kathu	Thohoyandou	Ficksburg	Strydenburg	Kestell	Villiers	Steynsrus
Hartswater	Swellendam	Keimoes	Trompsburg	Frankfort	Stutterheim	Klipplaat	Virginia	Thaba 'Nchu
Jansenville	Tulbagh	Kroonstad	Upington	Heilbron	Tarkastad	Koffiefontein	Warden	Tweeling
Kakamas	Uniondale	Lady Frere	Victoria West	Hendrina	Wakkerstroom	Koppies	Warrenton	Villiers
Kamieskroon	Vanderkloof	Ladybrand	Vrede	Hofmeyr	Zastron	Luckhoff	Wepener	Vredefort
Kleinmond	Vosburg	Laingsburg	Welkom	Hoopstad		Marquard	Wesselsbron	
Ladismith	Vredendal	Lime Acres	Williston				Winburg	
Loxton	Yzerfontein	Loeriesfontein	Willowmore					
Lutzville		McGregor						

EDI, Enterprise Dependency Index (population needed to 'carry' the average enterprise).

Table 2: The population and Enterprise Dependency Index (EDI) characteristics of the selected groups of towns

		Population				EDI			
EDI Group	**Number**	**Minimum**	**Maximum**	**Average**	**Median**	**Minimum**	**Maximum**	**Average**	**Median**
Total	188	892	211 011	18 473	9099	13.8	1074.3	169.6	148.3
10–80	45	892	76 667	11 675	6372	13.8	79.4	56.8	57.2
80–150	45	1592	211 011	25 017	9680	80.2	139.5	106.6	105.3
150–200	38	2987	71 011	17 099	13 112	143.0	195.1	170.3	170.5
200–300	41	2967	109 468	17 273	11 260	200.1	289.6	235.4	234.7
≥300	19	3935	181 712	24 407	9423	301.9	1074.3	442.6	357.7

Enterprises, enterprise richness and Enterprise Dependency Indices

The enterprises and enterprise types of each of the 188 towns were identified, classified and enumerated as previously described.[4,15,16] Telephone directories (supplemented by Internet searches where necessary) were used for the identification of the enterprises in each town[4] and the enterprises were then enumerated. Enterprise types were determined from a database of more than 500 enterprise types hitherto encountered in South African towns to provide the ER of each town.[15,16]

The towns were allocated to their respective EDI groups and two relationships were determined for each group: (1) the linear relationship between population size and enterprise numbers (see Equation 1), and (2) the power law between ER and the population numbers of the towns (see Equation 6). Microsoft Excel software was used for the calculations.

Wealth/poverty and entrepreneurial spaces

The power laws between ER values and the population numbers (see Equation 6) of the towns of each EDI group were calculated and compared to assess whether wealth/poverty impacts the development of entrepreneurial spaces in towns. The spread of the data points of groups was graphically examined for this purpose.

Scenarios of towns' growth

Scenarios were selected to investigate how towns of different wealth/poverty statuses would respond entrepreneurially to population growth over time. The linking of EDIs (wealth/poverty) and ER (proxy for productive knowledge) was investigated using the linear regression equations of the selected groups of towns to predict enterprise numbers for hypothetical population numbers and using power laws to predict the number of enterprise types for the same hypothetical population numbers in the scenarios. Two growth scenarios (2% per annum and 4% per annum) and two initial population sizes (10 000 and 50 000) were used. To ensure that the growth scenarios were reasonable, a frequency distribution was calculated of the population growth rates between the censuses of 2001 and 2011 of South African towns which had fewer than 200 000 residents in 2001.[24] The median population size of the towns used in this study was 9030. The selection of initial population sizes of 10 000 and 50 000 for the scenarios was considered to be representative of the 'average South African town' in the former case and 'reasonably large towns' in the latter.

Results

Population numbers and enterprise numbers of groups

The linear relationships between the population numbers (independent variables) and enterprise numbers (dependent variables) in the different groups are presented in Table 3. The relationships were all statistically significant at $p<0.01$. There was as expected a gradual lowering of the regression coefficients as the EDIs of groups increased. The group EDIs (=inverses of these coefficients, i.e. persons per enterprise) clearly separated the towns into richer and poorer representatives, thereby enabling comparisons of the impacts of wealth/poverty.

Population numbers and enterprise richness of groups

Previous studies revealed statistically significant relationships between the total enterprise numbers and the number of enterprise types (enterprise richness) in South African towns.[15,16] This study revealed for the first time that there are also statistically significant power law relationships ($p<0.01$) between the population numbers and the enterprise types in towns for each of the groups investigated (Table 3). In contrast to the progressive reduction in linear regression coefficients with increasing poverty levels, the exponential coefficients of the power laws did not show systematic change with increasing poverty levels of the groups (Table 3).

Linking of wealth/poverty and enterprise richness

The frequency distribution of growth rates between 2001 and 2011 of South African towns with more than 15 000 residents is presented in Figure 2. The growth rates are reasonably normally distributed with a peak between 2% and 3% per annum. For the scenarios used here, two growth rates (2% p.a. and 4% p.a.) were selected as being representative of typical (2%) and higher (4%) population growth rates for South African towns.

Table 3: The linear population:enterprises relationship and the power law population:enterprise types relationship of groups of towns with different Enterprise Dependency Indices (EDIs)

		Linear: Population–enterprises			Power law: Population–enterprise richness		
EDI Group	*n*	**Correlation**	**Regression coefficient**	**Intercept**	**Correlation**	**Coefficient**	**Constant**
10–80	45	0.97	0.0136	38.1	0.93	1.2671	42.9
80–140	45	0.98	0.0084	14.3	0.97	1.4422	41.2
140–200	38	0.99	0.0065	-7.3	0.98	1.2378	123.5
200–300	41	1.00	0.0049	-7.7	0.97	1.1944	195.9
>300	19	0.89	0.0012	17.6	0.91	1.4539	143.3

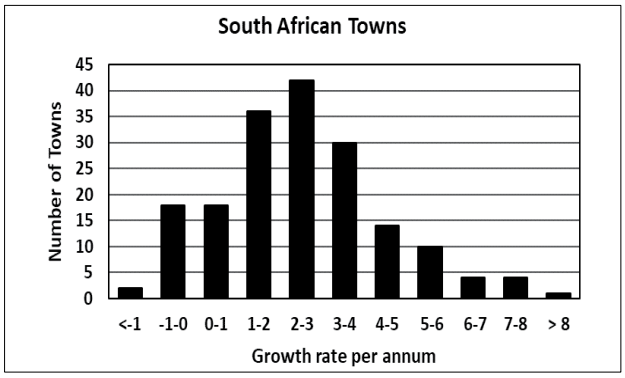

Figure 2: Frequency distribution of population growth rates of South African towns between 2001 and 2011.

It is clear that the poverty status of towns as indicated by rising EDIs has a severe influence on enterprise development, both in terms of total enterprises as well as on the numbers of enterprise types (Table 4). For instance, a rich town (EDI<80) with an initial population of 50 000 residents will have 718 total enterprises and 210 enterprise types. A similarly sized poor town (EDI>300) will have only 79 total enterprises and 47 enterprise types. After 5 years at a growth rate of 2% per annum, the former town will have 774 total enterprises and 222 enterprise types and the latter town only 85 total enterprises and 49 enterprise types. The entrepreneurial challenges of poor towns are clearly different from those of wealthier towns.

Table 5 quantifies the entrepreneurial challenges of towns with different wealth/poverty statuses and different growth rates. As towns grow there are two broad types of opportunities for entrepreneurs to start enterprises: (1) create more of the enterprise types that are already present in these towns, and (2) introduce types that have not yet been successfully started in the town. Larger towns that grow more rapidly will have more of both types of opportunities than smaller towns. These opportunities are severely impacted by poverty as is illustrated in the 10 years column in Table 5.

The prime purpose of this contribution was to investigate if the wealth/poverty status of South African towns is related to their enterprise richness, an indicator of the level of their productive knowledge pools. The results presented in Tables 4 and 5 clearly support this contention. In all scenarios, richer towns are linked to higher numbers of enterprises and more enterprise types. Importantly, the growth of all towns, irrespective of their wealth/poverty status and population sizes, requires entrepreneurs that can 'visualise' new opportunities. In this regard, richer towns benefit more than poorer towns, larger towns benefit more than smaller towns, and towns with higher growth rates benefit more than towns with lower growth rates.

Table 4: Projected increases in total enterprise numbers and the number of enterprise types in towns of two different population sizes and two different growth rates. Year 1 represents the initial conditions. Existing enterprise types = the difference between total enterprise numbers and the number of enterprise types. Higher Enterprise Dependency Indices (EDI) indicate higher poverty levels.

EDIs	Population growth rate	Initial population size	New enterprise types			Total enterprises			Existing enterprise types		
			Year 1	Year 5	Year 10	Year 1	Year 5	Year 10	Year 1	Year 5	Year 10
10–80	2	10000	70	74	79	173	184	200	103	110	121
80–140	2	10000	45	48	51	100	107	117	55	59	66
140–200	2	10000	35	37	40	58	63	71	23	26	31
200–300	2	10000	27	29	31	41	45	51	14	16	20
≥300	2	10000	19	21	21	30	31	32	11	10	11
10–80	4	10000	70	78	89	173	196	231	103	118	142
80–140	4	10000	45	50	57	100	114	136	55	64	79
140–200	4	10000	35	40	46	58	69	86	23	29	40
200–300	4	10000	27	31	36	41	50	62	14	19	26
≥300	4	10000	19	21	23	30	32	35	11	11	12
10–80	2	50000	210	222	238	718	774	851	508	552	613
80–140	2	50000	130	137	146	435	470	517	305	333	371
140–200	2	50000	121	129	139	320	347	383	199	218	244
200–300	2	50000	97	104	112	237	257	285	140	153	173
≥300	2	50000	47	49	52	79	85	92	32	36	40
10–80	4	50000	210	234	268	718	834	1006	508	600	738
80–140	4	50000	130	144	164	435	506	612	305	362	448
140–200	4	50000	121	137	159	320	375	458	199	238	299
200–300	4	50000	97	110	129	237	279	328	140	169	199
≥300	4	50000	47	52	58	79	90	106	32	38	48

EDI = population/total enterprises

Table 5: Projected net increases in total enterprises and enterprise types in South African towns subject to different growth rates and population sizes

EDIs	Population growth rate	Initial population size	New enterprise types		Existing enterprise types	
			Net growth after		Net growth after	
			5 years	10 years	5 years	10 years
25–80	2	10 000	4	9	7	18
80–140	2	10 000	3	6	4	11
140–200	2	10 000	2	5	3	8
200–300	2	10 000	2	4	2	6
≥300	2	10 000	2	2	0	0
25–80	4	10 000	8	19	15	39
80–140	4	10 000	5	12	9	24
140–200	4	10 000	5	11	6	17
200–300	4	10 000	4	9	5	12
≥300	4	10 000	2	4	0	1
25–80	2	50 000	12	28	44	105
80–140	2	50 000	7	16	28	66
140–200	2	50 000	8	18	19	45
200–300	2	50 000	7	15	13	33
≥300	2	50 000	2	5	4	8
25–80	4	50 000	24	58	92	230
80–140	4	50 000	14	34	57	143
140–200	4	50 000	16	38	39	100
200–300	4	50000	13	32	29	59
≥300	4	50000	5	11	6	16

EDI, Enterprise Dependency Index = (population/total enterprises)

Productive knowledge and total enterprise numbers

One issue remains to be resolved. The regression coefficients of linear regression equations relating total enterprises to population sizes are clearly different from one another (Table 3). However, the power law equations relating population sizes and enterprise types did not show systematic differences (Table 3). Yet the wealth/poverty status of towns clearly influences the number of enterprise types in towns (Tables 4 and 5). Against the background of an enduring relationship between enterprise numbers and enterprise types[16], similarities in the development of entrepreneurial space in wealthy and poor towns were investigated. In Figure 3 the spread of the data points of the different groups is superimposed on the power law line calculated from all of the towns used in the study. It is clear that the spread of the data points of the different groups is very similar, i.e. the development of entrepreneurial space is not affected by the wealth/poverty status of towns.

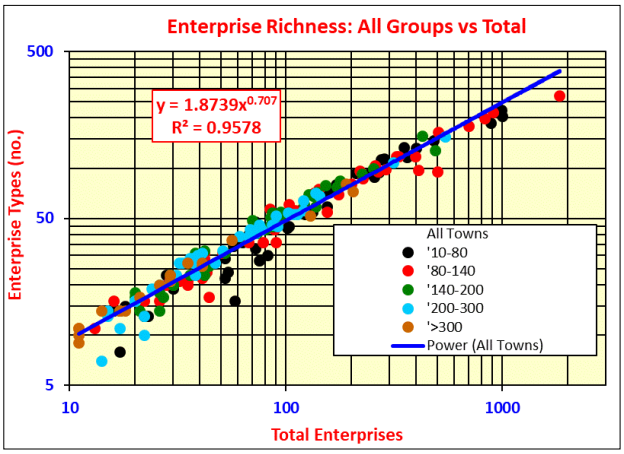

Figure 3: The relationships between total enterprises and enterprise types of the different EDI groups in relation to the power law line of total enterprises versus enterprise types of all the selected towns.

Based on the ideas of Hausmann et al.[19] that economic complexity is expressed in the composition of productive output, it was postulated (see earlier) that the ER of South African towns might be a measure of the productive knowledge embedded in them. In communities with higher levels of productive knowledge, there is a higher chance of the presence of people able to discern business opportunities that can be realised by innovative new combinations of knowledge, skills and other inputs from the community. This reasoning means that productive knowledge could be the driver of the enterprise richness/total enterprises relationship, and not vice versa. Figure 4 incorporates this possibility and presents the productive knowledge/enterprises power law relationship for the towns selected for this study (line in the graph) as well as the distribution of the data points of the different groups in relation to the line.

This power law equation:

$$\text{Enterprises in town} = 0.513(\text{number of enterprise types in town})^{1.3548}, \quad \text{Equation 7}$$

with $r=0.98$ and $n=188$, is statistically highly significant ($p<0.01$). It indicates that for each doubling of ER (i.e. the doubling of productive knowledge), the total enterprise numbers will increase by 2.56 times. This quantifies the expansion of entrepreneurial space, measured in the total number of enterprises when productive knowledge increases in towns. Importantly, this relationship is not affected by the wealth/poverty status of towns (Figure 4). Doubling the productive knowledge of poor towns will also expand the total enterprises by 2.56 times.

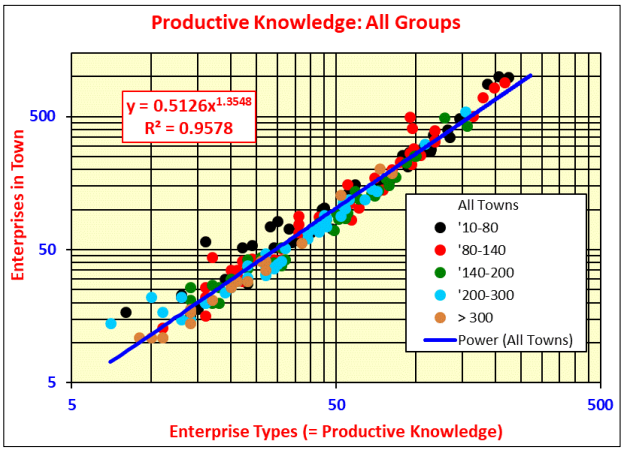

Figure 4: Productive knowledge, measured by the enterprise richness of 188 South African towns, as a driver of the enterprise types–total enterprises relationship.

Equation 7 was used to calculate the entrepreneurial challenges of South African towns in terms of new enterprise types and existing enterprise types (Figure 1). Up to a size of approximately 100 enterprises per town, the growth of towns requires more new enterprise types than existing enterprise types. The linear regression equations of Table 3 indicate that this point will be reached at approximately 7000 persons in the richer towns but only at about 80 000 persons in the poorest towns. This illustrates the impact of the presence of wealth in the population of a town and highlights the 'catch-22'-like poverty trap of poor towns: they are poor because they lack the productive knowledge to produce products or deliver services needed outside their domains. However, to overcome poverty, they need to have productive knowledge!

It must also be kept in mind that the growth of all towns, irrespective of their size, requires entrepreneurs with productive knowledge to start new types of enterprises as well as more enterprises of types already present (Figure 1). Even in very large towns, further growth is dependent on a Pareto-like division between new and existing enterprise types, i.e. about 20% of new enterprises have to be of types that have not yet been present in these towns (requiring higher levels of productive knowledge than before) and 80% must be of types already present in the town (the productive knowledge for this is already present).

Discussion and conclusions

South Africa's exports per capita over the past 40 years have been stagnant because the country is specialised in sectors intensive in highly specific factors of production that cannot be easily redeployed to other activities.[21] Hausmann and co-workers[19] state that countries tend to converge to the level of income that can be supported by the know-how that is embedded in their economies – their so-called productive knowledge. Richer countries have more productive knowledge than poor countries, and vice versa. South Africa has an obvious lack of productive knowledge to move beyond the constraints mentioned above.

Despite a general decline in poverty between 2006 and 2011, poverty levels in South Africa rose in 2015.[25] More than half of South Africans are poor. The National Development Plan[26] considers the development of entrepreneurship to be one of the key developmental issues in overcoming poverty although it admits that early-stage entrepreneurial activity rates in South Africa are about half of what they are in other developing countries.

The possibility of a relationship between poverty and the lack of productive knowledge in South African towns was investigated here. EDIs (i.e. persons per enterprise) proved to be a useful measure of the wealth/poverty status of towns and it clearly separated South African towns into richer and poorer groups (Table 3). For the first time, statistically significant power law relationships between the population numbers and enterprise types of South African towns, including richer and poorer groups, were recorded (Table 4). Similarly sized populations in richer towns can 'carry' many more enterprises than those in poorer towns. Entrepreneurial dynamics and the wealth/poverty status of South African towns are clearly linked. It will be very difficult for poor towns to escape the poverty trap. The ideas of Hausmann and colleagues about the importance of productive knowledge in the economic fate of countries also seem to apply to the economic fate of towns in South Africa.

Previous studies of enterprise richness considered total enterprise numbers as the driver of the total enterprises/enterprise richness power law.[15,16] The present contribution indicates the possibility that enterprise richness could be the driver of an enterprise richness/total enterprises relationship. This statistically significant power law (Figure 4) implies that for each doubling of the number of enterprise types (equals a doubling of productive knowledge), the total enterprise numbers will increase by 2.56 times. This quantifies how entrepreneurial space expands when enterprise richness (=productive knowledge) increases in towns.

Entrepreneurial space develops similarly in wealthy and poor towns (Figures 3 and 4). The growth of towns, irrespective of their wealth/poverty status and their population sizes, requires entrepreneurs who can 'visualise' new opportunities (Figure 1). Two broad types of entrepreneurial opportunities were discerned: (1) starting more enterprises of types that are already present in towns (existing types), and (2) starting enterprises of types not yet present in the towns (new types) (Table 5, Figure 1). The latter requires the expansion of productive knowledge. Larger towns that grow more rapidly will have more of both types of opportunities. Scenario projections indicate that richer towns are linked to higher numbers of enterprises and higher ER values, now and in the future (Tables 4 and 5). Towns with fewer than 100 enterprises will be particularly challenged to start more enterprises of new types than of existing types, and this requires higher levels of productive knowledge. As a consequence, there is a 'catch-22'-like poverty trap for poor towns: they lack productive knowledge, yet to overcome poverty, they need to have productive knowledge. However, even in large towns there is a Pareto-like requirement: 20% of new enterprises must be new types and 80% existing types (Figure 1).

The identity of new enterprise types obviously changes as towns grow larger. For example, in small towns a new enterprise type might occur when the first attorney starts a practice in a town and in larger towns it might be when the first enterprise starts offering back-office services. Examples of existing enterprises might be the second hotel in a town or the second general trader. This aspect requires further research to establish if specific patterns of enterprise development can be discerned.

Two perspectives are available to improve our understanding of the influences of poverty and the lack of productive knowledge on entrepreneurship in, and the growth of, South African towns. In the first, increasing poverty in towns induces a 'slide' down the slope of the line in Figure 3. A poorer town with the same population as a richer town will have less productive knowledge, fewer enterprises and fewer employment opportunities. In the second, towns with fewer enterprise types (i.e. less productive knowledge) will 'slide' down the slope of the line in Figure 4, resulting in fewer enterprises and fewer employment opportunities. These perspectives have potentially crucial implications for local economic development plans to reduce poverty and enhance employment.

Local economic development is a core local government mandate in South Africa.[27] However, despite the significant support it received for nearly 20 years, results have been modest. Nel and Rogerson[27] expressed concern about a potential over-focus on pro-poor local economic development. The 'catch-22'-like trap of poor communities implies that pro-poor local economic development could only be successful if the productive knowledge of these communities is increased. The insightful views of Hausmann and co-workers[19] and the results of this study should be considered when local economic development strategies to address poverty are developed and implemented.

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