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Backbone services as growth enabling factor – an Input-Output analysis for South Africa

Susanne Fricke[*] and Bianka Dettmer[†]

May 2014

Abstract

While previous studies highlight the importance of the manufacturing sector in the economy, we argue that rather backbone services play a key role for economic growth. We perform an Input-Output analysis to determine the linkages between backbone services and manufacturing in South Africa. We find high and evenly spread forward linkages of backbone services to the rest of the economy which indicate strong growth-inducing downstream effects. Moreover, the interconnectedness between backbone services and manufacturing is twofold and depends on the level of technology intensity of industries. Especially the production of high technology goods requires a relatively higher share of inputs from backbone services. Thus, an efficient provision of backbone services is essential to induce manufacturing production and enable economic growth in South Africa.

JEL-Codes: L8, L9, O1, O4, R15

Keywords: Backbone Services, Growth, Input-Output Analysis, South Africa

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1. Introduction

Services are a determining factor for economic growth and multinational activity and they are key linking elements of the fragments of production within Global Value Chains (GVCs). Especially, infrastructure related backbone services play an important role. Backbone services in general comprise energy supply, communication, distribution, transportation, finance and insurance services and form the foundation of the economy[3]. According to Hoekman (2006), the competitiveness of domestic firms in open economies is largely driven by low-cost and high-quality services since fragmentation of production depends on the access to and the costs of these services. Barriers to an efficient provision of backbone services would be detrimental for the performance of other domestic sectors and industries and a country's potential for participation in Global Value Chains (Miroudot 2009). With a share of 69 % of GDP (in 2012) (WTO 2014) services are a main source of economic growth and employment creation (Draper et al. 2008). But despite that, South Africa has been stuck in the range of middle income countries for over 4 decades, facing stagnant growth with an extremely high unemployment rate (Felipe et al. 2012; Cattaneo 2011).

Therefore, South Africa adopted a careful approach to services liberalization (UNCTAD 2005). At the multilateral level, South Africa undertook relatively extensive commitments within the General Agreement on Trade in Services (GATS) (Cattaneo 2011). However, since 2000 South Africa's multilateral negotiations on trade in services have decelerated (Cattaneo 2011). Domestically, the South African government recognized the growth potential of services (Steuart and Cassim 2005) and, in 2010, launched the *Trade Policy and Strategy Framework* which emphasizes the role of services for the facilitation and support of the manufacturing, mining and agricultural sector (Cattaneo 2011). Nevertheless, South Africa still suffers from expensive and relatively inefficient backbone services, especially in the field of telecommunications and transport and by shortages in energy supply (see OECD Indicators of Product Market Regulation (OECD 2011a)). These backbone services are amongst the most protected sectors in terms of regulation, licenses and state participation (Draper et al. 2008) and tend to be considerably restricted towards foreign investments (UNCTAD 2006). A pro-competitive change in the market structure and new investments are crucial, since backbone services provide key inputs for manufacturing industries and, hence, influence the competitiveness of the economy substantially (Draper et al. 2008; Steuart and Cassim 2005).

[3] The definition of backbone services is comparable with other studies addressing the relevance of these services, such as Sakho and Walkenhorst (2008) or Andriamananjara et al. (2009).

However, it seems difficult to enforce the opening of the backbone services sectors. According to Draper et al. (2008), the South African government fears that services liberalization has contributed to the relatively poor manufacturing performance with a high unemployment rate which, in turn, led to the relative reluctance to opening services markets. Quite the contrary, the government points to the need of applying advanced manufacturing technologies in order to gain competitive advantage in global markets (Department of Science and Technology 2005, p. 31). In light of the highly restricted backbone services and the concurrent emphasis on the importance of manufacturing strengthening, studies addressing the relevance of backbone services for, and their interconnectedness with, manufacturing are scarce. To the best of our knowledge, Tregenna (2008), as an exception, analyzes linkages between services and manufacturing sectors based on the South African Input-Output tables. Although the focus lies on the manufacturing sector as the engine of growth, she concludes that an effective manufacturing strategy requires an efficient service-provision Moreover, the interaction of backbone services provision and manufacturing industries is indispensable in order to derive a comprehensive development strategy for the South African economy (Cattaneo 2011). In this paper we analyze the linkages between backbone services and manufacturing sectors in South Africa. We account for the high heterogeneity within both services and manufacturing sectors by focusing on a more disaggregated level of analysis and distinguishing industries by their technology intensity.[4] The paper is structured as follows. The next section describes the theoretical background and derives the hypotheses based on an overview on the relevant literature. Section 3 proposes the analytical framework and data sources. Empirical evidence is presented in section 4. The last section concludes the paper with policy implications.

2. Theoretical Background and Hypotheses

Evaluating the role of specific sectors both within the economy as a whole and within the inter-sectoral system can be done using input-output analysis which is primarily developed by Wassily Leontief (1936). By means of analyzing inter-sectoral transaction flows it mainly considers the interconnectedness between specific sectors (Miller and Blair 2009). The role of linkages to other sectors of the economy is of significant importance. According to Tregenna (2008), backward and forward linkages are two main mechanisms through which growth in

[4] Throughout the rest of the paper the services communication, distribution, transportation and finance and insurance are included in the term backbone services. Energy and water supply is excluded due to data constraints.

one sector affects the growth of the economy as a whole and of other sectors in particular. Backward linkages create additional demand and production in upstream sectors which in turn leads to increased upstream investment, higher levels of capacity utilization and possible technological upgrading. Forward linkages, on the other hand, yield growth-inducing downstream effects, comprising downstream investments, technological upgrading or increased productivity (Tregenna 2008).

In his theoretical foundation of inter-industrial linkage analysis, Hirschman (1959) attributes more importance to backward linkages than to forward linkages. Accordingly, derived demand by backward linkages is more effective in activating decisions and employment than induced supply by forward linkages (Park 1989). Hirschman (1959) further argues that forward linkages cannot exist in pure form since they are a result of demand emanating from existing backward linkages. The existence of demand is therefore a condition for forward linkages (Hirschman 1959). Accordingly, he states that forward linkages can be considered a powerful reinforcement of backward linkages. This consideration leads to the differentiation between industries that *induce* economic development via backward linkages and industries that *enable* economic development via forward linkages.

Jones (1976) states that an expansion of a high forward linked sector may not necessarily lead to growth of downstream sectors since the sector's expansion may take place more as a result of demand generated by the user's backward linkages. This consideration is in line with Hirschman's explanation of economic priority of backward linkages (Hirschman 1959). Jones (1976) argues that it is necessary to distinguish between *causal* and *permissive* linkages. Thus, high forward linkages are still of economic importance since they are necessary in a permissive sense. In the absence of response of these linkages to the user's demand, constraints on the development of the users would emerge (Jones 1976). This consideration is similar to the above mentioned sectoral functions of forward linkages as enablers of economic development.

The literature so far has applied input-output analysis mainly to figure out general inter-sectoral linkages and specifically the role of manufacturing in industrial and emerging economies (see Kowalewski (2013) for Germany, Bharadwaj and Chadha (1991) for India, Andreosso-O'Callaghan and Yue (2004) and Heimler (1991) for China and Egilmez et al. (2013) for the USA). Since sectoral interdependence is largely the result of industrialization, high degrees of sectoral linkages indicate a relatively high level of development (see Hirschman 1959 for theoretical explanation and Yotopoulos and Nugent 1973 for empirical confirmation). In addition, Park (1989) concludes that the intermediate demand for services

increases with the country's stage of industrialization. This is mainly due to a relatively high income elasticity of services. However, he mainly ascribes income-induced demand to services such as health, education and tourism (Park 1989). Comparing studies addressing inter-sectoral linkages by means of an input-output analysis is somewhat tricky due to differing levels of sectoral aggregation and sectoral classifications. The aggregation level influences the results and sectoral classification the interpretation of the linkages. These considerations should be kept in mind when depicting comparative studies. The development level of the analyzed countries in comparable studies influences their results substantially. Therefore, studies selected for comparison below mainly focus on results from other emerging economies.

Based on Indian Input-Output tables for 1989-99, Singh (2006) finds relatively high forward and backward linkages of services to the rest of the economy. In a more disaggregated Input-Output analysis for the Indian economy for 1993-94, Hansda (2001) finds as well both high backward and forward linkages of services. He especially emphasizes the role of retail trade and transport services. He concludes that the services sectors' purchases from other sectors (i.e. backward linkages) are highly concentrated to a small segment of the economic sectors. However, forward linkages of the Indian services sectors are more evenly spread within the inter-industry system, suggesting evenly spread supplies from services sectors to the other sectors (Hansda 2001). This deviation between the evenness of backward and forward linkages implies that the respective services are inputs of general purpose for all the sectors of the economy but require specialized inputs from only a few industries (Singh 2006). These implications lead to the following hypothesis concerning the role of backbone services within the South African economy:

Hypothesis 1: Backbone services reveal higher and more evenly spread forward linkages to the other sectors of the South African economy than it is the case for backward linkages.

On the basis of backward and forward linkages assessment, key sectors can be evaluated. Singh (2006) concludes for the Indian economy, that electricity, gas and water supply are the leading sectors with a substantial growth impact[5]. Moreover, he confirms that the services sub-sectors 'trade', 'transportation' and 'communication' are particularly important for the Indian economy. This coincides highly with the sectors included in backbone services as

[5] However, due to data constraints, energy and water supply are not included in the clustering of the backbone services in our analysis.

applied in this paper (see footnote 2). Based on Iran's 2001 input-output table, Salami (2012) finds that manufacturing is a key sector of the whole economy whereas services are a key forward oriented sector. For South Africa, Tregenna (2008) reports stronger forward linkages from services to manufacturing than vice versa. She concludes that the strength of the backward linkages from manufacturing to services and the high forward linkages from services to manufacturing imply that cost and quality of services inputs into the manufacturing sector are crucial for its competitiveness (Tregenna 2008). This is leading to our second hypothesis:

Hypothesis 2 Backbone services are key forward oriented services sectors for the South African economy.

Shedding more light on the interconnectedness between manufacturing and services, Park (1989) finds for the Pacific Basin countries that the manufacturing's backward linkages to services are generally higher than its backward linkages to other sectors of the economy. He argues that the *expansion of services* is needed to meet growing intermediate demand coming from the manufacturing sector (Park 1989). At the same time, he concludes that the services sector could not expand its output without the respective support by the manufacturing sector (Park 1989). In line with that, Kaur et al. (2009) find for the Indian economy that services are 'manufacturing-intensive' (Kaur et al. 2009). Based on the examination of inter-sectoral linkages for South Africa in the period 1980 to 2005, Tregenna (2008) concludes that manufacturing and services are roughly equally dependent on each other. In particular, 'transport' and 'community, social and personnel services' are dependent on manufacturing inputs. When excluding imported intermediates from the analysis, the manufacturing sector appears to be more dependent on services inputs provided by domestic producers than vice versa (Tregenna 2008).

Furthermore, a number of studies confirm a positive impact of an expansion of services and especially of Foreign Direct Investments (FDI) in services on the productivity of manufacturing firms (Arnold et al. (2011) for the Czech Republic, Fernandes and Paunov (2012) for Chile, Arnold et al. (2012) for India and Arnold et al. (2006) for Sub Saharan Africa). Whereas existing studies considered manufacturing at a highly aggregated level, an analysis at a more disaggregated level i.e. clustering manufacturing industries by technology-intensity, will be more revealing.

Studies addressing the interconnectedness of services and manufacturing accounting for the level of technology-intensity of manufacturing sectors are scarce. Providing cross-country evidence for 78 countries, Francois and Woerz (2007) find that open producer services (including communication, financial, insurance, business and transportation services) have a positive effect on skill- and technology-intensive manufacturing industries. Services included in the term producer services partly overlap with the ones classified as backbone services in our paper. Francois and Woerz (2007) conclude that the protection of producer services places the manufacturing firms at a comparative disadvantage (Francois and Woerz 2007). This is insofar relevant for the South African economy, since high technology-intensive manufacturing sectors yields important growth opportunities by means of knowledge spillovers and increased attractiveness to foreign investors (Olteanu 2006). As a consequence, liberalizing backbone services in the South African economy can be even more growth *inducing* when high-technology manufacturing industries demand backbone services as inputs into production. Moreover, when production of high-technology intensive sectors depends on services inputs by more than production of other i.e. low technology industrial sectors than small and careful steps towards service liberalization (as done by the South African Government) will not be sufficient to increase production in high technology sectors and activate the spillover channels associated with it. Yet, an analysis addressing the interconnectedness of backbone services and manufacturing sub-sectors clustered by the level of technology-intensity has not been made. We expect that:

Hypothesis 3: The industries' dependence on backbone service inputs increases with the technology-intensity of manufacturing sectors.

The hypotheses are evaluated using input-output analysis. The appropriate parameters measuring the interconnectedness between backbone services and manufacturing sectors are input- and output coefficients. The next section briefly describes the analytical framework.

3. Analytical Framework

3.1 Input-Output Analysis

Flows of goods and services within an economy are illustrated by Input-Output tables, building the basis for the analysis[6] (European Commission 2008). This study analyzes Input-Output tables based on the *static open quantity model* (for theoretical foundations see Holub and Schnabl 1994 and Miller and Blair 2009)[7]. The two basic models for analyzing Input-Output tables are the Leontief (1936) and Ghosh (1958) approaches. Leontief's (1936) approach is a demand-driven model and relates sectoral gross outputs to the final demand, which comprises consumption, investment and exports. It thus focuses on units of a product *leaving* the inter-industry system. By contrast, Ghosh (1958) developed a supply-driven model which relates sectoral gross production to primary inputs and to units *entering* the inter-industry system in the beginning of the production process (Miller and Blair 2009). On the basis of these two approaches, inter-sectoral backward and forward linkages and their relative evenness within the economy, economic key sectors as well as sectoral coefficients illustrating input requirements and output distribution can be assessed.

An important aspect in the calculation of inter-sectoral linkages is the treatment of *intra*-sectoral transactions. In order to specifically measure a sector's backward or forward linkage to exclusively the rest of the economy it is useful to omit intra-sectoral transactions and hence the on-diagonal elements. Calculating on the basis of omitted on-diagonal elements is called the *net* approach (Miller and Blair 2009). In this study we apply the net approach since we are interested in the pure linkages between backbone services and manufacturing.

Backward and Forward Linkages: The power and sensitivity of dispersion indicators

Backward linkages represent the strength by which sector j's production depends on inter-sectoral inputs (Miller and Blair 2009). A first attempt to supply a quantitative evaluation of this linkage was made by Chenery and Watanabe (1958) [8], who suggest using the column

[6] Input-Output analysis is based on two basic assumptions: the existence of constant returns to scale and the non-substitutability of inputs within the production process. Both assumptions are deployed on the grounds of practicability (Christ 1955).

[7] Importantly, all comparative studies cited by this paper apply as well the Input-Output analysis based on a static and open model, as it is the case in this study.

[8] The Leontief model is a set of linear equations, written in matrix representation by: $\mathrm{x} = (\mathrm{I} - \mathrm{A})^{-1}\mathrm{f}$ with x as a $1xn$ column vector of the gross output of the x industries; f is the $1xn$ final demand column vector; I is a nxn identity matrix and A is a nxn matrix of *direct input coefficients* with $A = [a_{ij}]$. (Miller and Blair 2009, p. 21).

sums of the direct input coefficient matrix A as a measure of *direct* sectoral *backward* linkages, thus $BL_j^{CW} = \sum_{i=1}^{n} a_{ij}$. (1)

A *total* measure of *backward* linkages, comprising both direct and indirect effects has been suggested by Rasmussen (1956). Total backward linkages represent the change in economy-wide output in case the final demand for a particular sector increases by one unit (Miller and Blair 2009). The total backward linkage of sector j is defined as the column sum of the Leontief inverse L, thus ($BL_j^R = \sum_{i=1}^{n} l_{ij}$) (Miller and Blair 2009) [9]. For a reliable comparison of sectoral backward linkages, normalizations are useful (Miller and Blair 2009). Accordingly, Rasmussen (1956) developed the index of *power of dispersion*. It reflects the relative extent to which an increase in final demand for the products of industry j is dispersed throughout the total inter-industry system (Drejer 2002). It is described as:

$$\sum_i U_{ij} = \frac{\frac{1}{n}\sum_i l_{ij}}{\frac{1}{n^2}\sum_{ij} l_{ij}}\,, \quad (2)$$

with $\sum_i l_{ij}$ as the column sums of the Leontief inverse (Drejer 2002). Sectors with above average backward linkage reveal indices greater than one, indicating a strong integration with the rest of the economy. Those with below average linkages reveal indices lower than one (Miller and Blair 2009).

Similar to direct backward linkages, Chenery and Watanabe (1958) suggest a *direct forward* linkage index which is defined as the row sums of the direct output coefficient matrix B, thus $FL_i^{CW} = \sum_{j=1}^{n} b_{ij}$ (3)

(Miller and Blair 2009) [10]. For calculating *total forward* linkages, Rasmussen (1956) also developed a normalized index which describes the extent to which the total inter-industry system depends on the particular sector i. This index is called *sensitivity of dispersion*. The index measures the increase in production of industry i in the course of an additional unit of primary input for total industries (Drejer 2002). It is defined as:

$$\sum_j U_{ij} = \frac{\frac{1}{n}\sum_j l_{ij}}{\frac{1}{n^2}\sum_{ij} l_{ij}}\,, \quad (4)$$

with $\sum_j l_{ij}$ as the row sums of the Leontief inverse (Drejer 2002). To confirm Hypothesis 1, we expect backbone services to reveal higher forward linkages than backward linkages,

[9] L is denoted as: L = $(I - A)^{-1}$ with $(I - A)^{-1}$ as the Leontief inverse (Holub and Schnabl 1994, p. 102-104).

[10] Similarly, the Ghosh model is a set of linear equations. By contrast, it is given by: x' = $(I - B)^{-1}$ v', with x' as the transpose of the $nx1$ output vector and v' as the transposed $nx1$ vector of primary inputs. $B = [b_{ij}]$ denotes a matrix of direct output coefficients (Miller and Blair 2009).

reflected by greater values of the sensitivity of dispersion indices than the values of the power of dispersion indices.

Robustness measure:

As an *alternative approach* for the calculation of *total forward* linkages, Jones (1976) proposes to utilize the Ghosh inverse $G = [g_{ij}]$ for the calculation of forward linkages[11]. He argues that using the Leontief inverse twice, both as a measure of total backward and total forward linkages involves a problem of double counting causal linkages, inasmuch as sales from sector i to sector j are recorded as i's forward linkage and j's backward linkage. But only one of these linkages can be effectively causal. Using the Ghosh inverse as a measure of total forward linkages avoids this problem (Andreosso-O'Callaghan and Yuen 2004). Accordingly, total forward linkages are defined as the row sums of G, thus ($FL_i = \sum_{j=1}^{n} g_{ij}$) According to Rasmussen's sensitivity of dispersion index, forward linkages based on the Ghosh inverse can be normalized (following Miller and Blair 2009) correspondingly:

$$\sum_j U_{ij} = \frac{\frac{1}{n}\sum_j g_{ij}}{\frac{1}{n^2}\sum_{ij} g_{ij}}, \qquad (5)$$

Relative Evenness of Inter-sectoral Linkages: The variation indicators

An additional aspect of importance is that both backward and forward linkages are sensitive to extreme values. In case a sector buys large amounts only from few of the sectors within the economy, it still denotes high backward linkages. The same is the case for forward linkages (Hansda 2001). Thus, the drawback of these indices is the lack of representing how evenly one sector draws on the other ones (Salami et al. 2012). As an index of the relative evenness of a sectors' purchases or sells to other sectors, Rasmussen (1956) developed the *variation indices,* based on total linkages. The variation index of backward linkages is based on the elements of the Leontief inverse l_{ij} and is calculated as follows:

$$V_b = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(l_{ij} - \left(\frac{1}{n}\right)\sum_{i=1}^{n} l_{ij}\right)^2}}{\frac{1}{n}\sum_{i=1}^{n} l_{ij}} \qquad (6)$$

(Salami et al. 2012). The variation index for forward linkages can be also calculated according to the Rasmussen method based on the Leontief inverse, as depicted by equation

[11] G is denoted by $G = (I - B)^{-1}$ with $(I - B)^{-1}$ as the Gosh inverse (Miller and Blair 2009).

(6). Alternatively it can be assessed according to Jones' method based on the Ghosh inverse, as illustrated by equation (7).

$$V_{fL} = \frac{\sqrt{\frac{1}{n}\sum_{j=1}^{n}\left(l_{ij} - \left(\frac{1}{n}\right)\sum_{j=1}^{n} l_{ij}\right)^2}}{\frac{1}{n}\sum_{j=1}^{n} l_{ij}} \quad (7)$$

$$V_{fG} = \frac{\sqrt{\frac{1}{n}\sum_{j=1}^{n}\left(g_{ij} - \left(\frac{1}{n}\right)\sum_{j=1}^{n} g_{ij}\right)^2}}{\frac{1}{n}\sum_{j=1}^{n} g_{ij}} \quad (8)$$

(Rasmussen 1956; Salami et al. 2012). A relatively large value of the backward variation index indicates that sector i purchases its inputs from only a few other sectors. Relatively large values of the forward variation index reflect that sector *j* sells outputs only to a few sectors within the economy (Hansda 2001). According to hypothesis 1, forward linkages of backbone services are expected to be more evenly spread than the respective backward linkages. We therefore expect lower coefficients on the forward variation index than the respective coefficients on the backward variation index.

Key Sectors

On the basis of the linkage calculations and their relative evenness, it is possible to identify key services. Salami's (2012) approach of determining key sectors is therefore convenient. This approach is treating total backward and total forward linkages separately subtracting their respective variation indices. Sectors with high linkage indices and low variation indices can be regarded as key sectors since they reveal strong and evenly spread linkages to the other sectors of the economy (Salami et al. 2012). It implies a differentiated identification of key sectors split into key backward and key forward linked sectors. We expect backbone services to have strong and evenly spread forward linkages to the other sectors of the South African economy in order to confirm backbone services as key forward oriented sectors, as stated in Hypothesis 2.

Input and Output Coefficients

Input coefficients address the demand side by representing sectoral input requirements. These requirements are expressed both as direct requirements from another sector and as indirect requirements, which take account of indirectly required inputs to a sector. *Direct input coefficients* $[a_{ij}]$ are calculated on the basis of the Leontief model and are as well called

technical coefficients. They denote the share of intermediate products of sector i bought by sector j in the given point in time and are thus calculated by $a_{ij} = z_{ij}/x_j$, with z_{ij} as intermediate sales from sector i to j and x_j as inputs into sector j. In monetary terms, they depict the currency unit's worth of inputs from sector i per currency unit's worth of output of sector j (Miller and Blair 2009). By contrast, *total input requirements* $[l_{ij}]$ comprising direct and indirect ones are calculated on the basis of the Leontief inverse, where the elements l_{ij} illustrate the changes of outputs from sector i both directly and indirectly necessary to produce one additional unit of sector j (Holub and Schnabl 1994).

Output coefficients however, address the supply side by illustrating the distribution of a sector's sales to the other sectors of the economy. Their calculation is based on the Ghosh model. *Direct output coefficients* $[b_{ij}]$, calculated by $b_{ij} = z_{ij}/x_i$ represent the distribution of sector i's output across sector j. Accordingly, they are called *allocation coefficients* (European Commission 2008; Miller and Blair 2009). Analogous to the Leontief inverse, the *Ghosh inverse* G = $[g_{ij}]$ with its elements g_{ij} depicts *total output coefficients* (direct and indirect), representing the induced value of production in sector j per unit of primary input in sector i (Miller and Blair 2009).

According to Hypothesis 3, we expect the interconnectedness between backbone services and manufacturing varies with the level of technology in the manufacturing sector. If so, we will find higher (backbone service) input coefficients in high-technology industrial sectors which depend more on backbone service inputs than other i.e. low technology intensive sectors.

3.2 Data

Input-Output tables of the South African economy are obtained from the OECD Input-Output table database (OECD 2012). The tables reveal inter-industrial transactions in Millions of Rand, the South African national currency. For each of the three years, transaction flows are distinguished according to the intermediates' origin (domestic, imported, total). Sectors are classified according to the United Nations' *International Standard Industry Classification of All Economic Activities, Revision 4* (ISIC Rev. 4) (OECD 2012). Tables for South Africa designate 48 sectors of industry and are available for three points in time: the years of 1993, 2000 and 2005.However, for the years of 1993 and 2000, 12 out of the initial 48 sectors do

not report data while in the year 2005, 22 out of the 48 sectors had to be deleted.[12] In light of the high deletion rate of sectors for the year 2005, this year will not be considered in this study due to a resulting bias and a lack in comparability with the other two years. Thus, the analysis is based on the tables of 1993 and 2000 which reveal 36 out of the 48 sectors for each year (see Annex 1).

Transaction flows in input-output tables are reported at different levels of sectoral aggregation. The 36 sectors display the economic activities at a relatively disaggregated level. The data processing for testing the hypotheses comprises several steps. First, the 36 sectors are pooled to broader industries which are in turn broken down to a more disaggregated level.[13] The clustering of manufacturing and services sectors is shown in Annex 1. This is based on the *United Nations' International Standard Industrial Classification of All Economic Activities, Revision 4* (ISIC Rev. 4).[14] Out of the 36 initial sectors for which data is available, 20 sectors belong to the ISISC Rev. 4 manufacturing sector while 11 services sectors correspond one on one with ISIC Rev. 4, when 'electricity' and 'water supply' is considered separately[15] (see Annex 1)[16].

Following the first step, we focus on the importance of backbone services and cluster services according to the *Services Sectoral Classification List* of the WTO (WTO 1991) (see Annex 2). Subsequently, four sectors are classified as backbone services: *'wholesale and retail trade; repairs'*, *'land transport; transport via pipelines'*, *'post and telecommunications'* and *'finance and insurance'*. Out of the remaining services 'hotels and restaurants', 'real estate activities', 'other business activities', 'health and social work', 'other community, social and personal services' are pooled together to professional services. The services 'construction'

[12] For analytical purposes the principles of basic matrix algebra must be considered. A vital step in Input-Output analysis is the inversion of matrices. Matrices containing only zeros either in a row or a column cannot be inverted (Anton 2010). Therefore, sectors containing only zeros both in the row and the columns were deleted from the underlying data set. Deleted sectors are: aircraft and spacecraft; railroad equipment and transport equipment, manufacture of gas and distribution of gaseous fuels through mains; steam and hot water supply; water transport; air transport; supporting and auxiliary transport activities and activities of travel agencies; renting of machinery and equipment; computer and related activities; research and development; education; private households with employed persons and extra-territorial organizations and bodies.

[13] As mathematical foundation the aggregation approach outlined by Holub and Schnabl (1994) is deployed.

[14] An alternative classification scheme would be the United Nations' *Standard International Trade Classification, Revision 4 (SITC Rev. 4)* which refers to the traded products themselves (United Nations 2006). However, since the aim of this study is the identification of the interconnectedness of industries rather than products and with the underlying data already being classified according to *ISIC Rev. 3* (OECD 2011b), it is more appropriate to apply the *ISIC Rev. 4* (OECD 2012) classification for the data analysis.

[15] For the electricity and the water sector it has to be taken into account that both sectors, as depicted in the Input-Output tables, include processes of production, collection (purification in the case of the water sector), and distribution. Consequently, both the sectors cannot be clearly identified as either pure manufacturing or pure services sectors. They thus build separate categories.

[16] The remaining three initial sectors of the Input-Output tables match with the ISIC Rev. 4 sectors 'agriculture, forestry and fishing' and 'mining and quarrying'.

and ‘public administration and defense, compulsory social security’ are not applicable to this assignment.

In a further step, the initial 20 manufacturing sectors, pooled to the ISIC Rev. 4 manufacturing sector, are additionally clustered according to their technology-intensity based on the OECD’s *ISIC Rev. 3 Technology Intensity Definition* which classifies technology according to R&D intensities (OECD 2011b). According to Annex 3, the classification lists four categories of technology intensity: (included numbers of manufacturing sectors of the data set in brackets): high (4), medium-high (4), medium-low (7) and low technology intensive (5) (see Annex 3).

4. Empirical Results

Backbone services are scrutinized in terms of their relevance for South African economic growth in two respects: First, we will compare backbone services in the aggregated form with other sectors of the economy. Second, we will compare them at a more disaggregated level with other services sub-sectors. To this end, we will assess backward and forward linkages, including an analysis of the relative evenness of these linkages[17] and, based on these key services sectors of the South African economy are defined. These assessments can show whether forward linkages are higher and more evenly spread than backward linkages (Hypothesis 1) and if the position of backbone services within the ranking of forward orientations of all services sectors allows classifying them as key forward oriented services (Hypothesis 2). Finally, the interconnectedness between services and the manufacturing sector is scrutinized while clustering manufacturing sectors according to the level of technology intensity. This is done in order to test Hypothesis 3 which postulates that the manufacturing sectors dependence on inputs from backbone services increases with the level of technology intensity.

Backward and forward linkages

[17] We apply the net approach (excluding intra-sectoral transactions). Calculations are only done on the basis of domestic transaction flows since those are more important for the assessment of potential sectoral growth stimuli (Tregenna 2008).

Table 1 displays both direct and total backward and forward linkages of the considered sectors of the economy measured for net domestic transaction flows[18]. The sectors backbone services and professional services are depicted both in aggregate and disaggregate terms. The aggregated backbone services record the lowest *backward linkages* of all sectors in both the years (direct 0.17 and 0.15; total 0.89 and 0.88), indicating a relatively low demand for intermediate inputs. Also the manufacturing sector records relatively low ranks in both direct and total backward linkages (direct: 0.32 and 0.27; total: 1.03 and 1.00). The three sectors with highest direct and total backward linkages are 'construction' (direct: 0.49 and 0.42; total: 1.21 and 1.14), 'agriculture' (direct: 0.34 and 0.39; total: 1.05 and 1.10) and 'mining and quarrying' (direct: twice 0.36; total: twice 1.07). These industries, thus, rely heavily on inter-industry inputs from other sectors. 'Electricity' ranks in the middle range (direct: 0.23 and 0.29; total: 0.97 and 1.03) whereas 'water supply' records very low linkages as well (direct: 0.19 and 0.20; total: 0.90 and 0.93).

Despite the low direct and total backward linkage values of the aggregated backbone services, a detailed look at the backbone services sub-sectors is revealing. Table 1 displays direct and total backward linkages of all services sub-sectors considered (the sub-sectors and numbers are presented in italics). The four sub-sectors of the backbone services record relatively low domestic backward linkage values. 'Finance and insurance' rank lowest (direct: 0.08 and 0.13; total: 0.78 and 0.84), followed by 'information and communication' (direct: 0.19 and 0.18; total: 0.89 for both years), whereas 'transportation and storage' respectively 'wholesale and retail trade' are higher ranked (direct: 0.35 and 0.30; total: 1.06 and 1.01 resp. direct: twice 0.34; total: 1.03 and 1.04). By contrast, disaggregated professional services reveal higher values for both direct and total backward linkages, in particular for 'health and social services' (direct: 0.44 and 0.41; total: 1.14 and 1.11), 'administrative and support services' (direct: 0.38 and 0.34; total: 1.07 and 1.04) and 'accommodation' (direct: 0.33 and 0.40; total: 1.03 and 1.10) (the latter only in 2000).

<< Insert Table 1 here >>

Forward linkages indicate the interconnectedness of a specific sector to those to which it sells its output (European Commission 2008). Direct and total *forward linkages* at the aggregated

[18] Direct backward linkages are based on the Chenery-Watanabe approach and total backward linkages on Rasmussen's power of dispersion index (see 3.1).

level are depicted in the right part of Table 1[19]. Indeed, manufacturing ranks place 1 for both years and both direct and total forward linkages, indicating a high reliance of the total system of industries on the manufacturing sector. But the forward linkage values for the aggregated backbone services rank places 3 (0.48 and 0.44) for direct linkages, which is an indication that backbone services are important suppliers to the economy. This can be confirmed when looking at total forward linkages. Applying the Rasmussen index, backbone services even rank places 2 (1.46 and 1.45) for total linkages. Furthermore, also when proving these results with the Jones method - in consideration of his critique of the double-counting of linkages – results are robust, only with a slight change in sectoral ranking to places 3 (0.91 and 0.94). It is thus evident that in contrast to the low ranked direct and total backward linkages, backbone services rank considerably higher in both direct and total forward linkages, indicating a significant importance as suppliers for the rest of the economy. This unequivocal disparity by higher forward linkages of aggregated backbone services is in line with the first part of **Hypothesis 1**.

To gain a more detailed insight on sub-sectoral driving forces of the linkages, Table 1 also depicts direct forward linkages of the disaggregated services sub-sectors of both backbone services and professional services (the sub-sectors and numbers are presented in italics). Also within all sub-sectors, backbone services are well ranked: For direct linkages, the backbone services sub-sector 'information and communication' ranks places 2: 0.47 and 0.40), followed by 'finance and insurance' (ranks 4 and 5: 0.31 and 0.25), 'transportation and storage' (ranks 6: 0.25 and 0.20) and 'wholesale and retail trade' (ranks 8 and 7: 0.21 and 0.20). Rank 1 is hold by the professional services sub-sector 'administration and support services' (0.63 and 0.52). Looking at total forward linkages, the table shows another ranking which is depending on the applied measure. For the Rasmussen's sensitivity of dispersion index, the backbone services 'wholesale and retail trade' and 'finance and insurance' rank highest (ranks 1 and 2, respectively: 1.33 and 1.30 and 1.14 and 1.17, respectively) for both the years whereas the backbone service sub-sector 'information and communication' respectively 'transportation and storage' rank lower (ranks 7 and 5 resp. ranks 8: 0.84 and 0.97 resp. 0.79 and 0.78). However, when applying Jones' method, the backbone service 'information and communication' ranks highest (ranks 2 for 1993 and 3 for 2000: 0.88 and 0.85) among the backbone services sub-sectors whereas the backbone service 'finance and insurance' (ranks 6 and 5: 0.76 and 0.75), 'wholesale and retail trade' (ranks 8 and 4: 0.72 and 0.76) and

[19] Direct forward linkages are based on the Chenery-Watanabe method and total linkages on the Rasmussen's sensitivity of dispersion index as well as the Jones' method (see 3.1).

‘transportation and storage’ (ranks 7: 0.74 and 0.71) are lower positioned. Taking the results of direct and total forward linkages together, ‘information and communication’ and ‘finance and insurance’ are the two backbone services with the highest forward linkages, followed by ‘wholesale and retail trade’ and ‘transportation and storage’. However, results for total forward linkages depend on the applied linkage measure.

When comparing the forward linkages of the disaggregated backbone services with the respective backward linkages, higher forward linkages become evident. This is the case for ‘finance and insurance’ by direct and total measures (except Jones’ method) whereas for ‘information and communication’ this finding is restricted to direct measures and to the 2000 total forward linkages by Rasmussen’s method. For ‘wholesale and retail trade’ higher forward linkages are restricted to total forward linkages (by Rasmussen’s method). For ‘transportation and storage’ higher forward linkages are not evident. Altogether these results meet the proposition of the first part of **Hypothesis 1** which postulates higher forward linkages of backbone services for the South African economy than it is the case for backward linkages.

This yields interesting implications. Even if forward linkages cannot be regarded as independent inducement mechanisms for economic growth, their indirect growth inducing function is substantial (see 2.2). This gets plausible when looking at the study’s results and the high forward linkages of the backbone services sub-sectors ‘information and communication’ and ‘finance and insurance’ and slightly behind ‘wholesale and retail trade’. Thus, it may be assumed that these high forward linkages reveal a permissive nature for the economic development. It may be possible to conclude that these services affect economic production and growth *indirectly*, due to its permissive forward linkages. Correspondingly, backbone services may be considered important *enablers* of economic development.

The relative evenness of linkages: The Variation indicators

A general growth enabling function of the previously ascertained dominance of backbone services’ forward linkages is depending on their even spread throughout the economy. Therefore, the relative evenness of the linkages of the backbone services is of additional

interest[20]. Table 2 displays both the *backward* and *forward variation indices* for both the aggregated sectors and the disaggregated services sectors. With regard to the backward linkages, low values of the backward variation indices imply that the sectors purchase their inputs from a lot of industries. Aggregated backbone services reveal a high value (ranks 8 and 7: 1.50 and 1.48) what indicates that their purchases are restricted to few industries. As to be anticipated at the aggregated level, the separately considered sectors ‘electricity’ and ‘water supply’ record lowest values, thus ranking highest (places 1: 0.99 and 1.01 and 2: twice 1.11), implying evenly spread backward linkages. Within the ranking of disaggregated services sub-sectors, the backbone services ‘wholesale and retail trade’ resp. ‘finance and insurance’ rank relatively high (ranks 2 and 3: twice 1.21 resp. ranks 5 and 4: 1.33 and 1.28), which points to a relatively high evenness of their backward linkages. Against that, ‘information and communication’ and ‘transportation and storage’ rank distinctly lower (ranks 7 and 8: 1.37 and 1.48 resp. ranks 9 in both years: 1.55 and 1.53), documenting a low degree of evenness of their purchases. By contrast, the professional services sub-sectors ‘administrative and support services’ and ‘health and social services’ have the most evenly spread backward linkages (ranks 1 and 2: 1.19 and 1.16 and ranks 2 and 1: 1.21 and 1.15) among all regarded services sub-sectors.

<< Insert Table 2 here >>

The displayed values of forward variation indices for the aggregated level and the disaggregated services sub-sectors are based on both Rasmussen’s sensitivity of dispersion index as well as on Jones’ method. They depict the relative evenness of a sector’s sales to the rest of the economy. At the aggregated level, the evenness of forward linkages of the backbone services sector, according to Rasmussen's sensitivity of dispersion index, is confirmed (ranks 2 and 1: twice 0.44), only exceeded by ‘water supply’ (rank 1: 0.43 and 0.44). When applying Jones' method, the picture is similar: Backbone services rank 2 resp. 3 for both years (0.73 and 0.68) and water supply ranks twice place 1 (0.70 and 0.52), indicating an evenly spread supply of these sectors' sales to the rest of the economy. At the disaggregated level, ‘wholesale and retail trade’ resp. ‘finance and insurance’ show a relatively well-marked evenness of linkages. According to the method of Rasmussen they hold ranks 2 and 1 resp. 1 and 3 (0.53 and 0.50 resp. 0.50 and 0.54). Applying Jones' method the ranks are 6 and 1 (1.08 and 0.69) and 2 and 7 (0.92 and 0.93). ‘Transportation and storage’

[20] It is measured by means of the Rasmussen’s variation index. It is calculated on the basis of net total linkage measures. Low values of the variation index indicate an evenly spread linkage. Low values of variation indices thus record high rankings (see 3.1).

resp. ‘information and communication’ are lower ranked (Rasmussen/Jones ranks: 5;7/1;3 resp. 8;6/twice 8).

As Table 2 shows, forward variation indices of both aggregated and disaggregated backbone services are distinctly lower than their backward variation indices (one exception for ‘information and communication’: in 1993 the forward variation index by Jones’ method exceeds the backward variation index slightly: by 0.08). Taken together, these findings are indicative for the second part of **Hypothesis 1**. Moreover, within the inter-industry system, aggregated backbone services rank very high for forward variation indices (ranks 2 and 1 according to Rasmussen and 2 and 3 according to Jones, respectively). This shows that their output spread is among the most even ones. At the disaggregated backbone services level, sectoral outputs of ‘wholesale and retail trade’ and ‘finance and insurance’ are among the most evenly spread, followed by ‘transportation and storage’ and ‘information and communication’. The backbone services' deviation between high ranked forward variation indices and low ranked backward variation indices indicate that they are inputs of general purpose for the rest of the economy but require only specialized inputs from a few other sectors. In principle, a strong and evenly spread enabling effect on economic growth is especially realized when low forward variation indices is coupled with high forward linkages, as is the case with backbone services. For disaggregated backbone services this constellation reveals above all for ‘wholesale and retail trade’ and ‘finance and insurance’.

Contrary to their backward linkages, the essential role of backbone services for the South African economy is shown by their substantially higher forward linkages, which is additionally emphasized by the more evenly spread of these linkages. These findings support Hypothesis 1 in total.

Key Services Sectors

Considering Hypothesis 2, the potential qualification of backbone services as key services sectors has to be evaluated. Following Salami’s (2012) approach for assessing key sectors, the identification of key services is split into key backward and key forward linked services. Backward and forward linkages of both disaggregated backbone and professional services are treated separately subtracting their respective variation indices (see Table 3). In light of the deviating extents of the services’ backward and forward linkages and their corresponding variation indices, as calculated before, this approach is especially revealing for a further

characterization of the role of backbone services sub-sectors within the total of services sub-sectors.

Regarding the backward orientation of disaggregated backbone services, 'wholesale and retail trade' ranks best (twice ranks 3) and may be considered key backward oriented backbone service, whereas the other 3 backbone services rank bottom half. The strongest backward orientation is ascertained for the professional services sub-sectors 'health and social services' and 'administration and support services' (twice ranks 1 and 2). When looking for key forward oriented services sub-sectors, Table 3 displays results based on both Rasmussen's sensitivity of dispersion index and on Jones' method. For the Rasmussen index the backbone service 'wholesale and retail trade' resp. 'finance and insurance' rank best (twice rank 1 resp. ranks 2) and can thus be considered key forward oriented services. The backbone service 'information and communication' resp. 'transportation and storage' are lower positioned (ranks 8 and 6 resp. ranks 6 and 8). For Jones' method the results differ. According to this approach, 'wholesale and retail trade' ranks 6 and 2, whereas 'finance and insurance' rank places 3 and 6. Also 'transportation and storage' is middle ranked (4 and 5). 'Information and communication' ranks lowest (8 twice).

For defining key forward oriented services sub-sectors, the results for backbone services sub-sectors are not consistent. An unequivocal stronger forward orientation in comparison to the degree of respective backward orientation is evident for the backbone services 'wholesale and retail trade' and 'finance and insurance' when applying Rasmussen's sensitivity of dispersion index (ranks 1 and 2 within the total of regarded backbone and professional services sub-sectors). When applying Jones' method, these sub-sectors are middle ranked (6 and 2, resp. 3 and 6). Even though the rankings are depending on the applied measure, two of the four backbone services sub-sectors can be treated as key forward oriented services sub-sectors. Altogether these results are indicative for **Hypothesis 2** in part. This is an additional accentuation of the growth enabling role of backbone services.

<< Insert Table 3 here >>

Input and Output Coefficients

According to hypothesis 3, input- and output-coefficients reveal a quantitative graduation of the interconnectedness between backbone services and manufacturing when the manufacturing sector is disaggregated and clustered by different levels of technological intensity. Based on the OECD's ISIC Rev. 3 technology intensity definition (OECD 2011b),

manufacturing industries are classified into 4 categories, ranging from low to high-technology (see annex 3 for an overview). For the analysis, the input- and output-coefficients are depicted in total terms (i.e. based on the Leontief- and Gosh-Inverse respectively). These coefficients are more informative since they measure both the direct and indirect effects on the required inputs (by a one unit increase in output) and the direct and indirect effects on output (induced by a one unit increase in input respectively). In its upper part, table 4 shows total domestic (backbone service) input coefficients of each of the 4 categories of manufacturing for the years 1993 and 2000. The respective input coefficient denotes the share of intermediate products (i.e. backbone services) required by each manufacturing industry to produce a unit of output. The total input coefficient (i.e. required backbone services) of high-technology manufacturing is 0.27 and 0.24 in the year 1993 and 2000 respectively. Thus, backbone services worth 27 respectively 24 South African Rand are required as inputs for the production of high technology goods worth 100 South African Rand. Medium-high manufacturing industries record the highest input coefficients (0.28 and 0.25) for backbone services. By way of example this connection becomes elucidated: '*Transportation and storage'* as a backbone services sub-sector is strongly connected with medium-high manufacturing such as *motor vehicles* or *machinery and equipment*. Also high-technology manufacturing sub-sector *radio, television and communication* requires inputs from the backbone service '*information and communication'*. The total input coefficients (of backbone services) in low technology and medium-low technology manufacturing sectors are following with a small gap. The lower part of table 4 displays the total domestic input coefficients of backbone services, i.e. measuring the share of each of the 4 manufacturing categories required in the 'production' of backbone services. Noticeably, values of these input coefficients are generally smaller. Supplying backbone services to the economy requires rather products from low and medium-low technology manufacturing sector (each with an input coefficient of 0.06 in the year 2000) than from high-technology sectors. In more detail, it is plausible that for example the supply of '*transportation and storage'* services requires inputs from the medium-low technology intensive sectors *iron and steel* and *non-ferrous metals*. Also the low technology manufactures *textiles and textile products* are important products delivered as inputs to '*wholesale and retail trade*' services. Total input coefficients which measure the requirements of inputs from medium-high and high technology manufacturing sectors in the supply of backbone services are comparatively small. From this point of view, it is noticeable that the interconnectedness between backbone services and the level of technology in the manufacturing sector is twofold: high and medium-high technology sectors depend

substantially more on backbone service inputs than vice versa. In turn, supplying backbone services to the economy requires rather a relatively higher share of products from medium-low and low technology intensive manufacturing sectors than from high technology sectors.

Table 4 displays total output coefficients of each of the four manufacturing sectors. The output coefficients in the upper part of the table, in contrast to the input coefficients, indicate the total effect of an additional unit backbone services input on the additional production generated in each of the four manufacturing categories. The induced value of production of high technology manufactures per unit backbone services input is considerably low (0.02 in the year 2000). But, low technology (0.22 and 0.l7) and medium-high technology (0.14 and 0.13) record distinctly higher output coefficients, followed by medium-low (0.09 and 0.11) technology intensive manufacturing. Thus, a one unit expansion of backbone services inputs, for example, '*transportation and storage'* and '*wholesale and retail trade'* induces a proportionally higher increase in output of low technology sectors e.g. *food products and beverages* or *textiles and textile products* than in high technology sectors. Given that high-technology sectors require a comparable higher share of services in production than low-technology sectors, a one unit increase in backbone services induces, as a consequence, a relatively smaller output when allocated to high technology sectors than distributing it to low technology sectors. The lower part of table 4 shows also the total output coefficients of backbone services, i.e. the output coefficients indicate the effect of a one unit increase in the supply of products from each of manufacturing sectors on the output induced in backbone services. Thus, for example '*building and repairing of ships and boats* (as a medium-low technology manufacturing) has important output effects on the supply of '*transportation and storage'* services. According to the table, medium-low technology manufacturing sectors record the highest output coefficients (0.51 in 1993 and 0.40 in 2000 respectively) and, thus, the induced effects on backbone service production, followed by low technology manufacturing (0.36 and 0.30), whereas high and medium-high manufacturing reveal lower values on the output coefficients (0.12 and 0.15 in the year 2000 respectively).

<< Insert Table 4 here>>

In order to get a detailed view on the total input- and output coefficients of each of the 4 categories of manufacturing, backbone services have to be considered at a more disaggregated level. Table 5 combines the total input- and output coefficients of both disaggregated backbone services and professional services. In both years 1993 and 2000, '*wholesale and retail trade*' is the sector recording consistently highest total input coefficients in all 4 manufacturing categories (rank 1). Also the input coefficients of the backbone services

'*finance and insurance'* and '*transport and storage*' are in the upper range (ranks 4 and 5) followed by '*information and communication*' (rank 7). Total input coefficients of backbone services of pooled groups of industrial sectors show on average larger values on the coefficients for the groups high and medium-high manufacturing compared to the groups medium-low and low technology manufacturing (exception: in 2000 equal values for 'transportation and storage' and 'information and communication').

The picture changes when looking at total output coefficients (Table 5). Also here the backbone service '*wholesale and retail trade*' is the best positioned backbone service inducing the highest output effects in manufacturing but overall it holds only rank 3 behind the professional services sub-sector '*administrative and support services*'. It is followed by the backbone services '*information and communication*' (rank 4), '*transportation and storage*' (rank 6) and '*finance and insurance*' (rank 7). When comparing the total output coefficients of the backbone services for the pooled groups of industrial sectors , the result is in contrast to total input coefficients, showing higher values for the groups medium-low and low technology manufacturing both in 1993 and in 2000 than in the groups high and medium-high technology manufacturing sectors.

<<Insert Table 5>>

According to **Hypothesis 3,** special emphasis is placed on the fact that the input coefficients to manufacturing sectors (required backbone services inputs) are determined by the technology intensity of the respective industries. It is evident that high and medium-high technology manufacturing sectors require a considerable share of backbone services inputs when producing a unit of output. Output coefficients suggest that the distribution of a unit of backbone services inputs to the economy induces a relatively smaller output effect in high and medium-high technology intensive manufacturing compared to output expansion in low technology manufacturing. These findings support hypothesis 3 and they are leading to a very important developmental aspect: The relatively high input demand for backbone services suggests a general degree of dependence of the high and medium-high technology manufacturing on these services. This is especially noteworthy in light of the high input coefficients of the backbone services sub-sectors 'wholesale and retail trade', 'finance and insurance' and 'transportation and storage'. This implies that an improvement in the provision and quality of these services may especially benefiting high and medium-high technology manufacturing via these linkages. In light of the growth potential of high-technology

manufacturing, its input requirements for backbone services emphasize the aforementioned permissive function of backbone services.

6. Conclusion

The services sector and its interconnectedness with the manufacturing sector are of high importance for the overall development of the South African economy. The interrelations between backbone services and manufacturing are specific. Backbone services comprise basic infrastructural services including transportation, communication, distribution and finance and insurance services. An efficient provision of these services is considered as growth enabling for the whole economy. This growth enabling nature of backbone services becomes evident through a precise characterization of their role within the inter-industry system and the inter-sectoral linkages with the manufacturing sector. Linkages within the inter-industry system of the South African economy are evaluated by means of an input-output analysis. The results confirm that backbone services play an essential permissive role within the South African economy, since they supply important inputs to the rest of the economy. Backbone services further reveal predominant high and evenly spread forward linkages to other sectors of the South African economy. This allows us to classify backbone services as *enablers* of growth of production. Especially, the sub-sectors 'wholesale and retail trade' and 'finance and insurance' can be classified as key forward linked backbone service. Whereas the manufacturing sector is the key sector within the economy and remains important for overall economic growth, pivotal interrelations with backbone services are evident. We find that the interrelatedness between backbone services and the manufacturing sectors is twofold and depends on the level of technology intensity of manufacturing industries. On the one hand, especially the production of high and medium high technology goods (e.g. worth 100 South African Rand) -require a relatively higher share of backbone services inputs (e.g. worth 27 South African Rand) than low technology goods. This is insofar relevant for the South African economy, since high technology manufacturing can yield important growth opportunities by means of knowledge spillovers and increased attractiveness to foreign investors. As a consequence, liberalizing backbone services is even more growth inducing, since high technology industries depend more heavily on backbone service inputs. On the other hand, supplying backbone services to the economy requires rather products from low and medium-low technology manufacturing sector than from high-technology sectors.

As a consequence, it is important for economic policies to focus on this issue Especially, backbone services are amongst the most protected sectors in terms of regulation, licenses and state participation in South Africa. Policy should aim at an increased availability and efficiency of these services. Particularly the consideration of the manufacturing sector as the South African 'engine of growth' stresses the need for an unrestricted provision of backbone services. This can be achieved by deregulation and liberalization of backbone services, which, in turn, can then function much better as efficient 'enablers of growth'. In addition, allowing for an efficient provision of backbone services has also important implications for South Africa to participate in Global Value Chains and to benefit from multinational activity. This would allow South Africa to face stagnant growth and tackle the high unemployment rate.

Tables

Table 1 Domestic net backward and forward linkages of the South African economy (1993 and 2000)

Industry	Backward linkages (domestic, net terms)				Forward linkages (domestic, net terms)					
	Direct		Total by Rasmussen		Direct		Total by Rasmussen		by Jones	
	1993	2000	1993	2000	1993	2000	1993	2000	1993	2000
Agriculture	0.34	0.39	1.05	1.10	0.13	0.12	0.84	0.85	0.83	0.85
Mining and quarrying	0.36	0.36	1.07	1.07	0.26	0.29	0.89	0.96	0.68	0.84
Manufacturing	**0.32**	**0.27**	**1.03**	**1.00**	**4.26**	**3.34**	**1.56**	**1.58**	**3.01**	**2.82**
Electricity	0.23	0.29	0.97	1.03	0.23	0.20	0.87	0.86	0.68	0.73
Water supply	0.19	0.20	0.90	0.93	0.24	0.16	0.75	0.76	0.67	0.68
Construction	0.49	0.42	1.21	1.14	0.08	0.06	0.80	0.81	0.53	0.58
Public administration/defence	0.22	0.16	0.94	0.89	0.00	0.00	0.72	0.74	0.47	0.53
Backbone services, of which	**0.17**	**0.15**	**0.89**	**0.88**	**0.48**	**0.44**	**1.46**	**1.45**	**0.91**	**0.94**
Wholesale and retail trade	*0.34*	*0.34*	*1.03*	*1.04*	*0.21*	*0.20*	*1,33*	*1,30*	*0.72*	*0.76*
Transportation and storage	*0.35*	*0.30*	*1.06*	*1.01*	*0.25*	*0.20*	*0.79*	*0.78*	*0.74*	*0.71*
Information and communication	*0.19*	*0.18*	*0.89*	*0.89*	*0.47*	*0.40*	*0.84*	*0.97*	*0.88*	*0.85*
Finance and insurance	*0.08*	*0.13*	*0.78*	*0.84*	*0.31*	*0.25*	*1.14*	*1.17*	*0.76*	*0.75*
Professional services, of which	**0.24**	**0.22**	**0.96**	**0.94**	**0.78**	**0.53**	**1.11**	**1.01**	**1.23**	**1.01**
Accommodation	*0.33*	*0.40*	*1.03*	*1.10*	*0.29*	*0.33*	*1.13*	*1.08*	*0.79*	*0.86*
Real estate activities	*0.23*	*0.20*	*0.92*	*0.90*	*0.32*	*0.26*	*1.00*	*0.97*	*0.77*	*0.75*
Administrative and support services	*0.38*	*0.34*	*1.07*	*1.04*	*0.63*	*0.52*	*1.02*	*0.99*	*1.05*	*0.98*
Health and social services	*0.44*	*0.41*	*1.14*	*1.11*	*0.07*	*0.06*	*0.71*	*0.73*	*0.55*	*0.58*
Other services	*0.30*	*0.26*	*1.00*	*0.96*	*0.22*	*0.14*	*0.91*	*0.83*	*0.87*	*0.70*

Note: own calculations, calculations of direct linkages based on the Chenery Watanabe method according to formular (1) for backward linkages and formular (3) for forward linkages, calculations of total linkages based on Rasmussens' power of dispersion index (formular (2)) for backward linkages and sensitivity of dispersion index (formular (4)) for forward linkages, Jones' method for forward linkages based on formular (5).

Table 2 Domestic net backward and forward variation indices of the South African economy (1993 and 2000) (for total linkages)

Industry	Backward variation index (domestic, net terms)		Forward variation index (domestic, net terms)			
			by Rasmussen		by Jones	
	1993	2000	1993	2000	1993	2000
Agriculture	1.51	1.59	1.19	1.24	2.53	0.84
Mining and quarrying	1.19	1.28	1.16	1.05	2.14	0.82
Manufacturing	**1.23**	**1.17**	**0.74**	**0.73**	**1.25**	**0.91**
Electricity	0.99	1.01	0.82	0.98	1.13	0.61
Water supply	1.11	1.11	0.43	0.44	0.70	0.52
Construction	1.49	1.54	0.81	1.10	1.24	0.78
Public administration/defence	1.20	1.24	2.83	2.08	2.83	2.83
Backbone services, whereof	**1.50**	**1.48**	**0.44**	**0.44**	**0.73**	**0.68**
Wholesale and retail trade	*1.21*	*1.21*	*0.53*	*0.50*	*1.08*	*0.69*
Transportation and storage	*1.55*	*1.53*	*0.68*	*0.80*	*0.90*	*0.79*
Information and communication	*1.37*	*1.48*	*0.91*	*0.79*	*1.45*	*1.21*
Finance and insurance	*1.33*	*1.28*	*0.50*	*0.54*	*0.92*	*0.93*
Professional services, whereof	**1.47**	**1.48**	**0.62**	**0.51**	**0.96**	**0.78**
Accommodation	*1.52*	*1.45*	*0.67*	*0.80*	*0.96*	*0.82*
Real estate activities	*1.33*	*1.33*	*0.80*	*0.73*	*1.20*	*1.09*
Administrative and support services	*1.19*	*1.16*	*0.57*	*0.51*	*0.99*	*0.82*
Health and social services	*1.21*	*1.15*	*1.87*	*1.10*	*2.30*	*1.37*
Other services	*1.28*	*1.32*	*0.83*	*0.77*	*0.98*	*0.75*

Note: own calculations, based on formulas (6), (7) and (8).

Table 3 Hierarchy of backward and forward orientation of backbone and professional services subsectors of the South African economy (1993 and 2000)

Industry	Backward orientation (total backward linkages - backward variation index)				Forward orientation (total forward linkages - forward variation index)							
					by Rasmussen				by Jones			
	1993		2000		1993		2000		1993		2000	
	value	rank	value	rank	value	rank	value	rank	value	rank	value	rank
Backbone services, of which												
Wholesale and retail trade	*-0.18*	*3*	*-0.18*	*3*	*0.80*	*1*	*0.80*	*1*	*-0.36*	*6*	*0.07*	*2*
Transportation and storage	*-0.49*	*7*	*-0.52*	*8*	*0.11*	*6*	*-0.02*	*8*	*-0.16*	*4*	*-0.08*	*5*
Information and communication	*-0.47*	*6*	*-0.59*	*9*	*-0.07*	*8*	*0.18*	*6*	*-0.57*	*8*	*-0.36*	*8*
Finance and insurance	*-0.54*	*9*	*-0.45*	*7*	*0.64*	*2*	*0.64*	*2*	*-0.16*	*3*	*-0.18*	*6*
Professional services, of which												
Accommodation	*-0.49*	*8*	*-0.34*	*4*	*0.46*	*3*	*0.28*	*4*	*-0.17*	*5*	*0.04*	*3*
Real estate activities	*-0.41*	*5*	*-0.43*	*6*	*0.20*	*5*	*0.23*	*5*	*-0.43*	*7*	*-0.34*	*7*
Administrative and support services	*-0.12*	*2*	*-0.12*	*2*	*0.45*	*4*	*0.48*	*3*	*0.06*	*1*	*0.15*	*1*
Health and social services	*-0.07*	*1*	*-0.05*	*1*	*-1.15*	*9*	*-0.38*	*9*	*-1.75*	*9*	*-0.79*	*9*
Other services	*-0.29*	*4*	*-0.36*	*5*	*0.08*	*7*	*0.05*	*7*	*-0.11*	*2*	*-0.05*	*4*

Note: approach according to Salami (2012).

Table 4 Total input and output coefficients (domestic, net terms) of backbone services into technology classes of manufacturing* and conversely in the South African economy (1993 and 2000)

Input/Output		Total Input coefficient		Total Output coefficient	
from	into	1993	2000	1993	2000
Backbone services	High-technology manufacturing	0.27	0.24	0.02	0.02
	Medium-high technology manufacturing	0.28	0.25	0.14	0.13
	Medium-low technology manufacturing	0.23	0.21	0.09	0.11
	Low technology manufacturing	0.24	0.24	0.22	0.17
High-technology manufacturing	Backbone services	0.00	0.00	0.09	0.12
Medium-high technology manufacturing		0.03	0.03	0.15	0.15
Medium-low technology manufacturing		0.06	0.06	0.51	0.40
Low technology manufacturing		0.07	0.06	0.36	0.30

*: classified according to the OECD classification of technology ISIC Rev. 3 (OECD, 2011b).

Table 5 Total input and output coefficients of disaggregated backbone and professional services sectors into technology classes of manufacturing* in the South African economy (1993 and 2000)

	Total domestic input coefficients							
	1993				2000			
	high-tech	medium-high	medium-low	low tech	high-tech	medium-high	medium-low	low tech
Wholesale and retail trade	0.16	0.15	0.09	0.12	0.14	0.13	0.08	0.12
Other services	0.11	0.08	0.08	0.08	0.06	0.05	0.08	0.05
Administrative and support services	0.08	0.06	0.07	0.06	0.05	0.05	0.04	0.04
Finance and insurance	0.05	0.06	0.05	0.05	0.05	0.03	0.03	0.04
Transport and storage	0.05	0.06	0.04	0.05	0.03	0.02	0.02	0.03
Real estate activities	0.03	0.03	0.02	0.03	0.02	0.02	0.02	0.02
Information and communication	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.02
Accommodation	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Health and social services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	Total domestic output coefficients							
	1993				2000			
	high-tech	medium-high	medium-low	low tech	high-tech	medium-high	medium-low	low tech
Other services	0.02	0.08	0.06	0.14	0.01	0.05	0.05	0.06
Administrative and support services	0.02	0.07	0.04	0.10	0.01	0.04	0.03	0.06
Wholesale and retail trade	0.01	0.04	0.03	0.06	0.01	0.04	0.02	0.05
Information and communication	0.01	0.03	0.02	0.06	0.01	0.03	0.02	0.04
Accommodation	0.01	0.03	0.02	0.04	0.00	0.02	0.01	0.03
Transport and storage	0.00	0.03	0.02	0.04	0.00	0.02	0.01	0.03
Finance and insurance	0.00	0.03	0.01	0.04	0.00	0.02	0.01	0.02
Real estate activities	0.00	0.02	0.01	0.03	0.00	0.01	0.01	0.02
Health and social services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: own calculations (see 3.1),
backbone services are highlighted in grey.

*: classified according to the OECD classification of technology ISIC Rev. 3 (OECD, 2011b).

Annex

Annex 1: South African Input-Output data (1993 and 2000) according to (ISIC Rev. 4) (United Nations 2006)

ISIC Code	Sector description
A	**Agriculture, forestry and fishing**
	1 Agriculture, hunting, forestry and fishing
B	**Mining and quarrying**
	2 Mining and quarrying (energy)
	3 Mining and quarrying (non-energy)
C	**Manufacturing**
	4 Food products, beverages and tobacco
	5 Textiles, textile products, leather and footwear
	6 Wood and products of wood and cork
	7 Pulp, paper, paper products, printing and publishing
	8 Coke, refined petroleum products and nuclear fuel
	9 Chemicals excluding pharmaceuticals
	10 Pharmaceuticals
	11 Rubber & plastics products
	12 Other non-metallic mineral products
	13 Iron & steel
	14 Non-ferrous metals
	15 Fabricated metal products, except machinery & equipment
	16 Machinery & equipment, nec
	17 Office, accounting & computing machinery
	18 Electrical machinery & apparatus, nec
	19 Radio, television & communication equipment
	20 Medical, precision & optical instruments
	21 Motor vehicles, trailers & semi-trailers
	22 Building & repairing of ships & boats
	25 Manufacturing nec; recycling (include Furniture)
D	**Electricity, gas, steam and air conditioning supply**
	26 Production, collection and distribution of electricity
E	**Water supply; sewerage, waste management and remediation activities**
	29 Collection, purification and distribution of water
F	**Construction**
	30 Construction
G	**Wholesale and retail trade; repair of motor vehicles and motorcycles**
	31 Wholesale & retail trade; repairs
H	**Transportation and storage**
	33 Land transport; transport via pipelines
I	**Accommodation and food service activities**
	32 Hotels & restaurants
J	**Information and communication**
	37 Post & telecommunications
K	**Financial and insurance activities**
	38 Finance & insurance
L	**Real estate activities**
	39 Real estate activities
N	**Administrative and support service activities**
	43 Other Business Activities
O	**Public administration and defence; compulsory social security**
	44 Public admin. & defence; compulsory social security
Q	**Human health and social work activities**
	46 Health & social work
S	**Other service activities**
	47 Other community, social & personal services

Note: capital letters correspond to ISIC, Rev. 4 while numerals correspond to sectors of the South African Input-Output tables.
Source: own compilation based on OECD (2012).

Annex 2: Services classification of South African Input-Output data (1993 and 2000)

ISIC Rev. 4 classification and corresponding sectors of South African Input-Output tables		Corresponding WTO services categories	Authors' assignment
F	**Construction**	Construction	
	30 Construction		
G	**Wholesale and retail trade; repair of motor vehicles and motorcycles**	Distribution services	Backbone services
	31 Wholesale & retail trade; repairs		
H	**Transportation and storage**	Transport services	Backbone services
	33 Land transport; transport via pipelines		
I	**Accommodation and food service activities**	Tourism	Professional services
	32 Hotels & restaurants		
J	**Information and communication**	Communication services	Backbone services
	37 Post & telecommunications		
K	**Financial and insurance activities**	Financial services	Backbone services
	38 Finance & insurance		
L	**Real estate activities**	Business activities	Professional services
	39 Real estate activities		
N	**Administrative and support service activities**	Business activities	Professional services
	43 Other Business Activities		
O	**Public administration and defence; compulsory social security**	Other services, not included elsewhere	
	44 Public admin. & defence; compulsory social security		
Q	**Human health and social work activities**	health related and social services	Professional services
	46 Health & social work		
S	**Other service activities**	health related and social services	Professional services
	47 Other community, social & personal services		

Source: own compilation based on the Services Sectoral Classification List of the WTO (WTO, 1991).

Annex 3: Technology intensities of the South African manufacturing industries

High	Medium-high	Medium-low	Low
Pharmaceuticals	Electrical machinery & apparatus, nec	Rubber & plastics products	Manufacturing nec; recycling (include Furniture)
Office, accounting & computing machinery	Motor vehicles, trailers & semi-trailers	Coke, refined petroleum products and nuclear fuel	Wood and products of wood and cork
Radio, television & communication equipment	Chemicals excluding pharmaceuticals	Other non-metallic mineral products	Pulp, paper, paper products, printing and publishing
Medical, precision & optical instruments	Machinery & equipment, nec	Iron & steel	Food products, beverages and tobacco
		Non-ferrous metals	Textiles, textile products, leather and footwear
		Fabricated metal products, except machinery & equipment	
		Building & repairing of ships & boats	

Note: classification according to OECD ISIC, Rev. 3 Technology Intensity Definition (OECD 2011b) and the corresponding sectors of the South African Input-Output tables (OECD 2012).

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