OECONOMICA

STUDIA
UNIVERSITATIS BABEŞ-BOLYAI
OECONOMICA

1/2019

April

Studia Universitatis Babeş-Bolyai Oeconomica

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EMPLOYEES' COMPETENCES IN KNOWLEDGE-INTENSIVE BUSINESS SECTOR – COMPARATIVE ANALYSIS IN TWO CEE COUNTRIES

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Abstract
Knowledge-Intensive Business Services (KIBS) are services that involve intensive use of high technologies, specialized skills and professional knowledge. However, there are insufficient findings on the competences of employees in the sector of KIBS. The purpose of this paper is to present the results of the research on employees' competences in different service sectors of two CEE countries: Poland and Belarus. This study adopted a quantitative approach based on a questionnaire applied to 101 companies from Poland and 42 companies from Belarus. The comparative analysis shows quite similar findings - the most significant competencies are employee engagement, motivation and customer-focused orientation and play a crucial role in the efficiency of services in both countries.

1. Introduction

There is widespread agreement that knowledge is a source of economic growth and that, in turn, learning and innovation are key drivers of global competitiveness for both companies and economies. The increasing importance of knowledge has triggered interest towards knowledge-intensive business services (KIBS). Those activities involve intensive users of technology that employ specialized skills and professional knowledge

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which is a significant source of job growth and competitiveness in a modern knowledge-based economy. KIBS accomodate private organizations which use a high degree of professional knowledge and provide other companies with high quality industrial services that are based on this knowledge (Viljamaa, Kolehmainen, Kuusisto, 2010). The value of KIBS companies lies in their capacity to offer services that meet their customer's needs with regard to the access to technical, commercial, or scientific knowledge (Muller, Doloreux, 2009). Most companies need highly-skilled, experienced and motivated employees to gain competitive advantage. Human capital is more important in a service sector which is knowledge-intensive work (Kianto, Hurmelinna-Laukkane, 2010). Therefore, there is a need to shed light onto the role of human capital in KIBS and the challenges of managing those services.

The authors want to investigate the factors that have a positive impact on the efficiency of services in KIBS, the significance of employees' competences that contribute to the development of services in this service sector, and the methods of assessment of selected aspects of employees' work. The authors specifically concentrate on knowledge-intensive business services in two neighboring post-communist CEE countries – Poland and Belarus.

2. Research trends in KIBS

The growing interest in KIBS has contributed to emergence of various research in this sector. This leads to the possibility to identify different approaches and trends on the topic.

Most of the previous studies focused on the nature of these services. Some researchers tried to conceptualize KIBS (Gallouj, 2002; Hertog, 2000; Miles, 2005; J-Figueiredoet et al., 2017). Their research has proposed definitions, classifications, and pointed out the features of this sector. Some of this has determined the characteristics of KIBS in terms of methodological aspects (Djellal, Gallouj, 2000; Toivonen, 2006).

A great number of studies concentrate on a broad range of innovation research and treat KIBS as a support innovative activity. It is a crucial organizational ability to compete in highly innovative, professional business environments (Menguc, Auh, 2006; Benkenstein, 2017). Most studies have emphasised the contribution that KIBS make to regional innovation and growth (Aslesen, Isaksen, 2007; Cooke, Leydesdorff, 2006; Hu, Chang, Lin, Chien 2006; Koch, Stahlecker, 2006; Simmie, Strambach, 2006; Toivonen, 2006). One of the most common definitions presents KIBS as 'bridges of innovation' between manufacturing and service sectors (Miles et al., 1995). This sector allows one to support a company in its innovation process and to transfer existing innovations from one entity, or industry, to another company or industry by benchmarking practices (Hauknes, 1998). Muller and Zenker (2001) suggest that KIBS play the role of a co-innovator and provide a bridge or an interface function between the environment and the customer. In the KIBS sector, significantly more money has been spent on innovation than in the non-KIBS sector (Tether, Hipp 2002, p. 173).

The research of the subject has provided information on different levels of the analysis, e.g. with regard to regional and national aspects, micro and macroeconomic views as well as for the comparisons between the KIBS sector and other sectors defined as non-KIBS sectors or manufacturing sectors. A key focus in many studies

was to identify the factors associated with different levels of innovativeness and to show that KIBS are indeed innovative (Cainelli, Evangelista, Savona, 2004; Camacho, Rodriguez, 2005; Freel, 2006). These issues are analyses across the KIBS sector. Moreover, past research treated KIBS as a homogenous group, while now there are the variety that exists among KIBS (Pina, Tether, 2016).

It is suggested that there are differences between professional KIBS (P-KIBS) and technological KIBS (T-KIBS) (Freel, 2006), or technical KIBS, compared to nontechnical KIBS (Tether, Hipp, 2002), or KIBS with non-KIBS (Camacho, Rodriguez, 2005). Freel (2006) indicates that innovativeness in P-KIBS is connected with highly qualified personnel, whereas innovativeness in T-KIBS is linked to cooperation between customers and suppliers. Tether and Hipp (2002) observe that R&D, as a component of innovation expenditures, is more important for technical KIBS than nontechnical KIBS. Most studies compare the nature of innovation activities between KIBS and manufacturing companies, showing that innovativeness in KIBS is dependent on 'soft' sources such as knowledge and qualification (de Jesus, Mendonça, 2018), while in manufacturing companies, the intensity of R&D distinguishes the most from the least innovative companies (Freel, 2006). This research has been confirmed by Wong and Singh (2004). The authors suggest that KIBS are more intensively engaged in innovation activity, human capital intensity and training, but they are less likely to develop innovation in collaboration with international partners and to perform R&D (Wong, Singh, 2004). Some studies examine the factors such as regional economic specialization, regional firm size distribution or concentration of (high-tech) manufacturing or business R&D centres of selected KIBS (Ženka et al. 2017).

The following research trend analyzes accumulation, creation, and dissemination of knowledge within the KIBS sector. In the KIBS sector the knowledge allows a company to achieve and sustain its competitive advantage to ensure its long-term success (Zahra, George, 2002; Miles, Belousova, Chichkanov, 2018).

The most significant finding of the research is that the knowledge-intensive services influence the productivity in manufacturing and industry in general (Doloreux, Shearmur, 2013). For a long time, the service sector and manufacturing were analyzed separately as two clearly distinct economic activities. The attempts to analyze the innovation processes and the spread of knowledge within KIBS and the other sectors have been made by many researchers (Consoli, Elche-Hortelano, 2010; Djellal, Gallouj, Miles, 2013). The output result was that KIBS played a crucial role as a knowledge producer and a stimulator of innovation in the entire economy.

3. Significance of human capital factor in services

A lot of research in KIBS shows the intensity of knowledge. The processes for managing and creating knowledge are the heart of the competitive advantage of knowledge-intensive companies, in particular in professional services (Swart, 2007), where their innovativeness is directly connected to the acquisition, processing and delivery of new knowledge (Amara, Landry, Doloreux, 2009). However, knowledge lies in people and the process of knowledge sharing is controlled by an employee. Thus, KIBS are, most of all, built on intangible assets, with the knowledge and experience embedded in human capital. KIBS provide quality services with a high added intellectual

value (Muller, Zenker, 2001). They are people-based rather than equipment-based services (Hill, Johnson, 2003). Intellectual capital is practically becoming the only competitive advantage for companies (Shakina, Barajas, 2013, p. 41). Therefore, there is a need to shed light onto the significance of human capital management in KIBS.

Firstly, the main production and outcome factor is knowledge. Its use and the way of sharing depend on an employee. There are few studies that examine the links between knowledge sharing and employee attitudes, such as their competences, commitment, or trust (Hislop, 2003; Lin, 2007; Ravishankar, Pan, 2008]. Hislop (2003) finds that commitment affects the employees' knowledge sharing. Lin (2007) finds that organisational commitment and trust in co-workers are important mediators in the sharing of tacit knowledge. However, professionals are committed not only to the organisation that employs them but also to the work teams and the customers with whom they work (Ravishankar, Pan, 2008). Thus, knowledge is closely tied to the person who has created it and strongly connected to its knower. Consequently, companies should be able to manage the process of organizational learning effectively and encourage employees to create, share and exploit knowledge. Human capital management plays a critical role in knowledge sharing practices so leaders have an important impact on developing human capital in organisations (Mayo, 2001).

Secondly, a significant fact is that a custoimer plays a crucial role in the service provision process. Services are characterized by a high degree of customization and an every new order introduces elements of diversity and changeability. A customer participates in the process of co-creation of service. Each time, they co-create the value of service. A service provider does not deliver it – they only propose it (Bettencourt, Ostrom, Brown, Roundtree, 2002). In KIBS, there is an interaction between the knowledge and experience of experts from KIBS companies with the knowledge and experience of their customers (Hertog, 2002). In KIBS companies, workers adapt their knowledge to specific requirements of individual customers in order to solve a problem. The interaction between a service provider and a service receiver is of great importance. Thus, KIBS need specific paths for human capital management because of the significance of customers' contribution and close relations with them. From a managerial point of view, finding methods to ensure client's participation in the co-creation process of service and delivery provides valuable information which beneficial to both parties. This also leads one to another issue.

Thirdly, there are strong and close in-depth interactions between a customer and a creative supplier. There is always a direct contact between a customer and a service provider in KIBS. A client should at all time know who the performer of the service is, which makes this performer (an employee), contrary to work performed in production, a non-anonymous party (Skapska, Samul, 2015). Knowledge-intensive service enterprises must concentrate their efforts on personnel that are in contact with a client. Many companies found it difficult to recruit commercially aware and customer-focused professionals. In some cases, work-focused individuals and their commitment to customer's needs were seen as an important attribute (Bryson, Taylor, Daniels, 2008). People employed in services should have professional knowledge on the subject matter and also understand information regarding psychological aspects of a client's behavior. Thus, KIBS companies should take into account workers' competences with the same degree of diligence as they care about their prospective customers.

Finally, the activity of KIBS is mostly based on the exploitation of the skills, abilities, knowledge and specializations of their employees. Multiple qualifications such as professional training, competence, predispositions and attitudes of people who provide services determine the content and a form of the service provision. It is righteous to say that qualified personnel come first and this fact is in accordance with the collection of twenty five determinants of a service enterprise success (Mangold, 2000). Paige and Littrel (2002) show that creative individuals play a critical role in creative industries such as advertising, architecture, branding and design consultancies. Furthermore, they suggest that employee's motivations and characteristics, such as their lifestyle, have a great impact on the company and its operation. Most researchers indicate the influence of human resource management on an employee and organizational performance (Sanders, Shipton, Gomes, 2014; Sydler, Haefliger, Pruksa, 2014).

The awareness of the significance of human capital influences the way in which KIBS are managed and organised. Following this logic, the most important task of companies is to recruit and retain the most qualified and suitable employees, to train skills and abilities, and to codify and capture knowledge in order to improve overall performance. A strategic approach in human competence enhancement may contribute to organizational success.

4. Problem statement

A brief look at trends in KIBS shows that there has been little study done on human capital in this sector. It seems the researchers have paid little attention to the management of employees' competences in knowledge-intensive business services.

The authors want to investigate factors that have positive impact on the efficiency of services. This is the first inquiry in this study. The second one regards employees' competencies which contribute to the development of services. Then, the third question concerns the indicators of human capital management that are usually used in companies.

5. Methodology

Measurement and sampling

This study adopted a quantitative approach by means of a questionnaire in order to reach the largest possible group of respondents. The quantitative study was used because of the need to measure the researched phenomenon. The results were obtained in a way that allowed to know the opinion of a given group of respondents and then to use them to form certain generalisations.

The questionnaires were hand-delivered to the representatives of service companies that operating in Poland and Belarus. The study participants were randomly selected from the population for inclusion in the study. As for the selection of companies, senior executives were chosen (i.e., directors, chief executive officers) and approached to respond to the survey. The questionnaire was aimed at KIBS. The business services were grouped into three main categories according to classification of KIBS. The firms which belong to the one of the group were selected:

- technical services, such as engineering, architecture and technical studies;
- computer services, such as software design and database management;
- other professions concerning legal services, accounting, consultancy and management services.

The research was carried out in 2018 from February to June. The questionnaires were prepared in Polish and then, translate in Belarusian by the native researcher. Thus the questionnaires were identical. The questionnaire was made up of several parts. One of them focused on human capital and included factors that have a positive impact on the effectiveness of service. The others covered the significance of employees' competences in the development of services and tools used for the assessment of employees' effectiveness.

All items were rated on the five-point Likert scale ranging from 1 ('strongly disagree') to 5 ('strongly agree'). The questions had an option of adding one's own additional answer.

Research sample

The final sample consists of 101 companies from Poland (Podlaskie province) and 42 companies from Belarus (Table 1). The companiess are represented by various kinds of profiles. Most of them have domestic capital in both countries. However, the structure of companies, in terms of size, is definitely different. In Poland, the majority of the surveyed enterprises are small entities, including micro enterprises (93%) and only 1% are large enterprises. This is quite consistent with the overall structure of enterprises (due to the number of employees) in the economy of the country as well as with European trends. In Belarus, the structure is slightly different: small and micro enterprises account for slightly more than 50%, and the large ones constitute about 17%.

Table 1. Characteristics of KIBS companies

	Poland	Belarus
Profiles of service companies		
Computer programming, consultancy and related activities and coomunication	8%	19%
Accounting activities	3%	5%
Legal activities	0%	2%
Consultancy activities	9%	2%
Architectural and engineering activities	14%	29%
Advertising	9%	2%
Educational activities	29%	2%
Medical activities	9%	10%
Trade activities	12%	17%
others	8%	12%
Total	100%	100%
Size of service companies		
micro (1-9 employees)	65%	17%
small (10-49 employees)	28%	36%
medium (50-249 employess)	6%	31%
large (at least and more than 250 employees)	1%	17%
Total	100%	100%

Ownership of capital		
domestic	96%	76%
foreign	2%	10%
mixed (domestic and foreign)	2%	14%
Total	100%	100%

Source: Own elaboration.

5. Results

Business representatives were asked about factors that had a positive impact on the efficiency of services. It can be noticed that the mean of the factors is simillar in both countries. However, in Belarus it is lower than in Poland (Table 2). The second highest factor is customer-focused employees. It is one of the most important competences of workers and it has beem mentioned before. The next highest factor is the access to knowledge and its transfer, which is also related to employees.The other factors do not have such a significant impact. There were no additional answers from the respondents.

Table 2. Factors that have a positive impact on the efficiency of services in KIBS

Factors	Poland		Belarus	
	mean	std. dev.	mean	std. dev.
high competences and skills of employees	4.8	1.3	4.5	1.0
customer-focused employees	4.3	0.8	4.0	0.5
access to new knowledge /knowledge transfer	4.3	1.3	4.0	1.0
relatively large number of loyal customers	3.9	0.9	3.8	0.8
indirect character of the service	3.8	0.8	3.6	0.6
a high degree of specialization	3.7	0.7	3.5	0.5
investments aimed at reducing labor intensity	3.6	0.6	3.4	0.4
the right location of the facility	3.6	0.6	3.4	0.4
automation of services	3.5	0.5	3.9	0.9
indirect character of the service (via the Internet)	3.4	0.4	3.5	0.5

Source: Own elaboration

Next, the business representatives were asked about particular employees' competences which can be important for the development of services (Table 3). Nearly all the mentioned factors have a significant influence. Again, there are certain differences between the countries. All competences were assessed slighty higher in Polish companies (almost all competencies are above 4 points) than in Belarusian ones (all competencies are below 4 points). Moreover, in Polish companies, employee engagement has the higest mean. Whereas in Belarusian companies, this competence has the lowest rate. A surprising fact is that the ability to create innovation was assessed quite low - the last place in Polish companies and the last but one in Belarusian companies. It seems that the companies from the KIBS sector should appreciate the ability of creating innovation. There were no additional answers from the respondents.

Table 3. Employees' competences that contribute to the development of services in KIBS

Employees' competences	Poland		Belarus	
	mean	stand. deviat.	mean	stand. deviat.
Employee engagement	4.76	0.76	3,67	1.76
Employee motivation	4.52	1.02	3,93	1.02
Strong customer orientation	4.42	1.42	3,86	1.42
Sharing knowledge	4.31	0.31	3,86	1.31
Ability to create innovation	3.41	0.41	3,76	0.41

Source: Own elaboration

The participants were also asked about the use of indicators for human capital measurement in their companies. The purpose was to determine which measures are usually used in those businesses. The indicators were divided into six groups:
- Assessment of employees' attitudes (i.e. level of commitment, motivation)
- Assessment of the level of employee competence
- Assessment of the company's overall performance (i.e. customer service level, company innovation level)
- Measurement of employee performance indicators (i.e. remuneration effectiveness, employee value added)
- Assessment of the structure of employees
- Methods of assessing human capital (Navigator Skandia, BSC, HR Scorecard).

Our study's results reveal the use of indicators to measure human capital (Table 4). As for Polish companies, assessment of the employees' attitudes and the level of employee competence are used most often – respectively 80% and 75% (strongly agree or agree). The previously mentioned results showed the engagement and motivation were the most important for these businesses. Thus, it is not surprising that these indicators are measured. Whereas in Belarusian companies, the most commonly used indicator is the company's overall performance – 76%. The methods of assessing human capital such as Navigator Skandia, BSC or HR Scorecard are seldom used in companies of the both countries. Quite a large percentage of respondents - from 11% to even 33.3% - admitted that they had no opinion (neither disagree nor agree).

Table 4. Assessment of selected aspects of employees' work

		employees' attitudes	level of employee competence	company's overall performance	employee performance indicators	structure of employees	methods of assessing human capital
Poland	strongly agree	50.0%	42.9%	33.7%	20.6%	7.1%	0.0%
	agree	29.6%	32.7%	33.7%	39.2%	20.4%	7.2%
	neither disagree nor agree	11.2%	18.4%	20.4%	16.5%	27.6%	15.5%

		employees' attitudes	level of employee competence	company's overall performance	employee performance indicators	structure of employees	methods of assessing human capital
	disagree	5.1%	2.0%	9.2%	9.3%	12.2%	16.5%
	strongly disagree	4.1%	4.1%	3.1%	14.4%	32.7%	60.8%
Belarus	strongly agree	31.0%	21.4%	19.0%	28.6%	9.5%	7.1%
	agree	23.8%	45.2%	57.1%	31.0%	26.2%	11.9%
	neither disagree nor agree	26.2%	21.4%	11.9%	19.0%	33.3%	14.3%
	disagree	11.9%	9.5%	9.5%	14.3%	21.4%	19.0%
	strongly disagree	7.1%	2.4%	2.4%	7.1%	9.5%	47.6%

Source: Own elaboration

A structure of employees is measured by almost one third of company in both countries. The lowest percent are indicated in case of using methods of assessing human capital. It means that these methods are still unknown well in both CEE countries.

6. Conclusions

A brief look at the KIBS shows its role as an innovator and knowledge provider. The analysis of the research trends in these services shows that KIBS are an integral part of the economy and thus are vital to its functioning and development. Moreover, KIBS have been seen and identified at various levels of the economy. Nevertheless, it has been displayed that the main trends in the research of KIBS norrowly cover the issues of the human capital management and the employees' competencies.

The research results show that the competencies of employees play a crucial role in the efficiency of services in both Polish and Belarusian KIBS. As for the most sigificant competencies, they include employee enagagement, their motivation and customer-focused orientation. The research demonstrates the differences in the use of indicators of human capital measurement with regard to the countries' companies. The respondents of Polish companies declare that they use measures which are related to employees' attitude, i.e. engagement, motivation, satisfaction as well as employees' competencies. The respondents of Belarusian companies indicate that the company's overall performance such as remuneration effectiveness or employee value added is the most commonly used aspect. The most advanced methods to evaluate human capital such as HR Scorecard are used neither in Poland nor in Belarus.

The results are interesting becuse of the comparative analysis which shows that the findings are quite similar. Although all factors and competences have had lower levels in Belarusian companies than in Polish ones, these differences are not

much statistical significant. It can be related to the specificity of the economies in these countries.

The contribuition of this research is investigation of the dimension of importance and understanding of the employees' competences in KIBS which is relatively new sector in these particular CEE countries. Poland with a long delay entered the market economy, while in Belarus, economic changes were not made. Most of existing research present the results from developed countries, not developing ones.

This study has certain limitations. One limitation is the number of studied companies, especially from Belarus. However, KIBS is developing sector in this country. The second limitation is that the research results come from only one province from Poland and one from Belarus. This is not the sample of the whole country. Thus, it is difficult to generalize.

There are some suggests for further studies in this area. Generally, the actions concerning personnel management, as well as their motivation and commitment to work, translate into true service company value. Further studies in the field should take into consideration the specific paths of human capital management and measurement.

References

Amara, N., Landry, R., Doloreux, D. (2009) Patterns of innovations in knowledge-intensive business services, *The Service Industries Journal*, 29(4): 407-430.

Aslesen, H.W., Isaksen, A. (2007) Knowledge intensive business services and urban industrial development, *The Service Industries Journal,* 27(3): 321–338.

Benkenstein, M., Bruhn, M., Büttgen, M., Hipp, C., Matzner, M., Nerdinger, F.W., (2017) Topics for service management research: a European perspective, *Journal of Service Management Research* 1: 4–21.

Bettencourt, L.A., Ostrom, A. L., Brown, S.W., Roundtree, R.I. (2002) Client co-production in knowledge-intensive business services, *California Management Review*, 44(4): 100-28.

Bryson, J.R., Taylor, M., Daniels, P.W. (2008) Commercializing "Creative" Expertise: Business and Professional Services and Regional Economic Development in the West Midlands, *Politics & Policy*, Blackwell Publishing Inc., United Kingdom, 36(2): 306-328.

Cainelli, G., Evangelista, R., Savona, M. (2004) The impact of innovation on economic performance in services, *The Service Industries Journal*, 24(1): 116–30.

Camacho, J.A., Rodriguez, M. (2005) How innovative are services? An empirical analysis for Spain, *The Service Industries Journal*, 25(2): 253–271.

Consoli, D., Elche-Hortelano, D. (2010) Variety in the knowledge base of Knowledge Intensive Business Services, *Res. Policy*, 39: 1303–1310.

Cooke, P., Leydesdorff, L. (2006) Regional development in the knowledge-based economy: The construction of advantage, *Journal of Technology Transfer*, 31(1): 5–15.

Djellal, F., Gallouj, F. (2000) Le "casse-tête" de la mesure de l'innovation dans les services: enquête sur les enquêtes?, *Revue d'économie industrielle*, 7–28.

Djellal, F., Gallouj, F., Miles, I. (2013) Two Decades of Research on Innovation in Services: Which Place for Public Services?, *Structural Change and Economic Dynamics*, 27: 98-117.

Doloreux, D., Shearmur, R. (2013) Innovation strategies: are KIBS just another source of information?, *Industry and Innovation,* 20(8): 719-738.

Freel, M. (2006) Patterns of technological innovation in knowledge-intensive business services, *Industry and Innovation*, 13(3): 335–358.

Gallouj, F. (2002) Knowledge-intensive business services: processing knowledge and producing innovation*.* In Gadrey, J., & Gallouj, F. (Eds.), *Productivity Innovation and Knowledge in Services*, Edward Elgar, 256-284.

Hauknes, J. (1998) *Services in Innovation*, Innovation in Services Synthesis report nr. 1 of the SI4S programme. European Commission, Brussels, TSE.

Hertog, P. (2000) Knowledge-intensive business services as co-producers of innovation, *International Journal of Innovation Management*, 4(4): 491-528.

Hertog, P. (2002) Co-producers of innovation: on the role of knowledge-intensive business services in innovation. In J. Gadrey & F. Gallouj (eds), Productivity*, Innovation and Knowledge in Services: New Economic and Socioeconomic Approaches,* Cheltenham: Edward Elgar, 233-255.

Hu, T.S., Chang, S.L., Lin, C.Y., Chien, H.T. (2006) Evolution of knowledge intensive services in a high-tech region: The case of Hsinchu, Taiwan. *European Planning Studies*, 14(10): 1363– 1385.

de Jesus, A. Mendonça, S. (2018) Lost in Transition? Drivers and Barriers in the Eco-innovation Road to the Circular Economy, *Ecological Economics*, 145: 75-89.

Figueiredo, J-.R., Neto, J.V., Quelhas, O.L.G., Ferreira, J.J.M. (2017) Knowledge intensive businessservices (KIBS): bibliometric analysis and thir different behaviors in the scientific literature, *RAI Revistade Administraç ̃ao e Inovaç ̃ao*, 14(3): 216-222.

Kianto, A., Hurmelinna-Laukkanen, P. (2010) Intellectual capital in service- and product oriented companies, *Journal of Intellectual Capital*, 11(3): 305-325.

Koch, A., Stahlecker, T. (2006) Regional innovation systems and the foundation of knowledge intensive business services. A comparative study in Bremen, Munich, and Stuttgart, Germany, *European Planning Studies*, 14(2): 123–146.

Lin, C. P. (2007) To share or not to share: modelling tacit knowledge sharing, its mediators and antecedents, *Journal of Business Ethics*, 70(4): 411–428.

Mangold, K. (2000) Dienstleistungen im Zetalter Globaler Märkte. Strategien für eine verletzte Welt, Frankfurt am Main, *Betriebswirtschaftlicher Verlag Gabler*, Wiesbaden.

Mayo, A. (2001) *The Human Value of the Enterprise – Valuing People as Assets – Monitoring, Measuring, Managing.* Nicholas Brealey, London.

Menguc, B., Auh, S. (2006) Creating a firm-level dynamic capability through capitalizing on market orientation and innovativeness, *Journal of the Academy of Marketing Science*, 34(1): 63-73.

Miles, I. (2005) Knowledge intensive business services: prospects and policies, *Foresight*, 7(6): 39-63.

Miles, I., Kastrinos, N., Bilderbeek, R., den Hertog, P., Flanagran, K., Huntink, W., & Bouman, M. (1995) *Knowledge intensive business services: users, carriers and sources of innovation*. European Innovation Monitoring System (EIMS), Report to the EC DG XIII, 15, Luxembourg.

Miles, I., Belousova, V. & Chichkano, N. (2018) Knowledge intensive business services: ambiguities and continuities,*foresight*, 20(1).

Muller, E., Doloreux, D. (2009) What we should know about knowledge-intensive business services, *Technology in Society,* 31(1): 64-72.

Muller, E., Zenker, A. (2001) Business services as actors of knowledge transformation: The role of KIBS in regional and national innovation systems, *Research Policy*, 30(9): 1501–1516.

Paige, R. C., Littrel, M. A. (2002) Craft Retailers' Criteria for Success and Associated Business Strategies, *Journal of Small Business Management*, 40: 314–32.

Pina, K., Tether, B. S. (2016) Towards understanding variety in knowledge intensive business services by distinguishing their knowledge bases, *Research Policy*, 45(2): 401-413.

Ravishankar, M. N., Pan, S. L. (2008) The influence of organizational identification on organizational knowledge management, *Omega,* 36(2): 221–234.

Sanders, K., Shipton, H., Gomes, J. F. S. (2014) Guest Editors' Introduction: Is The HRM Process Important? Past, Current, And Future Challenges*, Human Resource Management,* 53(4): 489–503.

Shakina, E., Barajas A. (2013) The Contribution of Intellectual Capital to Value Creation, *Contemporary Economics*, 7(4): 41-56.

Simmie, J., Strambach, S. (2006) The Contribution of KIBS to Innovation in Cities: an Evolutionary and Institutional Perspective, *Journal of Knowledge Management,* 10(5): 26–40.

Skapska, E., Samul, J. (2015) Human capital indicators in service industries: from workforce profile to output measures, *European Scientific Journal,* 11(10): 292-301.

Swart, J. (2007). Human resource management and knowledge workers, In Boxall, P., Purcell, J. Wright, P. (Eds), *Oxford Handbook of Human Resource Management*, Oxford University Press, Oxford.

Sydler, R., Haefliger, S., Pruksa, R. (2014) Measuring intellectual capital with financial figures: Can we predict firm profitability?, *European Management Journal,* 32: 244–259.

Tether, B.S., Hipp, C. (2002) Knowledge intensive, technical and other services: Patterns of competitiveness and innovation compared, *Technology Analysis & Strategic Management,* 14(2): 163–182.

Toivonen, M. (2006) Future prospects of knowledge-intensive business services (KIBS) and implications to regional economies, *ICFAI Journal of Knowledge Management,* 4(3): 18–33.

Viljamaa, A., Kolehmainen, J., Kuusisto, J. (2010) For or against? An exploration of inadvertent influences of policies on KIBS industries in the Finish policy setting, *The Service Industries Journal*, 30(1): 71-84.

Wong, P.K., Singh, A. (2004) The pattern of innovation in the knowledge-intensive business services sector of Singapore, *Singapore Management Review*, 26(1): 21–44.

Zahra, A.S., George, G. (2002) Absorptive capacity: a review, reconceptualization, and extension, *Academy of Management Review,* 27(2): 185-203.

Ženka, J., Novotný, J., Slach, O., Ivan, I. (2017) Spatial distribution of knowledge-intensive business services in a small post-communist economy. *Journal of the Knowledge Economy*, 8(2): 385-406.

AUTOMATING FORWARD AND REVERSE SUPPLY CHAINS IN THE CONTEXT OF INDUSTRY 4.0

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Abstract
The 4th industrial revolution brings in a transformation of the traditional supply chain towards a digital supply chain. The machines will be able to use algorithms that will enable them to automate the supply chain formation process and to quickly react to disruptions. The current approach proposes a mechanism based on a message passing inference scheme in order to address the automated supply chain formation problem in a closed-loop supply chain by integrating forward and reverse supply chains. Forward supply chain imply a series of activities required to produce new products from virgin materials and distribute them to consumers while reverse supply chains require collecting used products from consumers and reprocessing them to either recover their leftover market values or dispose of them. It has become common for companies involved in a forward supply chain to also carry out collection and reprocessing of used products. Strict environmental regulations and diminishing raw material resources have intensified the importance of reverse supply chains at an increasing rate. The proposed mechanism is evaluated using two type of supply chain configurations from textile and automobile industry, demonstrating that automated integration of reverse supply chains along with forward supply chains, lead to benefits for the participants in the supply chain.

JEL classification: C61

Keywords: Forward Supply Chain, Reverse Supply Chain, Closed-Loop, Automated Supply Chain Formation, Belief Propagation

1. Introduction

The closed-loop represents an important topic within the domain of supply chain (SC) formation in the recent times. A closed-loop supply chain implies combining the forward supply chain with reverse SC, maintaining and recovering value from used products, while helping to create as little waste as possible (Govindan et al., 2015).

Due to environmental regulations or consumer pressures, the companies are being constrained to set up reverse supply chains (Patroklos, Besoiu, 2010).

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For instance, the Waste Electrical and Electronic Equipment (WEEE) directive (directive 2002/96/EC) became European law in 2003, which contains mandatory requirements on collection, recycling, and recovery for all types of electrical goods, with a minimum rate of 4 kilograms per head of population per annum (Patroklos, Besoiu, 2010). WEEE-like legislation was also introduced in Canada, Japan, China, and many states in the US (Quariguasi Frota Neto, et al., 2010).

In a forward supply chain, the customer is typically the final entity of the process. However, a closed-loop supply chain includes the returns processes, the reverse supply chains being now a revenue opportunity for manufacturers instead of a cost-minimization approach (Guide, Van Wassenhove, 2009). Industry 4.0 transformations will enable machines to make autonomous decisions, hence there is need to create algorithms that will enable the shift from traditional supply chains to the digital supply chains of the future by automating several process.

Several studies have been conducted regarding automation of the Forward Supply Chain Formation (SCF). The work of Cerquides et al. (2007), Collins et al. (2002) and Walsh et al. (2000) addressed the problem by means of combinatorial auctions that compute the optimal SC allocation in a centralized manner. Recent papers that consider the SCF problem are using a message passing mechanism in graphical models in order to solve the SCF problem. In Winsper and Chli (2010, 2012, 2013), a decentralized and distributed approximate inference scheme, named Loopy Belief Propagation (LBP) was applied to the SCF problem, noting that the passing of messages is comparable to the placing of bids in standard auction-based approaches. The authors show that the SCF problem can be cast as an optimization problem that can be efficiently approximated using max-sum algorithm (Bishop, 2006). Thus, the authors offer the means of converting a SCF problem into a local term graph, on which max-sum can operate. As LBP suffers of scalability issues in Penya-Alba et al. (2012) the authors introduce the Reduced Binarized Loopy Belief Propagation algorithm (RB-LBP). RB-LBP is based on the max-sum algorithm and introduces binary variables in order to encode decoupled buy and sell decisions and a selection term and an equality term in order to assure coherent decisions between participants.

However, the existing research literature for automation of the supply chain formation does not consider automating also the reverse supply chains as a closed-loop.

Hence the current work proposes a mechanism for automating the closed-loop supply chain and also evaluates the impact of integrating reverse supply chains along with forward supply chains.

The paper is structured as follows: the first section provides an introduction of the considered problem, section 2 provides the fundamentals of the concept of Industry 4.0, section 3 describes the terms of forward and reverse supply chain and emphasizes the differences between them, section 4 highlights the challenges for reverse supply chain, section 5 provides the description of existing work regarding automated supply chain formation, section 6 describes our proposed mechanism for automated closed-loop formation, section 7 provides implementation details and evaluation and finally section 8 provides conclusions and future work.

2. Fundamentals of Industry 4.0

Industry 4.0 specifically involves a radical change in how production process currently operate. Defined by many as a global transformation of the manufacturing industry by the introduction of digitalization and the Internet, these transformations consider revolutionary improvements in the design and manufacturing processes, operations and services of manufacturing products and systems. The notion of Industry 4.0 has been labeled in different ways as: Smart Industry, Smart Factories, Advanced Manufacturing or Industrial Internet of Things (IIoT). A smart factory is referred to as the use of new innovative developments in digital technology including "advanced robotics and artificial intelligence, hi-tech sensors, cloud computing, the Internet of Things, data capture and analytics, digital fabrication (including 3D printing), software-as-a-service and other new marketing models, mobile devices, platforms that use algorithms to direct motor vehicles (including navigation tools, ride-sharing apps, delivery and ride services, and autonomous vehicles), and the embedding of all these elements in an interoperable global value chain, shared by many companies from many countries" (Geissbauer et al., 2016). Within the context of Industry 4.0, the factory of the future will enable the connection between machines and human-beings in Cyber-Physical-Systems (CPSs). These new systems focus their resources on the introduction of intelligent products and industrial processes that will allow the industry to face rapid changes in shopping patterns (Brettel et al., 2014). Generally speaking, the term Industry 4.0 involves four main features (Hahn, 2014):

Horizontal integration via a new generation of global value chain networks: The implementation of the CPS within the smart factory requires strategies, networks and business models to accomplish a horizontal integration, which subsequently provides high levels of flexibility, enabling the company to respond faster. The transparency within the value chain allows the manufacturer to identify changes in customer requirements and to reflect them in all of the production steps, from development to distribution.

Vertical networking of smart production systems: This type of networking is based on CPSs to build reconfigurable factories that are flexible and react rapidly to changes in the customer demand. Manufacturing processes in a smart factory enable the true mass customization. It enables not only autonomous organization of production management but also maintenance management. Resources and products are networked, and materials and parts can be located anywhere and at any time. All processing stages in the production process are logged, with discrepancies registered automatically.

Through-life engineering support across the entire value chain: Innovation and technical improvements in engineering are present in the design, development and manufacturing processes. These enable the creation of new products and production systems utilizing a large amount of information (big-data).

Acceleration through exponential technologies: The implementation of innovative technologies enables companies to reduce costs, increase flexibility and customize the product. Industry 4.0 involves automated systems including Artificial Intelligence (AI), robots, drones, nanotechnologies and a variety of inputs that enable customization, flexibility and rapid manufacturing.

Industry 4.0 also promotes the use of big data, IoT and Artificial Intelligence (AI) as one. This revolution envisages an environment whereby smart machines can communicate with one another, not only to enable the automation of production lines but also to analyze and understand a certain level of production issues and, with minimal human involvement, to solve them. Even though this revolution is initially considered to affect mostly manufacturing industries, these innovations will affect retailers, operations companies as well as service providers.

3. Forward and Reverse Supply Chains

The forward supply chain (FSC) includes of series of activities in the process of converting raw materials to finished products. The managers try to improve forward supply chain performances in areas such as demand management, procurement, and order fulfillment (Cooper et al., 1997).

Reverse supply chain (RSC) is defined as the activities of the collection and recovery of product returns in supply chain management (SCM). Economic features, government directions, and customer pressure are three aspects of reverse logistics (Melo, et al., 2009). Generally, there are more supply points than demand points in reverse logistics networks when they are compared with forward networks (Snyder, 2006). Reverse logistics include the process of planning, implementing and controlling the inbound flow and storage of secondary goods and related information opposite to the traditional supply chain directions for the purpose of recovering value and proper disposal (Fleischmann, 2001).

The reverse supply chain, starts from end producers where used products are collected from customers (return products) and then attempts to manage end of life (EOL) products through different decisions are undertaken including recycling (to have more raw materials or raw parts), remanufacturing (to resale them to first customers) and finally, disposing of some used parts. Table 1 presents difference in forward and reverse supply chains.

For instance, the discarded plastic polyethylene terephthalate (PET) bottles are collected from the market, then are either remanufactured or used as regrind mixed with virgin PET to produce new bottles to satisfy varying demand. Kodak remanufactures its single-use cameras after the film has been developed. H&M collects unwanted clothes, placing easily accessible collection boxes in almost all H&M stores, rewarding contributors with discounts as thanks. All collected clothes are then recycled into the first new yarn to make new clothes and then they are blended in about 20% of these fibers without any loss of quality or longevity. Within the automobile industry companies like Bosch, Volvo and General Motors are the few ones to name which have successfully implemented the reverse logistics in their supply chain management.

If we consider the forward and reverse supply chains simultaneously, the result network will construct a closed-loop supply chain. In general, the companies that have been most successful with their reverse supply chains are those that closely coordinate them with their forward supply chains, within a closed-loop system. For example, they make product design and manufacturing decisions with eventual recycling and reconditioning in mind.

Table 1 Differences in forward and reverse supply chains

Forward	Reverse
Forecasting relatively straightforward	Forecasting more difficult
One to many transportation	Many to one transportation
Product quality uniform	Product quality not uniform
Destination/routing clear	Product packaging often damaged
Standardized channel	Destination/routing unclear
Disposition options	Exception driven
Pricing relatively uniform	Disposition not clear
Importance of speed recognized	Pricing dependent on many factors
Forward distribution costs closely monitored by accounting systems	Speed often not considered a priority
Inventory management consistent	Reverse costs less directly visible
Product lifecycle manageable	Inventory management not consistent
Negotiation between parties straightforward	Product lifecycle issues more complex
Marketing methods well-known	Negotiation complicated by additional considerations
Real-time information readily available to track product	Marketing complicated by several factors

Source: Tibben-Lembke and Rogers, 2002

There are multiple reasons for implementing or operating through the reverse logistics systems. The economic, legal, and social reasons are among the few important ones to name. The economic reasons are the direct reasons behind the popularity of reverse logistics. Reverse logistics essentially helps in reduction of disposal costs and the usage of raw materials. Also, any indulgence in the reverse logistics essentially depict the significance of environmentally responsible behavior for the ensuring the improvements in customer relations (Ravi, Shankar, 2012), (Khan et al., 2016). There are also several legal bindings for being indulged in the reverse logistics. For instance, the companies in European Union are required to ensure the most appropriate disposal or recovery of waste that is a result of their production activities. According to Grabara et al. (2014) and Rubio and Parra (2014) there are also social reasons behind the increasing attention paid to reverse logistics. There is an ever increasing awareness in the society for protecting the environment and capitalizing over the scarce resources. Thus, reverse logistics facilitate the companies to be environment friendly as carbon emission and waste generation is immensely reduced.

4. Challenges for Reverse Logistics

There are different challenges which underline the implementation of reverse logistics in the supply chain management of companies. According to Demirel et al. (2014) and Khan et al. (2017) there are the challenges due to which companies hesitate to become involved in the process of reverse logistics. Below are highlighted the most important challenges for the implementation of reverse logistics in the supply chain management of companies.

Willingness to Pay: One of the most important challenges that highlight the utilization of reverse logistics is the minimum willingness to pay for the products. There is a general assumption amongst consumers that remanufactured products are not as effective and useful as the newly made products are. This assumption directly impacts the willingness to pay for the remanufactured products. Consumers essentially believe that the remanufactured products have a lower value than the original products (Chan et al., 2012). Consumers are not at all willing to pay any premium prices for such products as compared to the genuine products. This is one of the most important challenges that force the organizations not to be involved in the reverse logistics process. Consumers urge that companies must clearly state that the products are remanufactured.

Consumers' Perception: Another important challenge that entails the domain of reverse logistics is related to the consumers' perceptions. Consumers do not buy products without the satisfaction of the product's quality. If the remanufactured products are priced low, consumers would believe that the quality is low and thus only few consumers would pay for such products (Ravi, Shankar, 2012).

Cannibalization: Remanufacturing of old products may cannibalize the sales of new products, if the customers are convinced to purchase the remanufactured products. This might lead to a situation where companies are not able to sell their new products. However, the underlying benefits associated with the remanufacturing can easily outcast the costs of cannibalization (Aitken, Harrison, 2013).

5. Background for Automating Supply Chains

The Supply Chain Formation (SCF) problem has been widely studied by the multi-agent systems community using computational agents that act in behalf of the participants during the SCF process and making possible to form SCs in a fraction of the time required by the manual approach (Walsh et al., 2000, Collins et al., 2002, Walsh, Wellman, 2003, Cerquides et al., 2007, Giovannucci et al., 2008, Winsper, Chli, 2010, Mikhaylov et al., 2011, Winsper, Chli, 2012, Winsper, Chli, 2013).

The SCF methods can be classified in three categories depending on the architecture they follow. A first division is to separate SCF into centralized and decentralized architectures. Furthermore, we can separate the decentralized methods into two further categories depending on whether the communication between participants is either direct or mediated.

In a centralized approach (Walsh et al., 2000, Collins et al., 2002, Cerquides et al., 2007, Giovannucci et al., 2008, Mikhaylov et al., 2011), participant agents inform a central authority of their preferences (encoded as offers). After collecting the offers of all participant agents, the central authority determines the resulting SC.

Decentralized SCF appears as an alternative to centralized SCF in order to overcome some of its limitations as: participants might be reluctant to share this information with any central authority, given the hardness of the SCF problem centralized optimal solvers might suffer from scalability issues, the existence of a central authority introduces a single point of failure for the SCF process.

One approach to decentralized SCF is that of mediated SCF. In this setting, participant agents resort to local markets in which the goods they want to sell or buy are being traded (Walsh et al., 2000, Walsh, Wellman, 2003). The authors proposed a market protocol with bidding restrictions referred to as simultaneous

ascending (M+1)st price with simple bidding (SAMP-SB), which uses a series of simultaneous ascending double auctions. SAMP-SB was shown to be capable of producing highly-valued allocations solutions which maximize the difference between the costs of participating producers and the values obtained by participating consumers over several network structures, although it frequently struggled on networks where competitive equilibrium did not exist. The authors also proposed a similar protocol, SAMP-SB-D, with the provision for de-commitment in order to remedy the inefficiencies caused by solutions in which one or more producers acquire an incomplete set of complementary input goods and are unable to produce their output good, leading to negative utility.

Another approach to decentralized SCF is Peer-to-Peer (P2P), where each participant agent communicates directly with the participant agents representing its potential buyers and sellers (Winsper, Chli, 2010), (Penya-Alba, 2012). Therefore, the SCF process takes place between participant agents with no intervention of any third party, thus preserving participants' privacy since they only need to share their preferences with local trusted parties rather than communicating them to a central authority and it offers better scalability for large scenarios due to the fact that each participant is responsible of a small part of the computation.

Loopy Belief Propagation (LBP) is the first peer to peer approach that has been used to solve the SCF problem in a decentralized manner (Winsper, Chli, 2010, 2012, 2013). The work in Winsper and Chli (2013) shows that the SCF problem can be cast as an optimization problem that can be efficiently approximated using max-sum algorithm for loopy graphs or can find exact solutions when the graph is a tree. LBP starts by initializing the beliefs of each agent about each of their possible states to zero. Each agent then passes a message containing a vector of belief values to each of its neighbors in the network. Once all agents have passed a message to each of their neighbors, each agent updates its beliefs based upon the content of the messages it received. The cycle of message passing and belief update continues until the network becomes stable when finally, the states of the variables are determined.

As LBP suffers of scalability issues in (Penya-Alba, 2012) the authors introduce the Reduced Binarized Loopy Belief Propagation algorithm (RB-LBP). RB-LBP is based on the max-sum algorithm and introduces binary variables in order to encode decoupled buy and sell decisions and a selection term and an equality term in order to assure coherent decisions between participants.

A belief propagation-based method, called PD-LBP, was proposed in (Kong et al., 2017) for task allocation in dynamic environments. It is composed of two phases: a pruning phase that aims at reducing the searched resource providers, and a decomposition phase that decomposes the initial network into several independent sub-networks on which is operated in parallel the belief propagation algorithm. Also PD-LBP approach overcomes the limitation of LBP where only the quotes of the participants are considered, by considering both a reserve price and a deadline for agreement to be accomplished.

A decentralized approach for allocating agents to tasks whose costs increase over time was proposed in (Parker et al., 2017) aiming to minimize the increase in task. Based on max-sum algorithm, the authors show how a distributed coordination algorithm, can be used for including costs of tasks that grow over time, enabling a wider range of problems to be solved.

6. Proposed mechanism for automating closed-loop supply chains

The current work considers the problem of supply chain formation as a form of coordinated commercial interaction. The considered supply chain scenario represents a network of production and exchange relationships that spans multiple levels of production or task decomposition.

The entities are characterized in terms of their capabilities to perform tasks, and their interests in having tasks accomplished. A central feature in the considered scenario is hierarchical task decomposition: in order to perform a particular task, an agent may need to achieve some subtasks, which may be delegated to other entity. These may in turn have subtasks that may be delegated, forming a supply chain through a decomposition of task achievement. Constraints on the task assignment arise from the underling suppliers' network as exemplified in Figure 1.

The final product owner X1 at the root of the supply chain can chose among X2, X3, X4 and X8 sub-assembly suppliers. The length of the four possible supply chains is different because there may be 1st tier suppliers that are able to produce the sub assembly without further task decomposition. At lower levels a certain subassembly supplier or a certain part supplier has the option of choosing among multiple possible descendant suppliers. For example X3 may chose X6 or X11 as his fabricated part supplier and X5 may choose between X7 and X12 as raw material suppliers.

Our work aims at providing support for linking end-consumer requirements to underlying suppliers to conjointly guarantee end-to-end agreed contract parameters and integrate the reverse supply chain by recycling and remanufacturing parts of the used good in order to exploit the opportunity for manufacturers. Due to the differences presented in Table 1, the contracts between partners in a closed-loop supply chain involve an increased complexity. For instance, in reverse supply chains the product quality is not uniform, the pricing is dependent on many factors and speed often is not considered a priority while in forward supply chains negotiation between parties is straightforward, in reverse supply chains the negotiation process is complicated by additional considerations.

In order to model the complexity of a closed-loop supply chain, the current work translates the Supply Chain Formation problem in terms of a directed acyclic graph where the nodes are represented by the agents. The entities involved in forward and reverse supply chain are heterogeneous and their payoffs obtained for being part of the supply chain are different and involve all kinds of different variables. These give raise to different utility values for a contract of the participating entities, according to their preferences and their specific interest in participating in the supply chain.

Figure 1. Scenario for Closed-Loop Supply Chain
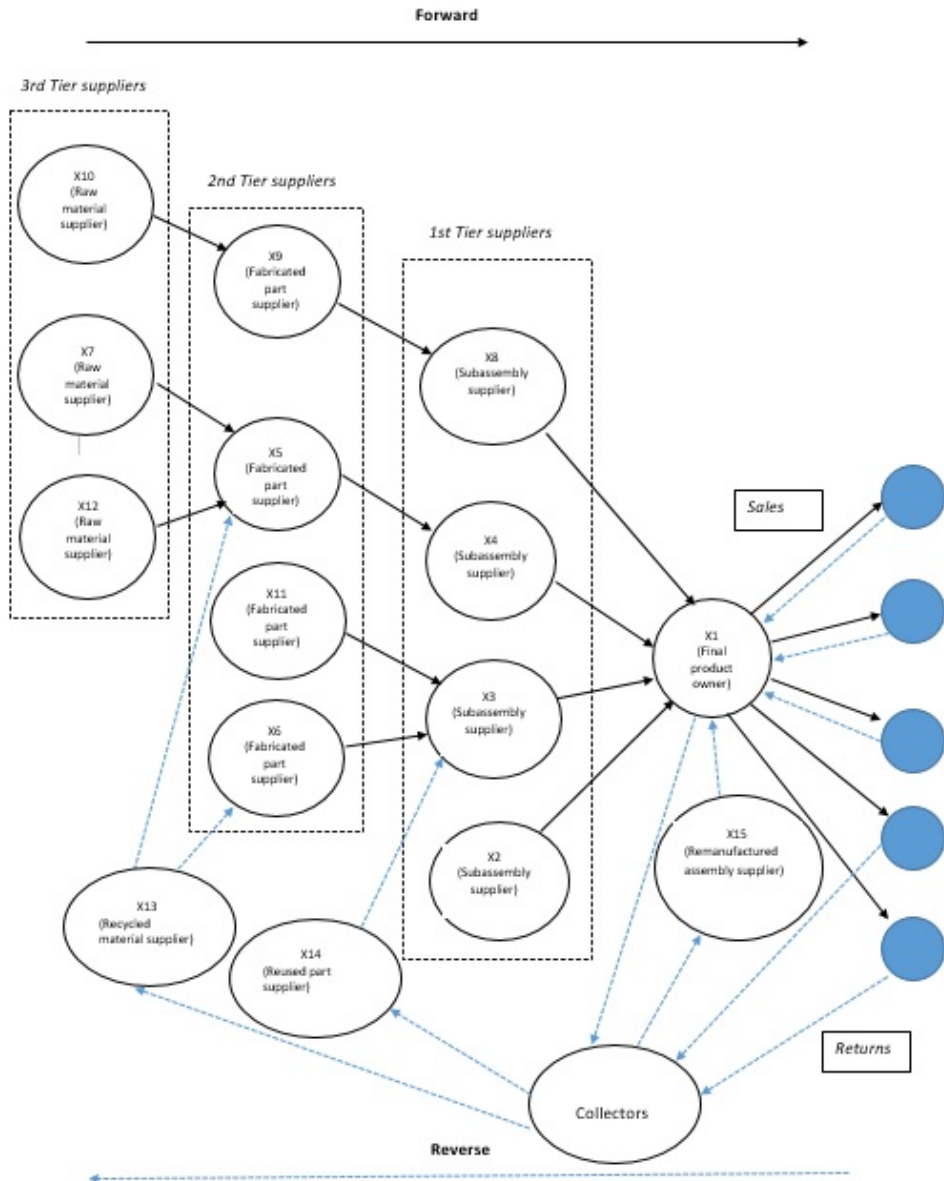
In the following we provide a formal description of the supply chain formation problem in terms of a directed, acyclic graph *(X, E)* where *X= {X₁,X₂, ...,* X_n*}* denote the set of participants in the supply chain represented by agents and a set of edges E connecting agents that might be involved in a form of commercial interaction.

The agents need to agree on multiple contract parameters, the goal being to get a contract that is composed of the actual values of the issues that they have agreed on. Notation $U(v)$ represents the utility that a participant obtains from a contract. When a supplier (seller) negotiates with a consumer (buyer), both parties are interested in obtaining those contract values that maximize their utility functions $U(v)$. This means that during the negotiation, the agents send messages to their neighbors regarding the states of their variables that are maximizing their utility functions.

To solve the SCF problem we need to get an allocation, representing a sub-graph $(X',E') \subseteq (X, E)$. An edge E between Xi, Xj means that agent Xj provides goods to agent X_i. An agent is in an allocation graph if it acquires or provides goods.

The agents communicate one to each other by sending messages according to their preferences over the parameters they share in their contracts. By sending the the max-marginalization of B over A ($max_A(U(a_i,b_j)$)) agent X_i says to X_j which is his preferred value from the set of values for issue B that they share .

$$\lambda_{i \to j}(B) = max_B(U(b_j, c_k) + max_A\left(U(a_i, b_j)\right)) \quad (1)$$

X_j assesses the received message and afterwards adds his own computed utility and finally computes the max marginalization of B over the above terms, according to equation (1) and send it to the next participant in the supply chain.

The message passing process continues until it reaches the final product owner and afterwards the messages are sent back. For example, in Figure 1, the subassembly supplier X3 needs fabricated parts from fabricated part supplier X6 and also from reused parts supplier X14. Either the parts are new or reused the subassembly supplier needs them both in order to assembly an engine for example and to send it further to X1. Hence, X3, X6 and X14 need to agree on parameter time when they discuss about the contacts and afterwards X3 needs to agree further with X1 regarding the delivery time of the subassembly.

The above mechanism provides means for automating closed-loops supply chains described in the considered scenario, in the context of the digitalization process that Industry 4.0 imposes.

7. Implementation and Evaluation

To run the proposed mechanism described in the previous section and to analyze results, we need an implementation of the algorithm within an execution environment. Hence, we describe hereafter our practical implementation of the theoretical solution proposed in the section above.

Our implementation uses the factor graph (.fg) file format from libDAI (Mooij, 2010), which supplies an open source library for approximate inference in graphical models. We specifically use the .fg file format of libDAI, enhancing each factor of our model by specifying which variables occur in that factor, together with the number of possible values for the variable. We add a table listing all the values of that factor for all possible configurations of these variables.

We have implemented the proposed algorithm on Apache Spark2 using the GraphX3 format for graphs and we have used Databricks Community Edition as a platform in order to run our experiments.

Figure 2. Closed-loop supply chain in the textile industry
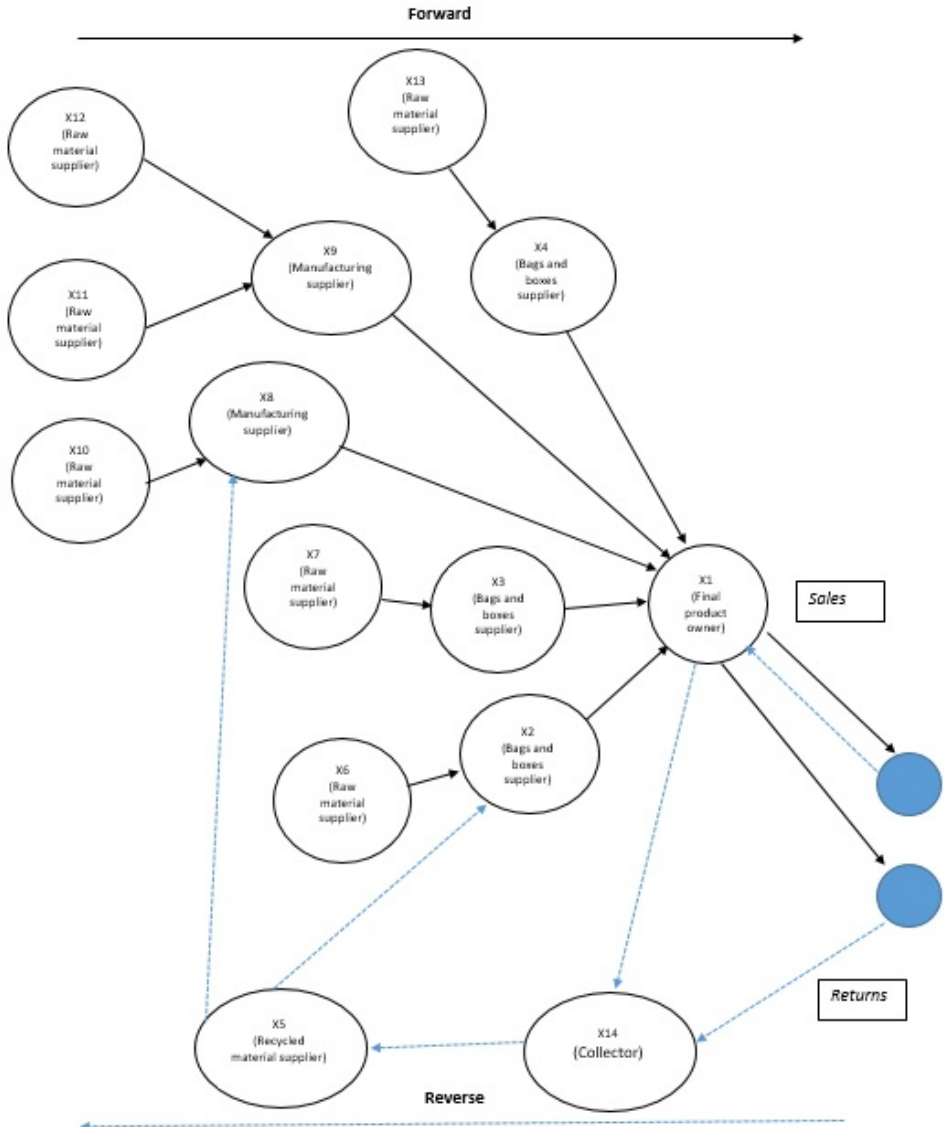
The experiments were run on two types of supply chain configurations from two different industries: the textile industry and automobile industry. The considered configurations of the supply chains are presented in Figure 2 and Figure 3.

The big brands in the fashion industry collect nowadays used clothing in their stores worldwide. The clothes can be any condition or brand, and they are using the clothing they've collected to create all-recycled clothing lines or to create mixed fibers from new raw material and recycled fibers. The returns are extremely effective as the delivered returned goods can be re-launched into the supply chain: either in their current state or after appropriate modification.

Figure 3. Closed-loop supply chain from the automobile industry
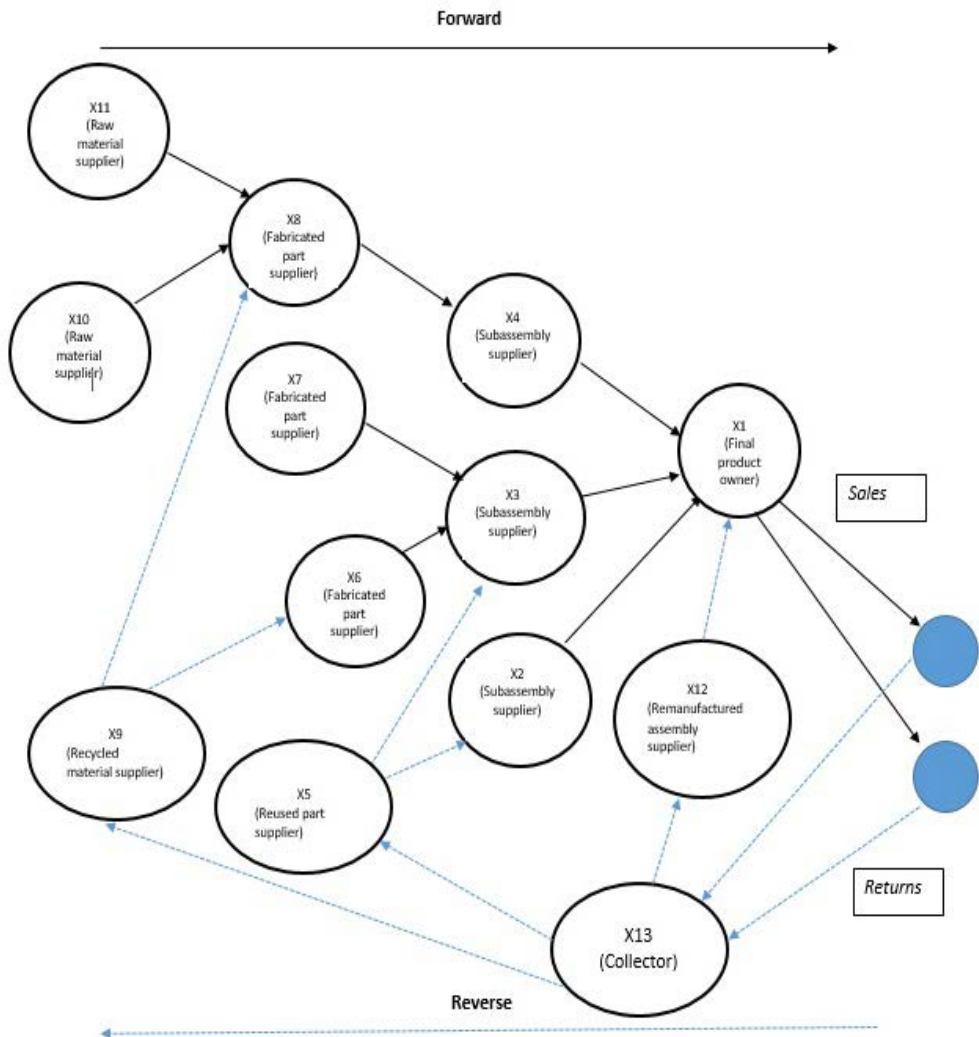
For the automobile industry, the importance of reverse logistics remains incontestable as it becomes dominant due to various reasons. The most important reasons to mention are the increasing product recalls, the changes within the

legislative requirements, and focus over environmental issues. As the time passes, the increased requirement for recovering the returned vehicles is getting enhanced attention mainly owed to the recent environmental concerns. The primary areas that are recovered are parts in working order that are getting reused, assemblies such as engines, alternators, starters and transmissions that are remanufactured and materials that are recycled.

To estimate the impact and the benefits of implementing closed-loop supply chains we have run series of experiments in two stages: in the first stage we are using only forward supply chains and at the second stage we have run experiments using closed loop supply chains.

The utility functions assigned to every participant in the supply chain, involve two up to three parameters like price, time and quality. Every participant gives a certain weight for each parameter in his utility function in order to express his preference over the parameters. Hence, for each one of the two networks configuration considered, we randomly generated weights for the final product owner in order to obtain three categories of utility functions: "price-pref", "time-pref", "quality-pref". We have named the categories according to the most weighted parameter, in order to emphasize the preference over the considered parameters. Figures 4-9 emphasize the experiments results.
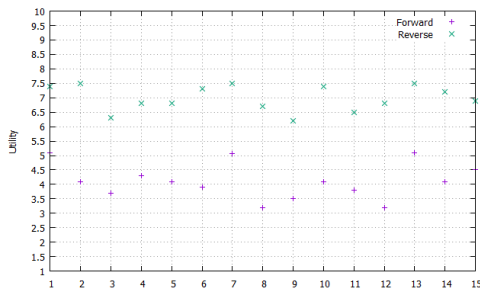
Figure 4. Textile industry "price-pref"   **Figure 5. Textile industry "quality-pref"**
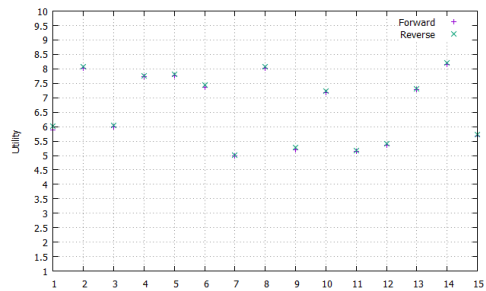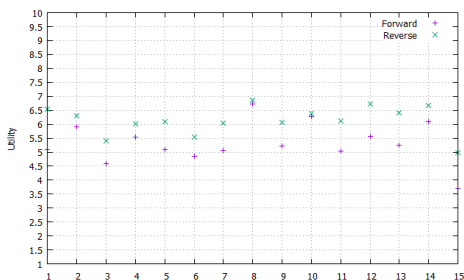

Figure 6. Textile industry "time-pref"   **Figure 7. Auto industry "price-pref"**
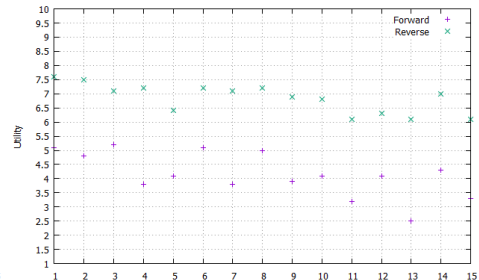
Figure 8. Auto industry "quality-pref"   **Figure 9. Auto industry "time-pref"**
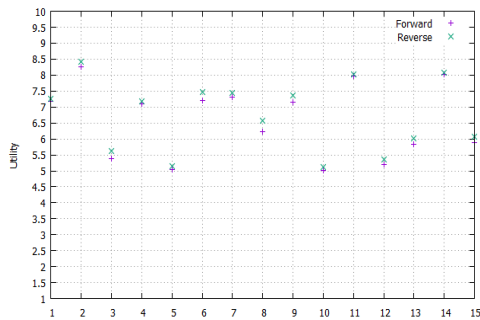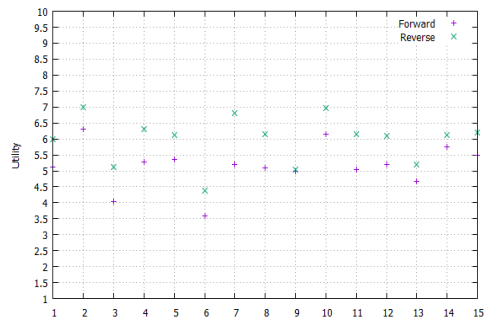
On the other side, Figure 5 and 8 show that when participants own "quality-pref" utility functions, integrating reverse supply chains doesn't bring much benefits over forward supply chains. This might be due to the fact that the final owner of the product cannot accept a lower quality for the products when using recycled raw materials or remanufactured assemblies. Figure 6 and 9 show that when time is the most important criteria, integrating reverse supply chains can bring certain advantages. Even the impact is not as high as when using "price-pref" utility functions, it stills brings a higher utility for the entities in the supply chain.

The forecasts regarding the recycled materials may be more difficult to estimate as there is no certain amount of returns when using reverse supply chains, therefore the entities in the supply chains might need to agree longer periods for delivering the required products.

It can be observed that the above presented trends are present in both considered industries: textile and automobile industry. Hence, we can say that integrating reverse supply chains along with forward supply chains can bring certain advantages to the final owner of the product, even though it might face several challenges in the integrating process like: no uniform product quality, difficult forecasting of the delivered quantities, longer negotiated periods for delivering products.

8. Conclusions

Initially, the growing attention on Reverse Supply Chains and Closed-Loop Supply Chain issues originated with public awareness. Then governmental legislation forced producers to take care of their end of life products. In other cases, companies are taking the initiative, seeing opportunities to reduce their operating costs by reusing products or components.

The current work proposed a mechanism that can automate the formation of supply chains in the in the context of Industry 4.0 using utility functions that can capture the increased complexity in closed-loop supply chains. Previous work regarding automating supply chains was focusing only on the forward supply chains, hence the proposed mechanisms advances the state of the art regarding supply chain formation by providing support to integrate the reverse supply chain by recycling and remanufacturing parts of the used good in order to exploit the opportunity for manufacturers. The integration of forward and reverse supply chains in a closed-

loop supply chain involve an increased complexity of the contracts between the entities in the supply chain as in reverse supply chains the product quality is not uniform, the pricing is dependent on many factors and speed often is not considered a priority while in forward supply chains negotiation between parties is straightforward, in reverse supply chains the negotiation process is complicated by additional considerations.

However, the proposed mechanism may encounter efficiency issues when the contract parameters are taking values over continuous domains.

For further research, it is recommended to evaluate the impact of the integrating reverse supply chains along with forward supply chains, when incorporating more issues in the utility functions of the entities involved in the supply chain. Whether a company is using a closed loop supply chain by choice or necessity, it will face many challenges. It will have to educate customers and establish new points of contact with them, decide which activities to outsource and which to do itself, and in general figure out how to keep costs to a minimum while discovering innovative ways to recover value while meeting stringent environmental standards.

References

Aitken, J., Harrison, A. (2013). Supply governance structures for reverse logistics systems. *International Journal of Operations & Production Management,* 33(6), 745-764.

Bishop, C. (2006). *Pattern recognition and machine learning.* New York: Springer.

Brettel, M., Friederichsen, N., Keller, M., Rosenberg, M., 2014. How Virtualization, Decentralization and Network Building Change the Man-Ufacturing Landscape: An Industry 4.0 Perspective. *International Journal of Mechanical, Industrial Science and Engineering,* Volume 8, 37-44.

Cerquides, J., Endriss, U., Giovannucci, . A., Rodriguez-Aguilar, J. A. (2007). *Bidding languages and winner determination for mixed multi-unit combinatorial auctions.* s.l., IJCAI, Morgan Kaufmann Publishers Inc..

Chan, F., Chan, H., Jain, V. (2012). A framework of reverse logistics for the automobile industry. *International Journal of Production Research,* 50(5), 1318-1331.

Collins, J., Ketter, W., Gini, M., Mobasher, B. (2002). A multi-agent negotiation testbed for contracting tasks with temporal and precedence constraints. *International Journal of Electronic Commerce,* Vol. 7.

Cooper, M., Lambert, D., Pagh, J. D. (1997). Supply chain management: more than a new name for logistics. *The International Journal of Logistics Management,* 8(1), 1-9.

Demirel, E., Demirel, N., Gökçen , H. (2014). A mixed integer linear programming model to optimize reverse logistics activities of end-of-life vehicles in Turkey. *Journal of Cleaner Production.*

Fleischmann, M. (2001). Quantitative Models for Reverse Logistics. In: *Lecture Notes in Economics and Mathematical Systems.*, p. 501.

Geissbauer, R., Vedsø, J., Schrauf, S. (2016). A Strategist's Guide to Industry 4.0: Global businesses are about to integrate their operations into a seamless digital whole, and thereby change the world.. *Strategy and Business*.

Giovannucci, A., Cerquides, J., Rodríguez-Aguilar, J. (2010). Composing supply chains through multiunit combinatorial reverse auctions with transformability relationships among goods. *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans,* 40(4), 767-778.

Giovannucci, A., Vinyals, M., Rodriguez-Aguilar, J., Cerquides, J. (2008). *Computationally-efficient winner determination for mixed multi-unit combinatorial auctions.* s.l., Proceedings of the 7th international joint conference on Autonomous agents and multiagent systems, Vol. 2, 1071–1078.

Govindan, K., Soleimani, H., Kannan, D. (2015). *Reverse logistics and closed-loop supply chain: A comprehensive review to explore the future*, European Journal of Operational Research, Volume 240, Issue 3, 603-626

Grabara, J., Man, M., Kolcun, M. (2014). The benefits of reverse logistics. *International Letters of Social and Humanistic Sciences,* Vol. 15, 138-147.

Guide, V., Van Wassenhove, L. (2009). The evolution of closed-loop supply chain research. *Operations Research,* 57(1), 10-18.

Hahn, T. (2014). *Future of Manufacturing - View on enabling technologies,* s.l.: Siemens Corporate Technology.

Khan, S. A. R., Qianli, D., SongBo, W., Zaman, K., 2017. Environmental logistics performance indicators affecting per capita income and sectoral growth: evidence from a panel of selected global ranked logistics countries. *Environmental Science and Pollution Research,* 24(2), 1518-1531.

Khan, S. A. R., Zaman, K., Zhang, Y. (2016). The relationship between energy-resource depletion, climate change, health resources and the environmental Kuznets curve: Evidence from the panel of selected developed countries. *Renewable and Sustainable Energy Review,* Vol. 62, 468–477.

Kong, Y., Zhang M., Ye, D. (2017) A Belief Propagation-based Method for Task Allocation in Open and Dynamic Cloud Environments, *Knowledge-Based Systems,* vol. 115, 123-132.

Melo, M., Nickel, S., Saldanha-da-Gama, F. (2009). Facility location and supply chain management – A review. *European Journal of Operational Research,* 196(2), 401-412.

Mikhaylov, B., Cerquides, J., Rodriguez-Aguilar, J. (2011). Solving sequential mixed auctions with integer programming. *Advances in Artificial Intelligence, Springer,* 42-53.

Mooij, J. M. (2010). libDAI: A free and open source c++ library for discrete approximate inference in graphical models. *Journal of Machine Learning Research,* Volume 11, 2169–2173.

Parker, J., Farinelli A., Gini, M. (2017). Max-Sum for Allocation of Changing Cost Tasks, *Intelligent Autonomous System. Advances in Intelligent Systems and Computing,* vol. 531, 629-642.

Patroklos, P., Besoiu, M., 2010. Environmental and economical sustainability of WEEE closed-loop supply chains with recycling: a system dynamics analysis. *The International Journal of Advanced Manufacturing Technology,* 47(5-8), 475–493.

Penya-Alba, T., Vinyals, M., Cerquides, J., Rodriguez-Aquilar, J. (2012). *A scalable Message-Passing Algorithm for Supply Chain Formation.* s.l., 26th Conference on Artificial Intelligence.

Quariguasi Frota Neto, J., Walther, G., Bloemhof, J., van Nunen, J.A.E.E., Spengler, T. (2010). From closed-loop to sustainable supply chains:The WEEE case. *International Journal of Production Research,* 48(15), 4463-4481.

Ravi, V., Shankar, R. (2012). Evaluating alternatives in reverse logistics for automobile organisations. *International,* 12(1), 32-51.

Rubio, S., Parra, B. (2014). Reverse Logistics: Overview and Challenges for Supply Chain Management. *International Journal of Engineering Business Management,* vol. 6.

Snyder, L. V. (2006). Facility location under uncertainty: A review. *IIE Transactions,* 38(7), 537-554.

Tibben-Lembke, R., Rogers, D. (2002). Differences between forward and reverse logistics in a retail environment. *Supply Chain Management: An International Journal,* 7(5), 271-282.

Walsh , W. E., Wellman, M. P., Ygge, F. (2000). *Combinatorial auctions for supply chain formation*, Proceedings of the 2nd ACM conference on Electronic commerce.

Walsh, W., Wellman, M. P. (2003). Decentralized supply chain formation: A market protocol and competitive equilibrium analysis. *Journal of Artificail Intelligence Research,* Volume 19, 513-567.

Winsper, M., Chli, M. (2013). Decentralized supply chain formation using max-sum loopy belief propagation. *Computational Intelligence,* 29(2), 281-309.

Winsper, M., Chli, M. (2010). Decentralised supply chain formation: A belief propagation-based approach. *Agent-Mediated Electronic Commerce.*

Winsper, M., Chli, M. (2012). *Using the max-sum algorithm for supply chain formation in dynamic multi-unit environments.* s.l.: Proceedings of the 11th International Conference on Autonomous Agents and Multiagent Systems.

A CAUSALITY ANALYSIS OF THE RELATIONSHIPS BETWEEN GROSS FIXED CAPITAL FORMATION, ECONOMIC GROWTH AND EMPLOYMENT IN SOUTH AFRICA

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Abstract
In terms of macro-economic policy, gross fixed capital formation, which is the major component of domestic investment, is seen as an important process that could accelerate economic growth. This study re-examines the controversial issue of causality between domestic investment, employment and economic growth using South African data. The traditional assumption of causality running from investment to economic growth has remained inconclusive while empirical findings on the investment and employment growth nexus are also largely unsettled. The study makes use of quarterly data from 1995Q1 to 2016Q4 within the framework of the Johansen cointegration and Vector Error Correction Models (VECM). The empirical findings suggest that a long run relationship exists between domestic investment, employment and economic growth, with causality running from economic growth to investment and not vice versa. The results also demonstrate that investment has a positive long-run impact on employment. The empirical evidence further suggests bi-directional causality between employment and economic growth, while evidence of uni-directional causality, from investment to employment, is also found. The major implication of the study is that although there is bi-directional causality between economic growth and employment, economic growth does not translate to increased employment in the long run confirming "jobless growth". Investment is found to be a positive driver of employment in the South African economy in the long-run. The study concludes that, in order to stimulate employment, investment enhancing policies, such as low interest rates and a favourable economic environment should be put in place to accelerate growth. Measures to promote economic growth, such as improved infrastructural facilities and diversification of the economy, should be further engineered so as to encourage increased investment.

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1. Introduction

Domestic investment, or gross fixed capital formation, has in terms of theory recognized as an essential component to facilitate economic growth and employment (Overseas Development Institute (ODI, 2016)). Keynes argued that new and additional investment increases the aggregate demand in the economy (Tobin, 1965). An increase in domestic investment occurs when existing firms make new investment or new domestic investors enter the market (Faulkner, Loewald & Makrelov, 2013). Theoretically, an increase in investment is expected to provide more jobs or increase the employment level. Meanwhile, higher growth rate of the economy has also been agued to stimulate domestic investments. As a result, from theoretical point of view, there exists bi-directional causality between investment and economic growth. However, improvements in innovation, science and technology, which have resulted in manpower being displaced by machines and leading to a situation known as "*jobless growth*" may undermine the role of investment in accelerating the growth of an economy (Coombs & Green, 1981; Hodge, 2009). Some of the functions previously performed by people have been computerised or mechanised, a process which allows certain types of work to be completed more efficiently and more cost effectively, enhancing productivity (Davis, 1991). In sum, this process may result in employment losses in the economy and consequently lead to jobless growth (Frey & Osborne, 2015).

Empirical literature has established a robust positive relationship between investment and economic growth (Levine & Renelt, 1992; Mankiw *et al.*, 1992; De Long & Summers, 1992). However, there are limited empirical studies that consider the impact of investment on employment creation in the literature. De Long and Summers (1992) assert that the positive association actually represents a causal link running from investment to economic growth. In this view, increased growth is triggered by higher investment rates or higher capital formation in the form of investment in equipment. However, Kuznet (1973) was of the opinion that there were cases where acceleration in growth had preceded increases in investment. By implication, he argued there could be cases where the causal link could run from economic growth to investment; not vice versa. Few empirical findings have supported this claim in the literature. Motivated by this claim, Summers and Heston (1991) investigated a set of 101 Organization for Economic Co-operation and Development (OECD) countries using averages of investment shares and economic growth over the post war period: they observed that an increase in the level of investment is preceded by steady and long term economic growth. Blomstrom *et al.* (1996) found that economic growth Granger-cause investment, but investment does not Granger-cause economic growth. Similar results are reported by Carroll and Weil (1994). This has led to an interrogation of the earliest theoretical position that investment Granger-causes long-run economic growth and not vice versa. This study revisits the relationship on the direction of causality between investment and

economic growth on the one hand, and between investment and employment on the other. Also, most of the existing empirical studies have mainly focused on the nexus between foreign direct investments and economic growth. The study would be contributing to scarce empirical studies on the relationship between domestic investments, employments and economic growth. The remainder of the study is structured as follows: Section 2 reviews relevant theories and literature while Section 3 presents the econometric methods and procedures. Section 4 provides the empirical results; the last section, 5, concludes the study.

2. Literature Review

The central role of domestic investment as one of the engines of growth is contained in several economic growth theories (Keller & Yeaple, 2009). Reig (2013) mentions the classical political economy of the nineteenth century, the Keynesian view of growth (Harrod-Domar model), the neoclassical growth theory (Solow and Denison) and the endogenous growth theories. This theoretical position was examined in the light of several empirical studies. Bond *et al*. (2007) discover evidence for 94 non-OECD countries where a major share of investment in economic growth generates a higher level of output per worker, as well as a higher rate of growth in the long term. On the contrary, there is not much empirical evidence in favour of investment leading to economic growth. In this study, Bond *et al*. (2007) mention that a large number of recent studies have found that investment does not Granger cause economic growth, such as Jones (1995) and Blomstrom *et al.* (1996). These approaches address the issue of investment by means of different emphases but all agree that investment is important in explaining the growth pattern of the economy (Mordecki & Ramírez, 2008).

Other authors have emphasised that causality does not move from investment to growth, because in most cases, investment levels depend on the preceding business cycles (Mordecki & Ramírez, 2008; McKinnon, 2010). Antelo and Valverde (1994), on the other hand, investigated private investment in Bolivia. They argued in view of the Keynesian theory that investment affects economic growth positively and depends on the expected rate of return of capital. Antelo and Valverde (1994) added that according to the neoclassical theory, investment depends on economic growth and interest rates. However, in developing countries where financial markets are less developed, the level of interest rate is not a significant determinant of investment. Attanasio *et al.* (2000) found that investment Granger causes growth; another related study by Bond *et al.* (2004), also provides evidence that investment Granger causes economic growth. They investigated 94 countries; their empirical findings also suggest that a major share of investment in GDP generates a higher level of output per worker, as well as a higher rate of growth in the long term. Meanwhile, Cheung *et al.* (2012), found heterogeneity in the relationship between investment and growth. They examined the case of 188 rich and poor countries. Their empirical findings largely suggest a negative association between investment and economic growth. This, they argued, is particularly true for developing countries. Similarly, Ibarra and Moreno-Brid (2004), who studied the relationship between economic growth, investment and foreign direct investment (FDI) in Mexico, find that investment depends crucially on economic growth and real wages.

Mordecki and Ramírez (2014) investigated the relationship between domestic investment, economic growth and employment in Uruguay, using a VECM framework. Their findings propose a long-term relationship between economic growth, investment and employment. The Granger test results suggest that economic growth precedes investment and employment, while investment also precedes employment. Podrecca and Carmeci (2001) examined the causal relationship between investment and economic growth using panel data in European countries. They established that causality between investment and growth is bi-directional. The above findings are confirmed by Bekhet and Othman (2011).

Kanu and Ozurumba (2014) researched the impact of capital formation on the economic growth of Nigeria by means of multiple regression analysis and a VAR model. They found that variables such as total exports, domestic investment and lagged values of economic growth had positive relationships with economic growth on the long run. No significant relationships were established on the short run between the variables. This result is supported by earlier studies in Nigeria. For instance, Ugochukwu and Chinyere (2013) and Bakare (2011) argued that capital formation is positively and significantly related to economic growth in Nigeria. Similarly, Shuaib and Dania (2015) and Adegboyga and Odusanga (2014) also confirmed that investment has a significant positive impact on economic growth.

Mohsen and Maysam (2013) investigated the causal relationship between gross domestic investment and economic growth for the Middle East and North African countries. They employed a panel unit root tests and panel cointegration analysis from 1970 to 2010. Their empirical findings suggest strong causality from economic growth to investment in these countries. However, they confirmed that investment has no significant effects on economic growth in the short- and long-run. Consequently, their findings support the line of argument in the literature that economic growth is the driver of investment. In another dimension, Rajni (2013) argued that a bi-directional causality exists between gross domestic capital formation and export growth. His empirical findings also support the evidence of uni-directional causality from capital formation to changes in exports.

Iocovoiu (2012) examined the relationship between the net capital investment and employment in Romania. He concluded that net capital formation positively and significantly affects employment. Within the framework of a Structural Vector Analysis, Karim, Karim and Zaidi (2012) empirically researched the dynamic relationship between economic growth, fixed investment and household consumption in Malaysia. Their findings confirm the evidence that fixed investment significantly affects economic growth. They, however, argued that fixed investments significantly affect economic growth only in the short run. Neanywa and Makhenyane (2016) studied the impact of investment on the economic growth of South Africa. They employed the Johansen co-integration econometric method and a vector error correction model (VECM). Their empirical results revealed that gross fixed capital formation has a positive relationship with economic growth in the short as well as in the long-run. They also found evidence of bi-directional causality between gross capital formation and economic growth. Kumo (2012) examined investment in infrastructure and economic growth in South Africa by means of a Granger causality analysis; the empirical findings revealed the evidence of bi-directional causality between investment in infrastructure investment and economic growth.

In conclusion, there is no conclusive evidence from the literature review of the direction of causality between investment, economic growth and employment. The South African case analysis presents evidence from 1995 to 2016 and allows a modern perspective from a developing country's point of view.

3. Methods and Econometric Procedures

To carry out this study, a vector autoregressive (VAR) model with error correction mechanism (VECM) was estimated. The variables used in the study include: economic growth with GDP as the measurement, gross fixed capital formation for domestic investment, number of people employed as employment and exports. Export was included because of its significant theoretical relationship with the remaining variables and as such being mostly used in the literature. All series were converted to logarithms. The variables with abbreviations are listed as the log of real GDP (LRGDP), log of investment (LINV), log of employment (LEMPLOY) and log for exports (LEXP). All the data for the series are extracted from the South African Reserve Bank (SARB) data base. The series were taken quarterly; modelling was from the first quarter of 1995 to the fourth quarter of 2016. In order to analyse the integration degree of the series to be modelled, the augmented unit root testing was performed using the Dickey-Fuller (ADF) and Phillips and Perron (PP) tests for both levels and first differences of all the variables. Both the ADF and PP unit root tests utilise the various specifications of the following regression model (Levin, Lin, & Chu, 2002).:

$$\Delta x_t = \alpha + \beta x_{t-1} + \lambda t + \sum_{s=1}^{n} \gamma_s \Delta x_{t-s} + \varepsilon_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(1)$$

Where x_t is the variable of interest, ε_t is the disturbance term and t is a time trend. Assuming that each of the variables contains a unit root in levels, but not in the first differences, one can proceed to determine the number of cointegrating vectors among the variables in question. Johansen (1991) suggested a method to test for cointegration by considering the following p-variable VAR model:

$$X_t = \mu + \sum_{i=1}^{k} \theta_i X_{t-i} + \eta_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(2)$$

Where X_t is $(p \times 1)$ vector of the variables in question, which is (4×1) vector. η_t is the disturbance term assumed to be a normally and independently distributed Gaussian process with zero mean and variance Ω. Although these variables are individually non-stationary, if there are linear combinations of these variables that are stationary, then they form a meaningful and stable long run relationship. Thus, exploiting the notion that they are cointegrated, one may re-parameterise equation (2) to obtain the following vector error correction representation (VECM):

$$\Delta X_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-k} + \eta_t \dots\dots\dots\dots\dots\dots\dots\dots\dots(3)$$

The symbols included in equation (3) represents the following: the Γs are parameters; and Π represents the parameter matrix which rank defines the long-run relationships between the various variables included in the model. Johansen (1992) formulated test statistics to determine the r based on the maximum likelihood estimation method, firstly the trace test and secondly the maximum eigenvalue test.

The causal relationship between investment and economic growth on one hand and between investment and employment on the other hand, were examined with the help of the Granger-causality procedure based on VECM. This procedure is particularly attractive over the standard VAR because it permits temporary causality to emerge from the sum of the lagged coefficients of the explanatory differenced variable and the coefficient of the error correction term. In addition, the VECM allows causality to emerge, even if the coefficients of lagged differences of the explanatory variable are not jointly significant (Anoruo & Ahmad, 2001).

4. Empirical Findings and Discussion

4.1 Unit root tests

Using equation (1), the ADF and PP unit root tests were estimated. Table 1 presents the results of the time series properties of the variables with both trend and intercept being significant. All the variables are non-stationary in levels I(0) but stationary in first difference I(1) at 5 percent significant levels.

Table 1: Unit Root Results

Variable	ADF test		PP test	
	T-stat	P-value	T-stat	P-value
LRGDP	-1.4724	0.5428	-1.3726	0.5921
LEMPLOY	-0.4683	0.8912	-0.4587	0.8931
LINV	-0.9619	0.7635	-1.2073	0.6683
LEXP	-1.6491	0.4534	-1.4086	0.5745
ΔLRGDP	-4.6708	0.0002*	-4.5917	0.0003*
ΔLEMPLOY	-4.6766	0.0002*	-7.4850	0.0001*
ΔLINV	-5.2081	0.0001*	-5.2081	0.0001*
ΔLEXP	-13.1699	0.0001*	-13.8226	0.0001*

Note: * implies rejection of the null hypothesis at the 1% level.

4.2 Long-run analysis

Having determined the stationarity of time series, the Johansen cointegration test for long-run relationships is performed to test for any linear combinations of the variables that have a common stochastic trend. The Johansen test is quite sensitive to the lag length selected; consequently, a lag selection test was conducted to determine the optimal lag length. A lag length of 2 was selected because this is supported by all the lag selection criteria. In a multivariate system, consisting of economic growth, employment, investment and export, the maximum number of co-integrating vectors is 3, so that the null hypothesis is that there is no co-integrating vector and the alternative is that there is at least one co-integrating vector. The cointegration result is presented in Table 2. The null hypothesis of no co-integration (i.e. r = 0) is rejected at the 5 percent significance level in all the cases. However, the alternative hypothesis that there are at most 3 co-integrating vectors (r ≤3) could not be rejected for all the cases. The fact that the variables are co-integrated suggests that there is a long-run equilibrium relationship between the variables in the time series as well as the existence of causality in at least one direction.

Table 2: Johansen Cointegration Results

Trace Test				Max Eigen Test			
H0	H1	Trace stat	P-value	H0	H1	Max Eigen stat	P-value
r = 0	r ≥ 0	64.9647*	0.0040*	r = 0	r > 0	36.8905*	0.0035*
r ≤ 1	r ≥ 1	28.0740	0.2380	r ≤ 1	r = 1	14.2595	0.4385
r ≤ 2	r ≥ 2	13.8146	0.3024	r ≤ 2	r = 2	10.5980	0.2829
r ≤ 3	r ≥ 3	3.2159	0.5412	r ≤ 3	r = 3	3.2159	0.5412

Note: Both Maximum-Eigen test and Trace test show one cointegrating equation at the 5% significance level.

Equations (4) and (5) present the results of the long-run relationship between the variables at 5 percent significant levels. From equation (4), the empirical results show that there is a positive, long-run relationship between employment, investments and export, while economic growth is found to have a negative long run impact on employment. This confirms the hypothesis of jobless growth in the long run in South Africa, and the unemployment rate remaining unacceptably high. Equation (5) indicates a positive long-run relationship between economic growth, investments and export. This positive long-run relationship between economic growth, investments and export is consistent with Kanu and Ozurumba (2014) as well as Mordecki and Ramírez (2014), Ugochukwu and Chinyere (2013), Bakare (2011) and Neanywa and Makhenyane (2016), amongst others. This, however, is in contrast to a number of other empirical studies which either could not establish a long-run relationship between investment and economic growth or established a negative long-run relationship as found by Mohsen and Maysam (2013), Podrecca and Carmeci (2001) as well as Cheung *et al.* (2012) and Attanasio *et al.* (2000). The observed negative relationship between growth and employment could be associated with inefficient use of fixed available factors of production and inadequate technological advancement.

$$LEMPLOY = 7.07 - 0.486LRGDP + 0.27635LINV + 0.9443LEXP......................(4)$$

$$LRGDP = 14.53 + 0.567LINV - 2.053LEMPLOY + 0.193LEXP.........................(5)$$

4.3   Causality tests

Given the results of the co-integration tests, the next step is the estimation of the VECM of equation (3) to determine the direction of causality between employment, investment, economic growth and export. The results of the causality tests from the estimates of the VECM are reported in Table 3.

Table 3: VEC Granger Causality

Dependent Variables	Independent Variables				
	D(LRGDP)	D(LINV)	D(LEMPLOY)	D(LEXP)	All Variables Combined
D(LRGDP)	-	5.5582 (0.0621*)	3.9625 (0.1379)	2.8635 (0.2389)	11.1118 (0.0850*)
D(LINV)	11.7779 (0.0028***)	-	0.5322 (0.7663)	0.1084 (0.9472)	18.4106 (0.005***)
D(LEMPLOY)	10.2534 (0.0059***)	1.0556 (0.5899)	-	6.2844 (0.043**)	22.2411 (0.0011***)
D(LEXP)	15.5976 (0.0004***)	2.6107 [0.2711]	3.8057 (0.1491)	-	28.9284 (0.0001***)

Note: *** implies rejection of the null hypothesis at the 1% level, ** at the 5% level and * at 10% level while the p-values are represented in parentheses ().

In the analysis of Table 3, a significance threshold at the 5% level was selected. As may be observed from Table 3, a unidirectional causality exists between GDP and investment, with causality running from GDP to investment and not the other way round (only at the 10% significance level), in South Africa. This position supports other studies in the literature that have argued that investment does not Granger cause growth (Mordecki & Ramírez, 2014; Antelo & Valverde, 1994). In addition, there is uni-directional causality running from real GDP to employment, not vice versa, while GDP is also found to drive export in South Africa. Lastly, it was found that changes in exports cause changes in employment. These findings confirm the previous empirical positions, such as Rajni (2013), Kanu and Ozurumba (2014) and Neanywa and Makhenyane (2016), among others.

To check the robustness of the results, the standard pairwise Granger causality test was also conducted. As recorded in Table 4, GDP causes investment but not vice versa, indicating that economic growth drives investment in South Africa. There exists a bi-directional causality between GDP and employment in South Africa, as well as between investment and employment. Furthermore it was found that GDP causes export and export causes employment. This empirical evidence affirms the earlier position and other studies, such as Mordecki and Ramírez (2014), Rajni (2013) and Adegboyga and Odusanga (2014).

Table 4: Pairwise Granger Causality Test

The Null Hypothesis	P-values
LEMPLOY does not Granger Cause LRGDP	0.0586*
LRGDP does not Granger Cause LEMPLOY	0.0003***
LINV does not Granger Cause LRGDP	0.3513
LRGDP does not Granger Cause LINV	0.0006***
LEXP does not Granger Cause LRGDP	0.2014
LRGDP does not Granger Cause LEXP	5.E-07***
LINV does not Granger Cause LEMPLOY	0.0157**
LEMPLOY does not Granger Cause LINV	0.0816*
LEXP does not Granger Cause LEMPLOY	0.0201**
LEMPLOY does not Granger Cause LEXP	0.2092
LEXP does not Granger Cause LINV	0.1812
LINV does not Granger Cause LEXP	0.0058***

Note: *** implies rejection of the null hypothesis at the 1% level, ** at the 5% level and * at 10% level.

The significance of the coefficient of real GDP from the VECM estimation in Table 5 is that real GDP adjusts in the short-term to the long-run relationship deviations, while the decision criteria for the other variables regarding the coefficients and t-values, suggests that they do not adjust in the short-run to the long-run relationship deviations.

Table 5: VECM estimation

Error correction	D(LRGDP)	D(LINV)	D(LEMPLOY)	D(LEXP)
Cointegration equation 1	-0.0153 (0.0044) [-3.5118]	0.0197 (0.0165) [1.1952]	0.0154 (0.0061) [2.5157]	0.0716 (0.0350) [2.0452]
D(LRGDP(-1))	-0.4612 (0.1233) [3.7398]	0.7743 (0.4673) [1.6567]	0.3254 (0.1734) [1.8767]	3.3022 (0.9896) [3.3367]
D(LRGDP(-2))	-0.1669 (0.1309) [1.2751]	1.1223 (0.4960) [2.2624]	0.3314 (0.1840) [1.8010]	0.8942 (1.0504) [0.8513]
D(LINV(-1))	-0.01338 (0.0304) [-0.4392]	0.3712 (0.1154) [3.2148]	-0.0036 (0.04285) [-0.0854]	0.3010 (0.2445) [1.231]
D(LINV(-2))	-0.0579 (0.0294) [-1.9646]	-0.1373 (0.1117) [-1.2300]	0.0404 (0.0414) [0.9768]	-0.3410 (0.2365) [-1.4419]
D(LEMPLOY(-1))	0.1314 (0.0828) [1.5868]	0.1520 (0.3138) [0.4846]	0.0218 (0.1164) [0.1876]	0.2762 (0.6644) [0.4157]
D(LEMPLOY(-2))	-0.0200 (0.0802) [1.2877]	-0.1574 (0.3042) [-0.5177]	0.0158 (0.1128) [0.1406]	-1.2110 (0.6441) [-1.8800]
D(LEXP(-1))	-0.0200 (0.0131) [-1.5201]	-0.0162 (0.0499) [-0.3259]	0.0105 (0.0185) [0.5673]	-0.4547 (0.1057) [-4.3021]
D(LEXP(-2))	-0.0166 (0.01284) [-1.2990]	-0.0085 (0.0486) [-0.1762]	-0.0360 (0.0180) [-1.9979]	-0.2372 (0.1030) [-2.3029]

4.4 Stability tests

The diagnostic tests are presented in Table 6. The results indicate an absence of serial correlation and heteroscedasticity. The null hypothesis of no serial correlation, and no heteroscedasticity, were accepted because of the insignificance of the probability values as they are greater than 5 percent. Also, the null hypothesis of normal distribution was accepted since the probability value is greater than 5 percent.

Table 6: Diagnostic test results

Item	Applied Test	P-Value	Decision
Serial Correlation	LM Test	0.4214	No serial correlation
Normality	Jacque Bera	0.1976	Variables normally distributed
Heteroscedasticity	Breusch Pagan Godfrey	0.2699	No heteroscedasticity

5. Conclusion

The relationship and the direction of causality between investment, growth and employment has been an important subject of investigation in economic literature. This is because investment is traditionally believed to play a pivotal role in the growth process and growth is assumed to play an important role in employment generation. Evidence from the literature demonstrates that empirical findings on the nature of the relationship between investment and economic growth are far from being settled, since they are still divergent, and that the employment growth nexus also remains inconclusive. There are empirical studies in favour of the theoretical position that investment precedes growth, while there are others that provide evidence in favour of the hypothesis that growth determines investment. Likewise, some empirical studies furnish evidence of the positive impact of economic growth on employment while others argue the opposite.

This study, motivated by lack of consensus in the literature on the direction of causality between investment, employment and economic growth, investigated the nature of the relationship between these variables in South Africa within the framework of the Vector Error Correction Model (VECM). The empirical results show that a long run relationship exists between the variables. The empirical findings also suggest evidence in favour of bi-directional causality between employment and economic growth, with economic growth impacting negatively on the employment in the long-run. Economic growth is also found to precede investment, rather than vice versa. The major conclusion derived from the study is that economic growth is an important driver of investment, employment and export in the long-run in the South African economic environment. The empirical findings also confirm the jobless growth hypothesis in the long-run. The study concludes that, in order to stimulate employment, investment enhancing policies such as low interest rates and a favourable economic environment should be put in place. Government should also vigorously pursue growth stimulating policies such as improved infrastructural facilities and diversification of the economy so as to spur the investment level in the economy. Future research will include a comparative panel analysis on developing countries, including the BRICS countries with regard to the relationship between investment, growth and employment.

References

Adegboyega, B., Odusanya I. (2014). Empirical analysis of trade openness, capital formation, FDI and economic growth: Nigeria experience. *The International Journal of Social Science and Humanities*, 1: 36-50.

Anoruo, E., Ahmad, Y. (2001). Causal relationship between domestic savings and economic growth: Evidence from seven African countries. *African Development Review*, 13(2): 238-249.

Antelo, E., Valverde, F. (1994). Determinant of private investment in Bolivia. *Unidad de Análisis de Políticas Sociales y Económicas,* 8: 1-30.

Attanasio, O., Picci, L., Scorcu, A. (2000). Saving, Growth, and Investment: A Macroeconomics Analysis using a Panel of Countries. *The Review of Economics and Statistics,* 82(2): 182-211.

Bakare, A.S. (2011). A theoretical analysis of capital formation and growth in Nigeria. *Far East Journal of Psychology and Business*, 3(2): 11-24.

Bekhet, H.A., Othman, N.S. (2011). Causality analysis among electricity consumption, consumer expenditure, gross domestic product (GDP) and foreign direct investment (FDI): Case study of Malaysia. *Journal of Economics and International Finance*, 3(4): 228-235.

Blomstro, M., Lipsey, R., Zejan, M. (1996). Is fixed investment the key to economic growth? *Quarterly Journal of Economics*, 111: 269-276.

Bond, S., Lebeblicioglu, A., Schiantarelli, F. (2007). Capital accumulation and growth: A new look at the evidence**.** *IZA Discussion, 1174.* https://ideas.repec.org/a/jae/japmet/v25y2010i7p1073-1099.html

Carroll, C.D., Weil, D.N. (1994). Savings and growth: a reinterpretation. *Carnegie Rochester Conference Series on Public Policy*, 40: 133-192.

Cheung, Y.W., Dooley, M.P., Sushko, V. (2012). *Investment and growth in rich and poor countries* (No. w17788). National Bureau of Economic Research.

Coombs, R., Green, K. (1981). Microelectronics and the future of service employment. *Service Industries Journal*, 1(2): 4-21.

Davis, T.R. (1991). Information technology and white-collar productivity. *The Executive*, 5(1): 55-67.

De Long, J.B., Summers, L.H. (1992). Equipment investment and economic growth: How strong is the nexus? *Brookings Papers on Economics Activity*, 157-211.

Faulkner, D., Loewald, C., Makrelov, K. (2013). Achieving higher growth and employment: Policy options for South Africa. *South African Reserve Bank Working Paper,* 13(3): 1-35.

Frey, B.C., Osborne, M. (2015). Technology at work: The future of innovation and employment. *Global Perspectives & Solutions,* 1-108.

Hodge, D. (2009). Growth, employment and unemployment in South Africa. *South African Journal of Economics*, 77(4): 488-504.

Iacovoiu, V. B. (2012). Impact of Capital Investments on Unemployment in the Context of Economic Crisis. The Case of Romania. *Economic Insights-Trends & Challenges*, *64*(4).

Ibarra, D., Moreno-Brid, J.C. (2004). Private investment, foreign direct investment and economic growth. *ECLAC, United Nations.*

Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian Vector Autoregressive Models. *Econometrica,* 59(6): 1551-1580.

Jones, C. (1995). Time series tests of endogenous growth models. *Quarterly Journal of Economics,* 110(2): 495-525.

Kanu, S.I., Ozurumba, B.A. (2014). Capital Formation and Economic Growth in Nigeria. *Global Journal of Human-Social Sciences,* 4(4): 1-17.

Karim, Z.A., Karim, B.A., Zaidi, M.A.S. (2012). Fixed investment, household consumption, and economic growth: A structural vector error correction model (SVECM) study of Malaysia. *International Journal of Business and Society*, 13(1): 63-74.

Keller, W., Yeaple, S. R. (2009). Multinational enterprises, international trade, and productivity growth: firm-level evidence from the United States. *The Review of Economics and Statistics*, *91*(4): 821-831.

Kumo, W.L. (2012). Infrastructure investment and economic growth in South Africa: A granger causality analysis. African development Bank Group Working Paper Series, (160)*. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications.pdf.* (accessed January 15, 2018).

Kuznets, S. (1973). *Modern economic growth: Rate, structure, and spread* (Vol. 2). New Haven, US: Yale University Press.

Levin, A., Lin, C. F., Chu, C. S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of Econometrics*, *108*(1): 1-24.

Levine, R., Renelt, D. (1992) A sensitivity analysis of cross country growth regressions, *American Economic Review,* 82: 942- 963.

Mankiw, N.G., Romer, D., Weil, D. (1992) A contribution to the empirics of economic growth. *Quarterly Journal of Economics*, 107: 407- 437.

McKinnon, R. I. (2010). *Money and Capital in Economic Development*. Brookings Institution Press.

Mohsen, M., Maysam, M**.** (2013). The Causality between Capital Formation and Economic Growth in MENA Region. *International Letters of Social and Humanistic Sciences,* 8, 1-7 doi:10.18052/www.scipress.com/ILSHS.8.1

Mordecki, G., Ramírez, L. (2014). Investment, growth and employment: VECM for Uruguay. *Serie Documentos de Trabajo/FCEA-IE; DT07/14.*

Neanywa, T., Makhenyane, L. (2016). Can investment activities in the form of capital formation influence economic growth in South Africa? *SAAPAM Limpopo Chapter 5th Annual Conference Proceedings,*1-10.

Overseas Development Institute. (2016). What are the links between power, economic growth and job creation. *Development Impact Evaluation,* 1-30.

Podrecca, E., Carmeci, G (2001). Fixed investment and economic growth: New results on causality. *Applied Economics,* 33: 177-182.

Rajni, P. (2013). Linkages between export, import and capital formation in India. *International Research Journal of Social Sciences.* 2(3): 16-19.

Reig, N. (2013). Effects of foreign direct investment on investment in Uruguay in a long run perspective (1960-2011)*. Department of Economics, Faculty of social sciences, Universidad de la República,* 4: 1-20.

Summers, R., Heston, A. (1991). A new set of international comparisons of real product and price levels estimates for 130 countries, *Quarterly Journal of Economics*, 106: 327-368.

Solow, R.J. (1956). A contribution to the theory of economic growth, *Quarterly Journal of Economics*, 70: 65- 94.

Shuaib, I.M., Ndidi, N.D.E. (2015). Capital formation: Impact on the economic development of Nigeria 1960-2013. *European Journal of Business, Economics and Accountancy*, *3*(3): 23-40.

Tobin, J. (1965). Money and economic growth. *Econometrica: Journal of the Econometric Society*, 671-684.

Ugochukwu, U.S., Chinyere, U.P. (2013). The impact of capital formation on the growth of Nigerian economy. *Research Journal of Finance and Accounting*, *4*(9): 36-42.

DETERMINANTS OF THE PERCEIVED INTERNSHIP EFFECTIVENESS: EXPLORING STUDENTS' EXPERIENCES

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Abstract
Internships are increasingly important for the business higher education as they help students to make the connection between their academic studies and the world of business. This study analyzes the internships of students within an international study program (German line of study) in order to determine what factors account for the most valuable internship experience. Based on the elements of the experiential education approach, the results reveal some characteristics that contribute to a higher level of perceived internship effectiveness in accordance with the employment status and gender. These results provide a basis for designing successful internship programs in business universities.

1. Introduction

Internships have been introduced in many of the universities around the world as there is a common understanding that it will help prepare students to enter the workforce. Moreover, the benefits brought by internships are two fold. According to Cheong, Yahya, Shen and Yen Yen (2014), internships also provide companies with potential recruits. As interns/ students are the main beneficiars of the internships, their feedback is crucial in ensuring that the entire program meets the expectations.

The paper firstly discusses the importance of the internships among business students and explains how the experiential education contributes to the perceived effectiveness of the internships. Then, the case study presented in the paper aims to explore students' experience and perception of participating in

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internship programs within an international study program (German line). As internship experiences were considered as valuable experiences for undergraduate students, their perceptions may well reflect the outcomes of the program.

By highlighting the main determinants of the perceived internship effectiveness by employment status and gender, the paper illustrates some aspects that are perceived by the students as being more effective for them after completing the internship program. Moreover, the exploration into students' perceptions would enhance our understanding of the internship experiences and therefore benefit from the development of appropriate internship programs.

2. Literature Review

Despite the growing popularity of internships in Romania surprisingly little research has been done regarding its perceived effectiveness and the experiential education as most studies were performed regarding the internship quality within the study programs.

For example, a study performed in 2018 in the most extended Business Administration University in Romania aims to identify and analyze the main factors which influence the quality of an internship program from Romanian business and administration students' perspective. The results show that there exist 5 key factors influencing the quality of internship: job arrangements, mentorship and employability benefits, learning content, academic supervision, bureaucracy, and accessibility. The survey provides good insights for companies and universities about the quality dimensions of internship programs in the economic area (Marinas, et al., 2018).

Thus, the literature on business school internships is scant, it lacks a dominant theoretical perspective and is mostly descriptive in most empirical studies (Narayanan and Olk 2010). Although internship programs involve a complex relationship between students, faculty staff, and companies, most research is traditionally focused only on a small part of the overall process and mainly on the perceived quality. Therefore, we attempt to address these gaps as follow.

Actually, in Romania there are no studies addressing the determinants of perceived effectiveness of internship in accordance with the experiential education. As business teachers we have been involved in the tutorial activities of the internship programs and also have the possibility to supervise this program directly from the company by means of the practical experience we gained in the last 3 years.

Therefore, the paper provides an analysis of the main determinants of the internship effectiveness by taking into consideration five dimensions of experiential education: personal, interpersonal, academic, employment and civic impact. The study has also an informative role as it provides valuable information for the companies in order to assess attractive internship programs and help students to find a job after finishing the studies. After performing the internship programs, the university representatives had some discussions with the core companies and there were implemented some improvement measures and also designed further plans for the next internship program. In this context, one could mention that internships provide new recruitment opportunities for the employers and HR, as they have the possibility to evaluate interns in order to access new skills and talent in a cost-effective way and to bring in the companies one of the best entry-level employees (Knemeyer, Murphy, 2002).

The main reason why such a study is beneficial for the universities, students and companies is that students actually ranked internships as the most important contributors to their learning and consequently to their future career development (Karns, 2005). The research shows that there are numerous experiences a student can engage in during the internship, that could result in the student perceiving the internship as a satisfying and worthwhile experience. Moreover, internships seem to close the gap between learned theory and practical reality and are often the first opportunity for many students to obtain meaningful field experience in their area of study (Koo, Diacin, Khojasteh, Dixon, 2016).

A supplement of theoretical education helps the students to gain new skills and experiments in practice and to reach the relevant field of business (Abrudan, Lazar, Munteanu, 2012). The internship is an important way through which students need to get to know the business world by working in it and to implement the information they acquired during their theoretical education (Seyitoglu and Yirik, 2015).

Universities and colleges have been using internships in order to provide business students with practical experiences and prepare them for their future careers (Moghaddam, 2011).

Martin and Wilkerson's (2006) performed a study on 132 accounting students and the research shows that the students agreed that their internship provided them with a solidified understanding of prior academic work, beneficial for subsequent academic work, provided them with new insights into courses and improved understanding of concepts (Cheong, Yahya, Shen and Yen Yen, 2013).

Referring to findings of various studies, one could mention that there exist four career preparation skill categories: communication skills, academic skills, interpersonal skills, and job acquisition skills. An effective internship program should be able to provide and/or enhance such skills and prepare students to face real life challenges after their graduation (Moghaddam, 2011).

Further, the variations among the terms used to describe outside-the-classroom learning opportunities can be condensed into one phrase: experiential education. It is well known that this kind of experiential education includes potential experiences, including self-learning internships, academic service learning, community service learning, cooperative education programs and applied practice (Jackel, 2011).

Therefore, research suggests, that an experiential education learning outcomes are categorized into five sections: personal, interpersonal, academic, employment and civic impact (Raman and Pashupati, 2010, Jackel, 2011). The questionnaire in this study is designed by taking into consideration all the above-mentioned dimensions, but only two of them are analyzed in this paper: personal and academic outcome.

Personal outcomes are focused on individual thoughts, skills and values. A study quoted in (Jackel, 2011) found that students who participated in applied learning programs had greater volunteer motivation and moral development than students who did not participate. In this context, Androniceanu (2013) highlights that the absorption of ethical values depends on the work environment, organizational culture, and the particular characteristics of the human resources. In addition to exposure to the real-life business practices and cultures, one's personality traits (characteristics) may also impact his/her personal/business values.

Academic outcomes concentrate on the educational achievement and knowledge gained from the applied learning experience. Some researchers found that students who participated in an applied learning program received higher grades

than students who only receive the classroom instructions (Markus, Howard, and King 1993, Jackel, 2011). Therefore, internships provide learning opportunities for students to experience professional practice and activities related to the application of knowledge (Beggs, Ross, and Goodwin, 2008, Velez and Giner, 2015).

Taking into consideration that the internship program takes places in an international study program, in addition to the before mentioned benefits, internships in an international environment plays a pivote role in improving intercultural competencies. Intercultural competence includes three basic aspects: intercultural communicative skills, intercultural work experience and intercultural understanding. These three aspects appear to be improved through the experience of an international internship (Zhang, 2012).

Hergert (2009) discovers that a valuable internship was influenced by students' perceived value, demographic profile and the structure of the internship. Therefore, this paper evaluates the perception of personal and academic outcome in accordance with some demographical variables such as gender and employment status.

Finally, according to Narayanan and Olk (2010), internship experiences can overcome presumed shortcomings such as the lack of specific preparation, sometimes called "deficit reduction theory", Also, beyond skills training, internships also help socialize and acculturate, they improve career decision making and perceptions of self-efficacy.

3. Methodology

The current paper is divided into two sections. The first section presents the methodological research design and survey instrument and the second section discusses the data analysis and results.

3.1. Research Methodology and Measuring instrument

Based on the review and synthesis of relevant literature, this paper measures the determinants of internship effectiveness within an international study program at the German line of study. Therefore, there was designed a questionnaire based on the topic of experiential education (Jackel, 2011) and sent to the students at the German line of study, that performed the internship program. It is remarkable, that depending on the specialization, the students could perform the internship program either in the Business Administration Area (for the Bachelor students) or Economy of International Companies Area (for the Master students). The curriculum was designed so that one could perform the internship in one of the business support function departments within a company such as: HR, controlling, marketing, finance, Quality Management or legal. The curriculum has a defined structure but depending on the department, the students could perform the task they receive. Actually, research indicates the curriculum promotes the ability of the students to achieve one of the beneficial goals for them, namely to understand their lives and the extreme complexities of social organizations (Parilla & Hesser, 1998).

In order to asses the effectiveness of the internship program, a mixed method was implemented by using both qualitative and quantitative approaches. The survey was developed according to Jackel Daniel (2011) via E-mail to the respondents.

Before the survey distributions, the researchers conducted a focus group of 20 students in order to identify improvement areas. Some of the questions were reformulated and adapted to the internship program for the German Line.

A total number of 143 respondents completed the questionnaire (N=143) and the response rate was 70.4% (of the total number of 203 students that could perform the internship programs within the analyzed international study programs).

By analyzing the students' demographic structure, one can confirm that a significative number of the students were employed after this experience.

Nevertheless, most internships were not only in the Economic field, but also in the IT consultancy area, which is explained by the good cooperation the faculty has with the companies in this domain:

Table 1: Demographic characteristics of the respondents in the sample

Demographic Variables	Results
Gender	
Female	74.1%
Male	25.9%
Internship Area	
Economics	80.4%
IT Consultancy	19.6%
Employment Status	
Employed	51.7%
Unemployed	48.3%

Further, the questionnaire contains two main parts: the first part divided in five sections refers to the characteristics of the experiential education and the second section presents the demographic background of the students.

The five sections in the first part of the questionnaire include categories like: personal, interpersonal, academic, occupational and civic characteristics. Each of these sections presents five to eight statements that gave certain attributes supposed to be gained during the internship program. The respondents should use a five-point Likert scale in order to indicate the degree to which the internship program increased their abilities in each area.

The second part contains background information about the respondents such as those presented in Tabel 1: gender, employment status, internship area, but also some qualitative information about the improvement area that further programs should take into consideration in order to increase internship effectiveness.

The independent variables in this study refer actually to these background characteristics namely the articles focuses on employment status and gender. The dependent variables taken into consideration in this paper is indicated by the personal impact and academic impact dimensions. Regarding these specific variables' influence on the predicted learning outcomes, the following research model was proposed:

H1: there exist determinants of the perceived internship effectiveness, which differ in accordance with the employment status.

H2: there exist determinants of the perceived internship effectiveness, which differ in accordance with the gender.

3.2. Data analysis and results

In order to highlight those characteristics that set a higher level of effectiveness in accordance with the employment status and gender, there was used as a statistical method the independent samples t-test with SPSS. The test is used to compare the means between two unrelated groups on the same continuous, dependent variable:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

with

$$s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

According to Table 2 -Table 5, the Levene's Test for Equality of Variances and the independent samples test indicates that there are some characteristics of the internship program, there were perceived as more effective.

For the first hypothesis, these characteristics bring to the fore personal aspects like: the satisfaction in doing something worthwhile, the ability to make a difference, the capacity to be more productive, the ability to identify personal strengths, the sense of personal achievement and the ability to persevere in difficult tasks.

In other studies the dimension of personal impact was correlated with the number of hours worked weekly at placement site, internship paid *(yes),* preparation/ training *(yes), and* availability of internship program coordinator (Jackel, 2011). Therefore, related to the personal impact one of the most important features of internships should be the one that gives the students the possibility to see through personal learning experience what working in a certain company environment really entails (Hurst, Good,2010).

Table 2: Independent Samples Test for the independent variable Employment Status and Personal Impact

| | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | | |
| | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
								Lower	Upper
I have a sense of satisfaction in doing something worthwhile	.706	.402	-.944	141	.347	-.121230	.128462	-.375191	.132731
			-.943	140.008	.347	-.121230	.128524	-.375329	.132869
I believe in my ability to make a difference	.408	.524	-.864	141	.389	-.12143	.14049	-.39917	.15632
			-.861	136.806	.391	-.12143	.14101	-.40028	.15742

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
I am open to new experiences	1.935	.166	1.017	141	.311	.11927	.11727	-.11257	.35111
			1.024	139.063	.308	.11927	.11650	-.11107	.34962
I have gained the capacity to be more productive	1.212	.273	-.207	141	.837	-.02977	.14414	-.31472	.25518
			-.206	137.405	.837	-.02977	.14460	-.31571	.25617
I can recognize my personal strenghts	.000	.999	-.495	141	.621	-.06561	.13242	-.32739	.19617
			-.496	140.557	.621	-.06561	.13235	-.32727	.19605
I can recognize my personal weaknesses	1.029	.312	.591	141	.555	.08402	.14216	-.19702	.36506
			.593	140.978	.554	.08402	.14175	-.19621	.36424
I have a sense of personal achievement	.338	.562	-.601	141	.549	-.08676	.14444	-.37230	.19878
			-.600	139.115	.550	-.08676	.14467	-.37280	.19928
I have the ability to persevere in difficult task	.296	.587	-.053	141	.958	-.00764	.14360	-.29152	.27625
			-.054	139.684	.957	-.00764	.14276	-.28988	.27461

The academic impact highlights the following characteristics: the acquired knowledge, the development of critical thinking (reasoning, problem- solving) and the perception that after the internship program the classroom learning was enriched.

Table 3: Independent Samples Test for the independent variable Employment Status and Academic Impact

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
I have acquired knowledge form the job duties I performed	.724	.396	-.114	141	.909	-.01723	.15088	-.31551	.28104
			-.115	140.678	.909	-.01723	.15025	-.31428	.27981
I have developed my critical thinking (reasoning, problem solving)	.325	.569	-.542	141	.589	-.07814	.14426	-.36334	.20705
			-.542	140.170	.589	-.07814	.14429	-.36342	.20713

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
I have the ability to work and learn independently	2.926	.089	1.111	141	.268	.14414	.12969	-.11225	.40054
			1.109	138.687	.269	.14414	.12996	-.11282	.40111
I feel my classroom learning was enriched	2.764	.099	-.111	141	.912	-.01880	.16888	-.35267	.31507
			-.111	133.603	.912	-.01880	.16987	-.35479	.31719

Regarding the independent variable gender (Table 4) it is remarkable, that female respondent tends to perceive more effective personal aspects like: they are open to new experiences, the capacity to be more productive, the sense of personal achievement, the ability to identify personal weaknesses and the ability to persevere in difficult tasks.

Table 4: Independent Samples Test for the independent variable Gender and Personal Impact

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
I have a sense of satisfaction in doing something worthwhile	.338	.562	-2.099	141	.038	-.303927	.144793	-.590173	-.017680
			-2.095	62.694	.040	-.303927	.145046	-.593805	-.014048
I believe in my ability to make a difference	.092	.763	.265	141	.791	.04258	.16069	-.27509	.36025
			.279	69.248	.781	.04258	.15275	-.26213	.34729
I am open to new experiences	5.174	.024	-1.264	141	.208	-.16879	.13354	-.43280	.09522
			-1.125	52.271	.266	-.16879	.15008	-.46990	.13232
I have gained the capacity to be more productive	.071	.791	-2.132	141	.035	-.34523	.16190	-.66529	-.02517
			-2.109	61.679	.039	-.34523	.16368	-.67245	-.01801
I can recognize my personal strenghts	.463	.497	1.377	141	.171	.20678	.15022	-.09018	.50375
			1.573	82.911	.119	.20678	.13142	-.05461	.46818
I can recognize my personal weaknesses	.703	.403	-2.286	141	.024	-.36461	.15948	-.67989	-.04933
			-2.224	59.930	.030	-.36461	.16394	-.69256	-.03666

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
I have a sense of personal achievement	2.354	.127	-.431	141	.667	-.07114	.16491	-.39714	.25487
			-.476	76.381	.636	-.07114	.14960	-.36907	.22680
I have the ability to persevere in difficult task	1.220	.271	-.081	141	.936	-.01326	.16384	-.33717	.31065
			-.090	77.819	.929	-.01326	.14739	-.30670	.28018

Further, the academic impact was rated as effective by female respondents in all the cases (Table 5) and refers to: the acquired knowledge, the development of critical thinking (reasoning, problem-solving), the ability to work in teams and learn independently and the perception that after the internship program the classroom learning was enriched.

Regarding the academic impact of the internship, the literature and empirical studies show that internships are a critical part of students' active engagement of their academic learning and their perceptions should be recognized. Also, according to Moghaddam (2011) internships could have positive responses from students regarding the value of business education and preparation for future careers. In a longitudinal study by Cook, Stokes, and Parker (2015), students reported that an internship helped them to relate classroom theories to the workplace and also to "become more mature individuals".

Table 5: Independent Samples Test for the independent variable Gender and Academic Impact

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
I have acquired knowledge form the job duties I performed	.030	.862	-.359	141	.720	-.06170	.17208	-.40189	.030
			-.350	60.160	.728	-.06170	.17650	-.41473	
I have developed my critical thinking (reasoning, problem solving)	.547	.461	-.466	141	.642	-.07675	.16465	-.40224	.547
			-.489	68.951	.626	-.07675	.15685	-.38966	
I have the ability to work and learn independently	.007	.935	-.879	141	.381	-.13029	.14822	-.42332	.007
			-.888	64.058	.378	-.13029	.14673	-.42342	
I feel my classroom learning was enriched	1.813	.180	-.885	141	.378	-.17007	.19217	-.54998	1.813
			-.972	75.760	.334	-.17007	.17499	-.51861	

4. Discussions

Our goal in this paper was to investigate the determinants of internship effectiveness in an international study program. Although there are some characteristics, that define a higher level of effectiveness in accordance with employment status and gender, our understanding of what makes for an effective internship might be limited.

Extant research provides minimal guidance on the determinants of internship effectiveness and this led us to use a complex questionnaire in order to measure students perception on what this means. So our first contribution is to highlight the central ideas in the literature in order to highlight the main determinants of internship effectiveness, including also evidences about international internships and demographic factors.

Further, our second contribution stems from applying a complex questionnaire to the internship participants within an international study program. The questionnaire suggests the importance of capturing information about each of three actors: students, universities and companies in understanding internship effectiveness.The outcomes of independent t-test were quite revealing. These analyses found that there exist some determinants of internship effectiveness that differ in accordance with gender and employment status.

In general, the importance of internships in business faculties are illustrated in some studies that found that the internships enhance the employability of students. Equally, the students who complete internships report higher salaries and higher level of job satisfaction compared with students who do not complete internships (Velez and Giner, 2015).

Our findings confirm that experiential education through personal and academic characteristics influence student perception of internship effectiveness. With regard to the academic impact, previous studies' findings show that the internships are positively correlated with their content and learning outcomes, the contribution of the internships to employability as well as with the management and supervision of internships (Newman et al., 2007).

Also, internships were correlated with better college performance and receiving a job offer (Knouse and Tanner,1999), which explains our findings that such determinants as the acquired knowledge, the development of critical thinking (reasoning, problem-solving), the ability to work in teams and the perception that after the internship program the classroom learning was enriched are perceived more effective.

Further, regarding the personal impact, employers especially value positive and responsible attitudes, professionalism (Zopiatis, 2007), and communication skills (Alpert et al., 2009) and believe that students should be willing and enthusiastic participants. This aspect is highlighted by the perceived effectiveness in this study through dimensions like: the satisfaction in doing something worthwhile, the ability to make a difference, the capacity to be more productive, the ability to identify personal strengths, the sense of personal achievement and the ability to persevere in difficult tasks.

Findings also indicate that the demographical dimensions such as employability and gender may cause in some situations a higher degree of internship effectiveness. Actually, these demographic and background information also help companies in

order to assess the structure of the internship programs and to see the overall impact and inclusion of these new joiners in the existing department within the company. For example, it is well known that some of the IT companies in Romania, where our students are performing the internship programs, are having much more males employees than females.

Concluding, our study and survey demonstrates that all the three types of effects of business internships on students: those related to the enhancement of employment opportunities, those related to the improvement of skills and competencies, and those related to the effects on career exploration are demonstrated by the results we received. This also are attesting prior search review conducted by Knouse and Fontenot (2008).

Nevertheless, students found that these business internships are effective in helping them to acquire personal and academic values. Therefore, such perceptions are significant in order to further design studies on greater samples, maybe not only within international study programs, but also within the business faculties in Romania.

5. Conclusions

Investigating the relationship between determinants of the perceived internship effectiveness and some demographical factors such as employment status and gender, the results highlight that there exist some characteristics, that are perceived more effective. Regarding the personal and academic impact, which improves career decision making and perceptions of self-efficacy, students confirm that internship helped them to be more open, productive and to perform difficult tasks.

The main conclusions of this article are as follows:

1)   There exist some determinants of the perceived internship effectiveness that differ in accordance with some demographic factors such as employment status and gender. Actually, there are some determinants of the internship, that are perceived as being more effective by the employed students and also by the females. It is well known that in Romania feminine student population prevails in the field of economic studies and also that internships support strong employment opportunities.

Since narrowing down the career choices is often a result of the type of work performed and working area, the employment enhancement is actually not related to the behavior, but is mainly a result of the environmental stimuli the students is exposed during the placement period. Nevertheless, males students are often more likely than females to experience a greater civic awareness, but females are often more responsive to the academic impact of the internship programs (Jackel, 2011)

2)   The personal and academic impact of the internship are two of the essential characteristics of experiential education. Students connecting and applying their academic experiences to internships may increase their opportunities for employment or entrepreneurship (Nicholas, 2016).

Regarding the personal impact, internship experience is related to higher levels of self-concept crystallization and internship characteristics of task variety, feedback, and opportunities for dealing with people were significantly associated with self-concept crystallization, amount of occupational information and self-efficacy (Brooks et al., 1995).

Taking into consideration these characteristics, there could be designed an internship program that suits not only to students' needs, but also to the actual labor market. In Romania, German speaking students are hunted by companies and prior internships have a great impact on their employability. Actually, the last study performed for the Romanian labor market shows that in 2019 companies will recruit juniors that have performed internships (Report on Romanian Labour Market, 2019, done by hipo.ro). Equally, internship programs contribute to a better understanding of business concepts and knowledge improvement.

Starting from these conclusions, one could also mention, that students benefit from stronger ties with the academic world. Internship programs are also beneficial to higher education institutions, because universities can attract potential students, enhance their reputation and visibility, and strengthen the collaboration between the academic world and companies (Velez and Giner 2015).

Further, this study found that students place a great value on the internship experience and this has to do with their career goals. The value of the internship is also maximized by the professors, that provide appropriate structure and integrate the internship programs with the students' background.

References

Alpert, F., Heaney, J.-G.,Kuhn, K.-A. L. (2009). Internships in marketing: Goals, structures and assessment—Student, company and academic perspectives. *Australasian Marketing Journal*, 17, 36–45

Androniceanu A. (2013). Ethical values and the human resources behavior in public management. *Administratie si Management Public*, 20, 49-61

Abrudan B., Lazar M., Munteanu A. (2012) Internship roles in training and professional development of student. *Annals of Faculty of Economics*, 1(1), 986–991

Beggs B., Ross, C. M., Goodwin B. (2008) A comparison of student and practitioner perspectives of the travel and tourism internship. *Journal of Hospitality, Leisure, Sport & Tourism Education,* 7, 31–39

Brooks. L., Cornelius, A., Greenfield, E., Joseph, R. (1995) The relation of career-related work or internship experiences to the career development of college seniors. *Journal of Vocational Behavior*, 46: 332–349

Cheong A., Yahya N., Shen Q., Yen Yen A. (2014) Internship Experience: An In-Depth Interview among Interns at a Business School of a Malaysian Private Higher Learning Institution, *Procedia - Social and Behavioral Sciences* 123, 333 – 343

Cook, S.J., Stokes, A., Parker, R. S. (2015) A 20-year examination of the perceptions of business school interns: a longitudinal case study. *Journal of Education for Business*, 90, 103-110

Gi-Yong Koo G., Diacin M., Khojasteh J., Dixon A. (2016) Effects of Internship Satisfaction on the Pursuit of Employment in Sport Management, *Sport Management Education Journal,* 10, 29-42

Hergert M. (2009) Student Perceptions Of The Value Of Internships In Business Education, *American Journal of Business Education*, 2 (8), 9-14

Hurst, J.L., Good, L.K. (2010) A 20-year evolution of internships: Implications for retail interns, employers and educators. *Int. Rev. Retail. Distrib. Consum. Res.,* 20, 175–186

Jackel D. (2011) Evaluating the Effectiveness of an Internship Program, Master Theses & Specialist Projects, Paper 1117.
https://digitalcommons.wku.edu/theses/1117/

Karns, G.L. (2005) An update of marketing student perceptions of learning activities: Structure, preferences, and effectiveness. *J. Mark. Educ.* 27, 163–171

Knemeyer, M.A., Murphy, P.R. (2002) Logistics internships: Employer and Students Perspectives. *Int. Journal of Physical Distribution and Logistic Management* 32, 135–152

Knouse, S. B., Tanner, J. R., Harris, E. W. (1999) The relation of college internships, college performance, and subsequent job opportunity, *Journal of Employment Counseling,* 36, 35–43

Knouse, S. B., Fontenot, G. (2008) Benefts of the business college internship: A research review, *Journal of Employment Counseling*, 45, 61–66

Marinas, C.V., Goia, S.I., Igret, R.S., Marinas, L.E. (2018) Predictors of Quality Internship Programs—The Case of Romanian Business and Administration University Education, *Sustainability Journal*, 10(12), 4741

Markus, G., Howard, J., King, D. (1993) Integrating community service and classroom instruction enhances learning: Results from an experiment. *Educational Evaluation and Policy Analysis,* 15(4), 410–419

Martin, D. R., Wilkerson, J. E. (2006) An Examination of the Impact of Accounting Internships on Student Attitudes and Perception, *The Accounting Educators' Journal*, 16, 129-138

Matthew S. M., Taylor, R. M., Ellis, R. A. (2012). Relationships between students' experiences of learning in an undergraduate internship programme and new graduates' experiences of professional practice. *Higher Education: The International Journal of Higher Education and Educational Planning*, 64(4), 529-542

Moghaddam J.M. (2011) Perceived Effectiveness of Business Internships: Student Expectations, Experiences, and Personality Traits, *International Journal of Management* 28 (4), 287-303

Moghaddam J.M. (2014) Impacts of Internships on Students' Personal/Business Values and the Role of Their Personality Traits, *The Journal of Global Business Management,* 10 (1), 52-60

Narayanan V.K.,OlkP.M. (2010) Determinants of Internship Effectiveness: An Exploratory Model, *Academy of Management Learning & Education*, 2010, 9 (1), 61–80

Newman, B.S., Dannenfelser, P.L., Clemmons, V., Webster, S. (2007) Working to learn: Internships for today's social work students. *Journal of Social Work Education*, 43, 513–528

Nicholas, A. J., (2016) Internships: Experiential Learning, Academic Connection and Assessment Faculty and Staff - Articles & Papers. 61. *https://digitalcommons.salve.edu/fac_staff_pub/61*

Parilla, P., Hesser, G. (1998) Internships and the sociological perspective: Applying principles of experiential learning, *Teaching Sociology*, 26(4), 310-329

Raman P., Pashupati, K. (2002) Turning good citizens into even better ones: The impact of program characteristics and motivations on service-learning outcomes, *Journal of Nonprofit and Public Sector Marketing*, 10, 187-207

Seyitoglu F., Yirik S. (2015) Internship Satisfaction of Students of Hospitality and Impact of Internship on the Professional Development and Industrial Perception, *Asia Pacific Journal of Tourism Research*, 20 (1), 1414–1429

Velez G.S., Giner G.R. (2015) Effects of business internships on students, employers and higher education institutions: a systematic review, *Journal of employment counseling*, 52, 121-130

Zhang X. (2012) Discussion on international internship and intercultural competence from a perspective of higher educational internationalization—A case study of the program Work and Travel USA. *Cross-Cultural Communication*, 8, 62–66

Zhao H., Liden R. (2011) Internship: A Recruitment and Selection Perspective *Journal of Applied Psychology,* 96 (1), 221–22

Zopiatis, A. (2007) Hospitality internships in Cyprus: A genuine academic experience or a continuing frustration? *International Journal of Contemporary Hospitality Management*, 19, 65–77

ANALYSIS OF THE DEMAND FOR PRIVATE HEALTHCARE IN SOUTH AFRICA

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Abstract
Access to a good and healthy life is a human right recognised globally. The fight to deal with poverty and food insecurity as the top two sustainable development goals (SDGs) under the global agenda 2030 can only be achieved if a majority of the world population is able to participate in economic activities. However, the provision of healthcare is complicated by the nature of the demand and supply function. There is inefficient provision due to the positive externalities associated with healthcare provision and consequently the social efficiency is not achieved, especially when private provision is considered, and therefore the need for government involvement. This paper analyses the demand for private healthcare in South Africa, using the data collected from a general household survey with a sample of 21601 households. The results of the logistic regression model show that the gender of the head of a household, income, food security status, age of head of household and social grant and pension status were among the significant predictors of demand for private healthcare. The study provides insights on how provision of healthcare should be tailored so as to achieve maximum efficiency in public provision of healthcare.

JEL classification: I11, I15, I32, H41

Keywords: households, externalities, demand structure, public goods, mixed goods, healthcare

1. Introduction and background of healthcare and its demand

A health and economically productive life is a good foundation for any society. It is pertinent in order to deal with the global issues of poverty inequality and unemployment. Each and every country strives to have a health workforce in

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order to have maximum utilisation of the skills that are available through human capital investments. The need to have a proper efficient and non-discriminatory health care system is therefore an integral part of dealing with the global problem of poverty and low growth. Different countries have policies aimed at providing good healthcare to their citizens. World over, the issues of access and affordability are paramount.

The Constitution of the Republic of South Africa stipulates in chapter 2 section 27 (1) that, access to healthcare is a human right and should be available to every person (Bill of rights, 1996). Therefore, the provision of healthcare falls under those services that need to be provided by government. The fact that healthcare is not provided only by government, but also the private sector makes healthcare's supply and demand unique. Healthcare is not a straightforward private good; it is associated with a number of unique features. The fact that a number of countries have had varied experiences in the provision or establishment of an efficient system is testimony to the uniqueness of the service (Asteraye, 2002; Gubb, James, Meller-Herbert, 2009; Hernandez, Suglia, 2016; Owusu-Sekyere, Chiaraah, 2014; World Bank, 1992).

Van Eeden (2009) identified three characteristics of the demand for healthcare. Firstly, it is a derived demand, meaning that individuals or households do not consume or demand healthcare primarily for the utility gained from directly consuming healthcare services or products. Derived demand entails that the utility or the satisfaction is derived from what comes after the product or service is consumed. Therefore, derived demand entails that what is needed is beyond the service. A similar example is demand for education, which is also a derived demand. Therefore, people demand healthcare for the perceived benefits in terms of their general health status (van Eeden, 2009). In the theoretical literature, this aspect of the demand for healthcare is usually linked to Grossman's demand for healthcare model where health demand is derived as both an investment and consumption expenditure. As will be discussed in detail in the literature review, Grossman argues that health is produced by the consumption of health inputs in the production of healthy days. Another unique characteristic of the demand for healthcare is that it is associated with excess demand. Most goods or services that have positive externalities are characterised by excess demand, as the private cost is usually much less than the social benefit, which includes the unintended positive externalities. Thirdly, there is supply-induced demand for healthcare. The absences of health may be associated with negative externalities. The market for healthcare is therefore different from the market of pure public goods or that of private goods. A private good or service is one that has both rivalry and is excludable, while a pure public good is both non-rival and non-excludable.

Beyond these characteristics of health demand, the demand for healthcare is affected by the same determinants that other private products have, especially when considered broadly at a household level (Asteraye, 2002; World Bank, 1992). A household that has health insurance coverage has to make a decision as to what the opportunity costs are in buying this health insurance. Therefore, the basic determinants of demand such as the price of the product, price of substitutes and complements, income and other demographic factors become important. These will be revisited in the research methods section when specifying the empirical model.

This paper, however, makes a bold statement that healthcare demand in South Africa is affected by the inequality nature of the country and consequently has become unaffordable to those who should ordinarily be able to afford it. This has been made possible by the availability of a bourgeoisie class of people at the very top who have accepted a very high premium for health insurance because they can afford it, and therefore the private health sector only serves a few at the expense of the overburdened public health system. It is the hypothesis of this paper that although in normal circumstance demand for health would be higher on female-headed households, being the case that mostly men are the ones that have access to higher levels of income, it will be likely that in South Africa the demand for private health care will be more on the male-headed households whose probability of being in employment is higher than female-headed households.

2. Literature review

The literature on the demand function for healthcare is similar to a large extent to that of demand for other semi-public goods such as education. Health is linked to a number of other valuable aspects of life that are not possible in the absence of good health (Asteraye, 2002). It is also considered a public good in the sense that it has higher levels of external effects. The externalities of health as a product can be both positive and negative (Goodman, Marin, 1998). Positive externalities are associated with good health and negative externalities are associated with the absence of good health. Ebola (Mehtar, 2018) is an example of negative externalities associated with poor health, and efficient labour force or flu prevention due to a flu vaccination are examples of positive externalities of good health (Blavin, Ramos, Lallemand,, Fass, 2017).

According to the World Bank (1992) in the understanding and formulation of healthcare functions, two alternative models for describing the way individuals or economic units make choices regarding health care utilisation and related decisions are used. Firstly, a basic approach is to treat health as one of the several commodities over which individuals have well-defined individual preferences, and therefore can be understood under the ordinary determinants of demand. A second approach used in the analysis of healthcare choices is to use an intertemporal model of consumption decisions and to treat health as a stock variable within a human capital framework (World Bank, 1992). Healthcare use can certainly have long-lasting effects, and the idea of healthcare representing an investment in health has been popular at least since the World Bank's 1993 World Development Report. When health is considered as an investment, then only those with the required capital to access inputs in the production of this health are able to have better health than those who cannot afford the investment. It is in the line of such thinking that the provision of healthcare is no longer in line with the constitution, which provides for access to health for all people.

2.2 Heath, income and income inequality

There is a simultaneous relationship between health and income. Those who have higher levels of income are able to access good healthcare, whereas those with low income depend on public health services, which, in many cases, are

of low quality, especially in developing countries. In what is known as the spirit level report by Wilkinson and Pickett (2009), it was put to the fore that income inequality was central to health; it is argued that inequality caused a large array of health and social problems, which affected everyone in society, not just those at the bottom (Rowlingson, 2011). The high level of income inequality has affected the health sector in a unique way in South Africa. Private healthcare or health insurance in South Africa is so expensive that it excludes the average person from coverage, and, in turn, the public sector has had to deal with a higher than normal demand due to the absence of affordable insurance for those with modest incomes.

2.3 Health and gender

There is a strong link between gender and health. Firstly, it is assumed that women tend to mind more of their health than men, but also because women are associated with child birth and child care at a higher level than men (Fikree, Pasha, 2004). In reality, women face more health challenges beyond their control, for example, Fikree and Pasha (2004) point out that by their nature, reproductive health hazards are borne by women alone and this in most cultures is not a choice. They further argue that poor outcomes for both mother and child are inevitable. There are a number of studies that have shown the link between gender and health and how there is a need to focus on the different dynamics, not essentially about women's health, but rather the interactions between gender and heath (Cameron, Song, Mnaheim, Dunlop, 2010, Doke, 2015, HLEG, 2010). In the United States of America, one of the debates around the Affordable Care Act, also known as Obamacare, was the issue of pre-existing conditions; and also that women were made to pay more by the mere fact that they were women and the Obamacare was to deal with those discriminatory clauses. There seem to be a significant link between healthcare demand and gender (Cameron et al., 2010).

2.4 Health and poverty

Poverty remains an important issue in almost all sectors of public discourse. The WHO (2013) argued that the poor suffer worse health and die younger. They also pointed out that the poor have higher than average child and maternal mortality, higher levels of disease, more limited access to healthcare and social protection, and gender inequality further disadvantages the health of poor women and girls (WHO, 2013). Wherever public expenditures are increasing, there is an intrinsic understanding that it will impact on the lives of the poor. Therefore, the introduction or intention to introduce a national health insurance is mainly premised on the understanding that there are too many citizens who are relying on public healthcare and yet the private sector could offer relief. This then is the link between poverty and health; the relationship is simultaneous, meaning that there is causality from lack of health to poverty or poverty to poor health (Grant, 2008; Ngoma, Mayimbo, 2017, Phipps, 2003, Price, Khubchandani, Webb, 2018). Households that are poor are more likely to have poor health due to the many attributes that are associated with poverty that may lead to less consumption of

health services, especially the private ones that require payment. On the other hand, poor health may also lead to poverty in the sense that people who are not physically fit are less likely to have a stable job or any source of income, and therefore are more likely to fall into the poverty trap.

The paper therefore attempts to bring to the fore the understanding that health provision that excluded the majority erodes the gains made by the few that are included due to the externality attributes associated with healthcare. There is also a deliberate attempt to show that there are consequences associated with health care, positive for good healthcare both at individual and societal level and negative for poor health, also both at individual and societal level.

3. Research method and data

In this paper, a deliberate attempt is made to distinguish research methods from research methodology. In most papers and postgraduate research, there is an acceptance in referring to research methods as research methodology. However, the two are fundamentally different in that research methods only present the steps followed in the data collection preparation and analysis, as opposed to research methodology, which is a study of research methods (Rajasekar, Philominathan, Chinnathambi, 2006, Walliman, 2011). Therefore, in this section, we present research methods and not methodology. The positivist paradigm of testing hypothesis with an objective as opposed to subjective approach and consequently testing hypothesis using quantitative data was used in the paper. The main objective, as discussed in the preceding sections, was to test which household and household head characteristics are significant in explaining the demand for private healthcare, with a special focus placed on the gender of the head of household.

The paper used data that was collected by Statistics South Africa in a General Household Survey (GHS). The study was conducted from January to December of 2016 and the data was made available on line on datafirst, published in 2017. The data has 21 601 households that were involved in the survey. These households were sampled across the country in an effort to have a representative sample. According to Statistics SA (2017), the target population of the survey consists of all private households in all nine provinces of South Africa and residents in workers' hostels. The survey does not cover other collective living quarters such as students' hostels, old-age homes, hospitals, prisons and military barracks, and is therefore only representative of non-institutionalised and non-military persons or households in South Africa (Statistics SA, 2017).

The demand for private healthcare was represented by where the household went for help when they were sick. Table 1 presents the frequencies of the responses. Based on these responses, a binary dependent variable was calculated.

Table 1. Source of medical help

Source of help	Frequency	Percent	Cumulative percent
Hospital	1674	7.7	7.7
Clinic	14044	65.0	72.8
Other	115	.5	73.3
Hospital	430	2.0	75.3
Clinic	332	1.5	76.8
Private doctor/specialist	4632	21.4	98.3
Traditional healer	100	.5	98.7
Spiritual healers	35	.2	98.9
Pharmacy/chemist	83	.4	99.3
Health facility provided by employer	52	.2	99.5
Alternative medicine, e.g. homoeopathist	2	.0	99.5
Other in private sector	10	.0	99.6
Do not know	4	.0	99.6
Unspecified	88	.4	100.0
Total	**21601**	**100.0**	

Source: Authors' calculations from the GHS data

Therefore, those who indicated getting help from private doctors and also those who went to other private sectors were categorised together as demanding private healthcare; the rest of the responses were categorised as not demanding private healthcare, and thereby relying on public healthcare services or otherwise. Table 2 therefore presents a frequency distribution of the binary variable, which will be used as a dependent variable in the model. The results in Table 2 show that 21.5% of the households in the sample demand private healthcare, while the majority of the households in the sample, accounting for 78.5%, did not demand or did not have private health coverage.

Table 2. Frequency distribution of demand for private health services

Health demand	Frequency	Percent	Cumulative percent
No private health demand	16959	78.5	78.5
Demand private health services	4642	21.5	100.0
Total	21601	100.0	

Source: Authors' calculations from the GHS data

3.1 Model specification

Based on the nature of the dependent variable, a conditional probability model needs to be used in a regression analysis. As the dependent variable is a two-category without need for ranking, a binary logistic model is appropriate. The binary logistic model estimated in this paper uses the maximum likelihood estimation. Logistic regression is the appropriate model when using a dependent variable of a categorical outcome. For categorical variables, it is inappropriate to use linear regression because the response values are not measured on a ratio scale and the error terms are not normally distributed (Czepiel, n.d.). The logistic regression model equates the logit and transforms the log-odds of the probability of a success, to the linear component. Therefore, the mathematical equation of the logistic regression model is specified as follows;

$$\log\left(\frac{\pi_i}{1-\pi_i}\right) = \sum_{k=0}^{K} x_{ik}\beta_k \qquad i = 1, 2, \ldots, N$$

(1)

Consequently, equation 1 is done with maximum likelihood estimation, which entails finding the set of parameters for which the probability of the observed data is greatest.

In logistic regression, a complex formula is required to convert back and forth from the logistic equation to the OLS-type equation. The logistic formulas are stated in terms of the probability that Y = 1, which is referred to as $\hat{p}$. The probability that Y is 0 is 1 - $\hat{p}$. Where Y =1 is the probability that the household has private healthcare coverage and Y= 0 means that the household does not have private health insurance or coverage.

$$ln\left(\frac{\hat{p}}{1-\hat{p}}\right) = \beta_0 + \beta_1 X \quad \ldots$$

(2)

From equation 2, we can calculate the expected probability that Y=1 for given values of X as follows

$$\hat{p} = \frac{\exp\left(B_0 + B_1 X\right)}{1 + \exp\left(B_0 + B_1 x\right)} = \frac{e^{B_0 + B_1 x}}{1 + e^{B_0 + B_1 x}}$$

$\ldots$ (3)

Therefore, with the variables that are used in the model for the determinants of demand for private healthcare, the model to be estimated will be simply expressed as follows:

$$ln\left(\frac{\hat{p}}{1-\hat{p}}\right) = \beta_0 + \Sigma_i^n \varnothing_i + \Sigma_j^n \theta_j + \varepsilon \ldots$$

(4)

Where $\Sigma_i^n \varnothing_i$ represents all the factors in the models and $\Sigma_j^n \theta_j$ represents the covariates in the model.

If $n\left(\frac{\hat{p}}{1-\hat{p}}\right)$ is substituted by Z, then the familiar presentation of the model becomes

$$Z = \beta_0 + \emptyset_1 Lonicome + \emptyset_2 HHsize + \emptyset_3 Age \ of \ head + \theta_1 Employstatus +$$
$$\theta_2 gender + \theta_3 Social \ Grants + \theta_4 Food \ Security \ Status + \theta_5 Pension + e \quad \ldots$$

$$(5)$$

4. Results and discussion

The presentation of the results and the discussion thereof start with the explanation of the variables and the descriptive statistics of the variables in the model. The dependent variable has already been presented in Table 2. Table 3 presents the frequency distribution of gender of head of households in the sample. This is relevant in the sense that the study focuses on the gender disparity between male and female heads of households, to investigate whether there are changes taking place with regard to access to income and employment that may proxy the ability to afford private healthcare. Table 3 shows that there were 41.7 % female headed households, and 58.3 % were male-headed households.

Table 3. Gender of the head of household

Gender	Frequency	Percent	Cumulative percent
Female head of household	9009	41.7	41.7
Male head of household	12592	58.3	100
Total	**21601**	**100.0**	

Source: Authors calculations from the GHS data

Gender was entered as a dummy variable in the model with females coded as 1 and males coded as 0, meaning that the coefficient represented the female headed households. Other variables in the model include household total income, which was transformed to natural logs; food security, which was measured as a scale, the higher the score the higher the probability of being food insecure, and the lower the score the lower the probability of being food insecure. Household size was also used in the model. Pension was another variable of interest, which was also entered as a dummy variable. Table 4 presents the coding of the categorical variables in the model.

Table 4. Categorical variable coding

Grants	Yes	10845	1.000
	No	10411	.000
Pensions	Yes	953	1.000
	No	20303	.000
Salaries/wages/commission	Yes	13520	1.000
	No	7736	.000
Gender head of household	Female	8904	1.000
	Male	12352	.000

Source: Authors' calculations from the GHS data

Therefore, the interpretation of the results of the regression model follows the normal understanding of a dummy variable, where the category of the variable coded 1 takes the coefficient and is interpreted in relation to the category coded 0.

4.1 Results of the logistic regression model

The results of the logistic regression model are presented in Table 5. The omnibus test had a p-value of 0.000 showing that the model is a good fit. The dependent variable was defined as 1 for having private healthcare coverage, or indicating the demand for private health services. Gender of the head of household was entered in the model as 1 for females. The coefficient for gender in the regression results is negative, which means that males have a higher probability of having private health coverage compared to females. The p-value for gender is 0.000, which means gender is a significant predictor of the probability of having private health insurance.

Table 5. Logistic regression results

Variables	B	S.E.	Wald	df	Sig.	Exp(B)
Gender head of household(1)	-.178	.042	18.425	1	.000	.837
Food insecurity	-.698	.045	243.484	1	.000	.497
Log of income	.194	.008	612.613	1	.000	1.214
House hold size categorised	-.025	.032	.637	1	.425	.975
Pensions(1)	1.168	.080	214.905	1	.000	3.216
Salaries/wages/commission(1)	.708	.049	208.890	1	.000	2.030
Age of household head	.017	.001	141.883	1	.000	1.018
Grants(1)	-1.498	.054	759.213	1	.000	.224
Constant	-2.949	.121	593.829	1	.000	.052

Dependent variable, 1= having health insurance coverage 0= no health insurance
*Significant at 10% **Significant at 5% ***Significant at 1%

Food insecurity is important as it depicts the availability of other necessities beyond private health. A score was used for food security, with a higher score implying insecure, and a lower score implying food secure. The negative coefficient in the model therefore means that food insecure households have a lower chance of having private health insurance as opposed to the food secure households. The p-value for food insecurity as a predictor was also 0.000, which is significant at 1% meaning that food insecurity status is a statistically significant predictor of the probability of a household demanding private healthcare. Therefore, food and health can be competing needs on poor households, just like food was also found to compete with housing in a study on similar households in South Africa (Dunga, Grobler, 2017).

Income, which was transformed to natural log, shows a positive relationship with the probability of having private healthcare. The positive coefficient means that the higher the total income of the household, the higher the probability of that household demanding private health insurance. The p-value was 0.000, which is less than 0.01 for the 1% significance level. Therefore, as expected income is a significant predictor of demand for private health. This is in agreement with a number of studies that have also found a positive correlation between health and income (Mutyambizi, 2008; Owusu-Sekyere, Chiaraah, 2014; n.d.).

The P-value for household size was 0.425, which is higher than 0.05 or 0.1 for the 5% and 10% significance levels, respectively. It therefore means that the size of the household was not a statistically significant predictor of private healthcare demand in the model.

People who are currently receiving pension are those who were previously employed and consequently have managed to accumulate savings; also, those on pension are usually older. The categorical variable for pension was defined as 1 for those on pension and 0 for those not on pension. The coefficient is positive with a significant p-value of 0.000. This means that having pension is a significant predictor of the probability of demanding private healthcare. Also linked to employment were those who indicated that they were on a salary or wages compared to those who were not. The coefficient is positive with a p-value of 0.000, indicating that having a job was a statistically significant predictor of the demand for private health demand. Therefore, those without a formal income source were most likely to depend on public health services.

Age of the head of household was positively and statistically significant with a p-value of 0.000, implying that older people demanded private healthcare more than the younger heads of households. This may be an indication of youth unemployment, since the younger heads of households comprise those who can be categorised as youth.

Lastly, the model also investigated those on social grants. The negative coefficient for social grants means that those on social grants are less likely to demand private health as opposed to those who are not on social grants. This is an expected outcome, since social grants target people who are considered poor. Therefore, it would be unexpected to find the poor demanding private health insurance. The p-value for the social grants variable was also significant at the 1% level of significance.

5. Conclusion

The study has revealed that the majority of households in the South Africa are relying on the public health sector, with 21.5% of the households in the sample having health insurance and being able to demand services from the private health sector. Gender of head of household was given special attention to test the hypothesis that women are more responsive to health issues and hence are more likely to demand private healthcare. The results showed that demand for private healthcare depended more on other factors such as income and employment, and that male-headed households were found to be more likely to demand private healthcare than females do; this was mainly because male heads of households were more likely to have a job than female heads of household.

Among the statistically significant determinants was the availability of employment that was represented by salaries or wages. People without a job were the ones who did not demand private health insurance. The most important lesson also coming out of the model was that these were mostly the young heads of household as the age variable showed that the older people were more likely to demand private healthcare than the young heads of household did.

Therefore, besides the fact that private healthcare is expensive, there is a need for the country to continue with the efforts of growing the economy and creating more jobs for the youth. Jobs for the youth will mean an increase in the demand for private healthcare from the youth, which may reduce the strain on the public sector. It may also mean a reduction on the number of people on social grants who are the same people that are also failing to demand private healthcare. Also linked to jobs is pension, and therefore the more people have access to jobs the better for the future as well, since these people will be able to pay for their health insurance after they retire and move on to receiving pension. This paper proposes a more in-depth analysis of the healthcare demand by looking at the provincial difference and also differences by education level. Also, a focus is needed on the cost of health insurance and a possibility of coverage that could be tailored to people's financial capabilities.

References

Asteraye, N. (2002). Determinants of Demand for Health Care Services and their Implication on Health Care Financing : The Case of Bure Town, *XI*(1), 87–122.

Blavin, F., Ramos, C., Lallemand, N. C., Fass, J. (2017). *Analyzing the Public Benefit Attributable to Interoperable Health Information Exchange*.

Cameron, K., Song, J., Mnaheim, L., Dunlop, D. (2010). Gender Disparities in Health and Healthcare Use. *Journal Of Womens Health*, *19*(9).

Czepiel, S. A. (n.d.). Maximum Likelihood Estimation of Logistic Regression Models : Theory and Implementation.

Doke, P. P. (2015). Gender issues in health sector. *Journal of Krishna Institute of Medical Sciences University*, *4*(2), 10–18.

Dunga, S. H., Grobler, W. (2017). The Nexus of Food and Housing Insecurity in South. *International Journal of Social Sciences and Humanity Studies*, *9*(2), 95–108.

Fikree, F. F., Pasha, O. (2004). Role of gender in health disparity: the South Asian context. *Bmj*, *328*(7443), 823–826. https://doi.org/10.1136/bmj.328.7443.823

Goodman, A. C., Marin, S. (1998). HMOs and Health Externalities : A Local Public Good Perspective (August).

Grant, U. (2008). Health and Poverty Linkages : Perspectives of the chronically poor. *Chronic Poverty Research Centre* (February 2005).

Gubb James Meller-Herbert, O. (2009). Markets in health The theory behind the policy (December), 1–69.

Hernandez, D., Suglia, S. (2016). *Leveraging the Social Determinants to Build a Culture of Health Housing as a Social Determinant of Health*. Retrieved from https://healthequity.globalpolicysolutions.org/wp-content/uploads/2016/12/Housing2.pdf

HLEG. (2010). Gender and Health. *High Level Expert Group Report on Universal Health Coverage for India*, 295–300.

Mehtar, S. (2018). Guide to Infection Control in the Hospital. In *international society for infectious diseases*.

Mutyambizi, V. (2008). Country Case Study Health Insurance in South Africa. *Health Economics Unit, Iniversity of Cape Town*, 11.

Ngoma, C., Mayimbo, S. (2017). The Negative Impact of Poverty on the Health of Women and Children. *Annals of Medical and Health Sciences Research*, 7, 442–446.

Owusu-Sekyere, E., Chiaraah, A. (2014). Demand for Health Insurance in Ghana: What Factors Influence Enrollment? *American Journal of Public Health Research*, *2*(1), 27–35. https://doi.org/10.12691/ajphr-2-1-6

Phipps, S. (2003). The Impact of Poverty on Health. *CPHiSPC*, (June).

Poor people ' s experience of health and ill-health Foreword. (n.d.).

Price, J., Khubchandani, J., Webb, F. J. (2018). Poverty and Health Disparities: What Can Public Health Professionals Do? *Health Promotions Practice*, (March). https://doi.org/10.1177/1524839918755143

Rajasekar, S., Philominathan, P., Chinnathambi, V. (2006). Research Methodology, 1–53. https://doi.org/arXiv:physics/0601009v3

Rowlingson, K. (2011). Does income inequality cause health and social problems ? *Joseph Rowntree Foundation*, (September).

Statistics SA. (2017). General Household Survey. *Statistical Release P0318*, *21*(4), 482. https://doi.org/10.1016/S0022-5223(12)00629-0

WALLIMAN, N. (2011). *Research Methods* (1st ed.). New York: Routledge.

WHO. (2013). *DAC Guidelines and reference Series: Poverty and Health*.

World Bank. (1992). The Demand for Health Care Services. *Microeconomics of Healthcare and Insurance Markets*, 55–90.