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VENTURE CAPITAL AND THE USE OF CONVERTIBLE SECURITIES AND CONTROL RIGHTS COVENANTS: A FUZZY SET APPROACH

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ABSTRACT

Although venture capital is considered crucial for promoting economic development and innovation, not much has been done regarding the use of complex financing contracts in venture capital backed investments. In this study we investigate the use of convertible securities and control rights covenants for a sample of 15 Portuguese venture capital firms. We use a relatively new methodology in business and management sciences – fuzzy set Qualitative Comparative Analysis – that considers both quantitative and qualitative factors for obtaining a solution that best fits the empirical data. Our results show that the use of convertible securities is affected by the anticipated severity of double-sided moral hazard problems. On the other hand, only a weak support is provided to the agency predictions regarding the use of control right covenants. Interestingly, the results reveal that convertible securities, unlike control rights covenants, are the most apt instruments to reduce costly double-sided incentive problems of a venture capital relationship.

KEY WORDS

venture capital, convertible securities, control right covenants, agency costs, fuzzy set theory

JEL CODES

C10, G24, G32

1   INTRODUCTION

There is a consensus that Venture Capital plays a catalytic role in promoting innovation (Kortum and Lerner, 2001), in contributing for economic growth and in fostering labour force capabilities by opening career opportunities to high-qualified individuals (Smith and Estibals, 2011; Christofidis and Debande, 2001; Andersson and Napier, 2007; Bascha and Walz, 2002).

Given the important role played by Venture Capital in providing financing resources to

new technology and entrepreneurial firms, it is crucial to investigate what are the determinants for the optimal design of financing contracts established between Venture Capital firms and their portfolio of firms.

Schmidt (2003) suggests that the predominance of convertible securities on Venture capital backed investments is due to the existence of double-sided moral hazard problems. Repullo and Suarez (2004) define the doubled-sided moral hazard as the financing problem that arises when the efforts that both venture capitalist and entrepreneur have to commit for the expansion of the project are unobservable at the start-up stage. Repullo and Suarez (2004) and Schmidt (2003) contend that convertible securities provide a powerful incentive mechanism that can induce both entrepreneur and venture capitalist to commit effort at the start-up stage and to invest efficiently at the expansion stage. Indeed, the incentive mechanism embedded in the conversion option ensures that the venture capitalist will invest at the expansion-stage if he/she exercises his/her conversion rights and this only happens if both venture capitalist and the entrepreneur put in the efficient amount of effort at the start-up stage. Therefore, as authors such as Schmidt (2003), Repullo and Suarez (2004), Gompers and Lerner (1996), Gompers (1997), Hellmann (1998) point out, convertible securities in venture capital financing strictly outperform any standard debt-equity contract.

On the other hand, extensive literature (e.g. Gompers, 1995; Gompers, 1997; Bergemann and Hege, 1998; Baker and Gompers, 2003; Sahlman, 1990; Lerner, 1995; Gorman and Sahlman, 1989; Smith, 2005; Schwienbacher, 2008) argues that the inclusion of explicit control right covenants in venture capital agreements allow for reduction of excessive conflicts of interest between venture capitalist and entrepreneur. More importantly, these authors contend that the mitigation of the conflicts of interests between venture capitalist and the entrepreneur cannot rely solely of the use of a particular financing instrument. Specifically, Gompers (1997) emphasises that, although many theories of financial instruments have

focused on optimal control allocation, the use of cash-flow rights – such as convertible preferred stocks or convertible debt – to resolve control rights allocation is deemed not to be optimal in the venture capital context. According to authors like Gompers (1997), Hellmann (1998) and Kaplan and Strömberg (2003), while convertible securities should be used to assure an optimal allocation of cash-flow rights, control rights covenants are better suited to solve conflicts of interest related to corporate control. In particular, a number of authors argue that the inclusion of contractual covenants in venture capital financing is particularly important to resolve disagreements regarding optimal exit strategies (Cumming, 2008; Kaplan and Strömberg, 2003; Smith, 2005; Bienz and Walz, 2010; Schwienbacher, 2008).

As pointed out by Gompers (1997), venture capital projects – characterised by extreme uncertainty, severe asymmetry of information and potentially high rewards – provide a unique perspective to assess the role of financing contracting and corporate control. Nevertheless, existing empirical studies tend to focus on the role played by individual rather than multiple contractual features in resolving issues regarding the allocation of cash-flow rights or corporate control rights. In this regard, this paper is novel in a number of ways. First, it provides a comprehensive empirical investigation of cost-effective contractual mechanisms (such as convertible securities and control rights covenants) that are expected to reduce the double-sided incentives in venture capital investments. Second, to our best knowledge, it is the first study that uses qualitative and quantitative methodology – the fuzzy set Qualitative Comparative Analysis (fsQCA) – to assess the effect of convertible securities and control right covenants in mitigating double-sided incentive problems arising from venture capital-backed investments. The fsQCA is a particularly well-suited methodology for this study because it considers not only the impact of individual factors (as in the traditional regression analysis) but most importantly it takes into account the effect of combinations of factors that shape the design of venture

capital contracts. Moreover, fsQCA considers both qualitative and quantitative sources of data in order to convey a more insightful account of the issues that influence the design of costeffective contracts. To this extend, in order to run our model we use both quantitative data – generated by the questionnaire survey – and qualitative data that is rooted on a comprehensive review of the extant literature on venture capital financing. Finally, this study focuses on a sample of venture capital firms operating in the Portuguese market which, albeit an expanding market, has not been well investigated by the existing empirical literature.

Our results reveal that convertible securities are more likely to be used when the severity of double-sided incentive problems is particularly stringent. This result provide strong support to the agency cost theory proposed by Schmidt (2003), Gompers and Lerner (1996), Gompers (1997), Hellmann (1998), among others. On the other hand, only a weak support is found for the use of control rights covenants to reduce double-sided incentive costs. Interestingly, although not consistent with broad agency predictions, this evidence corroborates theoretical predictions that deviate from the traditional corporate finance view. Indeed, a recent stream of literature suggests that, in the particular context of Venture Capital settings, the use of control rights covenants is required not necessarily to decrease principal-agent conflicts of interest, but rather to increase value-creation opportunities (e.g. Manigart et al., 2002; Wright and Robbie, 1998) or to reduce idiosyncratic risks associated to non-diversified venture capital portfolios (e.g. Wright and Robbie, 1998; Yoshikawa et al., 2004). Therefore, our paper provides a significant contribution to ongoing research regarding the different role played by financing instruments (namely, convertible bonds and convertible preferred shares) and by the use of control rights covenants in the specific context of Venture Capital.

The remainder of the paper is structured as follows. In the next section, we provide an overview of theoretical predictions and empirical evidence regarding the use of convertible securities and control rights covenants in Venture Capital contracts. Section 3 outlines the methodology, sample and data used in this study. Section 4 presents the results and discusses their implications. Finally, Section 5 presents the conclusions of this study and suggests future research paths.

2 LITERATURE REVIEW

Venture Capital firms are considered to have a positive effect on the backed firms' productivity (Croce et al., 2013) and growth (Davila et al., 2003), to be able to enhance the backed firms' operational and financial performance (Alperovych and Hübner, 2013; Gompers and Lerner, 2004) and to promote the backed firms' innovation (Gompers and Lerner, 2004; Kortum and Lerner, 2001). Additionally, authors such as Park et al. (2015) and Lockett et al. (2008) point out that Venture Capital firms contribute for enhancing the internationalisation prospects of venture capital-backed projects.

In the same context, Gorman and Sahlman (1989) list six ways in which Venture Capital firms can support new ventures. Thus, according to these authors Venture Capital firms assist entrepreneurs in getting additional financing, in developing both strategic and operational planning, in recruiting the management team, in fostering networks with potential customers and suppliers and in resolving compensation issues. Considering the substantial contribution of Venture Capital in promoting and developing new ventures, it is crucial to examine what are the optimal features in Venture Capital financing instruments and control mechanisms that allow for the reduction of inherent financing costs.

According to Schmidt (2003) the predominance of convertible securities on investments backed by Venture Capital can be explained by the existence of a double-sided moral hazard problem. Double-sided moral hazard occurs

when actions from the agent (entrepreneur) cannot be observed by the principal (venture capitalist) or verified by third parties (e.g. courts). To this extent, Schmidt (2003) points out that the success of highpotential entrepreneurial firms depends not only on the quality of the project and the effort exerted by the entrepreneur but also on the commitment of the venture capitalist to actively manage the projects they finance[1]. Therefore, there should be a mechanism to induce both venture capitalist and entrepreneur to undertake effort and therefore curb the double-sided moral hazard issues. Convertible securities act as such mechanism because on one hand, the venture capitalist will invest and exercise his conversion rights only if the entrepreneur commits sufficient effort to the project and on the other hand, the entrepreneur will commit sufficient effort only if the investor is actively involved not only on the financing but also on the management of the enterprise. According to Schmidt (2003), the latter explains why convertible instruments are very popular among venture capital financing and uncommon when the funding of small firms is made by banks or other passive investors. Bascha and Walz (2002) show that, for the German venture capital market, convertible securities (namely, convertible debt and convertible preferred shares) are used when the severity of agency problems is particularly high. Furthermore, their results are in line with theoretical predictions (Schmidt, 2003; Gompers, 1997; Hellmann, 1998) that convertible securities, unlike traditional mix of equity-debt financing, allow the optimal allocation of cash flow rights. Other strand of the literature (e.g. Marx, 1998; Berglof, 1994; Schwienbacher, 2008; Cumming, 2008; Arcot, 2014) emphasises that convertible securities allow for a reduction of conflicts between investors and entrepreneurs because it leads to a more efficient allocation of control rights, namely, the right to decide on exit strategy. Indeed, these authors argue that because entrepreneurs derive private benefits

from staying independent and remaining in control of their company after exit, they prefer exit through IPOs even when trade sale or write-off are more efficient strategies for the venture capitalist. Convertible options that are exercisable at different re-financing stages of the project would allow the allocation of control rights to the right persons. However, Gompers (1997), Hellmann (1998), Schmidt (2003), Kaplan and Strömberg (2003), Cumming (2005) among others, emphasise that convertible securities play a distinctive role from control rights covenants because they permit the de-coupling of the payoff from the control problem and allow double-sided monetary incentives to be dealt separately from control incentives. To this extent, this strand of literature suggests that conflict of interests between Venture capitalist with claims over residual equity rights and the entrepreneur who controls the value of those rights (Jensen and Meckling, 1976; Kaplan and Strömberg, 2003; Sapienza et al., 1996; Admati and Pfleiderer, 1994) can be mitigated by the inclusion of additional control rights covenants. In an extensive review of current Venture Capital literature, Yoshikawa et al. (2004) point out that, Venture capitalists protect their claims over residual equity rights by closely monitoring the management of the venture firm through the use of such mechanisms as investment staging (Bergemann and Hege, 1998; Gompers, 1995), active monitoring in the boardroom (Lerner, 1995; Gompers, 1997; Baker and Gompers, 2003), operational control (Gorman and Sahlman, 1989; Gompers, 1997; Baker and Gompers, 2003) and even shareholders agreements that allow the venture capitalist to replace the entrepreneur with outside managers (Sahlman, 1990; Gompers, 1997; Baker and Gompers, 2003). Additionally, Cumming (2008), Kaplan and Strömberg (2003), Smith (2005), Bienz and Walz (2010), Schwienbacher (2008) amongst others, show that the inclusion of specific contractual rights protect venture capitalist claims over exit decisions. We can

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[1]Some of the efforts committed by the entrepreneur can be described as his/her endeavours to build up the company, to engage in RandD and develop the product, to set up the production facilities and to market the product. On the other hand, the venture capitalist commits effort by advising on strategic decisions, helping to find key employees and to design suitable compensation packages for them, contacting key suppliers and customers and even by getting involved in day-to-day operations of the company (Schmidt, 2003; Hellmann and Puri, 2002).

therefore assume that these control rights mechanisms will dilute the entrepreneur incentives to incur in excessive risks and will align his/her interests with the interests of the venture capitalist. This in turn will lead to a desirable reduction in agency costs.

In line with existing literature we consider five potential causal conditions that might lead to the exacerbation of moral hazard problems. These are: the age and size of the Venture Capital firm (Bascha and Walz, 2002; Kaplan and Strömberg, 2003; Norton and Tenenbaum, 1993), the ownership structure of the Venture Capital firm – i.e. whether is privately or publicly held (Bascha and Walz, 2002), life stage of Venture Capital investment portfolio (Gompers, 1995, 1997; Bascha and Walz, 2002) and the venture capitalist's expected rate of return (Bascha and Walz, 2002; Gompers, 1995, 1997; Gupta and Sapienza, 1992; Manigart et al., 2002). According to these authors, younger and smaller VC firms, that are privately held and that invest primarily in seed and start up projects for which high returns are expected, are more likely to be exposed to excessive agency problems. Specifically, Bascha and Walz (2002), Kaplan and Strömberg (2003) and Norton and Tenenbaum (1993) argue that less experienced and smaller VC firms will face more asymmetries of information regarding the entrepreneur ability to pursue a successful venture which will exacerbate agency issues. On the other hand, Bascha and Walz (2002) stress that privately owned, unlike public VC firms, tend to invest in riskier activities for which higher returns are expected. Moreover, the uncertainty regarding the success of the venture capital investment tends to be exacerbated for early stage projects (i.e. seed and start up projects) (Gompers, 1995, 1997; Bascha and Walz, 2002) and for investments with particularly high expected returns (Bascha and Walz, 2002; Gompers, 1995, 1997; Gupta and Sapienza, 1992; Manigart et al., 2002). The increase of investment uncertainty is likely to increase the conflicting incentives between the investor and the entrepreneur. Against this background, we test the hypothesis that smaller and younger VC that are privately held and that invest in early stage projects for which higher rates of return are expected are more likely to include convertible securities to finance their portfolio in order to curb agency problems. In line with the arguments by Gompers (1995), Gompers (1997), Gompers and Lerner (2001), Cumming (2008), Kaplan and Strömberg (2003) and Smith (2005), among others, we also test the hypothesis that firms with these characteristics are more likely to include additional covenants in their shareholders' agreements in order to allow the optimal allocation of control rights. Tab. 5 shows the predicted relationships between the causal conditions and the two outcomes vis-à-vis the supporting literature.

3   METHODOLOGY

In this study we use a relatively new methodology in social sciences[2] – the fuzzy set Qualitative Comparative Analysis (Fuzzy set QCA) – that considers the impact of both quantitative and qualitative factors on the occurrence of the outcome. Moreover, as pointed out by Ragin (2000) QCA incorporates the concept of equifinality in which alternative causal conditions can produce the same outcome. Schneider and Wagemann (2012) also refer to the concept of conjunctural causation, stressing that QCA takes into account that the occurrence of the outcome is more often than not dependent on combinations of causal conditions rather than on the effects of single conditions acting in isolation of one another. Unlike conventional quantitative analysis, QCA does not focus on the linear relationship between variables but on the presence or absence of causal conditions that are necessary or sufficient for

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[2]Smithson (1987) was the first to provide a comprehensive application of fuzzy sets to social sciences. Nevertheless, only Ragin (2000) developed an analytic system – Qualitative Comparative Analysis – that allows the application of basic principles of fuzzy set analysis to social sciences phenomena.

the occurrence of the outcome (Schneider and Wagemann, 2012). Therefore, fsQCA methodology allows the separation of sufficient from necessary conditions which is impossible in conventional statistical tools, such as regression analysis, that rely on the existence of symmetric correlational measures or in other words in the presence of both necessary and sufficient conditions. Moreover, through Boolean algebra and algorithms, QCA reduces a large number of multiple causal conditions to a smaller number of combinations that lead to the outcome, therefore treating the cases (i.e. combinations of causal conditions) as a whole and not as a set of individual variables as in the conventional variable-based approach (Meneses et al., 2016; Felício et al., 2016). Considering the exploratory perspective of this study and its focus on investigating possible combinations of determinants for the choice of cost-effective contractual mechanisms in Venture Capital investments, this methodology is deemed most suitable for obtaining robust results[3]. We apply this methodology to a sample of Venture Capital companies from Portugal. Although Portuguese venture capital market is relatively small, it has been expanding considerably in recent years. According to CMVM (Market Securities and Exchange Commission) venture capital activity annual reports, the value under management for Portuguese venture capital funds rose on average 12% per year from 2013 to 2016 (CMVM, 2013, 2014, 2015, 2016). In 2016, this value increased by 11.3% (CMVM, 2016) surpassing the value of 8.8% that corresponds to the increase in European Venture Capital funds' value under management for the same year (Wijngaarde et al., 2018). The fast growing pace of Portuguese market together with the cross-border relevancy of venture capital contract design topic were the underpinning motives to focus on a relatively not well-known market in this study. The surveyed companies were selected from SABI (Iberian Balance sheet Analysis System) database according to their activity code. The survey was conducted during the first half of August 2016 and from an initial database of 29 companies, two companies were excluded, as they were no longer active. From the remaining 27 companies, we have collected responses from 15 companies, which corresponds to a response rate of 55.55%. The survey was comprised of a questionnaire sent to the CEO or to a fund manager of these companies. The questions were designed in order to obtain information regarding the prevalence of convertible securities (namely, convertible preferred shares and convertible bonds) in Venture Capital backed investments and of control rights mechanisms (namely, refinancing options, exit options and additional restrictive covenants) that allow venture capitalists to closely manage their portfolio of firms. Furthermore, additional questions were included to obtain information about the characteristics of Venture Capital firms (i.e. size, age, and ownership structure) and their portfolio of firms (predominance of seed and start-ups projects and of high return claims), which are considered in the literature as able to exacerbate moral hazard problems. The questions aiming to assess the importance of convertible securities and control right covenants in Venture Capital contracts and the predominance of seed and start up investments on the Venture Capital portfolio were set on a 7-point Likert scale spanning from 1: not important to 7: very important. Tab. 6 shows the survey questionnaire used in this study.

Apart from ownership structure (that we consider as a binary variable), we calibrate our remaining four causal conditions and two alternative outcomes into fuzzy sets. A fuzzy set can be seen as a continuous variable that is purposely calibrated to indicate the degree of membership in a well-defined and specified set (Ragin, 2008). We adopt the indirect method of calibration that allows us to group the initial data from the questionnaire into six-value fuzzy scale. Thus, we are able to consider the quantitative variation evident in the raw data from the questionnaire avoiding the restriction to three

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[3]In recent years, an increasing number of studies in the area of business and management sciences have used fsQCA in their empirical analysis. Among others, there are the studies by Meneses et al. (2016) on brand creation, Felício et al. (2016) on SME internationalisation, Coduras et al. (2016) and Beynon et al. (2016) on global entrepreneurship and Chaparro-Peláez et al. (2016) on e-commerce.

qualitative anchors i.e. 1 for full membership, 0 for full non-membership and 0.5 for maximum ambiguity point – which characterises the direct method of calibration (Rawlance, 2010). For Venture Capital firms' age and size, we attribute a score of 0 for firms with less than one year and with less than five Venture Capital projects in their portfolio (respectively) and a score of 1 for firms with more than ten years and more than one hundred Venture Capital projects in their portfolio (respectively). The intermediate scores were concomitantly allocated to the intermediate ranges. We use a similar procedure to calibrate the Venture Capitalist's expectation of return on seed and start-up investments. Thus, we attribute a score of 0 to expected returns below 10% and a score of 1 to expected returns above 30%. Intermediate codes were then allocated in tandem with the intermediate ranges. To calibrate the condition of life stage of Venture Capital investment portfolio we transformed the initial raw date of degree of importance of this condition into percentiles. We then calibrate these percentiles into a six-value fuzzy set in which fully in the membership set corresponds to values above the 85th percentile, mostly but not fully in the membership set corresponds to values between 75th and 85th percentiles range, more in than out the membership set corresponds to values between 55th and 75th percentiles range, more out than in the membership set corresponds to values between 35th and 55th percentiles range, mostly but not fully out of the membership set corresponds to values between 20th and 35th percentiles range and finally fully out the membership set corresponds to values below the 20th percentile.

According to Ragin (2008) indirect method should be used when it is not possible to precisely specify key benchmarks but only provide a broad classification of cases. Ideally, calibration thresholds should be set based on extant theoretical knowledge. However, as the literature related to Venture Capital does not provide guidance on what theoretically should

be the thresholds for the different degrees of membership, we use percentile ranges similar to ones used in previous studies that rely on fuzzy set methods (e.g. Lewellyn and Muller-Kahle, 2015; Jordan, 2012). To calibrate the two outcome sets, the convertible securities and the inclusion of control rights, first we relied on Boolean algebra to combine the several sets of contractual mechanisms such as convertible options and exit/refinancing options and other control rights (e.g. participation in the day-to-day management of VC-backed firms and inclusion of tag/drag along rights[4]) into these two outcome sets. According to Ragin (2008) two or more fuzzy sets can be compounded through the logical *and* (intersection of sets) or joined together through the logical *or* (union of sets). Specifically, if the final set is deemed to represent the intersection of two or more fuzzy sets, the score attributed to this set is the minimum membership score of each case in the sets that are combined together. On the other hand, if the joined set represents the union of two or more component sets, the score attributed to the former set is the maximum membership score of each case in the component sets (Ragin, 2008). In this study, we consider the use of convertible options on Venture Capital financing contracts as the union between the predominance of convertible bonds and the predominance of convertible preferred shares sets. Additionally, we consider the set, inclusion of control rights covenants in Venture Capital shareholder's agreements, as the intersection between inclusion of exit and refinancing options combined with the inclusion of more restrictive covenants such as drag/tag along options or covenants that allow the Venture Capitalist to participate in the day-to-day management Venture Capital-backed investment. As with project's life-cycle condition, initial Likert scale data is transformed into percentiles and the qualitative fuzzy set codes are allocated accordingly. Tab. 1 describes each causal condition and shows how each condition is calibrated into fuzzy set

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[4]Tag along provision grants the Venture Capitalist the right (but not the obligation) to have his shares bought on the same terms (including price) as the entrepreneur. Drag along provision grants the Venture Capitalist the right to force the entrepreneur to sell his shares on the same terms as the VC if the latter decides to sell his shares (BVCA, 2007).

Tab. 1: Causal conditions – Description, labelling and fuzzy set calibration method

Causal conditions	Labels	Meaning	Linguistic scale	Calibration	
				Fuzzy code	Survey scale*
Private	priv	Legal status of firms: private, public or private/public	Fully in	1	private
			Fully out	0	public, private/public
Expected return	expret	VC return expectations for seed and start up projects	Full membership	1	> 30%
			Mostly but not fully in	0.8	25%–30%
			More in than out	0.6	20%–25%
			More out than in	0.4	15%–20%
			Mostly but not fully out	0.2	10%–15%
			Full non-membership	0	0%–10%
Seed or start up stage	seedstartup	Propensity of VC firms to invest in seed/start up projects	Full membership	1	> 85th
			Mostly but not fully in	0.8	75th to 85th
			More in that out	0.6	55th to 75th
			More out than in	0.4	35th to 55th
			Mostly but not fully out	0.2	20th to 35th
			Full non-membership	0	< 20th
Age	age	Number of years of activity for VC firm	Full membership	1	> 10
			Mostly but not fully in	0.8	8–10
			More in than out	0.6	6–7
			More out than in	0.4	4–5
			Mostly but not fully out	0.2	2–3
			Fully non-membership	0	0–1
Size	size	Number of projects founded by VC firm at certain point in time	Full membership	1	> 100
			Mostly but not fully in	0.8	61–100
			More in than out	0.6	31–60
			More out than in	0.4	11–30
			Mostly but not fully out	0.2	6–10
			Fully non-membership	0	0–5

*) In the case of life-cycle the questionnaire 7-points Likert scale was converted into percentiles.

codes. Tab. 2 summarizes the application of the Boolean algebra and the calibration into fuzzy set codes for the two outcome sets: inclusion of convertible securities and inclusion of control rights covenants. Tab. 3 presents the distribution of fuzzy set codes for each causal conditions and outcome sets after calibration.

Tab. 3 reveals that the propensity to include convertible securities is high for the VC firms surveyed (only 2 out of 15 cases have a fuzzy code below 0.6). On the other hand, VC firms show higher diversity regarding the use of control right covenants. Thus, there are 5 firms with a fuzzy code below 0.6 and 6 firms with fuzzy code of 1 indicating a consistent use of covenants in their financing contracts. Most of the VC firms expect high returns on their early

stage investments (11 out of 15 firms expect returns higher than 31% corresponding to fuzzy set scales above 0.6). In one case the VC firm indicates very low expected returns. However, this firm is likely not to invest in early stage projects (fuzzy code for seedstartup variable is 0). There is high dispersion regarding the life cycle of projects funded by the surveyed firms. Thus, while 5 firms are most likely not to fund early stage projects (fuzzy code = 0), 10 firms reveal that they invest considerably in seed and start up projects (fuzzy codes higher than 0.6). A significant number of VC firms are in activity for more than 10 years (10 firms have a "full membership" fuzzy score indicating that they were established more than 10 years before) and only one firm is operating for a shorter period

Tab. 2: Outcome sets – Boolean expression, labelling, description and fuzzy set calibration method

Convertible Securities			Control Rights Covenants		
Boolean expression[*]	Convertible preffered shares + Convertible bounds		**Boolean expression**[*]	Exit options × Refinancing options + Additional covenants	
Label	conv		**Label**	contrig	
Meaning	Propensity of VC firm to use convertible bonds or convertible preferred stocks in its financing contracts		**Meaning**	Propensity of VC firm to include control rights covenants in its financing contracts	
Linguistic scale	**Percentile**	**Fuzzy code**	**Linguistic scale**	**Percentile**	**Fuzzy code**
Full membership	> 85th	1	Full membership	> 85th	1
Mostly but not fully in	75th to 85th	0.8	Mostly but not fully in	75th to 85th	0.8
More in than out	55th to 75th	0.6	More in than out	55th to 75th	0.6
More out than in	35th to 55th	0.4	More out than in	35th to 55th	0.4
Mostly but not fully out	20th to 35th	0.2	Mostly but not fully out	20th to 35th	0.2
Full non-membership	< 20th	0	Full non-membership	< 20th	0

[*]) The signs + and × stand for the logical *or* and the logical *and*, respectively.

of less than 3 years. Finally, most of the firms are small (13 out of 15 firms have a fuzzy score below 0.6) and privately held (only one firms in the sample is state owned).

Tab. 3: Fuzzy code for each condition and each outcome across VC firms (cases)

Cases	conv	contrig	expret	seed-startup	age	size	priv
1	0.6	0.2	1	1	1	0.8	0
2	1	1	1	0	1	0.4	1
3	0.8	1	0.2	0.8	1	0.4	1
4	1	1	0.8	1	0.8	0.2	1
5	0.6	0.6	0.6	0.6	1	0.2	1
6	0.4	0.4	0	0	0.6	0.4	1
7	0.6	0.6	0.4	0.6	0.8	0.2	1
8	0.2	0.6	0.6	0	1	0.2	1
9	0.6	0.2	1	0	0.2	0.2	1
10	0.8	0.4	0.6	0.6	1	0.2	1
11	0.8	0.8	0.2	0.8	1	0.4	1
12	0.8	1	0.8	0	1	0.2	1
13	0.8	1	0.8	0.6	0.6	0.4	1
14	0.8	1	0.6	0.8	1	0.2	1
15	1	0.2	1	1	1	0.6	1

After calibration, the fsQCA procedure involves three main steps (Ragin, 2000; Ragin, 2006). The first step is the construction of a truth table. The rows in the true table list display all the possible combinations of causal conditions. As it was explained above, this study uses 5 causal conditions. Therefore, there are a total of $2^5 = 32$ possible combinations on the true table list for both outcomes (Ragin, 2006). The second step is to set a frequency threshold so that around 80% of the sample in the analysis is considered in the final result (Greckhamer et al., 2013). Ragin (2008) suggests that for small sample studies the frequency threshold should be set at a minimum of 1 in order to keep all the empirically observable combinations to maximise diversity and coverage. To this extent, in the fuzzy set estimation we kept all the combinations that had at least 1 observable case. The third step is to define a consistency cut-off point. Ragin (2000, 2006) defines consistency as the degree to which cases exhibiting a causal or combinations of causal conditions agree with (or are included in) the outcome set. Although the minimum value for consistency cut-off recommended by Ragin (2006) is 0.75, we use a value of 0.9 for the consistency threshold in order to increase the overall consistency of the results. The final step is to choose one of the

three solutions provided by the fsQCA estimation: complex solution, parsimonious solution or intermediate solution. As pointed out by Legault Tremblay (2015) complex solutions rely on fewer assumptions but produce exhaustive final combinations that might be difficult to interpret. On the other hand, both parsimonious and intermediate solutions produce more concise results. However, parsimonious solution considers hypothetical and empirically absent combinations and the intermediate solution is based on theoretical knowledge that allows the researcher to discern which hypothetical combinations are plausible (Legault Tremblay, 2015). As it was pointed out above in the discussion of the literature, there are some causal conditions (characteristics from venture capital firms and their portfolio of firms) that are likely to have an impact on the decision to use convertible securities and/or control rights covenants on venture capital-backed contracts. However, extant literature does not predict whether the presence of a given causal condition might have greater impact than others on the occurrence of the outcome nor what would be the effect of considering multiple combinations of causal conditions. In order to obtain results that reflect our data as closely as possible, avoiding therefore the reliance on relatively subjective assumptions, the findings reported are restricted to the complex solution from the fsQCA 2.0 software[5]. As pointed out by Schneider and Wagemann (2012) the complex solution is the more adequate solution when there is no a priori "theory-guided hunches" about the effects of causal conditions on the occurrence of the outcome[6].

4   RESULTS

Tab. 4 (I) reports the complex solution from the fuzzy set Qualitative Comparative Analysis regarding the inclusion of convertible securities in venture capital-backed contracts. The results show that there are three configurations of the causal conditions (represented by C1, C2 and C3) that are sufficient to explain the inclusion of convertible securities in venture capital-backed contracts. Thus, small and private venture capital firms that are active for longer periods of time combined with either higher investment return expectations or investment in risky, early cycle enterprises are more likely to include convertible securities as a state contingency mechanism to curb double-sided moral hazard problems. These results provide support to our first hypothesis that private firms investing in riskier projects and with higher return claims use more often flexible, state contingent mechanisms like convertible securities. However, in contrary to theoretical predictions the results show that, more experienced Portuguese venture capitalist firms rather than younger, less experienced firms are more likely to use these more complex financial contracts. This evidence is however in line with Bascha and Walz's (2002) findings for the German Venture Capital market.

The third configuration comprising the complex solution reveal that more experienced, private firms combined with investments made in riskier projects and with higher return claims tend to use more often convertible options in their contracts. These results are also consistent with the agency costs predictions. Overall these results covered 74% of the outcome instances demonstrating that well over two thirds of the outcome conditions are explained by the configurations of the causal conditions. This reveals the empirical relevance of these configurations in determining the outcome. Moreover, the overall consistency value of 95% shows that

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[5]The fsQCA 2.0 software uses the Quine-McCluskey algorithm to logically minimize the several combinations in the true table to obtain the solution sets (Ragin, 2010).

[6]Although preferred due to theoretical considerations, the complex solution presented in Tab. 4 does not differ from the intermediate solution obtained in this study. The intermediate solution considers configurations that were not empirically observed but may occur in other settings (Thomann and Maggetti, 2017). Thus, the inferences made in this study, on the basis of the complex solution are externally valid i.e. their ability to be generalised to a broader universe of cases is not hindered (Cook and Campbell, 1979).

these configurations are indeed in agreement with the set outcome (Ragin, 2006). On the other hand, all configurations have unique coverage well over zero (0.06 to 0.17) which according to Schneider and Wagemann (2012) make them deemed for interpretation.

Tab. 4 (II) reports the complex solution for the inclusion of additional control rights covenants in the shareholders' agreement. Only one configuration is sufficient to explain the inclusion of control rights covenants (represented by CR). Like in the case of convertible securities, small, private and more experienced venture capital firms are more likely to use control rights covenants. However, contradicting our second hypothesis, the evidence shows that the use of control rights mechanisms is not related with the life-stage of the investment project or with the return rate expected by Venture Capitalist on this investment project. Therefore, as suggested in the literature (e.g. Gompers, 1997; Bascha and Walz, 2002; Jensen and Meckling, 1976; Kaplan and Strömberg, 2003; Sapienza et al., 1996; Admati and Pfleiderer, 1994), it seems that convertible securities, by allowing the decoupling of payoff from control mechanisms, play a different role from covenants in curbing double-sided incentives from venture capitalists and related portfolio of firms. Interestingly, although the evidence contradicts the use of control rights for highly uncertain, early-stage projects for which Venture capitalists demand higher required returns, it suggests that private,

smaller and more experienced firms are more likely to resource to control rights that allow them to more closely manage their financed-backed projects. Thus, although not supporting double-sided incentives theory, this result seems to be in line with Yoshikawa et al. (2004) and Wright and Robbie (1998) evidence that smaller venture capital portfolios with more specialized investments (namely, by technology and by industry) require a more direct and active monitoring from the venture capitalist. Moreover, this result is also consistent with value-creation theory that argues that post-investment direct monitoring by the Venture Capitalist creates value namely by helping to identify additional business opportunities (Manigart et al., 2002; Bhidé, 2000) or by providing the enterprise with more effective managerial skills (Wright and Robbie, 1998). Thus, this result points to new paths for further empirical research on venture capital market. Indeed, future empirical research should examine whether the use of control rights covenants by private, more experienced venture capital firms with lessdiversified portfolios is primarily due to the need to reduce idiosyncratic risk arisen from investment specialization and/or due to the desire to increase value-creation opportunities. This would provide a significant contribution to the analysis of the different roles played by convertible options and by control rights covenants on the design of optimal financing contracts in the Venture Capital setting.

5   CONCLUSION

In this study we examine the use of convertible securities and control rights covenants in Venture Capital contracts when double-sided moral hazard problems are particularly stringent. We focus on a stream of literature (e.g. Schmidt, 2003; Bascha and Walz, 2002; Gompers, 1995; Gompers, 1997; Bergemann and Hege, 1998; Baker and Gompers, 2003; Sahlman, 1990; Lerner, 1995; Gorman and Sahlman, 1989) that argues that both convertible securities and control rights covenants can be used to mitigate excessive agency costs. A number of authors

such as Gompers (1997), Hellmann (1998) and Kaplan and Strömberg (2003) emphasise that the role played by convertible securities is different from that of control rights covenants, as the former allow for the de-coupling of cash-flows rights from control rights. To investigate how excessive double-sided incentive problems affect the decision of using convertible securities or including control rights covenants in Venture Capital contracts, we use an innovative methodology – fuzzy set Qualitative Comparative Analysis – that considers the impact of

Tab. 4: Truth table solution for convertible securities and inclusion of control covenants models

(I) Model: conv = f(priv, expret, seedstartup, size, age)			
Algorithm: Quine-McCluskey			
Complex solution			
Frequency cut-off: 1.000000			
Consistency cut-off: 0.909091			
	Raw coverage	**Unique coverage**	**Consistency**
priv*seedstartup*~size*age	0.518519	0.111111	1.000000
priv*expret*~size*age	0.574074	0.166667	0.939394
priv*expret*seedstartup*age	0.462963	0.055556	1.000000
Solution coverage: 0.740741			
Solution consistency: 0.952381			
(II) Model: contrig = f(priv,expret,seedstartup,size,age)			
Algorithm: Quine-McCluskey			
Complex solution			
Frequency cut-off: 1.000000			
Consistency cut-off: 0.909091			
	Raw coverage	**Unique coverage**	**Consistency**
priv*~size*age	0.780000	0.780000	0.847826
Solution coverage: 0.780000			
Solution consistency: 0.847826			

Note: The tilde sign "~" is used to indicate negation of the causal condition, i.e. ~size indicates small firms (negation of membership in large firms set)

both qualitative and quantitative factors on the design of these contacts. This methodology is innovative and particularly suited to this type of exploratory study as current theoretical predictions do not shed light neither on the importance of each specific cause for agency conflicts nor on the impact that a combination of these causes might have on the choice of cost-effective contracting mechanisms in the Venture Capital setting. Our results for the Portuguese Venture Capital market show that, in line with the literature, convertible securities contribute for the reduction of double-sided moral hazard incentives. A weak support to the agency predictions is however found for the use of control rights covenants in Venture Capital contracts. Our evidence suggests that the use of control rights covenants in Venture Capital contracts might be rather influenced by the desire of Venture capitalist to increase value-creation opportunities (Manigart et al., 2002; Wright and Robbie, 1998) or to reduce idiosyncratic risks (Yoshikawa et al., 2004; Wright and Robbie, 1998). We therefore suggest that future empirical research on Venture Capital should address the different roles that financial instruments and control rights mechanisms play on the design of optimal contracts.

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7   ANNEX

Tab. 5: Predicted relationships between response and explanatory variables and related supporting literature

| Causal Conditions | Convertible Securities | | Control Right Covenants | |
	Expected sign	Supporting literature	Expected sign	Supporting literature
Age	(−)	Bascha and Walz (2002), Kaplan and Strömberg (2003), Norton and Tenenbaum (1993), Marx (1998), Berglof (1994), Schwienbacher (2008), Cumming (2008), Arcot (2014)	(−)	Kaplan and Strömberg (2003), Norton and Tenenbaum (1993), Hellmann (1998), Schmidt (2003), Cumming (2005)
Size	(−)	Bascha and Walz (2002), Kaplan and Strömberg (2003), Norton and Tenenbaum (1993), Marx (1998), Berglof (1994), Schwienbacher (2008), Cumming (2008), Arcot (2014)	(−)	Kaplan and Strömberg (2003), Norton and Tenenbaum (1993), Hellmann (1998), Schmidt (2003), Cumming (2005)
Expected return	(+)	Bascha and Walz (2002), Gompers (1995, 1997), Gupta and Sapienza (1992), Manigart et al. (2002), Marx (1998), Berglof (1994), Schwienbacher (2008), Cumming (2008), Arcot (2014)	(+)	Gompers (1995, 1997), Bergemann and Hege (1998), Gupta and Sapienza (1992), Manigart et al. (2002), Hellmann (1998), Schmidt (2003), Cumming (2005)
Seed/Start-up stage	(+)	Gompers (1995, 1997), Bascha and Walz (2002), Marx (1998), Berglof (1994), Schwienbacher (2008), Cumming (2008), Arcot (2014)	(+)	Gompers (1995, 1997), Bergemann and Hege (1998), Hellmann (1998), Schmidt (2003), Cumming (2005)
Private	(+)	Bascha and Walz (2002), Marx (1998), Berglof (1994), Schwienbacher (2008), Cumming (2008), Arcot (2014)	(+)	Hellmann (1998), Schmidt (2003), Cumming (2005)

Tab. 6: Survey Questionnaire to Venture Capital CEOs or Venture Capital Fund Managers

1. What type is the ownership structure of your firm?

Private
Public
Public-private agency

2. What is the number of years of activity of your firm?

0–1
2–3
4–5
6–7
8–10
More than 10

3. On average, what is the importance of the allocation of venture capital funds to the following stages of investments life cycle? (1 = not important, 7 = very important)

	1	2	3	4	5	6	7
Seed							
Start-up							
Growth and Expansion							

4. What is the probability of the following activity sectors being funded by venture capital from your firm? (1 = very improbable, 7 = very probable)

	1	2	3	4	5	6	7
IT							
Finance							
Hospitality and Food Service							
Health							
Energy							
Industrial technology							
Other (which?)							

5. What is the relevance of the following criteria in the selection of your investment projects? (1 = not important, 7 = very important)

	1	2	3	4	5	6	7
Management skills of the incumbent							
Entrepreneurship and communication skills of the incumbent							
Technological innovation							
Commercial viability of the project							
Environmental impact of the project							
Management skills of the incumbent							

6. What are the expected return rates of investment for seed or start-up projects?

0%–10%
10%–15%
15%–20%
20%–25%
25%–30%
More than 30%

7. What are the expected return rates of investment for growth/expansion projects?

0%–10%
10%–15%
15%–20%
20%–25%
25%–30%
More than 30%

8. What is the importance of the following financing structures used by your firm to fund venture capital investments? (1 = very improbable, 7 = very probable)

	1	2	3	4	5	6	7
100% enquity: common shares							
100% enquity: preferred shares							
Equity (common shares) and debt							
Convertible bonds							
Convertible preferred shares							
Others (which?)							

9. What is the degree of intervention of the venture capital firm on the management of the incumbent? (1 = not important, 7 = very important)

	1	2	3	4	5	6	7
Specified in the shareholders' agreement (SHA)							
Member of the board of directors of incumbent							
Exercise of refinancing options during the life of the project							
Inclusion of exit options in the investment contract							
Involvement in day-to-day management of the incumbent							
Other (which?)							

10. On average, at any single point in time, what is the number of projects funded by the venture capital company?

0–5
6–10
11–30
31–60
61–100
More than 100

11. What is the most probable academic degree of a venture capital manager in your firm?

Bachelor
MSc
PhD
Professional diploma

12. What is the most probable age bracket of a venture capital manager in your firm?

20–30 years
31–35 years
36–40 years
41–45 years
46–50 years
More than 50 years

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OPTIMIZATION OF GINI COEFFICIENT AFFECTED BY IMPERFECT INPUT DATA

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ABSTRACT

Most indicators used for determining the distributional effects of taxes as well as the inequality in the income distribution are based on the Gini coefficient and the Lorenz curve to a substantial extent, although the potential application of the Gini coefficient itself is much larger. However, the Lorenz curve and in particular the Gini coefficient need not present precise information on income or the distribution of wealth in a society. The Gini coefficient values may be affected by the form of the input data. We have ascertained that the level of Gini coefficient distortion depends on the number of households included in the research given that the income distribution in the sample is unequal. In addition, we define the form of the Gini coefficient in light of the form of the input data.

KEY WORDS

Gini coefficient, Lorenz curve, distribution, income, taxation

JEL CODES

H22, H23

1 INTRODUCTION

The numeric indicator of the income or wealth distribution in a society is called the Gini coefficient and was first formulated by Corrado Gini in 1912 (Gini, 1912). The curve that served as the basis for Gini's calculations had been developed by Max Otto Lorenz in 1905 (Lorenz, 1905). This curve represents the cumulative income of households in the context of the cumulative number of households in the economy in question.

The Gini coefficient is, in combination with the Lorenz curve, widely used as an instrument for the measurement of the impact of tax policy on the distribution of income or wealth in a society. However, the Lorenz curve, and especially the Gini coefficient, do not provide precise

information about certain specific situations (David, 2017). The Gini coefficient, for example, is unable to take into account the specifics of a particular form of income distribution. This imperfection can be compensated for with the Lorenz curve, which shows the exact shape of the distribution of income or wealth in the society. However, Gini coefficient values may also be negatively affected by the number of households, provided that income is unequally distributed among the population. In this case, the Lorenz curve cannot be used to correct for the deficiencies of the Gini coefficient.

This paper focusses on the parameters, which influence the Gini coefficient (e.g. the number of households and the inequal distribution of income) in an economy. We aim to formalise the Gini coefficient based on the deviations from expected Gini coefficient values, which result from the real-world nature of the input data, in order to exclude the before mentioned input data parameters. We base our calculations on the definition of the deviation from the expected value of the Gini coefficient.

2   THEORETICAL BACKGROUND

2.1   Essence and Significance of the Gini Coefficient and Lorenz Curve

The impacts of tax policy can be examined through either the direct and indirect tax incidence or as a property of wealth (Sen, 1976). The significance of indirect tax incidence is apparent from the studies by Besley and Rosen (1999), Boeters et al. (2010) and David (2012). The measurement of direct tax incidence is equally important. The Gini coefficient and the Lorenz curve are two tools for measuring the effects of the tax progressivity of direct taxes.

One of the factors which affects the analysis of tax progressivity is the selected period. When measuring tax progressivity, taxes can be assessed from the perspective of a specific year or of a life cycle. The importance of the lifetime approach is stressed by Poterba (1989) and Fullerton and Rogers (1994). For a concise overview, of the lifetime approach to tax progressivity, we refer the reader to Metcalf and Fullerton (2002). Empirical research in this area was conducted by Caspersen and Metcalf (1994) and Metcalf (1994). Theoretical studies draw attention to the substantial differences between the annual and lifetime approaches, annual data are more commonly used. This is also the case for the Lorenz curve and Gini coefficient.

Global tax progressivity is almost exclusively graphed as the Lorenz curve. This method analyses the income distribution and the cumulative proportion of the total national income set off against the cumulative proportion of taxpayers. The Lorenz curve measures the impact of tax rate changes on the redistribution of the real disposable income of households in an economy. In case a Lorenz curve lies below another Lorenz curve, the former distribution leads to more equality than the latter (Fellman, 1976). The Lorenz curve is therefore often used to compare the income distributions before and after-tax rate changes. Where the curve approximates the line of equality, a progressive tax system is in place.

The Gini coefficient is a measure of income inequality (Gini, 1912). It is calculated on the basis of the discrepancy in the Lorenz curve. The coefficient may also be used for to compare different alternatives of the income redistribution within one country, as well as internationality. The Gini coefficient assumes values between 0 and 1. The resulting value of "zero" indicates an entirely equal distribution of incomes. On the other hand, the resulting value of "one" can be seen as a completely unequal distribution. The lower the Gini coefficient, the more equally income is distributed among various groups of taxpayers. The Gini coefficient can only be used for monitoring tax progressivity through comparison of income before and after tax.

2.2 Relation between the Gini Coefficient and Other Indicators of Tax Progressivity

Besides the Gini coefficient and Lorenz curve, global tax progressivity can also be measured with the Musgrave and Thin method, the Kakwani method, the Suits method, the Reynolds-Smolensky index, the Robin Hood index, entropy methods, the Atkinson index and the index of tax progressivity mentioned by Široký and Maková (2009). Most of the above-mentioned alternative indicators are directly or indirectly based on the Lorenz curve and the Gini coefficient and are therefore depended on the type of input data.

Musgrave and Thin (1948) use the Lorenz curve as a function related to the distribution of incomes before and after tax. The Musgrave and Thin index derives from the ratio of the area below the curve of the function after tax set off against the area below the curve before tax. The index is structured on the basis of the Gini coefficient before and after taxes. Although the efficacy of the Musgrave and Thin index is indisputable, it was criticized by Bracewell-Milnes (1979) on the grounds that is it unable to identify the deviation from proportionality.

Kakwani's method is also based on the Lorenz curve (Kakwani, 1977). The Kakwani index is derived from the ratio of the area between the Lorenz curve function and the function of the concentration curve below the line of equality. To determine the concentration coefficient, it is necessary to carefully classify households according to income levels (Hoffmann, 2012). The Kakwani index may be understood as a function of the Gini coefficients of the concentration curve and the Lorenz curve. Bracewell-Milnes (1979) points out that Kakwani's difference between the progressivity and the amount of the tax is less relevant compared to the difference between progressivity and the inequality of income before tax. To defend his index, Kakwani (1979) states that it focuses on the progressivity of taxes incidence and public expenditure. In addition, according to Kakwani, helps to analyze the effects of various types of taxes as well as government expenditure.

The Suits index measures the dependence of the cumulative proportion of tax liability on the cumulative proportion of incomes before tax (Suits, 1977). This index is not directly based on the Lorenz curve or the Gini coefficient; however, it was designed on the same principles. The line of equal distribution represents the situation in which tax is proportional. Where progressive tax is applied, the function deviates to the right of the straight line of equality. The area between the line of equality and the function concerned indicates the degree of deviation. Although the Suits index and the Kakwani index are similar, they lead to different tax progressivity assessments in cases, in which the source data are incomplete. This fact reveals the weakness of the Kakwani index and, by extension, the Gini coefficient.

Another indicator of global tax progressivity is the Reynolds-Smolensky index (Reynolds and Smolensky, 1977). Similarly, to the Musgrave and Thin index, its focus is the redistributional effects of taxes. The index is defined as the difference between the inequality of after-tax incomes and inequality of pre-tax incomes. The index may also be expressed through the Kakwani index if the total average tax rate and the Kakwani index are known. The Reynolds-Smolensky index is influenced by the tax rate and tax progressivity based on the Kakwani index.

The extend of redistribution that would lead to complete equality of income in an economy can be expressed with the Hoover index, also known as the Robin Hood index (Hoover, 1936). The index is related to the Gini coefficient and is based on the same principle. It measures the distance between the Lorenz curve and the line of equality. The resulting index value shows the percentage of overall income that has to be redistributed in order to achieve equality in the income distribution, provided that taxpayers' incomes as well as their mean value are known. The index can also be used for the measurement of progressivity through the quantification of the difference between its values before and after taxation.

Other important methods of tax progressivity measurement do not have any direct or

indirect link to the Gini coefficient and we will therefore only provide a brief overview. These are primarily entropy methods, which estimate the difference between entropy indexes on the basis of the distribution of income before and after tax (Zandvakili, 1991). The most frequently used entropy index is the Theil index of inequality (Theil, 1967). In addition, there are indicators of the mean logarithmic deviation, squared coefficient of variation, and generalized entropy (Kesselman and Cheung, 2004). The Atkinson index, which is based on

the calculation of a fair average per capita income (Atkinson, 1970), forms the foundation for two additional but largely similar progressivity indicators. The first, the Kiefer index (1984), uses the Atkinson index before and after taxation. Blackorby and Donaldson (1980) use the same indicators as Kiefer (1984), but in a slightly different way. Finally, we should mention the tax progressivity index which is composed of a quotient of volatility of tax revenues and incomes (Kakinaka and Pereira, 2006).

3   METHODOLOGY AND DATA

This theoretical overview of the measurements of the distributional effects of tax and the estimation of the distribution of income in a given economy, using the Lorentz curve and the Gini coefficient, aims to present new findings and the contexts in which they are relevant. The research is based on the generation of simple models which enable a more comprehensive study of the income distribution in an economy, without the necessity to collect concrete data that may prevent general conclusions.

The application of models generally presupposes the use of data concerning household incomes. This approach to the measurement of tax policy impacts was criticized by Fullerton and Rogers (1991), who prefer to approach the problem from the perspective of the incomes of individuals. However, if such models consistently used household data, such values may be considered representative of the incomes of individuals, with little risk of distorting results or their interpretation.

Standard mathematical methods are used define model situations through equations, which are adjusted and solved according to needs. The definitions of functional relationships and limits of sequences of values are considered as well.

This research does not involve practical applications and does not use, and therefore does not require, empirical data. This work merely aims to redefine the formula of the Gini coefficient for further use, while eliminating its hitherto imperfections, i.e. the distortions its output due to the range of the examined sample and the degree of equality in the income distribution in an economy. The adjustments proposed by alternative methods for examining the distributional effects of taxation and the income distribution in an economy, point at shortcomings in the Gini coefficient and related indexes, which derive from imperfect input data with regard to the number of included households and the inequality in the income distribution in an economy.

4   RESULTS OF ELIMINATION OF
THE GINI COEFFICIENT DISTORTION

Based on our previous points, it can be stated that the importance of the Gini coefficient and the Lorentz curve goes beyond their frequent application. Many, if not most, of the alternative indicators of tax progressivity and the

inequality of income distribution are based on the Lorenz curve and the Gini coefficient to a certain extent, and therefore are equally influenced by input data. However, the possibilities of the Gini coefficient use are much broader.

Evidence for this for instance derives from the measurements of the intersectoral digital divide, which result from differences in the use of information systems (Fidan, 2016). Therefore, to insure that the results reflect the real state of affairs and not just the optimal situation based on optimal input data, the form of the Gini coefficient and Lorenz curve must be defined as precisely as possible.

The Lorenz curve is usually depicted in a uniform manner. However, there is no way of removing the distortion caused by the limited number of households included, and the unequal distribution of income among those households from this graphic representation of the income distribution. This imperfection should, however, not lead to refraining from the application of the Lorenz curve. As Dixon et al. (1987) point out, certain imperfections of indicators should not lead to their automatic rejection. Therefore, it suffices to keep these imperfections in mind when working with the Lorenz curve. Moreover, the curve provides additional information about the distribution of income among households that is not apparent from any other indicators, which determine only numeric values of the income distribution in the society.

The original Gini coefficient can be quantified in several different ways. Lerman and Yitzhaki (1989) define it as a covariance of the income function. The calculations can, in addition, be based on the median difference of income values. We may also mention the well-known Brown formula (Brown, 1994). There are some creatively formed mutations of the Gini index (see sub-chapter two), like the well-known Brown formula (Brown, 1994), which stress the significance of the Gini coefficient. In this paper, we will limit ourselves to the variation of the Gini coefficient G, which is based on the application of basic mathematical operations (Foldvary, 2006). This variation is an optimal form of the logical solution of simple models of income distribution in an economy, where n is the number of households and I is the households' income:

$$G = 1 + \frac{1}{n} - \frac{2}{n^2 \cdot \overline{I}} \cdot (I_1 + 2I_2 + \ldots + nI_n) \quad (1)$$

For the sake of simplicity, we will use the standard form of the Lorenz curve, with the x-axis depicting the cumulative proportion of households and the y-axis, depicting cumulative income in ascending order, with a maximum value of "one", or 100%. Consequently, the average income $\overline{I}$ equals the proportion of the number of households n:

$$\overline{I} = \frac{1}{n} \quad (2)$$

For the examination of the Gini coefficient, we will use a simple model with two households. One household has a 100% of the income and the other household has no income. This is an absolutely unequal distribution of incomes in an economy and the value of the Gini coefficient should be "one". In this model it follows that the total proportion of household incomes equals 1:

$$I_1 + 2I_2 = 1 \quad (3)$$

By necessity, the sum of the income of all households equals 1:

$$I_1 + 2I_2 + \ldots + nI_n = 1 \quad (4)$$

After the modification of the basic formula, while formulas (3) a (4) apply, we can get the Gini coefficient in following form:

$$G = 1 - \frac{1}{n} \quad (5)$$

After substituting the number of households with the value "two", the resulting value of the Gini coefficient is surprisingly 0.5, and not the expected "one". Let us add other households to the model and leave the situation at the most unequal level; three households of which one receives all the incomes two have no income at all. The result of the Gini coefficient, in this case, is 0.66 (calculated as $1 - \frac{1}{n}$, that is $1 - \frac{1}{3}$). If we add another household with zero income, the coefficient value will increase to 0.75. With the growing number of households, the value of the Gini coefficient approximates the expected value of 1. If we have an unequal distribution of income, the Gini coefficient may be expressed as a function of the number of households $G(n)$:

$$G(n) = 1 - \frac{1}{n} \quad (6)$$

If, with a growing number of households, the value of the Gini coefficient approximates the value of "one", this relationship can be expressed with the help of a lim $G(n)$ and subsequently be modified:

$$
\begin{aligned}
\lim_{n \to \infty} G(n) &= \lim_{n \to \infty} \left(1 - \frac{1}{n}\right) \\
&= 1 - \lim_{n \to \infty} \frac{1}{n} = 1 \qquad (7)
\end{aligned}
$$

If the number of households reaches infinity, the index value will equal the expected value of "one". Therefore, the following relationship applies:

$$
\text{if } n \to \infty, \text{ then } \frac{1}{n} \to 0. \qquad (8)
$$

The deviation from the Gini coefficient value can be quantified for this model with absolute inequality of distribution of incomes in an economy. If equation (5) applies, the deviation from the Gini coefficient D_G reaches the following level:

$$
D_G = 1 - G = \frac{1}{n} \qquad (9)
$$

Although the identified deviation applies, it is relatively trivial and divorced from reality for two reasons. Firstly, the small number of households in our example does not represent any real economy. And secondly, absolute inequality, although theoretically plausible, is highly unlikely in reality. The deviation from the expected value decreases with the growing number of households, and the deviation may be considered negligible with a sufficient number of households. Unfortunately, in practice we must use the available data, which often classify households in percentiles, or, more commonly, deciles. Consequently, despite the originally broad sample, the sample yields only ten datapoints. In practice, the Gini coefficient deviation may reach the value of 0.1 if we have a sample of ten datapoints and the hypothetical situation of an absolutely unequal distribution of income in the economy in question, may arise. This is a significant problem and the question thus arises; what is the dependence of this deviation on the inequality of income distribution in a given economy? A completely

equal situation for two households, or any number of households, requires the coefficient result to be "zero". If the basic formula (1) is applied, we find that the result always equals "zero". Consequently, it holds true that, if household income is distributed absolutely equally, the deviation from the expected value is "zero" regardless of the number of households.

On this basis we can assume that any deviation from the expected Gini coefficient value will indicates inequality in the income distribution in a given economy. Let us introduce a model with a certain level, although not absolute, inequally, where the concurrent validity of the conditions is represented by symbol $\wedge$.

$$
\begin{aligned}
I_1, I_2 \neq 0 \quad &\wedge \quad I_1, I_2 \neq 1 \\
&\wedge \quad I_1 + I_2 = 1 \\
&\wedge \quad I_1 > I_2 \qquad (10)
\end{aligned}
$$

Let us modify formula (1) for the purposes of this model:

$$
G = 1 + \frac{1}{2} - (I_1 + 2I_2) \qquad (11)
$$

This equation may be further modified, if the conditions under (10) apply, i.e. the sum of incomes of the two households in the model equals 1:

$$
G = 1 + \frac{1}{2} - (1 + I_2) \Longrightarrow G = \frac{1}{2} - I_2 \qquad (12)
$$

At this point we should focus on the identification of the deviation from the Gini coefficient value. Unfortunately, we are not able to define the expected Gini coefficient value in a model with an unequal distribution of incomes. Consequently, we are unable to precisely quantify the deviation from the expected value. What we do know is that the deviation lies between "zero" and 0.5. The maximum deviation $\max D_G$ is therefore 0.5. We also know that an increase in inequality raises the maximum deviation. The value of the deviation in this situation may be quantified in several manners. We will choose a simple method, which consists of the quantification of deviations from the income average, which is 0.5:

$$
D_G = \max D_G \cdot \left(|I_1 - 0.5| + |I_2 - 0.5|\right) \qquad (13)
$$

After inserting the income distribution $1/0$, the deviation is at its maximum: 0.5. In case the income distribution is, for instance, $0.7/0.3$, the deviation is only 0.2. If the equality of the income distribution between two households is further increased to $0.6/0.4$, the deviation will be 0.1 and a distribution of $0.5/0.5$ yields a deviation of 0.

Finally, the model must be generalized to include any number of households and their unequally distributed income. The average value is a quotient of the value "one" and the number of households n. The deviation from the Gini coefficient depends on the average deviation from the average value of household income:

$$D_G \quad = \quad \frac{|I_1 - \frac{1}{n}| + |I_2 - \frac{1}{n}| + \ldots + |I_n - \frac{1}{n}|}{n} \tag{14}$$

Now we can make our final modification to the Gini coefficient G^*, based on formulas (1) and (14):

$$G^* \quad = \quad 1 + \frac{1}{n} - \frac{2}{n^2 \cdot \overline{I}} \cdot (I_1 + 2I_2 + \ldots$$
$$\ldots + nI_n) + D_G \tag{15}$$

This equation must be broken into partial items and subsequently modified to get the final form of the Gini coefficient which allows for a deviation from its expected value.

$$\begin{aligned} G^* \quad = \quad & 1 + \frac{1}{n} - \\ & - \frac{2}{n} \cdot (I_2 + 2I_3 + \ldots + (n-1)I_n) + \\ & + \frac{|I_1 - \frac{1}{n}| + |I_2 - \frac{1}{n}| + \ldots + |I_n - \frac{1}{n}|}{n} \end{aligned} \tag{16}$$

The final resulting value of the Gini coefficient can be further modified through standard mathematical operations. However, this will not lead to an apparent simplification of the coefficient allowing for a deviation from the expected value. Formula (16) is the resulting form of the modified Gini coefficient G^*, which allows for imperfections and inconsistencies in initial datasets.

It should, however, be noted that, after the adjustment of the original calculation of the Gini coefficient, values still range from 0 to 1. This means that the extreme, i.e. maximum values and their interpretation have not been affected by the adjustment.

5 DISCUSSION AND CONCLUSIONS

A number of methods may be used for the measurement of the distributional effects of taxes and of distribution of wealth in an economy. There are many entropy indexes and other indicators unrelated to the Lorenz curve and Gini coefficient, for instance the Theil index, Atkinson index etc. The Lorenz curve, Gini coefficient and indexes which are based on them, are widely used for the measurement of distributional effects of taxes and of the distribution of wealth in a society. These indexes have indisputable advantages, but also certain imperfections. Some of them have been the subject of previous papers, e.g. Bracewell-Milnes (1979). In addition, the differences of the Suits index (Suits, 1977) and the Kakwani index (Kakwani, 1979) are commonly recognized.

The Gini coefficient, Lorenz curve and many other indicators (Musgrave and Thin index, Kakwani index, Suits index, Reynolds-Smolensky index, Hoover index) also suffer from certain shortcomings, which result from incomplete input data. This includes the problem of a limited number of households entering the research, while the incomes in a society are unequally distributed. These imperfections are can be resolved in the case of the Gini coefficient, whereas the Lorenz curve must be interpreted with a certain distortion in mind.

We have ascertained that the degree of the Gini coefficient distortion grows with a decreasing number of households and increasing inequality in a society. The maximum degree of the Gini coefficient distortion, 0.5, was iden-

tified in an extreme model of two households, in which income was distributed absolutely unequally. Conversely, a model with an infinite number of households as well as a model with absolute equality shows s no distortion and reached the value of 0. Although this situation is not feasible in practice (as well as the opposite extreme), it may be approximated to a certain extent. It may be concluded from the above that the value of the Gini coefficient will be systematically overestimated in cases with a limited number of households and a growing inequality of income. On the other hand, it must be said that the change in the Gini coefficient after tax in comparison with the situation before tax or the situation with the original tax is substantial. The deviations of the two compared Gini coefficients are compensated for, in the indicator of the Gini coefficient change. Therefore, the distortion of the difference of the Gini coefficients, which is caused by the input data, is reduced. However, we cannot completely elimination the distortion, which would only be possible in case the distributional effect of taxation on the household income distribution is zero.

The distortions in the Gini coefficient may be mitigated by modifying the standard formula (1) used for its calculation. The formula for calculating the Gini coefficient (16) involves, following Foldvary (2006), the sum of the standard formula (1) and of the deviation from the Gini coefficient in formula (14). This is one way to eliminate some of the imperfections, which result from secondary data that include only data on certain quantiles of the distribution of household income in the economy, when the real distribution of incomes among individual households is unequal. The application of this finding may not be restricted to the examination of the distributional effects of taxation, and could be useful in other domains, as well. The original range of the Gini coefficient has not been changed through the application of the mentioned procedure.

The validity of the proposed procedure is supported by its logic rationale, and its impact will be quantified in the future work of the author. We assume that the impact on realistic measurements will not be significant and that the proposed modification of the formula will predominantly contribute to formal correctness in cases for which the input data are not perfect. The only significant impact of our reformulation of the Gini coefficient could occur in the case of extremely unequal income distribution and a very low number of households or taxpayers, a plausible, but highly unlikely scenario.

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IMPACT OF SAVINGS ON CAPITALIZATION: CASE OF SOUTHEAST ASIAN ECONOMIES

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ABSTRACT

The study analyses the economics intuition that the domestic savings may determine the investments in a country. The assumption is tested on domestic savings between 1982 and 2016 in Southeast Asia economies in a panel regression framework. The hypothesis is that domestic savings stimulate economic growth through investment financing and, thus, the high savings rate observed in Southeast Asian countries can contribute to the outstanding GDP growth in the region. The tests sort out the significant determinants of investments. The analysis successfully indicates the significance of domestic savings beside other variables, and confirms the hypothesis, namely, the domestic savings affect investments and indirectly the economic growth, while FDI does not prove to be significant.

KEY WORDS

savings, investment, Southeast Asia, FDI, economic growth, Feldstein-Horioka puzzle

JEL CODES

C32, D14, E21, E22, F43

1   INTRODUCTION

There is a common approach among the various economics schools that households' saving is an engine of economic growth through investments. According to economic history, catch-up models based on internal savings can result in a more sustainable economic growth path for a national economy. Retail savings represent a secure and predictable source for both the companies and the state. There is a positive correlation assumed between higher household savings rates and investment, although there is a dispute in international literature: higher domestic household savings rates can be coupled with higher investment rates according to Feldstein and Horioka (1980).

In the following study, the focus is on foreign and domestic savings in several Southeast Asia countries (Singapore, Thailand, Malaysia, China, South Korea, Vietnam and Japan) in the period between 1995 and 2015. The Asian developmental state model has strongly built on the GDP impact of investment and preferred the saving attitude of households to finance the domestic investment.[1] According to the saving and investment preference of the developmental state model, it is a relevant question whether there is any impact of domestic savings on (next period) investments. The analysis focuses on explaining outstanding values and the co-movements. The hypothesis is that domestic savings stimulate economic growth through investment financing and, thus, the high savings rate observed in Southeast Asian countries can contribute to the outstanding GDP growth in the region. The methodology is panel regression analysis on Southeast Asian data. The tests aim to determine the significant determinants of investments in a country. Augmented Dickey-Fuller test is performed to sort out unit root problem of independent variables. The purpose of analysis is to indicate the significance of domestic savings beside other variables, and this way to prove the hypothesis, namely, the domestic savings affect investments and indirectly the economic growth.

The structure of the study starts with the theoretical framework to support the empirical analysis with economics and empirical tests. It reviews the loanable funds theory as the model describing the relation between the savings and investments, the theory of life cycle hypothesis as a microeconomics modelling on factors of savings which helps to explain the trends in Asian household savings. Besides, the framework gives an outlook about the current approach of Feldstein-Horioka puzzle and the empirical literature about the Asian saving-investment relation.

The methodological part explains the selection of determinant variables, the composition of the regression function and the sources of data together with some overview on the trends of data. The part about the empirical results explains the multi-steps process of selection of significant determinants of investment and measure the role of domestic household savings in the Southeast Asian case to test the Feldstein-Horioka puzzle. Finally, the discussion compares the current results to the earlier conclusions appearing in the empirical literature review.

2   THEORETICAL FRAMEWORK

The relation between savings and investment is described by the loanable funds model where the real interest rate create link between the two flow variables. The model was built on Knut Wicksell's theory which was developed by Bertil Ohlin, Gunnar Myrdal, Jacob Viner and Erik Lindahl. Later, the model got renewed by Hayek as part of neoclassical (neo-Wicksellian) theory, then it was integrated into the new-Keynesian IS-LM model by Hicks, as one partial market. From the loanable funds model, mutual lagged determination can be derived between investment and savings. More savings creates bigger pool of sources for investment, and more investment results in bigger disposable income as a base for saving. Focusing on the impact of savings on investment, the loanable funds model helps us to understand that higher volume of domestic savings means higher supply of financing, thus, lower cost of interest payable for debtors/investors who will be willing to raise their investment for lower cost of loans. Even though, more savings means less household (and maybe public) consumption, the economics intuition assumes multiplier effect growing from investment, and this way expects additional economic growth. (Mankiw, 1997; Mátyás, 1980)

But the globalized world economy raises an issue whether is there any growth impact of domestic savings in an internationalized market of loanable funds? The Feldstein-Horioka puzzle

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[1]The deep institutional explanation of the Asian model is analyzed by Benczes (2002).

gives an empirical reply by assuming that international capital mobility is not perfect, that is why the level of domestic savings can determine the level of domestic investment. Feldstein and Horioka (1980) uncovered in their empirical paper that there is a strong link between the domestic savings rates and domestic investment rates. This means that not the direction of international capital mobility explains the international differences in investment first of all, but the domestic savings since the international differences of savings rate "have resulted in almost equal corresponding difference in the domestic investment rates" among similarly high developed countries. This lead to the second conclusion that actually the capital is not perfectly mobile as it was assumed before by the neoclassical economics.

Tesar (1991) made a robustness check test about the saving-investment linkage, which found significant and well explaining regression function about the correlation for certain group of OECD countries, but uncovered sample bias problem and the challenge of capital control by states. As Bibi and Jalil (2016, pp. 236–238) summarized, there are numerous studies which found spurious correlation related to the puzzle or simply found weak link between savings and investments, in other words, strong international capital mobility, meanwhile the authors themselves confirmed the existence of the puzzle with a Common Coefficient Mean Group model. Beyond their literature summary, Fidrmuc (2003, p. 136) recognized that high developed EU countries have financed a high share of their domestic investment from international sources, which phenomenon indicated that the Feldstein–Horioka puzzle has had less importance in the EU with free movement of capital. Baxter and Crucini (1993) uncovered some explanation for the contradictory conclusions. They connected the coexistence of strong saving-investment correlation and high mobility of capital to the investment boom periods on the one hand, and the size of the countries on the other hand.

Attanasio et al. (2000) made a clash of OLS, GMM, Granger Causality and Dynamic Trivariate Model tests on several samples of countries to verify the assumptions among savings, investment and economic growth – among others, the hypotheses by Feldstein and Horioka (1980) and Baxter and Crucini (1993). Focusing on impact of savings on investment, their result confirmed the significant impact of savings on investment. Only in case of GMM model, the level of significance did not achieve 5%, but only 10%.

The relationship to the Feldstein-Horioka puzzle in the current study is that it aims to find evidence, first of all, of the strong link between domestic savings and investment. The imperfection of capital mobility in the Southeast Asian region is just the thesis concluded from the puzzle, but not analysed directly.

Savings are influences by decisions made by governments and the corporate and household sector, and the social, economic and demographic characteristics of the household sector. Kapounek et al. (2016) reviews the approach of the so-called lifecycle hypothesis (LCH), which was formulated according to Modigliani (1966) and Sturm (1983). Namely, the lives of individuals are divided into two stages, one active and one inactive. Their savings targets are categorized into four categories by the LCH model: retirement, precautionary reserve, bequest and finally purchase of tangible assets. The model assumes a steady state economy. According to Sturm (1983), the following variables determine the willingness to save the household sector: life expectancy, retirement age, age distribution, family size, average age of employment, skill level. However, the LCH model was questioned by the behavioural economics picture of household preferences (Diamond and Vartiainen, 2007). This conclusion resulted in the behavioural life cycle hypothesis (BLCH).

The outstanding economic performance of Southeast Asian countries has been widely discussed in the literature for a long time. However, there is no consensus on factors of rapid growth experienced in the region. One explanation assumes that the reason of success is the high level of capital accumulation. Namely, these countries prefer savings for future investments to current consumption. While another approach emphasizes the adaptation

of technologies from developed countries and, this way, the improvement of productivity. Although capital accumulation and productivity growth do not necessarily separate or even strengthen one another in supporting economic growth (Collins and Bosworth, 1996).

The growth model of Collins and Bosworth (1996) allows the release of output-change to factor accumulation and efficiency improvement, and thus can be determined as the source of economic growth.[2] It was concluded that capital accumulation was remarkable in East Asia, but productivity growth was rather average, thus, the remarkable performance in the region was a result of high level of savings.

There are studies concentrating on interregional capital immobility inward China, which are based on the Feldstein-Horioka approach. On Chinese regional savings and investment, Narayan (2005) executed cointegration test over the period 1952–1998, Li (2010) made OLS and Granger causality tests over the period 1978–2006, and both proved significant saving-investment relation and low interregional capital mobility, what was connected to government restriction on capital.

Kim (2001) analyses the Asian saving ratio before the financial crisis 1997, when the savings fluctuated between 30% and 50% of GDP, which has proved to be a factor in rapid economic development and has contributed to job creation, poverty reduction, productivity growth, trade expansion and increased prosperity. According to Kim's conclusions, it is worth to stimulate savings as there is a mutual positive relationship between GDP per capita growth and domestic savings rates even in those Asian countries where per capita national income is low.

Liu and Xu (1997) analysed the case of Shanghai in 1981–1993, and they found strong correlation between the accelerating domestic household savings and a notable shift in importance of investment contributing to the economic growth. They emphasized the role of household savings in investment financing. Their conclusion was that, before the economic reform in 1978, the Chinese government covered the necessary investments from "compulsory savings" and transferred most of the resources to the heavy industry. However, the savings rate has remained high after the reform, with a variety of financial instruments for households.

Tang et al. (2008) investigated the impact of foreign direct and domestic investments on economic growth in China with variable vector autoregressive (VAR) and error correction (ECM) models between 1988 and 2003. Their results show that FDI did not crowded out, but complemented domestic investment, thus supporting economic growth. At the same time, the impact of domestic investment on growth has been much more significant than in case of FDI, and therefore the authors suggest to encouraging domestic savings much more than attracting foreign investment.

3   METHODOLOGY AND DATA

The time series will be collated together with additional variables, in panel regression. The main question is whether the investment is significantly influenced by the determinant variables, and besides, whether investment is driven by rather domestic savings or FDI. In addition to the FDI and savings variables analysed in the first half of the study, the following economic indicators were included as the explanatory variables in the model: real interest rate, inflation, GDP growth and government debt. Many previous studies have shown a strong and positive relationship between savings and investment (Feldstein and Horioka, 1980; Bayoumi, 1990, etc.), so the hypothesis in the following analysis will be the same.

In case of FDI, the net inflow data was included in the model. The link between FDI and investment depends on the sector including the foreign investment inflows, and the activity level of domestic enterprises in the sector.

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[2]The holistic concept of growth potential and structural conditions are analysed in details by Halmai (2015).

If the domestic companies are represented in high number in a certain industry, either the domestic or the foreign capital can suffer from crowding-out independently from the economic policy (İpek and Ayvaz Kızılgöl, 2015). Similar trends can be observed in four ASEAN countries (Vietnam, Malaysia, Thailand and Singapore) and South Korea. Most of the foreign capital flows into the manufacturing industry, the financial services sector and the commercial sector. In China, the preferred sectors of investment are the manufacturing industry and the real estate sector in the largest proportion. Generally, the proportion of domestic investments in the agricultural sector and in the manufacturing is roughly the same as FDI share. In the case of the service sector, however, the former rate is much higher. Thus, the crowding-out effect of FDI does not prevail, and we expect a positive, significant relationship between domestic and foreign investments (ASEAN and UNCTAD, 2017).

To characterize the economic growth of each country, we used the annual percentage growth rate of GDP per capita. Based on Thomas Nixon Carver's and Albert Aftalion's accelerator theory, we expect a positive relationship between output growth rates and domestic investments. According to the theory, if aggregate demand is increasing, companies either increase prices or expand their supply. Companies usually choose the latter option; they are deciding on new investments to increase productivity (Bălăceanu, 2011).

To measure the cost of capital, we introduced the national 12 months real interest rate into the model as an explanatory variable. The literature is very divided about the relationship between real interest rates and investments. McKinnon (1973) and Shaw (1973) argue that the low or negative interest rate will reduce the savings, and thus the investment capital, too (Cho, 1990). Nevertheless, at lower real rates, the cost of capital is lower, which stimulates the investment activity of firms. Namely, a negative relationship between the real interest rate and investments can be assumed.

We expect a negative relationship between sovereign debt and investment, since if government resources are to be spent on debt repayment, less investment can be financed. It is also difficult to reach a clear conclusion on the relationship between inflation and investment. High and unstable inflation is also unfavourable for foreign and domestic investment as it indicates an uncertain macroeconomic environment. Nevertheless, in those countries where inflation is higher, the investors may expect higher risk premia. Higher premium can attract more investment.

The regression equation is the following:

$$
\begin{aligned}
I_t =\ & \beta_0 + \beta_1 \cdot \text{FDI}_t + \beta_2 \cdot \text{GDPgrowth}_t + \\
& + \beta_3 \cdot \text{INF}_t + \beta_4 \cdot B_t + \beta_5 \cdot S_t + \\
& + \beta_6 \cdot \text{RIR} + \beta_7 \cdot I_{t-1} + \epsilon_t, \qquad (1)
\end{aligned}
$$

where I is investment, FDI is the net inflow of foreign direct investments, GDPgrowth is the annual growth rate of the GDP per capita, INF is the inflation rate, B is the public debt, RIR is the real interest rate, S is the gross national savings, t is the current time variable and $t-1$ is the first lag of the time variable, ϵ_t is the error term. Investment, FDI, public debt and saving are measured as percent of GDP, whereas GDPgrowth, inflation and the real interest rate are measured as percent.

The first phase is to filter the non-stationary variables with Augmented Dickey-Fuller test. Next, it is the correlation analysis among the variables. The third step to run OLS test with the first differential value of the determinant variables and the lagged dependent variable. Because of the limited significance, a second OLS test needs to be run which includes first differential of logarithmic values of the determinants. The logarithmic form of variables still includes unit root in the time series, that is why there is need for transformation to the first differential. The higher R^2 and better Durbin-Watson values give reason for the second OLS test. (The stationary variables were not transformed to the regression analysis.)

The data source is the Bloomberg database. The gross national savings and the investments data were indirectly imported from the IMF data base, the FDI net inflow and the annual

GDP per capita growth ratio indirectly from World Bank database.

The annual percentage changes in savings of the analysed countries include strong co-movement among the Southeast Asian countries' savings (except for Vietnam) and, due to the country's culture, a high saving rate. There are three significant negative shifts. The first between 1997 and 1998 due to the crisis in the Southeast Asia. It resulted in declining savings but not so sharply as the falling investments. This phenomenon led to imbalance between the two indicators. The second was due to the slowdown in US economy in 2001 and the third in 2008 due to the global financial crisis.

It is worth highlighting the tremendous growth in Vietnam's savings in 2005. The government launched its four-year socio-economic plan stimulating the growth of savings (Newman et al., 2006). China, like the Southeast Asian countries, has always been characterized by a high level of savings. Savings were slightly dropped back only by the Southeast Asian crisis in 1997. Since 1999 until 2007, a huge increase in savings was experienced, with an average 18.6% increase in government, corporate and household savings. The growth in private sector savings is due to the high profitability of companies. In the case of the government sector, primarily the increased tax revenues are in the background. As far as households are concerned, savings in this sector have increased the most. This is partly due to rising wages and, on the other hand, to the conscious consumer behaviour of the population (Yang et al., 2011).

The change of foreign investments was mainly affected by the economic crisis in Southeast Asia between 1995 and 2000 (except China). It is important to mention that commercial and financial liberalization programs have been introduced in Southeast Asian countries since the 1980s and these countries have had stable macroeconomic indicators (low budget deficit, stable exchange rate, high savings rate, etc.), which characteristic made the region very attractive for foreign capital (Bautista and Maveyraud-Tricoire, 2007). The Southeast Asian crisis has caused the biggest damage to investment in South Korea (-45%), Thailand (-32%) and Singapore (-16%).

The long-term effects of the Southeast Asian crisis manifested in that the foreign investment started to increase in the post-crisis period but did not reach the pre-crisis volume. On the one hand, the existing excessive capacity deterred the emergence of new investments. On the other hand, investment in Southeast Asian countries was clearly risky for investors (Lee and McKibbin, 2006), mainly due to structural problems (e.g. liquidity problems of financial institutions).

In China, the average FDI growth was 10% in the 90s. The Southeast Asian crisis had weak effect, thus, the FDI inflow deteriorated only by 1% in comparison to the previous year. After a greater slowdown occurred in the 2000s, there was a large influx of FDI (except for 2008, when FDI fell because of the effects of the global financial crisis), which was induced by China's favourable regulatory system for foreign investors. A significant part of FDI is still flowing into the manufacturing sector, but in the last couple of years, the service sector showed the highest growth in FDI (Davies, 2013).

Meanwhile the FDI quickened in the analysed region, the domestic investments seemed to be crowded out as their growth slowed down in the region. The decreasing tendency can be observed in each country, which is primarily the result of the fact that foreign capital inflows crowded out the domestic capital.

4 RESULTS

First, Dickey-Fuller tests (ADF) were completed. According to the null hypothesis there is a unit root in the time series. Our results are shown in Tab. 1. Where there is a unit root, the time series should be differentiated or transfer into logarithmic form to make stationary and thus to be included in a regression model. Among our variables, the time series GDP

Tab. 1: Augmented Dickey-Fuller test

Variable	P-value (lags)	Stationary time series	p-value of 1st differential	Stationary 1st differential
Debt in % of GDP	0.1380 (1)	NO	0.0030 (1)	YES
Net FDI inflow in % of GDP	0.2894 (2)	NO	0.0000 (2)	YES
GDP per capita growth ratio %	0.0000 (1)	YES	–	–
Real interest rate	0.0016 (1)	YES	–	–
Inflation	0.0000 (1)	YES	–	–
Domestic savings in % of GDP	0.1385 (2)	NO	0.0000 (2)	YES
Investment in % of GDP	0.4949 (2)	NO	0.0000 (2)	YES

Source: Bloomberg, IMF, World Bank.

Tab. 2: Correlation between the variables

	Investment	Debt	FDI	GDP growth	Inflation	Real interest rate	Saving
Investment	1.000000	−0.480747	−0.085231	0.574047	0.295034	−0.105068	0.577051
Debt	−0.480747	1.000000	0.091056	−0.429747	−0.308899	0.008265	−0.318261
FDI	−0.085231	0.091056	1.000000	0.146596	0.067300	0.132939	0.523608
GDP growth	0.574047	−0.429747	0.146596	1.000000	0.223060	−0.192537	0.493579
Inflation	0.295034	−0.308899	0.067300	0.223060	1.000000	−0.389367	−0.035538
Real interest rate	−0.105068	0.008265	0.132939	−0.192537	−0.389367	1.000000	0.071089
Saving	0.577051	−0.318261	0.523608	0.493579	−0.035538	0.071089	1.000000

Source: Bloomberg, IMF, World Bank.

growth, real interest rate and inflation did not contain unit roots, so in their case there was no need for logarithmic form.

Next step, the co-movement between the variables was analysed. As it is indicated in Tab. 2, it can be deduced that there is no strong correlation between explanatory variables. After implementation of the tests, panel regression was performed. In our first regression with 1st differentials, only the GDP growth and the 1st differential of lagged saving proved themselves to be significant. In the first regression, the Durbin-Watson statistic is 1.8284 which value indicates the presence of positive autocorrelation (Tab. 3, Model 1). To address this, the variables were transformed to logarithmic value, but it did not exclude the presence of autocorrelation. That is why the logarithmic values were differentiated. Thus, as it appears in our second regression with 1st differentials of logarithmic value of variables, Durbin-Watson resulted in a value above 2, which means successful elimination of autocorrelation (Tab. 3, Model 2).

Based on the p-value, we observed that at 95% confidence interval the lagged dependent variable the GDP per capita growth, the FDI the current saving and the lagged saving are significantly influencing current investment. Thus, according to the model, savings have impact on investment in the countries surveyed, and the 1 year lagged saving has outstanding positive impact among the determinants. Matching to our initial expectations, the relationship between the investment and lagged domestic saving is positive. The impact of domestic savings is significant. The model contains 225 observations, so the results are robust. Based on the regression analysis, it can be stated that lagged domestic savings affect investments much more, than the inflow of foreign capital. However, we have to conclude, too, that not the current saving is important, but the lagged saving. The negative coefficient of the FDI can understood as the crowding-out impact mentioned in the literature review.

Tab. 3: Regression with 1st differentials of variables and 1st differential of logarithmic value of variables at least 5% significance

Model	Model 1. diff	Model 2. log and diff
Dependent variable	1st diff. of investment	1st diff. of log-investment
Variables	**Coefficient**	**Coefficient**
Constant	-1.942186^{***}	-0.075097^{***}
GDP growth	0.013412^{***}	0.013412^{***}
1st differential of lagged saving (lag = 1)	0.197427^{***}	–
1st diff. Log-saving	–	-0.393945^{***}
1st diff. LogLag-saving (lag = 1)	–	1.205534^{***}
1st diff. of Log-FDI	–	-0.047769^{***}
1st diff. LogLag-investment (lag = 1)	–	-0.274487^{***}
R-squared	0.266071	0.410256
Durbin-Watson	1.828418	2.049447
Number of observations	242	225

Source: Bloomberg, IMF, World Bank (significance: *** at 1%, ** at 5%, * at 10%).

5 DISCUSSION

The literature review particularly overlaps with the results of the current research in the following theses: 1) relation between savings and investment (Feldstein and Horioka, 1980; Bayoumi, 1990; Liu and Xu, 1997); 2) importance of savings in economic growth (Kim, 2001); 3) crowding-out effect on FDI (Tang et al., 2008; İpek and Ayvaz Kızılgöl, 2015); 4) impact of low and negative interest rates on investment (McKinnon, 1973; Show, 1973; Cho, 1990).

Our results have consonance with the Feldstein-Horioka puzzle in a special way. The OLS regressions proved, that the domestic savings are causing investments but with one period lag. As Tesar (1991) stated and Bibi and Jalil (2016) reviewed, the empirical literature of the puzzle concluded that this is a sample bias problem whether there is higher capital mobility and lower importance of domestic savings (Fidrmuc, 2003) or – contrary – because of low capital mobility, the domestic savings has measurable significance in investment (Attanasio, 2000).

Our findings about the impact of savings is that there might be a limited capital mobility in the Southeast Asian region as significance of savings was proved in our analysis. However, it looks like that the not the current savings has the positive effect but the savings lagged with one year. This can indicate a slow realization of investment from savings in the region.

Overall, the analysed group of countries demonstrates the economics intuition worded by Feldstein and Horioka (1980) or Bayoumi (1990) among others. The impact of domestic savings is significant. Since investment contributes to the GDP, it can be concluded that economics intuition whether saving has importance in economic growth, since it affects investment, has been confirmed in harmony with the existing literature.

About the crowding-out effect of savings on FDI, is significant, however, very-very small, although with negative coefficient. This can be translated as savings are important and FDI is not important in the determination of rate of investment. Even though there is a minimal crowding-out effect, it is much closer to agree with the VAR model conclusion by Tang et al. (2008) about no sign of crowding-out, and not really supporting the conclusion made by İpek and Ayvaz Kızılgöl (2015) about the existence of crowding-out.

Although some wildly used citations were collected about the unfavourable impact of

low and negative interest rates on investment (McKinnon, 1973; Shaw, 1973; Cho, 1990), the current study did not find any negative consequences on investments originated in the interest rates of the analysed countries. The rates were definitely not in the negative margin, and maybe neither low enough. The regression analysis did indicate any significance of interest rates on investments, that is why this variable got excluded among the valid determinants.

6   CONCLUSION

The study analysed the relation between domestic savings and investment in the Southeast Asian region. The assumption was originated in the Feldstein-Horioka puzzle conjecturing that the domestic savings determine investment. The hypothesis is that domestic savings stimulate economic growth through investment financing and, thus, the high savings rate observed in Southeast Asian countries can contribute to the outstanding GDP growth in the region.

The literature review uncovered that one of the explanations for high economic growth in the deduces that high level of capital accumulation is the explanation of high investment activity and dynamic economic growth in Southeast Asia. In some literature it was concluded that capital accumulation was remarkable in the region, but productivity growth was rather average, thus, the remarkable performance in the region was a result of high level of savings.

The hypothesis was tested on domestic savings between 1982 and 2016 in a panel regression analysis. Singapore, Thailand, Malaysia, China, South Korea, Vietnam and Japan was included in the panel. The analysis focused on explaining variables and the co-movements. The methodology was a panel regression analysis. The following economic indicators were included as the explanatory variables in the model: real interest rate, inflation, GDP growth and government debt.

Augmented Dickey-Fuller test was implemented to uncover the unit root problem. Logarithmic form was introduced to filter the unit root out time series. Among the implemented determinants the following ones did not contain unit root: the time series of GDP growth, real interest rate and inflation. Namely, in their case there was no need for logarithmic form.

The Durbin-Watson statistic indicated autocorrelation. To eliminate it, the logarithmic and differentiated transformation of the variables was incorporated in the model. This resulted a successful elimination of autocorrelation

The purpose of analysis was achieved successfully, and the significance of domestic savings was demonstrated beside other variables, and this way the hypothesis was confirmed. Namely, the domestic savings affect investments and indirectly the economic growth. Our new finding is that the lagged savings proved itself to be important in the investment impact and not the current one. The conclusion is that national savings have the most determining impact on investments and not the FDI. Based on the regression analysis, it can be stated that domestic savings affect investments in the Southeast Asian region much more than inflow of foreign capital.

7   ACKNOWLEDGEMENT

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DYNAMIC ALIGNMENT OF DIGITAL SUPPLY CHAINS BUSINESS MODELS

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ABSTRACT

A model for managing strategic alignment and dynamic capabilities (DC) of Supply Chain Management (SCM) information systems (IS) has been developed and applied to a traditional German steel company and a highly innovative Austrian steel company. Different concepts of leading researchers have been combined to get a holistic and detailed view of IS capabilities' impact on strategic fit. The model enables companies to identify ideal levels to strategic fit needed from SC integration and its antecedents for predefining architectural artefacts as sources for dynamic capabilities. The study contributes to new insights into the IT productivity paradox, where possibilities from IS investments remain unused. Essential concepts for optimising SC performance by reducing SC complexity and increasing SC agility have been identified and integrated. The study highlights value enabler and Artificial Intelligence (AI) methods of digital SC models and how the model's ontology can be used to increase alignment autonomy. Finally, the approach supports organisational learning and development of cognitive profiles through collective assimilation and sensemaking effects.

KEY WORDS

ambidexterity, digital business models, dynamic capabilities, strategic alignment, supply chain management

JEL CODES

M100, M110, M150, O310, O320

1   INTRODUCTION

The motivation: Businesses demand of aligning SCM IS to their strategy increases globally based on ongoing changes of industry conditions and industry consolidations like Mergers and Acquisitions (M&A) as well as from technological change driven by the digital transformation

such as the Industry 4.0 initiative. The opportunities of SCM IS alignment are creating differentiated business value while companies need simultaneously managing IT costs and focusing on IT investments that are sources of competitive advantage. Procedures and tools for Supply Chain Performance Management (SCPM) using key performance indicators (KPI) are provided by best practice endeavours such as the 2009 SCORE model, which is offered by the US Supply Chain Management Institute and based on the Balanced-Score Card approach (Kaplan and Norton, 1992, 2001). However, a best practice for assessing the strategic fit of SCM IS and the related business and IT architectures appropriate to derive reasonable actions from is missing so far. Digital business models and manufacturing ecosystems such as driven by the Industry 4.0 initiative focuses on the autonomy in controlling business processes enabled by components such as Smart Services and Cyber-Physical Systems that provide smooth collaboration of ecosystem members connected via the internet at unforeseen events as well. While Artificial Intelligence (AI) methods are used primarily for managing the operational processes such as sensing of conditions, decision making based on business rules steering the physical systems, the author misses autonomy on the architecture levels for aligning business models and SCM IS onto changing environmental conditions.

The research objective: The main objective of this qualitative research was to explore new knowledge and methodology for the strategic alignment of SCM IS. For this reason, a generic, capability-based model being developed that is grounded in theoretical evidence by key constructs of leading researchers in the fields that have been integrated to get a holistic view and a detailed view of strategic alignment. The model should help companies to identify cases of misfit and the context-specific set of IS capabilities for SCM on multi-levels that lead to strategic fit and superior SC performance. Empirical evidence of the model's transferability to companies in the steel industry was searched by testing it at two companies that have been selected as polar types by a traditional

and a highly innovative company (Koulikoff-Souviron and Harrison, 2005, pp. 270–271). There is evidence that firms have successfully attained higher profitability through IS, enabling revenue growth (Mithas et al., 2011, pp. 237–243, 248–253) and IS executives are using IS-based resources to increase competitive advantages, by aligning IS plans with business plans (Kearns and Lederer, 2000, pp. 265–270). However, there is an observation that massive IS investments in advanced economies were not adequately reflected in the resulted business performance since the 1990s (Zukis et al., 2008, p. 5). Brynjolfsson calls this phenomenon as the IT Productivity Paradox, which refers to unused potentials from IT investments (Bashiri et al., 2010, p. 2; Brynjolfsson, 1993, pp. 67–75; Pinsonneault and Rivard, 1998). The study explores the causes and reasons of the phenomenon in the sample industry and develops the model useful for identifying these and prevent organisations from such miss-investments. Finally, this study explores knowledge and methodology for the strategic alignment of SCM IS utilising possibilities of emerging digitalisation technology such as of Industry 4.0 and Artificial Intelligence (AI). The study aimed to support autonomy in strategic alignment by adopting its ontology to AI-based concepts. For providing the context, the building blocks of digital business models and their enabler for dynamic capabilities (DC) for SCM have been explored.

The addressed gap in the literature: A 2016 systematic review about business-IT alignment by Spósito et al. (2016) concludes that there are many new ideas developed in the field, but with less development forward on existing constructs less and less empirical evidence from adoption in practice. For closing this gap, a concise strategic alignment model has been developed by combining key constructs of leading researchers; and grounded it in empirical evidence by applying and testing in at two global, leading companies in the steel industry.

The research question and objective: For addressing the stated research objectives, the following research question and main objective have been implemented:

- **RQ:** How, and to what extent does a capability-based model support the degree of strategic alignment of SCM information systems?
- **RO:** Explore, how, and to what extent does a capability-based model support the degree strategic alignment of SCM information systems.

The research sub-objectives: For working out the main research objectives, the following sub-objectives have been implemented:

- **RO1:** Develop a model for a holistic and detailed assessment of the strategic alignment of SCM IS, and test it at companies in the steel industry;
- **RO2:** Explore causes and reasons for the phenomenon of the IT Productivity Paradox as related to SCM IS;
- **RO3:** Explore the impact IS capabilities for SCM IS on strategic fit and how to govern these.

2   BACKGROUND AND THEORY DEVELOPMENT

The academic background and used key concepts: To compete in today's dynamic markets, firms must adapt their competitive strategies frequently and so need to align their business models and IS to comply with those new rules (Johnson et al., 2008, p. 3; McLaren et al., 2011, p. 909). For this reason, strategic alignment positively influences IS effectiveness and leads to higher business profitability (Avison et al., 2004, p. 224; Luftman, 2003, p. 9; Porter, 1987, p. 7). Previous approaches for measuring strategic fit or misfit between IS capabilities and competitive strategy, adopted by, for instance McLaren et al. (2011), Chan et al. (1997), Avison et al. (2004), and Sabherwal and Chan (2001), do not provide measurements on a detailed level. For obtain a holistic and a detailed view of IS capabilities' impact on strategic fit and business performance, different approaches of leading researchers have been combined into a new model. The model combines a profile-deviation approach (used by McLaren et al., 2011, pp. 918–919; Sabherwal and Chan, 2001, p. 13; Doty et al., 1993, p. 1198) with a cross-domain measurement approach (used by Avison et al., 2004, p. 230; Henderson et al., 1996) to enable assessing second-order effects of IS capabilities across SCM domains, which are called spill-over effects by Tallon (2012). The configurational theory has been adopted to the extent as capabilities can be assessed onto their fit to each other, which related to Mintzberg's postulation *"for being maximally effective, organisations must design configurations, those*

are internally consistent and fit in multiple contextual dimensions" (Doty et al., 1993, p. 1198; Mintzberg, 1978, pp. 941–943).

A robust model for managing fit of SC integration antecedents: In referring to the contingency theory, *"there is no universally superior strategy or way to manage in a given environment; instead, the context and structure must fit together if an organisation is to perform well"* (Donaldson, 2006, pp. 20–22; Pennings, 1975, pp. 394–395). The contingency theory postulates that alignment between patterns of relevant strategic, contextual, and structural factors leads to superior company performance and can prevent misalignment (Oh and Pinsonneault, 2007, p. 241; Doty et al., 1993, p. 1196). In referring to the systems perspective, Childerhouse and Towill (2011, p. 7445) state that SC integration achievements result in better performance by optimising an entire SC scenario rather than by optimising each of the sub-systems involved. They argue that through integration, trade-offs and far-reaching decisions can be carried out, based on shared information and coordination (Childerhouse and Towill, 2011, p. 7445). Various researchers define SC integration by the dimensions of organisational relationships, information sharing, coordination and resource sharing (for example van Donk and van der Vaart, 2005a, pp. 99–107; Childerhouse and Towill, 2011, p. 7443). Van Donk and van der Vaart (2005a, p. 100) point out that the increasing practice of integration efforts in volatile and uncertain demand situa-
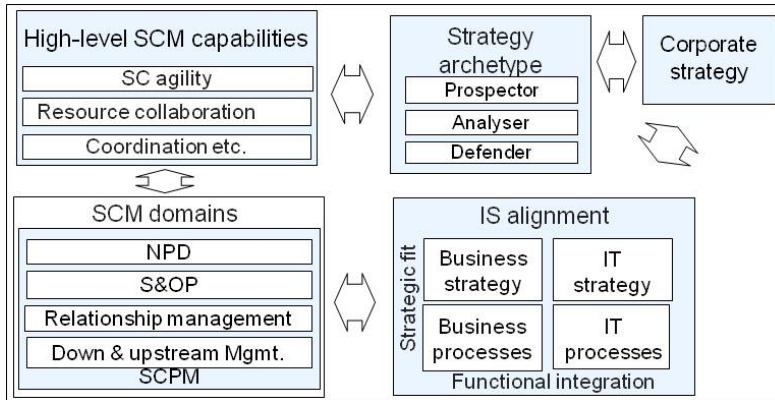
Fig. 1: High-level research model (an author's view; encases Miles' and Snow's strategy types, the SAM dimensions (Henderson et al., 1996), and the MSF model (McLaren et al., 2011)

tions will limit the adverse effects on SC performance. Many authors emphasise integration as an essential dimension of SCM, but the scope and context and their views vary considerably, and the objective of SC integration is not universally accepted as an ideal state and is not a question of *'high integration fits all'* (Godsell, 2008, p. 24; Childerhouse and Towill, 2011, p. 7445). For this reason, a robust, generic model is needed for manage the strategic fit of SC integration and their antecedent capabilities on different levels and multiple dimensions; to identify context-specific information about SC integration and SCM IS fit in detail.

Building on components of proven concepts: As highlighted in Fig. 1, the theoretical framework combines concepts of McLaren et al. (2011) and Sabherwal and Chan (2001), Avison et al. (2004) and Henderson et al. (1996), which provide the foundation on which developments of the present study is based.

Competitive strategy types and levels of support to fit: According to Miles and Snow, each of the archetypes *Defender*, *Prospectors*, *Analysers*, and *Reactor* shows an internally consistent pattern of competitive strategy, wherefore Conant et al. (1990) developed an 11 dimensional measure involving product-market breadth, success posture, surveillance, growth, process goals, competency breadth, adaptability, administrative focus, planning, organisational structure and control (Miles and Snow, 1978; Conant et al., 1990, pp. 367–370; McLaren

et al., 2011, p. 916). These unique patterns of response can help to determine a company's strategy type, according to Miles and Snows archetypes. Moreover, McLaren et al. (2004, pp. 52–58) found out that Miles' and Snow's archetypes show patterns of ideal levels of support for IS capabilities for SCM that are needed for strategic fit. They identified that businesses categorised as Prospector or Defender show a higher performance when key IS capabilities fit the theoretical ideal for their archetypes, which has critically reviewed by the study.

The concept of capabilities: In referring to Grant's (1996a) theory of the capability hierarchy, capabilities have been assessed on different levels of aggregation, and higher-level capabilities are integrated by involving lower-level capabilities such as specific knowledge, as illustrated in Fig. 2 (Grant, 1996a, p. 337). The higher the level of the capabilities in the hierarchy and the more aggregated the capabilities are, the more far-ranging cross-functional integration is needed; for example, new product development incorporates particularly wide-ranging integration (Grant, 1996a, p. 377). Capabilities at the highest level in the hierarchy directly support the ultimate business strategy regarding positioning the organisation in the target market. Hence, Venkatraman's (1989a) STROBE measures were used at the highest level of the capability hierarchy for assessing the strategic impact of SCM capabilities.
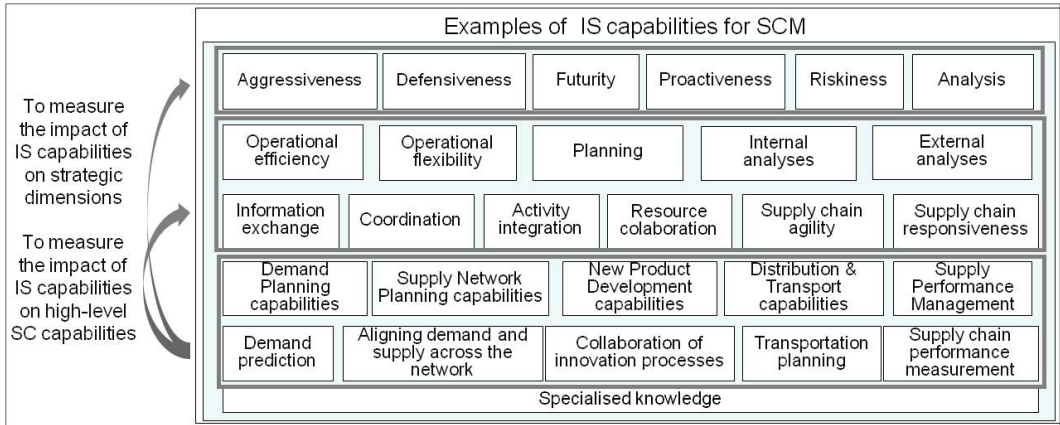
Fig. 2: Strategic fit of different levels (an author's view, encasing Grant's capability hierarchy)

Dynamic capabilities: The theory of dynamic capability, as an extension of Edith Penrose's theory of the resource-based view (1959) is described as a firm's ability to integrate, build, and reconfigure internal and external competencies to address rapid change in business environments (Teece et al., 1997, pp. 515–516). DCs are potentials for innovative capacity that enable firms to implement highly effective strategic alignment by reconfiguring their capabilities to sustain competitive advantage in fast-changing business environments (Teece et al., 1997, p. 511) through rent creating mechanisms (Makadok, 2001). The present research explores how DC related to SCM IS can be managed in an integrated and holistic way for dynamic alignment of SCM IS and in an ambidexterity way for exploration and exploitation (O'Reilly and Tushman, 2007).

Strategic alignment by IS capabilities for SCM: For exploring IS capabilities of SC domains, strategic alignment has been divided–as an adaptation of Venkatraman's definition of strategic alignment–into two components: (1) the concept of *'strategic fit of SCM'*, which represents the measurement of fit of IS capabilities with regard to supporting the firm's competitive position, and (2) the concept of *'functional integration of SCM'*, which represents factors that foster the alignment within the internal IS infrastructure for SCM. The degree of strategic fit of SCM IS is expressed by the levels of support IS capabilities for

SCM offing on strategic fit and the levels of functional integration. For consider SCM processes relevant to the steel industry, all SCM domains have been incorporated to identify the levels of support of IS capabilities for the strategic fit of steel firms' supply chains. Moreover, IS capabilities for SCM have been explored about their ideal levels and their actual levels of support to strategic fit. Capabilities embody a firm's qualifications for effectively combining resources for creating and sustaining competitive advantages knowledge integration from multiple sources across the supply chain (Wu et al., 2006, p. 502; Amit and Schoemaker, 1993, pp. 33–44; Grant, 1996b, pp. 115–116).

High-order SC capabilities as antecedents of SC integration: The literature suggests the growing significance of SC integration and collaboration with channel partners throughout the supply chain to secure business opportunities, and to focus on operations' effectiveness and efficiency. Wu et al. (2006) proposed the high-order SC capabilities *information exchange, coordination, activity integration* and *resource collaboration* for supporting cross-functional and inter-organisational activities within the domains of SCM (Wu et al., 2006, pp. 493–495). Hence, these high-order capabilities and further such as *responsiveness* and *agility* are uses as antecedents of SC integration and strategic fit in the present study as they allow aggregated measurements of operational SC capabilities across organisations
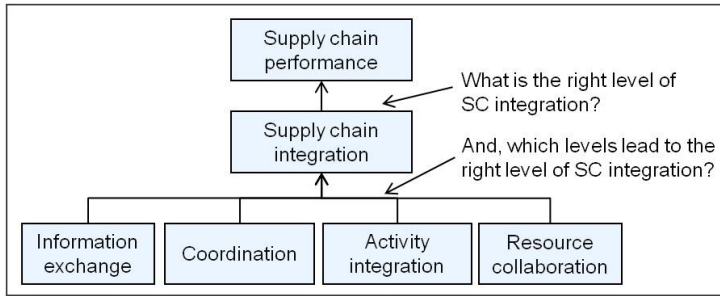
Fig. 3: SC integration antecedents (an author's view, encasing Wu et al.'s 2006 SC capabilities)

(Simatupang et al., 2002, pp. 291–306; Wu et al., 2006, pp. 494–495). Fig. 3 illustrates the SCM capabilities discussed and their relation to SC integration and finally to SC performance. Fig. 2 shows that these high-order SC capabilities are seen placed on a high level in the hierarchy and supported by functional capabilities implemented by SCM IS. Business performance and strategic alignment can be seen as supported by these high-level SC capabilities, as shown below.

Strategic alignment through the right levels of integration: SC integration capabilities are key drivers of business performance in today's business environment (Wu et al., 2006, p. 495; Shaw et al., 2005, p. 3497; Wang, 2011, pp. 42–43; Liu et al., 2013, p. 1453), but their required levels depend on several situational factors (Godsell, 2008, p. 24). SC integration seems to refer to the orchestration of other SCM capabilities, such as information exchange, coordination, and resource collaboration, which leads to the question of the right levels to fit of these antecedent capabilities. As McLaren et al. focus on the generic set of five higher-level IS capabilities, the necessity to enrich the model with capabilities for SC integration is seen, to obtain useful results that support organisations in strategic alignment in today's demanding business environment.

Measuring SCM IS' strategic fit using a profile deviation approach: Because both competitive strategy and IS capabilities are multi-dimensional constructs, to operationalise their strategic fit requires investigation of a considerable number of contingency relationships unless a configurational approach is used (McLaren

et al., 2011, pp. 915–916; Sabherwal and Chan, 2001, p. 13). Therefore, a profile deviation approach has been used for integrating measurements of IS capabilities, on different levels, on their impact on the dimensions of strategic fit. For this reason, capabilities that are organisationally and functionally related to the processes of an SC domain were measured using profiles. Fig. 4 shows how the profile deviation approach has been adopted for assessing the strategic fit of SCM IS. Profiles of IS capabilities with theoretical ideal levels – derived from the business strategy – are compared with profiles of IS capabilities with actually-implemented levels. While ideal levels are linked to an organisation's business strategy, actual levels of support are typically a result of the transformation of the IT strategy. As stated by Prieto and de Carvalho (2011, p. 1409), to possess capabilities with levels of support to strategic fit and not exhaust these for competitive advantage or for generating growth means they will be automatically wasted. Therefore, capabilities' actual levels of support that are higher than the needed levels are seen to have a negative impact on the overall level of strategic fit. The Euclidean distance method has been used for calculating vectors of capabilities' degree of fit as it was validated by previous research such as of McLaren et al. (2011). With this approach, a measure as an indication of the strategic fit of the whole SCM IS, and measurements for the SCM domains and SCM processes can be calculated. By this means, measurements of strategic misfit have been worked out using identified levels of misfit identified for detailed IS capability.
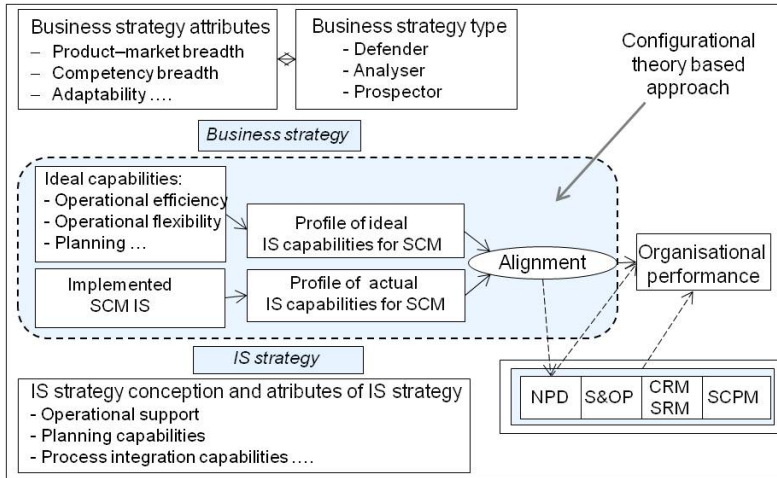
Fig. 4: A configurational theory-based concept for measure SCM IS's strategic fit (an author's view, adapted from Sabherwal and Chan, 2001)

Differences and similarities of the model to previous models: McLaren et al. inspired the present research with their 2011 MSF model. However, they give no description of the measurement model's content that is needed to identify the relevant IS capabilities, and they stated neither full IS capabilities for neither SCM nor anything about which domains they come. Moreover, the measurement instrument for analysis needs to be developed in the field study for each case individually. McLaren et al. used a questionnaire originated by Conant et al. (1990) to determine the firm's competitive strategy type and a justification table for identifying ideal levels that need the be provided by the generic capabilities. A reasonable measuring instrument needs to be developed for each study individually by identifying IS capabilities relevant to the case. The IS capabilities identified need refer to the generic capabilities given by McLaren et al., which is a prerequisite for integrating the case-specific measurement instrument in the MSF model. Thus, from the present study's point of view, McLaren et al. delivered a useful framework for building an applicable measurement model. For obtain a holistic assessment of SCM IS impact on strategic fit, the measurement model has been enhanced using concepts of leading researchers.

Proving McLaren et al.'s classification system: For proving the classification-system of predefined levels of support to fit by five generic SC capabilities pronounced by McLaren et al., their level of support for strategic alignment needs to be compared with the ideal levels of support identified by the present study. In their research, McLaren et al. (2011, p. 914) emphasise IS capabilities for SCM that are relevant for a firm's strategic fit as follows: (i) operational efficiency; (ii) operational flexibility; (iii) planning; (iv) internal analysis; and (v) external analysis. Furthermore, they disclose ideal levels of these generic IS capabilities, related to the firms' competitive strategy archetypes for supporting strategic fit. A cross-domain approach has been used in the present research to reflect the structures of the affected supply chain areas and their dependencies concerning both strategic integration and functional integration (Avison et al., 2004, p. 230; Henderson and Venkatraman, 1990, pp. 6–28). The IS capabilities identified must be mapped to the generic capabilities stated. For this reason, the generic capabilities propounded by McLaren et al. have been analysed by the present study related to the following SCM processes identified for the steel industry: (i) New Product Development, (ii) SC planning, (iii) SC operations, (iv) Relationship Management, and (v) SC Performance Management.

3   RESEARCH METHODOLOGY AND CASE STUDIES

As the nature of this research is to develop a new methodology and proof it in specific business contexts, a qualitative research methodology has been select. Qualitative research allows combining quantitative and qualitative methods such as case studies where the researcher is part of the sample to be explored. Finally, it is open to considering facts that were not expected at starting the research, and, therefore, is well suited for developing a new theory by linking data and theory iteratively (Eisenhardt, 1989, p. 533; Bryman and Bell, 2003, pp. 424–516; Silva and Hirschheim, 2007, pp. 333–334; Kaplan and Duchon, 1988, pp. 574–583; Yin, 2009, pp. 130–134).

Essential theory development based on secondary data: An exhaustive literature review has been conducted to identify key concepts for developing the research question and objectives and for grounding the research in theoretical evidence (Yin, 2009, p. 130). Regarding the multidisciplinary nature of the study, a wide range of literature from a variety of fields has been reviewed to select useful ideas. Hence, the following fields were systematically reviewed by focusing on key researcher:

1. *strategic alignment and measurement models* – as the main subject; concepts of business strategy and IS strategy as central components of strategic alignment;

2. *capabilities and IS capabilities* – as a capability-oriented approach has been used for assessing strategic fit and maintain DC for SCM IS;

3. *Supply Chain Management* – as a methodology for managing the degree of strategic fit of SCM IS have been developed and tested;

4. *Artefacts of IS for SCM* – as an objective of the research was to develop the model for maintaining strategic fit using EAM practice.

Methodical evidence implied in the theoretical framework: In referring to Klein et al. (2006b, pp. 88–91) framing/data theory for concept of mental models a design research approach has

been used for developing the theoretical framework and deriving the measurement model and methods. The critical constructs introduced above have been integrated so as to feature the favoured characteristics by the measurement model holistically, but, arriving it as simple as possible. Moreover, the methodology had to enable participatory design by experts of the subject and members of the target practice (Blomberg et al., 1993, pp. 123–150). *Theory triangulation*, as described by Yin (2009, p. 116) has been added to the research theory by investigating different complementing and revival concepts of strategic fit and through synthesising useful concepts of different key researchers in strategic alignment (Yin, 2009, pp. 130–134). The synthesis brings the findings together and leads to the development of the research question and the research objective. In referring to Yin's (2009, pp. 130–162) *logic models* for increasing case study evidence, the main building blocks of the present research methodology are the literature review and synthesis – in order *'to rely on proven theoretical propositions'* – form the basis for the development of the research question and objective and the development of the research theory and methodological framework – in order to develop *logic models*.

The rationale for case study research: While case studies in SC integration make it hard to generalise findings, specifically if there is no clear theoretical framework supporting these, surveys incorporated only limited aspects of integration and fail to consider what actually happens in SC relationships and to address the context or business conditions (van Donk and van der Vaart, 2005b, p. 32). They suggest the use of a multi-case study for research in integrative practice to bridge the gap between single case studies and surveys, and to develop knowledge in the field in its prevailing stage (van Donk and van der Vaart, 2005b, p. 33). Hence, three case studies were used as primary sources in order *'to use multiple sources of data'* for developing the final research theory and for testing the strategic fit measurement

model. Therefore, the developed model has been applied to companies in the steel industry, and semi-structured interviews have been used for collecting data from case study participants to the research objectives.

Exploratory field study at SAP instead of a pilot case study: A pilot case study is typically used for exploration-based research, which helps to test and refine the basic research theory and data collection plans (Yin, 2009, p. 92). Hence, the scope of a pilot case study can cover both substantive and methodological issues and helps to refine relevant questions and conceptual clarification of the research design. For reviewing the research theory and collecting qualitative data, a case study at the author's employer SAP SE has been used instead of a pilot study as SAP is a leading vendor for SCM solutions for the steel industry and takes care of the sectors' challenges and needs. Moreover, the author has access to SAP's field organisations on a global basis. Hence, an exhaustive case study within the SAP organisation has provided rich information about the industry related to the research objectives rather than using a single, industrial sample of a pilot case study. As a core objective of the case study at SAP, the entire concept of the model had been reviewed. Moreover, the model's content has been developed by identifying the right set of IS capabilities for SCM processes relevant to the steel business and prepared these as an industry template. For this reason, IS capabilities have identified by expert discussions on an individual level required to point out the industry and organisation specific vital differentiators that are relevant for a strategic fit. The case study at SAP has been conducted by session sequences with each of 12 experts. Comprehensive work sessions were conducted with each of the participants, including semi-structured interviews, and the validation of the case study outcome. Leading experts who developed SCM solutions for all manufacturing industries were involved, and, therefore, were able to assess the research theory regarding its generality and adaptability to other industries. More than 20 additional experts have been consulted for in-depth discussions of topics identified during the case study.

Five reports (each between 12,500 and 18,000 words in length) have created as the outcome and signed by the experts. These reports have served as raw data for the findings arrived.

The rationale for sample selection and participants of industrial case studies: The sample organisations are both global players based in Austria and Germany, with subsidiaries and international involvement around the globe. Moreover, both steel companies are engaged in both high-end product segments and low-end ones. The Austrian steel company is well known for highly innovative involvement in both collaborative product development concerning high-end products, and in driving IS innovations. In referring to Kuolikoff-Souviron and Harrison (2005, pp. 270–271), the present study goes for polar types in sampling the highly innovative Austrian steel company (A), that offers high-end products to the automotive industry on the one hand, and in sampling the traditional German steel company (B) with a stable product portfolio for the packaging industry on the other hand. Hence, the polar type rationale is seen in the products the companies offer and the resulting different characteristics in their SCM processes. Both organisations are large steel producers and have to plan and synchronise their supply chains on a global scale. The industrial case studies have been conducted by session streams as well, where six participants including the companies CIOs belonged to the core teams, and additional participants from the companies' business and IT teams contributed to the assessment of the SC domains they are managing and consulting. Finally, the companies' senior management contributed to the identification of the companies' competitive strategy type.

Qualitative data analysis using content analysis: For testing the model by validating measurements against the qualitative data collected, the directed content analysis approach, according to Mayring (2014) has been used. The recorded interview data have been transcribed carefully and *fitted* into a *frame* (measurement model) of predefined categories of capabilities so as to triangulate these against the quantitative calculated levels of strategic fit. The rationale
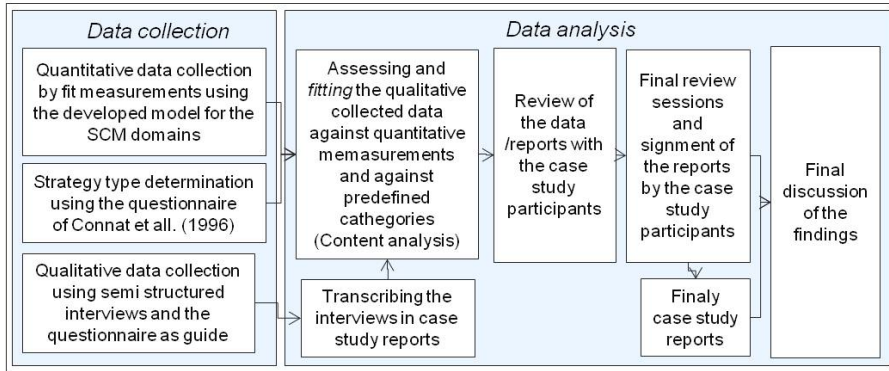
Fig. 5: The case study data collection and analysis process (an author's view)

for the *directed content analysis* approaches due to Hsieh and Shannon (2005, pp. 1281–1283) is based on the complexity of SCM data, as complex SCM processes and their relationship to the research objective was analysed, and terms of SCM are often used differently in individual organisations. Both categorising approaches, according to Mayring (2014), have been adopted. The *inductive category formation* has been used for identifying and weighing new categories and content for developing in-depth findings to the research objectives. The *deductive category application* was used by manually *fitting* interview data meaningful to predefined categories for the reason to prove the measurement model on construct validity and triangulating the qualitative data with the measurements as mentioned above.

3.1 Strategic Fit Assessment and Interim Result

Competitive strategy type assessments: As a first step, the scope of the strategic business areas and the relevant SCM processes to be assessed were determined by joint sessions. Based on that scope, the strategic fit measurement was calibrated using the prepared template. As a second step, the questionnaire of Conant et al. (1990) has been filled out by the senior management for identifying the strategy type according to Miles and Snow. The identified strategy type has been used to determine ideal levels of higher-order SCM capabilities,

according to McLaren et al. (2011). The results of the strategy type assessments do not show unique strategy types for all rated business dimensions. It shows the business of company A (Fig. 6) categorised by the leading strategy type Defender and by the second strategy type Protector, which reflect the company's characteristic on a high level.

A hybrid strategy with strong defender focus and strengths in innovation: The questionnaire response was also reflected by the result of the semi-structured interviews, which leads to the following view: the sample organisation shows a predominantly defender strategy type in a stable market position and steady market growth with a strong focus on high-end products, and, therefore with significant strengths in engineering. This prospector position with engineering competency breadth is reflected by the activities for searching business opportunities as an innovator in the market. According to the organisation's engineering strengths, new market opportunities result mostly from innovation offered from a stable customer base. At the same time, along with this prospector/innovator position, the sample organisation shows strong defender strategy characteristics for securing margins and a stable financial position through operational excellence. Because of the stable defender strategic position and the prospector position in engineering that allows screening the market for new opportunities, the product-market focus shows an analyser strategy type. Based on the preparatory steps, the

Tab. 1: Response to strategy type questionnaire of company A (Conant et al., 1990)

Business domain	Dimension	Rated characteristics	Strategy type
Entrepreneurial	Product–market focus	In comparison to competitors, our products are stable in certain markets while innovative in other markets.	Analyser
	Market leadership	In contrast to competitors, we have an image in the marketplace by offering selective products of high quality.	Defender
	Market surveillance	We are continuously monitoring the marketplace.	Prospector
	Market growth	In comparison to competitors, the increase or losses in demand are possible from concentrating more fully on developing our present markets.	Defender
Engineering	Process goals	One of our most important goals is our dedication and commitment to keep costs under control.	Defender
	Competency breadth	Our managers have broad entrepreneurial skills, being flexible, and enable change to be created.	Prospector
	Infrastructure adaptability	The one thing that protects us from competitive failure is that we can do a limited number of things exceptionally well.	Defender
Administrative	Administrative focus	Our management tends to concentrate on a secure financial position through cost and quality control measures.	Defender
	Planning	Our organisation prepares for the future by focusing on problems that, if solved, will maintain and improve our current offerings and market position.	Defender
	Org. structure	In comparison to our competitors, the structure of our organisation is product-market oriented.	Prospector
	Control	Unlike many of our competitors, we use decentralised procedures to evaluate our performance, and many members are involved.	Prospector

strategic fit measurement has been conducted. Initial sessions have shown that the assessment delivered fruitful quantitative results for the rating of capabilities' levels to fit.

Strategic fit assessment: Each relationship between the IS capability provided by the SCM IS and the high-order SC capability needed to support fit has been rated with the following levels: 'high', 'medium', 'low', and 'not relevant'. Besides, support of IS capabilities to fit through SC capabilities of other SCM domains have been considered for assessing second-order effects from such spill-over effects. Original assessment sheets of SC domains using the Euclidean distance method for calculating strategic fit are shown in the Appendix. Besides, rich qualitative information has collected about the contribution of SCM IS capabilities to fit for the different domains and causes and reasons for the IT productivity paradox. Finally, the model

itself has been rated using a five-point Likert scale on the appropriateness for measures the degree of strategic fit of a steel firm's SCM IS when considering their competitive strategy.

Strategic fit measurement and analysis of the model: For calculating the strategic fit ratio using the Euclidean distance method, the rated levels have been replaced using the following numeric values: 0 for *'not relevant'*, 1 for *'low'*, 2 for *'medium'*; and 3 for *'high'* levels of support of fit. The means of ideal levels and actual levels of support of fit have been calculated for each combination of IS capability and high-order SCM capability as derived from the assessment sheet and figured out in Tab. 2. The aggregated ideal levels show the significance of the S&OP domain's capabilities to strategic fit. The same procedure has been used for calculating aggregated levels of support by IS capabilities to strategic dimensions according to

Tab. 2: IS capabilities for S&OP support of fit (case study A)

IS capability	Ideal level	Actual level	Fit	Quotation or paraphrased quotation	Paraphrase	Paraphrase category B	Related KPIs
Demand planning	2.3	2.0	1.7	*"One of the most significant spill-over effects of demand prediction is the indirect, but the clear impact on resources balancing for productions of different segments. High levels of visibility in activity integration are the result contributing to smooth operations, SC synchronisation and coordination."* (PA1)	Demand prediction has an impact on well-utilised resources and indirectly on how well the activities are integrated for fulfilling the expected demand.	Enablement: The reached accuracy is a result of high SC modelling and configuration efforts in DP and S&OP.	1. Forecast accuracy
Demand review	2.2	1.9	1.7				2. Profitability
Demand alignment with operations	1.9	1.7	2.0				3. OEE and plant utilisation 4. Delivery adherence 5. Material & resource availability
Real-time visibility of demand changes across SC	2.6	2.1	2.2	*"Increased visibility of demand changes' impact on material flow has improved customer-order due-date adherence, reliability, and improved operational excellence as well."* (PA1)	Increased SC visibility improves operational excellence and delivery adherence.		6. Transportations adherence
SC modelling	2.4	1.7	2.6	*"Simulation capabilities support strategic decisions, pro-activeness, risk mgmt. also, increase SC agility by better decisions."* (PA1)	Capabilities for modelling and simulating different business situations and contradicting objectives are vital drivers.		
Plan simulation	2.4	2.2	1.4				

Venkatraman's (1989a) STROBE measures, as shown in Fig. 2. Finally, the strategic fit indicators that are provided by the IS capabilities of the S&OP domain have been calculated as an aggregated measure of each SC capability. Strategic fit indicator values between 0 and 1 indicate a high level of fitness to the strategy of the measurement capability combination. Levels between 1 and 3 indicate the extent of a misfit. By this approach, the strategic fit has been identified at an overall level and individual levels of IS capabilities' impact onto fit through higher-order SC capabilities.

As shown in Tab. 3, the average ideal level of 3.0 and the actual level of 2.95 for *'business predictability'* underpin the strategic significance of this high-order capability. Most capabilities with an aggregated value for the ideal level above '2' show significance to strategic fit as well. Moreover, the levels show that the core objective of predicting the business for the long-term has fulfilled to a high degree by the implemented IS capabilities. High levels of support of IS capabilities for *'exchanging information'* and *'coordinating related activities'* with customers and internal parties are needed to predict the forecast reliably. Potentials for improvements to fit were identified for demand management regarding *'SC responsiveness'* and *'SC agility'*.

However, the main objective of the S&OP processes is to develop a plan based on known and expected demand, while considering expected constraints in supply, such as downtimes

for resource maintenance, so that expected demand can be fulfilled. This main objective is rated with high levels for the capability *'coordination'* through IS capabilities of demand planning, which is indirectly fulfilled to a high degree through spill-over effects on the operations processes of the upstream and downstream domains. These secondary levels are also represented for the SCM capability *'coordination'* by IS capabilities for demand alignment that also have a positive indirect effect on *'operational efficiency'*. Tab. 2 shows the aggregated result of the strategic fit measures from the perspective of the IS capabilities for S&OP which has been derived from the columns *'fit ratio'*, *'average degree of ideal levels'* and *'average degree of actual levels'* of the assessment sheet figured out in the Appendix.

Identified potentials for improvement to fit (misfit): The most significant deviation between ideal and actual levels has identified for *'activity integration'* for aligning forecast with production management. Hence, the analysis shows significant potentials for improvement in *'activity integration'* between involved parties. Demand alignment with production management, procurement and logistics represent a core function of central planning. High levels were rated for demand alignment capabilities for providing the required levels for *'SC responsiveness'* and *'SC agility'*. These requirements were fulfilled to a medium level by the actual

Tab. 3: IS capabilities' contribution to fit from S&OP (case study A)

SC capability	Ideal level	Actual level	Fit	Quotation or paraphrased quotation	Paraphrase (category A)	Paraphrase to category B	KPIs
Business predictability	3.0	2.9	1.0	Business predictability is fulfilled to high-level for the long-term. Predictability on characteristics levels is essential. A significant spill-over effect is the indirect balancing of critical resources, which reduces efforts in coordination.	Prediction on characteristics levels is of high relevance with indirect impact on balancing critical resources among the supply chain.	S&OP capabilities provide business predictability capabilities. The accuracy is reached by high efforts of SC modelling in S&OP.	1. Forecast accuracy 2. Revenue 3. Profitability 4. OEE & plant utilisation 5. Delivery adherence 6. Material and labour availability 7. Transportations adherence
Coordination	2.9	2.8	1.7	High levels of *'information exchange'* and *'coordination'* are needed for demand collection & supply alignment.	Contribution to fit from S&OP relates to a high degree on stakeholders' collaboration for aligning demand and supply.	Collaboration capabilities for demand alignment enabled by control and SC modelling for alignment workflows.	
Information exchange	2.8	2.7	1.7				
Activity integration	2.7	2.3	3.0	Misfit in *'activity integration'* between demand management and production planning.			
Operational efficiency	1.8	1.7	1.0	The indirect impact of DP capabilities on the coordination of manufacturing has a positive effect on *'operational efficiency'*.	S&OP capabilities have a positive impact on operational efficiency.	The second-order effects of S&OP enable high levels of operational efficiency.	
SC responsiveness	2.2	2.0	2.2	Medium levels of support to fit by *'SC responsiveness'* and *'SC agility'* underpin the misfit in activity integration between S&OP & production.	High levels of integration between demand management and production planning provide high levels of SC responsiveness (coverage and enablement by modelling the right levels).		
SC agility	2.2	2.0	2.2				
SC risk mgmt.	2.2	2.1	1.4	Plan simulation helps to analyse options against expected risks by improved visibility.			

capabilities. The potential for improvements in *'SC responsiveness'* and *'SC agility'* from demand alignment underpin the misfit in *'activity integration'* capabilities between demand management and production planning. The identified levels of the misfit in *'activity integration'*, *'SC agility'* indicate that improvements in IS capabilities for optimising, simulating, and visualising plans can help to increase levels of fit between demand management and production management. Fig. 6 shows the impact from levels of a misfit onto SC planning by modelling and simulations capabilities and internal alignment by activity integration, SC agility and SC responsiveness. Moreover, it shows also high levels of a misfit in the visibility of supply chain end-to-end processes. Modern Integrated Business Planning (IBP) solutions can be evaluated for improving the strategic fit of SC visibility and alignment. Such IBP solutions emphasise on the collaboration of stakeholders involved in the overall planning consensus process.

The high levels of a misfit in *activity integration*, *SC responsiveness* and *SC agility* indicate needed improvements in *collaboration* between stakeholders and transparency of the planning process. On the other side, the level '1' of fit in *operational efficiency* shows that the S&OP

processes have a very positive impact on the efficient utilisation of the production assets by spill-over effects. The level '2' for *coordination* and *information exchange* and the vast extent of misfit of *activity* integration with the value '3' indicates the need for improving SC visibility and stakeholder collaboration as well. Alignment of changes in customer demand with the available production capacity in the most profitable way is a highly demanding task for all involved parties for optimising contribution margins. Hence, there are remaining potentials for improvements in profit-oriented plan optimisation. Moreover, there were improvement potentials seen for increasing SC transparency by visualising the impact of demand dynamics on production, supply, and Financials, throughout and in time. The assessment shows that the IS capabilities support the sample organisation's business strategy to a high degree through the SC capabilities. The direct impact of IS capabilities to the strategic dimension due to Venkatraman's STROBE measures is visible with significance for *'riskiness'* and *'defensiveness'*.

Strategy type of organisation B: There was a collective sense among the case study participants and the company's managing board about the view of the company being in a
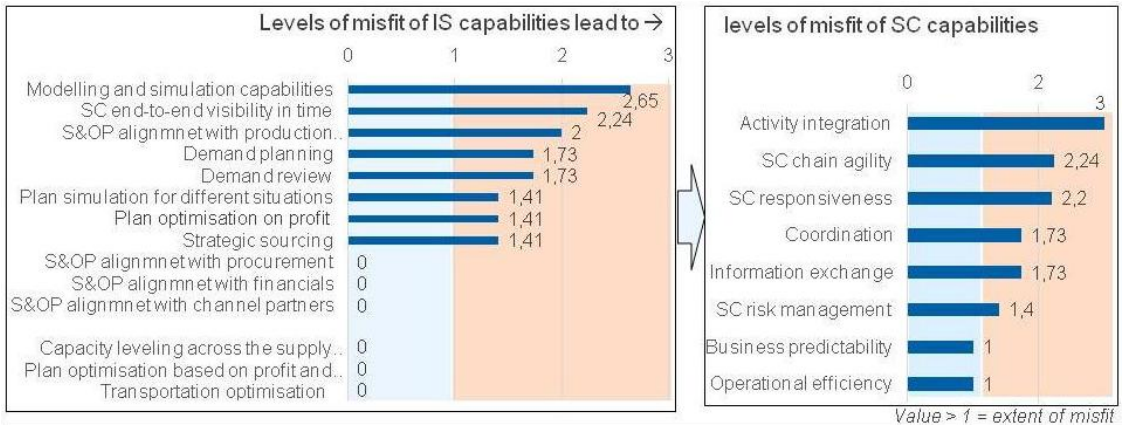
Fig. 6: Levels of SC misfit from IS capabilities for S&OP at company A

strong Defender strategy position with characteristics and behaviour of an Analyser in observing the market for new opportunities for securing the position in a long-term perspective. The response to the questionnaire also reflects this strategic positioning. According to the discussions, the sample organisation has a robust product portfolio but is very active in searching new customers in new geographic markets to sustain the competitive position, which underpins the Analyser characteristics in market surveillance.

The strategic relevance of company B's SCM process and their fit: The processes of the upstream and downstream domain, the S&OP domain, and the Relationship Management domain, have been identified as strategically relevant for securing the company's Defender strategy position through high levels of efficiency and agility. These processes have to provide the necessary conditions for *'SC responsiveness'* and *'SC agility'* by alignment activities and active information exchange with customers. Backlog management has been identified as the backbone process for securing effective asset utilisation and for satisfying strategic customers' demand reliably and with the required profitability at the same time. The backlog management process bases primarily on collaboration between sales and production management and requires underpinning inputs from demand management and relationship management processes for preparing the nec-

essary conditions for effective demand alignment by *information exchange* with customers. Hence, backlog management's effectiveness is, based on high levels of *'activity integration'* between demand management, relationship management, and operations. It helps the company to fill customer orders highly effectively and efficiently by its use of supplying organisational parties. Moreover, these strengths support highly responsive changes in the order backlog such as through very high levels of integration of collaborative activities between involved parties. For that reason, its strength in this core SCM process helps the company to secure the *Defender strategy position* by providing operational excellence in efficiency and agility. Also, the flexibility described in the planning and operations processes allows the company to act in new markets by taking chances on new opportunities based on the existing product portfolio. Based on the maturity of the company's processes, high-levels of fit of IS capabilities for SCM were identified in general. Nevertheless, significant opportunities for improvements were identified for SCM core processes as summarised below.

Improvement potentials from identified levels of a misfit at company B: High potentials of improvement were identified for the SCM *activity integration* within the company's parties, using IS capabilities of *demand management* and production/inventory management. The same levels of improvement were identified

for *activity integration* with external channel partners, such as the parent company for managing raw material supply. Moreover, further opportunities have been identified about *operational efficiency* and *flexibility* of internal and external transportation management activities. Because active and efficient backlog management with high levels of integration among the parties involved' has been identified as core strength, improvements were estimated instead from predecessor processes such as demand management, since demand is managed manually. For this reason, support by Integrated Business Planning (IBP) capabilities promises to support the operational backlog management process without losing flexibility. Moreover, the assessment shows that increased transparency of SC optimisation potentials can support SC integration, SC risk management and operational excellence.

4 FINDINGS AND DISCUSSION

4.1 Commonalities and Contrasts of the Assessed Business Models

Context-specific profiles of IS capabilities and levels of support needed to strategic fit: For both companies, the actual implemented and ideal levels of SCM IS capabilities to support strategic fit of their SC business models were identified considering context-specific implications. Moreover, levels of a misfit from SC integration and antecedent capabilities have been calculated that expresses the impact onto business strategy. A holistic picture of SCM IS strategic fit from IS capabilities' effect on process levels and second-order effects within and across SC domains has been yielded from triangulating the calculated figures with the qualitative extracted information. The strategic fit assessments provide the companies with a solid basis for defining qualified and focused action plans.

High visibility of contrasting key priorities in SC capabilities for SCM: Due to the polar type sample selection, valuable contrasting information has been found and can make visible such as crucial differences in the companies' strategic positioning and the impact on the differentiation of there is capabilities for SCM. For instance, where spillover effects from SC planning to SC operations processes are very important for company A's strategy adoption, spill-over effects from relationship management to SC operations are vital enablers for company B's strategic strengths as highlighted in Fig. 7. Hence, operational excellence of company B is based to a significant extent on *second-order effects* of proper relationship management providing high levels of flexibility. The participants expect significant effort reduction in the coordination of operational processes from enhanced collaboration capabilities by modern IBP solutions in the future. Interestingly, the highly innovative company A needs more demanding planning capabilities in comparison to the low-end company. This finding rebuts the assumption of McLaren et al. (2011) that companies showing *Defender* strategy type characteristics need a higher level of support to fit from planning capabilities as companies related to an *Innovator* strategy type. Fig. 7 highlights the companies' second-order effects.

1. High levels of support of fit of high-order SCM capability *'coordination'* indirectly by high levels of *'IS capabilities for S&OP'* at sample company A.

2. High levels of support to fit of *'coordination'* indirectly by high levels from *'IS capabilities for relationship management'* at sample company B.

Differences in second-order effects through IS capabilities' spill-over effects: The case study at company A affirms the assumption that steel companies in the high-end sector, such as automotive suppliers have very complex SCM processes, particularly in SC planning. On the one hand, they need to deal with variant configuration throughout their planning and operations processes in the same way as Engineering-to-Order (ETO) producers in the
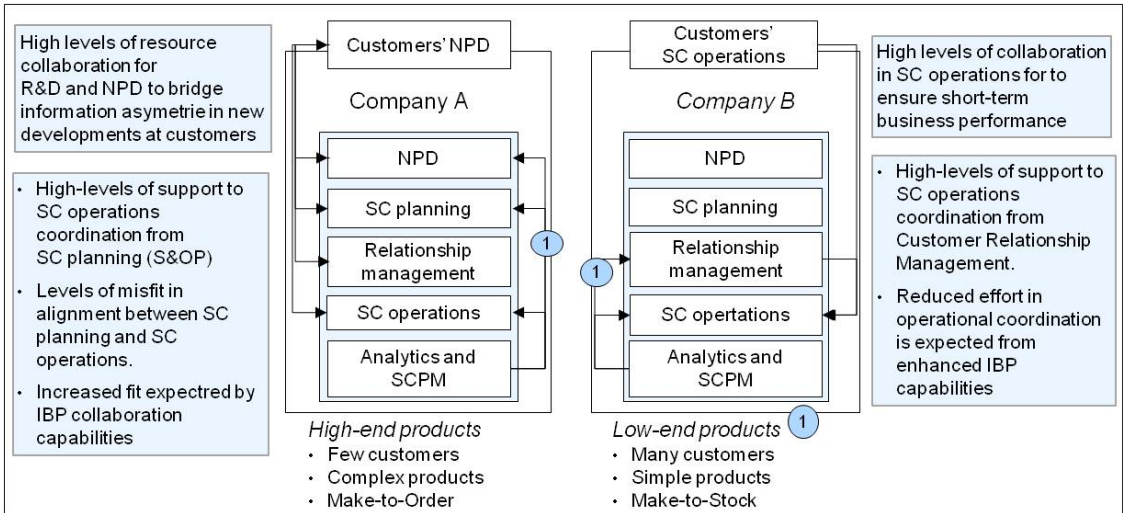
Fig. 7: Strategic support from second-order effects of IS capabilities across the supply chain

discrete manufacturing industry. On the other hand, they have the same logistics and SCM requirements as the process industry in managing their production flow. To find the optimal plan needs demanding SC planning capabilities such as characteristic based demand planning capabilities for modelling different levels of profit contributions by different customers for the same product. Such information can be considered by S&OP optimiser solutions to create master plans that prefer profitable orders for allocation at available finite resource capacity. However, the planned profitability needs to be realised by operational excellence. Hence, high levels of support to operational excellence are required from SC capabilities such as *resource collaboration* and *coordination* of upstream and downstream processes, which are implied from antecedents of NPD and the S&OP domain. High levels of operational excellence have been identified at company B based on second-order effects from high levels of *operational collaboration* with customers. Hence, high levels of support to fit by *upstream and downstream coordination* are implied by the capabilities of relationship management. The participants expect reduced efforts in *operational coordination* from enhanced S&OP capabilities. Interestingly, the highly innovative company A needs more demanding planning capabilities

in comparison to the low-end company. This finding rebuts the assumption of McLaren et al. (2011) that companies showing Defender strategy type characteristics need a higher level of support to fit from planning capabilities as companies related to an Innovator strategy type.

Relationship capital as a DC: Collaborative NPD using engineers positioned at the customers as Key Accounts pro-vide company A with relationship capital as an absorptive capacity, which provides insights on further demand and developments and enables to identify business opportunities by vertical forward integration. Collaborative knowledge management and knowledge assimilation act as antecedents of developed DC relationship capital, which enables company A to moderate the business functions innovation management, NPD and SC planning due to business needs. Company A's strengths in SC planning and simulations act as antecedents for moderating operational excellence providing fast, useful plan alternatives. Company B's relationship capital provides degrees of freedom in fulfilling promised service levels on an exceptional basis, and, therefore, acts as an absorptive capacity enable to re-plan and synchronise operational order volumes to deal with unforeseen events in a profitable way.

4.2 Assessment of the Strategic Fit Measurement Model

Findings of the model test and review of the applicability: The model's appropriateness to measure the degree of fit of steel firms' SCM IS in a concise way was rated by all the participants between *'fits'* and *'fits very well'* as an average of a five-point Likert scale as shown in Tab. 4.

The approach of rating 'actual levels' against ideal levels of IS capabilities for SCM has been approved as very useful for evaluating the fit of an SCM IS to a prevailing strategy in detail. Increased transparency of needed levels of IS capabilities' support to fit across end-to-end processes has been particularly useful valued, which can be identified using the model and were regarded by the participants for the following:

1. *Transparency of improvement potentials* – the strategic fit assessment can point out potentials where SCM capabilities can be better utilised or where constraints at specific points prevent the optimal utilisation of the whole supply chain (TOC analysis).

2. *Balanced IS investments based on increased transparency* – uncontrolled placed IT investments result in a lack of clarity as to whether prerequisites from predecessor processes are given, which are required for exhausting the given advantages. Because it is difficult for big companies to reach transparency throughout the supply chain to support the strategy on the right level, the model has been rated as a best practice for SCM IS alignment in the steel industry and for large-scale enterprises in general.

3. *Comparison of the capability approach and KPI measurements* – benchmarking using KPIs helps to improve the business processes continuously, but it will not help to align the business and IS systems to future requirements. The capability approach, therefore, is more oriented toward the future, for showing structural problems in the business model, and where they can arise in cases of strategy refinements.

4. *Secondary levels of support of fit through spill-over effects* – the ability to highlight the essential relationships across SCM domains by assessing IS capabilities' levels of indirect support for business processes of other SCM domains has been rated as particularly useful. This feature helps to increase the transparency of where a business performance from given IS investment is exhausted in the supply chain. Hence, the present study's model helps to assess second-order effects in supply chains caused by spillover effects, which help for TOC analysis across domains and on IS architecture level.

5. *Contribution to organisational learning* – The development of a common understanding of the actual situation of fit across all domains and a shared awareness about overall business objectives and the effects of one's own efforts to achieve these is seen as very valuable among the stakeholders involved. Hence, the model has been rated as very valuable and is seen as a best practice for strategic fit assessment of SCM IS.

4.3 Assessment of the Capability Concept and Strategy Type Schema

The field experts rate the capability concept and the capability content used by the different levels as very reasonable and coherent for investigating their impact on strategic fit (1) at the strategic level; (2) at the level of higher-order SC capabilities; and (3) at the specific level of IS capabilities. Because of the growing volatility of business conditions in the steel industry, the experts see the high-order capabilities *SC agility* and *SC responsiveness* as a moderator between business strategy and IS capabilities as particularly important. Furthermore, they agree on the importance of capabilities such as *coordination*, *activity integration*, and *resource collaboration* as drivers for SC integration. The domain shape has been assessed as very useful for investigating SCM IS impact from an SCM cross-domain perspective. The structure of the model has been rated as flexible and generic

Tab. 4: Validation result of the strategic fit measurement model assessment

Criteria	Fit	Quotation or paraphrased quotation (extraction) to validation criteria
To the sample company	Fits very well	The model has been rated as very valuable for identifying levels of a fit/misfit on an aggregation level for informing senior management and on an individual level for creating plans of action. It has been rated as very useful for balancing capabilities of end-to-end processes across supply networks to avoid ineffective IS investment and to increase the speed to fit by focused alignment efforts. It enables to develop reference capability patterns for different product segments and for different business situations to increase agility.
Eligibility to assess the strategic fit	Fits very well	The model fulfils requirements to assess the fit of steel companies' SCM IS very good, particularly at different levels, in levering processes of different domains. Different priorities can be considered for processes, capabilities, and domains.
The fit of the assessment procedure	Fits	The two-step approach has been rated as valuable for identifying areas of strategic relevance in a first step, and for defining the required level of detail to assess the fit of SCM IS. Also, to assess fit in a second step. The procedure seems very useful for scoping activities, and for supporting EAM cycles and due diligence activities.
Profile deviation approach	Fits	The profile deviation approach has been rated as valuable for benchmarking actual levels against ideal levels. Also, it has been rated as valuable for rating 'actual levels' of fit against target levels of transition stages/architectures.
Capability versus KPI approach	Fits	In comparison to KPI measurements, the capability approach has been rated as highly valuable and more appropriate to evaluate the fit of levels that reflect future business strategies. KPI measures can remain the same after a change in processes, but the capabilities can be different for reaching the KPIs after a strategic change.
Organisational learning	Fits	The model's application can develop a collective view of the participants needed levels to support fit and the overall objectives for improving the awareness of members' contributions to performance. So can create, therefore an aligned flux of action.
SCM domain structure	Fits	The ability to assess indirect effects of IS capabilities help to increase transparency on where in the supply chain given IS investments are exhausted. Priorities and relationships between capabilities and processes of different domains can be well identified and assessed.
Performance drivers	Fits	The model helps to identify critical drivers of SC performance. The assessment can deliver valuable information on IS capabilities' contribution to SC performance key driver.
Usability of the model	Fits	The usability of the model has been rated as easy to use. However, a common understanding of the SCM capabilities' meaning is needed.
The generality of the model	Fits	The model's construct has been rated as highly adaptable to firms in other industries as a high degree of generality has been established. However, the IS capability content needs to be adjusted to the prevailing industry needs.
Key points need to be considered	Fits	The interpretation of the capability levels (low, medium, and high) depends on the organisation's individual strategic needs. For assessing the fit of cross-organisational end-to-end processes, it is suggested to rely on levels such as process throughput.
Missing aspects	Fits	The model focuses on the measurement of fit and misfit, and, therefore, on scoping of alignment requirements. There is no aspect missing.

for companies in other industries to adopt it for measuring SCM IS's fit the strategy. Hence, it has been thought as reasonable by the involved experts to establish and maintain a repository for sector-specific measurement templates. The model has been rated as valuable for informing senior management as it provides a quick overview of the right balance between strategy and a company's SC model, and critical gaps. There is a shared view among

the participants that, in comparison to KPI measurements, the capability approach helps to identify structural strengths and gaps in firms' SCM models and provides information about how to address these gaps. Hence, the strategic-fit measurement model has been rated as very valuable to provide transparency of firms' capability patterns.

Strategy types and capability pattern of steel companies: From their professional experience in the steel industry, the experts at SAP faced a mix of different strategic characteristics and requirements with a focus on the defender strategy type according to the Miles and Snow archetypes. However, at the same companies, there are also, in most cases, products and areas of high innovation. They conclude that steel companies show, by their product segments, a trend in two types of strategic orientation:

1. *'high-end products'* such as those for automotive customers, which relates to the Miles and Snow strategy archetype Innovator; and
2. *'low-end products'* such as those for the construction industry, which relates to the Miles and Snow strategy archetype Defender.

The strategy categorisation approach is rated as very useful for identifying areas with a significant deviation from the leading business strategies. Reference capability patterns can help companies to transform strategic changes to business and IS infrastructure more quickly, and, provide enhanced transparency of the capability levels needed for target architectures. Such artefacts can also support activities for harmonising, adopting and scaling of steel companies' SCM models as part of M&A projects. These findings provide evidence of the contribution to the development of DC and absorptive capacity provided by maintaining capability patterns.

Comparing predefined levels to fit of previous research against levels from the case studies: McLaren et al. (2011) identified five generic SCM capabilities (*operational efficiency*, *operational flexibility*, *planning*, *internal analysis*, and *external analysis*) with ideal levels (McLaren et al., 2011, p. 918) of support of fit in reference to Miles and Snow strategy

archetypes. They compared actual levels identified by strategic fit assessments against these predefined levels. By comparison, the present study identified the actual levels and the ideal levels for each capability separately. For assessing the classification scheme of McLaren et al., ideal levels predefined to generic SC capabilities were compared with ideal levels of present assessed SC capabilities that refer to the former in a highest possible accurate way as presented in Fig. 8. As the strategy type identified by the questionnaire survey shows a hybrid with a stable Defender position and significant Prospector strengths, the ideal levels of both strategy archetypes are shown as reference levels for the five generic SC capabilities.

Context dominates levels of fit by IS capabilities for SCM: The review shows high deviation between ideal-levels of the five generic capabilities identified by previous research and the ideal levels of the present study's capabilities; for example, medium levels of *'operational efficiency'* of the present study A being compared to high levels from previous research for both the Defender and the Prospector strategy characteristics. The result of this comparison affirms the assumption of the present study that ideal levels identified by previous research are not suitable as reference levels for determining the fit of the steel company in the accuracy required to express needed context-specific levels to fit. The review of the classification scheme using data from case study B strengthens this finding with more evidence.

The average ideal levels identified for all SC domains in case study B show a high correlation with the ideal levels identified by McLaren et al.'s previous research. However, there are high variations in ideal levels for the same SC capabilities of different SC domains that lead to a core finding as follows.

Core finding to SCM IS fit measurement a businesses' strategy types: For aligning a firm's SC operating model onto the business strategy, ideal levels of SC capabilities' support to strategic fit need to be identified according to the company's individual needs rather than to use predefined ideal levels of reference strategy

Fig. 8: Comparing ideal levels of company A with predefined ideal level by McLaren et al. (2011)

types. Moreover, for identifying ideal levels of support for companies' SCM IS's fit, it is essential to investigate antecedent capabilities of SC integration such as *SC agility*, *SC responsiveness*, and *activity-integration* to consider appropriately business conditions steel companies are facing. Finally, ideal levels of support to fit by high-order SC capabilities from IS capability need to be investigated separately for each SCM domain to consider *first-order* effects and *second-order* effects across the supply chain appropriately.

4.4   Causes and Reasons for the IT Productivity Paradox

The declining contribution of IT to productivity growth: The steady growth of IT spending over the last three decades reflects the tenet of technology-enhanced productivity. However, the evidence suggested that IT's contribution to growth in productivity has been declining since 2001 (e.g. Zukis et al., 2008). The phenomenon of the gap between projected and realised performance is referred to as the *'IT productivity paradox'* by researchers such as Brynjolfsson (1993) and Pinsonneault and Rivard (1998). There are several explanations such as by Brynjolfsson (1993, pp. 67–75): (1) *miss-measurement*, (2) *redistribution*–there are profits, but they come at the expense of others, leaving little net gain, (3) *time lags*, and (4) *mismanagement*–there are no gains because of the unusual difficulties in managing IT or in-

formation. A primary objective of research into the phenomenon of the IS productivity paradox is to improve the balance of investments in IS and the exploited business value concerning the company's competitive advantage (Bashiri et al., 2010, p. 2). Hence, the causes and reasons for the IT productivity paradox have been explored for the steel industry, using the qualitative case study at SAP and the industrial case studies. The phenomenon has been explored from the perspective of more transparency in the contribution of IS investments in strategic fit.

Leading causes of the phenomenon in the sample industry: Based on the observation from customer projects in the global steel industry, the experts at SAP for SCM and business transformations stated that *'quick wins'* were made fast by SCM implementations in the early 80s and 90s but win behind these *'low hanging fruits'* are highly dependent on integration aspects of the SCM processes to the organisational environment. Finally, *'talent management'* has been identified as a core challenge for mastering the complexity of steel companies SC processes. The following top issues were identified:

1. *insufficient alignment of SC objectives* in multiple tier supply chain networks;

2. *insufficient SC modelling* use for dealing with supply chain complexity;

3. *insufficient SC integration and end-to-end visibility* caused by heterogeneous SCM IS;

4. *lack of project governance* as a reason for SCM implementations' misfit.

Alignment effectiveness by a focus on value management: One of the main reasons for insufficient alignment results are fragmented IS landscapes as a result of M&A and too small scopes of IS implementations. Different IS systems have not only an impact on increased TCO but, more important, they have different approaches to address the business needs and for reaching the objectives. This phenomenon can be addressed by increased IT budgets' proportion released for innovation at the same time, while IT complexity must be managed out and focus needs to be set on business value creation. The technology can address drivers and inhibitors of IT value by impacting innovation and complexity and inflexibility. For example, software as a service (SaaS) and Cloud solutions allow users to *'pay for usage'* and significantly reduce the capital wasted in supporting software and hardware. By managing in favour of innovation and against complexity, companies can once again drive value through IT spending. The following high-level priorities are suggested to drive IT value contribution to organisations:

1. *Prioritise IT value management* to create differentiated business value by focusing simultaneously on IT costs and – primarily – on sources of competitive advantage.

2. *Management out of complexity* allows the reallocation of funds and higher levels of IT productivity for innovation by identifying cases of a misfit on all IS levels.

3. *'Management in' of innovation* – the use of IT for creating innovation most effectively may be the best to generate sustainable value from IT spending. Emerging digitalisation technology provides new sources of IS innovation, and Enterprise Architecture Management (EAM) provides a methodology for adopting the value in time (Ross, 2006).

4.5 The Impact of Business Model Types onto SC Dynamics

Market-oriented versus sales-driven businesses have been identified as main differentiators regarding who is driving the SC processes and how the SC dynamics is characterised. According to the interviewees, sales-driven businesses are able to adapt their SC model fast to new requirements from the market. In such businesses, sales can determine the portfolio and the forecast, whereas the production units have to follow and fulfil. Marketing-oriented business – where the steel companies belong to – need a taller horizon to plan and achieve their business as they often cannot adapt their SC models in the short-term. Hence, they need sophisticated planning capabilities to be able to make the best of each business situation that will come with the available resources by considering contradicting objectives of the stakeholders. These are such as high plant utilisation that is wished by plant managers but also prioritised order fulfilment for strategic customers that is wished by sales managers, and the senior management focuses on the overall profitability. Due to these findings, the present study draws on the view combining Miles and Snow archetypes with the *marketing-oriented* and *sales-driven* view for categorising companies and their segments regarding their needs in SC dynamics and SC modelling. The x-axis in Fig. 9 shows increasing SC dynamics based on adoption activities such as scaling out business models, while the y-axis shows increasing SC complexity from innovations and differentiation.

Balancing market-grow and market-share using product portfolio analysis: The Portfolio Analysis provides practitioners with a well-recognised concept for balancing fit of a company's portfolio regarding the dimensions market growth and market share. It provides information such as the proportion of products with a high market share but a low growth rate those come to the end of their life-cycle and need to be replaced by innovations. This approach shows which products are at the end of their life-cycle and needs to be
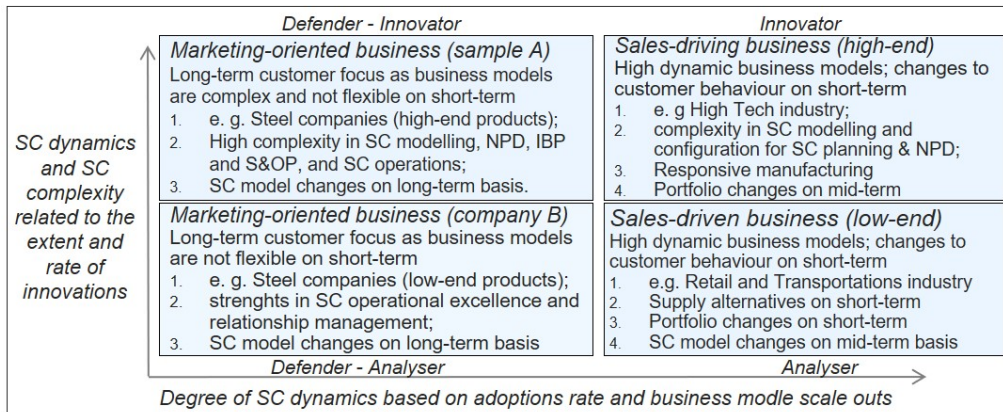
Fig. 9: Market-oriented vs. sales-driven business and the impact on SC dynamics (an author's view)

replaced by innovations. Hence, the portfolio analysis provides a valuable tool for identifying areas of innovations and for deriving focused development of DC for SCM that promises significant value potentials.

Ambidexterity–dynamic-capability for balancing exploration and exploitation: Ambidexterity refers to managing the inherent conflicts from explorative variability creation and exploitative variability reduction process on multi-levels of organisations (Bledow et al., 2009). Hence, it refers to a company's ability to balance exploration activities and exploitation activities in a way to optimally acquire and assimilate new knowledge that can be exploited in innovations and will result ultimately in business performance. *Ambidexterity* refers in this context to the balance between absorptive capacity acquisition and business performance exploitation, whereas balance needs to consider structural, contextual, domain and organisational dimensions. In this regard, an organisation's Portfolio Management (PM) and Innovation Management such as New Product Management (NPD) and Research and Development (R&D) need to collaborate in a closed way to sustain revenue and with balanced innovation for a consistent value stream. A company's core strengths and capabilities determine the portfolio with a focus on high-end products in case of *Innovator* business model characteristics and focus on low-end products for the *Defender* strategy type. According to the case study findings, the extent

of *Marketing-based* versus *sales-driven* business has a significant impact on the short-term and mid-term agility for changing resource capacity and capabilities.

SC differentiation using customer and product segmentation: The modelling of capability-patterns as yielded from the strategic fit analysis have been estimated as very useful for expressing needed levels for SC differentiation that can be used for IS configuration per companies' product segments. Based on this finding, a company's customer/product segments can be enhanced by the capability approach by dimensions and characteristics useful for describing SC strategy and SC differentiation. By this approach, the model combines information that needs to be interpreted together for reaching coherence between portfolio strategy, marketing strategy and supply chain strategy and differentiating criteria. The SC strategy can be presented for each product segment by capability-pattern describing the requirements and characteristics of architectural artefacts needed for SC differentiation.

The impact of SC dynamics on SC complexity and SC performance: According to the SCM experts' experience, the complexity implied in SCM IS has been often the primary concern of companies against the implementation of these solutions. When systems settings were made in one place in the SCM IS to align processes, side-effects on other places within SCM processes are often not predictable. The complexity of supply
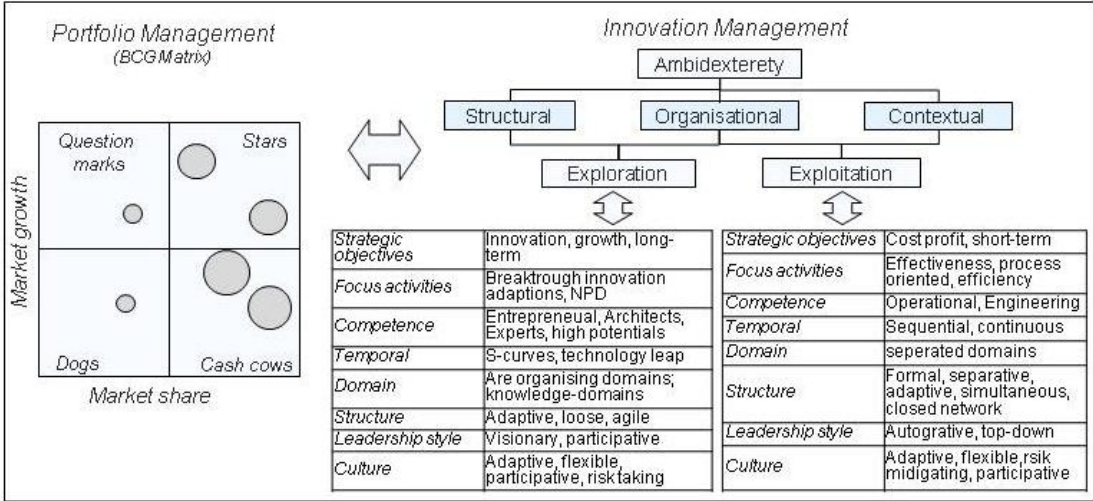
Fig. 10: Ambidexterity: balancing exploration and exploitation (an author's view)

chains and SCM IS implementations often cannot be handled. Moreover, SCM processes are often highly automated and balanced against the known business situation but failed in cases when things change. Therefore, configurations of SCM IS are often not robust against a massive change in business conditions. Another aspect the experts observed is that physical resources of steel companies' supply chains are often not balanced against the actual business requirements. When a bottleneck resource needs to be utilised to their available capacity to fulfil customers demand, often SCM IS systems could not help to get feasible and consistent planning results. For that reason, the experts estimated SC design and SC modelling as the most significant practices for dealing with the SC dynamic and SC complexity that steel companies are facing. Mainly, balance long-term business objectives against short-term order fulfilment in a way to maximise sales-profit and utilise resources effectively but to avoid extensive stock-inventory presents a key challenge. Fig. 12 shows the main processes that need to be mastered in a steel company's supply chain to reach business objectives. The targets are partly conflicting, but highly related to each other, so that interdependencies are complex to predict in the case of changing business conditions.

Key trends that contribute to increasing SC complexity: The individual characteristics of steel companies' products and the production capabilities have a direct impact on SC complexity. As a result, there is a high interdependency between planning processes and sales of products and the manufacturing of the individual product. Hence, the following key trends have been identified that contribute to increasing SC complexity at steel companies:

1. outsourcing of manufacturing and globalisation of operations;
2. demanding customers and shorter lead times and special delivery requirements;
3. more use of managed inventory programs– vendor managed inventory (VMI);
4. increase in numbers of customised products.

These industry trends have a direct impact on SC design and on the question of how to optimally plan elements such as sales items, facilities and locations, customers and suppliers. In dealing with the wide variety of resulting requirements, planning in varying granularity is practised. These covers high-levels of aggregation at the long-term planning level and high levels of detail on the planning and fulfilment level of individual pieces and orders that need to be synchronised in a detailed and continuous manner. According to the case study findings, in today's typical SCM set-up, the processes are

mostly covered by different IS applications that are connected by interfaces. As a consequence, the existing setup of IS applications does cover the company's business from a local point of view. However, the sum of all the local best results is mostly not the best overall possible, as existing information in neighbouring areas cannot leverage based on missing transparency throughout the supply chain processes. The experts see the transformation of such IT brownfield landscapes into new SCM IS as the most critical challenges of steel companies for optimising their overall business objectives. For that reason, SCM IS has to provide modelling capabilities to design integrated feasible plans meeting profitability and other criteria according to corporate objectives. Hence, SC modelling and visualisation capabilities are essential for mastering these objectives in a dynamic environment.

Vital capabilities for mastering SC dynamics: Comprehensive IS capabilities have been identified in the SAP case study and integrated into the measurement model that has been applied to the industrial case studies. For orchestrating the IS capabilities of steel companies' SCM processes so as to moderate SC performance and antecedent SCM capabilities regarding SC dynamics, the following key capabilities have been identified by the present study:

1. SC planning and optimisation capabilities;
2. SC simulation and visualisation capabilities; and
3. SC design and SC modelling capabilities.

Reducing SC complexity: Constraints and sensitivity to business conditions in SC planning and execution scenarios make SCM in steel companies a highly sophisticated task. For this reason, simulation capabilities have been estimated to be a high priority for dealing with SCM complexity. Moreover, participants have rated simulation capabilities as very useful for managing SC dynamics by preparing plans for different situations in advance. SC modelling and SC simulation capabilities have been identified for managing both low-end products and high-end simultaneously and dynamically. Hence, the experts see the approach of creating capability patterns as architectural artefacts

as very useful to drive fast re-modelling of supply chains, responsive to changing business conditions. Fig. 11 illustrates how capability patterns can support SCM processes that need to be balanced to reach business objectives. Moreover, predefined capability patterns can contribute to more transparency o SC processes and can help to develop alternative SCM scenarios to respond faster to changes.

The impact of SC moderating capabilities on SC performance: The findings of the present study on moderating SCM capabilities are in line with the process industry's SC problems identified by Shaw et al. (2005) such as in SC network design, SC simulation, and SC planning (Liu, 2011, p. 21; Shaw et al., 2005). Moreover, Papageorgiou (2009) divided the process industry's key capabilities into SCM in SC design, SC planning and scheduling, and supply control (Liu, 2011, p. 21; Papageogriou, 2009). The impact of changes which influence factors such as environmental ones needs to be moderated by *'SC performance'* antecedent capabilities that are orchestrated by *'IS capabilities for SCM'*.

4.6 Dynamic Capability Management using the Study's Concept

DC from architectural artefacts from for moderating fit of SCM IS: The model has been estimated as very useful to determine new levels required for SC capabilities and IS capabilities when the company's business strategy needs to be adjusted to new market conditions. This finding shows the value of the concept for pre-developing capability pattern as architectural artefacts the act as absorptive capacity and can be exploited in business performance by an IS Governance cycle by moderating fast alignment of SCM IS capabilities to changing environmental conditions. Business Model stress tests according to Haaker et al. (2017) can provide a systematic analysis of BM components' robustness in different future situations and environments and enables to identify sources of dynamic capabilities for SCM IS. Business Model Canvas methods and SWAT and PESTE
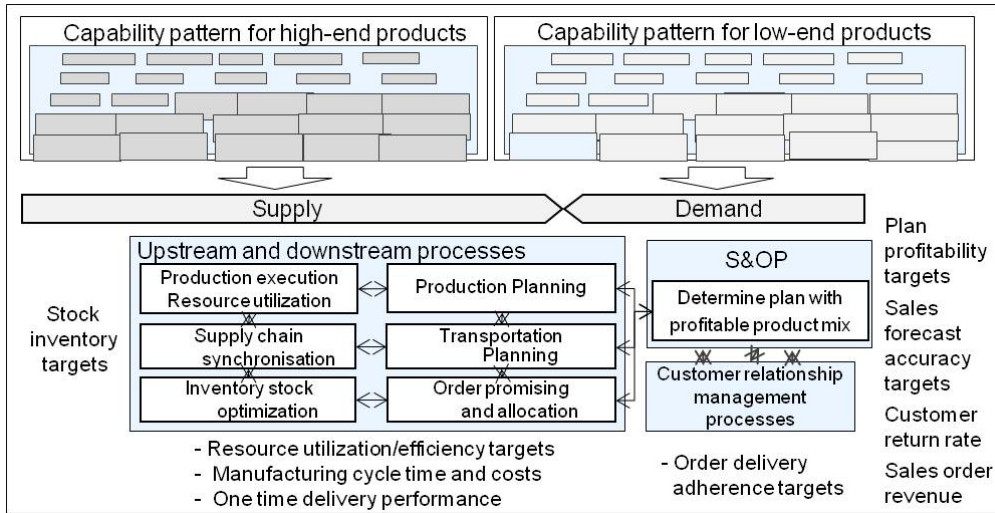
Fig. 11: Supporting SC dynamics using capability-patterns (an author's view)

analysis can help to identify and predict further states with a high probability of occurrence and significant impact on BM components and IS capability for SCM. Digital Twins and simulation and optimisation methods of SCM IS helps to redefine the actual required technical and organisational configurations figured out by the artefacts. Before developing the artefacts, the Return on Investment (ROI) can be calculated using the discounted cash flow (DCF) method to balance the expected business value against the Total Cost of Ownership (TCO) that reflect all initial and ongoing cost related to an IS investment (Kirwin and Mieritz, 2003). Fig. 13 shows how the model can be applied in an Enterprise Architecture Management (EAM) cycle. The right side of the cycle shows the artefact development that refers to DC exploration and the left side highlights the IS implementation that refers to exploiting business performance from the materialised DC/absorptive capacity. In referring to Raisch et al. (2009), the model enables exploration and exploitation of DC in an ambidexterity way for the dimensions *domain*, *organisational*, *context* and the *timely* and *situational*, where the degree of integration between relates to the extent of the dynamics the organisational units face.

Due to the proven procedure, the strategic alignment model needs to be calibrated.

Therefore, a two-stage review is to recommend using the first step to identify areas that need further in-depth analysis in a second step. The areas of misfit and their types of misfit such as functionality, data, role, control, usability and organisational needs to be identified, analysed and documented as input for developing artefacts. Moreover, for addressing the needed actions to close the technical and organisational gaps in SC interoperability required to support SC integration at the level required for strategic fit. In referring to Strong and Volkoff (2010, pp. 747–749), misfit can be addressed by *coverage*, which relates to functionality and features provided by SCM IS, and it can be addressed by *'enablement'* through context-specific SCM IS modelling and configuration of the application and data. This differentiation is seen as very important as the ability to deal with the complexity in SCM in a simplified way relates to a significant extent on SC modelling and secondly on technical features of purchased IS solutions.

Organisational learning mechanisms: All learning stages that are crucial for enhancing organisations' competitiveness such as structural, cultural, psychological and policy mechanisms (Knoppen et al., 2015, pp. 544–550) are seen supported by the present IS Governance approach. Moreover, the evidence for organisa-
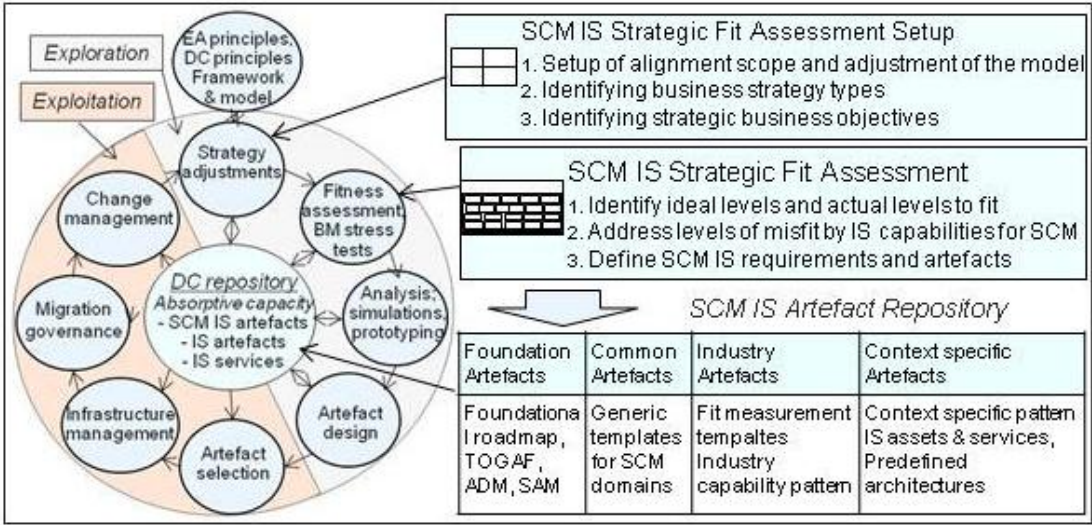
Fig. 12: The SCM IS dynamic alignment methodology (an author's view, encasing TOGAF)

tional learning is seen by sensemaking effects according to Weick et al. (2005) at applying the model, such as arriving at a common understanding of SCM IS capabilities effects and their use for directed actions with clear, prioritised objectives. The approach supports deutero learning by providing the participants with the big picture of where their efforts have an impact on business objectives and by their continuous reflection of developed artefacts and routines, which develops and align their cognitive profiles as well.

4.7 Dynamic Capabilities of Digital Business Models

Trusted collaboration in SC ecosystems by a Blockchain approach: A blockchain, as a shared, ledger technology, improves business network efficiency by the increased visibility of business transactions to all members of an ecosystem. The key benefits are significantly reduced settlement time and overhead costs and reduced risks of collusion and tampering because of full transparency to all actors. Hence, the system inherent fraud prevention and reduced integration complexity that results in increasing efficiency. The Internet of Things (IoT) and the Blockchain technologies offer new ways to

do business even in complex supply chains (Armstrong, 2016). Internet-capable sensors capture granular real-time data about products and logistic events with timestamps at different locations throughout the supply chain. Hence, the blockchain technology can support trusted collaboration in digital SC ecosystems by capabilities such as real-time transfer of control data and 'digital assets' and Smart Contracts for system-enforced inter-company business-rules for the process autonomy. Neutral collaboration platforms for shared business data and business logic enable new business models with trusted scenarios for multiple parties, which led to the following benefits:

1. cost reduction and risk minimisation of automation scenarios;
2. secure and reliable tracking of SC events and fraud reduction by increased transparency;
3. increased real-time SC visibility within ecosystems and consistent progress information;
4. real-time ad-hoc processing of exceptions using machine-learning capabilities.

4.7.1 Platform and Data-Driven Business Models

Platform-driven business model–outside in innovations: Digital business models are characterised by innovations in the value chains

and their transformation to the cross-industry digital ecosystem. Platforms are used for connecting intelligent products and driving processes personalised to user/customer through data-driven and dynamically configured smart services. Moreover, service platforms enable modular orchestration of value chains through the dynamic configuration of digital and physical services. Big data technology allows data collection across various technical and physical domains (e.g. Energy sector, traffic, and whether to name a few) and from different social and business contexts (e.g. consumer behaviour and perceptions, demographics). Such cross-context data seems useful for analysing demand patterns and analogies across markets and provides enhanced capabilities for searching network effects and scaling effects in the markets. Moreover, new sources of value are searched from collaborative business models enabled by Platform technology as they support the orchestration of entire ecosystems of interconnected customers, producers, service providers and suppliers. Initiatives such as industry 4.0 enable companies to create ecosystems with enhanced collaboration capabilities allowing new business strategies as ecosystem partners can commonly share services and can complement resources and processes in a highly integrated and autonomous way.

Rules and value enablers of platform-driven business models: Among the most important rules for designing and optimising platform business models belong (1) *network effects*, (2) *distribution power law* and (3) *asymmetric competition* for providing different ways to grow (Daugherty et al., 2016). Digital business models that are developed based on these rules can scale exponentially, and, can complement existing traditional business models. *A distribution power law* relates to scalable platform business that allows others to generate profits in a way avoiding diminishing returns that would be related to traditional value chains (Daugherty et al., 2016).

Network effects and macroeconomic impact of platform business models: Network effects come from products that are attractive to users and from *interoperability capabilities* rather

than from scale effects of the organisations' quantitative size. While the economy of scale in SCM typically are realised on the supply side, network effects arise primarily on the demand side. The concept of *network effects* has been popularised by Metcalfe (a co-inventor of the Ethernet). Metcalfe's law state that *"the cost of an IT network was directly proportional to the number of network cards installed, but the value of the network was proportional to the square of the number of users (cost of N results in a value of N^2)."* The actual numbers of this proposition are not affirmed so far, but, the stated positive and negative effects of the concept are indisputable. IoT Platforms provide the infrastructure to create intellectual property and to offer the right to use it to other users by earning income from it. Finally, platforms provide the infrastructure to transfer digital goods to others and to enforce property rights. Demand-side economies-of-scale focuses on network effects of two-sided markets, where value creation is enabled by platform ecosystems incorporating stakeholders such as customers, partners, producers, retailers, transportations, service providers and others. (Daugherty et al., 2016). Tab. 1 contrasts significant differences in traditional business models and platform-based business models.

Asset-light business models: A core trend of the digital transformations is a move from *asset-heavy* to *asset-light* business models, where intangible assets create value. The advantages of these are growth with reduced risks through shared investments with others. Companies without tangible assets seem at first sight as not solidly based, but, the market power seems to distribute opposing to this assumption, which can be observed by companies such as Amazon and Google. Market platforms are successful in *asset-light* business models. All types of *outsourcing* physical production to other companies such as by *sub-contracting*, where the intellectual property is protected or is not a source of differentiation can be seen as asset-light business models (Kachaner and Whybrew, 2014). Finally, *product-to-service-transformation* such as the transition from computer selling to offering services like IT

Tab. 5: Traditional vs digital business models (author's view enhanced from Daugherty et al., 2016)

Traditional industrial business models	Digital, platform-driven business models
Products, services	Products, services, platform services
Linear value chains	Non-linear ecosystems
The supply-side economy of scale	The demand-side economy of scale
Organic grow and merger & acquisition	Network effects & asymmetric driven growth
Physical assets	Digital assets
Asset-driven market value	Ecosystem driven market value
Power from controlling the supply chain	Power from optimising the ecosystem

consulting shows useful when the products get commodity.

Between 'asset-heavy' and 'asset-light' business models: Due to the present study's findings, there are seen two main areas of value from platform-driven innovations as follows:

1. *Asset-heavy business* can be supported by platform innovations in operational excellence by methods such as (1) operational sensing and (2) condition monitoring for process autonomy and (3) performance management. Preferred Artefactual Intelligence (AI) methods are Cyber-Physical Systems (CPS), machine learning capabilities, optimisation, simulations and business model stress tests using digital twins. Moreover, they can be complemented with *asset-light* business such as outsourcing, resource-collaboration, payment-per-use and marketplaces.

2. *Asset-light* business can focus, for instance, on network effects of the demand side and resource-sharing with partners for compensating short-term capacity overloads to minimise capital invested. Preferred AI methods for demand-side processes are *'user modelling and personalisation and service adaptation'* (UMPA) for autonomous service adoption to meet users needs at marketplaces.

Fig. 13 shows the levels and methods of platform business architecture. The platform provides the technical infrastructure for developing and operating intelligent business services with learning and self-adapting capabilities. The platform orchestrates sensing capabilities

for supply-side monitoring and condition management. Example companies with platform strategies for enhancing their existing business are Fiat (connected car), Caterpillar (connected machines), Schneider Electric (smart cities, buildings, and homes), and Philips (smart health). *Asset-light business models* are such as those of Google and Uber, while Apple and Amazon drive both, *asset-heavy business* by retail of physical products and asset-light business (iTunes, Amazon-Prime) by digital products via marketplaces.

New value propositions and profit models: New value can come from the product and service individualisation for customers' particular situation. Moreover, it can come from significant improvements in quality and cost-effectiveness preferably realised by simplified processes. New profit models can be based on flexible pricing models that can be usage-based, output-based, and value-based (profit sharing). Moreover, the monetisation of smart data can be a value driver and contributor to profit. Finally, the integration of services from partners and competitors into the own offering can play a significant role in exhausting network effects with highly economical way. Hence, Smart Services and Platforms form the basis of innovative digital business models. To summarise, the primary value drivers are (1) *Improved performance, functionality* and *reliability* of processes and products, (2) *BM innovations* and *new commercial models* (as-a-service, pay per use) and new sources of revenues and profits (performance guarantees, smart data), and (3) *faster innovation cycles.*

Smart Service, as core components of digital business models, are generating value for
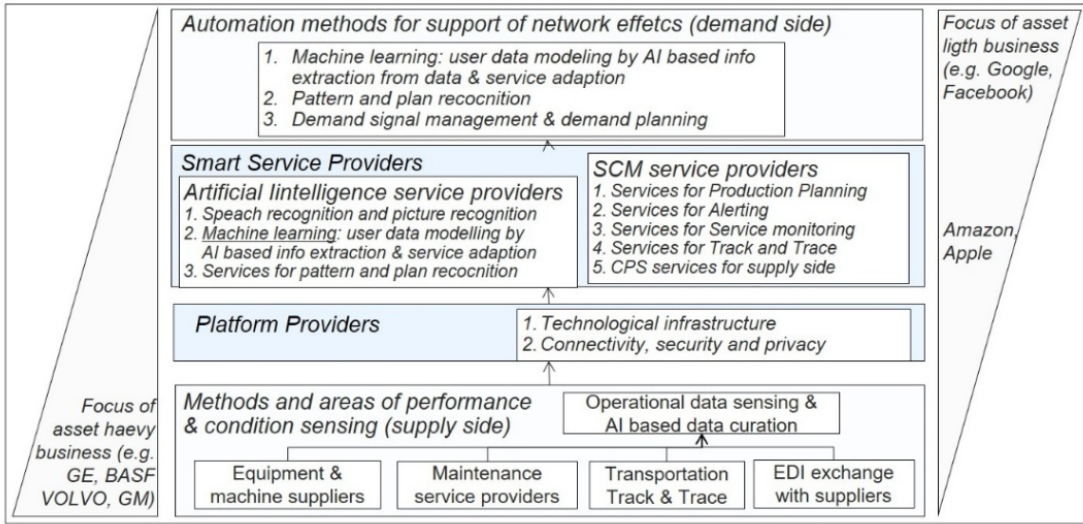
Fig. 13: Layers and opportunities of platform-driven business for asset-light and asset-heavy business models (an author's view), adapted from Kagermann et al. (2015)

businesses and customers and further ecosystem members. They are managed via platforms and can be provided by internal and external service providers for orchestrating and operating the modular processes of ecosystems. They interact with sensors, systems and actors, and are based on algorithms and be able to adapt to changing contexts over time. Cost of smart services is minimal as the marginal costs of digital value creation are nearly zero (Rifkin, 2015) and can be distributed across the ecosystem that uses the service. While economists and managers have focused so far on the reduction of marginal cost, the paradigm change from physical assets to digital assets can reduce these nearly zero. Finally, Smart Services shift the focus from product ownership to their value-oriented usage.

Potentials of Smart Services are the detection of deviations in business processes and deriving measures for responses. Moreover, they can orchestrate processes by predefined rules and can be combined flexibly with other services and adapt to environmental needs. Based on these capabilities, they can increase process effectiveness and efficiency, help to avoid waste, increase resource usage and solve unforeseen problems at an early stage. Smart Services potentials for external processes cover the au-

tonomous interaction with customers to gather and analyse data individually and on a large scale. In sum, the potentials can lead to increase innovative strength and increase turnover and profitability as well as increase customer loyalty and can provide a significant competitive differentiator. Fast innovation cycles for Smart Services can be accelerated by generic enables such as Open Source concepts and scalable platforms. Wahlster (2018) reported the following solutions based on Smart Services:

1. *Sensing:* Collaborative Robots, Virtual Agents, Autonomous System (Cars, Ships, Trains);

2. *Understanding:* Intelligent Smart Home, Answering Engines; Digital IT Assistants;

3. *Acting:* Intelligent Help Systems; Recommendation and Persuasion Systems, Intelligent Tutor and Training Systems (Wahlster, 2018).

AI methods such as the following are supporting these Smart applications:

1. *Sensing* is supported by methods such as signal symbol transformation, multi-sensor fusion, pattern recognition, emotion/user/context recognition;
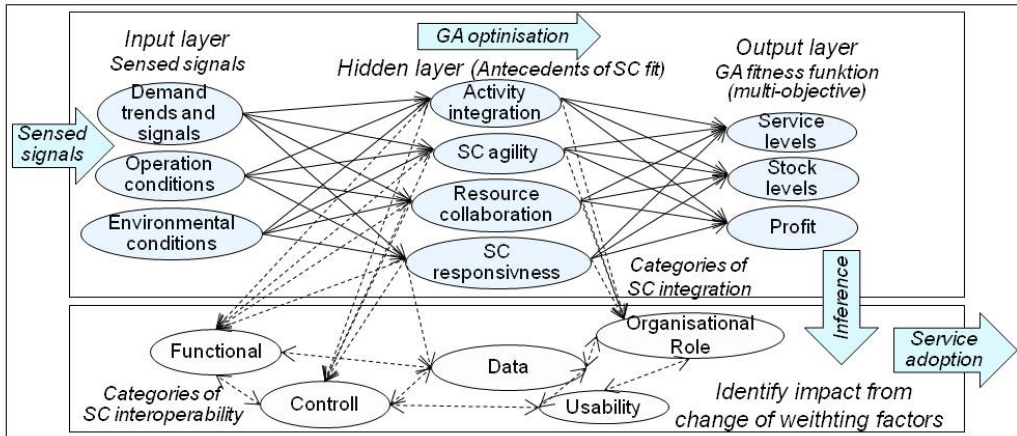
Fig. 14: Using the research theory for a GA-ANN based autonomous alignment (an author's view)

2. *Understanding* is support by methods such as text/video/dialogue understanding, information extraction, machine learning, action planning and plan recognition.

3. *Acting* is supported by methods such as sensor motoric feedback, adaptive user interaction, multi-agent collaboration techniques, personalised presentation (Wahlster, 2018).

Demand-side Artificial Intelligence (AI) methods enable to generate and adapt user data models and services of web-based applications at their usage by identifying the users' needs, interests and preferences. By this approach, user models present properties of individual users and their cognitive and behavioural characteristics established by variables and their declaration, which can be used to personalise products and services to these users. Because user modelling covers many aspects of the human nature those vary in different contexts, interoperability of application-independent models that merges psychology and artificial intelligence and ontology modelling standards are significant. Wahlster (2018) reported the following AI techniques used in practice for self-learning smart services:

1. *Interactive configuration* using constraint processing to get desired features.

2. *Recommendation techniques* for configurations such as knowledge-based and demographically based recommendations; recommendations based on previous choices

and ratings; collaborative filtering across domains.

3. *Personalised service-interaction* to customers' concerns using knowledge about their interests that influence their choice.

4.7.2 The Study's Contribution to Digital Business Models

Absorptive capacity allocation and effects in SC ecosystems: The study's approach makes visible where relationship capital that has been invested in certain places of the supply chain shows a positive effect on business performance. The author of the study sees this effect as particularly useful for digital business models as these focus on network effects as sources for new business value that arise from collaboration across SC ecosystems partners and interoperability capabilities. For this purpose, the approach supports transparency of SC interoperability on different levels as a core enabler of network effects and the efforts and effects across the value chain. Moreover, the focus on cross-organisational value development of digital businesses through utilising AI methods and Smart technology drives increasing dynamism of SC business models, which underpins the value of the present study's methodology.

Dynamic alignment using GA and adopting the concept's ontology to an ANN: The ontology of the presents study's concept can be translated into a machine-readable semantic such as the Web Ontology Language (OWL). OWL

and the vocabulary of the Resource Description Framework (RDF) are components of the Semantic Web, which is an initiative by the World Wide Web Consortium for standardisation of knowledge digitalisation as an extension of the www. Fig. 14 demonstrates how the concept can be adapted to an Artificial Neuronal Network (ANN) for optimisation using a Genetic Algorithm (GA), where Note-to-Note relationships of the ANN show the high-order SC capabilities. The idea is to identify the changes in the note weight factors necessary to compensate for the changes of the sensed conditions to reach the objectives of the fitness function again after environmental changes. The identified deltas can be used to determine ideal response by categories of misfit/interoperability (inference) for re-configuration. The concept can be used as a basis for autonomous alignment of SCM IS and for simulation purposes using Digital Twins. For that purpose, the physical supply chain needs to be monitored by sensors to collect data of the relevant conditions and transform these for the input vectors of the GA optimisation process.

5 CONCLUSION

A best practice for the strategic alignment of SCM IS–a holistic view by combined concepts: The study closed the gaps of missing best practice for assessing the strategic fit of SCM IS and missing methodology for orchestrating DC on multi-levels related to SCM IS. In referring to Minsberg's *P*'s for *plan* and *pattern*, the methodology has been developed for identifying and aligning patterns of a company's SCM IS capabilities in detail–that refers to the *resource-based view*–to match context-specific needs of the *market-based view*. The combination of a *profile deviation approach* (that was used in 2011 by McLaren et al.) that based on the *configurational theory* with a *domain approach* (that is related to Henderson's and Venkatraman's 1996 *Strategic Alignment Model (SAM)* and used by Avison et al. (2004) for strategic fit analysis), the methodology enables to manage strategic alignment with regard to the dimensions domain, organisational and contextual. According to the contingency theory, there is no universally superior strategy or way to manage in a given environment (Venkatraman, 1989b). Instead, the context and structure must fit together if an organisation is to perform well (Van de Ven and Drazin, 1985). Because SC integration is not a question of *'high integration fits all'*, rather the degree of integration depends on several situational factors (Bagchi et al., 2005; Childerhouse and Towill, 2011; Godsell, 2008), a *hierarchical capability structure* (according to Grant, 1996a) has been integrated for assessing fitness at different levels of aggregation to identify context-specific characteristics of SC integration antecedents and their impact on SC performance. The study enables the analysis of antecedent capabilities of SC integration such as *'information exchange'*, *'coordination'*, *'activity integration'* and *'resource collaboration'* (Wu et al., 2006; Rai et al., 2006; Childerhouse and Towill, 2011) and their needs and contribution to strategic fit of SCM IS for individual business contexts.

Based on the integrated domain concept, the model enables to identify second-order effects of IS capabilities along the supply chain caused by spill-over effects (Tallon, 2012). This approach helps to identify unused potentials from IT investments that *Brynjolfsson* called the *IT Productivity Paradox* and to identify bottlenecks from IS capabilities across domains that refer to *Goldratt's Theory-of-Constraints (TOC)*. While TOC focus in practice on performance management of business process using balanced scorecards and KPI management, the present study' model enables TOC analysis at the architectural level before IS investments are allocated and shows cross-domain effects that are not visible before. By the use of the model in an IS governance cycle, a methodology has been provided for exploring, materialising and deposit DC as an *absorptive capacity* for fast exploitation into business performance. Based on the configurational theory for identifying ideal configurations and the SC domain struc-

ture, the concept is in line with the systems theory and enables strategic alignment of SCM IS to contingencies across organisations, context, domains and situations on multi-levels. Operational excellence, as a hot topic in SCM of manufacturing companies, will be provided by the effectiveness of the SCM IS architecture by the present approach, and secondly, be realised by operational efficiency controlled by SCPM using business metrics. Moreover, the model enables harmonisation and simplification of SCM IS architectures to prevent from implementing too much complexity. Finally, the approach has been assessed as particularly useful for supporting scale-out scenarios and due diligence assessments of M&A activities by enabling to identify the potentials and synergies of the companies' SC models as a more reliable basis as the approach using only financial key figures.

DC enabled by IS Governance: Development of absorptive capacity refers to a firm's ability to acquire, assimilate, and deposit external knowledge and commercialise it by exploiting it for organisational performance (Liu et al., 2013, p. 1454; Brettel et al., 2011, pp. 164–174). According to Liu et al. (2013, p. 1460), developing *absorptive capacity* and DC related to SCM has an indirect positive effect on *'SC agility'* as a driver of *'SC performance'*. In referring to Blome et al. (2013) and Liu et al. (2003), developing absorptive capacity related to antecedent capabilities of *'SC integration'* contributes to DC of *'SC agility'* and *'SC responsiveness'*, and, hence contributes to *'SC performance'*. The present approach enables organisations to predefine patterns of capabilities as architectural artefacts, which express industry-specific and context-specific configurations to fit business strategies. These artefacts will lead to increased SC agility and SC performance through faster IS adoption in fast-changing business environments. Hence, the study contributes to the DC renewal process, and SCM IS alignment by providing a framework, methods and routines for managing DC through sensing, assessing, managerial-decision-making, artefact development, selection and implementation for aligning business models to the prevailing strategy. Finally, the

methodology supports to manage the balance and dynamics of DC exploration and exploiting (Brettel et al., 2011), which O'Reilly and Tushman (2007) refer to ambidexterity.

Evolutionary vs behavioural economic or best practice vs innovation: For making the most from DC both evolutionary and behavioural economics aspects are essential and considered by the present concept. For Teece (1982, 2018), best practice are not necessarily DC as he focuses on Schumpeterian's innovation (1934) combined with higher-order routines (Arndt and Pierce, 2018, p. 414) such as asset orchestration activities, which involve *"new combinations"* that are not merely adaptive. Such re-combinations can be new technologies as well (Arndt and Pierce, 2018, p. 413). However, Eisenhardt and Martin (2000) suggest the use of best practices and simple rules such as decision-making heuristics as DC as they see companies in the same industry with a reasonable amount of competitive homogeneity expressed through significant commonalities across capabilities (Arndt and Pierce, 2018, p. 414). In referring to Arndt and Pierce (2018, p. 413), the present concept's mechanisms, routines and repositories for developing and exploiting DC is seen founded in evolutionary economics. The methods identified for developing Smart business models allow a significant degree of freedom for creativity to consider the Schumpeterian view of innovation for developing DC. However, aspects of the behavioural theory play also an essential role in the concept such as dealing with heterogeneity, individual expectations and goal formation.

Sensemaking and organisational learning: In considering *design-science* aspects according to Hevner et al. (2004) and *sensemaking aspects* such as *'framing'* according to Klein et al. (2006a, p. 71), a coherent research theory and methodological framework have been developed, which enabled to prove the model on framing data as meaningful for strategic fit. By this approach, content analysis, according to Mayring (2014) is implied in the model for deductive category formation by *fitting* meaningful data to predefined categories to triangulate qualitative and quantitative data

at applying the model. Hence, high levels of construct validity are provided by the approach (Yin, 2009). According to Weick et al. (2005), sensemaking in organisations is not a question of accuracy, but rather about plausibility and the development of a collective mindset for understanding the past and the present, and to develop a directed flux of action to master the future. Sensemaking properties according to Weick et al. (2005) were identified as supported to a high degree in applying the model by supporting a collective view of objectives and directed actions and increased shared awareness about the value of supply chain members' efforts spent on SCM processes on the overall business performance.

Contextual factors are dominating the levels of IS capabilities required to fit: The present study shows a high variability of levels needed to fit by (1) generic/high-order SC capabilities and (2) detailed IS capabilities for companies that show the same strategy type due to Miles and Snow. Hence, the present study proposes Miles and Snow strategy archetypes as a reference for high-end product and low-end product strategies, but it is highly recommended to identify ideal levels of support of fit using firm/context-specific assessments. Hybrid strategy types have been identified for both sample organisations. The study provides evidence that a higher level of detail in IS capabilities and their levels of support to fit is needed sooner then it was used in previous research for considering strategic orientations and the resulting requirements for SC differentiation appropriately. Moreover, SC domains' IS capabilities need to be assessed individually for their ideal levels rather than to use predefined ideal levels of reference strategy types because situational and context-specific support need to be prioritised in today's business dynamics for inferring appropriated levels of SC capabilities. Finally, ideal levels of support to fit by second-order effects across the supply chain need to be considered appropriately.

SC models' dynamics driven by complexity and adoption: We found out that the combination of strategy types according to Miles and Snow with the categories of marketing-oriented

business and sales-driven business helps to differentiate companies' SC models in regard of their dynamics and whether complexity or adoptions drive it. This finding helps to categorise SC models in their design requirements regarding the extent of complexity in SC differentiation and the required degree of dynamics for adoptions. Moreover, it provides the basis, in combination with the customer and product segmentation, for defining detailed SC strategies and expressing the related SC differentiation by capability pattern per segment. This approach provides significantly increased transparency in companies' product segments and their related SC strategy and differentiation and finally, of IS capabilities for managing the supply chains. Finally, it helps in benchmarking implemented configurations against ideal ones to firms' competitive strategy, and fast scaling out IS capabilities to new business models.

The contribution to digital business models: As shown by the study, the approach makes visible where and when relationship capital allocated as absorptive capacity shows a positive effect on business performance in the supply chain, which can significantly depend on the businesses' strategic orientation. The author sees this effect significant for digital business models as these focuses on new sources of value such from network effects across SC ecosystems. Essential sources of network effects are – among the right products – high levels of interoperability for scaling at minimal marginal cost (Rifkin, 2015). Hence, the present approach supports transparency of SC interoperability on different levels and efforts and value contributed from ecosystem members. The focus on cross-organisational and collaborative value development utilising AI methods and Smart technology drives dynamism of business models. For this reason, the concept shows high potentials for support autonomous strategic alignment of digital business models by adopting the ontology to machine-learning services, Cyber-Physical Systems (CPS) and Smart Services.

Criticism of previous research: Henderson's and Venkatraman's 1996 SAM provides a useful methical framework for assessing the rela-

tionships of strategic fit and functional integration between IT and business domains but lacks quantitative measurement and benchmarking capabilities, which have been integrated and combined by the present study. Five generic SC capabilities were used by McLaren et al. (2011) for predefining ideal levels of support to strategic fit in reference to Miles and Snow strategy archetypes. The present study shows the categorisation of *high-end products* that relate to the Innovator strategy type and *low-end products* that relate to the Defender strategy type – according to Miles and Snow – as useful for expressing ideal levels of support needed for the strategic fit of product segments in the steel industry. However, the present study provides clear evidence that for deriving reasonable actions from assessment results, a higher level of detail in IS capabilities' levels of support to fit is needed to consider strategic orientations and the resulting requirements for SC differentiation appropriately. Moreover, SC domains' IS capabilities need to be assessed individually and for each SC domain for their levels as situational and context-specific support need to be prioritised in today's business dynamics for providing the right levels of *responsiveness*, *agility* and *resource-collaboration*.

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7 ANNEX

Fig. 15: The Supply Chain Dynamic Capability Framework (an author's view)

Tab. 6: Dynamic capabilities for SCM IS and digital SC business models (an author's view)

Dynamic capability	Exploration methods	Deposit methods	Exploitation methods	Implication & effects	Antecedents	Antecedent to
Sensing	Data collection, information extraction	User modelling, Artefact development	Service & artefact adoption	Autonomous service adaption fast ROI	–	Inference, Service adoption, Sensemaking
Sense-making	consensus on objectives, levels of fit and gaps; fit measurements	Artefacts that as common view of context contingency	Utilise artefacts by adoptionalso, align configurations	Common view and sense of objectives & directions to reach these	Transparency info-sharing, Collective assimilation & Common view	Common objectives, ideal plans, transparency & agility
Optimi-sation	ANN, GA, LP Optimisation, Reference Plans	Reference Plans & configuration	Inference; Plan-recognition; configuration	Optimal plans for profit; fast alignment at volatility	Sensing, Synchronisation, Planning	Operational excellence, context contingency
Inference	premises, arguments, rules & policies; AI-based machine-learning	References; ideal plans; premises; Artefacts for rules, policies	Smart Services; SC visibility; autonomous systems, CPS	Plans, services with ideal levels; Autonomous plan recognition	Optimisation, reasoning, verification, validation	Plan recognition, conclusion drawing, Autonomous systems
Integration	Misfit identification by assessment of integration antecedents	Artefact & IS service development	Artefact selection, recognition and adoption	Context contingency of capabilities	Activity-integration collaboration, agility and more	Strategic fit, operational excellence
Alignment	Strategic fit measurementalso, consensus	EAM repository, Service Libraries	IS Governance, ontology, DC framework	Contingency fit of capabilities to the context	Ideal future state and present status are known	Strategic fit, operational excellence
Orchestra-tion	IS components, services, rules, modular configuration	Libraries of Services Artefacts, IS assets, contracts	Smart Services CPS, Service composition	Better RIO, fast and reliable realignment using proven components	Sensemaking Plan recognition; Consensus artefacts	Business modelling, Architecture alignment
Adoption	Sensing for the scale of economy, EA architecture Harmonisation	Templates of SC model, architectures, processes; IS services	Template roll-out and localisation (configuration alignment)	Generality scalability, Effective business scale-out	Sensemaking between host and local business units, Integration	Successful replication of business models
Reconfi-guration	Sensing, Recognition,artefacts, rules for generic services	Predefined configuration rules, policies artefacts	Artefact selection configuration adoptions	Better RIO from fast and more reliable reconfiguration	Identification and recognition of ideal plansalso, settings	Strategic fit, operational excellence
Inter-operability	Measurements & simulations to identify levels of fit & misfit and gaps	Service and Artefact repository, aligned SCM IS	Plan recognition, implementation of services and artefacts	Closed gaps of misfit, High-levels of fit & business performance	Levels of fit for Function, data control, role, organisational	Integration, strategic fit operational effectiveness
Synchro-nisation	Strategic Fit assessment; Alignment of demand and supply	Master plans and plans references, scheduling capabilities	Utilise plan- and schedule alternatives that fit the situation	Operational excellence, plan and delivery reliability	SC visibility Optimisation, SC modelling, Strategic Fit	SC agility responsiveness; Plan and execution reliability
Autonomy	CPS, Smart Services UMAP machine learning	Predefined rulesets and policies	Ad-hoc configuration	Responsiveness to unforeseen events	Sensing, self-learning configuration	Acting, self-learning service
Responsi-veness	Strategic fit assessment of capabilities & SC domains	Continuous development of artefacts	Continuous fit measures and artefact utilisation	High service levels and operational excellence	SC agility; SC visibility; Integration; Collaboration	Operational excellence by effectiveness service levels
SC agility	Strategic Fit assessment of capabilities & SC domains	Ideal plans; priorities & procedures to situations	Alignment of planning priorities and exception management	Flexibility to changes, but, remaining effectiveness	SC visibility, relationship management; Interoperability	Integration, Responsiveness
Collabo-ration	Strategic Fit assessments	Active relationship maintenance	Activate physical relationships	improved agility and end-to-end performance	Relationship capital	SC agility Integration Responsiveness
Simulation	Optimisation, SC modelling Stress tests	SC artefacts for different ideal plans	Artefact, Plan selection and implementation	Visibility on the impact of changes	Optimisation SC modelling SC visibility	Decision-making, SC agility Responsiveness
SC visibility	Strategic Fit assessment of capabilities & SC domains	IS artefacts; SC Data models, DB schemas	alignment, IT footprint simplification SC modelling	Improved prioritisation Transparency	SC modelling IT footprint simplification	Operational excellence, Integration SC agility
SC modelling	Architectural artefacts Blueprints	Artefacts, repository, services	Recognition, adoption, alignment	Improved visibility reduced complexity	Segmentation differentiation SC strategy	Integration SC visibility, effectiveness
Activity integration	Levels of extent identification by assessments	Artefacts and service definition for needed levels	Utilise artefacts by it IS services configuration	Smooth flow of information, material and value,	SC modelling information flow collaboration	SC agility Integration SC visibility

Appendix Tab. 6 shows DC for SCM, their antecedents and methods for exploring and materialising and deposit, and exploiting these in business performance.

Fig. 16: Examples of Strategic fit assessment sheets

Sales & Operation Planning

Core processors	IS capabilities	Detailed organisational & functional capability	Business predictability (Ideal)	(Actual)	Information exchange (Ideal)	(Actual)	Coordination (Ideal)	(Actual)	Activity integration (Ideal)	(Actual)	Operational efficiency (Ideal)	(Actual)	Supply chain agility (Ideal)	(Actual)	Supply chain responsiveness (Ideal)	(Actual)	Supply chain risk management (Ideal)	(Actual)	Internal analysis (Ideal)	(Actual)	External analysis (Ideal)	(Actual)	Aggressiveness (Ideal)	(Actual)	Defensiveness (Ideal)	(Actual)	Futurity (Ideal)	(Actual)	Proactiveness (Ideal)	(Actual)	Riskiness (Ideal)	(Actual)	Fit indicator	Average degree of ideal levels	Average degree of actual levels
	Demand planning capabilities	Capabilities for demand planning	2,00	2,00	3,00	3,00	1,00	1,00	1,00	1,00	3,00	3,00	1,00	1,00	1,00	1,00	2,00	1,00	2,00	1,00	2,00	1,00	3,00	3,00	3,00	3,00	0,00	0,00	3,00	2,00	3,00	3,00	2,00	2,00	1,73
		Capabilities for demand review	2,00	2,00	2,00	2,00	1,00	1,00	1,00	1,00	3,00	3,00	1,00	1,00	1,00	1,00	2,00	1,00	2,00	1,00	2,00	1,00	3,00	3,00	3,00	3,00	0,00	0,00	3,00	2,00	3,00	3,00	2,00	1,93	1,67
		Capabilities for modelling and simulating planning scenarios	2,00	2,00	2,00	2,00	1,00	1,00	1,00	1,00	3,00	3,00	1,00	1,00	1,00	1,00	2,00	1,00	2,00	1,00	2,00	1,00	3,00	3,00	3,00	3,00	0,00	0,00	3,00	2,00	3,00	3,00	2,00	1,93	1,67
Demand mgmt. capabilities		Capabilities for determine forecast based on profit optimization	2,00	2,00	2,00	2,00	1,00	1,00	1,00	1,00	3,00	4,00	1,00	1,00	1,00	1,00	2,00	1,00	2,00	1,00	1,00	1,00	3,00	2,00	3,00	3,00	0,00	0,00	3,00	2,00	3,00	3,00	2,24	1,87	1,67
	Demand alignment capabilities	Capabilities for aligning forecast with production planning	4,00	3,00	3,00	2,00	3,00	2,00	2,00	1,00	3,00	3,00	3,00	3,00	3,00	3,00	2,00	1,00	3,00	3,00	0,00	0,00	3,00	3,00	3,00	3,00	0,00	0,00	3,00	2,00	3,00	3,00	2,65	2,53	2,07
		Capabilities for aligning forecast with financial management	3,00	3,00	2,00	2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,00	1,00	2,00	2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,00	0,90	0,80
		Capabilities for aligning forecast with sales allocations	3,00	2,00	3,00	2,00	3,00	2,00	2,00	1,00	3,00	2,00	0,00	0,00	0,00	0,00	2,00	1,00	1,00	1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,45	1,70	1,10
Strategic fit indicator			2,57	2,29	2,43	2,14	1,43	1,14	1,14	0,86	2,57	2,43	1,75	1,75	1,75	1,75	2,00	1,00	2,00	1,43	1,00	0,57	2,14	2,00	2,14	2,14	0,00	0,00	2,14	1,43	2,14	2,14			
Average degree of strategic fit by the SCM capability			1,41		1,41		1,41		1,41		1,73		0,00		0,00		2,65		2,00		1,73		1,00		0,00		0,00		2,24		0,00				

Fig. 17: Part of the S&OP calculation sheet of case study B

Upstream & Downstream Management

| Core processes and IS capabilities | | | | | | | | Contribution of functional IS capabilities for SCM to high-order SCM capabilities | | | | | | | | Contribution of IS capabilities for SCM to strategic capabilities | | | | | | Calculated levels of fitness and levels of degree of strategic fit | |

Fig. 18: The upstream and downstream management calculation sheet of case study B

Relationship Management

Core processors	IS capabilities	Detailed organisational & functional capability	Information exchange Ideal	Information exchange Actual	Coordination Ideal	Coordination Actual	Activity integration Ideal	Activity integration Actual	Resource collaboration Ideal	Resource collaboration Actual	Supply chain agility Ideal	Supply chain agility Actual	Supply chain responsiveness Ideal	Supply chain responsiveness Actual	Supply chain risk management Ideal	Supply chain risk management Actual	Internal analysis Ideal	Internal analysis Actual	External analysis Ideal	External analysis Actual	Aggressiveness Ideal	Aggressiveness Actual	Defensiveness Ideal	Defensiveness Actual	Futurity Ideal	Futurity Actual	Proaktiveness Ideal	Proaktiveness Actual	Riskiness Ideal	Riskiness Actual	Fit indicator	Average degree of ideal levels	Average degree of actual levels
Customer relationship management	Capabilities for strategic CRM	Capabilities for customer stakeholder management	1,00	1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,07	0,07
		Capabilities for supporting relationship sustainability	1,00	1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,07	0,07
	Capabilities for operational CRM	Capabilities for lead and backlog management	3,00	2,00	3,00	2,00	3,00	2,00	0,00	0,00	3,00	3,00	3,00	3,00	3,00	3,00	1,00	1,00	0,00	0,00	4,00	3,00	3,00	3,00	0,00	0,00	4,00	3,00	3,00	3,00	2,24	2,36	2,00
		Capabilities for customer contact management	4,00	4,00	4,00	4,00	2,00	2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,00	3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,00	1,36	1,14
	Capabilities for sales analytics	Capabilities for sales analysis (e.g. Sales revenue analysis; opportunity analysis)	4,00	4,00	4,00	4,00	4,00	3,00	0,00	0,00	2,00	2,00	0,00	0,00	3,00	3,00	3,00	3,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	2,00	1,00	2,29	2,21
Strategic fit indicator			2,60	2,40	3,67	3,33	3,00	2,33	0,00	0,00	2,50	2,50	3,00	3,00	3,00	3,00	2,67	2,33	2,00	2,00	3,00	2,50	2,50	2,50	2,00	2,00	3,00	2,50	2,50	2,50			
Average degree of strategic fit by the SCM capability			1,00		1,00		1,41		0,00		0,00		0,00		0,00		1,00		0,00		1,00		0,00		0,00		1,00		0,00		0,00		

Fig. 19: The relationship management calculation sheet of industrial case study B

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MIND YOUR SPACE!
DESK SHARING WORKING ENVIRONMENTS
AND EMPLOYEE COMMITMENT
IN AUSTRIA

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ABSTRACT

This paper empirically examines the influence of desk sharing on the various forms of employee commitment. Previous literature has examined the influence of innovative workspace on employee satisfaction as well as the possible the benefits and disadvantages of desk sharing, but not the influence desk sharing may have on employee commitment. Our study examines the level of commitment in organisations that apply desk sharing compared to those with traditional office settings, finding that desk sharing does not necessarily have a negative influence on commitment. Indeed, desk sharing employees show higher level of affective commitment when applied moderately. However, a radical application of desk sharing leads to lower commitment; thus, when applying desk sharing it is important to consider the specific conditions, organizational needs as well as managerial example. The findings point to a number of implications relating to the application of desk sharing and other flexible office settings.

KEY WORDS

desk sharing, employee commitment, new ways of working, organizational change, flexible organisations

JEL CODES

M10, M12, M14

1   INTRODUCTION

Due to digitalization, the way of how we work in today's organisations is experiencing many changes. Organisations implement new ways of working that are characterized by flexibility of time and space, such as desk sharing (Anderson and Kelliher, 2009; Hirst, 2011). Literature suggests that flexible forms of working influence employee satisfaction (Anderson and Kelliher, 2009) and organizational identification (Millward et al., 2007), pointing

out that it might have negative implications to commitment (Hirst, 2011), however, this has not been addressed yet. This study addresses this gap and empirically examines the influence of desk sharing on employee commitment.

Globalization, technological changes and volatility of international markets are drivers for more complex environments in which today's organisations operate. Organisations are implementing innovative work environments in order to tackle this complexity by providing environments that stimulate creativity and innovativeness as well as satisfaction among employees (Covarrubias Venegas and Groblschegg, 2015b). The concept of *New Work or New Ways of Working* (NWoW) addresses how organisations can support their employees to unleash their full potential and thus increase performance to meet organisational objectives (de Kok, 2016). NWoW is a people centred approach, where freedom to determine how they work, where they work, when they work, what they work with and with whom they work is given, always within organisational limits (de Kok et al., 2013). Trust and freedom are two key aspects in NWoW. Three areas are described as central to NWoW, namely people, place and technology. The interplay of place and technology leads to working independently of time and place (Covarrubias Venegas and Groblschegg, 2015a). Desk sharing, also named hot desking, is defined by a situation where employees no longer have an assigned working space but share desks with colleagues. Desks are usually chosen on a "first come, first serve" principle (Daniels, 1994). In addition to mobile working, traditional office settings are being questioned too and new concepts such as activity-based working and non-territorial workspaces are employed (Brunia et al., 2016). Activity-based working describes an office setting where employees seek a desk/working station according to their needs, the task in question and the availability (Felstead et al., 2005). Arguments supporting these new office settings are often based on both cost savings and a higher degree of innovativeness and/or creativity of the employees (Felstead et al., 2005; Warren, 2006). Despite perceptions that

work is more collaborative and mobile, most workers around the world remain in traditional work environments, with an emphasis on hierarchy and desk-based work (Steelcase, 2016).

Flexible working environments are argued to have a positive impact on employee satisfaction (Anderson and Kelliher, 2009), particularly if employees have the possibility to choose their workspace based on the corresponding activity and personal needs (Bodin Danielsson and Bodin, 2008; Leaman, 1995). However, there is also contradictory evidence that desk sharing may have a negative influence on employee commitment (Hirst, 2011) and that the focus of the organizational identification of employees changes through desk sharing (Millward et al., 2007). Considering the various forms of commitment, this study examines the relationship between desk sharing and employee commitment. In order to give a comprehensive insight, we have integrated concepts such as managerial role model, age and organisational tenure in our analysis as explanatory variables.

This paper has several theoretical as well as practical implications. Previous literature has examined the influence of modern and flexible office settings as well as the advantages and disadvantages of desk sharing but neglected the direct examination of the possible effects on employee commitment, despite of the findings pointing to potential negative implications it may have (Hirst, 2011). Employee commitment is of particular interest for organizations as it influences organizational performance (Becker et al., 1996; Wright and Bonett, 2002), employee satisfaction (Kim et al., 2005) and the other way around (Matzler and Renzl, 2007), employee motivation (Altindis, 2011; Mowday et al., 1982) and turnover (Griffeth et al., 2000; Stanley et al., 2013). Besides, just recently it was found that NWoW workers more often share information (de Kok et al., 2013).

This study examines whether employee commitment in organisations with desk sharing is different from those with traditional office settings. Furthermore, we examine the level of application of desk sharing, the influence of managerial example, employee age and job tenure.

The paper is structured as follows. First, the current relevant literature regarding desk sharing as well as employee commitment are examined, followed by the hypotheses and method description. The final section describes the results and implications for research as well as practice.

2 LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 Desk Sharing & Activity Based Working

The concept of desk sharing means that more than one employee are sharing a working spot or a table (Daniels, 1994). Desk sharing became popular in the 1990s with the increasing technological developments (Felstead et al., 2005). NWoW are characterized by the following aspects: Flexibility of working place and time, adequate technological support, changes in organizational systems and leadership and changes in the working culture (Blok et al., 2012; ten Brummelhuis et al., 2012; Covarrubias Venegas and Groblschegg, 2015b). A very developed form of desk sharing would be not only sharing of a working spot but connect the working environment to zones that are activity-based. This office layout is often referred to as activity based working, namely different offices and/or areas are designed for specific kinds of activities and tasks. Usually, these are areas are concentrated work areas, network areas where informal exchange with colleagues occurs, meeting rooms, project areas and areas for phone calls (Covarrubias Venegas and Groblschegg, 2015b). Early experiments showed that desk sharing may increase communication within a department (Allen and Gerstberger, 1973). Nevertheless, very often desk sharing is connected with a strong noise pollution. The further development into activity based working concepts where clearly areas for concentrated tasks exist weakened the critics. Interestingly, satisfaction with the office setting has even a bigger effect on well-being, performance, motivation and commitment than autonomy at work, whilst on the contrary dissatisfaction with the office setting considerably decreases commitment (Kim et al., 2016).

Besides, we expect that NWoW office layouts lead to a reduction in face time between colleagues as well as managers and their team members due to the given locational flexibility. Subsequently, not only the way we work together changes considerably, but also the commitment level towards teams and organisations.

But, in activity based office settings the desk is not a personal space for the employee anymore, instead employees seek a suitable area that supports the particular task they are currently working on (Felstead et al., 2005). Although desk sharing may be cost-effective and foster creativity and/or innovativeness (Felstead et al., 2005; Warren, 2006), it may prevent the employee's need for stability and thus be perceived as an insecure, unpredictable and therefore negative way of working (Felstead et al., 2005; Warren, 2006). Besides, employees may feel their individuality lessen or their social status threatened, as each working spot is identical and interchangeable (Case et al., 2006; Elsbach, 2003). Despite the rise of collaborative work globally, more workplaces are still configured with entirely private offices than those comprising completely open space configurations. Moreover, recent data shows that individual private offices continue to be a function of hierarchy: The more senior people are in their organization, the more likely they are to have their own private office (Steelcase, 2016). It could be argued that desk sharing might furthermore lead to a less hierarchical attitude within organisations if all employees are affected by these new office layouts. The managers' role as a "figurehead" (Mintzberg, 1989, p. 21) is explored in the management literature in different contexts as employees need a leader to identify themselves with (Bass,

1990). Still, employees in more senior roles are more likely to work in a private office (Steelcase, 2016). In this vein, we argue that for a successful implementation of desk sharing, the managers' role is central to its success and influences employee commitment.

2.2   Employee Commitment

85% of employees worldwide are not engaged or are actively disengaged in their job. In detail, the global aggregate from Gallup data collected in 2014, 2015 and 2016 across 155 countries indicates that just 15% of employees worldwide are engaged in their job. Two-thirds are not engaged, and 18% are actively disengaged (Gallup Consulting, 2013). Comparable surveys show similar data, such as one-third of workers in 17 of the world's most important economies being disengaged (Steelcase 2016). Besides, the Global Workplace survey found that organizations with an average of 9.3 engaged employees for every actively disengaged employee in 2010–2011 experienced 147% higher earnings per share compared with their competition in 2011–2012 (Alvino, 2014). Moreover, studies show that higher engagement levels are linked to a range of positive business outcomes, such as business/work unit profitability, productivity, employee retention and customer perceptions in good and bad economic times (Gallup Consulting, 2013; Harter et al., 2002).

Studies show that the possibility of choosing where to work based on the task increases significantly employee engagement. The most engaged and satisfied workers report having access to a variety of spaces and the autonomy to control their need for privacy (Steelcase, 2016). This leads to the assumption that activity based working environments can be considered as a positive driver to employee commitment.

Commitment can be understood as a multidimensional concept (Meyer and Allen, 1991) that steers a person's behaviour to a predetermined, ideal direction (Meyer and Herscovitch, 2001). Employees can show their commitment to organizations through forms of behaviour that are manifested in policies or rules (Meyer and Herscovitch, 2001). In our study, the three

components of commitment described by Meyer and Allen (1991) are taken into account: affective, continuance and normative commitment. *Affective commitment* describes the emotional relationship between employee and organization and the employee's identification with the organizational values: employees with affective commitment want to stay in the organisation because of their positive experiences and awaited future aspects (Meyer and Allen, 1991). Affective commitment is connected with the employees' intrinsic motivation, the organisation's values and goals being relevant for the employee (Meyer and Herscovitch, 2001). Affective commitment can be increased through measures such as increasing perceived fairness and transparency in organization's processes and transactions (Meyer et al., 2002). Transformational leadership can influence employees' values, motivation and attitudes in order to pursue better organizational performance (Pundt and Nerdinger, 2012) and therefore increases employee commitment (Meyer et al., 2002).

Employees pointing to *normative commitment* stay in the organisation due to a feeling of obligation towards colleagues or tasks due to the internalizing of norms such as loyalty, however, this internalizing may be of cultural, organizational or familiar art (Meyer and Allen, 1991; Meyer and Herscovitch, 2001). Through NWoW the psychological contract between employee and organisation is diminished, as old structures such as an own office are being questioned and organizations cannot expect employees' unrestricted loyalty, which is why organizations aim at generating affective commitment (Millward et al., 2007; Rump and Eilers, 2013).

Continuance commitment refers to a level of commitment where employees stay in the organisation for monetary reasons, i.e. as long as the costs for leaving are weighted higher than staying (Meyer and Allen, 1991): Costs may apply for the lower valuation of the job market or for training or education. The level of continuance commitment depends on the number of the possibilities offered outside the current organization and the perceived applicability of the employee's qualifications

(Meyer and Herscovitch, 2001; Rego et al., 2004). For example employees with a lower level of education would point to continuance commitment, as they might not see many opportunities outside their current position (Rego et al., 2004).

Some findings suggest that desk sharing may lead to lower employee commitment (Hirst, 2011), as the employees have no longer the possibility to personalize their working space (Brown et al., 2005). Indeed, employees who are not satisfied with their working environment also show lower levels of commitment (Bauer, 2014). Besides, desk sharing may also have negative effects on teamwork (Hirst, 2011; Millward et al., 2007). Contrastingly, there is also evidence showing that desk sharing does not lead to lower identification with the organisation. Employees with a fixed working space identified stronger with their teams whereas those without identified more strongly with the organization as a whole (Millward et al., 2007). Thus, we expect that desk sharing has a negative impact especially on the affective commitment of employees. Given the above, Hypothesis 1 is formulated as follows:

H1. Affective employee commitment is lower in organisations with desk sharing compared to organisations with traditional office settings.

Level of Application of Desk Sharing
Organisations differ in terms of how broadly they apply desk sharing. Alternatives vary from desk sharing, where employees seek each day a working spot to so-called *touchdown areas*, which are designed for short time use only (Millward et al., 2007) or *hotelling*, where employees can book a working space in a corresponding area beforehand according to their needs (Schmalzl, Merkl, and Imbery, 2004). The level of application changes the communication and working processes; each variation requires clear policies, such as guidelines for the space bookings and common rules for where and for what kind of work each areas are meant for (Schmalzl et al., 2004). According to previous works (Elsbach, 2003), desk sharing might lead to de-individualization and thus a higher level of anonymity, which might have a negative impact on commitment. Consequently, a higher level of

application of desk sharing can be expected to lead to a lower employee commitment. Fig. 1 illustrates the operationalization of this variable, for example the highest level of application would mean that all employees pursue desk sharing, no assigned areas are available, that sanctions are in place in case the guidelines are not followed, and clean desk policy is seen as mandatory. Thus, Hypothesis 2 is formulated as follows:

H2. The higher the level of application of desk sharing in the organisation, the lower the employee commitment.

Managerial Example
As discussed above, managers represent "figureheads" and act as an example in the organization (Mintzberg, 1989, p. 15). This role as a "role model" is discussed in other management theories as well. For example, Bass (1990) finds that for transformational leadership it is important for employees to be able to identify themselves with their managers. Transformational leadership influences employee's values, motivation and attitudes regarding their performance (Pundt and Nerdinger, 2012) and it is also expected to influence employee commitment (Meyer et al., 2002). Managerial example reflects commitment, which is one of the critical success factors in implementing a modern workspace (Brunia et al., 2016). As affective commitment relates to the accordance of personal and the organisation's values, we assume to find differences especially regarding affective commitment. We expect managerial example to influence this relationship as follows:

H3. The level of commitment differs between employees whose managers also pursue desk sharing compared to those whose managers do not.

Additional Analysis
In the following section additional analysis which produced interesting results are reported.

Employee Age and Tenure
The office settings of the future need to be designed to support and retain also ageing workers in order to meet their specific requirements (Haynes et al., 2017). Indeed, age has been found to influence employees expectations and

attitudes towards organizations (Covarrubias Venegas and Kollinger-Santer, 2015). Furthermore, employee needs, such as the need for growth or security and commitment changes with age and satisfaction with job security is connected to commitment especially among older workers (Finegold et al., 2002). Additionally, affective and normative commitment are found to increase with age, whereas continuance commitment is connected to organizational position and tenure (Allen and Meyer, 1993). Thus, we expect a connection between age and commitment:

H4. There is a connection between employee age and level of commitment.

Besides, we examine differences in level of commitment between desk sharers and non-desk sharers when considering their tenure levels. Previous findings are somewhat inconclusive: Beck and Wilson (2000) suggest that affective commitment would decrease with longer periods of tenure, whereas Cohen's (1993) meta-analysis suggests that higher tenure levels also indicate higher level of commitment. We assume that employees who work already for a longer time in the organisation show higher level of continuance commitment due to the knowledge and emotional value invested.

H5. Employees with higher tenure show higher level of commitment.

3   DATA AND METHOD

The analysis in this paper is based on an online questionnaire conducted with the online tool GlobalPark. The original questionnaire was formulated after an extensive literature analysis. Commitment was measured using the validated scale by Felfe et al. (2014). The original items as well as our survey was conducted in German. Firstly, a pre-test was conducted. In this paper a stratified random sample was drawn, whereas the population consists of different, heterogeneous subsets with respect to office settings. Data collection followed purposive sampling. The authors sent invitations to selected groups of employees, attempting to target respondents with experience in desk sharing in different organizations. The field phase lasted from 05.11. to 15.12.2016. The questionnaire was opened by a total of 183 persons, 137 of whom started the questionnaire and 105 completed the entire questionnaire, consisting of 51 male and 53 females.

The sociodemographic of our sample show that the majority of the respondents (43.8%) have been employed for more than 10 years in their current organisation. 32.4% have been in the organisation for 1–5 years, 18.1% for 6–10 years and 5.7% for less than a year. 65.7% of the respondents are not in a managerial position, 32.4% work in lower or middle management and 1.9% in top management positions. Despite the attempt to reach an even distribution regarding employees in organisations with and without desk sharing, the shares are not even: 70.5% of the respondents work in organisations that have implemented desk sharing whereas only 29.5% work in organisations with no desk sharing. For further analysis weighting was applied (Hatzinger and Nagel, 2013).

Level of commitment: In order to measure the level of commitment, the validated scale with 14 items developed by Felfe et al. (2014) was used. Items are presented: Affective commitment (5 items):

1. I would be very happy to spend the rest of my working life in this organisation.

2. I don't feel emotionally connected to this organization.

3. I am proud to belong to this organisation.

4. I feel a strong sense of belonging to my organisation.

Tab. 1: Age structure of the respondents

% of respondents	Number of persons	Age group
22%	23	21–30
31%	33	31–40
34%	36	41–50
11%	11	51–60
2%	2	> 61

5. I think that my values fit with those of the organization.

Normative commitment (5 items):

1. Many people who are important to me would not understand or would be disappointed if I left this organisation.
2. Even if it would be beneficial for me, I would not find it right to leave this organization.
3. I would somehow feel guilty if I left this organization now.
4. it doesn't make a good impression to change organisations more often.
5. I would not leave the organization now because I feel obliged to some people in it.

Continuance commitment (4 items):

1. There would be too many disadvantages for me if I left this organization at the moment.
2. Too much in my life would change if I left this organization now.
3. I think I have too few chances at the moment to seriously consider a change of organization.
4. I have already put too much power and energy into this organization to think about a change now.

Level of application for desk sharing: The level of application of desk sharing was operationalized according to various aspects that where adapted to the questionnaire. In the thought of Millward et al. (2007), the question whether clean desk principle is applied or regulated altogether was sought as a criteria for the level of application of desk sharing. Further criteria of the level regards the existence of sanctions against the guidelines and the existence of such guidelines (Schmalzl et al., 2004). If there are assigned areas for certain teams or types of activities, "neighbourhoods", it is seen as a lower level of application of desk sharing, as employees tend to choose certain spot within the team (see e.g. Adams, 2013). Finally, whether desk sharing is directed at all employees or only at certain groups (Elsbach, 2003). Operationalization of level of application

desk sharing is applied as a criteria to measure the level of desk sharing.

Operationalization of the level of application of desk sharing are illustrated in Fig. 1 and Tab. 2. For example, a low level of application would mean a score of 4 where only single groups of employees are working in desk sharing environments, if assigned areas are available, if there are no sanctions for not following desk sharing guidelines and if there are no guidelines regarding clean desk after work. A high score, then, would mean that all groups are targeted, no assigned areas are available, sanctions for not following the guidelines exist and the working area may have to be cleared even during the day.

Tab. 2: Measurement of the variable "level of application of desk sharing"

	Target group	Neigbour-hoods	Sanc-tions	Clean desk
All	2			
Only single groups	1			
Yes		1		
No		2		
I strongly disagree			1	
I disagree			2	
Neither agree nor disagree			3	
I agree			4	
I strongly agree			5	
During the day				3
End of the day				2
No guidelines				1

Notes: Maximum points = 12, minimum points = 4.

The objective of the quantitative analysis of the present paper is to understand whether there are differences regarding level of commitment within a sample of employees working in traditional office settings compared to a sample of employees working in desk sharing office settings. Where data is normal distributed, a one-way ANOVA was used to test whether the mean values of these two independent groups differ.
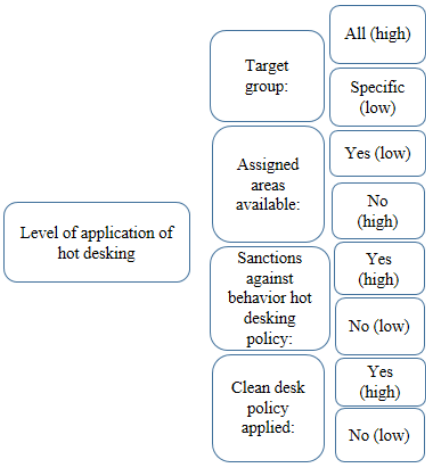
Fig. 1: Operationalization of level of application desk sharing

4   RESULTS

4.1   Employee Commitment and Desk Sharing

This part presents the empirical findings and describes the statistical tests applied. As for H1, we expected a different level of commitment between organisations that have implemented desk sharing and those with traditional office settings. As the sample was not equally large (70.5% of the respondents worked in organisations where desk sharing was applied, whereas 29.5% in organisations without desk sharing), for further statistical analysis the values were weighted (Hatzinger and Nagel, 2013, p. 68). A weighting factor was applied as follows: for employees in organisations with desk sharing: 50/70.5 (0.71) and for the ones without 50/29.5 (1.70). Tab. 3 illustrates the distribution.

Tab. 3: Employees in organisations with and without desk sharing after weighting

Prevalence	Absolute frequency (n)	Relative frequency $(\%)$
Yes	52	50%
No	53	50%
Total	105	100%

The validated commitment scale by Felfe et al. (2014) was used as it is accessible in German language. Sample items for affective commitment include "I do not feel very emotionally connected with this organization" and "I am proud to be part of this organization". For normative commitment, sample items include "Many people who are important for me would not understand or would be disappointed, if I would leave this organization". For continuance commitment, sample items were e.g. "There would be too many changes in my life if I would leave this organization now" and "I have invested already too much energy in this organization to be able to think of changing a job". (Items originally in German, translation for this paper by the authors.)

For statistical analysis, the mean level of affective, normative and continuance commitment is measured and compared between the two different samples (different office settings).

Where data is normal distributed, a one-way ANOVA was used to test whether the mean values of the two independent groups differ.

To compare the two means of the groups, t-tests are used. In our case, an independent (unmatched) t-test is used, as the two samples are independent. After applying t-tests for the

mean values of all the forms of organizational commitment, the level of affective commitment, interestingly, was found to be significantly ($p = 0.01$) higher in organisations with desk sharing. Tab. 4 shows that mean values of respondents in organisations with desk sharing is higher than in organisations without.

Tab. 4: Dimensions of commitment and desk sharing

In my organisation, desk sharing is applied	Absolute frequency (n)	Mean	SD	SE
Affective commitment				
Yes	52	3.86	0.83001	0.11457
No	53	3.30	1.11652	0.15403
Normative commitment				
Yes	52	2.67	0.83805	0.11568
No	53	2.54	1.05786	0.14594
Continuance commitment				
Yes	52	3.07	0.87195	0.12036
No	53	3.27	0.78876	0.10882

4.2 Level of application of desk sharing

As for H2, we expected a negative correlation between the level of application in desk sharing and employee commitment. Desk sharing is considered as an independent variable and employee commitment as a dependent variable, both being metric. Starting from a bi-variate correlation, we first checked whether there are linear correlations. The relationship between the dependent and independent variable is most reminiscent of a snow flurry, but outliers are visible, therefore the Spearman correlation may be applied. Operationalization of this variable is illustrated in Fig. 1 and Tab. 2. H2 can be partly confirmed; as can be seen in Tab. 5, there is a negative, significant correlation between affective ($p = 0.001$) and normative commitment ($p = 0.05$) and desk sharing. For continuance commitment, the value is not significant ($p = 0.09$).

4.3 Managerial example

As for H3, following the literature we assumed that the role of managerial example influences the level of commitment, especially affective commitment in desk sharing environments. If employees are expected to work in desk sharing environments but their managers are exempt from this practice, a negative impact on employee commitment is expected. We expected a different level of commitment for employees whose managers pursue desk sharing than those whose do not, namely the latter being lower. After dividing our sample in two groups, namely with managers also in desk sharing environments and teams where managers still had their own offices, we tested this hypothesis by comparing the mean values of the two different groups.

As continuance commitment is not normally distributed, we applied Mann-Whitney U-Test, which shows that employees, whose managers also pursue desk sharing show a lower level of continuance commitment ($p = 0.01$). In the case of affective and normative commitment, we combine the mean values for the two groups and find that the employees whose managers also pursue desk sharing show higher affective commitment ($p = 0.04$). For normative commitment, the difference is not significant ($p = 0.46$). Thus, we were able to find significant differences about affective and continuance commitment.

This means that those employees whose managers also perform desk sharing have a higher average affective commitment and a lower mean value for continuance commitment than other employees do.

4.4 Age and organizational tenure

To measure H4, we compared both employees with and without desk sharing without weighting the sample. Affective and normative commitment are normally distributed, whereas continuance commitment is not, which is why we apply Kruskal-Wallis H-test to continuance commitment and to the other forms single factor ANOVA. The age groups are presented in Tab. 2. We found no significant relationship

Tab. 5: Correlations between application of desk sharing and commitment ($N = 74$)

Affective commitment		Var_Level of application of desk sharing	Mean_affective commitment
Level of application of desk sharing	Correlation coefficient	1.000	−0.294
	Sig		0.011
Mean_affective commitment	Correlation coefficient	−0.294	1.000
	Sig	0.011	
Normative commitment			**Mean_normative commitment**
Level of application of desk sharing	Correlation coefficient	1.000	−0.228
	Sig		0.05
Mean_normative commitment	Correlation coefficient	−0.228	1.000
	Sig	0.05	
Continuance commitment			**Mean_continuance commitment**
Level of application of desk sharing	Correlation coefficient	1.000	−0.2
	Sig		0.088
Mean_continuance commitment	Correlation coefficient	−0.2	1.000
	Sig	0.088	

between age groups concerning continuance commitment ($p = 0.39$), affective commitment ($p = 0.41$) or normative commitment ($p = 0.53$). The descriptive statistics show, however, that continuance commitment is at highest in the age group of 51–60 years and at lowest in the group of 61 and older.

4.5 Tenure

To measure H5, we compared more than two groups and employees with and without desk sharing possibilities, thus unweighted data is applied. We expected higher commitment for longer duration of employment. We compared employees that are in the organisation less than 1 year, 1–5 years, 6–10 years and more than 10 years. As continuance commitment follows normal distribution, we apply single factor ANOVA. For affective and normative commitment, we apply Kruskal-Wallis H-Test. For continuance and normative commitment, no significant differences are found between the groups regarding tenure. Concerning affective commitment ($p = 0.02$): the group of employees less than 1 year in the organisation show the highest level of affective commitment, followed by the group with more than ten years. Thus, H5 could not be confirmed.

5   DISCUSSION

This study attempted to examine whether employee commitment in organisations with desk sharing is different from those with traditional office settings. Furthermore, we examined the level of application of desk sharing, the influence of managerial example, employee age and job tenure. Previous works refer to desk sharing having a negative impact on employee commitment (Hirst, 2011). Surprisingly, our findings show that the level of affective commitment is even higher for employees with desk sharing than for those without. To get a better picture on possible reasons, we run some additional tests. With a χ^2-Test, we measured the desk sharers' wish of assigned working spaces, which the most employees would have liked to have.

However, they did not see it as a signal of appreciation from the organisation: to the question "I see it as a form of appreciation of the organisation to provide me a fixed working space" only 27% of desk sharers fully agreed compared to that non-desk sharers 41.9% who fully agreed. In addition, the measurement of scale level shows that most desk sharers do not see a fixed working space as a prerequisite of an organisation's appreciation. Another reason for the high level of affective commitment of desk sharers may be that they showed lower agreement on aspects such as "setting up personal objects or photos to my working space is important for me" and the majority (79.7%) of desk sharers found it easy to find their colleagues they needed to coordinate with. This suggests that desk sharing does not impede the coordination with colleagues, which is why it does not have a negative impact on affective commitment.

When examining the level of application of desk sharing we found that the more radically desk sharing was applied, the lower the values of employee commitment are. A possible reason for this might be that affective commitment aims at accordance of the employee's own and the organisation's values. Normative commitment regards to the moral commitment towards colleagues. Thus, both forms of commitment refer to the individual values and relationships. Taken that a high level of desk sharing lowers the level of expression of individuality and social context, it is comprehensible that also the expression of such commitment is lower. Continuance commitment relates to a cost-benefit analysis of the employees and their possible alternatives. These considerations are apparently independent and not related to the spatial organization of the working environment. The higher the level of application of desk sharing, the less possibilities there are to express individuality or team structures, which could affect the level of commitment.

Managerial example was perceived important when applying desk sharing. Desk sharing employees whose managers did not do desk sharing showed lower level of affective commitment, as it relates to the employees' identification of the organisation's values. This was also the case for continuance commitment. Our results imply that the identification with the organisation's values and its credibility decreases when the idea of desk sharing is not pursued in all organizational levels and if managers still have traditional office settings. Ultimately, it does not appear authentic if organisations hype equal standards but still make managers "more equal". For the importance of the equal standards speaks also that all the desk sharers whose managers also do desk sharing state that their managers follow the given desk sharing guidelines. Thus when applying desk sharing, practitioners should consider equal guidelines for all organizational levels; otherwise this may influence the levels of affective commitment and credibility of the organisation.

Regarding employee age, no significant differences between the age groups in commitment were found. As different age groups may have different expectations towards the organisation, it was expected that older employees might show higher continuance commitment due to the lack of possible alternatives in job market. One possible interpretation would be that the group of 51–60 sees their possibilities not as broad in the job market compared to younger employees. Thus, the cost-benefit analysis leads to weaker prospects for this group. The group of 61 and older is already close to retirement, thus for this group the future job prospects are not as relevant for this group and thus continuance commitment is also lower. It may be that other parameters such as career possibilities and education influence the employees' chances more than age.

Finally, it was examined whether the organizational tenure influences the level of commitment. The only significant difference is found in relation to affective commitment; this is due to that employees with shorter employment are not influenced by their previous experiences in the organisation. In the beginning new employees are motivated and content and perhaps some might have particularly chosen the organisation due to the coherence of the values. In the group of employment of more than 10 years it is assumed that employees have

already considered carefully whether they fit to the organisation. Consequently, a longer period of employment could contribute to higher level of affective commitment. Regarding the other forms of commitment, no significant differences were found. Thus, longer period of employment does not lead to higher normative commitment. This may be due to that normative commitment regards not only to the obligations towards the organisation but also moral thoughts about others' opinions on changing job. Changing job is not seen as a taboo anymore and in many branches even a necessity for professional development. This may be a reason why there was no effect regarding continuance commitment

to be found. It does not only relate to the costs but also the potential alternatives that the employee sees in his/her current job situation.

To summarize, our findings imply that desk sharing does not necessarily have a negative influence on employee commitment. It seems that it should not only be considered whether to pursue desk sharing but to consider the conditions and people whom it regards, how are working spaces sought, who is working where, how do I find my colleagues etc. These aspects influence the employees' identification with the organisation. Furthermore, managerial example is important in acceptance of desk sharing.

6   IMPLICATIONS AND FUTURE RESEARCH

Our study has several important practical and theoretical implications. Firstly, we provide support for the finding that physical factors at the office, such as assigned desks, are not necessary important for the formation and focus of commitment (e.g. Millward et al., 2007). There is some evidence suggesting that desk sharing may have a negative influence on commitment (Hirst, 2011; Millward et al., 2007). Our study follows these indications but adds the important dimension of level of application of desk sharing and analyses how the managers influence commitment as well. Contrary to the suggestions of previous work, we find that desk sharers show higher level of affective commitment. However, the effect seems not to be as straightforward: desk sharing may lead to negative commitment if implemented too radically, if guidelines are missing or not followed

or if the application lacks managerial support. This should be examined by future research in a wider empirical setting in order to find out how the level of commitment behaves in specific conditions and over a longer time. Second, we contribute to the literature on employee commitment by examining how the various forms of commitment changes in a setting of office settings, which has not been previously examined. Third, our findings show empirically that there is a connection between the level of commitment and the applied office setting, specifically desk sharing. This finding should be relevant for practitioners and all organisations considering their office settings, regarding the positive attributes of committed employees such as motivation, high performance and lower retention.

7   LIMITATIONS

Some limitations can be identified from our study, mostly stemming from the dataset. It cannot be omitted that due to convenience sampling, our results might be subject to bias (Bornstein et al., 2013) and can thus not be unconditionally generalized. Besides, the

sample was rather small and exclusively examining employees in Austria. Furthermore, our empirical setting could not screen the reliability of combining two independent constructs, desk sharing and commitment.

This study provides fruitful avenues for future research. Firstly, the specific conditions on why and in what context does desk sharing influence on commitment, as well as the value added of desk sharing for employees. Secondly, the when, how and why do desk sharers or employees with assigned desks feel committed? How does this change over time? Thirdly, the longitudinal aspects of desk sharing are worth analysing, namely the change of commitment after implementing desk sharing in a specific organisation through case study design.

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PERCEPTUAL CARRYING CAPACITY AND TRADE FAIRS – EYE TRACKING EXPERIMENT

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ABSTRACT

This study was focused on application of perceptual carrying capacity concept in the environment of trade fairs. The main contribution of this study is exploration of customers' attitude towards overcrowding at trade fairs as there is not known any study with focus on these events. For this purpose, the eye tracking experiment was conducted, where different images depicting different level of visitors were used. In addition, the aim of the study was to identify what is at the centre of people's attention when looking at photographs taken at trade fairs. The study was conducted with 30 respondents from generation Y. The results imply that the number of people is a very important factor in deciding whether to attend these events (in this case trade fairs) or not at all. Simultaneously the in-depth interviews showed that people tend to have more of a negative attitude towards both overcrowding and a low number of people perceived at an event. This study also suggests that the optimal number of people at trade fairs is not extreme, not too low or not too high.

KEY WORDS

social carrying capacity, threshold of perceptual carrying capacity, trade fairs, crowding, eye tracking

JEL CODES

M310, M370

1 INTRODUCTION

Events are an important part of our culture, with last years witnessing a significant rise in the number and event diversity worldwide. This was caused mainly by the positive impact of such events on host community development with many corporations and companies using these events for promotional purposes. For the companies to be able to actually use these

events as their marketing strategy, a high level of participants' satisfaction needs to be ensured. Because satisfied participants will share the experience with family members and acquaintances which will then lead to an increased number of visitors. Therefore, it is essential to understand the complex motivations behind one's participation in events as it can help guide the decisions for organising a successful event (Cosma et al., 2017).

One of the best known and most discussed drivers of willingness for return to such events are factors generated on-site such as satisfaction and positive emotions with event satisfaction being the significant one (Jahn et al., 2018). One of the factors of customer satisfaction is the density of people at the event. In the case visitors feel the density is too high and they feel the negative effects of overcrowding, it might lead to a lower level of their satisfaction (Zehrer and Raich, 2016).

How crowding affects local communities and its impact on tourist/visitor (dis)satisfaction is often the focus of social carrying capacity (Coccossis and Mexa, 2004). The research of the social (perceptual) carrying capacity has so far focused on natural sites such as parks (e.g. Sever et al., 2018), coasts (e.g. Gonson et al., 2018) and cities (e.g. Neuts and Nijkamp, 2012). Therefore the main contribution of this study is exploration of customers' attitude towards overcrowding at trade fairs as there is not known any study with a focus on these events. This study also aims to determine the visitors' threshold of perceptual carrying capacity. The incentive for this paper came from the BVV Trade Fairs Brno, with whom we maintain long-term cooperation.

2 LITERATURE REVIEW

2.1 Perceptual Carrying Capacity

Social (perceptual) carrying capacity is one of the components of tourism carrying capacity, which states 'the maximum number of people that may visit a tourist destination at the same time without causing destruction of the physical, economic or socio-cultural environment and an unacceptable decrease in the quality of the tourist satisfaction' (World Tourism Organization, 2004). Social carrying capacity falls under the social-cultural part and is perhaps the most difficult to evaluate in comparison with physical-ecological and economic components (Coccossis and Mexa, 2004).

The term social carrying capacity means the level of use (often, the number of visitors) for a given site, and when this limit is crossed the users' quality of experience decreases or is no longer acceptable (Shelby and Heberlein, 1984). The quality of this experience might be diminished by both the crowding effect and ecosystem degradation caused by high use level (e.g. Gonson et al., 2018). How each person subjectively views density levels in a specific place is called perceived crowding (Shelby and Heberlein, 1984) and it is usually defined as a negative assessment of visitor density within a given area (Graefe et al., 1984).

Earlier studies with focus on crowding had assumed that the visitors' perception of crowding was mainly connected to the number of other visitors with whom they came into contact and the more this number grows the more the experience decreases. However, studies conducted later showed that the perception of crowding is much more complex than that and it includes various social, psychological and situational factors (Ditton et al., 1983; Arnberger and Haider, 2005).

If levels of crowding are perceived as too high, cognitive control, behavior and affective responses during and after these situations can be all affected, as social psychology literature shows (Langer and Saegert, 1977). These high levels of perceived crowding can lead to negative behavioral consequences including decreased tolerance levels for frustration (Sherrod, 1974). Also, stress levels are higher when visitors cannot accomplish their intended goals of relaxing and socializing due to external factors (Baum and Paulus, 1987; Gramann, 1982; Schmidt and

Keating, 1979). As a result, the quality of the visitors' experience is reduced.

Many studies were conducted on age and its connection to perception of crowding and it was proven that younger people are more prone to be affected by crowding than older people (Fleishman et al., 2004). Study from 1983 found that more physical space is generally required by younger people (Golant, 1983). Study from 1990 shows, that there are also gender differences in crowding perception. In this case, men were reported with higher crowding tolerance than women (Eroglu and Machleit, 1990).

2.2 Trade Fairs and Image Promotion

For many people, the most effective way to get messages across to them is with visual aids.

With the massive expansion of social media, the potential of an image grew exponentially. Images can draw people in, they give them a much clearer idea of what to expect and they can even help create an emotional bond with a potential visitor. Images elicit emotions and that is why consumers are less likely to be interested in texts only. Aesthetically appealing photographs can eventually be more helpful to a potential customer in deciding whether to attend an exhibition or not more than a text message would be (Jackson and Angliss, 2018).

As for a photograph's composition, in the center of tourists' attention are generally things associated with fun/pleasure, food and its consumption, people and places (Jackson, 2018).

3   METHODOLOGY AND DATA

The study was launched in October 2018 and concluded in December of the same year and it took place in the Eye Tracking laboratory of the Business and Economics Faculty at Mendel University. The research consisted of 2 distinct stages. The first one was the Eye-tracking experiment and after that came the second stage, in-depth interviews.

There were 30 participants (15 men and 15 women) and they all belonged to generation Y with ages between 19 to 28 years. As for their nationalities, there were 23 Czechs, 5 Slovaks and two respondents were born in Russia, but all the respondents speak Czech fluently. All the participants are either currently studying or have already finished studying at one of Brno's universities; Tab. 1 shows the respondents' birthplace according to its size.

Tab. 1: Representation of respondents according to their place of birth

4999 residents and less	7 respondents
5000–24999 residents	2 respondents
25000–49999 residents	7 respondents
50000 residents and more	14 respondents

The photographs, which were used in the Eye-tracking experiment and survey, were taken at the International Engineering Fair 2018 under the agreement with BVV Trade Fairs Brno, who organized this event. During the Eye-tracking experiment 6 photographs were used (2A, 3A, 1B, 3B, 1C, 2C), additional three (1A, 2B, 3C) were then added during the interview survey. The number of visitors in the photographs are shown in Tab. 2.

3.1 Eye-tracking Experiment

During the experiment, 6 photographs were shown to all the respondents. These photographs contained 3 different aisles taken at the International Engineering Fair 2018 and each aisle had 2 stages of crowding. The photographs were shown for 10 seconds (from 9992.0 to 10000.2 ms) in a random sequence and the respondents were then asked if they would be interested in entering the aisle shown in the photograph. The respondents had to choose between 7 levels of the response scale.

The Eye-tracking experiment was conducted using the SMI RED 250 device. This type of

Tab. 2: Number of visitors in each used photograph

	1A	2A	3A	1B	2B	3B	1C	2C	3C
Visitors	0	0	0	1–10	1–10	1–10	11–25	11–25	26+
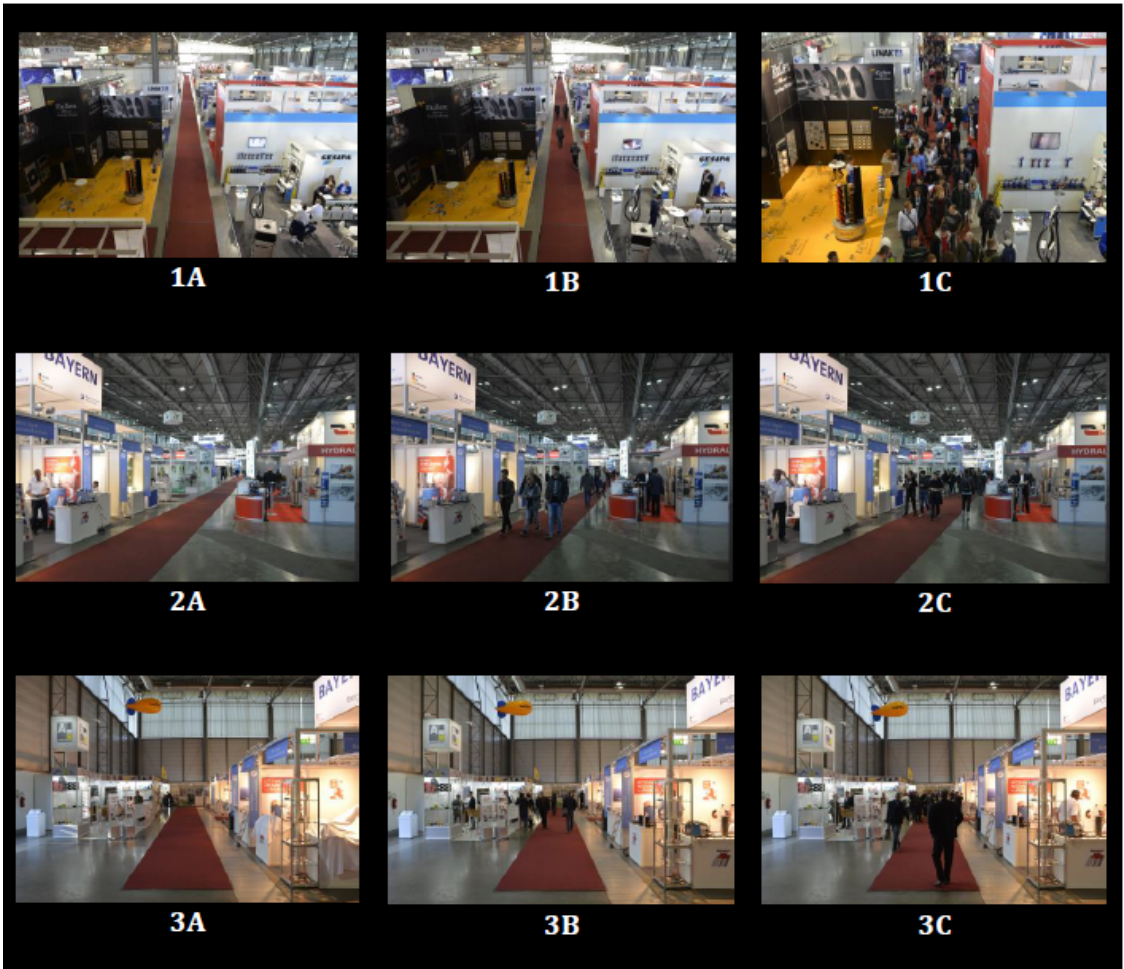
Fig. 1: Aisles showing different stages of crowding

a device is desktop/remote Eye-tracker, which means that it is attached to the area under the computer screen (with diagonal size of 22 inches with a 16:10 aspect ratio) and the respondents' vision is scanned from a distance of 60 to 66 cm. The device operated with sample frequency of 250 Hz. The experiment itself was created in SMI Experiment Centre software. Eye deviation was between 0.15 and 0.39 degrees and tracking ration was between 91.64% and 99.64%. Data obtained were then processed using the editor in SMI BeGaze software, where there were pointed out so-called areas of interest (AOI), in this case it was people and products, and for every area of interest the software produced statistical data which were then used.

3.2 In-depth Interview

The survey consisted of two parts. The first part focused on the respondents' general experience with trade fairs, and on whether they even take the number of people at trade fairs into account and how. In the second part, a visual

method was used. The respondents were shown photographs of aisles taken at trade fairs with different number of people pictured there. In this part, the respondents were supposed to evaluate the level of crowding pictured in each photograph and choose the optimal situation for them. The most frequent responses were translated into English and quoted.

4 RESULTS

4.1 Perception of People in Photographs Taken at Trade Fairs – Eye-tracking Experiment

One of the outcomes of this exploration study is survey of how much of the respondents' attention was paid to the people in the photographs taken at trade fairs. Tab. 3 summarizes times of respondents' observation of people and data about how much attention the people in the photographs paid to the products. The pictures 3B, 1C and 2C were the ones the respondents paid the most attention to people, ranging between 20 to 34%. To the people in the pictures 2A, 3A, 1B the respondents gave maximum of 16% of overall time. However, it is necessary to mention that the number of people in these photographs is either minimal or none and most people there were the staff. The results also show that with the exception of photographs 3A, 1B, more attention was being paid to the people in the photographs rather than the displayed products.

Tab. 3: Eye tracking experiment – Summary of results

	2A	3A	1B	3B	1C	2C
AOI Coverage – people (%)	2.8	0.3	3.0	4.8	21.0	6.9
Net dwell time – people (%)	7.4	4.1	16.0	20.6	32.2	34.4
AOI Coverage – products (%)	1.9	8.2	12.4	8.2	12.4	1.9
Net dwell time – products (%)	5.4	19.3	24.4	11.5	26.2	5.9

Notes: AOI Coverage is how much of a photograph's space is taken by a subject. Net dwell time is what percentage of the overall observation time was devoted to a specific subject.

4.2 Perception of Crowding at Trade Fairs

Descriptive analysis (see Tab. 4) of the sample shows, that more than two thirds of the trade fairs' visitors perceive overcrowding negatively, 3% neutral and less than one third perceive high number of people positively. The main reason for a negative attitude was a general reluctance to visit crowded places, a difficult passage through aisles and long queues, which make access to the stands difficult. From some responses, however, it is apparent that overcrowding is a sign of a general interest in the trade fair and that trade fair in turn gives the impression of being more attractive and livelier and overcrowding is then perceived positively.

On the other hand, more than half of the respondents perceive a small number of people negatively. It shows lack of interest and the potential visitors fear that the vendors would try to lure them to the stands and force their goods on them. In total 18% are neutral and 16% look at it positively (they do not have to push through a crowd and they have an easier access to the stands and the exposition).

Tab. 4: Perception of crowding at trade fairs and attitude toward overcrowding and spaces with a minimal number of people

	Perception of overcrowding	Perception of spaces with a low number of people
Negatively	21	20
Neutral	1	6
Positively	8	4

4.3   Threshold of Perceptual Carrying Capacity

Research shows that trade fairs' visitors are not oblivious to the number of people at the site. Subsequently the respondents were shown photographs of aisles and they were asked to decide whether they would enter the aisles based on the number of people in these photographs. According to Shelby and Heberlein (1984), if more than two-thirds of the visitors say that they are crowded, it appears likely that the capacity has been exceeded. If less than one third senses the overcrowding, the area is probably below the load capacity. When the perception of the mass is between these thresholds, determination can be made with this rule (Shelby and Heberlein, 1984).

Tab. 5: Respondents' interest to enter aisles

	1A	2A	3A	1B	2B	3B	1C	2C	3C
Yes	10	14	10	25	30	29	7	28	28
No	20	16	20	5	0	1	23	2	2

As seen in Tab. 5, an interest to enter completely empty aisles, tagged with the letter A, was shown by 10 to 14 respondents. A half of these respondents stated that their reasons were a simple passage through the aisle, an unobstructed access to the stands and plenty of personal space. The second half stated that the number of people could be higher, but they would not be discouraged. More respondents shown interest to go into the aisle 2A, because there were more staff there. The visitors who would not enter said aisle stated that their reasons were: *'Nobody is here, and the stands seem to have been just opened or recently closed – that the preparations are not finished', 'too few people send a message that the stands' offer is not interesting and high quality'.*

Majority of all the respondents would enter the aisles tagged with the letter B, where there were one to 10 people shown. Five respondents evaluate the aisle 1B to be too unpopulated and there are no staff at some of the stands, so they would rather not enter said aisle. The number of people in the aisles 2B and 3B is said to be ideal by more of a half of all the respondents. The most frequent reasons are: *'Optimal number of people, which allows you to easily access any stand and at the same time there is plenty of personal space', 'It seems natural, there are not too many or too few people there'.* The aisles 1C and 2C showed 11 to 25 people. An interest to enter these aisles was showed by 1 or 2 respondents less than the aisles 2B, 3B. Respondents' reasons for entering said aisles were the same as for the aisles 2B, 3B and those who would not enter these aisles stated that *'there are too many people there and they could not move here'.* The number of people shown in these photographs was said to be ideal by 10 people.

The last aisle 1C showed 26 persons and more. The four respondents who stated they would be interested to enter this aisle said: *'this number of people can show there are interesting products there but it can be uncomfortable'* and the other three stated that *'this number of people is the limit for what they can stand'.* The respondents who would not enter this aisle said *'there are too many people there so it would be impossible to move there', 'it is too much, I would avoid the site completely or I would wait for it to become less crowded'.*

The respondents were also asked to determine the ideal number of people, this is summarized in Tab. 6.

Tab. 6: Ideal number of people

Crowding	Empty	1–10	11–25	26+
Optimum for	10%	53,3%	33,3%	3,3%

What the interviews show is that 10% of respondents prefer minimal number of people at trade fairs and their reasons are: they do not have to push through crowds, easier access to information, the staff at the stands show more interest in the visitors. The largest group of people considers one to 10 people in a trade fair's aisle to be ideal because: *'there is plenty of personal space there, but the place is not totally deserted'.* One third of the overall number of respondents prefers 11 to 25 visitors in an aisle because: *'it shows that the trade fair has interesting goods to offer'* and only one respondent chose the option of 26 people and more.

4.4   Testing Hypothesis

H0: The perception of crowding is not dependent on gender.

This dependence is based on the assumption that men are more likely to tolerate overcrowding than women (Eroglu and Machleit, 1990). To determine whether the dependence exists, contingency analysis was used with level of significance at 5%. This analysis showed Pearson's χ^2 statistic of 3.281250 and *p*-value of 0.19386. This means that the null hypothesis is not rejected, and the perception of crowding is not dependent on gender.

H0: The perception of crowding is not dependent on a respondent's place of residence.

This dependence assumes that the size of one's place of residence and so the number of people surrounding the respondent is dependent on the perception of crowding. To determine whether the dependence exists, contingency analysis was used with level of significance at 5%. This analysis showed Pearson's χ^2 statistic of 7.0000 and *p*-value of 0.32085. This means that the null hypothesis is not rejected, and the perception of crowding is not dependent on a respondent's place of residence.

5   DISCUSSION AND CONCLUSIONS

The results of this exploration study imply that the level of crowding at trade fairs and the number of people in general is the centre of attention when looking at photographs taken at trade fairs and it can influence a potential visitor. Unfortunately, earlier studies were focused mainly on outdoor venues (e.g. Sever et al., 2018; Gonson et al., 2018; Neuts and Nijkamp, 2012) so any comparisons of the previously achieved results might not be relevant. The main contribution of this paper is thus it's exploration of customers' attitude towards overcrowding at trade fairs.

The eye-tracking experiment's results show that when the respondents were showed photographs taken at trade fairs, the most attention was being paid to the people rather than the products displayed. This can be used for further studies, with focus on whether the people showed in the promotional photographs are indeed that important in deciding whether to attend an event or not. The outcome of the in-depth interviews is that people have a negative attitude towards both overcrowding and a minimal number of people shown, and, in these cases, they are prone to not attend at all. This was supported by determining the thresholds of perceptual carrying capacity where most of the respondents had a positive attitude towards photographs with a medium number of people, which tended to be the ones

most interesting to them and because of those they would consider attending the event.

Another part of this study was testing dependence of gender and the size of one's place of birth on the level of tolerance for overcrowding. Although the literary review stated that this dependence should exist, neither was confirmed. Among the reasons for why these dependencies were not confirmed can be: small sample size and small age range. As for the dependence of the size of one's place of birth, the cause can be that the size of one's place of birth often does not match the size of one's place of current residence. Therefore that person is actually more comfortable in a different setting.

Because of the technical orientation of fair trade used in this paper (International Engineering Fair 2018), the results of this paper might not be applicable to the trade fairs in general. In addition, the photographs picked and the locations displayed in them played a significant role in conducting this research. Furthermore, these photographs were shown in a laboratory environment and it may have affected the respondents' attitude towards crowding.

These events, trade fairs especially, is a relatively unexplored area and further research into crowding at trade fairs in relation to deciding whether to attend such an event and in connection to satisfaction after leaving

such an event should be more explored. In future studies, the researchers could also use other neuroscience devices such as face reader or electroencephalograph (EEG) to study the emotional state of participants.

6 ACKNOWLEDGEMENT

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COMPARISON OF TRANSITIONAL THEORIES TO POST-SCARCITY IN SCIENCE-FICTION LITERATURE

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ABSTRACT

Scarcity, or limited resources, is the fundamental economic problem the humanity faces continuously. Without it, economics would be meaningless. Science-fiction literature depicts societies where abundance is becoming persistent feature. Humans no longer participate in the production process itself, machines become sentient thanks to artificial intelligence and everyone has access to all goods and services desired. Scarcity as a multiple-born phenomenon, namely originating with labour and land, has been eradicated. Everyone is fully satisfied, exchange is non-existing, the medium of exchange – money – is no longer required. This paper compares some of the most representative economic thoughts in science – fiction genre since 1910s. Main purpose is to identify whether the societies have really achieved post-scarcity or they are only transitional theories, suffocating from still-present scarcity. Results of the paper suggest that even though the societies look like and are presented as they achieved post-scarcity, they are still experiencing scarcity in certain forms and use a medium of exchange to redistribute resources. This implies that these theories rather depict a socialistic utopia than a fully emerged post-scarcity society, even in the most progressive novels scarcity still occurs. Only the Culture series indicate signs of fully developed post-scarcity era.

KEY WORDS

post-scarcity, abundance, science-fiction, scarcity, artificial intelligence, utopia, socialism

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1   INTRODUCTION

We are living in an era of immersive break-throughs. Robotics became so flexible that they can deliver packages and not trip over during the journey (O'Kane, 2018); autonomous cars can take over control on highways or even park (Armstrong, 2018); and machine learning is able to learn and create well-constructed responses better than some of us can (Gesso, 2017). The implications of such advances provide a rather optimistic view towards the development of economy as well the structure of societies but rises questions of the purpose of an individual as an economic unit (Garrett, 2015). You see, automation is taking a good part of our jobs and is hungry for even more (Cunningham, 1957), causing disruptive forces not only in the low-performing jobs, but also in a combination with artificial intelligence it is taking over positions of doctors, financial brokers, transportation (Goos et al., 2014). Such progress causes disruptions on labour markets as well as transmit the decision-making power to machine and artificial intelligence (McGarrah, 1985). With the exponential growth of such technological progress, we may sooner or later face the question of how to secure those who cannot possibly employ themselves anymore under a current capitalist system (Shanahan, 2015). Will a new system of allocation of goods produced by machines alone occur (Eberly and Stock, 2018)? A question posed by Torry (2013) on the other hand reveals concerns whenever consumers will be still able to consume even if they no longer participate on markets. Such questions were tried to be answered and prediction made on how a such society shall function. Karl Marx pointed out that not only tools and machines were coexisting together to form a singular sociological structure, where the human

mind remained the decision-making body of this socio-economic entity (Marx, 1973). John Maynard Keynes dreamt in his famous speech Economic Possibilities for our Grandchildren (Madrid, June 1930) about a society, where the leisure time would be not the privilege of the upper class – industrialists but enjoyed by proletariat class thanks to the massive technological progress. Is this dream achievable thanks to the Artificial intelligence (Folgieri, 2016)? Author of *The Age of Spiritual Machines* (2001) and *The Singularity is Near* (2006), Ray Kurzweil, believes so. Basing his research on exponential growth enabled by high robotics and artificial intelligence, he predicts that artificial intelligence will be on part with those of humans within 21st century (Kurzweil, 2001). He refers to it as Technological Singularity, a point, where the machines will be able to replicate on their own and AI keeps writing and improving its own lines of code (Kurzweil, 2006).

The scientific and economic theories are prophesying possible outcomes based on the current socio-economic paradigms, however, this paper is not about them. Search for answers takes place in the most imaginative and progressive literature of today: science-fiction. The aim of the paper is thus to identify within science-fiction literature transformation theories of societies from capitalistic systems into post-scarcity. How are the natural scarcities, labour and resources, dealt with in order to achieve such a transmission? Is the money eliminated in the process as well or do they persist? Not only we will answer these questions, we will reveal how easily socialism utopia can be falsely labelled as a post-scarcity society.

2   ECONOMIC ORIGIN OF SCARCITY

Scarcity is commonly defined between people as a *'lack of something'* thanks to a highly perceived demand and it can be subjectively eliminated by perception of *'having consistently full shopping shelves'*. From the economic point of view, scarcity is recognized as a higher demand for free goods rather than the ability to supply those goods for free (Bronfenbrenner, 1962). Scarcity can be perceived as absolute, where the inability to find additional unit of resource is impossible due to its physical limits and non-existent substitute; or relative, in which shortage of supply in one or several areas is imbalanced, or even disrupted by external or internal forces (Daoud, 2010; Wagner and Newman, 2013). Though these two rises from a natural development, a third one is created by rigidities on markets (e.g. slow implementation of new technology), but especially by restricting the amount of produced output to induce scarcity in consumption, leading to an increase of price of a given product. This is known as artificial scarcity (Bronfenbrenner, 1962).

The nature of scarcity can be derived from multiple sources. One of the fundamental limits is identified in the non-renewable resource, respectively in the land itself (Mackellar and Vining, 1989). Effectiveness is being compromised by such theories as Hotteling's law, suggesting that producing goods as homogenously as possible to leads to minimalization of inputs (Krautkraemer, 1998), or by annexation of the land (Barbier, 2012). Labour is identified by Fang and Wang (2006) as another factor playing a significant role in the production of scarcity. Not only positive net immigration seems to be a very intuitive short-run solution of this problem (Jenkins, 1978), but it triggers the initiative to innovate if technology is strongly labour saving inclined (Acemoglu, 2010) as well. Therefore, upon these limitations is successfully thriving capitalism (Panayotakis, 2011) and failed pure socialism (Machaj, 2018).

As is suggested by Schwab (2017), the Industry 4.0 is already right behind the corner, bringing substantial changes. Artificial intelligence (AI), the core leader of this change, is significantly shaping the possibilities of computing power and starts making visible impact in the markets (Skilton and Hovsepian, 2018). Moreover, its advancement can greatly benefit collective intelligence and impact it on a brand-new level (Mulgan, 2018). Moreover, it helps to develop Internet of Things (IoT), agents with specific purpose within electronic wireframe, together creating a complex nature of an artificial organism capable of perceiving various variables autonomously (Manu, 2015). With AI and IoT expanding, robotics is becoming much cheaper and intelligent, replacing not only blue-collar workers (Ford, 2018). Is the Universal Basic Income the right reciprocal action (Downes and Lansley, 2018)? How can the education positively affect the way fourth industrial revolution will keep developing and eventually transmit itself beyond (Gleason, 2018)?

Thanks to scarcity as the main capitalistic constrain, inputs inevitably relocate limits to every output regardless whenever it is a good or a service. Overcoming these restrictions could mean a rise to a new economy, an economic agent and even a structure of society, which would have been gifted not only by a limitless consumption, but also by eliminating the medium of exchange – money. Such scarcities do not imply only on eliminating the physical, natural obstacles, but imply changes in the management (Carter and Jackson, 1987) and is perceived as an aspect stimulating violence (Käkönen, 1986). An escape from scarcity is observed by inclining towards the undergoing of a natural revolution (Best, 1998), but does it truly represent a post-scarcity society we would like to achieve?

3   CRITERIA FOR SELECTING REPRESENTATIVE SCI-FI LITERATURE

The context of scarcity therefore sticks to the physical, fundamental reasons for it to occur in labour and land, which implies elimination of money (or similar commodity) as a medium of exchange in the process. The criteria are summarized and compared between scarcity and post-scarcity economy in the Tab. 1.

People are scarce input in the production process, continuous employment would imprint transform scarcity into final output. This can be effectively solved only by substituting labour by a *'perfect entity'* (artificial intelligence) or by not requiring labour in the production process at all. Scarcity born from limited resources will keep prevailing as long the economy depends on the discovery of new deposits of the raw materials. Exponential growth in technology is required to achieve production that will eliminate exploitation of raw materials and will enable production even if they are gone. If scarcity is gone, no longer is required to allocate these inputs to be effectively employed. Medium of exchange no longer matters – it has lost power in deciding what a customer chooses to consume. These are our primary targets to identify in the book. One more concept will help to select appropriate novels. The dynamic nature of society is continually captured and clear progress from society A to society B is established will. If author depicts only the transformed society (already in point B), there is a chance that the drivers behind the change will not be explained exhaustingly enough. Contemporary economy without a deeper economic background is meaningless to resolve. Therefore, the nature of the selected literature has to showcase not only sociological change within societies, but economic transformation as well.

The historical development of sci-fi literature is astounding; however, we will focus on the review of novels from 20th to 21st century. With the birth of a *robot* in *R.U.R.* by Karel Čapek, the authors started shifting more focus on how such artificial entity can change not only the world of technology, but what impact could it bring in relation to humanity and economics. More importance was put on showcasing the socio-economic world than before. However, not every author of that era wrote to that desirable extend to draw a comprehensible conclusion. For example, Isaac Asimov in his book series *Foundation* depicts the galactic conflicts between worlds as well as their technological development within framework of the contemporary society. On the other hand, the series *The Space Odyssey* written by Arthur C. Clark, pinpoints technological progress in the society within few decades, omitting any representation of how the economy works at all. Popular novels of the last decade within science-fiction genre, such as *The Hunger Games* or *Divergent* trilogies, depict post-apocalyptic world, reconstructed into dystopian societies lead by 'chosen ones', living in prosperity and abundance while others are outcasts or servants. Similar dystopian world is also showcased in *The Maze Runner* series; however, the world here is still in its apocalyptic setting, unable to make a transition to neither utopia nor dystopia. Due to the lack of economic approach and static attitude, these books do not fulfil necessary standards to be considered in the paper standards. Comparison of socio-economic aspects of selected novels is made in a Tab. 2.

Based upon the criteria, the selected literature novels for the purpose of the review are: *Moving the Mountain* by Charlotte Perkins Gilman, *Riders of the Purple Wage* by Philip José Farmer, *Mars* trilogy by Kim Stanley Robinson, *The Culture* series by Iain M. Banks and *Down and Out in the Magic Kingdom* by Cory Doctorow.

Tab. 1: Comparison of scarcity society with post-scarcity society in regard to identified conditions

Criteria	Scarcity society	Post-scarcity society
Labour scarcity	Prevailing; scarcity decreased through migration, distribution of labour and specialization	Eliminated; labour no longer desired in production process
Land/resources scarcity	Prevailing; technological progress improves production capabilities; new mineral deposits discovered	Eliminated; ability to multiply products without a need of additional input; enough inputs to produce unlimited output
Medium of exchange	Present; monetary medium to re-allocate inputs to satisfy most desired wants and needs	No longer relevant as output is sufficient for all the wants and needs to be satisfied
Decision making body	Management	Artificial Intelligence

Tab. 2: Socio-economic aspects of sci-fi literature

Novel (series)	Sociological aspect	Economic aspect	Dynamic development
Hunger Games (trilogy)	Yes	No	No
The Divergent (trilogy)	Yes	No	No
The Maze Runner (series)	Yes	No	No
The Space Odyssey (series)	Yes	No	No
Foundation (series)	Yes	No	Yes
The Culture (series)	Yes	Yes	Yes
Down and Out the Magic Kingdom	Yes	Yes	No
The Mars trilogy	Yes	Yes	Yes
Riders of the Purple Wage	Yes	Yes	No
Moving the Mountain	Yes	Yes	Yes

4 COMPARISON OF TRANSITIONAL THEORIES IN SCIENCE-FICTION LITERATURE

4.1 Labour Scarcity

Journey in identifying post-scarcity starts with the factor which Classical Political Economists considered to be the cause of the growth for the contemporary economies of the 18th century – labour.

Let us begin with the oldest novel on our list, *Moving the Mountain.* It is important to notice that the contemporary societies of the late 19th and early 20th century, in which the Charlotte Perkins Gilman lived, were strongly influenced by the movement of feminism to regain rights for women. This should be kept in mind, as lot of the initiative is done thanks to the strong women movement in the novel.

Moving the Mountain recognizes the status of women in the society as a trigger for changes. Arguably enough, strong feminine movement invoked that *'He [a man] has no right to her "services" anymore.'* This is very consistent with the institute of marriage in 19th century, as women indeed where deemed as second-class citizens, serving the household and raising the children. The argument for marriage weakened in the novel after the equalization of women, allowing them to do what a man could do for centuries. Owning capital and conducting business even enforced these movements: *'She does not "belong" to anyone in that old sense'* and *'a woman who is in a business [...] does not give it up when she marries'*, revealing that

independency has become on part with men's level. (Gilman, 1911, p. 102–103)

The liberalization kickstarted the change of view on society, economy and government after women flown into these important institutions. The first trigger in the process of scarcity elimination is recognized in the 3rd chapter, revealing a significant movement within the food industry, which was initiated by the success of *'some women with a real business sense, and enough capital'.* (Gilman, 1911, p. 84)

What the business model looked like? Simply put, these women overtook a block of abandoned apartments and redefined them to serve a new purpose. A visionary social hub interconnecting various activities was created, putting emphasis on the link of various activity institutions: from work to culture, education to health care provision and child caring centres connected to others through playgrounds and parks. A very similar to Gilman's idea was introduced by Viktor Gruen, a father of shopping mall, described by Trufelman (2015) in the podcast *99% Invisible*, episode 163. His initial vision of a shopping mall did not encompass only shops, it was rather a mixed-use facility: *'See image of people living closer communication with other people, see image of having the possibility to walk from one place to another.'*

Gilman (1911, p. 88) continues to explain how the population of such facility started once a centralized food service for the community was introduced, giving birth to *'high wages, first-class houseworkers, and the residents paid for them by the hour.'* Kitchens were considered as manufacturing units, hugely dispersed, causing inefficient redistribution of labour, wasting a significant part in the process of gross domestic product. The idea was that by centralizing these units and eliminating them from households, costs will be pushed down, making the food much cheaper. Considering the prediction that such unification occurs through the whole US within several years, the price of the food will decline even more rapidly thanks to a perfect competition reciprocates eliminating any sign of profitability whatsoever. This centralization affected other industries as well, creating benefits

in substantial reduction of the work time *'that no one needs to work over two hours a day and most people work four.'* (Gilman, 1911, p. 48)

We can conclude that movement from scarcity to abundance of products occurred not due to the technology, but rather by incorporating previously ineffectively used workforce (= women) and by substantial improvement in the specialization of labour and skills which happened in the centralisation of production. To support this theory, Gilman (1911, p. 54) furthermore denotes importance of the future generations *'[…] we train them to higher efficiency, especially the children'* carried through by *'best and wisest of us are proud to serve [them]'* as the core of the development of future abundance, still triggered by highly skilled labour. Unifying argument upon which Gilman (1911, p. 131) builds the theory is a fact that *'All these people work'* and are willing to work for *'true social economics, not the dismal science.'* However, this concept would sooner or later crumble, as we know that the labour is not as productive as capital (i.e. machinery, tools) in the long run and its scarcity will always be present due to the nature of labour to be limited in any given time.

The novel *Riders of the Purple Wage* recognizes the need for people to work, as the main character still creates art not for pleasure, but for a sell. However, the contemporary need of society for labour is not depicted; the author rather focuses on how a man has to change to achieve post-scarcity society thanks to the labour itself.

A rather deep depiction of what society should look like and behave like to reach full post-scarcity is initiated by comparing interaction within societies based on the Chaos theory (mockingly transposed Butterfly effect): *'Confucius once said that a bear could not fart at the North Pole without causing a big wind in Chicago'* to a self-made *'Theory of electrical circuit'* (name of the theory is not fully proposed, rather derived from text). For the sake of the simplification of the argument in comparison, let us imagine a simple society as a unit composed of many variables. Under chaos theory the author predicts *'human society*

is a daisy chain', an indeterministic system of unsure (but not unknown) outcomes. Let us interpret it on an example, where a small change in the increase of traffic jams induced an increase demand for cigarettes. Now, let assume position under *Theory of electrical circuit*, where one variable has a well-known impact on others, just like in electrical circuit each component acts based on his role and influences results of others seamlessly through its action. Under this theory we can develop the example a little further: a small change in the increase of traffic jams *has impacted the stress levels of individuals* and induced an increase in the demand for cigarettes. A rather small change but with a significant impact of the missing variable in Chaos theory, which would not make an electrical circuit function properly. The author depicts the world under this theory as *'Age of Complete Interconnection'*, where each variable within the system is inevitably important for its functioning *'No wires can hang loose; otherwise we all short-circuit.'* (Farmer, 1992, p. 54–55)

However, the system works only under the assumption of perception of individualistic nature; a sort of a *'hapax legomenon'*[1] entity. The man under a current system is too rigid, bearing the burden of past norms depicting what a man should be, look like and perform. The author gives a birth to a highly-individual entity named *'The Totipotent Man'*. In biological terms, totipotent describes an immature or incomplete cell capable of transforming itself to any cell type and thus able to create any body organ imaginable. This concept applied in economic terms creates a being capable of limitless flexibility (flexibility symbolizing the ability of the immature cell to grow to anything desirable); a well-balanced structure which 'grows' and reflects the current society's desires. Such entity, strong individual is according to an author a condition for achieving post-scarcity, *'Golden world'* society: *'He must come into being before the Golden World can be realized. How can you have a Utopia without Utopians?'* (Farmer, 1992, p. 55)

This idea confirms that the author recognizes that his world isn't really the one he envisioned to be and suggests how to improve it. *'The Totipotent Man'* seems to be born from the concept of beauty and freedom, just like art, where art is the high expression of individualism. That's why the most profitable activities occur in the art, even though the competition is fierce. This may imply a possible metaphor that the individuality starts to be reflected in many people, getting them closer to the mythical *'The Totipotent Man'*, who can eliminate labour scarcity in process.

Author of Mars trilogy, Kim Stanley Robinson, on the other hand relies heavily on the skilful and intelligent workforce. Through the series, definition of *'who is a scientist'* comes from various members of the crew going to Mars. One describes a scientist to be: *'[an] apolitical, supposedly, like civil servants – empiricists'*, who would like to persuade *'rational scientific style, the greatest good for the greatest number, which ought to be fairly simple to arrange.'* The premise here is clear: the scientist is acknowledged as a perfect being bound not by economical rationality, but cognitive rationality, a sort of segregate *'pure'* thinking impossible to be achieved (unless the argument bestows on artificial intelligence). Robinson (1996, p. 85–86) advocates that such thinking lacks any *'emotions, religions, governments, and other mass delusional systems of that sort'* to secure that the system is based solely on high-scientism. Robinson (1996, p. 129) furthermore keeps denying the efficiency of economic rationality in creating wealth in the third book, *Blue Mars*, claiming that *'Economic rationality is simply not the highest value. It is a tool to calculate costs and benefits, only one part of a larger equation concerning human welfare.'* Similar preposition, even though more archaic in the core, is declared by a third scientist, who identifies the research facility as *'a little model of prehistoric utopia'*, operated by *'clever primates'* integrated in satisfying their utility through self-sustainability (even though it could be argued that the scientist here is depicted as a rational economic entity). This argument

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[1]A word or phrase that appears only once in a manuscript, document, or particular area of literature.

showcases the benefits of rather enclosed, self-sufficient community, providing one for another is prevailing notion for a society structure on Mars. (Robinson, 1993, p. 337)

It seems that the author seeks that the change comes from the most skilful and educated group of people, especially scientists and engineers etc.; through holding assumption that they are perfect entities capable of mastering self-management. The preposition involves a high level of decentralization of government creating interconnected communities capable of surviving on their own. The refusal of leadership or any kind of hierarchy is constantly supported and followed: *'[...] and for all that time we have had no leaders, really. [...] the group decides what needs doing most. It's been a very communal society, a democratic group.'* (Robinson, 1993, p. 165)

On the other hand, there is not a significant demand for blue-collar workforce. This argument is supported later in the first novel, where the machines work with *'very little supervision, like most of the project, in both manufacture and operation'*, showcasing that their high autonomous performance eliminates the need for physical labour. Newcomers arriving to these newly formed apartments are mostly another engineers and scientists who *'[...] had to see [only] to programming, deployment, maintenance, and troubleshooting of these machines.'* Enumerated responsibilities create a demand for jobs that are not interfering with the production process itself; their purpose is to set up and 'accommodate' this machinery. Robinson (1993, p. 234) this way implies a desire for skilled workers devoted to employing such machines, as they cannot replicate. Even though later in the third novel, *Blue Mars*, the author showcases that people cultivate potatoes in the Mars soil, or even hunters and gatherers are present, their 'labour' is not conditioned by the requirement of conducting the physical work. They serve for scientific research and/or as a source of fun.

Doctorow (2003, p. 12) depicts in *Down and Out in the Magic Kingdom* a post-capitalistic *'Bitchun Society'*, a cultural phenomenon developed all around the world based on *'benef-*

icent ways: introducing Free Energy to their greenhouses, then an engineered crop or two, then curing a couple deaths [...].' The author unfortunately uses static approach in describing the society; the vague explanation of what initiated the changes does not hold up and is vastly insufficient in regard to evaluated criteria.

Given the development, two new fundamental benefits of such society were introduced, that being transhumanism *'the death of death'* and post-scarcity *'the death of scarcity'*, evaluating them as obsolete concepts which were accepted for too long and prolonging the time of economic/society change. The society was successful in eliminating as well *'any sort of dull, repetitious labor [...]'* which Doctorow (2003, p. 59–66) owes to the unconscious state of mind thanks to their advanced transhumanist bodies. This implies that bodies are overtaken by the artificial intelligence for a while and then switched back to the owner of the body once the task is completed, however, these actions is performed only in tasks which are recognized as unpleasant.

Labour is a long-forgotten concept in the Culture series. Everything is done thanks to the highly developed artificial intelligence called Mind, which exercise extraordinary power and is fully autonomous, developing itself for the pleasure of its inhabitants. They not only manage the whole orbital system but manifest themselves as *'the silver-skinned avatar is under the direct control of the god [the Mind] which holds the power of life or death over the Orbital and everybody on it'* and provide life to androids (which are self-conscious as the Mind itself). (Banks, 2010, p. 148)

4.2   Resource Scarcity

In the previous chapter we have identified the novel *Moving the Mountain* as being strongly dependent on the exploitation of labour from multiple points of view – integration of women in the production process (a wasted resource) and enabling a significant specialization to occur in every possible field. However, the author remains very limited regarding the identifica-

tion of how the resource scarcity was lifted up and eliminated. We are aware of the fact the primary sector is the one which benefited the most, as the significant improvements in agriculture were conducted. However, there is not a clear answer for other sectors. The author derives the benefits to occur in vertically aligned industries, such as those in transportation and improved agriculture *'the soil improved; the output growing in quantity and quality'*, but others are not mentioned or just very briefly (improvement in electrical industry, especially batteries).

Riders of the Purple Wage depict rather progressive production methods, yet they seem to be greatly compromised. Stating that imported *'inorganic chemicals are converted into energy and then into the matter of food, drink, medicines, and artefacts*, production is presented so advanced that the cheapest output comes directly from laboratories and only literal chemicals are imported, supported by the claim that they produce *'Artificial but exact duplication of organic stuff.'* Interestingly, the author proposes that *'little agriculture or animal husbandry outside the city walls'* still occurs. Extraordinarily presented common agriculture production when *'there is superabundance for all'* provides base for Farmer (1992, p. 73) to express that markets might not be perfectly competitive and are likely to be affected by marketing, where *'goodies'*/premium products are sold at a higher price, even if their quality might be the same – similarly to the market of common agriculture products and premium products, e.g. Bio products. Resources, even though that a significant progress in production has been established, are still scarce, meaning that market stimulates its allocation and affects the prices. We will come back to this when discussing the requirement of owning a medium of exchange – money.

Unlike the first two novels, where the extend of scarcity in the primary resources wasn't clear, the *Mars* trilogy clearly showcases the importance of raw materials, especially heavy metallurgy. Not only that the primary aim of the newcomers on Mars is focused on the mining of the raw materials, but the conflict between the Earth and Mars on who has the right for the Mars' natural resources has escalated to a war with scalable results. As the author suggests, these heavy metals become the core attribute for the expansion of production. Moreover, the importance of machinery is clearly shown, creating them from resources found on Mars. The signs of certain abundance start to emerge once the machines become responsible for the construction of shelters autonomously. Later on, a further revelation about machines showcases that they had advanced and are even possible of reproduction, self-construction to the extend the are possible to construct even larger structures: *'[…] month these three components together would have conjured obedient beasts out of the sand: first the factories, then the assembly plants, then the construction robots themselves, vehicles as big and articulated as a city block.'* This implies that machines are ready to produce a vast number of products, at costs driven to non-existence and establish post-scarcity in the production industry. (Robinson, 1993, p. 483)

In the case the novel *Down and Out in the Magic Kingdom*, we can get a better insight on how the resources are scarce by showcasing it on a rather indirect example. At one stage, a protagonist of the novel gets to the point where his Wuffies (a so called medium of exchange, elaborated in next chapter) becomes significantly low. A person with this status is not a subjected to a direct threat of crisis survival: *'the number of low-esteem individuals at large was significant'*, and can still carry on living *'just fine, hanging out in parks, arguing, reading, staging plays, playing music.'* He himself regards at this point as being richer than *'99.99999 per cent of all the people who'd ever lived, I had a life of unparalleled luxury'* and elaborates what actually being *'low on Whuffies'* means in regards to obtaining goods and services in a simple comparison: *'While I couldn't get a table in a restaurant, I was free to queue up at any of the makers around town and get myself whatever I wanted to eat and drink, whenever I wanted it.'* (Doctorow, 2003, p. 104)

We can conclude that there is a certain recognized minimum regardless of the position

of your personal Whuffie, a sort of guaranteed basic product. This is however not caused by the abundance generated on the markets, but represents a re-definition, per se, of how social securities in the society are defined. In our contemporary society, these securities take especially the form of money; however, in the case of this novel's *'Bitchun society'* the social benefit represents an access to basic commodities, seamlessly abundant. Thus, even though necessities can be relatively fulfilled limitlessly, other services and products can be accessed only once you raise your reputation score.

The Culture series is the one which defines itself as the *'true abundant'* society. Inhabitants of the planet no more work, they have been substituted by physical representatives of the Hub (a place storing the Mind, basically the hardware dome), governed by the Mind (Artificial intelligence occupying the Hub): *'millions of human-form representative entities called avatars'*, which are capable to *'deal(s) on a one-to-one basis with its inhabitants.'* Argument could be applied that a scarce labour has been replaced by scarce *Avatars*, not eliminating the scarcity, only changing a scarce variable for another one. This argument could hold if the Mind would not exercise inhuman capabilities thanks to the computational raw power of the Hub: *'It is theoretically capable of running each of those and every other system on the Orbital directly while communicating individually with every human and drone present on the world, plus a number of other ships and Minds.'* (Banks, 2010, p. 276)

Only the idea of having produced landscape to one's desires means that the inhabitants of the Culture were not only granted ability to consume limitlessly, but the AI has been able to transform non-economic goods to economic ones through the Artificial Intelligence as well, increasing the boundaries of what the consumer can consume. However, how this artificial intelligence exercises such a magnitude of tasks is unknown.

4.3   Presence of a Medium of Exchange

If we recapitulate the knowledge we have received from the previous two chapters, we can identify that most of the authors do not fulfil the conditions for elimination of scarcity either from labour or natural resources/land, except from the Culture series by I. Banks. This means that if scarcity is still prevailing in these novels, the presence of medium of exchange is inevitable.

In *Moving the Mountain* and *Riders of the Purple Wage*, both authors use money to identify what should be produced from the scarce resources. Even though that goods you are paying for seem to be in these novels as relatively cheap, scarcity implies that certain products need to be more expensive than the others due to their properties. The importance of money is proposed in the following sentence: *'It's as big a place as being head of Harvard College,'* she said, *'and better paid than that used to be'*, applying that diversity on markets is still there and highly-paid people can live wealthier than the others. (Gilman, 1911, p. 198)

Riders of the Purple Wage provides a more elaborated insight into the problematic. The author implies that the government redistributes a certain amount of money to everyone, a certain guaranteed income: *'[…] those on the purple wage get their goods and those with extra income get their goodies'*. This basic income (= purple wage) can be used only for obtaining certain commodities, possibly basic needs (food, shelter, water, etc.), while an additional income covers utility gained from wants. The limitation of what can one buy supports the fact the world has not achieved a full post-scarcity production, therefore, there is still limitation in the production capabilities and it requires working to obtain more from society. Scarcity is perfectly depicted on the inability to obtain what is desired: *'Trouble is, he's short of units and coupons and can't buy the materials'*, applying that through negatively perceived actions the purple wage can be reduced as well: *'But Mama spends far too much and also is addicted to gambling, a vice which deprives her*

of her full guaranteed income.' This forces the main character to work *'by selling or trading his paintings'*, implying that the money still has to be earned in order to gain access to more services and goods. (Farmer, 1992, p. 83)

According to the author, creating the purple wage was the direct answer to the problem which economies face: overpopulation and automation. The term overpopulation bears Malthusian's feeling and unfortunately is not the best one to be used; as it has been proved that overpopulation as a theory doesn't hold up (Longman, 2004). Author doesn't identify any other variation which would be more beneficial and would solve both problems at the same time, otherwise forcing us in an indecisive loop of which problem to support: *'Buridan's ass, dying of hunger because it can't make up its mind which of two equal amounts of food to eat.'* (Farmer, 1992, p. 82)

When money becomes obsolete, to what kind of medium can we derive scarcity in society? Later in the first novel *Red Mars* a full-scale *'eco-economics'* is proposed; a distribution system reflecting the arising post-scarcity. It is structured on a system of complex mathematical equations deriving *'how many calories we create by our efforts or send on to future generations […].'* The system is *'very indirect, naturally, and it involves a lot of speculation and subjective judgment'*, but due to the author's immersive notion towards high scientism, he assumes *'to simply assign certain calorie-equivalent numerical values to all kinds of activities'* to stabilize the system. Such complexity arises from the notion of non-physical contribution to society in the form of services and culture, whose output cannot be physically measured and thus the energy output derived is highly unlikely to be identified. However, author identifies the main driver of the change of caloric outcome is located within its *'ecological efficiency by efforts to reduce how many kilocalories they use.'* This performance evaluated structure can be asserted to each and every job and rank them were bottom-lined, most inefficient ones are *'parasitical jobs that add nothing to the system by an ecologic accounting.'* This happens as

they *'predate on the system without having any predators, in other words, produce meaningless outcome (energy) willing to consume by no-one.'* The author furthermore suggests that *'The entire […] executive class does nothing a computer couldn't do,'* giving out the notion that computer systems and presumably artificial intelligence applied in these places would significantly improve ecological efficiency of the system. (Robinson, 1993, p. 292–294)

How such evaluation of the system can be elevated to a *'cognitive'* rationality level? Presented is a data set of what economic rational Martians considered as the most impactful on their living: *'that our best to calculate what they contribute back to the system in terms of well-being, and for transfiguring this economic rationality to be measured as a physical thing'*. The common physical thing is considered to be economic necessity *'What does the activity equal in terms of food, or water, or shelter, or clothing'*, even though a relevancy is found as well in *'medical aid, or education, or free time.'* (Robinson, 1993, p. 295)

A different concept is proposed in the novel *Down and Out the Magic Kingdom.* The author creates a so called 'Whuffie', a reputation-based currency. It works on the premise of actions people undertake continuously, then evaluated by others based on how favourable or unfavourable the action is perceived. Simultaneously, this alternates the Whuffie score. Doctorow (2003, p. 15) however claims that even if you were *'broke but respected, you wouldn't starve; contrariwise, if you were rich and hated, no sum could buy you security and peace.'* Human behaviour, or rather self-esteem, becomes a direct source of your *'price'* in the society. Such implication strongly supports the doing of what a man likes to do, not where he is paid the most, as no longer post-scarcity (in most of the cases) does reflect itself on wages and salaries (the scarcer the skill, the higher the payment). As long as they are happy doing what they do, the Whuffie will stay relatively favourable.

Whuffies act more like a scale, a meter: the higher your respect is the more commodities and services you are allowed to consume, and

vice-versa. This can be rather confusing at the beginning as the main character says that he *'pissed away most of my Whuffie – all the savings from the symphonies and the first three theses [...], until I'd expended all the respect anyone had ever afforded me'*, suggesting the possibility that he had to pay by his earned score in order to receive services and goods. Luckily, the author clarifies the statement right away by saying *'I'd pretty much—drinking myself stupid at the Gazoo, hogging library terminals, pestering profs'*, elaborating on the idea that the main character *'misbehaved'* and his actions were deemed as unfavourable ones, lowering his Whuffie in process. Not spending, but countervailing measures in form of negative scores are a reason for someone's decline of Whuffies. (Doctorow, 2003, p. 14)

Even though this concept looks very favourable, it still suffers: your actions may receive you positive reputation if you are acting on the behalf of a popular opinion at the expense of public discourse. At the same time, it does not offer a weight of importance/difficulty to the given action evaluation (even though this could be justified by the perceived utility for the action; the same cup of coffee could be worth for someone 2 Whuffies and for someone 10 Whuffie). Unlike to money, the Whuffies' history of *'transaction'* is publicly available on a network to review with access for everyone, securing a publicly, peer-to-peer controlled system.

Moreover, the rule *'the death of scarcity'* is in conflict with the idea that people, even though voluntary, still undertake jobs in order to increase their prestige and thus wealth.

Iain M. Banks (2017, p. 7) perceives medium of exchange, money, as *'a sign of poverty'* and tool that *'implies poverty'* throughout his first novel *The State of the Art* from the *Culture* series. Medium of exchange is irrelevant to discuss once the Artificial Intelligence becomes present and eradicates scarcity both in labour (artificial intelligence and machines) as well as in resource scarcity (large uninitiated landscapes, produced by Artificial Intelligence on command). A well

proposed argument occurs in the novel Look to Windward, where a character discusses what a word *'holiday'* in scarcity economy represented: *'People had to do all the work and create wealth for themselves and society and so they couldn't afford to take very much time off. So they worked for, say, half the day, most days of the year and then had an allocation of days they could take off, having saved up enough exchange collateral.'* But the Culture does not live in *'Age of Scarcity'* anymore, eliminating the primitive stuff, money at process. (Banks, 2010, p. 12)

However, I. Banks still admits that artificial scarcities can occur from time to time, breaking the established cycle and retracting the temporary need for a medium of exchange into the system. A perfect example of such scarcity is provided in the novel *Look to Windward*. A famous composer creates a symphonic orchestra masterpiece, which takes place at the largest possible stadium at The Culture's orbital at the specific time to commemorate anniversary of a great galactic war. Due to the one-time occurrence and restricted amount of capacity of the facility (producing scarcity), the Avatar (representation of The Mind, artificial intelligence) proclaims that the inhabitants are *'reinventing money'* by forcing themselves to obtain tickets by doing favours to please the others in order to receive one: *'People who can't stand other people are inviting them to dinner, booking deep-space cruises together – good grief – even agreeing to go camping with them [...], have traded sexual favours, they've agreed to pregnancies, they've altered their appearance to accommodate a partner's desires, they've begun to change gender to please lovers; all just to get tickets.'* The Avatar concludes that *'Suddenly everybody's a live symphonic music fan.'* applying how rarity of an event or product alters the taste and impacts the demand of the consumer for it. Otherwise overlooked product becomes perceived differently due to the change in perception, alternating emotional attachment towards consuming, increasing or decreasing the demand for it. (Banks, 2010, p. 349)

5 THEORETICAL INSIGHTS
AND OBJECTIVE JUDGMENT OF CLAIMS

Even though that the representative novels suggested that post-scarcity occurred, it isn't true. For the post-scarcity to truly be reached, the labour and land scarcity has to be fully wiped out, alongside with the eradication of medium of exchange. All three of these conditions are not fully satisfied in most of the theories. In *Moving the Mountain*, the theory heavily draws from the success of its labour, implying the importance of education and immersive distribution of labour. If such model is run in the long-run, the society will keep facing the labour scarcity and thus will not be able to elevate itself to a next step in reaching post-scarcity. Moreover, the society hasn't achieved similar benefits like in agriculture; therefore, scarcity is still prevailing and requires money as a medium of exchange to resolve it. Similar problems occur in the novel *Riders of the Purple Wage.* To enjoy more commodities, you are required to work to get money. Wants (and as the author suggests, partially even needs) cannot be fully satisfied by universal basic income. Dependency on the labour is no longer perceived as the most useful stimuli for abundance to occur. Scarce resources are still prevailing, even though the processing of them has progressed substantially.

In the Mars trilogy, we take a step further. The society developed on Mars no longer pursues a capitalist market; money is not present but substituted by ideological redistribution of commodities and services upon amount energy transformed into the society due to your doings. This means that work is still prevalent and required for the people to conduct in order to enjoy wider range of commodities. Even though the machines have been able to build themselves as well as to conduct most of the physical work on behalf of the people, scarcity is still prevailing.

A similar scenario is in *Down and Out Magic Kingdom*, where output is redistributed upon your social score – the higher the score, the wealthier you are. However, this novel eradicates the concept of death, where immortality gives you the chance to regain the social perception. The arising question is whether such principle cannot be abused easily? Will there be enough output to satisfy the demand once many inhabitants will become significantly rich due to the fact that they defined each other as respectable? If not, would it lead to a devaluation of 'Whuffie'? At the same time, the concept of *'death of scarcity'* doesn't hold due to the prevailing use of medium of exchange.

These four theories cannot be labelled as one which transformed themselves into post-scarcity; however, can be perfectly sorted into a category of socialism utopia theories. They enwrap themselves in a peaceful world full of benefits, which are mostly driven by recognition of a contribution to a common wealth.

The only example from this is the I. Banks *Culture* series. The society is developed to such extent that no one has to work in order to consume and can consume whatever they demand. If those attributes are resolved as fulfilled, medium of exchange no longer persists. It is true that artificially created scarcities can occur from time to time as was shown, whilst reinventing an undefined medium of exchange, which greatly diversifies from individual to individual.

6   DISCUSSION AND SUGGESTION FOR FURTHER RESEARCH

As the outcome of the literature suggests, the nature of the theories lie in the paradigm shifts in socio-economic factors. Transformation of these factors is trigged by industrial revolutions (Nochteff, 1988) and is clearly perceived within the reviewed literature. From a rise of international trade of manually constructed goodies known as proto-industrialization (Ogilvie and Cerman, 1996) exploited to a first industrial revolution, breaking any commonly established economic theories (Clark, 2014). Massive mechanization took place as a response, making the Great Britain a leader in agriculture and textile production (Allen, 2011), enveloping further to labour distribution and its specialization (Smith, 2007).

The second industrial revolution exploited these factors even further thanks to the utilization of gas and petrol for chemical synthesis and automotive industry (Jevons, 1931). However, negative consequences of this industrial revolution had emerged as well. The labour force was formed by people of all categories (Berg and Hudson, 1992), where children were no exception (Humphries, 2013); unsatisfactory working conditions and unsustainable working hours present (Clark, 2005). Environment was affected as well to the extent that it reciprocated and requested regulations to reduce not only natural damage (Foster, 1999), but as well health issues due to the incorporation of chemical processes and the lack of their safety regulation (Le Roux, 2018).

These negative outcomes gave birth to two economic ways of thought in 19th century: utopian socialism, which desire was to create a harmony in small society structures, where everyone played certain part (Miller, 2008); and scientific socialism, represented by a strong class ideology, common wealth and subjecting capitalism to a self-destructing, unsustainable concept (Leontiev, 1946).

As most of the reviewed science-fiction literature built heavily upon first and second industrial revolution, mostly upon its failures; and was being written during the boom of computing power and a possible birth of artificial intelligence (Folliet and Cunneen, 1957), it tends to strongly depict socialistic-utopian world transcended after third industrial revolution. How far these theories predict the development and how correct are they?

Further research shall be focused on comparison of the current economic theories trying to predict the inevitable socio-economic paradigms thanks to the upcoming fourth industrial revolution and contrast them with the science fiction literature. Industry 4.0 built itself on the success of robotics, artificial intelligence and cheaper production (Schwab, 2017), but rises a question whether the labour markets are flexible enough to accommodate these changes (Ford, 2018). Would the solution be based in the basic income distributed equally to everyone as a social security to help them leverage the negative consequences of the Industry 4.0 (Downes and Lansley, 2018), a payment similar to the one in the *Riders of the Purple Wage* (Farmer, 1992)? Or do the theories go beyond Industry 4.0, into socio-economic paradigms such as those presented in Technological Singularity theory (Raulerson, 2013), where the artificial intelligence will be on par of humans (Shanahan, 2015), extensively prolonging our life-spans (Thompson, 2012) and starts with terraforming (Neyrat, 2019), just like in *The Mars* series (Robinson, 1993) or in *Down and out of the Magic Kingdom* (Doctorow, 2003)? How well do these theories reflect (if at all) the sublimation of human and artificial into a singular seamless society, where the human consciousness remains on top and keep control over all the process just like predicted in Marx's *Fragments on the Machines* (Marx, 1973) – or is the other way around? I believe such pluralities within real economic theories and science fiction literature can be identified, moreover, economic theories can be positively influenced by recognizing and implementing possible details of economic outcomes which they have not thought about yet.

7   CONCLUSIONS

Even though the limitless conceptual factor provides the authors with the power to create scarcity unbound societies, they do not do so. However, we can still draw conclusions from this paper and suggest possible outcomes.

Firstly, it is a common denominator that the post-scarcity-like (= almost abundant) state always occurs and/or originates in a certain economic sector; meaning it cannot be triggered by multiple sectors at same time. This could imply that the world economies shall look for the signs of abundance in one sector, focus on its continuous stimulation to the point it starts to lower the prices in response even in other sectors. Such trigger-sector would transpose itself to the point it would no longer be deemed profitable and exploitable from a capitalistic point of view (= generate a profit).

Secondly, the theories suggest that it is easier to eradicate scarcity within the resources than from the labour itself. This means that we can obtain products cheaper by focusing on imprinting technological innovation into the production process, lowering the overall costs instead of trying to eliminate the human impact from the production process, which seems to be rather impossible. Every novel besides the Culture series perceives the work as a still necessary variable, especially for the accumulation of more wealth (*Moving the Mountain*, *Riders of the Purple Wage*, *Down and Out of the Magic Kingdom*, *Mars* trilogy).

Thirdly, there seems to be a certain impact of freedom of markets and liberty towards eradication of scarcity. The more liberal the environment seems to be in socio-economic terms, the more likely signs of output abundance starts to occur in technologically strongly dedicated economic sector (especially quaternary industry). On the other hand, authoritative approach and centralisation indicates that abundance will appear in less technologically depending sector (primary sector).

To sum it up, the theories due to their utopian movement rather than post-scarcity notion still bear interesting ideas of the socio-economic structures, where abundance is the main building structure to follow. A further research could be conducted in the identification of how these theories perceive utility maximization as a process eventually leading to the bliss point or how institution of religion impacts the development of the socio-economic variables.

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