Internal and external sources of technology: The impact of the sourcing balance on the transformative- and innovative capacity of a company

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The present paper investigates how the sourcing balance impacts the two R&D capabilities 'transformative capacity' and 'innovative capacity'. Based on previous examples of companies, in which the sourcing policy affected either one of the capacities, this paper proposes the sourcing balance as a tool to increase those two R&D capabilities. This study provides additional theoretical background on the effects of transformative capacity and innovative capacity and why a company is advised to achieve high performance in both activities. The relationship between the sourcing balance and the two constructs was expected to be positive. The findings, however, found no evidence that the sourcing balance has an effect on either transformative capacity or innovative capacity.

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Keywords:
Sourcing Balance, Innovation, Research and Development, R&D, Transformative Capacity, Innovative Capacity, Exploitation

7th IBA Bachelor Thesis Conference, July 1st, 2016, Enschede, The Netherlands.

1. INTRODUCTION

Research and development (R&D) has been prevalent in a lot of companies over the years and can influence the survival of a firm; especially high-tech companies are dependent on innovation. R&D is composed of the innovation activities of a firm: creating new technologies, knowledge through internal or external means. Companies engage in R&D activities for several reasons. The value of a firm can be can be influenced by the R&D capabilities of a firm (Connolly & Hirschey, 2005). Collins and Porras (1997) describe that the reliance on commitment to R&D is one of the characteristics of successful, long lasting and visionary companies (Collins & Porras, 1997). There is an importance for businesses not only to exploit their current knowledge, but also to explore new technologies in order to stay competitive. Innovation can provide unique opportunities for firms that can lead to a competitive edge that could not have been achieved otherwise. Investment into R&D is the main source of product innovation and superior returns (Kor, 2006).

Several scholars see expenditures in R&D activities as a prerequisite for a company's innovation endeavours (Frenkel, Shefer, Koschatzky, & Walter, 2001; Shefer & Frenkel, 1998). Schefer and Frenkel (2005) call R&D activities the "catalyst for innovative industrial activities, and ultimately […] responsible for the growth in productivity and total revenue (Shefer & Frenkel, 2005, p. 30). Because of the importance of R&D activities for a firm, companies are keen on improving their R&D capabilities. But not only can the R&D capabilities improve the general performance factors of a company, they can improve the innovation performance of a firm. Innovation has become a highly important factor for a company, substantial for their survival and growth (Shefer & Frenkel, 2005). Additionally, innovation has been recognized by several scholars to be the foremost function for a company to stay competitive and profitable (Erden, Klang, Sydler, & von Krogh, 2014; Kessler & Chakrabarti, 1996).

In order to tackle the challenge of creating innovation, a company can either choose to source their innovation externally through customer involvement and collaboration with strategic partners or decide to create the knowledge with internal R&D activities (Tsai, Hsieh, & Hultink, 2011). For several decades internal R&D was prevalent, but in newer times a shift to a more open R&D has been recognized (Hagedoorn, 2002). In today's age the environment is becoming increasingly more competitive, forcing companies to steadily invest in innovation activities, which causes R&D activities to shift from internally closed departments to a more open R&D structure by including external sources of knowledge through licensing, alliances and technology agreements (Hagedoorn, 1993). The sourcing balance measures where the knowledge exploration takes place and where the technology is acquired. It is also known as the 'make-or-buy' decision (Cassiman & Veugelers, 2006).

The literature suggests that a company which is making use of internal and external sources of knowledge generally achieves a higher innovation performance (Berchicci, 2013; Cassiman & Veugelers, 2006; Hargadon & Sutton, 1997). Yet, in a recent study it was found that the firm's ability to explore knowledge internally and or externally does not affect the innovation performance (Zaadnoordijk, 2012).

However, it was found that the two other R&D activities transformation and exploitation positively influence the innovation performance (Berchicci, 2013; Zaadnoordijk, 2012; Zahra & George, 2002). Transformation refers to the ability of a company to manage their knowledge base and how well the company is able to activate that existing knowledge stock. Exploitation is the ability of a company to apply existing and new knowledge into new products or services. In a study it was found that the company Cisco Systems had a high innovative capacity, due to them sourcing from external and internal sources of knowledge (Moore, 2007). The literature lacks further research on this topic. Since companies desire a high innovation performance, transformative capacity and innovative capacity have been found to directly affect innovation performance. The purpose of this research is to show how the policy of sourcing knowledge can impact the R&D capabilities of a company and to what extent a company needs to adjust their sources of knowledge to achieve the maximum R&D potential. This paper suggests to have a look in what way the sourcing balance is a possibility to influence the transformation and exploitation capability of a firm.

In order to do so, this paper will examine in what way the transformation and exploitation activities can be affected by the sourcing balance and thereby this paper is suggesting another method of improving the innovation performance through the improvement of transformation capacity and exploitation capacity. The potential implications of this research are that companies need to pay more attention to their sourcing balance, because it would need adjustment to achieve maximum performance or that a company is now aware that the sourcing policy will not affect the two introduced R&D capabilities. In other words that would mean a company can easily add external sources into their knowledge stream without having to fear that R&D capacities suffer.

Therefore, the following research question will direct this paper

> How does a firms' sourcing balance affect the transformative capacity and the innovative capacity (exploitation)?

To test this effect, the research will examine how the propensity to acquire external sources of knowledge relates to the performance of transformation and exploitation. This paper is structured the following way. Section 2 defines the theoretical. Section 3 will include the methodology. The analysis is split in section 4, the data analysis, and section 5, the results, including the hypotheses test. In section 5 and 6 the discussion and conclusion can be found and lastly the section 7, the implications of this study for practice.

2. THEORETICAL BACKGROUND

2.1 Transformative capacity

Transformation is an activity that is part of knowledge retention and indicates a company's capability of internally retaining knowledge over time and being able to reactivate it. The activity connects the two other internal R&D abilities of knowledge exploration and knowledge exploitation. A firm's knowledge stock size influences the ability to maintain and reactivate additional knowledge (Garud & Nayyar, 1994). A high knowledge stock aggregated in a given field makes it easier for the company to further develop new knowledge and use the existing in that field. Dierickx and Cool (1989) further state that "firms who already have an important stock of R&D know-how are often in a better position to make further breakthroughs and add to their exist-

ing stock of knowledge than firms who have low initial levels of know-how" (Dierickx & Cool, 1989, p. 1508). Furthermore, studies show that transformation capacity positively influences the innovation performance of a firm (Berchicci, 2013; Zaadnoordijk, 2012).

Companies that rely on their knowledge base are therefore advised to have a strong transformative capacity, so can they can exhaust the full potential of their acquired knowledge. That is way, for instance, IBM has built up a strong transformative capacity to exploit their substantial knowledge base (Chesbrough, 2003; Dittrich, Duysters, & de Man, 2007). As a result of that learning process, IBM has managed to become the company with the most patent applications worldwide (Dittrich et al., 2007). Xerox, on the other hand, has built up a large knowledge base through internal sourcing, however, they were not able to transform that knowledge and adapt to new market situations because they failed to developed a strong transformative capacity to retain that knowledge (Chesbrough, 2003; Loutfy & Belkhir, 2001). The literature does not provide further information on the reasons why Xerox was not able to develop a transformative capacity, but the focus on only sourcing internally might suggest a reason. In general, not only maintaining of the existing knowledge base is important, but the quality of the transformation process affects how well newly created knowledge is embodied, and therefore indirectly how well the company is able to exploit its existing knowledge into new products or services. In summary, the transformation activities consist of all the process stages of maintaining knowledge in a firm's knowledge stock (Garud & Nayyar, 1994)

2.2 Innovative capacity

Innovative capacity, also called exploitation, is defined as a "firm's ability to internally exploit knowledge" (Lichtenthaler & Lichtenthaler, 2009, p. 1321). Exploitation is engaged with combining market knowledge with technology knowledge. Through the linking of technological knowledge with market knowledge, a company is able to commercialize its knowledge. The innovative capacity determines other factors as well. Without a firms exploitation ability a firm is not able to exploit and apply the knowledge it has generated over time (Lane, Koka, & Pathak, 2006). In addition, a well performing exploitation process allows a company to gain the benefits from using both internal and external sources to explore knowledge more effectively (Lichtenthaler & Lichtenthaler, 2009; Tsai et al., 2011). Application of knowledge from either internal exploration or acquired from external sources is a further aspect of exploitation.

There is a lack of research whether the origin of knowledge affects the innovative capacity, i.e. if either external or internal sources perform better or the same. However, in a study by Moore (2007) the case of Cisco was examined, and he found that Cisco was using both internal and external sources of knowledge and, because of that sourcing policy, was able to develop a strong innovative capacity (Chesbrough, 2003; Moore, 2007). Because innovation is often the result of combining or re-combining existing ingredients of knowledge with new knowledge, exploitation is a highly important aspect of the R&D activities and to the company in general (Anderson & Tushman, 1990; Henderson & Clark, 1990; Kogut & Zander, 1992). Moreover, it was found that the innovation performance can directly be positively influenced by exploitation (Zaadnoordijk, 2012; Zahra & George, 2002). In conclusion, the innovation capacity includes all stages of transforming knowledge and consequently applying this knowledge into new products and services fit for the market (Khilji, Mroczkowski, & Bernstein, 2006).

2.3 Sourcing balance

In order to come to an answer for the research question this study will examine the outcome that sourcing balance has on the two introduced R&D capabilities. The aim of the sourcing balance is to determine the origin of technology sources. The sourcing balances measures the propensity of firms to acquire technology external (Jones, Lanctot, & Teegen, 2001). A low sourcing balance would mean that a company is sourcing all knowledge from internal sources only. A medium sourcing balance would mean that a company is sourcing mostly of their knowledge from internal sources and is not actively looking for external sources, but uses them on the occasion. High sourcing balances assumes that a company is actively engaging in both external and internal knowledge exploration activities.

Both external and internal sourcing can have benefits. External sourcing of R&D can be less expensive and therefore better suited for smaller companies, while internal R&D, which is more expensive and done by larger companies, has the advantages of acquiring the technology exclusively (O'Regan & Kling, 2011).

In the example of Cisco, which got presented in the theoretical background, it was found that the sourcing from both internal and external sources led to an increase of the innovative capacity of that firm. The paper assumes that the cause for the increase was due to the fact that knowledge exploration happened internal as well as external (Moore, 2007). The effect observed in that paper would correspond to a high sourcing balance, which is why the sourcing balance is expected to positively influence exploitation. Since transformative capacity is the link between the exploration and exploitation of knowledge, this study expect the effect to behave the same way as for the innovative capacity. Moreover The literature also examined the case of Xerox, which had only sourced internally and couldn't build up a transformative capacity to apply that knowledge in new products (Loutfy & Belkhir, 2001). The case of Xerox relates to a low sourcing balance.

This leads to the two following hypotheses:

H1: Sourcing Balance has a positive effect on transformation capacity (transformation).

H2: Sourcing Balance has a positive effect on innovative capacity (exploitation).

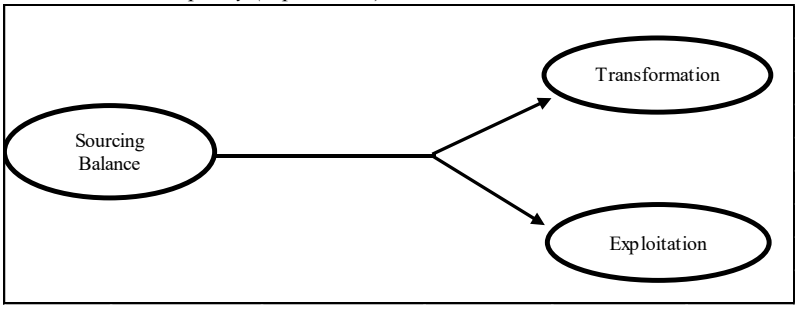

Figure 1: Research mode

3. METHODOLOGY

The dataset consists of data collected by Zaadnoordijk (2012) carried out in 2011 to 2012 through an online survey in the Netherlands with a response rate of 56 companies. In addition, that same survey was sent out in 2016 to 275 companies based in the Netherlands. For the survey we used the same criteria as Zaadnordijk's. We had 14 responses thus far, however, we were not able to use any new data, because of time constraints.

The survey was developed by Zaadnoordijk (2012) based on an extensive literature review. The items were measured on a 7-point Likert scale, ranging from "strongly agree to" to "strongly disagree".

The original sample of Zaadnordijk consisted of 600 medium sized High Tech firms located in the Netherlands. The companies were selected through the Dutch database 'company.info'. Zaadnordijk refined this sample based on short interviews by telephone ensuring the firm met the requirements. Firms had to have a staffed in-house innovation department, have at least 100 FTE and had to be willing to participate. Of the firms which met the requirement 218 agreed to participate. The criterion to have at least 100 FTE stems from Zaadnordijks assumption that in small companies, individual efforts play a larger role in certain task performances than the actual process does.

The firms were sent a personalized paper invitation which was directly followed up by a personal invitation e-mail. The first wave resulted in 27 usable responses. After one month, a reminder was sent yielding another 19 responses. The third wave was a follow up by telephone yielding ten additional responses. Finally, 56 responses were received, which is a 25% response rate and deemed quite high for studies directed at top managers (Gruber et al., 2010). The data was collected from November 2011 until January 2012. The firms all originate from one of the following industries; chemicals, pharmaceuticals, metals, electronic devices, and computers and optical devices. Firm size varied from less than 150 (19.6%), 150 to 300 (24.8%), 300 to 500 (27%) and more than 500 employees (28.6%)(Zaadnoordijk, 2012).

3.1 Dependent variable

Transformative capacity is the first dependent variable and consists of the two activities 'maintain' and 'reactivate'. 'Maintain' addresses the firm's actions of retaining and storing knowledge, while 'reactivate' comprises the activities that capture whether a firm can quickly react to opportunities by relying on its existing knowledge (Lichtenthaler & Lichtenthaler, 2009). The questions in the survey are based on Lichtenthaler and Lichtenthaler (2009) and try to answer the two before mentioned concepts and thereby measuring the transformative capacity. The questions are answered in a 7-point Likert scale, ranging from "strongly agree to" to "strongly disagree".

The second dependent variable is the innovative capacity, also known as exploitation. It consists of the two concepts of 'transmute' and 'apply'. The questions for 'transmute' try to identify the firm's ability of combining new and existing knowledge. 'Apply' considers how easily a firm is able to implement technologies in new products and if the company constantly considers how to better exploit technologies (Lichtenthaler & Lichtenthaler, 2009). All questions are based on the findings of Lichtenthaler and Lichtenthaler (2009) and are designed to answer the innovative capacity of a company. The score of the individual items were summed up and the mean of the scores correspond to the value of the construct.

3.2 Independent variable

The sourcing balance is the independent variable, a measurement construct adopted from Jones et al. (2001), and is operationalized to measure the propensity of firms to acquire technologies externally. The underlying principle for this paper is that internal sourcing is always happening and the sourcing balance is measuring to what extent the company is using additional external sources.

A high sourcing balance assumes that the company is using both external and internal origins as sources for new technology, whereas a low sourcing balance assumes that a company is only using internal sources. In our database, it showed that no company relies only on external sourcing.

The questions were aimed to identify to what extent the firm sources technologies internally or externally. They were answered in a 7-point Likert scale, ranging from "strongly agree to" to "strongly disagree". The mean of all items corresponds to the value of the variable.

4. DATA ANALYSIS

All tests and statistical methods were conducted with IBM SPSS 23.

In the beginning of the data analysis a Shapiro-Wilk and Kolmogorov Smirnov (KS) test were conducted to test for normal distribution. Sourcing balance tested significantly not normally distributed for Shapiro Wilk (0.012), but normally distributed for KS (0.058), which is a more conservative test. Innovative capacity tested significantly not normally on both tests (0.03; 0.30). Transformative capacity was tested normally distributed (0.087) on Shapiro Wilk, but significantly not normally on KS (0.05).

Table 1: Reliability and validity

	KMO	Cronbach's Alpha	Average Loading
Sourcing Balance	0.778	0.864	0.77
Exploitation	0.809	0.845	0.788
Transformation	0.762	0.887	0.771

In order to test for reliability, the Cronbach's Alpha analysis was used. A Cronbach's Alpha value above 0.7 is a widely suggested minimum(Veaux, Velleman, & Bock, 2014). The Cronbach's Alpha was above 0.7 in every case, therefore, the data gives no evidence to question reliability.

Additionally, the validity was tested. The Kaiser-Meyer-Olkin criterion (KMO) was found above 0.7. A KMO above 0.7 is acceptable, therefore making the data suitable for a factor analysis. However, since all constructs were already tested for validity in the work of Zaadnoordijk (2012), we only tested the average loading factors for each items of the construct through a principal component analysis (PCA). In that analysis, the results were above 0.7 in every construct, and since 0.7 is widely regarded an appropriate minimum, it led us to conclude that the validity of the construct is not a reason for concern (Veaux et al., 2014). The PCA can be found in the appendices.

In order to check for a common method bias (CMB), a Harman single factor test was conducted. The test included all the items from all constructs into one single factor analysis to determine whether the majority of the variance can be explained by one general factor. The result of the Harman single factor analysis showed that, 39% of the variance could be explained through a single factor. A score below 50% is acceptable to conclude, that there is no CMB (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).

Table 2: Distribution

	Transformation	Exploitation	SourcingBalance
Std. Deviation	1,13	1,12	1,34
Mean	4,96	5,25	3,05
Median	5,14	5,40	2,75
Variance	1,28	1,25	1,80
Range	5,29	5,60	4,67
Minimum	1,71	1,40	1,00
Maximum	7,00	7,00	5,67

To give an overview about the distribution of the data, the frequencies will be analyzed.

The mean score for Sourcing Balance was 3.05 with a standard deviation of 1.34. Transformation had a mean of 4.96 and a standard deviation of 1.13. Exploitation a mean of 5.25 and a standard deviation of 1.12. The range of sourcing balance attracts attention. The potential scale ranges from 1 to 7, yet, the maximum is 5.67 only. For both transformation and exploitation there are cases that reach the maximum scale of 7, but no cases with only 1 point. Since transformation has a mean of close to 5 with a standard deviation of 1.13, the maximum of the range is close to 2 standard deviations away from the mean. According to the three-sigma rule of thumb, it therefore can be concluded that only approximately 5% have a score close to 7 (Veaux et al., 2014). For exploitation, the lowest score is approximately 3 standard deviations from the mean, which can be considered an outlier. We did not exclude that outlier because it did not influence the relationship we tested.

Since the exploitation mean and median is higher and the standard deviation lower, we can conclude through the variables' distribution that the exploitation abilities scored higher across the companies in general than transformation activities.

5. RESULTS

To determine the direction of the relationship both relationships were plotted on a scatterplot. Figure 2 shows the sourcing balance plotted against transformation. The best fit line is negative. The regression formula for the slope is y = 5.87 – 0.2 * x, which indicates a negative correlation and a negative slope. To further test the correlation, we conducted a Kendall Tau-B analysis. Kendall Tau-B is better suitable for smaller data sets and ordinal values as opposed to Spearman's Rho (Veaux et al., 2014).

The findings for the correlation of transformation and sourcing balance show a correlation coefficient score of –0.136 with a value of p = 0.077, making the correlation negative, but not significant. In addition, a correlation coefficient of –0.136 indicates a very weak correlation.

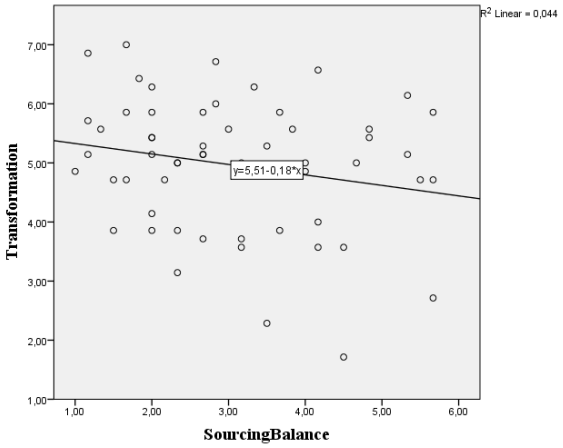

Figure 2: Plot transformation

Figure 3 shows the sourcing balance plotted against exploitation. The best fit line is negative. The formula for the slope of the regression line is y = 5.51 – 0.18 * x, indicating a negative correlation and a very low negative slope.

The Kendall Tau-B analysis for the correlation of exploitation and sourcing balance showed a negative correlation coefficient score of –0.182 with a value of p = 0.029, suggesting a significant, but weak, negative correlation

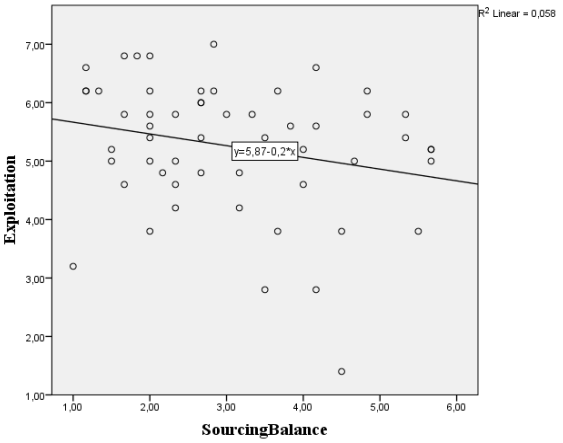

Figure 3: Plot Exploitation

5.1 Hypotheses Test

5.1.1 Hypothesis 1

The first hypothesis proposes a positive relation of sourcing balance to transformative capacity. Although the samples were not perfectly normally distributed, we decided to test this hypothesis using the general linear model in SPSS. The test was conducted with a significance level of $\alpha = 0.05$. The R^2 for the model is 0.044, which is a reasonably enough good fit (Veaux et al., 2014). The results of the test didn't show any significant effect ($F = 2.488$, $p = 0.121$) between the sourcing balance and the transformative capacity, which means there is no direct relationship between the two variables. Therefore, we reject hypothesis H1. The whole results can be found in appendices.

Table 3: Regression H1

Dependent Variable: Transformation					
Source	Type II Sum of Squares	df	Mean Square	F	Sig.
SourcingBalance	3,102	1	3,102	2,488	0,121
a. R Squared = ,044 (Adjusted R Squared = ,026)					

5.1.2 Hypothesis 2

The second hypothesis proposes a positive relation between the sourcing balance and the innovative capacity. Again the the relationship was tested with general linear model. The R^2 (0.581) is high enough to suggest a good fit of the model. The result ($F = 3.324$, $p = 0.074$) showed a better significance than for transformation, but the results still could not show any evidence for a significant effect between sourcing balance and innovative capacity. Therefore, we reject hypotheses 2. The complete results for this test can also be found in appendices.

Table 4: Regression H2

Dependent Variable: Innovative Capacity (Exploitation)					
Source	Type I Sum of Squares	df	Mean Square	F	Sig.
SourcingBalance	3,983	1	3,983	3,324	0,074
a. R Squared = ,058 (Adjusted R Squared = ,041)					

5.2 Additional Analysis

To provide an additional statistical method of testing the strength of the relationships of our constructs, a Spearman's rho analysis was conducted. The Spearman's rho test is a very widely used method of examining the direction and strength of two variables, useful with ordinal data and robust to outliers (Veaux et al., 2014). We wanted to examine if Spearman's rho gives us the same results as Kendall's Tau. Our results suggest a small difference to Kendall Tau-B. For transformation find a non-significant ($p = 0.085$) negative correlation (–0.186) was found, compared to Kendall Tau-B ($p = –0.077$, –0.136). For our second variable innovative capacity, we were able to find a significant ($p = 0.032$) negative correlation (–0.249), compared to Kendall Tau-B correlation (–0.182, $p = 0.029$). The Spearman's rho analysis had slightly higher correlations in both cases.

In order to have a more detailed look in the relationships of our constructs, we took a look at the impact of individual items of the sourcing balance and their effect on both capacities. The item that attracted our attention was about whether the firms spending more on developing their own product technology rather than on purchasing it from other companies. It caught our attention the most because it had a significant effect ($F = 7.897$, $p = 0.007$) with transformation and a significant negative correlation (–0,236). Since the item was reversely coded, it would mean that that a company which is spending more on developing its own product than on purchasing it also increases its transformative capacity.

6. DISCUSSION

In our theoretical background the examples of Cisco and Xerox were examined. In both companies the sourcing policy caused them to either increase or decrease their R&D capabilities. Cisco had a high innovative capacity because of sourcing externally and internally, whereas Xerox had a low transformative capacity because they only sourced internally. The findings of this study were contrary to the expectations. One significant but weak, negative correlation for sourcing balance with exploitation, was found, which would mean that the sourcing balance negatively influences the innovative capacity. However, after conducting a test through GLM we could not confirm any significant effect the sourcing balance has on either capacity. Therefore it can be concluded, that the addition of external sources of knowledge into the knowledge exploration stream does not have an effect on the two tested R&D capabilities. Despite the fact that the test showed no significant relationship the correlation between exploitation and sourcing balance should act as an indicator to warrant future research on that topic. In the provided example of Cisco (Moore, 2007), the degree to which sourcing was conducted externally was not revealed, knowing that could help in specifying a better suitable research model. The example of Cisco is supported by the work of Tsai and Wang (2008) and Cassiman and Veugelers (2006), who found that internal and external sourcing result in complementary effects. This paper however cannot support those findings. Both studies used a different way to operationalize the sourcing of knowledge, which is a possible cause that this paper could not provide any significant effects. Foremost both used one construct to measure the internal sourcing and another construct for external sourcing. In the work of Tsai and Wong (2008) internal sourcing was measured through the R&D stock and patent acquisition was used as a measurement for external procurement.

Cassiman and Veugelers (2006) measured the engagement of companies in external acquisition activities for external sourcing and for internal sourcing proxy variables for the internal R&D budget. It could also be the case that not the sourcing balances influences the R&D capacities, but that the R&D capabilities influence the company's decision where to source their knowledge.

The plots in the results section both showed a similar pattern, which supports the goes hand in hand with the assumption that transformation and exploitation go hand in hand and are linked in the knowledge creation process (Lichtenthaler & Lichtenthaler, 2009).

In the additional analysis we found out that one item of the sourcing balance had a significant relationship with the transformative capacity. The relationship suggests that a company, which is spending more on developing its own product rather than purchasing it, has a higher transformation performance than other companies. That would mean a company should spend invest more into the development of their own products to increase their transformation performance. This studies result do not give an explanation for that observed effect, therefore the relationship has to be studied in further research. Furthermore it is to be expected that internal R&D investments are going to have a diminishing return at one point(Cassiman & Veugelers, 2006).

7. CONCLUSION

This paper examined a possible way for companies to increase their R&D capabilities and consequently the innovation performance through the right sourcing of knowledge. We asked how the firms' sourcing balance can affect the transformation and exploitation of a company. We theorized, based on previous examples of companies, that sourcing balance has a positive effect on both capabilities. To examine the direction of the relationship, two correlation analyses for each relationship were conducted. Both correlations have been found to be weak and negative, but only in the

case of exploitation significant. In the general linear model, we tested the relationships and found neither transformation nor exploitation to be significantly affected by the sourcing balance. Based on the findings of this study, we therefore can answer our research question and conclude that the sourcing balance does not affect the two R&D capacities. This study implicates that a firm does not need to adjust their sourcing balance to achieve the maximum of their R&D capabilities, because the sourcing balance has no effect on the capabilities. In other words this paper did not find any effects on the performance of transformation or exploitation if a company adds external sources of knowledge as addition to their internal sources of knowledge.

8. IMPLICATIONS FOR PRACTICE

Since we could not find any significant effects of the sourcing balance in our analysis, we assess that a company cannot influence their transformation and exploitation capabilities with the right sourcing balance. A firm is therefore advised to look for other options to increase their R&D capacities and, in consequence, to achieve higher innovation performance. However that also means that a company can easily add external sources into their knowledge stream without suffering performance loss in the two R&D capabilities.

In addition companies can take away from this study that there is a significant indication that investing into the development of own products is positively related with the transformative capacity. However it should be noted that this relationship was only tested on a small scale and should only be taken as an indicator and other factors need to be taken into account as well.

9. LIMITATIONS AND FURTHER RESEARCH

This study had several limitations. The sample size (n = 56) was considerable small, leaving no room to analyze different size of companies or different industry sectors. The low sample size makes it hard to generalize the findings of this study. A second study with a higher sample size would be needed to give a more universal answer. In addition, the data at hand was gathered in 2011 to 2012 in a period of time where the Netherlands was struck by an economic crisis and the economy shrank by 1.2% (Centraal Bureau voor de Statistiek, 2012), which leads to the assumption that R&D was not of greatest importance to a company. Also, this study collected data at one point of time only. Therefore, this paper cannot make conclusions on how the sourcing balance affects the two R&D capabilities in a long term scenario. Further research over a certain period of time or repeated measurements at the same companies are advised. R&D is said to be a long term commitment, hence it would be a useful to compare the age of companies in future research. Moreover the data was not perfectly normal distributed, that is why a non- parametric test might have been suited better.

The construct that was used for determining the sourcing balance is a very abstract concept and relies on the manager to fill in the survey honestly. Donaldson and Grant-Vallone (2002) showed that the perceptions of humans can be skewed and people tend to evaluate performance of their company higher than it actual is (Donaldson & Grant-Vallone, 2002). In the additional analysis we tested several items of the variable sourcing balance and only one item was tested to have a significant relationship. Since other studies suggest a relationship between the sourcing policy and R&D activities (Cassiman & Veugelers, 2006; Dittrich et al., 2007; Tsai & Wang, 2008) the validity of the construct should be questioned. For further studies on the effects of the sourcing balance we suggest to use the raw percentage data of technology sourced either internally or externally. In the discussion two additional operationalizations for the measurement of the sourcing policy are presented. For further studies into effects of the sourcing balance those should be considered

The data of this study showed that the constructs of transformation and exploitation showed a significant relationship with each other in the data. That is why it would be of interest for future studies to include both constructs again and examine if they react different from another to an alternative operationalization of sourcing balance.

10. ACKNOWLEDGEMENTS

We would like to thank Marc Zaadnoordijk for allowing us to use his dataset.

11. REFERENCES

Berchicci, L. (2013). Towards an open R&D system: Internal R&D investment, external knowledge acquisition and innovative performance. *Research Policy, 42*(1), 117-127. doi:http://dx.doi.org/10.1016/j.respol.2012.04.017

Cassiman, B., & Veugelers, R. (2006). In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition. *Management Science, 52*(1), 68-82. doi:10.1287/mnsc.1050.0470

Chesbrough, H. W. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*: Harvard Business Review

Collins, J. C., & Porras, J. I. (1997). *Built to last: Successful habits of visionary companies.* . New York: HarperBusiness.

Connolly, R. A., & Hirschey, M. (2005). Firm size and the effect of R&D on Tobin's q. *R&D Management, 35*(2), 217-223. doi:10.1111/j.1467-9310.2005.00384.x

Dierickx, I., & Cool, K. (1989). Asset Stock Accumulation and Sustainability of Competitive Advantage. *Management Science, 35*(12), 1504-1511. doi:doi:10.1287/mnsc.35.12.1504

Dittrich, K., Duysters, G., & de Man, A.-P. (2007). Strategic repositioning by means of alliance networks: The case of IBM. *Research Policy, 36*(10), 1496-1511. doi:http://dx.doi.org/10.1016/j.respol.2007.07.002

Donaldson, S. I., & Grant-Vallone, E. J. (2002). Understanding Self-Report Bias in Organizational Behavior Research. *Journal of Business and Psychology, 17*(2), 245-260. doi:10.1023/a:1019637632584

Erden, Z., Klang, D., Sydler, R., & von Krogh, G. (2014). Knowledge-flows and firm performance. *Journal*

of Business Research, 67(1), 2777-2785. doi:10.1016/j.jbusres.2012.09.001

Frenkel, A., Shefer, D., Koschatzky, K., & Walter, G. H. (2001). Firm Characteristics, Location and Regional Innovation: A Comparison Between Israeli and German Industrial Firms. *Regional Studies, 35*(5), 415-429. doi:10.1080/00343400123360

Garud, R., & Nayyar, P. R. (1994). Transformative capacity: Continual structuring by intertemporal technology transfer. *Strategic Management Journal, 15*(5), 365-385. doi:10.1002/smj.4250150504

Hagedoorn, J. (1993). Understanding the rationale of strategic technology partnering: Interorganizational modes of cooperation and sectoral differences. *Strategic Management Journal, 14*(5), 371-385. doi:10.1002/smj.4250140505

Hagedoorn, J. (2002). Inter-firm R&D partnerships: an overview of major trends and patterns since 1960. *Research Policy, 31*(4), 477-492. doi:http://dx.doi.org/10.1016/S0048-7333(01)00120-2

Hargadon, A., & Sutton, R. I. (1997). Technology Brokering and Innovation in a Product Development Firm. *Administrative Science Quarterly, 42*(4), 716-749. doi:10.2307/2393655

Jones, G. K., Lanctot, A., & Teegen, H. J. (2001). Determinants and performance impacts of external technology acquisition. *Journal of Business Venturing, 16*(3), 255-283. doi:http://dx.doi.org/10.1016/S0883-9026(99)00048-8

Kessler, E. H., & Chakrabarti, A. K. (1996). Innovation Speed: A Conceptual Model of Context, Antecedents, and Outcomes. *Academy of Management Review, 21*(4), 1143-1191. doi:10.5465/amr.1996.9704071866

Khilji, S. E., Mroczkowski, T., & Bernstein, B. (2006). From Invention to Innovation: Toward Developing an Integrated Innovation Model for Biotech Firms*. *Journal of Product Innovation Management, 23*(6), 528-540. doi:10.1111/j.1540-5885.2006.00222.x

Kor, Y. Y. (2006). Direct and interaction effects of top management team and board compositions on R&D investment strategy. *Strategic Management Journal, 27*(11), 1081-1099. doi:10.1002/smj.554

Lane, P. J., Koka, B. R., & Pathak, S. (2006). The Reification of Absorptive Capacity: A Critical Review and Rejuvenation of the Construct. *Academy of Management Review, 31*(4), 833-863. doi:10.5465/amr.2006.22527456

Lichtenthaler, U., & Lichtenthaler, E. (2009). A Capability-Based Framework for Open Innovation: Complementing Absorptive Capacity. *Journal of Management Studies, 46*(8), 1315-1338. doi:10.1111/j.1467-6486.2009.00854.x

Loutfy, R., & Belkhir, L. (2001). 'Managing innovation at Xerox. *Research Technology Management, 44*, 15-24.

Moore, G. A. (2007). To succeed in the long-term, focus on the middle-term. *Harv Bus Rev, 85*(7-8), 84-90, 192.

O'Regan, N., & Kling, G. (2011). Technology outsourcing in manufacturing small- and medium-sized firms: Another competitive resource? *R and D Management, 41*(1), 92-105. doi:10.1111/j.1467-9310.2010.00626.x

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*(5), 879-903. doi:10.1037/0021-9010.88.5.879

Shefer, D., & Frenkel, A. (1998). Local milieu and innovations: Some empirical results. *The Annals of Regional Science, 32*(1), 185-200. doi:10.1007/s001680050069

Shefer, D., & Frenkel, A. (2005). R&D, firm size and innovation: an empirical analysis. *Technovation, 25*(1), 25-32. doi:http://dx.doi.org/10.1016/S0166-4972(03)00152-4

Tsai, K.-H., Hsieh, M.-H., & Hultink, E. J. (2011). External technology acquisition and product innovativeness: The moderating roles of R&D investment and configurational context. *Journal of Engineering and Technology Management, 28*(3), 184-200. doi:http://dx.doi.org/10.1016/j.jengtecman.2011.03.005

Tsai, K.-H., & Wang, J.-C. (2008). External technology acquisition and firm performance: A longitudinal study. *Journal of Business Venturing, 23*(1), 91-112. doi:http://dx.doi.org/10.1016/j.jbusvent.2005.07.002

Veaux, R. D., Velleman, P., & Bock, D. (2014). *Stats, Data and Models* (Vol. Third Edition): Pearson Education Limited.

Zaadnoordijk, M. (2012). The effect of sourcing balance on innovation performance and strategic flexibility.

Zahra, S. A., & George, G. (2002). Absorptive Capacity: A Review, Reconceptualization, and Extension. *The Academy of Management Review, 27*(2), 185-203. doi:10.2307/4134351

12. APPENDICE

12.1 Appendice I

Component Matrix[a]	
	Component
	1
Transformation01	0,790
Transformation02	0,790
Transformation03	0,811
Transformation04	0,896
Transformation05	0,839
Transformation06	0,730
Transformation07	0,541

Extraction Method: Principal Component Analysis.

Component Matrix[a]	
	Component
	1
SourcingBal 01	0,603
SourcingBal 02	0,798
SourcingBal 03	0,835
SourcingBal 04	0,827
SourcingBal 05	0,885
SourcingBal 06	0,668

Extraction Method: Principal Component Analysis.

Component Matrix[a]	
	Component
	1
Exploitation01	0,814
Exploitation02	0,852
Exploitation03	0,856
Exploitation04	0,864
Exploitation05	0,551

Extraction Method: Principal Component Analysis.

12.2 Appendice II

Dependent Variable: Exploitation					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
SourcingBal ance	39,876	24	1,662	1,788	0,064
Intercept	1106,272	1	1106,272	1190,645	0,000
Error	28,803	31	0,929		
Total	1614,280	56			
Corrected	68,679	55			
a. R Squared = ,581 (Adjusted R Squared = ,256)					

Dependent Variable: Transformation					
Source	Type II Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3,102[a]	1	3,102	2,488	0,121
Intercept	269,650	1	269,650	216,309	0,000
SourcingBalance	3,102	1	3,102	2,488	0,121
Error	67,316	54	1,247		
Total	1450,490	56			
Corrected Total	70,418	55			
a. R Squared = ,044 (Adjusted R Squared = ,026)					