Empirical analysis of Research and Development expenses in light of Chinese IP violations

Bachelor Thesis Bachelor Economics and Business Economics

Date final version: 16 august 2018

Student name: Wybe Wildenbeest

Student number: 385074

Supervisor: Dr. A. Erbahar

Abstract

This study looks in to the way intellectual property rights are granted in China and the effect this have on R&D expenses for non-Chinese firms. In light of international agreements regarding intellectual property, China does not comply. This also follows from the dispute settlement the United States and others have applied for at the WTO. This study looks in to relationship between the presence of non-Chinese firms in China, given these violations, and the effect this has on the innovation expenses. The data of twelve non-Chinese firms was collected over the period 2000 – 2017. Panel data analysis shows relative R&D expenses can be explained by the relative share of turnover achieved in China, operational profit and the industry firms operate in. With and without these control variables, the presence of non-Chinese firms in China has a significant positive effect on the level of relative R&D expenses. This is surprising, as it is generally assumed that violation of intellectual property rights leads to a decrease of innovation expenses.

Contents

I. Introduction

Innovation and Economic Development

Innovation is an important factor in generating more welfare. Due to innovation, production techniques are improved. Thereby, products are produced more efficiently or of a higher quality. Less resources are needed and thereby less money is spent. This leads to cheaper or better products for consumers.

This is in the interest of society. Given a competitive market, lower costs for production lead to a lower price for consumers. In a competitive market, all firms competing produce as much as they can. General economic theory states that the price in a competitive market is equal to the marginal cost of production. Lower costs of production lead to a lower price or goods of better quality for consumers, meaning they can buy more or better goods from their income.

In a situation where one firm would innovate in a competitive market, this would lead to the firm having an advantage over its competitors. After all, due to innovation, it has come up with a new way of production which is more efficient than that of its competitors. Lowering

its price would thereby lead to market power. Consumers are inclined to buy more goods of the firm that innovated since it offers goods of a higher quality or goods at a cheaper price. The competition will either lose customers or and go bankrupt or lower their prices and go bankrupt. This is not in the interest of society. Market power of firms leads to disruption of the market. The firm that innovated would remain as sole supplier. That firm would have an incentive to operate as a monopolist on the market. Again, this is undesirable and not in the interest of society.

By sharing the innovation one firm did among all firms competing, all firms competing are able to produce more efficiently. This increases overall welfare. Given the general theory on competitive markets, prices will drop due to more efficient production. Hence consumers will benefit via lower prices. Nevertheless, the firm that endured the innovation costs will not profit. Moreover, the firm will not be inclined to make these costs to innovate its production process, given that this does not lead to a reward in the sense of market power.

Intellectual property therefore is an important factor for economic development. In a competing market there is no incentive to innovate if there are no intellectual property rights granted in return. Not granting these rights will lead to competitors profiting from lower production costs, but these competitors do not have to make the fixed costs for innovation. It is therefore important to grant intellectual property rights. This creates market power for the firm investing in innovation and is therefore a reward. The market power forms an incentive to invest in research and development expenses.

To increase welfare, it is in the interest of governments to push firms to innovate on the one hand, and to make this innovation accessible for all those competing on the market. In practice, this is done by granting intellectual property rights to firms, such as patents. A patent forms the reward for the expenses endured on innovation, so called research and development expenses (R&D expenses). These rights expire after 20 years on average, thereby becoming generally accessible to all competing firms. Furthermore, these property rights represent a certain value and are tradeable. This way, firms interested in the innovation are able to buy the right hereto. The firm buys the intellectual property.

By granting intellectual property rights, governments on the one hand give firms an incentive to innovate. On the other hand, the innovation becomes accessible once the patent expires. Motta states that if intellectual property rights are protected in a way that leads to violation of these rights, companies will not be inclined to spend money on innovation,

resulting in a loss of welfare for society. In addition, granting intellectual property rights may also lead to an increase in R&D expenses as firms are more inclined to compete with each other on the quality of the goods they supply. The assumption is that the better quality the goods are, the more resources were put in innovation (Motta, 2004).

In the People's Republic of China, international observations find that the Chinese system granting intellectual property rights faces problems with the implementation of its written norms. In other words, firms cannot trust on the law granting their patent rights. In line with the previous, this implies that firms are not inclined to invest in innovation. Therefore, it is interesting to conduct a study on the effect this has on firms affected by these problems: non-Chinese firms. Therefore, our research question is the following;

How does a relatively higher share of total turnover, attributable to China, affect R&D expenditure for non-Chinese firms?

The China story

In 1976 Mao Zedong died, at that time chairman of the Communist Party and thereby leader of the Peoples Republic of China. Back then, China was a communist country with a focus on domestic issues. Furthermore, the Cultural Revolution in the period 1966 up to 1976 led much unrest in the Chinese society.

When Mao Zedong died, a struggle for power unleashed itself upon those wanting to succeed Mao from power. Eventually, Deng Xiaoping became successor of Mao. In line with his earlier quote "it doesn't matter whether a cat is black or white, if it catches mice it is a good cat" Deng Xiaoping opened up China to the world by letting foreign companies invest in China.

Being active on the Chinese market as a foreign company had and has to be done through a joint venture. This means that benefits from expenditure on research and development are shared among the firms that make up the joint venture. Non-Chinese firms gain access to China's domestic market, reduce costs, acquire legitimacy, learn about the Chinese environment, and gain power vis-a-vis their competitors. Chinese firms on the other hand get access to a way to help develop its economy through the transfer of technology, the acquisition of managerial skills, the influx of capital, the development of its infrastructure, and

access to export markets that can provide foreign exchange as is mentioned by studies of Osland and Cavusgil (1996) and Si and Bruton (1999).

A large portion of the annually applied for patents in industries interesting for China, such as the telecommunications industry, are registered by European and American entities. By obliging foreign companies to operate in co-operation – joint ventures – with Chinese counterparts, the Chinese government found a cost-effective way to share technology at a relatively low price (Devonshire-Ellis, Scott, & Woollard, 2011)

These joint ventures have proven highly successful if measured by the rate of growth of the Chinese economy and the profits these joint ventures gained. In the past 40 years, China was able to catch up to the highest technological standards.

This also follows from the Malmquist productivity index, which measures and compares the efficiency of the production of technology. In their contribution to the International Conference on Applied Economics the Chinese scholars from Wuhan University Qazi and Yulin confirmed that the Chinese high-tech sector was producing at an efficient level (Qazi & Yulin, 2012), comparable to high-tech industries in the United States and Europe. Given these results, we draw the assumption that Chinese firms are at a competing on the same level as their non-Chinese counterparts.

In 2005, under threats by Western countries to initiate dispute settlement at the WTO, China started drafting a third version of the Patent Law of which the first version got into force in 1992. The third version got into force in 2009. Nevertheless, international observations still find that the Chinese system faces problems with the implementation of its written norms. China has found problems on its way to comply with international treaties it is party to and its own laws it has put in to place granting firms' intellectual property rights. Agreements made in the light of China's membership of the World Intellectual Property Organization and the World Trade Organization, specifically the Trade Related Aspects of Intellectual Property Rights rules that are applicable to WTO members. The membership of WIPO and the WTO has led to implementation of intellectual property laws in China. Still, the Chinese system faces problems with the implementation of its written norms. Violation of intellectual property rights and piracy are reported often by both Chinese and non-Chinese firms active in China (Devonshire-Ellis, Scott, & Woollard, 2011).

Dispute settlement at the WTO can only be done between member states. It is not possible for civil legal entities to file for dispute settlement. This needs to be done by the government of the country the (legal) entity is established in (Klabbers, 2017).

In April of 2018 the United States filed for dispute settlement at the WTO in Geneva (WTO). Dispute has arisen between the United States and the People's Republic of China with regards to the protection of registered patents. The United States claim that companies cannot rely on their registered patents in China after termination of joint ventures with local companies since the Chinese government does no longer recognize them as patent holders. Furthermore, it is not possible for non-Chinese companies to make agreements on the sale of a patent-license on their own terms and conditions, on so-called market-based conditions. This observation is also shared by the Japanese Trade Committee of the Industrial Structure Council, which advises the Japanese ministry of Economic Affairs in 2016 (Trade Committee of the Industrial Structure Council, 2016).

In addition to the USA, the European Union, Japan, Taiwan, Saudi Arabia and Ukraine have also expressed a statement of interest at the secretariat of the WTO. The EU and Japan have indicated that they are affected likewise as the US and would also like to further protect their interests. Taiwan and Ukraine have showed interest in settlement of the dispute. Both countries want clarity on the legitimacy of the Chinese policy. Saudi Arabia has indicated it is interested since it imports Chinese technology.

Research question

Given these reports and the general theory regarding the relationship between innovation and economic development, it is interesting to conduct research on the relationship between the presence of non-Chinese firms on the Chinese market and the expenses they make on research and development. We therefore study the relationship between the share of turnover achieved in China and what affect this has on R&D expenses for non-Chinese firms.

The overall thought behind our research is that innovation leads to an increase in welfare if it is distributed to all those who profit from it. Nevertheless, sharing innovations without rewarding or compensating the firm that paid for the innovation leads to firms not being inclined to spend resources on research and development expenses. Welfare stays the same. It is therefore not in the interest of society to not compensate the firms that endured the costs

for the innovation. Given the current Chinese situation and the violation of intellectual property rights that take place in the country, we expect to see a negative relationship between the share of presence on the Chinese market and the relative R&D expenses.

To answer the research question, we have drafted a hypothesis. It is examined by panel-data analysis. The hypothesis is as follows;

Hypothesis: The level of the relative turnover achieved in China has a significant negative effect on the relative expenditure on R&D.

We expect a negative effect between the relative share of turnover achieved in China and the relative R&D expenses. We assume that when no rights are violated in China, other countries or trading blocks, member of the WTO, will not complain. By complaining, the members indicate an undesirable effect is taking place. This could imply many undesirable effects. Those members that have filed for dispute settlement have not yet substantiated on which grounds they are summoning China. We can only guess for their motives.

General economic theory suggests a claim would follow if (world) welfare were to decrease as an effect of the Chinese practices. Another reason to file for settlement could follow from fierce competition between Chinese- and non-Chinese-firms on the global market. This could put the profitability of non-Chinese firms under pressure, or could imply that Chinese firms are more innovative today than their western counterparts. By using lobbying power, these non-Chinese firms push for interference by their government. The most convenient way to do put the Chinese government under economic pressure is to file for dispute at the WTO. This is a cost-efficient way. Nevertheless, this latter argument has a more geopolitical nature. We will not discuss it any further in this research.

For this research we assume that the practice of China leads to a decrease of overall welfare. Overall welfare decreases when governments either restrict innovation too much by granting intellectual property rights that last too long, or do not encourage it enough by not implementing intellectual property laws that grant IP-rights. Given the complaint, we assume the latter is applicable. The Chinese government does not grant intellectual property rights enough, therefore there is no incentive for firms to innovate. Hence, lower welfare is achieved compared to the ideal situation. Furthermore we assume that R&D expenses are positive for society. Hence, being active in China leads to a lower incentive to innovate. We have to place a footnote with this assumption. The assumption made is a specific observation leads to a

general comment on worldwide R&D expenses for firms. We assume this is possible due to the scale of the Chinese market in comparison to the global market. A significant effect should be noticeable.

Furthermore, it is interesting to discuss why we do not expect a positive effect. In principal, a positive effect between relative turnover achieved in China and relative R&D expenses would indicate a strong presence of legal certainty in China. If you make an innovation, you become owner and are able to draw profit from these ownership rights. This appears not to be the case.

An additional argument for a positive effect could lie in a certain guarantee of intellectual property rights, be it on a different level than rights granted in the US, the EU and Japan. This may indicate that companies profit from their innovation just enough to undertake it. The profitability indicates that consumers are willing to buy more innovated products. Hence, competition is done by means of innovation. Not by means of price.

The next chapter provides description of the data, the way it is collected and the way it is analyzed. The third chapter will discuss the results. We conclude with a chapter discussing the results and draw a conclusion.

II. Data and Methodology

Data

The hypothesis is in line with the general assumption made by Motta; poor protection of intellectual property rights leads to lower investment in innovation (R&D expenses). It focuses on the relationship between the share of turnover gained on the Chinese market and the effect this has on relative R&D expenses. To test this hypothesis, (assuming a linear relationship) a model is created where the relative expenses on R&D are regressed on the share of turnover firms generate in China.

Relative R&D expenses are calculated by dividing the amount of expenses made on R&D on total turnover. Relative R&D expenses are a percentage of total turnover. In a similar way, we compute the share of turnover attributable to China, that is, turnover made in China is divided by the total turnover the firm makes. This share too is expressed as a percentage.

To take into account the risk of omitted variable bias, control variables are added. In his article in the journal Research Technology Management, Morbey showed there is a strong positive connection between operational profit and expenditure on research and development (Morbey, 1989). Therefore, operational profit is added as a control variable to the regression. Adding this variable is a good way to test the variable we expect to have explanatory power. Operational profit too is divided by total turnover.

Furthermore, dummy variables are added to the model. The relative height of research and development expenses are linked to the industry companies operate in. Firms active in the pharmaceutical industry are allocated in Industry1. Firms producing transportation vehicles are allocated in Industry2. Those firms producing consumer electronics are allocated in Industry3. Finally, the firms active in the so called fast moving consumer goods market (FMCG), and are allocated in Industry4.

Furthermore, we include purchasing power per capita in China in the dataset. the World Bank provides annual data on the average level of purchasing power per capita per country. On the basis of this data, in China, over the period 1990-2017, purchasing power per capita has grown substantially. Comparing the size of purchasing power per capita from 2000 to 2016, it appears that the Chinese GDP per capita has nearly six folded: from US$ 2933.31 in 2000 to US$ 16806.74 in 2017. As research shows higher income of consumers leads to an incentive, at least in the pharmaceutical industry, to do more innovations. In other words, spend more on R&D. The thought hereafter is that consumers with a higher income are more willing to pay more for higher quality medicine (Lichtenberg, 1998). To test this assumption, we have added purchasing power as independent control variable.

With the previous regressions we divided Chinese turnover, R&D expenses and operational profit by total turnover to make the data comparable. Given that purchasing power per capita can not be explained as a percentage of total turnover, all variables are exchanged to currency that purchasing power per capita is measured in: US dollar. All variables are expressed in US dollars in order to ensure a fair comparison, using the average exchange rate over the respective year and currency.

For this research, we constructed a dataset of 22 firms. We already noted that it is impossible for legal entities to start an own procedure at the WTO. This has to be done by the government the entity is registered in. Therefore, we have mainly incorporate firms from the European

Union, the United States, Japan. After all, these members of the WTO filed a complaint. Therefore, entities registered in these WTO-members probably experience negative effects of the Chinese policy.

We started off by inquiring the 30 largest publicly traded firms in the 1980's. That was the time when China opened up its economy for foreign firms. Most firms entering in China did so at first to allocate production. Labour was cheap and was skilled enough to fulfil the tasks as needed. The goods produced were shipped across the globe and not meant for consumption within China. Furthermore, those firms entering China at an early stage were obliged to create a joint venture. This is interesting given that in these joint ventures the transfer of technology takes place. Exactly the practice that is disputed today.

Over time, the purchasing power of Chinese households increased, making it a more interesting market for firms to operate on. Firms originally produced goods in China to export these. Now they are producing goods in China for export and internal use within China.
Those firms already operating in a joint venture in China already exchanged technology with their Chinese counterparts. In return these firms received knowledge on the Chinese market. Our assumption is that these firms are more likely to start selling goods in China from an earlier stage onwards than competitors. They therefor form an interesting group of firms to look in to closer. Therefore, our second criterion was that these 40 firms needed to be in a joint venture in China from the 1980's/1990's onwards. Twenty-two firms remained.

From these twenty-two firms that remained, we looked in to the annual reports published in the period 2000-2017. Seven firms produce transportation vehicles. Six firms are active within the pharmaceutical industry. Six other firms can be qualified as electronics manufacturers. Three firms produce so called fast moving consumer goods (FMCG). The companies were examined over the period 2000 up to and including 2017. Data sought for in the annual reports was annual turnover, turnover achieved in China, R&D expenses and the operational profit, also called earnings before interest and taxes. By excluding financial results and taxes we are able to better examine the relationship between the relative R&D expenses and relative turnover achieved in China due to the fact the it only takes into account the result on operations.

For ten firms, we were unable to find data regarding their turnover in China. These firms for instance provided information on Asia-Pacific turnover or non-US turnover. This is not specific enough. If included this would have led to a selection bias. Therefore, these ten firms have not been included in the dataset. No firm responded to our request for additional information.

From the examined annual reports for the period 2000 to 2017, it followed that 10 companies did not include relevant observations needed for this study in their annual reports. In table 3 of the appendix the names of the 12 firms with sufficient data are listed. The final dataset includes 4 firms in the pharmaceutical industry. Three firms produce consumer electronics, three firms produce transportation vehicles and two firms are active in FMCG. The annual reports provided information on the Chinese turnover ranging in some cases from 2000 onwards, or, in the case of Pfizer, on the period 2015-2017. Our final dataset is an unbalanced panel dataset on twelve firms, containing a total of 129 observations.

Figure 1 in the appendix shows the relative turnover achieved in China plotted against the relative research and development expenses. No significant outliers seem to lie in the data. There seems to be a negative relation between the relative turnover achieved in China and the relative R&D expenses. Another observation is that the observations are laid out along the axes. Firms with relative low turnover achieved in China tend to have relative high R&D expenses. Firms with relative low R&D expenses have a relative larger share of their turnover achieved in China. This effect is related to the industry firms are active in. Firms active in the pharmaceutical industry tend to have much higher relative and absolute R&D expenses compared to firms active in the FMCG industry: producing new medicine takes a lot longer than introducing new footwear.

Figure 2 in the appendix shows purchasing power per capita for China in the period 1990 – 2017. The large increase of purchasing power is clearly visible. Judging by the article of Lichtenberg, this should have a significant positive effect on the height of absolute R&D expenses.

Table 1 states the means, median, standard deviation and the minima and maxima of the dependent variable R&D expenses as a percentage of total turnover, and the independent

variables turnover achieved in China as a percentage of total turnover and operational profit as a percentage of total turnover.

Figure three, added in the appendix, gives a descriptive summary of the time-series variable. As previously stated, the data is unbalanced.

Table 1

Variable	Mean	Median	Std. Dev	Min	Max
R&D expenses as a percentage of total turnover	0,083	0,061	0,06	0,008	0,286
Turnover achieved in China as a percentage of total turnover	0,100	0,079	0,076	0,006	0,416
Operational profit as a percentage of total turnover	0,109	0,077	0,104	-0,431	0,406

Methodology

We assume a linear relationship. We test the coefficient corresponding to presence in China as measured by the relative turnover achieved in China. Furthermore, data on the height of purchasing power per capita is collected from the database of the World Bank. We run a pooled OLS regression on the panel-data. In the different regression formulas, i indicates the firm. T corresponds for the year in which the observation was done for the firm. The analysis uses single and multiple linear regressions.

These models use the Ordinary Least Square method for the parameters. In the multiple regression, the operating profit (EBIT), and the dummy variables 'Industry' are added as a control variable regression. With regards to the dummy variable we estimate the least square dummy variable. Furthermore, we assume that a consistent error term a_i is correlated with explanatory variables. We therefore control for fixed effects.

The simple regression is therewith;

$$Relative\ R\&D\ expenses_{iT} = constant + \beta 1 * relative.turnover.in.China_{iT} + a_i + u_{iT}$$

The first multiple regression model includes operational profit as a control variable. Here too we control for fixed effects. The regression thereby becomes;

$$Relative\ R\&D\ expenses_{iT} = constant + \beta 1 * relative.turnover.in.China_{iT} + \beta 2 * relative.operational.profit_{iT} + a_i + u_{iT}$$

To control for omitted variable bias, we include the dummy variables industry in the regression. Firms active in the pharmaceutical industry are allocated in Industry1. Firms producing consumer electronics are allocated in Industry2. Those firms that produce transportation vehicles are allocated in Industry3. Finally, the firms active in the FMCG market are allocated in Industry4. By controlling for fixed Industry effects, we do not control for other fixed effects. This leads to the following regression;

$$Relative\ R\&D\ expenses_{iT} = constant + \beta 1 * relative.turnover.in.China_{iT} + \beta 2 * relative.operational.profit_{iT} + \beta 3 * Industry2 + \beta 4 * Industry3 + \beta 5 * Industry4 + u_{iT}$$

To check for the effect with a third control variable, we now regress total R&D expenses over total turnover in China, total operational profit and the purchasing power per capita per year measured in US Dollars of Chinese households. By adding purchasing power per capita per year, we should be able to reduce the upward bias in the variable relative turnover in China. That way, we filter the effect the increase of purchasing power has on the relative turnover in China and are able to attribute the effect to the relative presence of firms in. Given that the annual reports are not expressed in the same monetary unit, we have exchanged all accounts in to US Dollars using the average exchange rate applicable for the respective currencies and the respective years. Finally, the independent purchasing power per capita in China seems to have a trend in it. We want our independent to be non-stationary. We therefore take the first

differences of all dependent and independent variables to construct this model. We exclude the dummy variable Industry. We do control for fixed effects.

This makes the following regression;

$$d\_R\&D\ expenses_{iT} = constant + \beta 1 * d\_turnover.in.China_{iT} + \beta 2 * d\_operational.profit_{iT} + \beta 6 * d\_purchasing.power.per.capita.CHN_{iT} + a_i + u_{iT}$$

III. Results

Table 2 shows the results of the four regressions. In the base model, model 1, the variable is significantly positive, implying the null hypothesis has to be rejected. This means that the variable has explanatory value. The coefficient of the variable relative turnover in China is positive. Therefore, an increase in the share of turnover achieved in China leads to relative higher R&D expenses. An increase of relative turnover in China with 1% leads to a relative increase of R&D expenses with 0.13%. We control for fixed effects.

In model 2, operational profit is included. Previous research already showed that operational profit has significant explanatory value for R&D expenses. Adding this variable as a control variable should lead to a more precise indication what effect relative turnover in China has on the relative R&D expenses. As expected, the coefficient of the variable relative operational profit is significant. Nevertheless, the sign of the coefficient of the variable relative operational is negative. This is not in conform the previous study of Morbey. His conclusion was that there is a positive relationship between operational profit and the expenses on R&D. The coefficient of the independent relative turnover in China is positive and significant. Furthermore, the coefficient only differs slightly from the coefficient in model 1. Concluding; this variable has explanatory value. Therefore, we conclude there is a positive effect between the relative turnover in China and the relative R&D expenses in model 2.

In model 3, we included industry fixed effects. We therefore do not control for firm-specific effects in the regression. All coefficients of the variables are significant. Thereby, all coefficients have explanatory value. Again, the sign of the coefficient of the relative turnover in China in this model is positive. We now have three models indicating that over time relative turnover in China does not decrease the relative amount spent on R&D, but rather increases.

Furthermore, the effect the different dummies have on the regression is noteworthy. By controlling with dummy variables instead of fixed effects, our outcome is similar but more robust. Industry1, the dummy left out to overcome the perfect multicollinearity is the dummy that represents pharmaceutical firms. Previously, we already discussed the way these firms differ from firms producing, for example, fast moving consumer goods. Costs involved in producing and innovating medicine are higher than costs involved in innovation in the FMCG industry. The model draws a similar conclusion. If a firm is active in another industry than the pharmaceutical industry, the relative R&D expenses drop significantly.

In model 4 we have transformed the variables from relative numbers to absolute numbers. This way purchasing power per capita in China in current US dollars can be added to the regression. All variables have been exchanged to current US dollars. Furthermore, to overcome stationarity, we have taken the first differences of all variables. Running the corresponding regression, we find that all coefficients except for turnover achieved in China are not significant. Again, the sign of the coefficient of turnover in China is positive. As other the other variables are not significant in this model, no explanatory value comes to these variables. Therefore we cannot draw a conclusion on the effect purchasing power per capita has on R&D expenses. What surprises is that in all four models the coefficient of the variable (relative) turnover achieved in China is significant.

Judging by the coefficients of the four different models, the significance and signs hereof, it seems to indicate that with some certainty a conclusion can be drawn on the relationship between share of turnover achieved in China and relative R&D expenses. Overall interesting to see is that all models assign a significant positive effect to the relative share of turnover achieved in China. This is not in line with the hypothesis. Expectation was that we would find a negative effect between share of turnover achieved in China and the relative R&D expenses. Also interesting to see is the drop of the negative coefficient of relative operational profit in these models. This may indicate a flaw in our research given previous research by Morbey.

In all models the independent variable to which we want to grant an effect gives a clear indication of a general relationship. Therefore, we draw a general conclusion that when over time firms achieve relative more turnover in China, they are more inclined to have relative

higher R&D expenses. In doing so, the data do not confirm the hypothesis. It indicates a positive effect rather than a negative effect. In table 4, added in the appendix, the F-statistics, R-squared, σ_e, σ_a and ρ are included. These are the estimates of the standard deviations of the error term *e* and the firm specific effect *a*, respectively. Rho is defined as the share of the estimated variance of the overall error accounted for by the individual firm-specific effect.

Table 2

Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Relative turnover in China[4]	0.126*** (0.031)	0.125*** (0.03)	0.116*** (0.032)	0.148*** (0.025)
Relative operational profit[4]		-0.144*** (0.036)	-0.078** (0.037)	-0.035 (0.023)
Industry2			-0.133*** (0.016)	
Industry3			-0.109*** (0.017)	
Industry4			-0.154*** (0.018)	
GDP per capita[4]				-0.357 (0.298)
Constant	0.07*** (0.004)	0.086*** (0.005)	0.169*** (0.013)	332.13 (281.3)
Number of obs.	129	129	129	129

* p-value < 0.1, ** p-value < 0.05, *** p-value < 0.01

4. in model 4 all numbers are absolute. Furthermore, we use first differences for the variables.

NB: Standard error included between parenthesis

IV. Discussion and results

In general, internal validity provides guidelines to interpret the conclusion made by the research, based on the dataset. By discussing the possible threats to internal validity we hope to give arguments why it is internally valid or to overcome these threats in future research. We discuss four threats to internal validity.

The first threat forms the number of observations. Given that only twenty-two firms were observed and only twelve provided data relevant for our research, it would improve this and future research if the total number of companies was increased. It forms a threat to the research in that sense that a lack of firms observed will make it impossible to draw a conclusion with certainty. In addition, only publically registered firms were observed. It takes considerably more effect to find information on non-public firms since these firms are not traded publicly.

Furthermore, the number of firms allocated per industry may prove a threat to internal validity. Given that R&D expenses are similar for firms in the same industry, but differ in relative height once industries are compared, it would improve the research if it focussed on merely one industry. Thereby a more specific conclusion can be drawn per industry, instead of a general conclusion for the whole industry. This general conclusion probably has an internal bias. Looking at our study, the share of pharmaceutical firms observed compared to the total number of firms observed, our general conclusion is probably upward biased.

In addition, we have to take note of the significant negative effect that relative operational profit has on relative R&D expenses. Previous empirical research of Morbey showed a positive relationship between operational profit and R&D expenses. It would therefore not be surprising if operational profit were to have a positive effect on R&D expenses. This is not the case. This could mean that there either is a flaw in our data or circumstances have changed since Morbey's research.

With regards to a flaw in our dataset, it is interesting to look into the dataset Morbey used to conduct his research. His dataset consisted data from only US firms in the period 1976 to 1985. His average data started off with low relative R&D expenses leading up to high relative R&D expenses. Relative operational profit on the other started high and ended low. When describing our dataset, we do not see a similar trend as occurring in our dataset. Profits and R&D expenses remain around the same relative level, with a negative exception around the years 2008 – 2010: the credit crisis. Nevertheless, this research too used relative expenses on R&D and relative operational profit in accordance to Morbey's research. As a result we cannot conclude that there is a flaw in our dataset.

A different explanation could follow from competition amongst firms entering a new market. In new markets, R&D expenses of firms tend to go up to, whereas (relative) profits tend to decrease. The possibility of expanding business and fierce competition amongst firms to take control of this new market, makes that firms are willing to invest in innovation of their product on the one hand. On the other hand, firms price their products competitively to compete with other firms entering this new market which leads to lower profits. This could be an explanation for the effect we are seeing in our dataset. The more firms are active on the Chinese market, the more they are inclined learn about their customer, hence the more is spent on R&D. On the other hand, other firms think alike, leading to profits that come under pressure, hence the negative effect we see in the different models.

The research could improve further if more work was put in to analyzing the effect of the size of joint ventures. How much resources are put into the joint venture? Are the resources of monetary or technological form? It would take a more serious study to look in to these effects. Unfortunately, the firms studied all consist of many legal entities. Annual reports published by these firms consist of a summary. All joint ventures and subsidiary firms are not traded publicly. Therefore, they are not obliged to publish their results.

Finally, it would be interesting to look into the law of the handicap of a head start and the effect this has on relative R&D expenses. China started competing on the international stage after the death of Mao Zedong and the takeover of power by Deng Xiaoping. Deng Xiaoping opened up the Chinese economy to foreign investors. Firms had an opportunity to start on a clean sleet in China. This makes it more interesting and easier to introduce relative new forms of innovation to the production process. This would lead to lower production costs or a higher quality of products, hence improving profitability. A profitable market leads to an incentive for other firms to allocate to this market too, leading to more competition. As the results of our research show, this may indicate firms competing more fiercely on innovation of their products, hence relative R&D expenses will increase.

The external validity of the research must also be examined. There are two possible threats, namely differences in the population of the study and the population over which the data

makes a prediction and when the environmental factors in the data of the study differ from the factors in the population for which conclusions are drawn.

With regards to the population of the sample, one may argue that the sample size is small. Overall, we have 129 observations. To improve external validity, the sample size should be enlarged. If firms where to provide data on their sales in China, this would improve additional research and would lead to a conclusion drawn with more certainty. Another argument that might threaten external validity is the difference in industries. A firm that produces shoes conducts different research than a firm that produces medicine. Therewith, different costs are involved for research and development. By adding a dummy variable, the model is able to take these different circumstances in to account. Thereby, drawing a conclusion that is of more general nature is more likely. Nevertheless, a larger sample size would likely lead to the ability of drawing sharper conclusions or research into a specific sector would improve the external validity.

The conclusions in the next paragraph exclusively concern individual firms. This means that the conclusions that follow, only apply to foreign firms active on the Chinese market and that are listed publicly. The application of these conclusions to firms other than non-Chinese firms that are not active in the Chinese market is not possible. Drawing these conclusions leads to 'ecological fallacy'.

In conclusion, we have studied the effect of the share of turnover achieved in China has on the relative R&D expenses. Our expectation was that there would be a negative effect between this share and the relative height of R&D expenses. Our baseline model showed a different relationship, namely positive. By adding control variables, we learn that all models have a similar significant positive effect for the independent variable on the dependent variable. Therefore, we draw the conclusion that under certainty a positive relationship is perceptible between the share of turnover achieved in China and the relative R&D expenses. In all models the independent variable to which we want to grant an effect gives a clear indication of a general positive relationship. This is not in accordance with our hypothesis, but still is a significant effect. Reason for this effect may follow from the newness of the Chinese market. There still is fierce completion amongst firms leading to relative higher R&D expenses than one may expect from observations.

V. Bibliography

Chang, H. (2001). Intellectual Property Rights and Economic Development: historical lessons and emerging issues. *Journal of human development, 2*(2), 287 - 309.

Devonshire-Ellis, C., Scott, A., & Woollard, S. (2011). Trends in China's IPR Enviroment. In C. Devonshire-Ellis, A. Scott, & S. Woollard, *Intellectual Property Rights in China* (pp. 3-5). Dordrecht, London, New York: Springer Heidelberg.

Klabbers, J. (2017). International Organisations. In J. Klabbers, *International Law* (p. 398). Cambridge: Cambridge University Press.

Kumar, N. (2003). Intellectual property rights, technology and economic development: Experiences of Asian countries. *Economic and Political Weekly*, 209-226.

Lichtenberg, F. R. (1998). *Pharmaceutical innovation, mortality reduction, and economic growth* (No. w6569). National Bureau of Economic Research.

Morbey, G. (1989). R&D expenditures and profit growth. *Research-Technology Management, 32*(3), 20-23.

Motta, M. (2004). *Competition policy: theory and practice.* Cambridge: University Press.

Osland, G., & Cavusgil, S. (1996). Performance issues in US—China joint ventures. *California Management Review, 38*(2), pp. 106-130.

Qazi, A., & Yulin, Z. (2012). Productivity Measurement of Hi-tech Industry of China Malmquist Productivity Index – DEA Approach. In N. Tsounis, & A. Vlahvei (Ed.), *The International Conference on Applied Economics (ICOAE),. 1*, pp. 330-336. Uppsala: Procedia Economics and Finance.

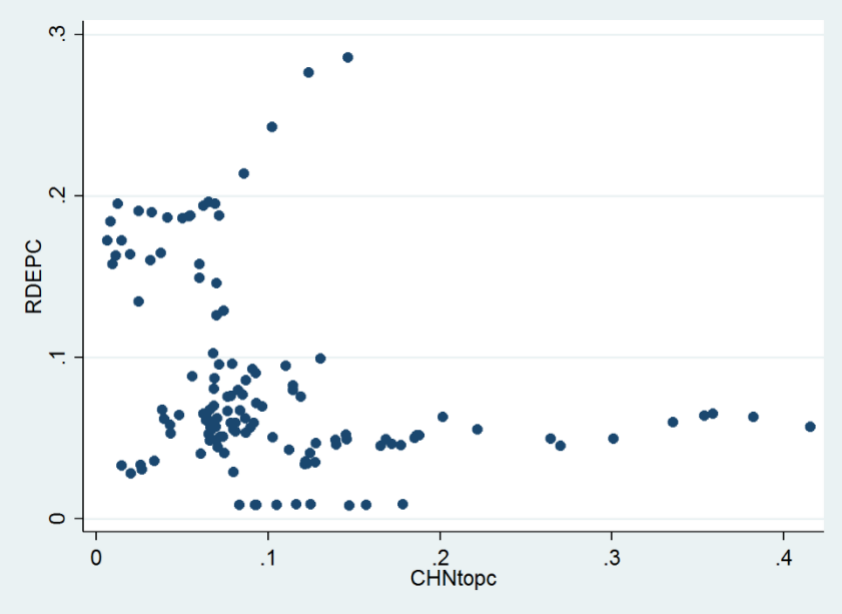
Si, S., & Bruton, G. (1999, Februari 1). Knowledge transfer in international joint ventures in transitional economies: The China experience. *Academy of Management Perspectives, 13*(1), 83-90.

The United States of America. (2018, March 26). *WTO documents*. Retrieved from World Trade Organisation: https://docs.wto.org/dol2fe/Pages/FE_Search/FE_S_S009-DP.aspx?language=E&CatalogueIdList=244329,244336,244337,244315,244321,244046&CurrentCatalogueIdIndex=5&FullTextHash=371857150&HasEnglishRecord=True&HasFrenchRecord=True&HasSpanishRecord=True

Trade Committee of the Industrial Structure Council. (2016). *2016 Report on Compliance by Major Trading Partners with Trade Agreements -WTO, EPA/FTA and IIA-.* Ministry of Economic affairs Japan, Subcommittee on Unfair Trade Policies and Measures. Tokyo: Ministry of Economic affairs Japan.

VI. Appendix

Figure 1



In figure 1 relative turnover achieved in China is located on the X-axes. The Y-axes indicates the relative R&D expenses.

Figure 2

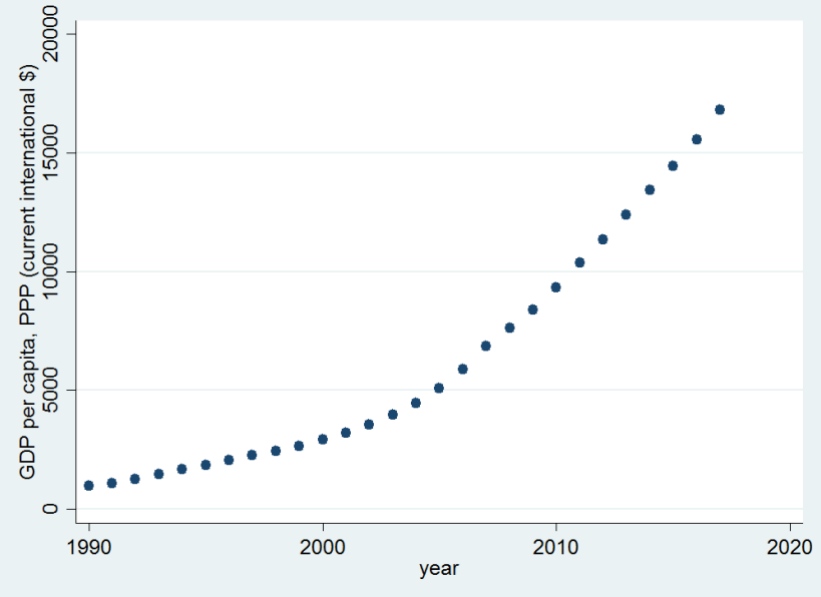


Figure 2 shows the increase of purchasing power per capita over the period 1990 – 2017 for the People's Republic of China.

Figure 3

Summary time series data

firm: Adidas, Astrazenca, ..., Volkswagen n = 12
year: 2000, 2001, ..., 2017 T = 18
Delta(year) = 1 year
Span(year) = 18 periods
(firm*year uniquely identifies each observation)

Distribution of T_i:	min	5%	25%	50%	75%	95%	max
	2	2	8	9	17	18	18

Freq.	Percent	Cum.	pattern
3	25.00	25.00	. . . . 1 1 1 1 1 1 1 1
2	16.67	41.67	. . . . 1 1 1 1 1 1 1 1 1
2	16.67	58.33	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1	8.33	66.67	. . . . 1 1
1	8.33	75.00	. . . . 1 1 1
1	8.33	83.33	. . . . 1 . 1 1 1 1 1 1 1 1 1 1 1 1
1	8.33	91.67	. . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1	8.33	100.00	. 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
12	100		X X X X X X X X X X X X X X X X X X

Table 3

Firm	Industry
AstraZenca	1

Bayer	1
Pfizer	1
Roche	1
BMW	2
Boeing	2
Volkswagen	2
Philips	3
Siemens	3
Sony	3
Adidas	4
Proctor&Gambel	4

Industry 1	Pharmaceutical
Industry 2	Transportation Vehicles
Industry 3	Consumer Electronics
Industry 4	FMCG's

Table 4

	Model 1	Model 2	Model 3	Model 4
F-test	16.18	17.12		107.08
Wald Chi2			105,17	
Degrees of Freedom	(1, 116)	(2, 115)		(3, 102)
P-value	0.0001	0.0000	0.0000	0.0000
R^2 within	0.1224	0.2294	0.2158	0.2630
R^2 between	0.2567	0.6328	0.7674	0.7263
R^2 overall	0.0841	0.4756	0.7232	0.3023
Corr e - Xb	-0.4417	-0.8362	0	-0.4785
σ_e	0.018	0.017	0.017	157.52
σ_a	0.065	0.077	0.017	666.78
ρ	0.931	0.956	0.509	0.053