Bachelor's thesis

Evaluation of a foreign investment project

NPV simulation, time series analysis, hedging foreign exchange exposure and managing non-financial risk in relation to an R&D project in the pharmaceutical industry

Spring 2009
Abstract

India is the world’s second largest country measured by inhabitants and has one of the world’s most rapidly growing diabetes populations. This presents an interesting investment opportunity for the Danish pharmaceutical company, Novo Nordisk, specializing in developing anti-diabetes drugs. Novo Nordisk is characterized as a pharmaceutical research and development (R&D) company. The value of their R&D activities can be based on the expectations towards the research outcomes and results. At the same time, R&D investments can yield valuable options in an emerging market like India, as this thesis will explore.

It is Novo Nordisk’s objective to relocate one third of its R&D activities to India by 2011. The aim of this thesis is thus to evaluate the investment opportunity arising from India seen from Novo Nordisk’s point of view through the application of an illustrative investment project. The project is primarily analyzed from a comprehensive financial perspective; however, some attention is also paid towards non-financial risk factors specific to India. A traditional tool for evaluating investment opportunities is the NPV analysis. In this thesis, an NPV model with interchangeable input variables has been constructed. The variables have been allowed to fluctuate in order to correct for any potentially faulty estimates. Special emphasis has been placed on the exchange rate, which is subject to a comprehensive time series analysis, as this is found to be the only variable to be hedged by Novo Nordisk using financial derivatives.

This extended NPV analysis has yielded several outputs depending on the fluctuations of the input variables. A macro enabling infinite simulations of the NPVs has been constructed to capture the fluctuations. The various NPVs are then viewed in a histogram and their distribution clearly state that the probability of yielding a positive NPV is small given the chosen input variables. The impact of hedging is evaluated next and even when taking a hedged position, the NPVs are most likely to be negative although the most negative of the values appeared to have been cut off. This indicates that hedging may contribute to an increased security of the potential outcomes.

However, the NPV approach has several shortcomings when it comes to valuing R&D projects. As an alternative, the theory of real options valuation is introduced viewing investment opportunities as options. As a result, the thesis presents an expanded valuation approach with real options and non-financial risk in mind.

Although unprofitable from an NPV perspective, the price of investing in R&D projects with a negative yield may be low, in exchange for keeping Novo Nordisk’s investment options in India open instead of disregarding them due to a negative NPV.
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List of abbreviations
AC Autocorrelation IPR Intellectual property rights
AR Autoregressive model LRAC Long run average cost
B2B Business to business MA Moving average model
BLUE Best linear unbiased estimator MNC Multinational company
BMI Body mass index NPV Net present value
BOP Balance of payments OLS Ordinary least squares
CAPM Capital asset pricing model PAC Partial autocorrelation
DKK Danish kroner PPP Purchase power parity
GDP Gross domestic product R&D Research and development
IDDM Insulin dependent diabetes mellitus USD United States dollars
IGT Impaired glucose tolerance WACC Weighted average cost of capital
IMF International Monetary Fund WHR Waist-hip ratio
INR Indian rupees WTO World Trade Organisation
1. Introduction

As any rapidly growing economy, India poses a substantial opportunity for foreign investors. The Indian government has acknowledged the importance of attracting foreign capital to the country over the past decades, and many foreign companies have already found steady ground in the South Asian nation. India lures investors with low cost on labor combined with a highly skilled workforce and possibilities of high yields on investments.

However, investing in India is not only an appealing opportunity – it also creates a considerable risk for the foreign investor due to economic instability, corruption, political risk, liberal laws on patents and bureaucracy.

With deep roots in the traditional caste system, India is subjected to vast discrepancies in its population. Housing some of the richest and some of the poorest people on earth, India also holds another disturbing record: Having the highest number of diabetics in the world. Diabetes especially prevails among the more affluent part of the population but also shows a high prevalence among the less privileged in rural areas and urban slum.

It is of paramount importance for the future of the nation to help prevent and treat this disease. Only with research, medical treatment and campaigns can the Indian people discontinue carrying the title as the world’s largest diabetic nation.

The many diabetics in India provide great opportunities for carrying out clinical trials due to the large number of trial candidates. Furthermore, the trial candidates present a wide gene pool for developing and improving drugs, thus presenting an opportunity for a pharmaceutical company to create a new diabetes drug based on research conducted in India.

The Danish pharmaceutical company Novo Nordisk A/S (Novo Nordisk) wants to relocate one third of its research and development (R&D) to India by 2011. The reasons for this strategy, other than the above mentioned characteristics of the Indian diabetes market, are the cost savings opportunities in India due to the low wages, together with an increasing demand for diabetes drugs. Novo Nordisk has already commenced a partnership with the India-based company Torrent Pharmaceuticals, who has obtained a license to produce anti-diabetes medicine on behalf of Novo Nordisk.

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1 *India beckons* Business India Intelligence February 20th 2008
1.1. Problem statement

This thesis seeks to explore, from a theoretical point of view, the opportunities in connection with conducting research and development (R&D) investments in India by using the pharmaceutical company Novo Nordisk as an example.

In order to review the framework of an investment project and perform a qualitative assessment of the attractiveness of the Indian market, general macro-economic factors will be presented. The incentives for investing in India will be analyzed, and the determinants will be viewed from Novo Nordisk's perspective.

In continuation of this, the demand for diabetes medicine will be examined; what characterizes the Indian demand for diabetes medicine now and in the future and how is the structure of the Indian diabetes market? Furthermore, it will be analyzed how Novo Nordisk can approach the market situation.

As a basis for a theoretical comprehensive quantitative analysis, a concrete R&D investment project will be presented and the following will be answered: How can a hypothetical investment project in R&D activities be evaluated? Which financial risk factors of the project can be hedged? Will the NPV-method suffice as an analytical tool, or should other options be taken into account?

An investment project holds various risks in relation to investing in a foreign country. Among these risks are non-financial risks, but what are the non-financial risk factors related to investing in India and how can they be mitigated? Finally, is this investment an attractive opportunity to Novo Nordisk?

1.2. Structure and methodology

The objective of this thesis is to investigate the considerations made by the management of a pharmaceutical company in relation to a foreign R&D investment project; both ex ante where the market opportunities are assessed and ex post, where the investment and the risks are evaluated.

A brief outline of the structure of the thesis is presented in the illustration below.
In the introductory section, we introduce Novo Nordisk, which throughout the thesis is used as an example. We then proceed to identify the investment opportunities in India based on an analysis of the Indian economic situation, the prevalence of diabetes in India and the structure of the Indian diabetes market. We analyze on the knowledge already presented by other researchers, in their aim to chart the development on diabetes in India and to map the structure of the pharmaceuticals market. The sources used in this part have been found in databases such as Business Source Complete and the general research paper database, ELIN, from the library of ASB. The collected literature is primarily written by academics and published in scientific journals.

In continuation of this, we present a hypothetical R&D project to be carried out in India in order to translate the above qualitative assessment of the investment opportunities into a quantitative analysis. A financial model for evaluating the project is thus introduced, and the variables of the model are thoroughly explained and analyzed. The model is applied in the case of Novo Nordisk, where special emphasis is placed on the exchange rate, which is the subject of an econometric time series analysis in order to investigate the basis for a hedging strategy. This data analysis is supported by existing research conducted within the area. An overview of the outcomes resulting from hedging the foreign exchange exposure versus the results from taking an un-hedged position is presented, and the section is completed with a discussion of the chosen project evaluation approach.

Non-financial risk in relation to the investment project is examined next and measures to be taken against such risks are suggested. This section is mainly based on a qualitative approach and is supported by existing literature, covering this aspect of international investments. As an alternative to the chosen project evaluation strategy, the real options approach is briefly introduced as another valuable tool for evaluating the project. A discussion of our methods, considerations and further research opens up to a conclusion, which will contain concrete guidelines for management facing the decision of engaging in a foreign R&D investment project.
1.3. Delimitation
This thesis aims at exploring the evaluation of an investment project from a theoretical point of view. Although an actual company is being used as an example, it should be stressed that Novo Nordisk is merely being used for illustrating a large multinational company’s considerations when initiating foreign R&D investment projects. It is not our aim to make a practical analysis with Novo Nordisk as an active participant.

This of course influences the evaluation criteria. Cash flows in order to perform an NPV analysis have been assumed based on information gathered from the financial report. While the financial report provides great insight to the company, we are aware that the report is written from Novo Nordisk’s perspective and thus is not completely unbiased. However, we will strive to consider the data objectively and clearly state, whenever we refer to information from the financial report.

The focus remains strictly on the anti-diabetes drugs, and Novo Nordisk’s other pharmaceutical products such as growth hormone therapy, will be disregarded in this thesis.

When analyzing India as a market opportunity, it should be stressed that however large and diverse India is as a nation – in this thesis, it will be viewed as an ethnic entity.

As to the various political incentives, it is not our objective to evaluate the adequacy but merely state and conclude the causes and consequences. Due to the scope and relevance we have chosen merely to focus on the economic factors from 1991 and onwards. However, as to the political factors such as patent laws, it has been relevant to compare the current situation with the regulations of 1970.

The diabetes market refers throughout the thesis to the market for diabetes medicine and covers both insulin and oral medication treatment.

The hypothetical investment project presented in section 6 is to be viewed as a theoretical framework for conducting exploratory R&D investments. Our focus will remain on the financial aspects of the investment project and not on the technical or pharmaceutical aspects, as we do not possess the required insight in order to assess the realization of the project in practice. In the aim of presenting an illustrative investment example, factors such as inflation, interest rates and taxes are disregarded. It is furthermore assumed that the project is financed with equity, disregarding the aspect of debt.
2. Novo Nordisk

Novo Nordisk A/S, initially carrying the name Novo Industri A/S, was founded in 1925 by Harald and Thorvald Pedersen (Stonehill, Arthur I. 1982). In 1989 Novo Industri A/S merged with the pharmaceutical company Nordisk Gentofte A/S and became Novo Nordisk A/S, today employing approximately 26,000 people in 79 countries. Novo Nordisk specializes in manufacturing and marketing anti-diabetes medicines and their products are marketed in 179 countries. Apart from mainly developing and producing insulin and other diabetes drugs, the company also manufactures drugs for growth hormone therapy and haemostasis management.

The dominating position within diabetes care is illustrated by the financial report from 2008, where diabetes activities account for 73% of Novo Nordisk total sales worth DKK million 45,553. Also as a pharmaceutical company, it is crucial that a lot of emphasis is placed on research and development and in 2008; R&D costs consisted of 17.2% of total sales.

Novo Nordisk aims at holding a large equity ratio – 65.2% was reported in 2008. This is a significant strength factor since a large equity ratio is an advantage in an industry in rapid growth. This makes the company very flexible in a changing environment and enables them to reduce potential risk by financing their foreign investment projects with a large proportion of local debt, which could weaken the firm and potentially endanger local creditors (Moffett, M. H. et al. 2008). Novo Nordisk’s B stocks are viewed by investors and financial institutions as a relatively safe investment, which is expressed in the company’s low estimated beta of 0.54. 3

In the past two years, Novo Nordisk has shown a sales growth rate of 8% and 9% respectively. To maintain such a growth rate, it is necessary to be alert towards any risk factors that may affect the result. Project failure represents a great risk factor because of the substantial sunk costs incurred in connection with product development. Research and development is cost-intensive and if a project turns out to be a failure, no refund is granted. While internal factors such as project failure can put pressure on Novo Nordisk, external factors such as a recession pose a smaller threat to the company compared to other industries. Given that their products, to a certain degree, are relatively in-elastic – demand is determined by people’s health condition more than their financial situation. However, in India and other developing countries this may be modified in the sense that you need to be able to afford healthcare.

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3 www.euroinvestor.dk
As a consequence, people will only visit a doctor when they can afford it and the demand for diabetes medicine will thus not only be determined by the patient’s health but also by the financial situation. Finally, it is important to note that it is the doctors who demand the diabetes medicine, as these types of medicines are prescription drugs. This means that the diabetes drugs market may be characterized as being a business-to-business market.

A crucial factor for maintaining its position as a market leader is significant investments in R&D. The continuous ageing of the developed part of the world’s population has posed a pressure on national resources resulting in governmental reluctance to grant premiums to development of new and innovative products. In the developing part of the world, however, the challenge lies in providing the access to the right healthcare. Novo Nordisk has increased its efforts in engaging policy makers in understanding the consequences – not only in health but also economically – of not taking actions against diabetes. By lobbying the policy makers – particularly in the developing world – it is likely that Novo Nordisk will be able to gain influence on health policy and participation in legislature on health issues and thus help create its own business environment in the particular area. Recently, Novo Nordisk has launched the global campaign Changing Diabetes in order to contribute to an increased public awareness.

Today, Novo Nordisk possesses 60% of the Indian diabetes medicine market which is estimated to have a total size of INR 3.75 billion. Prior to establishing their Indian office in 1994, they made marketing arrangements with Torrent Pharmaceuticals in 1990. Given the complexity of the Indian market at that time, it has been Novo Nordisk’s entry strategy to partner with a local company who has the sufficient market knowledge.

In summary, Novo Nordisk can be characterized as a firm possessing significant strengths in the sense that it is a well-established firm with an in-depth knowledge and presence in the various markets of the world. Financially, Novo Nordisk appears to be strong given its substantial equity-ratio and low stock volatility. Additionally, their products are to a lesser degree subject to fluctuations in the financial market compared to other industries.

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4 *India beckons* Business India Intelligence February 20th 2008
3. India as a market opportunity

In order to analyze the framework for an R&D investment project in India, it is necessary for Novo Nordisk to gather knowledge of the political and economic environment. A review of the opportunities arising from the Indian political and macro-economic environment and thus indirectly affecting the investment decision is performed in the following. First, a brief introduction to India is performed, followed by an analysis of the economic transition in section 3.1. In continuation hereof, the economic stability is evaluated in section 3.2 leading to an assessment of the attractiveness of the Indian market.

India is situated in South Asia and has the world’s second largest population after China, counting more than one billion citizens. India has a long history of colonization and by the 19th century, India was completely under British political control. Independence came in 1947 but the strong tie with the United Kingdom has persisted, with English enjoying a high status among the spoken languages as being the official business, legal and political language (Kulke, H. et al. 1997). This is of great importance to Novo Nordisk who has English as their corporate language, thus making it easier for Novo Nordisk to initiate co-operations with Indian companies and employ Indian workers. In addition, India offers a considerable cost saving opportunity in relation to R&D. Estimated cost savings range from 30% to 70% when conducting drug discovery and clinical trials.5

The GDP per capita calculated in PPP has grown by more than 170% over the past ten years.6 This, however, is not necessarily an indicator of overall wealth, as India is a country of large social gaps between the wealthy and the poor. This gap is illustrated by the Gini-coefficient being calculated as 37 in 2004, where the closer the coefficient is to 100, the larger the economic gap. This is compared to the considerably lower coefficient of 25 in Denmark 2007 (World Fact Book; www.cia.gov).

Traditionally, Indian society has been dominated by a caste system dividing the population into social groups with certain rules and restrictions regarding fraternising with members of other castes. This caused many people to get stuck in poverty because they belonged to a lower caste and had no possibility of climbing the social ladder. The new middle class appears to be more open and less dominated by the caste system, which means that there are now more opportunities for the common Indian citizen to make his own luck (Bullis, D. 1998).

5 Opportunities beyond cost savings, ContractPharma, January/February 2008
6 World Development Indicators
Furthermore, the rising middle class indicates that more people may be able to afford diabetes treatment as will be elaborated in section 4.3.

3.1. A change in paradigm
Today, India is a democratic federal republic. The country has transitioned from a plan economy to working under market regulating conditions.

In 1991 India was subject to a financial crisis. That year is by many considered as the turning point in India’s economic history, where India to some extends opened up to the global market. The cause of the crisis was the fact that the foreign exchange reserves had dropped to a critical point, where there were problems associated with financing imports, which eventually led to the Balance-of-Payment (BOP) crisis. During the 1980s, interest payments and imports grew faster than exports, leading to consistent current account deficits (Johri, D. et al. 2002). Inaugurated in June 1991, Narasimha Rao in companionship with Manmohan Singh\textsuperscript{7} as minister of finance faced two main tasks.

Firstly, the short term goal for Rao was to steer India out of the BOP crisis. The Indian government, who bore the responsibility for the BOP under a fixed exchange rate system, was forced to intervene by buying an excess supply of rupees in the world market. This could only be done by drawing on their foreign exchange reserves, which were very scarce, and to avoid running out of all foreign exchange, they chose to devaluate the rupee.

The rupee was devaluated vis-à-vis the dollar by approximately 20% leading to a real depreciation and thus to an increase in output, thereby braking imports and boosting exports in the short run. However, as effective as devaluation may seem in the short run, the economy will always adjust in the long run, generally referred to as the J-curve effect.

Secondly, in order to create long-run stability and growth, the Indian market was opened towards the world economy. This part of the solution to the economic instability was a loan sanctioned by the International Monetary Fund (IMF) in the region of 2 billion dollars, leading to the long term political consequences of the crisis. Along with the loan came the IMF conditionality and as a consequence hereof, the real shift of paradigm from socialism and isolation towards adopting more liberal policies.

When a country borrows from the IMF, its government makes commitments on economic and financial policies – a requirement known as conditionality. Conditionality is a way for the IMF

\textsuperscript{7} Incumbent Prime Minister of India as of 2009
to monitor that its loan is being used effectively in resolving the borrower's economic difficulties, so that the country will be able to repay promptly, and make the funds available to other members in need (www.imf.org).

India promised to further deregulate the licensing system, cut government spending and open up the market to foreign investments in order to integrate India with the global economy (Ahuja, S. 2006).

### 3.2. Economic stability

In 2008 the GDP was estimated to be US $ 1.237 trillion with a real growth rate of 7.3\%. The growth rate is considerably high, and is also a tempting factor for foreign investors. When looking at the composition of the GDP, agriculture still plays a large role in the economy accounting for 17.2\%. The axiom suggests that the more developed a country, the less the share of agriculture in the economy. The decrease in agriculture from 30\% in 1991 supports the arguments that India is an economy in growth.

Additionally, the inflation has dropped from 14\% in 1991 and was quite stable around 5\% in recent years increasing to an estimated 7.8\% in 2008, which is considerably higher than in the E.U. but not threatening to the economic stability. In general the Indian economy has coped well with the transition into the free market powers, and the growth and development shows stability.

According to Sachs, J. D. (2000), India is not unique in the sense of growth. In the period from 1950 to present day, rapid economic growth appears to be a global phenomenon. There are, however, different patterns of growth, which a country can follow. Given that technological progress accounts for 80\% of long-term increase in per capita income, and investment in capital and labor movement explains the remaining 20\% (Krugman, P. 1994), and that 13\% of the world’s population accounts for 95\% of patents\(^9\), India cannot be in an *endogenous growth* state (Sachs, J. D. 2000).

Instead, it must fall in the category of *catching-up growth*. The key to such growth is the fact that technologies cross national boundaries. Countries can enjoy rising living standards as a result of technology diffusing from “leader” to “follower” and are more likely to become successful cases of catching-up growth, when economic institutions and policies are focusing towards attracting foreign investment and encouraging technological transfers. This appears to be the case of India to a higher degree after the 1991 reform.

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\(^8\) World Fact Book

\(^9\) Patents are considered being a proxy for innovation and thereby technological progress.
In addition to the development of the market economy, the Indian government has made several incentives to promote foreign investment in order to keep the economy growing. The trade barriers such as import restrictions and nontariff barriers have dropped, partly due to the membership of WTO in 1995. The tax system has been simplified and the rates on international trade have been lowered gradually from 26% of income in 1991 to 15% in 2007\textsuperscript{10}. As to the governmental incentives to promote foreign R&D investments, the focus has primarily been put on financial support to higher scientific education. As a result, India today possesses highly skilled workers within fields of technology, IT and chemistry (Dahlman, C. & Utz, A. 2005 p. 86).

3.3. Summary
As a market opportunity, India provides several advantages for Novo Nordisk. The fact that English enjoys status as a primary language creates a potentially well-functioning working environment, where language barriers are absent.

The rise of the new middle class presents a new segment of diabetics with an increase in the ability to afford medical care. Furthermore, it is fair to assume that a middle class diabetic is more likely to pay for improving his health condition compared to a patient from a lower socio-economic group who is un-able to afford medical consulting.

India has undergone a transition from being a plan-economy before 1991 to being an open market-regulated economy. The government has shown openness towards foreign investment and the economy has shown long-term stability with a relatively low inflation rate and high economic growth. A further discussion on country-specific risk is conducted in section 7.

\textsuperscript{10} World Development Indicators
4. Diabetes

This section aims at analyzing the prevalence and risk factors of diabetes, beginning with a brief introduction to the types of the disease. Section 4.1 presents the causes and risks for developing diabetes, section 4.2 looks at future projections for the development, while section 4.3 looks at the economic burden of diabetes. As a whole, section 4 provides a view of the opportunities to be explored by Novo Nordisk arising from the Indian diabetes epidemic.

Diabetes, which is the common form of the correct medical term *diabetes mellitus*, can be divided into two main types, i.e. type I and type II, the latter being the most common. Type II diabetes mostly originates from obesity caused by an unhealthy lifestyle with a diet containing sugar and fats. Typically, the state before developing type II diabetes is the development of impaired glucose tolerance (IGT) which eventually – if left untreated – will cause the patient to develop diabetes. Type II diabetes is often being considered a disease of affluence (Misra, A. et al. 2001). This type of diabetes can most often be treated without the traditional treatment of insulin; however, an oral type of medication also produced by Novo Nordisk is needed. The two types of diabetes are often referred to as insulin dependent diabetes mellitus (IDDM), and non-insulin dependent diabetes mellitus (NIDDM) respectively (Misra, A. et al. 2001).

While type II diabetes is being highly prevalent in India, type I is relatively uncommon which is also the case for many other developing countries. According to Bjork, S. et al. (2003), only 5% of the Indian diabetics suffer from type I diabetes.

India is of substantial interest to a company like Novo Nordisk. Not only does India host the second largest population in the world – a wealth of data suggests that prevalence of diabetes is higher among Asian Indians than in other ethnic groups. This is due to greater abdominal obesity and insulin resistance and thus an increased risk for developing IGT (Misra, A. et al. 2001). Even at the same BMI-level as other ethnic groups, Indians have higher insulin resistance and glucose levels making them more prone to develop IGT (Boddula, R. et al. 2008). As a result, India presents a significantly interesting area of research within diabetes care.

India has in the past decades shown a trend towards a higher degree of urbanization. Figure 4.1 illustrates the increasing migration from rural to urban areas.

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11 From a survey conducted by Bjork, S. et al. (2003) showed that 95% of the diabetics sampled for the study suffered from type II.
12 See description in section 4.1.
Diabetes and IGT appear to be highly prevalent among migrant Indians. While the disease is not of particular risk to the rural population, the migrants to urban areas are exposed to various adverse influences regarding lifestyle and diet. Lifestyle alterations resulting from changes in eating habits, increased stress levels and decreased physical activity combined with new habits such as smoking or drinking are strong triggers for developing type II diabetes.

A British study of diabetes in developed countries concludes that diabetes risk factors are more common among people of lower socio-economic status. These findings appear to be applicable in this case also – assuming that the rural immigrants to urban areas have lower socio-economic status and lower levels of education (Misra, A. et al. 2001). As a consequence of the low level of education, the patient may be unaware of the characteristics of the disease, diet, hygiene etc. which may contribute to further aggravating the patient’s health condition.

Migration is not the only cause of changes in diet. India is in a phase of rapid economic transition, and the economic growth and hence increased wealth have changed the nature of the traditional Indian diet towards a diet containing more sugar and fat. An effect of the increasing urbanization is an alteration of the labor force characterized by an increasing share of women working outside the house. This presents a market for Western-inspired preprocessed meals containing more calories than traditional Indian meals (Pingali, P. et al. 2004). The same author argues that the diet transition happens in two phases as wealth increases; the first phase is characterized by an increased consumption of traditional diet with a few elements of diversification, whereas the second phase is called the diet globalization and is characterized by the abandonment of traditional diet and adoption of different diets.
In India, there appears to be a negative income elasticity of rice demand, since rice, which traditionally is an important part of Indian diet, is gradually being substituted with wheat and other grain types. According to Pingali et al., the income elasticity of rice is -0.29. The evidence of this diet change is seen both directly and indirectly – as a decline in the consumption of traditional foods and as an increase in obesity and diet-related diseases. The latter is caused by the economic growth in the 1990s resulting in larger consumption of so-called energy-dense foods, e.g. chips and sugar products. This is theoretically supported by Engel’s law, which argues that, as the income rises, the consumption shifts towards luxuries. In other words, consumption will shift from inferior goods towards goods with an income elasticity of demand greater than one (Gionea, J. 2005).

4.1. Recent studies and findings

With the awareness of diabetes being a potentially serious burden to the Indian economy, several studies have been undertaken in recent years, in order to investigate the causes and consequences of diabetes and IGT among the Indian population. People of both genders from various ages and socio-economic groups were sampled for the studies. It has earlier been argued that one of the most important causes of diabetes is obesity. This is supported by the statistical findings in the studies by Ramachandran, A. et al. (2001) conducted through univariate logistic regression analysis, where factors such as body mass index (BMI)\(^\text{13}\) and waist-hip ratio (WHR) together with age and family history of diabetes all yielded a p-value below 0.0001 when regressed on diabetes as the dependent variable – thus indicating that these are highly significant factors for developing the disease.

When regressed on IGT as the dependent variable, only BMI and age yielded p-values below 0.0001 and in an age-adjusted regression analysis, only BMI was significant with a p-value below 0.0001. Monthly income was also significant with a very low p-value in the age-adjusted regression, supporting that socio-economic factors in fact are highly significant. Based on these findings, it can be concluded that the most important cause for diabetes is obesity, given that it is the only variable that is proven significant in all of the regression analyses – both with respect to diabetes and to IGT.

In the study by Ramachandran, a BMI level above 25 was considered overweight, as was a WHR above 0.95 and 0.80 for males and females respectively.

\(^{13}\) BMI = weight in kg / (height in m)\(^2\)
Misra, A. et al. (2001) have carried out a study of diabetes and obesity in the urban slum of northern India, and the findings are indicating a high prevalence in this particular area. With a sample of 532 subjects (170 males and 362 females), the overall obesity was found to be 13.9%. 10.6% of males and 40.2% of females were characterized as obese. Furthermore, type II diabetes was found in 11.2% of males and in 9.9% of females.

Another study conducted between July and December 2003 among affluent Indians by Boddula, R. et al. (2008) presents the following data:

Table 4.1 Prevalence of diabetes and IGT among affluent Indians

<table>
<thead>
<tr>
<th></th>
<th>Diabetes mellitus</th>
<th>IGT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Age standardized prevalence</td>
</tr>
<tr>
<td>All = 1112</td>
<td>273</td>
<td>21.1%</td>
</tr>
<tr>
<td>Men = 557</td>
<td>158</td>
<td>25.2%</td>
</tr>
<tr>
<td>Women = 555</td>
<td>115</td>
<td>16.6%</td>
</tr>
</tbody>
</table>

Source: Adapted from Boddula, R. et al (2008)

This table indicates that although highly prevalent among the lower socio-economic groups, diabetes is indeed a disease of affluence. The samples for this study were taken from a high-income group defined by occupation e.g. businessmen, college-graduates, government officers etc.

The study by Boddula illustrates that in developing countries, people enjoying a high socio-economic status are more prone to developing diabetes than people from less privileged groups. In developed countries on the other hand, the situation is the opposite with more diabetics in the lower socio-economic groups due to poor levels of education, nutritional information and less focus on health issues.

This information of the socio-economic status of the diabetics in India is relevant in the sense that it clarifies what causes the disease to turn into an epidemic. It provides Novo Nordisk with the necessary knowledge for assessing the target groups when conducting awareness campaigns. Additionally, it indicates levels of profitability for Novo Nordisk, given that affluent people are assumed to be willing to spend more money in absolute terms on their health compared to people with lower socio-economic status.

4.2. Future projections
Several researchers have published forecasts in medical journals, among others King, H. et al. (1998). Appendix A presents the data from the study.
The study investigating the global burden of diabetes is only conducted among people above 20 years of age, since age is a significant factor for developing diabetes. This is also shown in appendix A, where the age group 45-54 represents the largest group of diabetics. Developing countries, including India, are estimated to have an increase in diabetes of 170% resulting in 75% of the world’s diabetics living in developing countries by the year 2025 – compared to 62% in 1995. However, it is important to note that although the increase is a lot higher in developing countries, the prevalence still remains higher in developed countries. These projections are supported by the World Health Organization (WHO) estimating the total number of diabetics in India to reach 79 million by the year 2030.\textsuperscript{14}

Demographically, India’s total population is growing by an annual 1.548\textsuperscript{15}, – posing a natural cause for an increase in the number of diabetics. The increased urbanization, as illustrated in figure 4.1, causes an increase in diabetics due to changes in lifestyle and diet and together with the natural population growth this contributes to an increase in the prevalence of the disease. The study conducted by King, H. et al. (1998) emphasized the differences between urban and rural areas in developing countries but concluded no significant difference between the two in developed countries. Finally, the large pool of Indians already suffering from IGT is likely to develop diabetes later in life, and hence contribute to the statistics.

\textbf{4.3. Economic aspects}

On macro-level, the increasing costs of healthcare make the prevention and treatment of diabetes crucial. As of 2003, the Indian government was without a long-term plan for diabetes. According to the World Bank Group, in 2003, 3.1\% of all governmental expenditures consisted of health-related expenditures. By the year 2005, this had increased to 3.5\%. In comparison, the contemporary number was 7\% and 8\% for the U.S. and Denmark respectively. Due to the relatively low level of public spending within the area, there is reason for serious concern regarding the rapidly increasing number of diabetics. The increase already present poses a unique opportunity for Novo Nordisk to actively lobby the Indian government, in order to further increase spending within diabetes care. As mentioned in section 2.2, Novo Nordisk can use the level of governmental interest to its own advantage by gaining influence in legislation and preferably promote increased governmental spending within diabetes care.

Given the vast number of diabetics and the projections for the future, the diabetes epidemic in India is bound to impose an economic burden on patients as well as on state resources.

\textsuperscript{14} WHO - http://www.who.int/diabetes/facts/world_figures/en/index5.html
\textsuperscript{15} World Fact Book (cia.gov) Estimate for 2009.
It is evident that the poorest families bear the largest relative financial burden of diabetes. In India, diabetes costs for one patient are approximately 25% of household expenditures for the poorest compared to 9% for a low-income American family (Bjork, S. et al. 2003). Additionally, more than half of all health expenditures are held by individuals, and governmental support is below 30% (Royal Danish Embassy, India 2005). In Denmark, the public health insurance grants subsidies of 100%, 74.7% or 49.8% on doctor prescribed medications independent of the patient’s financial situation.16

The major part of health expenditures in India is incurred during admission to hospital and medical treatment (Bjork, S. et al. 2003). The same authors have conducted a study investigating the economic consequences of diabetes. The study focused on the following six aspects: 1) socio-economic status, 2) diagnosis of diabetes, 3) treatment, 4) direct costs, 5) indirect costs and 6) awareness of diabetes. 5516 diabetes patients completed the study out of which only 282 suffered from type I diabetes. It was found that most patients living in rural or semi-urban areas had been diagnosed recently – suggesting that they had been undiagnosed for a longer time compared to urban patients.

The mean total direct costs were reported to be INR 7,159 p.a. per patient. The study proved a clear correlation between severity and complications and total direct costs. It also appeared that there were fewer complications among urban patients of higher socio-economic status given their more frequent monitoring.

The world diabetes foundation has introduced an economic model used for computing the total cost of diabetes in a particular area. The model is stated below.

\[
\text{Total cost} = P \times D \times T \times \left[ \left( \frac{\text{Low}}{\text{Total} \times \text{cost}} \right) + \left( \frac{\text{Medium}}{\text{Total} \times \text{cost}} \right) + \left( \frac{\text{High}}{\text{Total} \times \text{cost}} \right) \right]
\]  

(4.1)

P is the total population, D is percentage of diabetics and T is the percentage of diabetics being treated. Low represents the income group with the lowest amount of resources and is viewed as a percentage of the total population. The same applies for the groups medium and high. Cost represents the yearly costs per patient in each income group.

The variables used for estimating the total cost emphasize the socio-economic aspects as well as detection of the disease. By using the following data, the model can be applied to India:

16 Danish Ministry of Health: Danish law of health insurance, articles 6a and 7.
The population, percentage of diabetics and treated patients in the above table are actual numbers. The allocation of patients in the low, medium and high income groups is a simplified example based on the example presented by the World Diabetes Foundation.

Assuming an average yearly cost of INR 3,600; INR 5,400 and INR 12,000 for the low, medium and high resource groups respectively, we would yield a sum of INR 27.3 billion for the total costs. This is a significant burden on the Indian economy, but it can be changed by changing the variables in the model. If we assume that more people become aware of the disease and hence begin treatment, the proportion of the low resource group is estimated to rise. However, as detection is now assumed to be early, the average yearly costs per group is expected to fall. By introducing a simple numerical example, it should be proven that it indeed does pay off to create more public awareness of diabetes.

Increasing the treated from 15% to 25% would mean that the overall treatment of the diabetics in India would then be 7,500,000 against 4,500,000 before. The extra 3,000,000, who are then being medicated for their disease, are placed in the low income group – changing the percentages from 50, 25 and 25 to 70, 15 and 15 for the low, medium and high income group respectively. The reason for allocating the extra receiving treatment to the low income group, is the assumption that this group may have remained ignorant of the severity and consequences of the disease prior to the awareness campaigns.

Because these patients are now assumed to be diagnosed sooner in the course of their disease due to increased awareness, the costs are estimated to drop to INR 2,800; INR 4,800 and INR 10,000 for the three groups. Inserting this into the model, we yield a total cost of INR 31.4 billion. This is equal to an increase in total costs of 13% compared to an increase in treated patients of 67%. It is hereby concluded that the patients and the economy will benefit from increasing the awareness of the disease. In addition, a well treated patient is likely to avoid future complications such as cardio-vascular diseases and blindness, and this indirectly saves the patient and the society large future expenses.
4.4. Summary
Based on this section, India is a country of substantial interest to Novo Nordisk. The section has showed that diabetes type II is highly prevalent in India and more so for the affluent part of the population.

Indians appear to have an increased susceptibility for developing diabetes in comparison with other ethnic groups. In addition, the change in lifestyle combined with demographic transformation has contributed to the increase in the prevalence. Obesity is presented in section 4.1 as the main cause for developing diabetes due to the above mentioned conditions.

India only spends 3.5% of the GDP on health expenditures and the awareness of the disease is relatively low, with only approximately 15% of the diabetics receiving treatment. This low level of treatment is mainly due to low public awareness and lack of education. Furthermore, the costs of diabetes treatment are primarily placed on the individual as opposed to Western countries with higher levels of governmental support.

Novo Nordisk will be able to benefit from an increased level of awareness resulting from campaigns, as more patients may then realize their condition and seek treatment, thus increasing the demand for diabetes medicine.
5. The pharmaceutical industry

This section presents an overview of the pharmaceutical industry in India. Section 5.1 covers the development of the patent laws of India, which is very important to an R&D company. Section 5.2 analyzes the structure of the diabetes market and section 5.3 analyzes potential barriers to entry. This is applied to Novo Nordisk in section 5.4.

Like the rest of the Indian economy, the pharmaceutical industry has undergone a wide range of changes through the past two decades. Since the liberalization of the economy in 1991, India has acceded to the GATT/WTO Intellectual Property Rights (IPR) regime as mentioned in section 3. This has made it easier for companies in India to obtain patents on products. The general direction of policy is looking towards liberalization and integration with the global economy, and in order to achieve this, it is crucial that India is able to attract international investment projects. In 2005, the Indian government implemented new legislation on intellectual property – recognizing product patents on pharmaceuticals. This was also the year when Novo Nordisk in August chose to sign a new agreement with Torrent Pharmaceuticals permitting Torrent to manufacture Novo Nordisk’s products on license. Prior to this agreement, Torrent Pharmaceuticals were merely responsible for marketing Novo Nordisk’s products in the Indian market.

5.1. The patent laws

Until 1970, the market was dominated by multinational companies (MNCs). The situation was changed by the implementation of the 1970 Patent Act, merely recognizing processes – not products. This protective strategy created an opportunity for the Indian pharmaceutical companies, who could now legally sell cheaper copies of existing drugs. This caused the MNCs to minimize their activity in the Indian market – most of them stayed in the country undertaking minimum actions while waiting for stronger patent protection.

Figure 5.1. The pharmaceutical production process

Source: Adapted from (Smith, Sean E. 2000) pp. 16-17

Figure 5.1 shows the phases a pharmaceutical company goes through prior to introducing a new product on the market. After implementing the 1970 Patent Act, not much was invested by MNCs in the first two phases.
Until 2005, the Indian market was dominated by Indian pharmaceutical companies legally copying internationally patented drugs. By the year 2000, 80% of the Indian pharmaceutical market consisted of off-patent drugs (Smith, Sean E. 2000).

The Indian government had long appeared reluctant to implement new laws on patents, arguing that domestic firms would be worse off and that the consumers would face steeply increasing drug prices. This would create a negative impact on the health of the Indian people. However, to appease the WTO, who had long been criticizing the protectionist policy; the Indian government ratified the new law on IPR (Smith, Sean E. 2000). The same author argues that countries develop their own incentives to protect IP in parallel with their capacities to produce IP. This can only be deemed true in the case of India, where the workforce is known for its technical education and skills. Additionally, this implies that the Indian government may have had another objective – namely the opportunity of still protecting domestic property rights through the IPR law and thus promoting domestic R&D in addition to complying with the WTO.

This new law enabled companies to obtain patents for up to seven years\(^\text{17}\) and suddenly made it much more attractive for MNCs to do research in India. However, for the Indian companies this also meant a significant change. They had to review their strategy and transform their competences from being reverse-engineering, i.e. producing copies of existing drugs, to researching and developing. This has created a totally new market situation. Many Indian companies have shifted focus towards research and development, now emphasizing knowledge and technology over economies of scale. In order to access technology as a part of their new strategy, many top Indian firms have initiated co-operations with international drug companies – among those is Indian-based Torrent Pharmaceuticals who has initiated cooperation with Novo Nordisk (Chaturvedi, K. 2006).

The fact remains that India possesses relatively cheap and highly skilled labor within technology and chemistry (Smith, Sean E. 2000). This makes India favored as a research platform as such skills easily transform into drug research, hence creating a skilled workforce able to undertake research for MNCs like Novo Nordisk (Dahlman, C. & Utz, A. 2005 p. 87). Critics of these projections argue that Indians are unfamiliar with the risk of new project failure, since they have only specialized in copying already successful products.

\(^{17}\) This is compared to a patent period of 20 years in Denmark (The Danish patent and trademark office).
5.2. The market structure
The diabetes market is characterized as a business-to-business (B2B) market given that diabetes drugs are prescription drugs. It is thus the doctors and healthcare specialists who decide which drug to prescribe to their patients, and Novo Nordisk must therefore aim its advertising towards this segment.

In India, the diabetes market is dominated by Novo Nordisk who holds a market share of approximately 60%. Other actors in the pharmaceutical industry also specializing in diabetes care are domestic firms like Ranbaxy, Cipla, Dr. Reddy’s, Lupin, Novo Nordisk’s partner Torrent Pharmaceuticals and the multinational GlaxoSmithKline. To present an idea of their share of the Indian pharmaceuticals market, a table of the leading firms is presented below.

<table>
<thead>
<tr>
<th>Company name</th>
<th>Share of total pharmaceutical market (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranbaxy</td>
<td>15.1</td>
</tr>
<tr>
<td>Cipla</td>
<td>9.2</td>
</tr>
<tr>
<td>Dr. Reddy’s</td>
<td>6.8</td>
</tr>
<tr>
<td>Novo Nordisk*</td>
<td>6.6</td>
</tr>
<tr>
<td>Lupin</td>
<td>5.1</td>
</tr>
<tr>
<td>GlaxoSmithKline</td>
<td>4.0</td>
</tr>
<tr>
<td>Torrent</td>
<td>2.0</td>
</tr>
<tr>
<td>Others</td>
<td>57.8</td>
</tr>
</tbody>
</table>

*Calculated as 11% of 60%

Source: Derived from the Business Company and Resource Center, Gale databases

As the table is an overview of the total market share of the pharmaceutical industry, Novo Nordisk’s market share has been recalculated. An industry report from the database Business Company and Resource center states a share of 11% of the total market diabetes and related care. By taking 11% of Novo Nordisk’s share of 60%, we have derived the total share of 6.6%. These market shares can be used in the calculation of the Herfindahl-Hirschman Index (Lipczynski, J. et al. 2005 p. 218) which is computed as

\[
\sum_{i=1}^{N} s_i^2
\]

where \( N \) is the total number of competitors in the industry, and \( s_i \) is the market share of firm \( i \). The value of 1 occurs when there is one dominant firm, i.e. a pure monopoly and the value \( 1/N \) occurs in a case of \( N \) equal-sized firms. When computing the index value for the above seven companies, we yield a value of 0.174 indicating a moderate concentration in the market.
The higher concentration, the more difficult it is to make a profit for new entrants. However, a higher concentration also results in a higher profit margin for existing players. The Herfindahl index provides Novo Nordisk with an assessment of the market situation and the conclusion to be drawn from this must be that the market is fairly attractive to a strong incumbent firm like Novo Nordisk.

Given that Novo Nordisk possesses a dominant position in the diabetes market, which is not to be confused with the overall pharmaceuticals market; it may be argued that the diabetes market in India has traits of a monopoly. Because of its size, Novo Nordisk is not necessarily dependent on the actions of the other actors in the market. This market position provides a company with the ability to set prices above the marginal costs, and the amount by which price exceeds marginal costs is then inversely dependent on the elasticity of demand. This is referred to as abnormal profit (Pindyck, R.S. et al. 2005, p. 357). In Novo Nordisk’s case, this means that Novo Nordisk is able to undertake actions without fearing the response of the competitors since they don’t pose a major threat. This will be elaborated later in the section of strategic entry barriers.

Rather than a real monopoly, this market situation may also be denoted a differentiated oligopoly with monopolistic competition, given that the diabetes market in India is characterized by one large and several small manufacturers. Furthermore, the drugs produced by the various actors in the market differ slightly from one another but are at the same time close substitutes. In many ways, the industry can be compared to the Danish market for milk. The market is dominated by Arla, but several small producers of generic milk-products are also well-established. Each product has slightly different attributes and its own group of consumers.

Also, dairy-products are quite price-inelastic as people don’t necessary consume more if prices were to drop. In the same manner, diabetes drugs, which are prescription drugs, are also price-inelastic given the assumption that the patient does not consume more due to shifts in price levels, but only consumes the drug when it is prescribed by a doctor.

This market characteristic strongly influences the price setting of the competing firms. After having spent vast amounts of money in the development of a new drug, Novo Nordisk and its competitors face the problem of product pricing. Determining the price depends on the needs and preferences of the patients buying the drug, the characteristics of the drug and the characteristics of competing drugs (Pindyck, R.S. et al. 2005, p. 10). Before setting the price, it is therefore crucial that Novo Nordisk is aware of the market situation in which the drug is to be sold.
However, the pharmaceutical industry is not a market where price wars or predatory pricing are an optimal way of marketing a product. Since a company like Novo Nordisk is highly dependent on revenues after having placed so many sunk costs in the developing process, it will only damage Novo Nordisk’s profit margin if the prices were to drop. A more adequate approach may be to compete on advertising, public lobbyism, innovation, brand and quality. This is supported by Lipczynski, J. et al. (2005) p. 312, presenting empirical evidence stating that incumbent firms tend to prefer non-price strategies in order to deter entry.

5.3. Barriers to entry
A market is never defined without analyzing the barriers to entry. Barriers can be defined as conditions that allow incumbent firms to earn abnormal profits without attracting entry (Lipczynski, J. et al. 2005 p. 277). In general, such barriers can be divided into two groups, structural and strategic. Structural barriers are barriers that are characteristic to the industry, whereas strategic barriers are barriers to be imposed strategically by incumbent firms. In the following, examples of each type will be presented. The strategic barriers are presented with Novo Nordisk as the active firm.

An example of a structural barrier to entry is economies of scale, which is a phenomenon much known in the pharmaceutical industry. Once a new drug is developed, production costs per unit will initially drop dramatically for each new produced drug entity. This provides a barrier to new entrants, who must produce at a high initial capacity in order to achieve economies of scale. This is because they will have to invest just as much time and money, before they may be able to reach the production capacity as the incumbent firms. It may be argued that such an investment creates a very steep learning curve for the new entrants as they have to commit to development, clinical testing and the risk of failure and loss.

The regulatory character of the pharmaceuticals and diabetes market also presents a structural barrier towards new entrants. Lipczynski, J. et al. (2005) p. 284, state that legal entry barriers for new firms or drugs within pharmaceuticals are high, arising from the framework of safety rules and regulations. This is because new drugs need to be approved by several institutions both in the clinical phase and when the drug is completed. These rules protect patients from potential damage but at the same time pose inconvenience on the manufacturing firm, who may experience delays, disapprovals and increased costs due to improvement of failed drugs.
5.4. Novo Nordisk’s barriers
For Novo Nordisk as an active player in the Indian diabetes market, it is very relevant also to investigate the strategic entry barriers as they provide an idea of what can be done in order to maintain a dominant position in the market.

In their study of R&D option strategies, Smit & Trigeorgis (2001) state that an incumbent firm can preempt potential threats from new entrants by spending excessive amounts of sunk costs on R&D. A monopolist, however, may be reluctant to promote innovation since the threat imposed by entrants will be insignificant. On the contrary, a company subject to the threat of new competition may be encouraged to innovate earlier. This is in fact a strategy that is easily adopted by Novo Nordisk in this investment project, since it may be able to discourage new entrants from entering the market by investing massively in the development of a new drug.

Other strategic entry barriers to be raised by incumbent actors in a market are changes in price or production levels. By setting a price that is below a potential monopoly price but at the same time above the average costs, the incumbent firm may charge what is referred to as a limit price (Lipczynski, J. et al. (2005) p. 287). The result of this pricing strategy is an abnormal profit below monopoly profit. For Novo Nordisk to utilize this strategy it is necessary to have an advantage of economies of scale. A situation, where Novo Nordisk could use this strategy would be illustrated in figure 5.2.

Figure 5.2. Novo Nordisk’s use of limit pricing to deter entry

The figure assumes a case where Novo Nordisk is the only incumbent and where there is only one potential entrant. LRAC denotes the long run average cost function of both firms. The residual demand is the entrant’s demand function when Novo Nordisk is producing a quantity of Q* which is the equivalent of the market demand to the right of Q*.
As can be seen, the residual demand lies below LRAC at all output levels; meaning that if the entrant produces a low output it will fail to benefit from economies of scale. If instead the entrant should choose to produce a high output, this strategy will cause the price to drop and thus be unprofitable. Novo Nordisk can therefore prevent entry by operating at (P*,Q*).

However, some critique of limit pricing has been presented in Lipczynski, J. et al. (2005), stating that there is no reason to believe that the entrants should count on the incumbent to not alter its pricing policies if entry takes place. Another point of critique focuses on the absence of market structure theory, as this model, if applied in an oligopoly, would assume all firms to implement a limit pricing strategy. This could only work in a case of a high level of coordination. In addition, there is empirical evidence supporting that price-strategies such as this are not usually preferred by incumbent firms as mentioned in section 5.2.

Finally, a strategy to be chosen by Novo Nordisk, in order to prevent new entrants from entering the market, could be to deliberately increase the sunk costs in either existing projects or in new projects as we will elaborate in section 6. By increasing these costs, Novo Nordisk is able to signal commitment to fight new entrants. Such a strategy may prevent other firms from entering as they will know in advance that the competition from the incumbent actors will be fierce.

This is characteristic of the pharmaceutical market. Lipczynski, J. et al. (2005) p. 312 present an empirical study conducted by Rudholm (2001) concluding that the determinants of entry to 22 Swedish pharmaceutical markets were characterized by higher entry in markets where incumbent firms would earn high profits, and it was lower in markets where incumbent firms enjoyed long periods of patent protection. Thus, by investing massively in product development, Novo Nordisk may be able to obtain a new patent and hence prevent potential competitors from entering the market.

5.5. Current market situation
As to the contemporary situation in the Indian pharmaceutical market, Chataway, J. et al. (2007) argue that the current focus of pharmaceutical innovation in India is to be denoted as ‘catch-up’. This is in the sense that Indian companies now are focusing more on innovation, but still lie behind the foreign competitors. Due to the rapid expansion into international drug markets, the biggest Indian firms now have ambitions to compete domestically with foreign multinationals. However, the authors stress that the Indian market is much skewed and that it may be too insufficient to support an R&D intensive domestic pharmaceutical sector.
As a consequence of the barriers to entry, both structural and strategic as presented in sections 5.3 and 5.4, there is no previous example of an Indian pharmaceutical company transforming from being a producer to being an R&D-multinational. It is further argued in the study that the current R&D-based multinationals have co-evolved with the Indian regulatory systems making the two parts mutually reinforcing.

In order to achieve a position in the market, a new entrant must thus speculate in developing a brand new drug that may outperform the existing products. This strategy is characterized by high sunk costs, lengthy trial procedures and a risk of failing. The reward for success, however, is characterized by massive streams of patent-protected revenues. This strategy may also be used by an existing market actor, who wishes to strengthen its market position or as mentioned above; signal commitment. In this case, the initial investments may be considerably lower as the company does not need to establish the physical framework for conducting the research, given that it is already present in the market. This may be an ideal opportunity for Novo Nordisk as will be discussed in section 6.

5.6. Summary
The new law on IPR has made it easier to obtain patents in India, where patent rights as of 2005 may last up to seven years. This has made it more attractive for MNCs to conduct R&D projects in India. At the same time, India possesses a technologically skilled workforce, which also contributes to the attractiveness.

The diabetes market is characterized by B2B relations between the manufacturers and the professionals writing the prescriptions. The Herfindahl-Hirschman index indicates that there is a moderate concentration in the market, thus making India attractive to Novo Nordisk as such a concentration facilitates a high profit margin for incumbent firms.

Novo Nordisk holds an advantageous position in the diabetes market resembling a monopoly; however the market would be characterized as a differentiated oligopoly, given that several other manufacturers produce generic diabetes medicine. The product offered by Novo Nordisk is relatively price in-elastic in the sense that the end users won’t consume more or less as a consequence of shifts in prices. As a result, pricing strategies can be used to preempt potential entrants, although this may not be a preferred strategy.
The barriers to entry in the market are structural and strategic, where the latter can be actively used by Novo Nordisk in attempt to deter potential entry. An increase in sunk costs may also signal commitment to fight off potential competitors.

The current R&D situation in the Indian pharmaceuticals market is dominated by multinational companies. This is because the domestic Indian companies have been prevented from competing on equal terms due to strategic barriers imposed onto them by the multinational companies, who have placed substantial sunk costs in R&D activities.
The previous sections 2 and 3 have provided an overview of Novo Nordisk and the economic situation in India. Sections 4 and 5 presented an analysis of the prevalence of diabetes and the Indian pharmaceuticals and diabetes market. In the following a comprehensive quantitative investment project will be presented.

Novo Nordisk intends to shift one third of all its R&D activities to India by the year 2011. The main objective for this is the opportunity to benefit from the country’s special diabetes profile, low cost and highly skilled labor force. From a company viewpoint, this means that Novo Nordisk in the long run will be able to generate R&D cost savings of 30% to 70% in India as mentioned in section 3.

By intensifying its activity in a rapidly growing market now, Novo Nordisk will have the capacity to meet the increase in future demand and also create barriers to entry for competitors who may choose to wait. Additionally, when conducting research in drug development, Novo Nordisk can achieve a substantial competitive advantage due to the vast size and growth of the Indian diabetes market.

In order to illustrate the considerations to be taken into account when conducting an R&D investment project in India, we have created a theoretical investment project.

The investment project seeks to explore whether Novo Nordisk can utilize the opportunities of India to develop an anti-diabetes drug that is even better than any existing drug on the market. Given that type II is dominating in India due to the special genetic susceptibility towards developing the disease, Novo Nordisk should be able to benefit from the large gene pool of trial candidates in the development of the new drug.

The concept of a multinational company like Novo Nordisk engaging in foreign investment projects is usually referred to as multinational capital budgeting. As opposed to domestic capital budgeting, this approach contains a larger degree of complexity. Among the most important factors to take into consideration are legal and political constraints that may influence the investment. However, the introduction of the IPR law, mentioned in section 5, has mitigated these risk factors for an investment project in India. Another important factor is sudden shifts in exchange rates, which can cause changes in cash flows over time. However, foreign exchange risk can be hedged using financial derivatives as it will be described later.
Theoretically, there are four basic steps, which a company should follow when deciding to invest in projects abroad; 1) Identification of invested capital and currency, 2) Estimate of cash flows from the investment, 3) Identification of an appropriate discount rate and 4) Evaluation of the NPV (Moffett, M.H. et al. p. 532). These four steps will be further elaborated and evaluated later.

6.1. Project assumptions
The article from *The Economist*18, mentioned in the introduction, presents Novo Nordisk’s plans for India and states that the project consists of relocating R&D activities. This means either licensing operations to a foreign company or establishing facilities in a foreign country, in order to conduct either operations or, in Novo Nordisk’s case, research and development. In order to evaluate this project as an investment, the following is assumed:

Novo Nordisk is investing in an R&D project in India consisting of research facilities and local workforce. The expenditures are expected to be held in rupees paid for with Danish kroner and revenues from the investment project are expected to be reported in rupees, which are then converted to Danish kroner, thus making Novo Nordisk vulnerable towards fluctuations in the exchange rate. The invested amount has been estimated based on data from the 2008 financial report as appears from section 6.2.

It is assumed that Novo Nordisk itself will carry out the R&D activities focusing on specified trials on Indian patients. Research will be carried out by Novo Nordisk scientists and local workers from Torrent Pharmaceuticals given Novo Nordisk’s wish of enhancing the collaboration. When the products are developed and have passed the trials, Torrent Pharmaceuticals produces and markets the new drugs. Revenues from the project are assumed to merely consist of revenues from sales disregarding license fees from Torrent Pharmaceuticals. Additional factors like inflation, interest and taxes are also disregarded for simplicity. It is furthermore assumed, that Novo Nordisk finances the investment project with equity disregarding the aspect of debt.

The project assumptions are summarized in the roadmap illustrated in figure 6.1.

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The investment in the R&D project will consist of three various investments in time followed by a ten year sales period; firstly the initial investment in testing the hypothesis that a new diabetes drug can be developed; secondly, money is invested in clinical trials and patient testing. Thirdly, money is invested in marketing in order to realize revenues. In the following, each of the three investment phases will be briefly described. The information of the phases is primarily gathered from Novo Nordisk’s website.

**Phase 1: The research phase**

In the pharmaceutical industry, there is an estimated 10,000 to 1 ratio between laboratory ideas and actual products that reaches the customers, and the whole process takes 10 to 13 years. At first, a small team of researchers sets out to test a hypothesis via biochemical methods and/or animal testing. If experiments are positive and a lead compound has been identified, a formal research project is established. From this point of view, the investment is a two-case scenario:

\[
\begin{align*}
H_0: & \text{ No basis for developing a new type II product in India.} \\
H_1: & \text{ Basis for developing a new type II product in India.}
\end{align*}
\]

Disregarding the outcome, an R&D facility is established in India and will in either case lower Novo Nordisk’s costs considerably. In the \( H_1 \) case, which is the success criterion, a formal project is undertaken which in approximately ten years will lead to a new product.
The license to producing this product is then handed exclusively to Torrent Pharmaceuticals, increasing their sales and Novo Nordisk’s revenue.

**Phase 2: The clinical phase**

This part is divided into three clinical trial stages, where the most critical point is the drug approval leading to a transition between trial stages two and three. Stages one and two consist of animal testing and testing on humans in order to discover potential side effects and finding the correct dose and duration of the treatment.

On the basis of results from trial stages one and two, a decision must be made whether to continue into trial stage three. This stage can be considered a pre-launch where the new product is tested thoroughly and compared to existing commonly used products. The product must therefore be ready for full manufacture before start of stage three of the clinical trials. In fact, products that make it to this stage are assumed to have a probability of 30% of proceeding to general sale (Benninga, S. et al. 2002). The probability of ascending to the next level is of course dependent on the drug type and general research uncertainty. However, since the percentage presented by Benninga, S. et al. (2002), seems to be a valid estimate, we have chosen to apply this probability.

When a product is determined safe and effective from the stage three trials, it must be authorized before the product can be marketed. All data generated during the development period is collected and submitted as documentation to the authorities.

**Phase 3: The market phase**

The market phase is a bit more loosely defined than the other two phases. Marketing involvement begins in phase one or earlier to ensure market needs are reflected in the product development. A strategy process includes internal measures with affiliates, and external market preparation. Research results are promoted in symposia from early stages, and awareness campaigns among the medical community intensifies. Finally, the sales force begins an intense campaign prior to launch. It is also at this point, Torrent Pharmaceuticals should be notified about their future involvement in the license production of the new product. When the new product is launched after ten years, marketing activities are conducted and persist for a certain time in the product launch period. The whole process can be summarized in a decision tree as follows:
6.2. Identification of invested capital

In order to identify the amount of capital to be invested in the project, Novo Nordisk’s annual report from 2008 served as a guideline. It stated that R&D expenditures for the international operations accounting for all of Asia except for Japan, all of Africa, the Middle-East and Latin-America accounted for a total of DKK 2.181 billion. Since India is a large part of this segment, a ten percent share of these expenditures was used as an estimate of the average yearly cost in the investment period, resulting in a total investment of approximately DKK 2 billion to be held over ten years.

For this investment, the time horizon for the project is assumed to be 20 years, ten years of investments and ten years of revenues. The initial investment will take place in year zero, the second in year five and the third in year nine. The total investment is assumed to be approximately DKK 2 billion, arbitrarily allocated in the following way: 37.5% are allocated to the research phase in year 0. An additional 52.5% of the total amount is allocated to the clinical phase commencing in the fifth year. This is due to the assumption that the testing period is the most costly due to all the safety criteria that must be met. By the end of the investment period, in year nine, the cash flows from the project can be realized. However, a final investment in marketing and campaigning of 10% of the total invested capital is necessary in order to receive the cash flows from the newly developed product. This is often referred to as the market phase (Benninga, S. et al. 2002).
6.3. Estimation of cash flows

It is important to note that a pharmaceutical firm conducting R&D investments has no revenues in the investment period. On the contrary, the value of the project exists in the future cash flow opportunities. The investment, which takes place over a span of ten years, will initially generate a stream of negative cash flows. Positive cash flows are realized only after project completion followed massive marketing investment.

This example is a simplified version of such a project. In reality, not all research ideas become actual products that are sent to market. There will always be some probability that the project will fail. It is assumed that this investment project has a 70% probability of yielding positive results in the research phase and hence proceeds to the clinical phase. According to Benninga, S. et al. (2002) the average probability of a new drug entering the clinical phase is only 50%, however, since this case is dealing with developing a type II diabetes drug, which has been done by Novo Nordisk before, the probability is deemed to be higher. Once the clinical phase is reached, more money is invested and the probability of proceeding to the market phase is assumed to be 30%. This is based on the case presented by Benninga et al. (2002), since there is no reason to believe that this case will be any different.

If the market phase is reached, Novo Nordisk can begin to yield revenues from the R&D activities. In order to allocate the positive cash flows to be used in the NPV model, it is estimated that the average revenue of a successful drug in the start of the marketing phase, i.e. in year ten, will be 30% of the value of Novo Nordisk’s total market share in India – equal to INR 675 million\(^{19}\) growing with an annual rate of up to 20%\(^{20}\). This growth is assumed to be the case for seven years – the estimated duration of the acquired patent. After these seven years of patent rights expire, the drug will be known to the users and patents will have expired and other firms may have copied the drug. In general, the complete product life cycle of such a product will usually be 20 years or less. After this period the drug becomes obsolete (Grabowski et al. 2002).

The project will reach the market phase with a probability of \((70\% \times 30\%) = 21\%\). Once the market phase is reached, the revenues from the project may be generated.

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\(^{19}\) Value of Novo Nordisk’s market share: Market share * value of insulin market = 60% * INR 3.75 billion = 2.25 billion. 2.25 billion * 0.3 = 675 million.

Source: *India beckons* Business India Intelligence February 20th 2008

\(^{20}\) This rate is presented in an example of Benninga, S. et al. (2002)
6.4. NPV analysis

The NPV analysis of the investment and the estimated cash flows is carried out in Excel and appear from appendices C and F. The investments are placed as stated above, and the revenues are incurred in rupees and converted to Danish kroner. The NPV is calculated using the formula:

$$NPV = \sum_{t=1}^{T} \frac{E(c_t)}{(1+k)^t} - I_0$$

(6.1)

Where the initial investments denoted by $I_0$ are subtracted from the time-discounted revenues denoted by $E(c_t)$. It is important to note that the investments have been allocated based on the assumption that the project will be successful although there is only a 21% probability of that happening. The total investment, which takes place three different places in time, is subtracted from the present value of all the expected cash flows given that the project is realized.

It is assumed that the patent obtained on the new developed drug will expire after seven years on the market. After this period, sales will stagnate and decline. The investment horizon of ten years can be seen in relation to the projections of future diabetics in India mentioned in section 4.2. With the rapid growth prevailing, the time horizon gives Novo Nordisk a profitable position, once the new drug is launched. A successful R&D project will thus give Novo Nordisk a considerable competitive advantage in a highly attractive market.

A static NPV budget is presented on page iii in appendix C to provide an overview of the investment situation. This budget presents the foundation for the dynamic simulation model, where the variables explained below have been allowed to fluctuate within an assigned span.

In the following sections, each of the variables used in our NPV model is thoroughly explained, analyzed and evaluated. This is due to the fact that the outcome of the NPV analysis is highly dependent on the input data. Since this is a theoretical thesis, we have presented qualified estimates of the data. Novo Nordisk needs to apply the same procedure when undertaking capital budgeting, as many of the factors included in the model are unknown and uncontrollable. Although Novo Nordisk undoubtedly has knowledge and experience out of our work area, they cannot project the future revenues with certainty. All the variables are subject to change, which we will analyze further in our simulation analysis. In the following, we will present arguments for our choices of fluctuation span and probability distribution for each of the variables. The variables and the entire NPV analysis can also be viewed in the spreadsheets available on the enclosed CD.
6.4.1. Analysis of the nominal exchange rate

The exchange rate plays an important role in our scenario. It is the only variable in the analysis, which Novo Nordisk can hedge using financial derivatives. This makes the exchange rate a valuable tool, which is why we choose to emphasize it in this section.

Exchange rates have been subject to many research studies and have been found to follow a random walk, thus being very hard to forecast through simple time series models (Soenen, L. 2004 p. 58). In their studies, Raunig, B. (2008) and Kilian, L. (1999) suggest that more advanced econometric methods are used in order to forecast the exchange rate. We have chosen to perform time series analysis of the past four years’ INR/DKK nominal exchange rate in order to compare our findings with similar studies.

In order to present a valid exchange rate to be applied in our NPV model, we have gathered data from the Bank of England statistical database. The data consist of the nominal exchange rate reported daily for the past four years (April 2005 – March 2009). It has not been possible to obtain the direct INR/DKK rate so instead, we have computed the cross exchange rate using the US dollar as intermediary exchange rate.\(^{21}\) We imported the data into the econometric analysis program Eviews in order to analyze the value and fluctuation of the exchange rate which is illustrated below:

*Figure 6.3. – INR/DKK from April 2005 to February 2009 with trend line*

![INR/DKK trend line graph]

Source: Adapted from Bank of England website

It appears from the figure 6.3 that the trend line indicates a depreciating trend of the rupee against the krone in the time period.

\(^{21}\) The method for computing the cross rate is illustrated in appendix B
### Choosing a model

In the following, univariate time series analysis of the INR/DKK exchange rate will be applied. This type of analysis relates current values to past values of the same time series. The model that will be used here is an autoregressive process of order one, AR(1). An example of such a model is presented below:

\[ y_t = \delta + \theta y_{t-1} + \varepsilon_t \]  

(6.2)

where \( y_t \) denotes the nominal exchange rate at time \( t \) and \( \delta \) is a constant. The above model is of order one since it only includes one time lag of the dependent variable. The model states that the present value of the exchange rate in time period \( t \) is equal to a constant plus \( \theta \) times the values of the previous value of the exchange rate plus an unpredictable term, generally referred to as white noise. Another model, which is able to explain the exchange rate is the moving average process of order one, MA(1):

\[ y_t = \mu + \varepsilon_t + \alpha_1 \varepsilon_{t-1} \]  

(6.3)

Here, \( y \) or the exchange rate is equal to the mean of the time series plus a weighted average of the white noise terms. As opposed to the model stated above, the autocorrelation for the MA(1) implies that a given shock in the series will only affect the rate in two periods, where the AR(1) model implies that a shock will affect all future values – however, with a decreasing effect. For the MA(1), only adjacent terms in the series are correlated and is thus referred to as a weakly dependent sequence.

Both the AR(1) and the MA(1) may be extended with further lags or used in combination in an autoregressive moving average, ARMA model.

In order to properly analyze the data, we first examined the autocorrelation (AC) and partial autocorrelation (PAC) for the nominal exchange rate using lags of 25. The requirements for the two models are as follows:

For an AR model of order \( p \), the autocorrelation is characterized as infinite but tailing off. The partial autocorrelation is close to zero for any lags larger than \( p \). An MA model of order \( q \) is characterized by an autocorrelation that is close to zero for any lags larger than \( q \) and a partial autocorrelation that is infinite and tailing off (Verbeek, M. 2004 p. 284). The figure below shows the AC and PAC for the nominal exchange rate.
Figure 6.4 strongly suggests that the exchange rate is best described by an AR model of order one, given the fact that a genuine AR(p) model is characterized by a partial autocorrelation close to zero after the p\textsuperscript{th} lag (Verbeek, M. 2004 p. 284). The partial autocorrelation at lag p is the autocorrelation between \( y_t \) and \( y_{t-p} \) that is not accounted for by lags 1 through \( p-1 \). As can be seen from the figure and from the correlogram on page x in appendix D, the AC only tails off slowly and is significant at all lags with a p-value of 0.000. The PAC becomes close to zero for all lags larger than \( p = 1 \), suggesting a first order AR model for our data analysis.

6.4.1.2. Estimating the model

Before conducting the actual time series analysis, there are assumptions that must be satisfied. The assumptions are part of the Gauss-Markov theorem and imply, when satisfied, that the OLS is the best linear unbiased estimator (BLUE). The assumptions are stated below and will be commented in the order that they appear in the analysis.

1) The model must be linear in its parameters, 2) There must be no perfect collinearity, 3) The expected value of the error term for all time periods must be zero (zero conditional mean assumption), 4) Homoskedasticity must be present, 5) There must be no serial correlation and 6) the errors must be independently distributed as normal.

When estimating an AR model for the exchange rate in Eviews, the following model is yielded using standard OLS.\(^{22}\) (Standard errors are reported in parentheses).

\(^{22}\) All Eviews outputs can be found in appendix B
\[ ER_t = 0,032 + 0,9960ER_{t-1} \]  
\[ (0.024166) (0.003090) \]

The constant is quite close to zero and therefore has little influence on the exchange rate. The p-value of the constant is 0.3184, making the conclusion fairly certain. The lag of the dependent variable is significant in our model with a p-value of 0.000 indicating that the coefficient is significant at even very small levels. The model is linear in its parameters satisfying the first of the Gauss-Markov assumptions.

The correlation of the lags appearing from figure 6.4 is not perfect, thus satisfying the assumption of no perfect collinearity as there is no perfect correlation among the independent variables.

Additionally, the assumption of zero conditional mean demanding an expected value of the errors to be zero should be satisfied. This may also be referred to as the exogeneity assumption and cannot hold since \( \varepsilon_t \) is uncorrelated with \( y_{t-1} \) in (6.4). This indicates that \( \varepsilon_t \) must then be correlated with \( y_t \), which is why our model with a lagged dependent variable cannot satisfy this strict exogeneity assumption (Wooldridge, 2006 p. 388). This bias may be corrected for by having a large sample, and is thus not deemed a serious violation in this case.

White’s test for heteroskedasticity indicates that heteroskedasticity is present in the model. This is supported by the graphic plot of the residuals on page vii in appendix D taking the form of a funnel. The model is therefore re-estimated using heteroskedasticity resistant standard errors as heteroskedasticity is a violation of the fourth assumption of the Gauss-Markov theorem demanding homoskedasticity. When re-estimating the model, the coefficients are unchanged but the standard errors are slightly higher as appears on page viii in appendix D.

A test for serial correlation of the residuals is carried out in Eviews using the Durbin-Watson statistic. A value of 2.168 indicates that no serial correlation is present satisfying the fifth assumption of the Gauss-Markov theorem. Another adequate test for serial correlation would be the Breusch-Godfrey test, which is usually preferred when analyzing AR(1) models as it allows for lagged dependent variables that are not strictly exogenous. The test is presented by a Lagrange multiplier (LM) test and is stated below

\[ LM = (n - q)R^2 \]  
\[ (6.5) \]
Where n is the number of observations, q is the order of the model and R² is derived from the regression. The LM test is tested with a null hypothesis of serial correlation against the χ² distribution with q degrees of freedom. Yielding a statistic of 979 (n=989, q=1 and R²=0.9906) the null hypothesis is not accepted, indicating that serial correlation is not present supporting the result from the Durbin-Watson statistic.

When looking at the residuals from the regression, there appears to be a problem with normality. This is confirmed by the Jarque-Bera test which rejects the null-hypothesis of normality with a p-value of 0.000 and thus violates the sixth and final of the Gauss-Markov assumptions. The sample size, however, is so large that this shouldn’t cause any problems.

By using the log of the dependent variable, we are able to estimate the percentage change in the dependent variable (Wooldridge, 2006 p. 49). The model is stated as follows:

$$\log(ER_t) = 1.077 + 0.1249ER_{t-1}$$  \hspace{1cm} (6.6)

$$(0.004214) \hspace{1cm} (0.000555)$$

This is considerably different from the previously estimated model. Now, the constant is significant both in value and with a p-value of 0.000. Non-normality is still present with a Jarque-Bera p-value of 0.000 but it still isn’t considered a problem. Interpreting this model, the percentage change in the current exchange rate ER_t can be estimated as 12.49% given the change of the independent variable with one unit. This analysis is based on historical data and may not present a valid image of future fluctuations. However, this is the most qualified estimate of the future development of the exchange rate.

6.4.1.3. Test for unit root

Traditionally, exchange rates are found to follow a random walk (Kilian, L. 2003). The case where a time series is said to follow a random walk, is the case where θ is equal to 1. Whenever this appears to be the case, the process is said to have a unit root. An important property for identifying unit roots is stationarity. This requires that variances and autocovariances are finite and independent over time (Verbeek, M. 2004, p. 266). Where the MA model is stationary by construction, given that it consists of the weighted sum of a fixed number of stationary white noise processes, the AR model is non-stationary for all values of θ larger than 1. This non-stationarity appears from figure 6.3 where a trend line indicates a depreciating trend of the rupee. This trend supports the argument for the rupee exchange rate to be non-stationary as a stationary process will be mean-reverting and the rupee has a mean that changes over time.
In order to test for a unit root indicating a random walk in the time series process, it is necessary to correct for non-stationarity. This may be done by first differencing the time series. If stationarity is prevalent after this process, the series is said to be integrated of order one, which is denoted I(1). A random walk process with \( \theta \) equal to 1 is an example of an I(1) series (Verbeek, M. 2004, p. 268). A process, which without differencing has an exact unit root is denoted I(0). The main difference between the two processes is that the I(0) series is mean reverting. In addition, the I(0) has only limited memory of past behavior, where the I(1) on the contrary has an infinitely long memory. This also appears from the autocorrelation function, where the AC will decline rapidly as the lags increase, whereas it will only slowly tail off in the I(1) series. As it can be seen from figure 6.4, the latter appears to be the case for our model. This indicates that a potential shock in the exchange rate is likely to have persistent effects that will only slowly decrease over time.

A test for unit roots in AR(1) processes has been presented by Dickey and Fuller and is generally referred to as the Dickey-Fuller test, which appears on page x in appendix D. The test states the null hypothesis that the process has a unit root and is tested by a standard t-statistic using the following method: (Verbeek, M. 2004, p. 269)

\[
DF = \frac{\theta - 1}{SE(\theta)}
\]  

(6.7)

The series being non-stationary means that the standard t-ratio does not have a t-distribution, not even for large samples (Verbeek, M. 2004, p. 269). The Dickey-Fuller test takes this matter into account by first differencing the equation.

When first differencing equation 6.2, \( y_{t-1} \) is subtracted on both sides and \( \theta \) is substituted with \( (1 - \rho) \). When making this substitution, the test for a unit root may now be expressed stating the null hypothesis of \( (\rho = 0) \) instead of \( (\theta = 1) \).

The estimated equation, which is now stationary, can be written as

\[
\Delta y_t = \delta + \rho y_{t-1}
\]  

(6.8)

In this case, a t-statistic of -1.294 is yielded, and we thus fail to reject the null hypothesis. This is supported by our analysis in Eviews, where we conducted the augmented Dickey-Fuller test for unit root. In addition to the regular test, the augmented test cleans up any serial correlation in \( \Delta y_t \) by adding the lagged changes \( \Delta y_{t-h} \) to the regression.
Running the test on our data in Eviews having the null hypothesis that the series has a unit root, we get a p-value of 0.6941 and 0.7159 for the level and log-model respectively. These high p-values are strongly indicating that our series has a unit root, as we fail to reject the null-hypothesis. The unit root test appears from page xi in appendix D.

Comparing equation (6.4) to the equation of a random walk,

\[ y_t = y_{t-1} + \varepsilon_t \quad (6.9) \]

it is seen that there is considerable similarity. The constant is of no importance given its small coefficient and insignificant p-value. As can be seen, the coefficient for the dependent variable with one lag is close to one, supporting that the exchange rate follows a random walk. When revisiting figure 6.3, the depreciating trend can be separated from a random walk and is therefore not contradictory. Furthermore, the depreciating trend of the nominal exchange rate is not explained by a higher magnitude of depreciating residuals, as already analyzed in the zero conditional mean assumption above. The depreciating trend is determined by Fisher’s international parity conditions, whereas one can assume that the nominal interest level in India has been higher in the observed period.

In our NPV simulation analysis, we use the above percentage change yielded from equation (6.6) as this presents realistic estimates of the future exchange rate scenarios. As our base rate we choose an exchange rate of 8.77 INR/DKK. This is the reported spot rate of March 2, 2009 according to the Danish National Bank.\(^{23}\) Our data analysis supports the application of the current spot rate as a base rate and not e.g. the mean rate of our historical data sample, as it proved that the exchange rate follows a random walk.

Besides, the current financial situation may also influence the exchange rate as it can be assumed that a country like India might undertake protectionist actions in order to shield its economy. Such a scenario may have serious consequences, since a shock in the exchange rate will influence all future values of the series with a decreasing effect. This is a consequence of the exchange rate series being an autoregressive process of order 1 as it was determined in our time series analysis.

Our findings in the day-to-day time series analysis appear to agree with the presented literature on the exchange rate behavior.

\(^{23}\) The Danish National Bank only quotes historical data of the INR/DKK exchange rate one month back in time, which is why we obtained the data from the Bank of England.
We have concluded that the nominal exchange rate follows a random walk and can only be estimated with very short time horizons. Since we have a horizon of ten years, we cannot predict the exchange rate on an annual basis. As a consequence, we have chosen the current spot rate and assigned a fluctuation span of ± 12.49% in our sensitivity simulation in order to simulate the exchange rate volatility. To make the model even more dynamic, the possibilities of instead fluctuating ± 6.25% or simply to remaining unchanged were also included in the simulation.

The probability distribution of this assigned volatility appears on page iv in appendix C and is assumed to be uniform, as we have no reason to deem one scenario more likely than another. This is due to the low predictability in the exchange rate and the fact that it follows a random walk. We have made each exchange rate dependent on the previous with the possibility to fluctuate within the assigned span. This is done in order to present the most realistic scenario.

6.4.2. The market value and market share

Our data on the total market value is derived from an article from The Economist.\textsuperscript{24} However, it should be emphasized that it is very difficult to value a market or an industry. From the article we obtained information of the current Indian diabetes industry, which was valued at INR 3.75 billion. This value is only conjecture, as we cannot know for sure how the market is valued. For this purpose, the market value is assumed to consist of the total value of revenues from diabetes drug sales in one year. As mentioned earlier, Novo Nordisk holds a share of 60% of this value. Since we have used the market value as a factor for estimating revenues, this variable is very important as fluctuations in the market value will affect the revenues in Novo Nordisk’s project budget.

When the total market value is INR 3.75 billion, the value per diabetes patient is computed to be INR 125. This is computed based on an estimate of a current 30 million diabetics.\textsuperscript{25} Given the estimate of the number of diabetics reaching 79 million by 2030 as mentioned in section 4.2, the market value in the year 2030 is estimated to be 79 million times INR 125 which is equal to a total market value of INR 9.86 billion. In order to compute the annual growth in the number of diabetics and thus also in the market value, the following equation is solved for $x$.

$$30 \times (1 + x)^{21} = 79$$

The exponent of 21 is the difference in years from 2009 to 2030. Solving the equation for $x$, an annual growth rate of 4.7% is yielded.

\textsuperscript{24} India beckons Business India Intelligence February 20th 2008

\textsuperscript{25} India holds app. 30,000,000 diabetes patients. (3,750,000,000/30,000,000 = 125)
Assuming that Novo Nordisk initiates the investment project in the year 2009, the company can thus expect an annual growth in market value of 4.7%. However, this is provided the assumption that the demographic pattern of the diabetic population and their medical consumption is unchanged. A more likely scenario is characterized by a growing middle class and thus an increase in private health expenditures. Most likely, Novo Nordisk will be able to experience a growth rate higher than 4.7%. Assuming an increase in public awareness through e.g. campaigns creates an opportunity for an even larger growth rate, since only 15% of Indian diabetics receive medical care.

Given the above information, we have assigned the variable for market value a fluctuation span from an increase of 5% to an increase of 15%. The first is the rounded percentage from the equation 6.10 and is deemed to be a more likely scenario, thus giving the variable a distribution that is slightly skewed to the right. This can be seen on page iv in appendix C.

For simplicity, we assume that Novo Nordisk’s diabetes market share in India is kept constant at a 60% level, given that the new product is likely to gain shares from Novo Nordisk’s existing drug portfolio.

6.4.3. The revenue growth rate
An initial annual growth rate for the revenues proceeding from the sales of a new diabetes drug is assumed to range from 0-20% based on the study conducted by (Benninga, S. et al. 2002). In their study of valuation tools for pharmaceutical R&D projects, Benninga et al. assume an annual growth rate of 20%.

As we, given the limited amount of data on the subject, cannot estimate a growth rate with more accuracy, this rate is applied as our base growth rate in the first year with revenues. However, we know what may influence the growth rate and how Novo Nordisk may be able to influence these factors.

The growth rate is first and foremost dependent on the number of diabetics in India and the general awareness of diabetes among the Indian population. It is highly likely that the growth might be promoted through awareness campaigns either sponsored by the government or by Novo Nordisk itself. As an example, Novo Nordisk could introduce its campaign Changing Diabetes as mentioned in section 2, to the Indian market in order to promote both public and private awareness. Another opportunity would be for Novo Nordisk to lobby the Indian government and persuade them to raise their public expenditures within the diabetes sector.
The scenario with an annual growth rate of 0-20% is expected to continue for seven years until the patent expires and the new drug can be copied by other pharmaceutical companies and thus sold cheaper. As mentioned in section 5, Indian pharmaceutical firms are former specialists in copying and remanufacturing drugs created by multinational drug companies. It should therefore be effortless for the Indian companies to make a profit from copying Novo Nordisk’s new diabetes drug once the patent expires.

This time horizon is based on the rules from the 2005 Indian patent reform allowing pharmaceutical companies to obtain patents on a new drug for seven years after the completion. This means that Novo Nordisk’s patent will expire at the end of year 16 from the initial investment causing the growth rate to decline rapidly and even become negative as sales revenues in rupees will experience a decline as well.26

The considerations of the patent expiry are also incorporated in our simulation analysis. Based on the above, we have assigned a fluctuation span from 0-20% in the first year. As an increase of 20% in the growth rate is deemed much more likely than zero additional growth, the distribution is assumed to be fairly skewed to the left for the first seven years of revenues. After the expiry, however, the opposite will be the case as a steep decline is most likely, thus yielding a distribution which is skewed to the right. The fluctuation span in the growth rate after the patent expiry is assumed to range from -130% to – 110%. Negative rates have been assumed to illustrate the steep drop in the revenues that will occur, when the drug can be produced by others after the patent expiry. The drop is illustrated graphically on page iv in appendix C, where the graph of the growth rate shows a kink followed by a steep decline.

6.4.4. The discount rate

In order to evaluate the investment project properly, it is crucial to choose the right discount rate. When conducting a practical investment project, Novo Nordisk would need to estimate the project’s WACC as there is no argument in favor of using the company WACC given that India may present different risk compared to their existing assets. Dimasi and Grabowski (2007) report empirical studies of the project cost of capital for equivalent R&D projects to be 11.5%. This is based on a sample of 118 new chemical entities brought to market. The discount rate which is the project’s cost of capital is derived using the capital asset pricing model (CAPM):

\[
    k_e = R_f + \left(R_m - R_f\right) \beta
\]  

(6.11)

26 It is year 16 as this is the year where ten years of investments and seven years of revenues have passed. Please note that investments commence in year 0.
When using the CAPM framework, Novo Nordisk’s cost of capital is a weighted average of its cost of capital on its debt and equity capital. Because of the low debt values of most large pharmaceutical companies, the cost of equity becomes the important factor for deriving the WACC.

In their study, Dimasi and Grabowski discovered an average discount rate of 11.5% on R&D projects initiated since the mid 1990s through the early 2000s as a benchmark rate for biopharmaceuticals. In our simulation, we thus assigned the discount rate a mean of 11.5% based on the findings in (Dimasi and Grabowski, 2007). The fluctuation span assigned was a percentage change of ± 5% as we assume the discount rate to be relatively stable. The distribution of the span is chosen to be uniform, as all change scenarios are deemed equally likely. The fluctuation span and distribution appear on page iv in appendix C.

6.4.5. Total amount invested
The total investment consists of the accumulated investments of the three periods. The first period receives 37.5% of total investment in year 0, the second and third period receive 52.5% and 10% after year five and nine respectively as mentioned earlier in section 6.2. When the simulation of year five for example indicates a total investment of 2,200, this should be viewed as the total investment budgeted in that particular time period. This means that the percentages for each period will not add up to the budgeted amount from point of origin as they will be percentages of different total investments budgeted at different periods in time.

To simulate the potential changes in the previously described total investment we have assigned a fluctuation span of ±10% with a probability distribution that is skewed to the left, assuming that the probability of an increase in total investment is more likely than a decrease. The reason for the chosen distribution is the assumption that an increase should be expected more likely than a decrease. When budgeting the expenditures, it is more realistic to assume higher expenditures as real project costs may exceed expected costs. Both distribution and fluctuation span appear from page iv in appendix C.

It is important to note that the total amount invested is only relevant in the case, where the whole investment project is realized. The risk of failure in each phase is disregarded in the evaluation of the total investment, though; the investment project is only realized with a probability of 21% as mentioned in section 6.3.
6.5. Simulation analysis
Soenen, L. (2004) p. 77, recommends simulation analysis as a tool for computing the probability of failure in relation to an investment project. Therefore, in order to add more value to the NPV analysis as a valuation tool we have conducted a simulation analysis as an extension of the traditional sensitivity analysis, which appears from appendix C. Normally, the sensitivity analysis has the shortcoming of only changing one variable at a time – holding all the others fixed, hence providing a less dynamic picture of the reality. We have attempted to make a more realistic scenario by conducting a simulation, creating a dynamic NPV model. This was done in Excel by assigning each variable in our analysis a random number. The random number was applied in if-functions allowing us to randomly change the variable up or down within the allocated fluctuation span. In this way, we were able to generate several NPV-values under various circumstances, providing us with an overview of possible scenarios given changes in variables that cannot be controlled by Novo Nordisk. To derive these NPVs, we constructed a macro allowing us to run infinite trials of the possible investment outcome. These simulations were exported and analyzed in Eviews and appear from appendix E.

The simulation model can also be used in a case where the actual value of the variables is known, as they can simply be inserted into the spreadsheet causing the outcome to change. Furthermore, simulations are always an adequate tool for presenting possible outcomes to investors or simply for the management to obtain an overview of a situation.

6.5.1. Hedging the nominal exchange rate
As the exchange rate has been proved to follow a random walk and thus be very hard to predict, Novo Nordisk might benefit from hedging its rupee exposure. Novo Nordisk is exposed in both the expenditure and the revenue phase of the project but in different ways. Soenen, L. (2004) p. 78, argues that hedging is relevant in the case of Novo Nordisk as a company’s foreign exchange exposure becomes more significant as the time horizon lengthens.

The same author further argues that the economic exposure may outweigh the nominal foreign exchange rate exposure from the project, when dealing with continuous foreign currency cash flows (p. 152). Hedging continuous cash inflows in a persistently depreciating currency is no escape from declining profit margins. Additionally the theorem of purchasing power parity (PPP) implies that gains or losses from exchange rates will over time be offset by differences in inflation rates. However, even though PPP may hold in the aggregate, it does not necessarily hold for every commodity. As a consequence, prices from two competing firms may change relatively to one another as a result of fluctuations in the exchange rate.
If, for example, the price of Novo Nordisk’s drugs in India and the price of a similar drug in the U.S. do not increase at the same rate of inflation; then any fluctuation in the INR/USD exchange rate may result in a shift in the competitive position of the two firms.

This exposure is related to the real exchange rate, but in the following, the focus will remain on the nominal exchange rate as analyzed in section 6.4.1.

The initial investment in rupees will be more costly in Danish kroner to Novo Nordisk, if the rupee should appreciate. By hedging the rupee, Novo Nordisk is able to mitigate this risk. In the same manner, the exposure in connection with realization of revenues may be hedged, only here Novo Nordisk should hedge against the rupee depreciating, as this will influence the cash flows in a negative way when they are converted to Danish kroner.

6.5.1.1. Hedging instruments
There are several instruments for undertaking such hedging activities. Examples of hedging instruments are financial derivatives such as options and futures.

Other popular instruments used by importers, exporters and banks, in order to manage foreign exchange risk in India, are derivative instruments such as currency forwards, money market hedging and swaps (Sarkar, A., 2006). Even though this sector has experienced growth in the past few years, foreign exchange derivatives are less active and present a lower degree of liquidity. This is because only one institution offers these instruments, namely the Reserve Bank of India. As a consequence, the bank can offer a less attractive price on the forward (the bid rate) than in a case with competition. This will result in larger expenses for the company who wishes to hedge. In the following, each of the hedging instruments will be evaluated.

Indian currency futures are a relatively new derivative in the Indian financial market and only date back to 2007. The futures are traded against the dollar on the Dubai Gold and Commodities Exchange (DGCX).²⁷ They are delivered in monthly contracts and are arranged by a clearinghouse, which is a financial services company facilitating clearing and settlement services for financial transactions. Hedging with futures may not always result in a relative gain. Should the exchange rate depreciate (appreciate) in the period where Novo Nordisk hedges against its appreciation (depreciation), they will actually realize a relative loss from hedging with currency futures.

Options provide the Novo Nordisk management with a certain amount of flexibility, given the fact that the option does not have to be exercised if it is deemed unnecessary due to the development in the exchange rate. Just like futures, options contracts are based on a given amount but can be purchased with a maturity larger than six months. By purchasing a call option, Novo Nordisk can hedge its exposure in the investment phase, and by purchasing a put option, it can hedge its exposure in the revenue phase.

The downside of the options approach is that it requires the management to anticipate the direction of the change in the exchange rate. Since we have proved that the exchange rate follows a random walk in our data analysis, hedging with options may be pure speculation, as it is not possible to predict the direction of the fluctuation. Besides, such exchange rate analyses are costly, and do not fall in line with Novo Nordisk’s core competencies. That being said, options still serve as a tool for eliminating downside risk. At the same time, options do not lock in the outcome from hedging, but leaves room for considerable upside potential (Soenen, L. 2004, p. 127). With an option scenario, Novo Nordisk can simply choose not to exercise the option and thus only lose the option premium paid. In conclusion, the option will only be exercised if the rupee will appreciate in the investment phase and depreciate in the revenue phase, as this will yield a relative gain in comparison to taking an un-hedged position. In case of the rupee moving in the other direction, the option will yield a relative loss.

Forwards function in the same way as the futures contracts but are not sold in predefined contract sizes. Typical forward contracts last for either one, three or six months, with three months being the most common duration (Sivakumar, A. et al., 2008). Since they are only sold with short-term duration, it is not a recommended strategy for Novo Nordisk, given the investment horizon. In addition; a forward contract would in this case require an agreement with an American company interested in taking an opposite position in the foreign exchange market. This is because the INR/DKK forward market is illiquid due to the characteristic of the forward agreement, which is negotiated between companies without a clearinghouse as opposed to the case of futures.

A money market hedge is yet another hedging approach. This simple procedure requires taking a position in the money market that will offset the position in the foreign exchange market. If a firm needs to receive an amount in a foreign currency, it can borrow that amount from the bank today and convert it at the spot rate into the domestic currency.
Then, the amount is invested and at maturity, the firm can repay the loan with the receivables from the customer (Eitemann, D. K. et al. 2007, p. 265).

Finally, a swap is also an instrument for hedging. A currency swap is realized; when two counterparts through an intermediary party (swap dealer) agree to exchange principal amounts in different currencies with agreement to reverse the exchange at the same rate in the future (Soenen, L. 2004, p. 136). The theoretical risk arising from such a transaction is denoted counterparty risk and covers the potential exposure an individual firm may bear that the intermediary party to the financial contract may not be able to fulfill its obligations (Moffett, M. et al. 2008, p. 444). However, since the swap dealer will be the *de facto* counterparty, if Novo Nordisk should choose swaps as a hedging instrument, this counterparty risk is deemed highly unlikely.

6.5.1.2. *Hedging the rupee exposure*
Having evaluated the possible hedging instruments, it is necessary to make a choice of method. An options hedge possesses the advantage that it yields an absolute gain, minus the premium, in the event of depreciation of the rupee in the investment phase and appreciation in the revenue phase, while the opposite negative scenarios are limited. This is opposed to the other hedging instruments, where Novo Nordisk will experience a relative gain or loss since the exchange rate is locked in. While the application of these hedging instruments from a practical point of view should yield a similar result for the hedged position, the management is likely to perceive the options approach as more appealing. In the event of a negative exchange rate development, the approaches would appear similar, though the premium would still be lost, but in the opposite case, the effect on the cash flows can be seen directly on the bottom line and not just in relative terms. Therefore, from a practical point of view, it is deemed that the Novo Nordisk management would favor options as a hedging instrument.

The illustration in figure 6.5 shows the potential gains that can be realized from hedging with call and put options respectively.
The call option, which will be a useful hedging instrument in the investment phase, gives Novo Nordisk management the opportunity to realize a gain when exercising the option if the exchange rate appreciates. The option is thus said to be *in-the-money* and hence provides Novo Nordisk with an advantage. If the exchange rate should depreciate, Novo Nordisk simply chooses not to exercise the option and the only loss is the premium paid. In the revenue phase commencing in year ten, Novo Nordisk will benefit from the put option if the rupee depreciates as this will allow Novo Nordisk to sell rupees at a certain exchange rate above the actual rate and thus make a relative gain. The illustration shows that loss of hedging with options can be limited to the premium paid, which is illustrated by the hatched area below the x-axis.

In reality, hedging with options requires that the amount that the management wishes to hedge is known. However, as the project proceeds and the revenue phase is reached, it may be possible to use the previous year as a proxy when estimating the size of an options contract. In this case of capital budgeting, all amounts are estimated, which means that it is impossible to perform an accurate hedge at this point in time. However, the hedging example in Excel, which appears from appendix E, gives an idea of the value of hedging foreign exchange exposure.

We performed a hedged example in Excel based on the concept of a rolling hedge from year to year. In the investment phase, only the two subsequent investments are hedged, as the initial investment is placed in year zero and is based on the spot rate. The illustrative hedge was constructed by allowing the exchange rate to merely fluctuate negatively or remain unchanged in the investment phase, and to fluctuate positively or remain unchanged in the revenue phase. The technique is elaborated on page xv in appendix F. Since there are costs related to hedging with derivatives, we have incorporated this in our spreadsheet by assigning the transaction cost an estimated value of 20% of the amount hedged. These costs consist of transaction costs, which cover expenses related to employing finance-educated staff to perform and maintain the derivative trading, and the premium paid to the counterparty for the option from year to year.
The total costs are then being discounted with the discount rate and finally subtracted from the NPV. This is, of course, a simplification of the actual hedging scenario, as the hedged amounts as well as the actual costs are unknown.

6.5.1.3. Reasons to hedge
In theory, there’s no real economic gain of hedging. The reason why companies choose to hedge their exposure is their risk aversion, which is often illustrated by a concave utility curve. This indicates that it will be of larger disadvantage to lose one currency unit than it will be beneficial to gain one unit. This is also known as a decreasing marginal utility. By hedging, the company can achieve insurance in case of a negative development and thus maximize utility.

The only ways, where risk management may add value to a firm, is when there are imperfections in the market. An example of such imperfections might be the case of financial distress. Large corporations as Novo Nordisk who compete in a volatile industry are vulnerable to financial distress. In case of a bad turn of events, company stakeholders may alter their behavior, thus aggravating the situation (Meulbroek, L. K. 2002). Risk management reduces the probability of financial distress and may be performed using financial derivatives such as options.

In the case of Novo Nordisk it will be necessary to hedge the foreign exchange exposure twice given that derivatives on the rupee are only sold against the dollar. This requires an initial hedge of the dollar, before the rupee can be effectively hedged. This hedge is likely to be undertaken with call options of the dollar as the chosen hedging instrument. As a consequence, this will further influence the transaction costs connected with such a hedging operation.

By hedging the only variable that can be hedged in this scenario, Novo Nordisk is able to cut the lower tail off the potential NPVs. The illustration below shows, how hedging the rupee in both phases influences the final outcome and yields a distribution of hedged NPVs with the lower tail cut off.

*Figure 6.6. – Simplified assumed distribution of the NPVs, un-hedged and hedged.*
6.5.2. NPVs without hedge

We constructed an Excel macro in order to compute and analyze various potential NPV outcomes. In the following, the outcomes of the un-hedged NPVs are analyzed.

The distribution of the un-hedged NPVs is shown in appendix E. Out of 5000 possible NPVs, only 73 are positive – indicating a possibility of achieving a positive NPV of 1.46%. Kurtosis and skewness provide a more comprehensive picture of the distribution. As can be seen from the output in appendix E, the kurtosis is 4.18, indicating that our result is fairly certain. In comparison, the normal distribution has a kurtosis of zero, and is therefore said to be mesokurtic.

The positive skewness of 0.21 also indicates a higher probability of yielding a negative value giving the distribution a longer right tail. The highest possible value is 1648, the lowest is -2286 and the mean is -965 with a standard deviation of 409. The analysis of the NPVs suggests that the project should not be carried out, however, other factors may eventually influence the decision as we will emphasize later in this thesis. Relying on the NPV rule as a valuation tool for the investment, will most likely cause Novo Nordisk management to choose not to realize the project.

As mentioned in section 6.4.1, the exchange rate is the only variable in this NPV analysis that may be hedged using financial derivatives. By hedging the rupee through derivatives, another set of NPVs might be generated.

6.5.3. NPVs with hedge

We also used the macro to compute infinite numbers of hedged NPVs. To compare these values with the un-hedged, we ran the simulation 5000 times and exported the data to Eviews. As it appears from the Eviews output in appendix E, the distribution of the hedged NPVs resembles the above figure 6.6 with a cut left tail. This is because hedging has allowed us to avoid the most negative of the NPVs. We now observe a mean value of -716, a maximum of 1732 and a minimum of -1596. The standard deviation is 398 and the kurtosis of 4.57 and a skewness of 0.90 indicate that the distribution, in comparison to that of the un-hedged values, is now yielding a more certain conclusion, but at the same time has added to the length of the right tail. The number of positive NPVs is now 258 indicating a probability of yielding a positive value of 5.16% much higher than the un-hedged values.

This indicates that it would be profitable for Novo Nordisk to hedge its foreign exchange exposure. This, however, is a faulty assumption given that it should never be possible to realize an economic gain alone from taking a hedged position.
Hedging should merely serve as a tool for securing the outcome and minimizing the downside potential. In reality, hedging the exposure should have resulted in a slightly lower mean value due to the transaction costs and a higher minimum value. In this example, the hedged position presents a higher minimum value and also a higher mean. This may be due to the simplification of the hedging process. These simplifications cover the transaction costs incurred when performing a hedge such as premiums, wages to risk management personnel and perhaps a higher premium due to unexpected illiquidity.

Normally, Novo Nordisk might also operate with a certain hedge ratio and not hedge all its exposures. However, even though the hedged scenario may depict a biased version of reality, it still serves to show the effect of cutting off the lower tail of the NPV distribution providing Novo Nordisk with a more cost efficient allocation of resources in the sense that the outcome is now more certain.

6.6. Discussion of the NPV analysis
The NPV analysis has been conducted both with and without hedging the exchange rate. The reason why we chose to hedge the exchange rate was to observe, how much influence it would have on the final outcome, if the exchange rate was only allowed to fluctuate within a limited span. As we expected, it appeared to have a high degree of influence given its unpredictability and fluctuation which we discussed in section 6.4.1. Our example of hedging, however, is a simplified version of reality and may not have the same positive influence given higher transaction costs or a different fluctuation span.

After having conducted the NPV analysis, it is evident that the project does not seem attractive to Novo Nordisk based on the numbers in the analysis. Even though Novo Nordisk hedges its foreign exchange exposure, which can be a complex process, there is only a 5.16% chance of the project yielding a positive NPV and this is only in the case where the project is successful, which merely has a chance of 21% of being realized.

This again is an approximation to reality, as we have attempted to estimate the values and probability distributions of all the variables in our analysis. Small changes may yield different outcomes; however, by conducting a simulation of 5000 trials, we feel that we have provided a picture of possible scenarios for the Novo Nordisk management.

Our NPV spreadsheets provide a fine tool for valuating such a project, given that they are completely dynamic and can be modified by Novo Nordisk when information about values and
fluctuations becomes known. The incorporated macros in both spreadsheets are designed to simulate an infinite number of trials on the NPV and thus present an image of possible results of the project given that it is realized. This will provide Novo Nordisk with a tool for analyzing the consequences of possible shifts in the variables, both the one that can be directly hedged and the ones that cannot.

All things considered, the NPV analysis conducted in this thesis presents very little information without the simulation analysis. The simulation is crucial in order to take fluctuations in all the variables into account and thus to provide the most realistic picture of reality.
7. Non-financial risk

After having evaluated the financial risk related to this investment project and incorporated this in our model, we will now shift our focus towards the non-financial risk. This type of risk can be defined as the general level of political and economic uncertainty in a country affecting the value of loans or investments in that country (Vij, M. et al 2007). Non-financial risk is characterized by the fact that it cannot be directly hedged by Novo Nordisk. Non-financial risk is based on uncertainty and instability in a certain area and will be assessed on a basis of a number of macro-economic, socio-cultural and political variables.

A risk imposed by the government on Novo Nordisk could be the probability of excessive regulation in Novo Nordisk’s area of work, e.g. new rules of patents, reluctance in public health spending, favoring of domestic manufacturers as part of a protectionist strategy or in a much worse case scenario, expropriation. It is not easy to deal with political risk effectively as the measures taken by the Indian government are beyond the control of Novo Nordisk. It is assumed that Novo Nordisk would negotiate the investment terms with the Indian government prior to initiating the project, but the government, depending on who is leading, may choose to change the rules later as the project is progressing.

Soenen, L. (2004) p. 65, argues that country risk is higher when dealing with emerging economies as they typically have under-developed capital markets and a poorly defined legal framework combined with occasionally corrupt judicial authorities.

7.1. India-specific risk

In their risk assessment report of India, Vij, M. et al. (2007) argue that there are four main factors in the political framework which need improvement: 1) Democratic accountability and quality of bureaucracy, 2) stability of government, 3) corruption control and 4) government support to foreign ventures.

A questionnaire analysis conducted in relation to the above mentioned study presented a case of instability and inconsistency in policy-making, which is never desirable to foreign investors. When asked about the government, 30% of the Indian population disagreed with the statement that the government enjoys public support. This contributes to increased risk of political instability, demonstrations and general turmoil, thus presenting a risk to foreign investors like Novo Nordisk. Lack of transparency of policy-making was also found to be a significant issue. Furthermore, the government showed a tendency to protect the interests of domestic companies, and 88% of the respondents stated that the corruption level in India was high.
In 2007, India was placed on a 72nd place in Transparency International’s Corruption Perception Index (Moffett, M. H. et al. 2008 p. 516). This indicates that India is a fairly corrupt country based on indicators for nepotism, bribery, extortion and similar practices. This poses a serious threat to Novo Nordisk, as it forces Novo Nordisk to take a stand in this matter. For instance, Novo Nordisk management needs to consider how to manage the matter of bribery. The problem especially occurs if this appears to be the practice of the domestic competitors. Moffett, M. H. et al. (2008) recommend that the foreign multinational enterprise operating in a corrupt country outright refuses bribery as it otherwise will multiply quickly and educate management as well as local employees in the bribery policy that the enterprise intends to follow.

Any significant damage to its reputation, originating from bribery or corruption, would impair Novo Nordisk’s ability to meet its business objectives in the longer term. Another major political risk imposed on Novo Nordisk, is the risk of a reduction of the patent period. The Indian government may have several interests in reducing the period from the current seven years, as stated in section 5.1, in order to pave the way for local copying pharmaceutical firms. This will cause sales and therefore revenues to decline much sooner than originally budgeted and hence make the project less profitable for Novo Nordisk.

As to the economic factors, an unemployment rate of 21.3% (Political Risk Services report, PRS Group, 2008 p. 6) is extremely high and affects the overall economic situation in a negative way. This is because a high rate of unemployment indicates that the economy does not utilize its resources efficiently (Blanchard, O. 2005, p. 30). This may be a consequence of the degree of corruption and bureaucracy present in India, hence creating a less attractive investment environment for Novo Nordisk.

As to the socio-cultural aspects of risk, Vij, M. et al. (2007) emphasize lack of good standards for corporate governance, environmental safety standards and infrastructure as the major issues. For Novo Nordisk, this means that cooperation with Indian companies may be affected in the sense that the co-operating company may have different standards for conducting business. This may be reflected in lack of transparency among the players operating in the industry, combined with a different organizational culture. As to the environmental standards, Novo Nordisk may be able to use the lack of environmental security to its own advantage, given the company’s visions on sustainability which may appeal to the Indian government in their attempt to improve the national environmental conditions.
The Indian infrastructure may furthermore impose a disadvantage on Novo Nordisk. Infrastructure may be defined as the basic physical or organizational framework needed for a society or an organization to function. This may consist of roads, means of transportation, communication and supply of energy. Ecker, K. (2008) emphasizes that large companies face challenges operating in India due to lack of adequate power generation. This may affect Novo Nordisk when conducting research and manufacturing drugs in India. However, there remains a chance that Novo Nordisk may be able to influence the decision makers in order to improve the current infrastructure. Ecker, K. argues that there are examples of foreign companies contributing to improvement of the infrastructure by building areas of housing for their employees as many Indian cities still lack adequate lodging for the increasing workforce.

These risk indicators all suggest that the investment project may require a certain amount of caution from Novo Nordisk. The table below shows the summarized results of the questionnaire analysis.

<table>
<thead>
<tr>
<th>Category</th>
<th>Rating</th>
<th>Weight assigned to each category</th>
<th>Weighted rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political risk</td>
<td>2.52</td>
<td>40%</td>
<td>1.008</td>
</tr>
<tr>
<td>Economic risk</td>
<td>2.72</td>
<td>40%</td>
<td>1.088</td>
</tr>
<tr>
<td>Socio-cultural risk</td>
<td>2.67</td>
<td>20%</td>
<td>0.534</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>2.630 (Overall risk rating)</td>
</tr>
</tbody>
</table>


The ratings are mean ratings based on the questionnaire study conducted among 110 domestic respondents chosen from various sectors to provide a wide range of views. To each question, the respondents had to state a degree of risk, 5 being the highest and 1 being the lowest. In conclusion of this survey, India represents a country of moderate risk. Both economic political and socio-cultural risks are considered fairly high, which may affect Novo Nordisk’s plans of conducting business in India.

**7.2. Managing non-financial risk**

In order to mitigate these India-specific risk factors, there are several measures to be taken by Novo Nordisk. The government can be appeased by Novo Nordisk’s mission to develop a certain drug to be used specifically by the Indian population. This action is supported by Soenen, L. (2004) p. 66, where he recommends investing in projects with unique features. This investment project presents an opportunity to create a product beneficial to the whole Indian diabetic population and the government may thus be friendly set towards Novo Nordisk.
Furthermore, by initiating an investment project, Novo Nordisk creates jobs for local skilled workers, thus contributing to reduce unemployment which may cause the government to create a favorable working environment for Novo Nordisk (Political Risk Services report, PRS Group, 2008 p. 50). By choosing to do so, Novo Nordisk may signal commitment and benevolence towards its host country. Finally, actions like these may be particularly welcome in India due to the high unemployment rate of 21.3%.

These above actions can be said to be measures of governmental lobbyism, which, as stated in section 2.2 are not foreign to Novo Nordisk management. That being said, it is important to note that it may be costly to lobby decision makers both in time and money terms.

An issue, where Novo Nordisk is left with no influence is regarding the political instability. There is not much use in lobbying a government if the government is not stable. This instability may affect the project budget as presented in section 6 and may cause the project discount rate to rise due to political uncertainty. A higher discount rate will result in lower NPVs and may thus indicate that the project is less attractive than first presumed. According to Soenen, L. (2004) p. 66, this issue can be mitigated by purchasing investment insurance in the home country against political risk in the investment country. This is done through either government sponsored institutions, private insurers or through the Multinational Investment Guarantee Agency (MIGA), which is part of the World Bank Group. The coverage is limited to expropriation, war, civil unrest and currency inconvertibility.

The socio-cultural aspects may be hard to mitigate given that Indian corporate culture cannot be changed by one company. The infrastructure may not be optimal, but there is a tendency towards increased focus in this particular area. According to Hamm, S. et al. (2007) India has a history of ignoring infrastructural problems and thus only has 3,700 miles of express highways compared to 25,000 in China. The authors further state that the Indian bureaucracy implies that a road construction may take up to ten years from idea to realization, but also that the Indian prime minister has manifested the issue as a government priority. The only thing Novo Nordisk can do here is to use its size and financial power to try and influence the decision makers. However, the future projections for the Indian infrastructure could be better, and Novo Nordisk’s influence alone may not be sufficient. Though it is a large company, it may not possess the impetus for putting pressure on the Indian government and may thus have to accept the condition of the existing infrastructure.
7.3. Summary
India is considered a country of moderate risk. Non-financial country-specific risk in India may be divided into three sections; political, economic and socio-cultural. Politically, the main risk factors are corruption, political instability and a reduction of the patent period. These risks may be mitigated by establishing good relations with the government, for example by employing local workers and investing in a project beneficial to the Indian population.

Economic risk factors consist of inefficient use of country resources caused by corruption and bureaucracy resulting in a high rate of unemployment. Corruption and bureaucracy are endogenous factors not affected by measures taken by Novo Nordisk. However, Novo Nordisk can eliminate these factors within their own organization through the establishment of corporate policies.

As to the socio-cultural aspects, the infrastructure plays an important part in the sense that India lacks adequate power generation, which may affect Novo Nordisk’s activities. Novo Nordisk has the possibility to improve the infrastructure by, for example, investing in housing for its employees, as it is seen from previous examples of foreign companies in India. But, when it comes to influencing major parts of the infrastructure, Novo Nordisk may have to realize that its impetus for lobbying the government is insufficient.
8. Real option outlook

Although a simple tool and highly efficient for valuing other investment projects, NPV analysis undoubtedly has its shortcomings when it comes to valuing R&D projects. Trigeorgis (1993), among others, argues that this approach fails to acknowledge the management’s flexibility to adapt and revise later decisions in the project as a response to unexpected market developments. The following section presents arguments against the method.

The R&D project is characterized by a rapid change that cannot be fully captured by the NPV analysis, which merely focuses on short-term cash flows. Madhani (2008) argues that these short-term cash flows are of little relevance in R&D where the biggest benefit often lies in building a strategic asset for long-term growth – e.g. a patented diabetes drug. The NPV approach usually undervalues the returns of the projects evaluated. The reason for this is that the method does not offer sufficient information for strategic decision making, as it does not capture the options to delay, expand or abandon a project or adjust plans based on independent events affecting an investment project (Madhani, 2008). In summary, the traditional NPV analysis fails to correctly deal with uncertainty in a project – a concept of paramount importance to firms who operate in a rapidly changing business environment. The only way any risk is accounted for is through the discount rate which is often the cost of capital, rate of return or hurdle rate.

When using NPV as a valuation tool, the traditional action would be to reject all investment projects yielding a negative NPV. However, having the option to delay a project given certain information will cause the management to consider the project differently. This is the main argument for not using NPV analysis as the main valuation tool, as it simply assumes passive management and neglects the options of a project, and thus systematically underestimates the upside potential. Real option valuation allows the management to choose to abandon a project in case of failure, or to defer a project until more information has been gathered. Finally, also an option where a smaller initial investment is required to await the market prospects can be characterized as a real option. These three valuable options are called the option to abandon, option to defer and option to growth.

8.1. Real options as a financial derivative

Traditionally, managers have been taught to operate on the premise that investment decisions can be reversed or, if not, that the present now-or-never propositions. If instead viewing a project from an options perspective, a company with an opportunity to invest can be said to hold a
financial call option (Dixit, A. & Pindyck, R. 1995). This gives the company the right but not the obligation to initiate or proceed with the project and this creates substantial value to the project.

Investment expenditures are said to be irreversible, when they are specific to a company. This means that the investment cannot be used for anything else and thus cannot be recovered. This is the case when dealing with exploratory pharmaceutical R&D investments. Once held, the investment is a sunk cost.

The similarity with a financial call option arises from the fact that exercising such an option, just like investing in a project, also is an irreversible act. For an investment project, the real option is exercised by the investment, which the company may choose to place immediately or later in time. The asset returned to the company will in that case be the value of the project. This asset may be sold, but the investment itself may not be reversed. When recognizing the similarity with a financial call option, it is easier to understand the importance of timing the investment. For an investment project, the rule is that the higher the uncertainty of the outcome, the more valuable is the option and the greater the incentive to keep it rather than exercising it immediately (Dixit, A. and Pindyck, R 1995). The value of waiting and the value of being able to abandon a project are not reflected in the traditional NPV model. The NPV approach simply assigns the project a higher discount rate often denoted a hurdle rate. This results in distant cash flows getting much less weight and thus makes the project more unprofitable when evaluating the potential of an investment project.

8.2. Application to Novo Nordisk
In our project, we have applied a discount rate of 11.5%. Adding more uncertainty to the project would also increase this rate, hence resulting in a lower NPV. When dealing with real options, we are actually encouraged by uncertainty in cash flows, as increasing uncertainty increases the value of the real option. The reason is that we through the duration of the real option can exercise the option if it turns out to be highly profitable, and choose not to exercise if the opposite occurs. In the traditional NPV analysis, you have no flexibility and all investments are determined. This is a very relevant concept to be aware of in an R&D context, since investments are placed in different phases, and you will only continue to the next phase if the previous phase is approved.

If applied in the case of Novo Nordisk, the decision tree presented in figure 6.2 should be revisited. The real option approach may create added value to the project in the sense that Novo Nordisk will then have the opportunity to abandon the project, if no compound of value is discovered in the first phase of the investment period.
This will result in only the first year of expenditures being a sunk cost and this option to abandon thus makes initiating the project more appealing, given that Novo Nordisk keeps the opportunity to leave the project if no potential gain can be realized.

Another option valuable to Novo Nordisk would be the option to defer the investment, until more data has been gathered. Novo Nordisk might benefit from learning more about the possibilities from creating a new diabetes drug or from analyzing the market opportunities further. It may be that clinical trials cannot be realized in year five as originally planned or that the costs turn out to be higher than budgeted. By choosing to defer the investment, Novo Nordisk will be able to gather the information necessary and make an informed decision of whether or not to invest.

However, since this is a project in the R&D industry, this project would rather provide Novo Nordisk with a growth option. This type is very similar to the option to defer, and the only difference is that with the growth option, Novo Nordisk has to make a small initial investment. If the information gathered looks profitable at this point, Novo Nordisk can put even more emphasis and capital into completing the project, leading to a higher relative positive cash flow. Also, since the research is very complex and the cycle time in this industry is very long, it might be a simple requirement to make an initial investment. An investment in the R&D industry opens up to the accessibility of gathering the necessary information before potentially ‘growing’ the project, and to gain first mover advantage in a profitable market respectively.
9. Discussion

In the following, key points from the thesis and our considerations in relation to working with our model will be discussed. Firstly, we will present a brief discussion on our overall choice of subject. Secondly, we will evaluate our approach by discussing our choice of methods in relation to creating the NPV model and the application of the model to other investment projects. Lastly, suggestions for further research within the area will be presented.

In this thesis, we have investigated the considerations to be made by a multinational pharmaceutical company before engaging in international capital budgeting. In order to fully achieve an understanding of this issue, we have presented Novo Nordisk and stated its strategic objectives and overall resources within the pharmaceutical area together with an overview of the Indian market.

The main reason for choosing India instead of e.g. China or Japan, who also rank high in the diabetes hierarchy, was the fact that it is a relatively new market for Novo Nordisk. Until now, Novo Nordisk has only carried out manufacturing and sales in India through its partner Torrent Pharmaceuticals. When reading the article, *India Beckons*, from The Economist mentioning that Novo Nordisk was to relocate a third of its R&D to India, we were intrigued. Other than this brief mentioning, it has not been possible to gather more information about the relocating plans, so we were interested in analyzing the opportunities of investing in R&D in India as this appeared to be a brand new strategy for Novo Nordisk. At the same time, India was an interesting country as it presented intrinsic strength due to economic growth, skilled English-speaking workers and low wages. Additionally, India seemed to possess advantageous opportunities for conducting diabetes research due to the vast number of diabetics form various socio-economic groups.

After having introduced the company, the country and the market, the investment opportunities in India were analyzed. Since we were dealing with a budget and lacked the real insight in the pharmaceutical industry, it was necessary to estimate the variables for the model. We first presented a static budget to present an overview of the investment. We are aware that other estimates might have led to different results; however, we have attempted to correct the model for this bias by creating a dynamic budget based on simulations, allowing it to be flexible and ever changing. The distribution of the NPVs shows the effects of this changeability.

Since the only variable to be influenced by Novo Nordisk was the exchange rate, we deemed it important to analyze this topic in depth through a time series analysis.
Furthermore, it made it possible to include a practical analysis in the thesis as the exchange rate is a valuable tool for estimating risk. It is also a subject to hedging and thus presented us with a variety of related topics to be included in the thesis.

When emphasizing the exchange rate, we discussed whether we should have emphasized less on the statistical methods and instead have focused more on the derivation of the other variables in the model. The other factors, however, would require a lot of information that may not be available, even to Novo Nordisk. The discount rate, for instance, requires explicit information of the risk that arises from investing in India. If Novo Nordisk estimates the risk to be at the same level of that of its other existing assets, the corporate WACC may be utilized. In the case that the risk is deemed to exceed any existing risk, there is the argument that the discount rate should be higher. An assessment of the level of stability in India is presented in our model but left without any information of Novo Nordisk’s WACC; we chose to rely on the average discount rate used for similar ventures as presented in a scientific study.

Since it was not possible to obtain actual information of the discount and growth rate, we presented qualified estimates, allowed them to fluctuate and instead emphasized the analysis of the exchange rate. This allowed us to present a real image of the fluctuations in the exchange rate and further the effect of hedging the foreign exchange exposure. The statistical methods presented should easily be applied by Novo Nordisk or any other company as they are fairly simple and do not require special resources.

**9.1. Time horizon and hedging**

It may be discussed, whether the time horizon suggested in our model presents a realistic picture of such an investment project. Depending on the complexity of research, the waiting for approval and the expiration of the patent, both phases may be either longer or shorter. For simplicity, we chose a model with an equal number of years of expenditures and revenues. The average lifetime of a drug is said to be 20 years, but after the patent has expired, we deemed the remaining years to be of less interest. This was illustrated by a kink followed by a steep decline in the graph on page iv in appendix C.

The time horizon is especially important in the case of hedging. Given that Novo Nordisk operates with such a wide time frame, we chose a rolling hedge from one year to another, using foreign exchange options as the most appropriate solution. However, in practice, it might also be relevant to use a rolling hedge with three-month futures or other hedging instruments.
In addition, it may be argued that futures may be used in the investment phase and options may be used in the revenue phase. This is due to the fact that the investment phase only requires two periods of hedging, which are years apart, while the revenues will occur year after year. This will also make it easier to hedge the revenues, as the previous year may serve as a proxy for estimating the revenues for the following year.

The hedged position would be less attractive in reality, but the example still serves to illustrate the intended effect of minimizing the potential downside. Also, the transaction costs of 20% of the hedged amount may be different, but since it represents so many various expenses as option premiums and employing risk management personnel, we deemed it better to choose a percentage in this region as opposed to a lower rate.

It may furthermore be argued that Novo Nordisk, given its size and multinational characteristic may not need to hedge, as the main argument for hedging foreign exchange exposure is to correct for market imperfections and financial distress. By having operations worldwide, it may be reasoned that Novo Nordisk possesses a natural hedge given that a depreciation of one currency can be offset by an appreciation of another. Additionally, any transaction costs incurred due to hedging represents a net loss to the firm’s shareholders, and while hedging may reduce the total variation in the cash flows, the volatility eliminated is generally unsystematic in nature (Soenen, L. 2004, p. 81).

In relation to this discussion, it can be argued that it may not be relevant to convert rupee cash flows to Danish kroner through hedging with financial derivatives. The relevance of hedging the cash flows is dependent on the ownership structure, which has not been considered in this thesis. Considering a well diversified American investor; converting the rupees to dollars, then into kroner and back into dollars would be redundant. As this investor is only interested in the rupee/dollar relationship, Novo Nordisk’s risk management for this investor is a pure economic loss.

Compared to general portfolio theory, unsystematic risk or diversifiable risk may be eliminated by holding diversified investment portfolios. In the same manner, Novo Nordisk can be said to hold a diversified portfolio given that it conducts various investment projects all over the world. However, even to a well-established company like Novo Nordisk, financial distress may impose a threat, thus making hedging relevant.
9.2. Further research
Given the resources, this study could be extended in several directions. In addition to our findings in this study, empirical evidence could be collected to either support or modify our conclusions.

An extension of the study would be to improve our NPV model with more accurate data and to also include debt, interest rates, inflation and taxes. It would also be relevant to use more advanced methods such as the real options approach, which is merely introduced in this thesis. Further investigation of the exchange rate volatility might be useful together with an in-depth analysis of the need for hedging, potential hedge ratio and an expanded analysis of the transaction costs in relation to the chosen hedging strategies.

Other approaches could be taken towards the exchange rate exposure. First a thorough analysis of the ownership structure could shed a light on the investors’ desire to receive their return from Novo Nordisk in Danish kroner, hence diminish the incentive to secure this exposure.

A more practical angle to expanding in India could be to look at raising debt in the foreign country. A financial derivative as currency swaps could match the cash flows, thereby also leading up to a hedge of the economic exposure by effectively changing the debt denomination.

Placing even more emphasis on risk management in another study, Novo Nordisk’s project could also be evaluated in relation to indirect exposure. A cost structure analysis of Novo Nordisk as well as their significant competitors could lay the ground for further research of more complex corporate hedging strategies
10. Conclusion

India presents a variety of opportunities for a multinational pharmaceutical company like Novo Nordisk. Factors like economic growth, a rising middle class, new political incentives, more favorable patent laws and the fact that English is among the primary languages contribute to making India an attractive platform for conducting R&D. Given its experience and financial strength, Novo Nordisk is deemed to possess the resources needed in order to explore the potential of the market situation.

India is furthermore characterized by a rapid increase in the number of diabetics, and a tendency towards more focus and awareness of the disease is present. This causes a rise in the demand for diabetes medicine and thus presents a valuable opportunity for Novo Nordisk to solidify its position in India by investing in R&D. At the same time, Novo Nordisk has the opportunity to save costs spent on R&D by conducting the research in India compared to a Western country.

The Indian diabetes market is characterized by Novo Nordisk as the one dominant actor together with several less influential domestic and foreign suppliers of diabetes drugs. This provides Novo Nordisk with the ability to set the standards and raise strategic barriers to entry towards potential competitors. The market is thus deemed to be attractive to Novo Nordisk, given that it is already present and possesses the means to intensify its presence. Furthermore, the industry is characterized by structural barriers to entry creating a profitable environment for incumbent firms.

In order to evaluate an R&D project like the one presented in this thesis, the traditional NPV method presents an instrument easy to apply by any company. The disadvantage of this method, however, is that it disregards managerial flexibility, and that it is never better than the variables used. We attempted to improve the value of the traditional approach presented in the static budget by letting the input variables fluctuate, in order to design a simulation analysis. This was done in both a hedged and an un-hedged scenario. After having created a macro in Excel, these two scenarios were analyzed by generating 5000 possible outcomes of each position. Their respective distributions were plotted in order to present a more comprehensive view of the investment project.

The only risk found to be directly hedged using financial derivatives, was the exchange rate, which in the data analysis was found to follow a random walk. This exchange rate exposure was effectively hedged using currency options. Even when hedged, the NPVs were found to be mostly negative, thus causing the management to potentially abandon the project.
This, however, may be the wrong conclusion, as the project may be of value not accounted for in the NPV analysis. This argument is supported by the theory of real options, stating that the NPV method consequentially undervalues R&D projects. When instead viewing the project from a real options perspective, it is evident that investing in India, disregarding a negative NPV presents an opportunity to expand and thus generate massive possible cash flows in the long run. In this perspective, the project can be characterized as a growth option, where the uncertainty creates value to the scenario as opposed to the NPV analysis.

As to the non-financial risk present in India today, the bureaucratic legacy combined with a relatively high level of unemployment and corruption, together with lack of support, both towards and from the government, pose the most significant issues to Novo Nordisk. A way to mitigate these risks would be to maintain a friendly relationship with the Indian government, e.g. by employing skilled Indian labor. The level of corruption may not be directly influenced, however, Novo Nordisk possesses the resources to set its own standards and make its own anti-corruption policy. Additionally, an underdeveloped infrastructure may affect Novo Nordisk’s operations and may only be slightly improved by private incentives.

There is no doubt that it would be necessary for Novo Nordisk to collect more data on the Indian market and the related risk before concluding, whether relocating R&D or conducting a single investment project would be a profitable initiative. Based on the outcome of the comprehensive NPV analysis alone, the project does not appear to be profitable – a conclusion grounded on quantitative measures. However, the fact that India holds a large group of diabetics increasing at a rapid pace, and at the same time appears to increase its attractiveness when it comes to intellectual property rights, may speak in favor of placing R&D investments in India. Thus, in a real options perspective, Novo Nordisk could hold a valuable growth option when intensifying its presence in India now.
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### Table 4.2: Population size, prevalence and number of people with diabetes in adults aged >20 years

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<thead>
<tr>
<th>Country and year</th>
<th>Population (thousands)</th>
<th>Prevalence (%)</th>
<th>Rural</th>
<th>Urban</th>
<th>Male</th>
<th>Female</th>
<th>20-44</th>
<th>45-54</th>
<th>≥ 65</th>
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<td>n.d.</td>
<td>62,130</td>
<td>73,156</td>
<td>28,642</td>
<td>58,747</td>
<td>47,851</td>
<td>135,286</td>
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<td>Developing countries</td>
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<td>11,152</td>
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<td>11,914</td>
<td>31,112</td>
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</table>

Source: Adapted from King, H. et al. (1998), app. 2
Appendix B – Computation of the cross rate from section 6.4.1

Since it was not possible to obtain the direct exchange rate of the rupee more than one month back, we gathered data from the Bank of England’s website and instead computed the cross rate as shown below.

\[ ER_{INR/DKK} = \frac{INR/Dollars}{DKK/Dollars} \]

As an example the exchange rate of the rupee vis-à-vis the dollar on April 1, 2005 was 43.705 and the exchange rate of the krone vis-à-vis the dollar on the same date was 5.7479. This yields a cross rate of:

\[ \frac{43.705}{5.7479} = 7.603647 \]
**Appendix C**

**Static NPV model**

### NPV analysis of investment project - An overview

All numbers in millions

<table>
<thead>
<tr>
<th>Data</th>
<th>Project overview</th>
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<tr>
<td>Exchange rate INR/DKK</td>
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<tr>
<td>Growth rate</td>
<td>25%</td>
</tr>
<tr>
<td>Discount rate</td>
<td>11.24%</td>
</tr>
<tr>
<td>Total investment</td>
<td>DKK 2,000</td>
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<tr>
<td>Value of Indian diabetes market</td>
<td>INR 5,750</td>
</tr>
<tr>
<td>Novo's market share</td>
<td>80%</td>
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<tr>
<td>Value of market share</td>
<td>INR 2,250</td>
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**Investment phases & revenues**

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<th>Discovery</th>
<th>Clinical trials</th>
<th>Marketing</th>
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</table>

| Investment DKK | DKK 750 | DKK 1,000 | DKK 200 |
| Investment INR | INR 6,378 | INR 9,209 | INR 1,734 |

| Revenues INR | INR 6,705 | INR 8,110 | INR 9,072 | INR 1,166 | INR 1,400 | INR 1,490 | INR 2,016 | INR 1,685 | INR 1,422 | INR 1,305 |
| Revenues DKK | DKK 77 | DKK 92 | DKK 111 | DKK 139 | DKK 185 | DKK 182 | DKK 230 | DKK 185 | DKK 182 | DKK 155 |

**NPV**

-1120.9

**Check**

PF of investments: 1,434,302,760
PF of revenues: 3,014,900,944

NPV: -1120.9
## Simulation data
**Input variables**

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<th>Value</th>
<th>Value</th>
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## Variables and their assumed distributions

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### Discount rate

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### Growth rate

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### Market share

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<th>Mar</th>
<th>Apr</th>
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## Financial results

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## Graphs

- **Exchange rate INR/USD**
- **Discount rate**
- **Growth rate of the drug**
- **Value of Indian diabetes market share**
- **Value of Novo's market share**

---

*Simulation without hedging*
## Simulation analysis - NPV

All numbers in millions

### Allocation

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<th>Discovery</th>
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### NPV

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### Project overview

- **NPV**
  - DKK million 700, 70%
  - DKK million 1,156, 37%
  - Marketing
  - Discovery phase
  - Clinical trials 70%
  - Project failure 70%

### Year

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### Product launch

- **Product launch**

### Patent expiry

- **Patent expiry**
Appendix D – Eviews outputs for section 6.4.1

The nominal exchange rate

Level-level model

*Without adjusting for heteroskedasticity*

<table>
<thead>
<tr>
<th>Variable</th>
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<th>Prob.</th>
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<td>0.003090</td>
<td>322.3746</td>
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</table>

R-squared | 0.990602 | Mean dependent var | 7.801972 |
Adjusted R-squared | 0.990592 | S.D. dependent var | 0.568746 |
S.E. of regression | 0.055165 | Akaike info criterion | -2.954944 |
Sum squared resid | 3.000601 | Schwarz criterion | -2.945034 |
Log likelihood | 1461.743 | F-statistic | 103925.4 |
Durbin-Watson stat | 2.168859 | Prob(F-statistic) | 0.000000 |

Series: Residuals
Sample 2 989
Observations 988

Mean | -2.75e-15 |
Median | -0.001830 |
Maximum | 0.364463 |
Minimum | -0.291250 |
Std. Dev. | 0.055137 |
Skewness | 0.311782 |
Kurtosis | 8.030277 |
Jarque-Bera | 1057.675 |
Probability | 0.000000 |
Test for heteroskedasticity

White Heteroskedasticity Test:

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Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/02/09   Time: 15:55
Sample: 2 989
Included observations: 988

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R-squared: 0.115038
Adjusted R-squared: 0.113241
S.E. of regression: 0.007587
Sum squared resid: 0.056697
Log likelihood: 3422.357
Durbin-Watson stat: 2.018007
Level-level model

Adjusting for heteroskedasticity

Dependent Variable: RUPEE_PER_DKK
Method: Least Squares
Date: 03/02/09   Time: 10:47
Sample (adjusted): 2 989
Included observations: 988 after adjustments
White Heteroskedasticity-Consistent Standard Errors & Covariance

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R-squared 0.990602  Mean dependent var 7.801972
Adjusted R-squared 0.990592  S.D. dependent var 0.568746
S.E. of regression 0.055165  Akaike info criterion -2.954944
Sum squared resid 3.000601  Schwarz criterion -2.945034
Log likelihood 1461.743  F-statistic 103925.4
Durbin-Watson stat 2.168859  Prob(F-statistic) 0.000000

Series: Residuals
Sample 2 989
Observations 988

Mean -2.75e-15
Median -0.001830
Maximum 0.364463
Minimum -0.291250
Std. Dev. 0.055137
Skewness 0.311782
Kurtosis 8.030277
Jarque-Bera 1057.675
Probability 0.000000
Log-level model

Adjusting for heteroskedasticity

Dependent Variable: LOG_RUPEE_PER_DKK
Method: Least Squares
Date: 03/02/09   Time: 10:52
Sample (adjusted): 2 989
Included observations: 988 after adjustments
White Heteroskedasticity-Consistent Standard Errors & Covariance

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Adjusted R-squared 0.989500 S.D. dependent var 0.071366
S.E. of regression 0.007313 Akaike info criterion -6.996363
Sum squared resid  0.052728 Schwarz criterion -6.986453
Log likelihood     3458.203  F-statistic 93015.12
Durbin-Watson stat 1.891220 Prob(F-statistic) 0.000000

Series: Residuals
Sample 2 989
Observations 988

Mean     1.35e-16
Median   0.000244
Maximum  0.038729
Minimum  -0.038733
Std. Dev. 0.007309
Skewness -0.070374
Kurtosis 6.029402

Jarque-Bera 378.6135
Probability 0.000000
Correlogram for the INR/DKK exchange rate

Date: 03/04/09   Time: 12:09
Sample: 1 989
Included observations: 989

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Unit root test

Null Hypothesis: LOG_RUPEE_PER_DKK has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=21)

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Test critical values:
1% level  -3.436756
5% level   -2.864257
10% level  -2.568269


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOG_RUPEE_PER_DKK)
Method: Least Squares
Date: 03/02/09   Time: 10:49
Sample (adjusted): 3 989
Included observations: 987 after adjustments

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOG_RUPEE_PER_DKK(-1)</td>
<td>-0.003312</td>
<td>0.002998</td>
<td>-1.104534</td>
<td>0.2696</td>
</tr>
<tr>
<td>D(LOG_RUPEE_PER_DKK(-1))</td>
<td>-0.086860</td>
<td>0.031747</td>
<td>-2.735990</td>
<td>0.0063</td>
</tr>
<tr>
<td>C</td>
<td>0.006929</td>
<td>0.006155</td>
<td>1.125649</td>
<td>0.2606</td>
</tr>
</tbody>
</table>

R-squared 0.009131  Mean dependent var 0.000124
Adjusted R-squared 0.007117  S.D. dependent var 0.006731
S.E. of regression 0.006707  Akaike info criterion -7.168249
Sum squared resid 0.044266  Schwarz criterion -7.153372
Log likelihood 3540.531  F-statistic 4.534041
Durbin-Watson stat 2.007708  Prob(F-statistic) 0.010962
Null Hypothesis: RUPEE_PER_DKK has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=21)

Augmented Dickey-Fuller test statistic -1.158241 0.6941
Test critical values:
1% level -3.436756
5% level -2.864257
10% level -2.568269


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RUPEE_PER_DKK)
Method: Least Squares
Date: 03/02/09   Time: 10:49
Sample (adjusted): 3 989
Included observations: 987 after adjustments

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUPEE_PER_DKK(-1)</td>
<td>-0.003571</td>
<td>0.003083</td>
<td>-1.158241</td>
<td>0.2470</td>
</tr>
<tr>
<td>D(RUPEE_PER_DKK(-1))</td>
<td>-0.085849</td>
<td>0.031755</td>
<td>-2.703504</td>
<td>0.0070</td>
</tr>
<tr>
<td>C</td>
<td>0.028932</td>
<td>0.024116</td>
<td>1.199694</td>
<td>0.2305</td>
</tr>
</tbody>
</table>

R-squared 0.009095  Mean dependent var 0.000992
Adjusted R-squared 0.007081  S.D. dependent var 0.055159
S.E. of regression 0.054964  Akaike info criterion -2.961250
Sum squared resid 2.972680  Schwarz criterion -2.946373
Log likelihood 1464.377   F-statistic 4.515797
Durbin-Watson stat 2.008951 Prob(F-statistic) 0.011162
Appendix E – hedge vs. no hedge

Distribution of un-hedged NPVs

Series: UNHEDGED
Sample 1 5002
Observations 5000

Mean    -965.5734
Median  -964.0000
Maximum 1648.000
Minimum -2286.000
Std. Dev.  409.3154
Skewness   0.214386
Kurtosis   4.178341
Jarque-Bera  327.5690
Probability  0.000000

Distribution of hedged NPVs

Series: HEDGED
Sample 1 5000
Observations 5000

Mean    -716.1122
Median  -767.0000
Maximum  1732.000
Minimum  -1596.000
Std. Dev.   398.8805
Skewness   0.904067
Kurtosis   4.573005
Jarque-Bera  1196.602
Probability  0.000000
Appendix F - Explaining the simulation model

Please see complete spreadsheets with enabled macros on the enclosed CD.

Distribution of the input variables

Simulation data with hedging of the exchange rate

<table>
<thead>
<tr>
<th>Variables and their assumed distributions</th>
</tr>
</thead>
<tbody>
<tr>
<td>----------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

As can be seen from the above exhibit, we have allocated a fluctuation span to each variable. By assigning each variable a random number and programming an *if-function* the variable is allowed to change in correspondence with the random number. The *if-functions* can be very complex but are simply a logic way of assigning the variable a certain span with the chosen probability.

The exchange rate was assigned a uniform distribution as can be seen from the above exhibit. Other values were assigned a distribution skewed to the right or left indicated by probabilities of 0.4, 0.2, 0.1, 0.1 or vice versa. Whenever we had no reason to assume a certain distribution, we allocated a uniform probability distribution.

Random numbers

<table>
<thead>
<tr>
<th>Random yearly values</th>
</tr>
</thead>
<tbody>
<tr>
<td>INR, millions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.490351582</td>
<td>0.683456256</td>
<td>0.488067398</td>
<td>0.115901924</td>
<td>0.300901852</td>
<td>0.430591481</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exchange rate INR/DKK</th>
<th>8.77</th>
<th>9.28</th>
<th>9.32</th>
<th>8.15</th>
<th>7.84</th>
<th>7.64</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.199142842</td>
<td>0.62903294</td>
<td>0.213096701</td>
<td>0.912152206</td>
<td>0.16543353</td>
<td>0.834853535</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Discount rate</th>
<th>11%</th>
<th>11%</th>
<th>11%</th>
<th>11%</th>
<th>11%</th>
<th>11%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.413597165</td>
<td>0.23933914</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Total investment INR | INR 17.540 |                |                |                |                | INR 21.403 |
The random numbers are generated in Excel by typing ‘=RAND()’ in a cell. As appears from the above exhibit, a random number has been allocated to each variable, for each time period it is used in the analysis.

All of the variables in the data set are dependent on the previous value of the variable. For instance is the exchange rate in year 4 dependent on the exchange rate in year 3 ± a change according to the fluctuation span.

### Hedged exchange rates

<table>
<thead>
<tr>
<th>Year</th>
<th>Exchange rate INR/DKK</th>
<th>Hedged exchange rate INR/DKK</th>
<th>Discount rate</th>
<th>Total investment INR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.7799</td>
<td>4.6136</td>
<td>11%</td>
<td>INR 17,640.00</td>
</tr>
<tr>
<td></td>
<td>7.6938</td>
<td></td>
<td>11%</td>
<td>INR 19,348.30</td>
</tr>
<tr>
<td></td>
<td>7.1941</td>
<td></td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.0934</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9.1051</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9.6742</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The hedged exchange rates have been obtained by eliminating the appreciation through ‘if-functions’ for the investment period and by eliminating the depreciation for the revenue period. This is done in practice by letting the exchange rate remain unchanged, even though the random number is larger than 0.6 (smaller than 0.4) thus indicating an increase (decrease).

### Total investment

The total investment is computed as the complete investment budgeted in the particular time period. The different values of total investment should not be added over time, but merely serves for presenting various scenarios of the total investment, given the changes in the other variables.
The NPV-formula can seem confusing when viewed in Excel. It has been computed as the negative value of the investments, discounted with the discount rate in the power of the year that the investments take place. To this are added the revenues discounted with their respective discount rate in the power of the year the revenues take place.
The macro

The macro, which we created for generating the various NPVs, is shown below:

```
Sub Makro2()
    ' Makro1 Makro

    Dim antal As Integer
    antal = Sheet3.Range("B1")
    For i = 1 To antal
        Dim txt1 As String
        txt1 = Ark2.Range("B?").Text
        Sheet3.Cells(i + 1, 1) = txt1
        Calculate
    Next i
End Sub
```

<table>
<thead>
<tr>
<th>Trials</th>
<th>5000</th>
<th>Macro explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1004</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>-919</td>
<td>0</td>
<td>To use the macro, clear the values from cell A2 to A(#B1).</td>
</tr>
<tr>
<td>-1362</td>
<td>0</td>
<td>Enter the desired number of trials in cell B1 and run the macro.</td>
</tr>
<tr>
<td>-282</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>-956</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>-521</td>
<td>0</td>
<td>Number of positive values 78</td>
</tr>
<tr>
<td>-377</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>-1608</td>
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<td></td>
</tr>
<tr>
<td>-1740</td>
<td>0</td>
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</tr>
<tr>
<td>-1426</td>
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<tr>
<td>-1178</td>
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<tr>
<td>-439</td>
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<tr>
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<tr>
<td>-893</td>
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<tr>
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<tr>
<td>-1148</td>
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</tr>
<tr>
<td>-682</td>
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</tr>
<tr>
<td>-923</td>
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<tr>
<td>-1007</td>
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<tr>
<td>-1330</td>
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<tr>
<td>150</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>-153</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

The above screen print illustrates the results yielded when activating the macro and running 5000 trials. Note that all positive NPVs appear in green.