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INGENIERO INDUSTRIAL

NUEVOS MODELOS PARA EL DESARROLLO TECNOLÓGICO Y DE PRODUCTIVIDAD Y SU IMPACTO EN EL EMPLEO. MODELIZACIÓN PARA SECTORES INDUSTRIALES

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NUEVOS MODELOS PARA EL DESARROLLO TECNOLÓGICO Y DE PRODUCTIVIDAD Y SU IMPACTO EN EL EMPLEO. MODELIZACIÓN PARA SECTORES INDUSTRIALES

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RESUMEN DEL PROYECTO

El término inversión (en el ámbito económico que concierne a este proyecto fin de carrera) se suele definir como la colocación de capital con el objetivo de obtener una ganancia futura. Esta decisión supone la resignación de un beneficio inmediato por un beneficio en el futuro, que idealmente, debería ser mayor, aunque al ser el futuro impredecible en cierto modo, entra en juego la incertidumbre y el riesgo.

Hoy en día, hay inversiones realizándose de manera constante y continua alrededor del mundo, y el mercado de las inversiones está creciendo a pesar de la crisis financiera mundial. Sin embargo, aunque ha habido inversiones durante cientos de años, siempre ha estado presente un factor que ha atormentado a los inversores cuando realizaban una inversión. Este factor principal no es otro que la inseguridad a la que se enfrentan los inversores en el momento de decidir seguir adelante con una inversión. La inseguridad se debe a la incertidumbre a la hora de predecir el futuro y los riesgos que se toman. El futuro es incierto hasta cierto grado, puesto que se pueden realizar previsiones y pronósticos basados en el análisis y la investigación de patrones y la creación de modelos. En este contexto, el objetivo del proyecto era crear un nuevo modelo de inversión con la capacidad de pronosticar el impacto de una inversión sobre tres factores principales de interés: desarrollo tecnológico, productividad y generación de empleo.

Este proyecto fin de carrera ha consistido en tres etapas: la investigación y recopilación de datos; análisis y creación del modelo de inversión;

elaboración de conclusiones y recomendaciones. La primera fase incluyó cinco partes: un análisis previo de las fuentes adecuadas de información, recopilación de datos y de información de las fuentes aprobadas, identificación y determinación de los principales inversores, identificación de las inversiones más exitosas y recogida de datos de modelos anteriores para poder analizarlos. Esta fase inicial requirió la recopilación de datos procedentes de fuentes aprobadas, tales como el Banco Europeo de Inversiones (BEI), la Organización para la Cooperación y el Desarrollo Económicos (OCDE) y las Naciones Unidas (UN), además de asociaciones sectoriales y prensa especializada. La información obtenida a partir de la lista de fuentes aprobadas ha sido vital para el proyecto dado que el modelo creado en la siguiente fase depende directamente de los datos recopilados. Por otra parte, un análisis de la situación e identificación de las mejores prácticas, los principales inversores y las inversiones exitosas fue esencial para, más adelante en las siguientes fases del proyecto, estudiar las razones tras las que se esconden dichos resultados con el fin de elaborar un conjunto de directrices que explican el éxito de este tipo de inversiones. Lógicamente, esta información puede ser de gran utilidad para futuros inversores y de ahí su importancia. Además, al margen de la obtención de los datos brutos provenientes de las fuentes, se analizaron modelos de inversiones anteriores creados en el pasado y su metodología empleada.

La segunda fase se compuso de cuatro partes: la clasificación de las inversiones siguiendo diferentes criterios, el análisis de las causas que explican los resultados de las inversiones exitosas, la determinación de la relación entre las inversiones realizadas y las mejores que se producen como consecuencia en los tres aspectos principales y la creación del modelo. Esta segunda fase tuvo como objetivo, básicamente, clasificar las inversiones, analizar las mejores prácticas y la creación del modelo de inversiones. El desglose de las inversiones se divide en varias categorías: flujo de capital invertido, tipología (inversión pública o privada), sector industrial, el objetivo de la inversión (crecimiento, modernización, capacitación tecnológica, etc…), origen y destino de la inversión, geografía y, finalmente, los resultados

obtenidos de la inversión (el impacto en el desarrollo tecnológico, la productividad y la creación de empleo). El análisis de las inversiones que tuvieron éxito fue necesario para comprender las razones detrás con el fin de ser capaz de transmitir las ideas clave del éxito a los futuros inversores más tarde durante la tercera fase del proyecto. La parte más importante de la segunda fase consistió en la creación del modelo que ayudará a pronosticar de antemano el impacto de una inversión en los tres factores de interés. Este modelo se presenta como una herramienta útil para los futuros inversores a la hora de tomar la decisión con respecto a una posible operación, pudiendo comparar el impacto esperado de la inversión con los objetivos perseguidos por el inversor.

Finalmente, la tercera fase del proyecto se dividió en cuatro partes: elaboración de conclusiones sobre la segmentación de las inversiones, conclusiones con respecto a las mejores prácticas y por qué tienen que ver con el éxito de una inversión, conclusiones sobre la relación entre una inversión y el efecto producido sobre los tres aspectos principales y recomendaciones dirigidas a los inversores con el objetivo de lograr el mayor impacto en los tres aspectos. Tras haber terminado el modelo, el siguiente paso fue escribir una serie de conclusiones. Esta fase se centró en la elaboración de las conclusiones derivadas de la realización del modelo y de un conjunto de recomendaciones. Tener la herramienta completamente terminada y plenamente operativa permitió extraer conclusiones acerca del comportamiento del modelo, por ejemplo, referentes a la evaluación de la fiabilidad de las previsiones, así como otras conclusiones generales que se obtuvieron para resaltar los puntos importantes observados a lo largo de todo el proyecto fin de carrera. Adicionalmente, puesto que el producto final de este proyecto es precisamente el modelo de inversiones, también se ha redactado una sección de recomendaciones cuyo objetivo principal es asesorar a los inversores de la mejor manera posible para lograr el mayor y más beneficioso impacto como resultado de sus inversiones.

NEW MODELS FOR TECHNOLOGICAL DEVELOPMENT AND THEIR IMPACT ON PRODUCTIVITY AND EMPLOYMENT. MODELING FOR INDUSTRIAL SECTORS

EXECUTIVE SUMMARY

The term investment (in the economic sense which corresponds to this final project) is usually defined as the allocation of capital in order to obtain future profits. This decision implies the resignation of an immediate benefit in exchange for a future profit, which should ideally be higher, although, due to the unpredictable nature of the future uncertainty comes into play as a risk for the investor.

Nowadays, investments are occurring constantly and continuously around the world, and the investment market is growing despite the global financial crisis. However, even though investments have been going on for hundreds of years, there has always been present a factor that has tormented investors when they carried out an investment. This main factor is no other than the insecurity which investors face when deciding to go ahead with an investment. Insecurity arises from the uncertainty to forecast the future and the risks that are taken. The future is uncertain up to a certain degree, as predictions and forecast can be made based upon the analysis and investigation of patterns and the creation of models. In this context, the project aimed to create a new investment model with the ability to forecast the impact of an investment on three main factors of interest: technological development, productivity and employment generation.

This final project consisted of three stages: research, investigation and data collection; analysis and model creation; elaboration of conclusions and recommendations. The first phase included five parts: a previous analysis of the appropriate sources of information, collection of data and information from the approved sources, identification and determination of the major investors, identification of the most successful investments and collection of data from previous models in order to analyze them. This phase initially

required gathering data from approved sources such as the European Investment Bank (EIB), the Organization for Economic Co-operation and Development (OECD) and United Nations (UN), as well as specific industry associations and specialized press. The information obtained from the list of approved sources has been vital for the project as the model created in the next phase would directly depend on the collected data. Furthermore, an analysis of the situation and identifying best practices, major investors and successful investments was essential to, later on in the next phases of the project, study the reasons behind in order to elaborate a set of guidelines explaining the success of such investments. Logically, this information could be of great utility for future investors and hence its importance. Moreover, apart from obtaining raw data from the sources, previous investment models from the past were also analyzed.

The second phase was made up of four parts: classification of investments by different criteria, analysis of the reasons explaining the results of successful investments, determination of the relationship between investments carried out and improvements within the three main aspects and creation of the model. This second phase aimed to, basically, classify investments, analyze best practices and create the investment model. The breakdown of investments was divided into several categories: amount of capital invested, typology (public or private), industrial sector, objective of the investment (growth, modernization, technological capacitation, etc…), source and destination of the investment, geography and finally, the results obtained from the investment (the impact on technological development, productivity and employment creation). The analysis of successful investments was necessary to understand the reasons behind in order to be capable of transmitting the successful key ideas to future investors later on during the third phase of the project. The most important part of the second phase consisted in the creation of the model which would help to forecast in advance the impact of an investment on the three factors of interest. This model will come in as a helpful tool for future investors when it comes to decision making regarding a possible investment, being able to compare the

expected returns from the investment and the objectives pursued by the investor.

Finally, the third phase consisted of four parts: elaboration of conclusions about segmentation of investments, conclusions regarding best practices and why they are related to the success of an investment, conclusions about the relationship between investments and the effect on the three main aspects and recommendations addressed to the investors aiming at achieving the greatest impact on the three aspects. Having finished the model, the next step was to write a series of conclusions. This phase consisted of the elaboration of conclusions derived from the completion of the model and writing a set of recommendations. Having the tool completely finished and fully operative, conclusions regarding the behavior were extracted, for example, evaluating the reliability of forecasts as well as other general conclusions that were made to highlight the important points that have been observed throughout the entire final project. In addition, since the final product of this project is precisely the investment model, there is also a section of recommendations whose principal objective will be to advise investors in the best possible way to achieve the greatest and most beneficial impact as a result of their investments.

Table of Contents

1. Introduction

The first chapter of this final project will be a general introduction. There are several aspects that make up the first steps and these will be included in this chapter. The issues to be discussed here are an introduction to the term investment, what does it mean and which factors are important; the state of the art which considers the present situation with respect to this final project (existence of investment models); the motivation that has led to the election of this final project and explaining why it is of great interest; the objectives pursued at the completion of this project; the methodology that will be applied to carry out the project and the resources and tools used.

Thus, chapter 1 contains the following sections:

1. Introduction
2. State of the art
3. Motivation
4. Objectives of the final project
5. Methodology
6. Resources and tools

1.1. Introduction to investments

The term investment (in the economic sense which corresponds to this final project) is usually defined as the allocation of capital in order to obtain future profits. This decision implies the resignation of an immediate benefit in exchange for a future profit, which should ideally be higher, although, due to the unpredictable nature of the future, uncertainty comes into play as a risk for the investor.

While investments have been going on for thousands of years, the concept of investment doesn't differ from the one that the feudal lords could have in the Middle Ages when they decided to acquire lands in order to dedicate them to agriculture, always being behind the firm intention of obtaining a higher future benefit than the initial capital invested.

Returning to the present, there is a wide variety of investors who are responsible for carrying out investments. On the one hand, governments are one of the major sources of investment, since they are responsible for a significant number of investments in companies; at a national level, by region, province, etc… However, another important source of capital of investments comes from private investors. In the case of the private sector, private investors may not have a certain obligation or duty to invest in their own region (as government institutions could have) and thus can take the decision to invest in any public or private company, within or outside their country.

Investments may also of various types, existing for example purely financial investments, in other words, capital is invested in a determined moment with the objective of recovering this same capital plus a certain quantity in the future (such as investment funds). However, a variety of classifications exist covering the different type of investments. They can be classified in function of the objective pursued, for instance, an investment in industrial equipment (machinery for example), raw materials (acquisition), transportation fleet (vehicles or a transport system) or by companies just to name a few types.

Investments that are implemented within the proper company can also be grouped according to three general types: renewal and renovation investments (intended to replace equipment, which have stopped working properly, have a decreased performance, or have fallen into obsolescence), expansion investments (aimed at the creation of a new product line, or at an increase of the potential of a business market or entering new markets), modernization investments (in order to improve the existing situation, improving the company's presence in the market, or being an action plan to modernize technical and/or production processes in a factory or plant involving driving cost lower or achieving higher product quality) and strategic investments (usually focused at reducing the risks of technological progress or threat of competitors in the market). As mentioned above, the investments can be either public or private, due to the nature both of the investor and the receiver of the investment, accounting for an additional classification. In the particular case of this final project, the investments taken into consideration will be those aimed at technological productivity, increase in productivity and employment creation.

Not only it is important to distinguish between the types of investment but also a consideration must be made with the main aspects and questions that arise to the investor. Among them there are three important issues that are explained below:

- Expected return: either positive or negative, it is defined as the compensation which results from the investment of capital, i.e., its profitability
- Risk acceptance: it is the uncertainty over which the expected return of the investment is calculated at the end of the investment. It also includes an estimate of the paying capacity (to determine whether the results can be paid with the investment carried out)
- Time frame: either short, medium or long term; it is defined as the period of time during the investment will be sustained

These are the three main factors the investor has to consider when carrying out an investment, whether it is public or private, and they are partially responsible of determining what amount of capital can be invested. Moreover, apart from the factors mentioned above, there is another major issue that exists and it is the payback period of the investment. The expected return of the investment or the potential risk accepted are not the only issues that must be considered, but also knowing in what time period the investment will pay off, since it is from that point when the net benefits will appear (once the equilibrium point is reached). There is one more aspect to consider in financial investments, and it is the value of capital as time passes, i.e., Net Present Value, since 100€ today do not have the same value in 5 years time.

1.2. State of the art

In the present, investment operations (both in public and private institutions) are very frequent and involve capital movements (capital range may vary from a small amount to hundreds of millions) from investors to the investment receivers. Investments in companies is not an issue that has arisen today but has happened since thousands of years ago, as even the wealthy Romans in the Roman senate carried out investments, for example, buying and upgrading an amphitheater where performances took place and therefore earning the respect and support of the citizens, or buying agricultural land and hiring farmers to cultivate a particular product. This is why investments, particularly investment modeling, have an important role.

While in the past investors only performer successful investments based on their expertise and financial skills and that this produced long-term benefits in the long run, from some time ago a search started seeking to obtain ways to gather information and create models that would be able to predict the impact generated by an investment. Apart from common sense and experience, it is a great advantage to have a predictive model, which, being based on historical data of forecasts and built with prediction tools, can provide accurate data (a 100% accuracy in the estimation would be the ideal objective but the reality is that this is very difficult if not impossible to achieve as there is a large number of variables that influence, although, logically, a better model will provide a more realistic forecast) that will reveal the impact of the investment before actually carrying it out. What investor wouldn't be happy to have this valuable tool?

As of today there are programs or econometric models to predict the evolution of, for example, the evolution of countries or large markets, but always talking about a large scale. Furthermore, the latter implies a disadvantage since the predictions at a national scale or an entire market are unlikely to be accurate due to the amount of information that is responsible

for results of the model, making the task of obtaining the model a complicated one.

However, this final project will focus on creating a model for a smaller scale, i.e., in this case, investment models for companies (public or private). More specifically, this project aims to develop a model for the industrial sector, where, as discussed in the previous introduction section, the primary objectives as a result of an investment are technological development, productivity increase and generation of employment.

In the present, there aren't very much tools or models that help to predict with a certain degree of accuracy the impact of an investment on a company, and hence the importance of this final project. Even though, rather than talking about the accuracy of a model, it makes more sense to talk about the model as a tool to assist the decision making when the time comes to evaluate an investment opportunity. Achieving a high precision level close to 100% is not the main objective of this final project (it must be remembered that these models are aimed to forecast results, but not to accurately determine the impact of the investment since it is literally impossible to predict the future with total certainty) but rather serve as a guideline (taking into account many factors and variables) for the decision makers regarding the investment.

With the shortage of information available about current investment models, an exhaustive analysis will be done to get the best out of each model, determine which features can be improved and which new ones could be introduced to improve the quality of the model, being synonymous with reaching a better accuracy level, since the ultimate goal as said before is to develop a tool in order to assist the decision making process when it comes to an investment.

1.3. Motivation

Investments are an everyday action repeated with great frequency in all parts of the world. Every single day thousands of worldwide investments are made, and regardless of the size of each of these investments (whether a small payment carried out by an individual or a large sum of money from a company), the obvious conclusion is that there is a total capital flux of many millions of euros as an aggregate sum.

Nevertheless, in any case, making an investment decision is not simple. To begin with, the first step is to determine the purpose of the investment and on what aspects will it focus on. A very careful and thorough analysis must be made regarding the risks and uncertainties that may appear, being very aware what risks one is willing to take (there will be investments with a higher risk level and others with a lower one). Furthermore, a judgment should be made over the time period through which the investment will be made, i.e., whether short, medium or long term. Logically, quantitative targets and objectives as a result of the investment must be set, and these must be evaluated in order to determine if the expected returns from the investment are appropriate or if conversely they are smaller (meaning that the objectives are not met). To all of this evaluation process there is another step to add, which is that of course, the investor must be in possession of the capital budget, which may be, depending on the situation, very large and require some type of loans.

Investors, given that they have the necessary capital, will always find themselves face to face with the danger from the risks and specially the uncertainty of the results generated from the investment. Because of this, a need has been identified to provide potential investors with the assistance of a useful model for analyzing investments. There is a general need to arm oneself with all the possible help and tools available that minimize (as far as possible, to a certain degree) the uncertainty. Any investor asked about this issue will surely answer that the insecurity always acts as a great detriment.

Being able to count with a guide tool that can predict the impact of the investment will, without any doubt, be highly valued by an investor, as it would reveal part of the darkness mantle that underlies upon every investment.

For all the reasons mentioned above, one can clearly observe that there are several difficulties and challenges which an investor must deal with when taking a decision: to invest or not to invest. This final project aims to create an investment analysis tool which will aid decision makers. One of the most important aspects is to know to what extent and in what way will the return of the investment appear. The global framework of investments is very large, consequently, the degree of usefulness of the model created can be very high given the large number of investments made. In the scope in which this final project operates, the model that will be obtained will be used to recognize and predict the impact of investments on three key features: technology development, productivity and employment generation; three factors that remain very important nowadays, especially due to the global economic crisis situation. Therefore, it is expected that at the completion of this final project the model generated will be useful to face the important moment of decision making.

As discussed above, the capital volume invested today in companies pursuing an improvement in themselves is very high, and the model will address both public and private companies. This means that the tool will have a great impact when helping investors, so it is expected that as soon as this final project is completed, the model will have a high degree of usefulness and it will be suited to provide good forecasts.

1.4. Objectives of the final project

The final and main goal of this final project is the preparation of an analysis model of investments in both public and private companies that will serve to predict the impact of such investments on three key areas: technology development, productivity and employment generation. The volume of capital invested varies greatly from one case to another, but in general, the investments seeking improvements in businesses tend to rise to large sums of money. It is therefore logical to think that investors are eager to have all the possible help in order to minimize uncertainty levels and have a better and more accurate previous overview of the expected returns. What investor would not want to become acquainted on the extent of their investment before carrying it out and placing the money?

There are three objectives to be satisfied by the final project. Firstly, a characterization and estimation of the investment market will be done, being aware of the global volume of investments (being able to segment investments by continents or countries) and a focus will be made on Spain. In order to characterize the investment market, a segmentation of the market must be carried out, classifying investments by their nature: capital flow, typology (public or private), industrial sector, investment objective (growth, modernization, technological capacitation, etc…), source and destination of the investment, geography (at a worldwide scale, breakdown by continents, focus on Spain, etc…) and finally the results obtained from the investment. It must also be taken into consideration who are the main public and private investors, and in which sector do they operate (defense, infrastructure, health, automotive, etc…). The second objective is to conduct an investigation which will allow to identify the main investors in the market (the important players) and which are (and have historically been in the past) the best investment practices and policies, as well as evaluating them. This information is essential in order to determine which methods and practices are the most successful and how are they applied. The third and final main objective is to bring together all the information gathered and analyzed to

develop an investment model to predict the impact of an investment on the three key aspects of this project: technological development, productivity and job creation. This model will be useful for potential investors because it allows, in advance, to recognize the scope range and the impact of the investment on the three key aspects. Based on these results provided by the model, the investor will then be able to decide to invest or not to do so guided by the model, and the investor will also be in a position to compare different investments projects and determine which one could lead to better results.

Therefore, the main objectives associated with this final project are the following:

- To characterize and estimate the investment market and its global size, conducting a focus on Spain

- To identify and evaluate best practices historically on investment programs and policies (for both public and private investments)

- To develop a model which will assess the impact of investments on technological development, productivity and job creation

1.5. Methodology

It is important to define the starting point situation and consider what questions want to be answered and what challenges may arise when creating it the model as it is also of importance creating a work plan and defining how the problem will be solved, through the application of what techniques and what procedures.

The problem that investors face today is the uncertainty of not knowing with precision the future impact that their investments will have. For this simple reason, the best way to tackle this problem is to arm oneself with all the possible relevant information that can aid to provide a solution to the given problem. For this final project the general procedure to be applied to address the problems will be to clearly define the issues (and sub-issues arising thereof) related to the investment model. The starting point situation must define clearly before the project begins, and this situation isn't other than the risk and uncertainty that torment investors when they decide to carry out an investment. The next step is to pose and define the question that wants to be answered (within the framework of the project scope). In this case, it is desired to recognize the impact of an investment on the three mains aspects: technological development, productivity and job creation. Finally, the issues or problems to be addressed when creating the model must be taken into account. It is more than obvious that the model will have a high degree of complexity due to relying on a large number of variables to make the forecast, so this particular aspect will present an important challenge.

Phase 1: Investigation

To begin with, a phase of research and data collection must be carried out, since the data themselves will be the main element to develop a model. During this phase information will be obtained from the different variables involved in investments that have an impact on the three main objectives of investment: technological development, productivity and employment generation. To do so, at the beginning of the project it will be essential to

determine which sources of information can be useful for data collection. These data will serve as a starting point for the creation of the model. The analysis of other investment models and their characteristics will also be done as this step will assist in the development of the model for this final project.

Phase 2: Analysis and model creation

The second phase of this final project will require performing a thorough and careful analysis of the data collected. It is expected that the first phase will gather a large amount of factors and variables responsible for the final result of the investment, being important to contemplate all these variables and hence be able to determine the relationship (in the most accurate way) and their impact on the three main objectives of the investment (technological development, productivity and employment generation). The next step will logically consist of the creation of the model (applying different statistical techniques, linear regression, etc…) based on the analyzed data obtained previously from various sources and taking into account previous investment models made in the past. All the previously analyzed variables shall be considered when developing the model so that the effect of these variables on the three main objectives of an investment is established. The model will forecast the impact and scope of the investment and thereby will be available for investors to aid them.

Phase 3: Elaboration of conclusions and recommendations

Finally, the last phase consists of the elaboration of conclusiones derived from the completion of the model and writing a set of recommendations. Having the tool completely finished and fully operative, conclusions regarding the behavior of the model will be extracted, for example, analyzing the reliability of forecasts, and other general conclusions will be made to highlight the important points that have been observed throughout the entire final project. In addition, since the final product of this project is precisely the investment model, there will also be a section of recommendations whose principal objective will be to advise investors in the

best possible way to achieve the greatest and most beneficial impact as a result of their investments.

	October 2013 – January 2014 **Research/investigation and data collection**	January 2014 – April 2014 **Analysis and model creation**	April 2014 – May 2014 **Elaboration of conclusions and recommendations**

Characterize and estimate the investment market
- Capital flow
- Main industrial sector objectives
- Objectives of the investment
- Classification by geography
- Results of the investment
	- Analyze previously which might be the appropriate sources of information
	- Collect data from the different sources
		- Classification of investments by:
		  - Capital invested
		  - Typology
		  - Industry
		  - Objective
		  - Source and destination
		  - Geography
		  - Results obtained
			- Conclusions about segmentation of investments

Identify best practices in policies and programs of public and private investment - Most important investors - Successful investments	- Identify and determine who are the main investors - Identify which investments have been more successful	- Analyze the reasons explaining why have they been successful investments	- Conclusions regarding best practices and why they are related to the success of an investment
Develop a model to asses the impact on technological development, productivity and employment generation - Relationship between investments and the impact produced - Recommendations for future investors	- Collect information from past investment models to analyze them	- Determine the relationship between investments carried out and improvements occurring within the three aspects - Create the model and application to a case study	- Conclusions about the relationship between investments and the effect on the three aspects - Recommendations addressed to the investors to achieve the greatest impact on three aspects

Table 1. Scheme detailing the methodology and different phases of the project

1.6. Resources and tools

This final project consists of, in part, research, collection and subsequent analysis of information and data. Therefore, it is very important to check the source of the information obtained, since the information is as important as its origin. For this project, multiple channels of information sources will be considered, as described below.

A study to identify who the main investors are (both public and private ones) will be performed, and once they are tracked down, information from these major players will be obtained from them, as undoubtedly the main investors have much to say in this project. Governments in general are one of the biggest investment promoters since companies depend partially on them to achieve development. These government institutions are continuously carrying out investments making them a very interesting source of information that shall be considered during this project. Investment banks, as their name suggests, will be another useful source from which to extract data, since investments are their daily occurrence and they handle large capital volumes. Other sources such as the “Instituto Nacional de Estadística (INE)” and the “Real Instituto Elcano” will be consulted to have access to vital data for the development of the project. Major development organizations will be considered when searching for information, such as the OECD (Organization for Economic Co-operation and Development), the UN (United Nations) or the EIB (European Investment Bank). Specific industry associations and specialized press will also be considered as references when searching for data.

On the other hand, as this final project is being carried out in collaboration with the company AT Kearney, access will be granted to resources and sources of information coming from the company that collaborates with this project. Such information will be collected from previous projects of a similar nature and analysis of the investment market that the company has carried out in the past and can be helpful.

Apart from the sources mentioned before, there will be many others that will be considered when gathering information. To analyze such information in order to create the investment model, the data collected will be placed on a spreadsheet that will serve as a tool to establish the relationship between the variables analyzed and the three main objectives of the investment. A computer program to create presentations for the final project will be required, as well as another program to write the project itself. Therefore, the following three programs belonging to Microsoft will be used:

- Microsoft Excel
- Microsoft Power Point
- Microsoft Word

2. Investigation and Data Collection

This initial phase will consist in a series of tasks that will help defining the scope of the project and channel the works towards the consecution of the model. As explained before, the way to tackle this current problem regarding the scarce information and tools available for decision making, the first issue to be addressed must be an approach to estimate and characterize the market of investments. This market will be the one providing data for the model and hence it is important to know it very well.

At the same time, this first main issue may be divided into sub-questions that will make it easier to focus on each particular aspect of the investments. In this case, it has been decided to address the following sub-issues:

1. Previously analyze which can be the appropriate sources of information
2. Collect data and information of the approved sources
3. Estimation of the investment market
4. Identify and determine who are the major investors
5. Identify which investments have been most successful
6. Collect data from previous models in order to analyze them

2.1. Previous analysis of the appropriate sources of information

In any project that requires investment and research of information it is essential to previously analyze where this information can be obtained from. Nowadays, with the extended use of internet, there is a vast quantity of information on the net, but, however, one must be reluctant to accept information from any kind of source. Due to this, a study of the sources that will serve to later on create the model is important.

For this project, the sources considered are a variety of organizations that deal mainly with investment and development, such as investment banks, international organizations for development, statistical institutes and European offices.

The table below summarizes the sources consulted when searching for valid information.

Apart from the sources mentioned in table 2, as this final project is done in collaboration with the company A.T. Kearney, access has been granted to internal information in the form of projects, reports and data that have proved to be very useful.

	Press/News media	Reports	Government	Organizations/ Associations	Institutions
National	• Newspaper El País (Spain) • Newspaper Expansión (Spain)		• Centro para el Desarrollo Tecnológico Industrial (CDTI) • Programa de Incentivo al Vehículo Eficiente (Plan PIVE) • Secretaría de Estado de Administraciones Públicas (Fondo Estatal de Inversión Local) • Secretaria de Estado de Investigación, Desarrollo e Innovación	• Asociación Nacional de Fabricantes de Automóviles y Camiones (ANFAC) • Asociación Valenciana de Empresarios (AVE)	• European Regional Development Fund
International	• Travel agency Travel Weekly • Automotive News • Bloomberg • General Motors • Gulf News • Ford corporate website • Newspaper Japan Daily Press (Japan) • Newspaper Virginia (U.S.A.) • Newspaper The Globe And Mail (Canada) • Newspaper The Guardian (U.K.) • Newspaper The Wall Street Journal (U.S.A.) • Newspaper USA Today (U.S.A.)	• American Council for an Energy-Efficient Economy • International Finance Corporation • Political Economy Research Institute Massachusetts • University of Massachusetts-Amherst's Political Economy Research Institute	• Government of Connecticut (U.S.A.) • Government of Florida (U.S.A.) • Polish Information and Foreign Investment Agency	• Freight Rail Works	• European Comission

Table 2. Sources of information considered

2.2. Collection of data and information from the approved sources

Once there is a clearly defined list of approved sources of information, the next step involves collecting data from these sources. After considering all the sources, there is information of all kinds, in the form of reports, tables, spreadsheet documents, rankings, etc… All of these will be considered but they will not appear in this chapter as they would just obstruct the natural development of this final project, although they will be included at the end in chapter 5 which is reserved for appendices and documents of that nature.

However, a sample of a spreadsheet document used is presented below.

	A	B	D	E	F	G	H
1	**World Macroeconomic Indicators**						
2	*Source: International Monetary Fund, World Economic Outlook Database, October 2013*						
3							
4	**Country**	**Subject Descriptor**	**Scale**	**1980**	**1981**	**1982**	**1983**
11	Afghanistan	Total investment		n/a	n/a	n/a	n/a
12	Afghanistan	Inflation, average consumer prices		n/a	n/a	n/a	n/a
13	Afghanistan	Unemployment rate					
14	Afghanistan	Employment	Millions				
15	Afghanistan	Population	Millions	n/a	n/a	n/a	n/a
16	Albania	Gross domestic product, constant prices	Billions	293,363	310,085	319,078	322,588
17	Albania	Gross domestic product, current prices	Billions	1,833	2,099	2,162	2,184
18	Albania	Gross domestic product per capita, constant prices	Units	109.853,40	113.847,05	114.718,38	113.663,21
19	Albania	Gross domestic product per capita, current prices	Units	686,306	770,755	777,305	769,599
20	Albania	Gross domestic product based on purchasing-power-parity (PPP) valuation of country GDP	Billions	4,974	5,748	6,282	6,602
21	Albania	Gross domestic product based on purchasing-power-parity (PPP) per capita GDP	Units	1.862,48	2.110,39	2.258,49	2.326,05
22	Albania	Total investment		4,96	45,376	48,663	51,798
23	Albania	Inflation, average consumer prices		n/a	n/a	n/a	n/a
24	Albania	Unemployment rate		5,028	4,224	2,813	3,335
25	Albania	Employment	Millions				
26	Albania	Population	Millions	2,671	2,724	2,781	2,838

Table 3. Sample of spreadsheet document

Source: International Monetary Fund, World Economic Outlook Database, October 2013

2.3. Estimation of the investment market

The characterization and estimation of the investment market is important in order to have a general picture of investments and the amount of capital they account for. The data from past years has been recorded and it is interesting to compare the evolution of investment levels from the last years, as well as making predictions of the future situation.

Global FDI flows

The figure below illustrates the investment in the past years (2004-2013) and projections for the period 2013-2015.

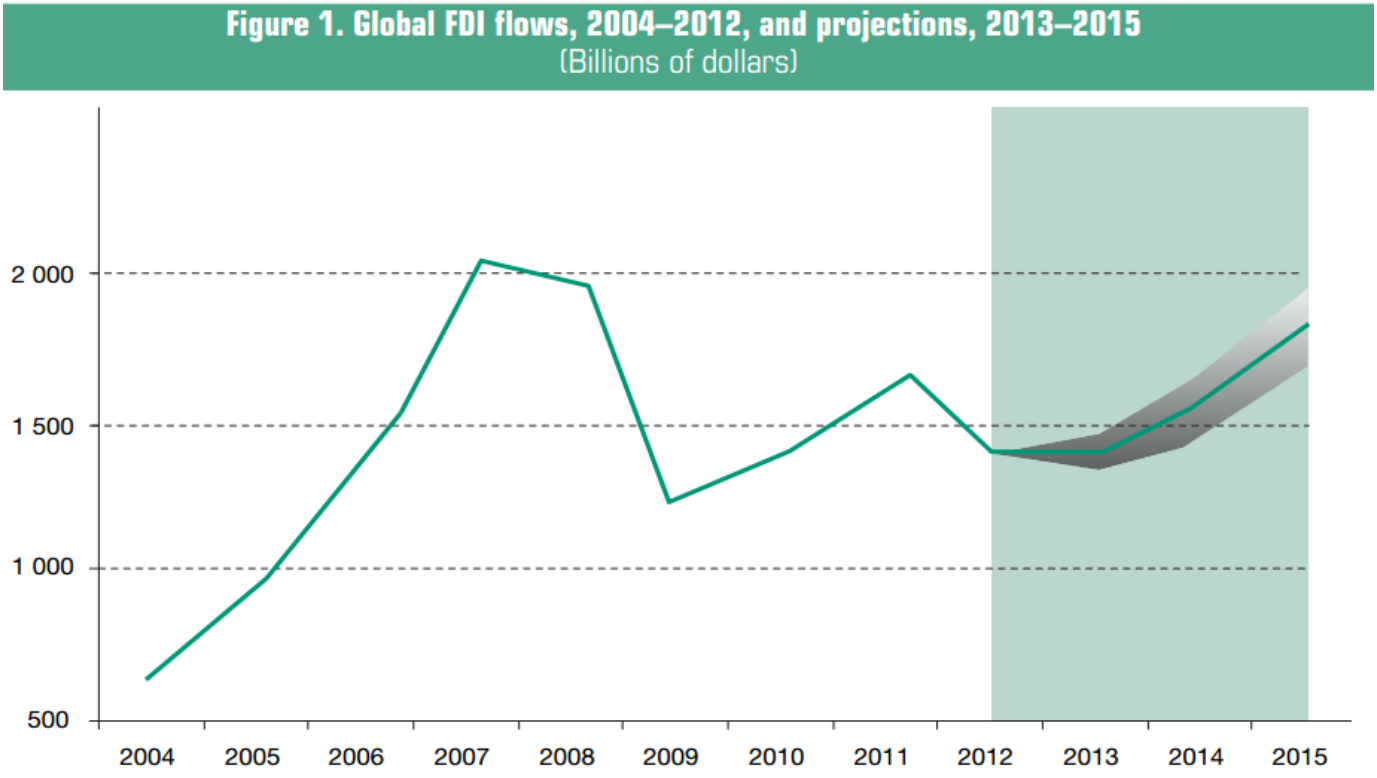


Figure 1. Global FDI flows, 2004-2012, and predictions, 2013-2015

Source: World Investment Report 2013: Global Value Chains: Investment and Trade for Development

Foreign Direct Investment (FDI) is defined as the direct investment carried out into a business in a given country by either an individual or a company of another country. The process can consist in buying the target company or by expanding operations of the existing business.

Figure 1 reflects that in the period 2004-2007 there was a rapid, steady growth in global FDI flows, rising from 600 billion dollars in 2004 to approximately 2000 billion dollars in 2007. Right after, there is a deep drop, concurring with the economic crisis, reaching a minimum investment level of 1250 billion dollars in 2009. From 2009 throughout to 2011 there is a recovery reaching the figure of 1650 billion dollars at the end of 2011. However, once again there is a drop from 2011 to 2012 although it is not as steep as the one during the period 2007-2009. Predictions from 2013 onwards to 2015 forecast a constant global investment level during 2013 but starting to rise again in 2014 and 2015 reaching 1850 billion dollars by mid-2015.

FDI flows by region

Apart from global figures regarding investment levels, it is important as well to understand how the investment is being divided by regions (such as continents and developed, developing and transition economies), considering both the level of FDI flowing into a region and outflowing from it. The following figure explains this in details.

Table 1. FDI flows by region, 2010–2012
(Billions of dollars and per cent)

Region	FDI inflows			FDI outflows		
	2010	2011	2012	2010	2011	2012
World	**1 409**	**1 652**	**1 351**	**1 505**	**1 678**	**1 391**
Developed economies	696	820	561	1 030	1 183	909
Developing economies	637	735	703	413	422	426
Africa	44	48	50	9	5	14
Asia	401	436	407	284	311	308
East and South-East Asia	313	343	326	254	271	275
South Asia	29	44	34	16	13	9
West Asia	59	49	47	13	26	24
Latin America and the Caribbean	190	249	244	119	105	103
Oceania	3	2	2	1	1	1
Transition economies	75	96	87	62	73	55
Structurally weak, vulnerable and small economies	**45**	**56**	**60**	**12**	**10**	**10**
Least developed countries	19	21	26	3.0	3.0	5.0
Landlocked developing countries	27	34	35	9.3	5.5	3.1
Small island developing States	4.7	5.6	6.2	0.3	1.8	1.8
Memorandum: percentage share in world FDI flows						
Developed economies	49.4	49.7	41.5	68.4	70.5	65.4
Developing economies	45.2	44.5	52.0	27.5	25.2	30.6
Africa	3.1	2.9	3.7	0.6	0.3	1.0
Asia	28.4	26.4	30.1	18.9	18.5	22.2
East and South-East Asia	22.2	20.8	24.1	16.9	16.2	19.8
South Asia	2.0	2.7	2.5	1.1	0.8	0.7
West Asia	4.2	3.0	3.5	0.9	1.6	1.7
Latin America and the Caribbean	13.5	15.1	18.1	7.9	6.3	7.4
Oceania	0.2	0.1	0.2	0.0	0.1	0.0
Transition economies	5.3	5.8	6.5	4.1	4.3	4.0
Structurally weak, vulnerable and small economies	**3.2**	**3.4**	**4.4**	**0.8**	**0.6**	**0.7**
Least developed countries	1.3	1.3	1.9	0.2	0.2	0.4
Landlocked developing countries	1.9	2.1	2.6	0.6	0.3	0.2
Small island developing States	0.3	0.3	0.5	0.0	0.1	0.1

Table 4. FDI flows per region, 2010-2012

Source: World Investment Report 2013: Global Value Chains: Investment and Trade for Development

When analyzing FDI values, it is important to distinguish between FDI inflows and FDI outflows. FDI net inflows account for the value of inward direct investment made by non-resident investors in the reporting economy. On the other side, FDI net outflows represent the value of outward direct investment made by the residents of the reporting economy to external economies.

One may think that developed countries would have the upper hand when it comes to FDI figures but table 4 reflects that this is not completely true. When analyzing FDI inflows, developed economies slightly present greater figures than developing countries in the years 2010 and 2011 but in 2012 developing countries became the major target of FDI inflows. Transition economies were, in all categories, representing a small portion of FDI flows. Talking about developing economies, Asia (especially East and South-East Asia) presented larger numbers than Africa, Latin America and the Caribbean, and Oceania. When it comes to FDI outflows, in this occasion developed countries are the main protagonists as they represent approximately 2/3 of the global FDI outflows compared to developing countries that account for the remaining 1/3. Global FDI outflows increased from 2010 to 2011 by 11% (from 1505 billion dollars to 1678) but suffered an important drop during 2012 decreasing to 1391 billion dollars. As before with FDI inflows, Asia represented the major FDI outflows, particularly in East and South-East Asia.

Confidence Index

The global situation over the last years has been conditioned by the financial crisis that has struck the economies around the world. For this reason, investment capital has become scarcer due to the economic downturn period. Therefore, it is also important to assess the investors' confidence which is reflected in the next figure.

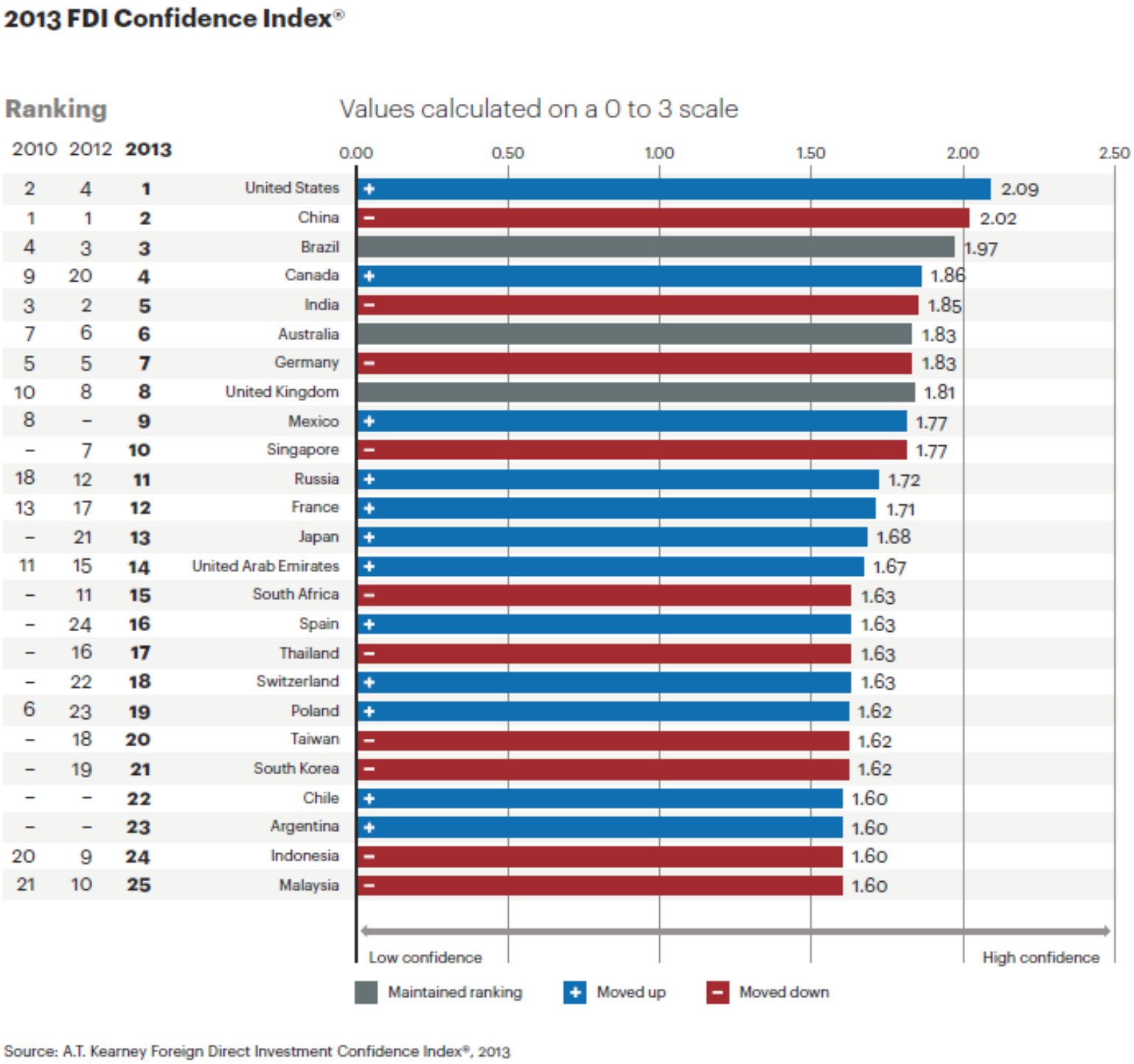


Figure 2. 2013 FDI Confidence Index®

Source: The 2013 A. T. Kearney Foreign Direct Investment Confidence Index®, page 3

Figure 2 represents the 2013 FDI Confidence Index® which allows understanding the situation of the 25 most important countries when it comes to FDI. The values for the confidence index are calculated on a 0 to 3 scale, 3 representing a high confidence a 0 a low confidence. This figure reflects that in the last years United States, China and Brazil have led this ranking with confidences ratings around the value of 2. In 2013, the rest of the countries that form this ranking follow up with Canada in the 4th position with a confidence index of 1.86 and end with Malaysia in the 25th position reflecting a 1.60 confidence index. However, this also implies that even the most confident countries at the top of the ranking are not totally confident on investments as the top grade for 2013 was United States with only 2.09 points of a total of 3. This ranking is a good mirror of the actual global situation in which the financial crisis has weakened investors' confidence. That said, the worst part has gone by and many countries are already recovering and presenting growth numbers. Due to this, it is expected that the confidence will start to grow gradually into more positive numbers meaning that more investment operations will be carried out and therefore the total FDI will tend to increase in the near future.

In 2010 and 2011, developing markets accounted for more than 50% of global investment. This means that emerging markets are becoming a complement, rather than an alternative, to the developed world. The traditional point of view of investors attracted to developing markets was due to low manufacturing costs, although, last year, investors reported that emerging markets had become an important target because of their consumer markets' size (71%) and growth (37%).

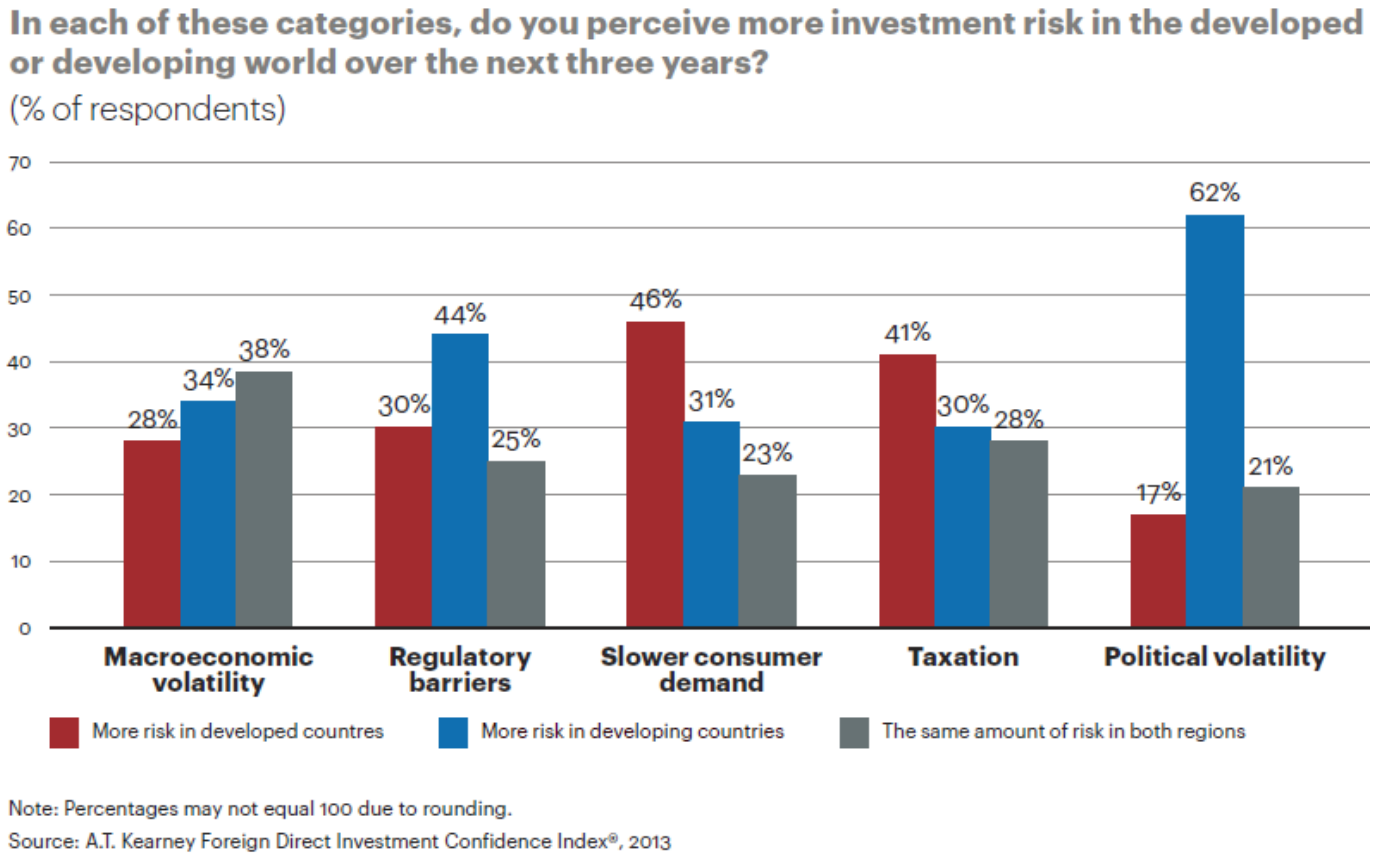
Investment risk perception, developed Vs developing countries

Traditionally, developed and developing countries were seen by investors as very different investments targets due to a variety of reasons. However, this point of view is gradually changing and emerging markets are now playing a more important role than in the past years. Hence, it is interesting to

understand this trend and compare the current situation of developed and developing countries.

Figure 9

The notion that developing markets are inherently riskier than developed countries is outdated



Note: Percentages may not equal 100 due to rounding.

Source: A.T. Kearney Foreign Direct Investment Confidence Index®, 2013

Figure 3. Investment risk perception, developed Vs developing countries

Source: The 2013 A. T. Kearney Foreign Direct Investment Confidence Index®, page 9

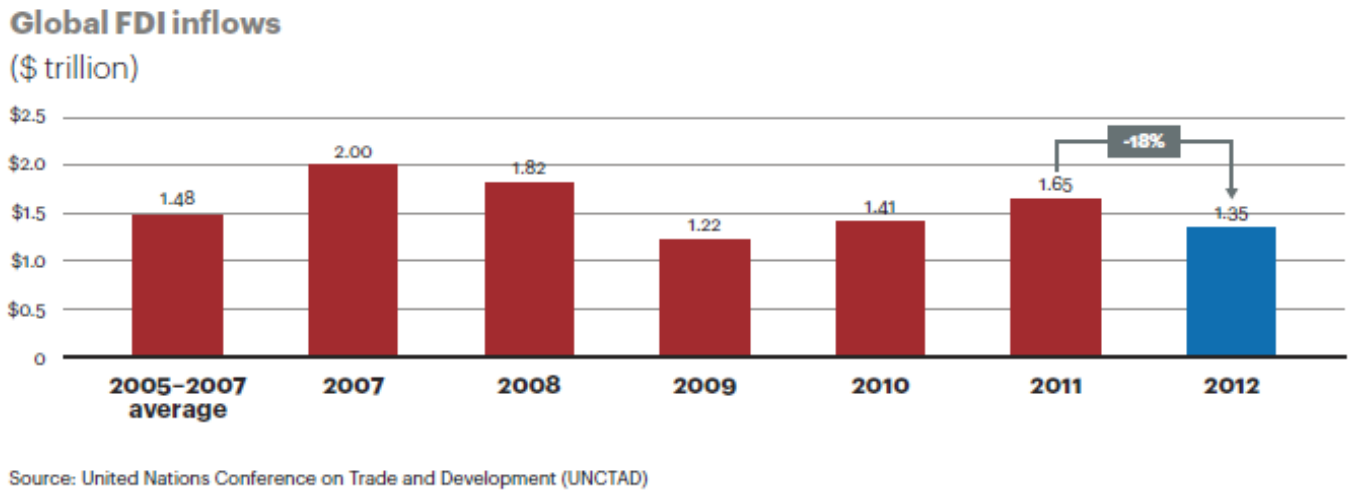
5 different factors are analyzed in figure 3: macroeconomic volatility, regulatory barriers, slower consumer demand, taxation and political volatility. Regarding the first four of them, developing markets are roughly perceived with a similar level of risk and uncertainty as developed markets. This year, the only category in which developing countries showed a

significant higher risk was in political volatility. The similarity in risk perception has been a result of the improved monetary and fiscal policies applied by developing countries, increased trade, diversification and more welcoming business environments. The important improvements made in the areas mentioned have put emerging markets at a very similar level to developed markets, implying that investment targeted at emerging countries will tend to become more important during the upcoming years.

FDI inflows

The next figure reflects the evolution of FDI inflows in the period 2005-2012. The analysis of this information will allow observing the pattern of over the last years.

Figure 2
World FDI inflows dipped 18% following two years of post-crisis gains



Source: United Nations Conference on Trade and Development (UNCTAD)

Figure 4. Global FDI inflows, 2005-2012

Source: The 2013 A. T. Kearney Foreign Direct Investment Confidence Index®, page 4; United Nations Conference on Trade and Development (UNCTAD)

Figure 4 shows that global FDI inflows have not followed a pattern as the numbers have fluctuated considerably year after year. Before the financial

crisis the level of global FDI inflows was 1.82 trillion dollars and dropped down to 1.22 trillion dollars in 2009. However, a noticeable recovery occurred in the following two years during which it rose to 1.65 trillion dollars in 2011. But once again, there was an important decrease (18%) in 2012, reaching 1.35 trillion dollars. A low value of global FDI inflows implies that the inward direct investment made by non-resident investors in the reporting economy is small compared to the pre-crisis period.

Investment-Impact Indicators

There are different indicators which measure the results obtained from an investment that has been carried out. As this final project is focused on the impact that investments have on three main aspects (technological development, productivity and job creation) it is important to understand how investments are measured.

Table 1. Summary of Investment-Impact Indicators

Area	Indicators
Economic Value Added	1. Total value added
	2. Value of capital formation
	3. Total and net export generation
	4. Number of formal business entities
	5. Total fiscal revenues
Job creation	6. Employment (number)
	7. Wages
	8. Typologies of employee skill levels
Sustainable development	9. Labour impact indicators
	10. Social impact indicators
	11. Environmental impact indicators
	12. Development impact indicators

Table 4. Investment-Impact Indicators

Source: UNCTAD, Promoting responsible investment for sustainable development and job creation, page 12

The United Nations Conference on Trade and Development (UNCTAD) summarizes investment-impact indicators in three areas making a total of twelve indicators. The three areas in which indicators are grouped are Economic Value Added, Job creation and Sustainable development. The indicators considered for this final project are related to Development impact indicators and Labor impact indicators (under the category of Sustainable development), Total value added (Economic Value Added) and Employment (Job creation). As table 2 illustrates, there are many indicators that can be used to quantify the impact of investments, although for this final project only the indicators mentioned previously will be considered.

2.4. Identification and determination of main investors

It is important to identify which are the main protagonists when it comes to investment levels. These countries will be the responsible for the greatest levels of investments and thus their importance in the global perspective. Without further investigation, it seems obvious to believe that the main investors are the world's most powerful countries, which are USA, China, Germany, France, Japan, UK, etc…

Investigation has shown that indeed these countries are the main responsible for investment but there are others that are important targets of investment (FDI, Foreign Direct Investment). The figures along this chapter show some of the investment levels in the world to better know the investment market.

2.5. Identification of successful investments

Case study: China's investment in renewable energies

China, one of the fastest growing countries in the world, is currently going through a change process regarding its energy system. At the moment, China is very dependent on fossil fuel energies, generating great part of its energy by burning coal at its fossil fuel power stations. This strong dependence on dirty energies entails negative consequences such as high pollution levels and earning the international reputation of being the worst polluter in the world.

However, China is determined to revert this situation. There are several reports by different national and international agencies (such as "China Council of International Co-operation on Environment and Development") urging China to replace its current dirty, energy intensive industries with renewable technology. This movement towards a more green energy system requires a very strong investment but will also create a large number of jobs. The China Council of International Co-operation on Environment and Development, headed by Li Keqiang (Chinese Prime Minister) includes 200 domestic and overseas experts and leading figures in the United Nations and other world bodies. The council recommends the government to spend 5.8 trillion yuan (71.000 €mn) over the next five years on policies and measures to save energy, protect the environment and replace polluting industries with hi-tech firms. Reports estimate that the results of this investment would be highly beneficial for China in all aspects: creation of jobs would reach the figure of 10.5 mn, GDP would be boosted by 8 trillion yuan and energy savings would amount to another 1.4 trillion yuan. These positive consequences clearly outnumber the transition costs to a greener energy system, predicted to be a decrease in GDP by 100 billion yuan and the loss of 950,000 jobs. Hence, by simply observing and comparing the figures, it is very clear that the investment is worthy.

The report placed great part of the blame on the obsession with GDP expansion over the last years, displacing environmental issues to a secondary

position. Due to this, there has been a lax implementation of environmental goals and policies. “The blind pursuit of economic growth has now become a huge obstacle for China's green growth” states the report.

According to the Paris-based agency’s *World Energy Outlook*, China will add more electricity generating capacity from renewable sources by 2035 than the U.S.A., Europe, and Japan combined. In order to do so, hydro power and wind power will become the two main sources of China’s pool of renewable energy, with solar photovoltaic cells coming in a distant third position, according to the agency’s forecast.

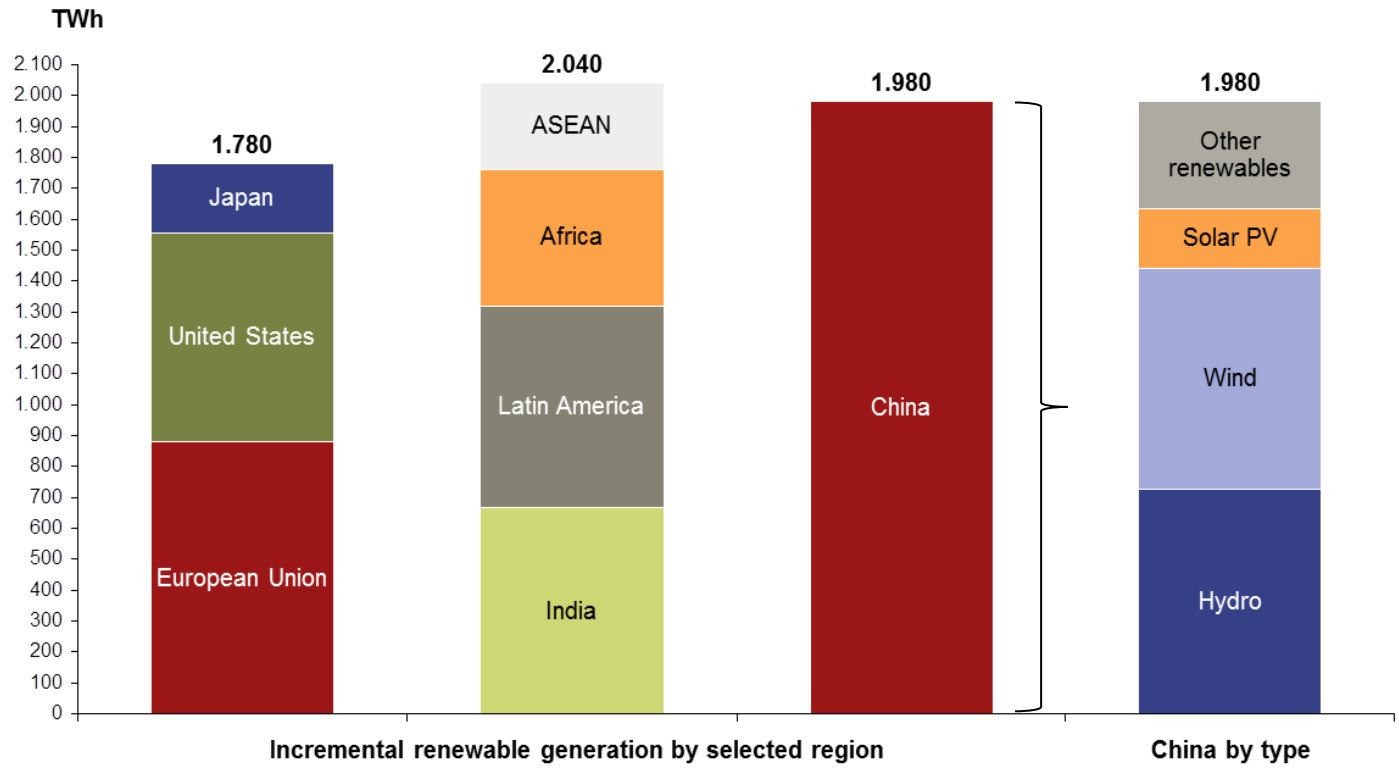


Figure 5. Incremental electricity generation from renewables in selected regions, 2011-2035

Source: International Energy Agency (IEA)

China’s global share of coal consumption will also decrease over the next 20 years due to the increasing importance of renewable energies.

As explained before, this planned investment in a greener energy system will not only reduce drastically the pollution levels and help to achieve environmental goals but it will also create a large number of jobs and raise GDP significantly; two important topics which are being analyzed in this final project. For this reason, and due to the huge capital that is being invested, it has been considered an important case study for this project.

2.6. Analysis of previous investment models

Unfortunately, there aren't many previous investment models developed in the past. This means that the possibility to get an insight on previous investment models is reduced, although as much information as possible will be gathered. Any relevant pieces of information will again be displayed in chapter 5 were the appendices will be present.

Three different models have been found in total. These will be analyzed carefully in order to identify the main features of each of the three models and a comparative table will be made including the characteristics of each model (description, applications and uses, advantages and disadvantages).

The three models are the following:

- Road investment and productivity growth: the effects of vehicle-intensity and congestion
  Author: Daniel Montolio

- Quantifying productivity gains from foreign direct investment
  Authors: Christian Fons-Rosen, Sebnem Kalemi-Ozcan, Bent E. Sorensen, Carolina Villegas-Sánchez, and Vadym Volosovych

- Does foreign direct investment Increase the productivity of domestic firms? In search of spillovers through backward linkages
  Author: Beata Smarzynska Javorcik

The first two models study the final effect on Total Factor Productivity. This term, also known as multi-factor productivity, evaluates the effects in total output not caused by traditionally measured inputs of labor and capital. Total Factor Productivity can be used as a measure of an economy's long-term technological evolution if all inputs are taken into account.

The equation relating Total factor Productivity and its inputs is as follows:

$$Y = A * K^{\alpha} * L^{\beta}$$

where:

Y = Total Output

A = Total-Factor Productivity

K = Capital Input

L = Labor Input

α = Capital Input share of contribution for K

β = Capital Input share of contribution for L

Total Factor Productivity is usually considered as the real driver of growth within an economy and studies have revealed that it can account for up to 60% of an economy's growth.

However, Total Factor Productivity logically depends on the estimates made for its components of the equation. Some studies ("Human Capital and the Wealth of Nations", May 2006) argue that estimations of the labor component are not very reliable and hence the Total Factor Productivity is distorted and its contribution to an economy's growth is substantially lower than initially believed.

Road investment and productivity growth: the effects of vehicle-intensity and congestion

Author: Daniel Montolio

This model studies public investment in road infrastructures as a determinant of what is called the Total Factor Productivity (TFP, hereafter) growth. The focus of the model is Spanish provinces for the period 1984-1994. The author takes into account the effect of road infrastructures that depend on the extent of the road use by provincial industries, affected by these industries' vehicle-intensity. Moreover, services provided by road infrastructure are considered an impure public good, that is, one that is subject to congestion.

Keywords: Road infrastructures, Productivity growth, Congestion

The objective of this model is to assess whether public investment in road infrastructure is a determinant of TFP growth across Spanish provinces for the period 1984-1994.

Apart from variables related to road infrastructure, other key variables taken into account were of political nature, such as the number of votes the ruling party obtained was also considered for the final prediction of TFP growth.

The conclusion of the model is that the results seem to support the null hypothesis that productive public investment in road infrastructures has, on average, affected relative provincial productivity performance in Spain for the period 1984-1994.

Quantifying productivity gains from foreign direct investment

Authors: Christian Fons-Rosen, Sebnem Kalemi-Ozcan, Bent E. Sorensen, Carolina Villegas-Sánchez, and Vadym Volosovych

This model studies the casual effect of foreign investment as a determinant of what is called the Total factor Productivity (TFP, hereafter) using a new global firm-level database. The identification strategy relies on understanding the difference in the amount of foreign investment by financial and industrial investors for country-sector-year factors. The focus of the model is over 60 countries around the world during the period 2002-2007.

The authors use estimates of the Foreign Direct Investment to calculate the aggregate impact of such investments on country-level productivity growth.

Keywords: Multinationals, FDI, Productivity

The model distinguishes between the countries, considering if they are emerging markets or already developed countries. As well, a distinction between different sectors of the economy is made (services, manufacturing, agriculture and mining, construction).

The conclusion of the model is that the results seem to support that Foreign Direct Investment has a small impact on the country's productivity.

Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages

Author: Beata Smarzynska Javorcik

This model studies the relationship between Foreign Direct Investment and productivity of domestic firms. The author states in his initial hypothesis that knowledge brought by multinationals will spill over to domestic industries and hence increase productivity levels. In this case, the focus of the model is Lithuania during the period 1993-2000.

Keywords: Foreign Direct Investment, Productivity, Domestic firms, Knowledge

The objective of this model is to assess to what extent does Foreign Direct Investment affect productivity levels. This model is focused on analyzing the relationship between Foreign Direct Investment and the productivity spillovers derived from the contacts that exist between foreign affiliates and their domestic suppliers (backward linkages) and interactions between foreign suppliers of intermediate inputs and their direct customers (forward linkages).

The conclusion of the model is that the results seem to support the hypothesis that partially but not fully owned foreign projects see their productivity levels increased by foreign direct investment.

After analyzing the three models, a comparative table is presented below to better understand the main features of each of the models.

	Road investment and productivity growth	Productivity gains from FDI	Does FDI increase productivity of domestic firms?
Description	- Study: Effect of public investment in road infrastructure on Total Factor Productivity - Scope: Spanish provinces, period 1984-1994	- Study: Effect of Foreign Direct Investment on Total Factor Productivity - Scope: More than 60 countries around the world (focus on European countries), period 2002-2007	- Study: Effect of Foreign Direct Investment on productivity levels of domestic firms - Scope: Lithuania, period 1993-2000
Application and Conclusions	- Application: Prediction of the effect of public investment in road infrastructure on domestic firms in Spain - Conclusion: Public investment in road infrastructure has some effect on provincial productivity performance (lower than expected)	- Application: Prediction of the effect of foreign investment on Total Factor Productivity of a wide range of countries, distinguishing between emerging and developed countries as well as between different economy sectors - Conclusion: Foreign Direct Investment has a small impact on the country's productivity	- Application: Prediction of the effect of Foreign Direct Investment on productivity of domestic firms - Conclusion: Partially but not fully owned foreign projects see their productivity levels increased by Foreign Direct Investment
Advantages and Disadvantages	- Advantages: Takes into account other variables (e.g.: variables of political nature) and distinguishes between different provinces in Spain - Disadvantages: The data on which the model is based is 25 years old and the focus of the model is reduced (only Spain)	- Advantages: Distinguishes between type of countries and by sector - Disadvantages: Only takes into account foreign investment	- Advantages: Analyzes the knowledge brought by multinationals to domestic firms and its spillover effects - Disadvantages: The focus of the model is reduced (only Lithuania)

Table 3. Comparison of different previous models

3. Analysis and model creation

This second phase is divided into four main sections involved in analysis of the information obtained in the previous phase and the creation of the model. Due to this, a classification of the investments based on different criteria will be made and the investment model will be created as well as. Before being able to create the model, the relationship between investments and the impacts they produce on the three factors of interest must be determined, and this will be done applying statistical methods and other appropriate tools. Moreover, investments that have proved to be successful will be analyzed to understand why and elaborate conclusions regarding this matter later on in chapter 4.

At the same time, this chapter may be divided into sub-sections that will make it easier to focus on each particular aspect of the analysis of investments. In this case, it has been decided to address the following sub-issues:

1- Classification of investments
2- Sample analysis
3- Determination of relationship between investments and their impact and Model creation

3.1. Classification of investments

After having extracted all the necessary data from the sources of information, the next logical step is the analysis of the data in order to create the model which is the main objective of this final project. However, in this section 3.1., an initial analysis of the data collected has been carried out in order to better understand the sample of investments that is being considered. In order to do so, a characterization of the investment market has been done focusing on the following aspects:

- Sample size
- Sources of information
- Starting date of the investments
- Invested capital
- Objective of the investments
- Source and destination of the investments
- Investment by sector
- Public and private investment
- Results of the investments

List of largest manufacturing companies by revenue

Before proceeding to the technical analysis of the data gathered from the different sources of information, it is interesting to know from which companies does this information come from. For this purpose, a table has been created to display some of the companies which make up the sample. This table appears in the appendices (as appendix A) at the end of this document and illustrates a list of the largest manufacturing companies by revenue that have been taken into account when gathering information.

Sample size

Having completed the phase regarding collection of information, the sample considered for the model has the following characteristics:

- 360 investments have been analyzed
- 31 different sources of information have been considered
- Total investment capital amounts to 174.000 €mn, the average investment being of 482 €mn
- Investments belong to the timeframe 2006-2016
- 17 countries represent the sources of investments
- 32 countries represent the destinations of investments
- Investments have been classified by typology: Public, Private
- Investments analyzed belong to 16 different industrial sectors
- Investments have been classified by 5 different objectives

Sample selection effect

The selection of data that make up the sample has not been random as this final project has focused on industrial sectors and particularly in the automotive sector. Hence, data search has been oriented at the industrial sectors of interest.

The automotive sector is of special interest due to the numerous investments it is currently going through, being one of the sectors that attracts more capital and a large number of jobs are being created, and therefore it represents a good source of information for this final project. The special interest in the automotive industry has resulted in 50% of the selected data belonging to this sector. This implies that conclusions derived from the final project are more valid when applied to the automotive sector.

3.2. Sample analysis

Sources of information

A total of 31 different sources of information have been taken into account while collecting data on investments. Below is a table that summarizes the sources of information that have been considered throughout the whole final project.

	Press/News media	Reports	Government	Organizations/ Associations	Institutions
National	• Newspaper El País (Spain) • Newspaper Expansión (Spain)		• Centro para el Desarrollo Tecnológico Industrial (CDTI) • Programa de Incentivo al Vehículo Eficiente (Plan PIVE) • Secretaría de Estado de Administraciones Públicas (Fondo Estatal de Inversión Local) • Secretaria de Estado de Investigación, Desarrollo e Innovación	• Asociación Nacional de Fabricantes de Automóviles y Camiones (ANFAC) • Asociación Valenciana de Empresarios (AVE)	• European Regional Development Fund
International	• Travel agency Travel Weekly • Automotive News • Bloomberg • General Motors • Gulf News • Ford corporate website • Newspaper Japan Daily Press (Japan) • Newspaper Virginia (U.S.A.) • Newspaper The Globe And Mail (Canada) • Newspaper The Guardian (U.K.) • Newspaper The Wall Street Journal (U.S.A.) • Newspaper USA Today (U.S.A.)	• American Council for an Energy-Efficient Economy • International Finance Corporation • Political Economy Research Institute Massachusetts • University of Massachusetts-Amherst's Political Economy Research Institute	• Government of Connecticut (U.S.A.) • Government of Florida (U.S.A.) • Polish Information and Foreign Investment Agency	• Freight Rail Works	• European Comission

Table 4. Sources of information

Corporate websites have proven to be one of the most useful sources of information when they actually did have information of interest. However, in general, corporate websites only tend to exhibit macro financial data and usually don't present data regarding employment creation or productivity increase which are the key factors for this final project. Specialized press (in the case of the automotive sector) was also very helpful as there was plenty

of information available. Several universities and institutes have carried out investigations such as the MIT and the results of these results will be shown later on during this chapter.

Starting date of the investments

The timeframe of the investments has also been considered in the analysis and the sample of investments have a starting date that lies in the period 2006-2016.

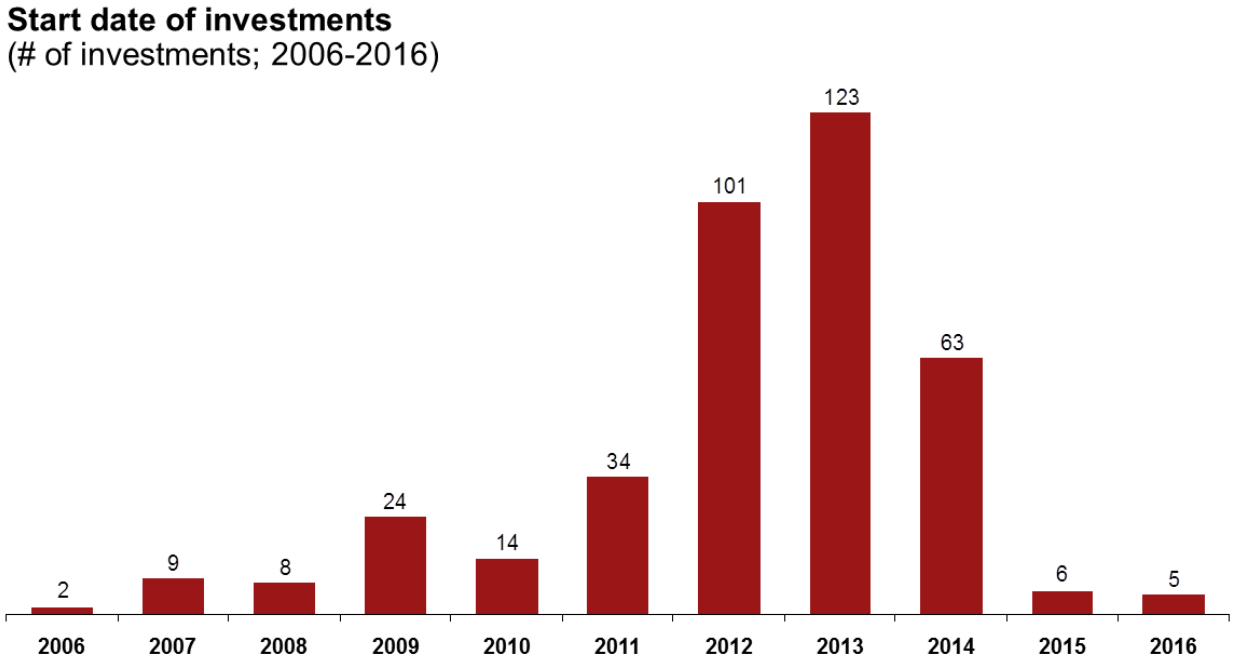


Figure 5. Starting date of the investments

Source: A. T. Kearney analysis

This final project has been carried out during the last months of 2013 and first months of 2014 which explains that the majority of the investments belong to this time period. This is strongly influenced by websites on the internet, due to the fact that when a search is carried out, results closer to the present date are more likely to appear.

There is a trend regarding start dates of investments. During the worse years of the financial crisis (2008-2011) the number of investments registered is

lower than the ones during the period (2012-2014). This can probably be explained by the fact that during the economic crisis there was less money available for considering investments projects and the priority was surviving the crisis rather than expanding business or building new factories. Not only this, but unemployment rose to high values all around the world as companies had to cut costs by any means, so investing in new projects was relegated to a lower priority level. On the other hand, there is little data for the years 2015 and 2016 as this represents the future and companies don't usually have definite investment plans and the corresponding data of interest (employment creation, productivity increase, technological development) for future investments.

Invested capital

The total invested capital obtained when adding up the 360 investments that make up the sample amounts to 173.581 €mn. For analysis matters, investments have been divided into five subgroups: 0-100 €mn, 100-250 €mn, 250-500 €mn, 500-1.000 €mn, >1000 €mn.

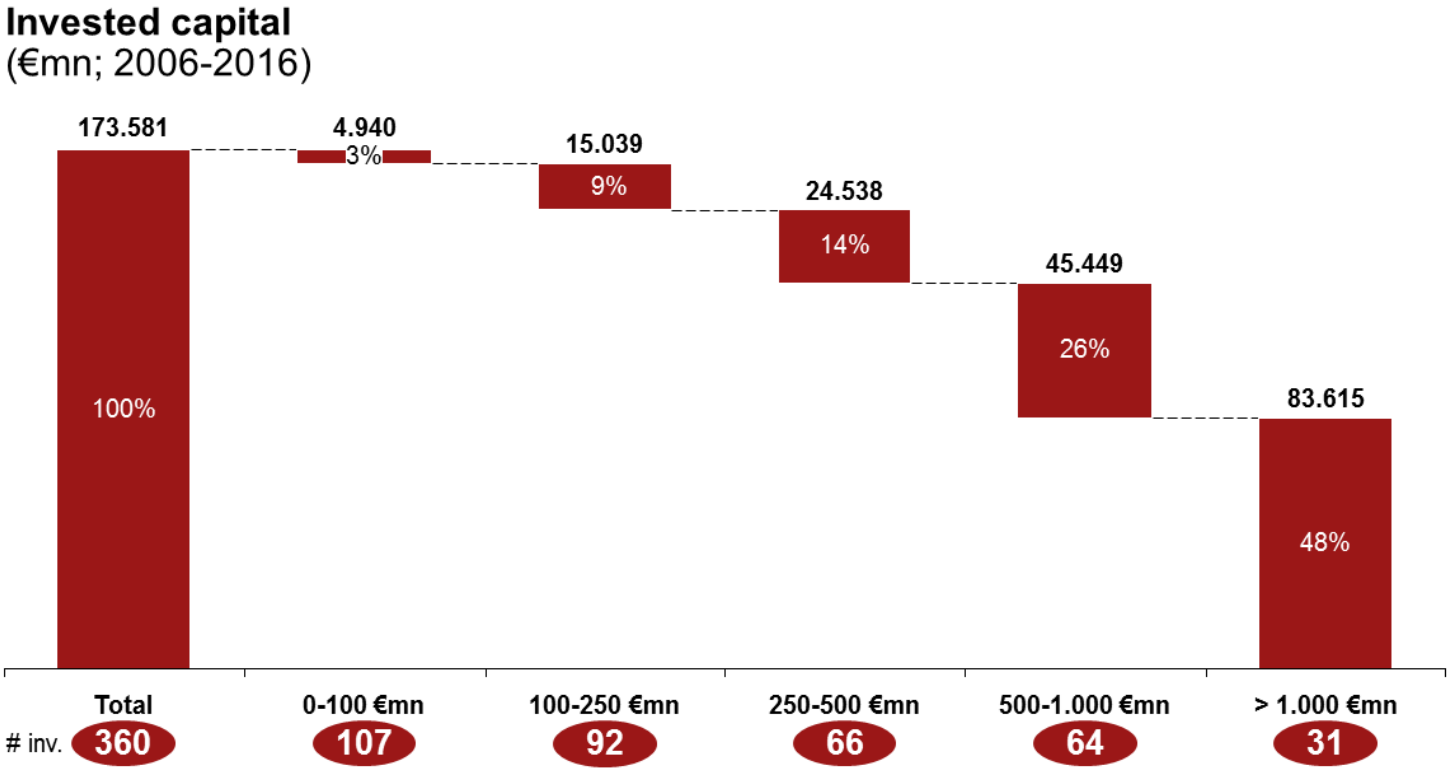


Figure 6. Capital invested

Source: A. T. Kearney analysis

Figure 6 above shows the distribution of investments by capital invested. Logically, capital available for investment is limited implying that small investments are more popular and frequent than large investments. This is clearly represented by the pattern of the number of investments by subgroup. On the other hand, investments accounting for more than 1.000 €mn correspond to almost 50% of the sample size in terms of capital invested. While it is true that the budget is limited for embarking in new investment projects, it is also true that larger projects may come across

economies of scale and hence this will represent an advantage as fixed costs will probably not be directly proportional to the size of the investment (while variable costs will surely be) so there is an opportunity to save some money regarding the fixed costs as they don't increase at the same rate at which the size of the investment does. For example, if an automotive company plans to set up a new factory for the operations and production of a new car, the size of the investment will be heavily influenced by the desired rate of production and the corresponding machines and number of employees required to achieve such rate. This comes in the cost equation as variable costs as they are dependent on the production volume. However, fixed costs such as real estate may not be so closely related to the production volume, and hence investors may decide to take advantage of this.

Objective of investments

Not only the capital invested is important but the kind of objective pursued by the investment is also of importance. 5 clearly different objectives have been defined when carrying out this final project:

- Growth
- Expansion
- Modernization
- Technological Capacitation
- Environmental

Objective	Definition	Examples
Growth	Purely hiring workers to increase production volume	▪ Hiring more workers to increase production rate, such as a third shift
Expansion	Expansion of facilities	• Building a new factory • Expansion of an existing factory
Modernization	Modernization of machinery or processes involved in production	• Renewal of machinery • Renewal of facilities
Technological Capacitation	Achieving a higher level of technology	• Purchase of specific hi-tech machinery attaining a superior level of technology • Investment in R+D laboratories
Environmental	Pursuit of environmental objectives	• Production of more efficient engines, lower air pollution emissions • Renewal of vehicle fleet

Table 5. Objectives of investments

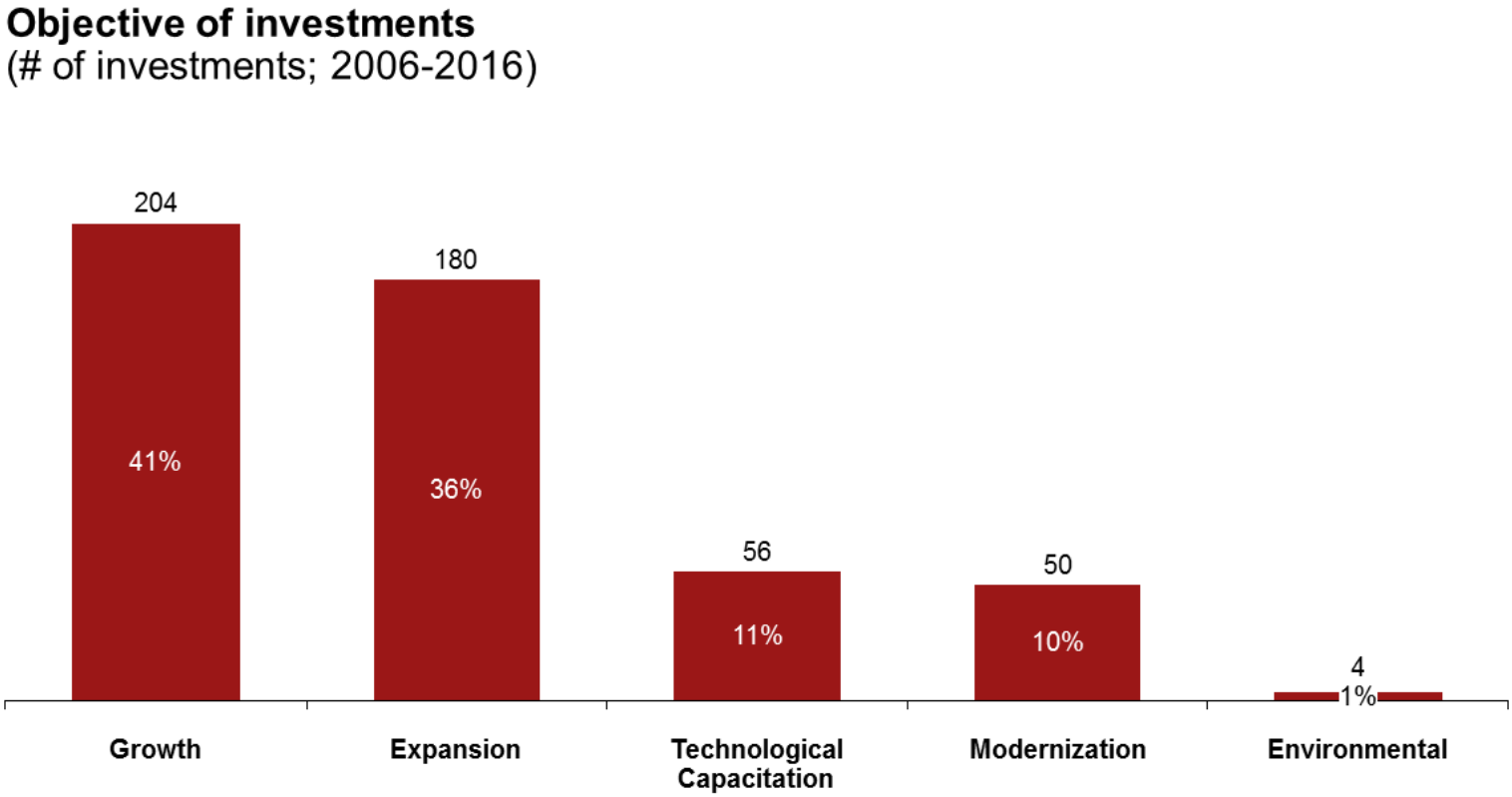


Figure 7. Objective of investments (numerical count)

Source: A. T. Kearney analysis

Note: There are more than 360 objectives of investments in total because a large number of them have been considered to have more than one objective.

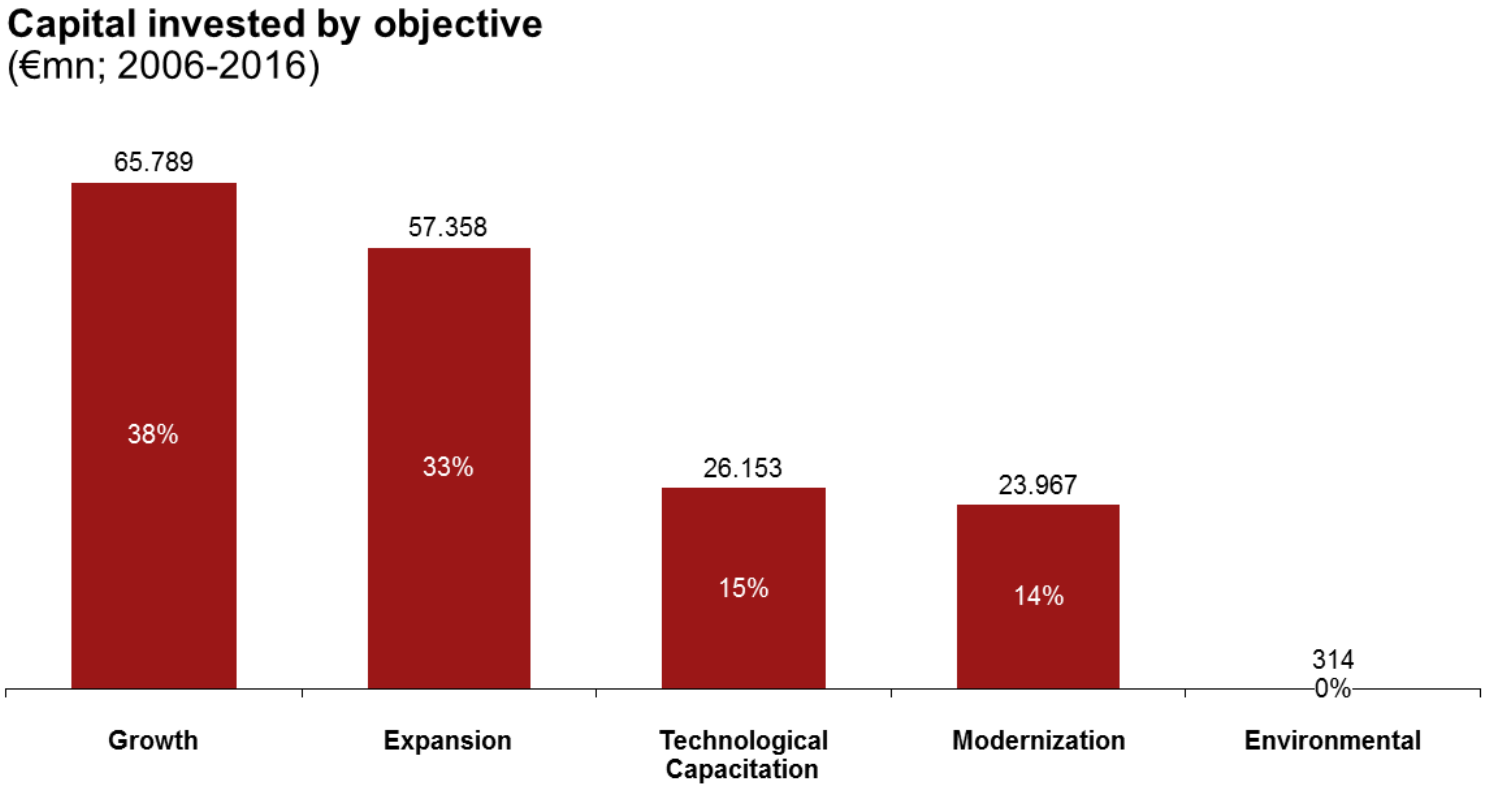
Figure 7 above clearly shows that growth and expansion are the main objectives pursued by investors with occurring 41% and 36% of the times respectively. Technological capacitation and modernization account for 11% and 10% respectively, followed by environmental objectives that are the less common. This trend represents that growth and expansion are by far what most of the times comes in investors' plans rather than the renewal of facilities or achieving a higher technological level. The data helps understanding that companies in general tend to prefer expanding their facilities to increase production volume rather than renewing their machinery (in order to attain higher production rates). Technological capacitation seems to not be very important for investors in most cases. These conclusions from the above graph make sense because factories in

normal circumstances do not work at 100% capacity so if an investor is seeking an increase in production volume it is simply less expensive to hire more workers to boost productivity (such as including a third shift which is a very frequent practice) rather than renewing expensive machinery or expanding the facility to be able to produce more. However, once a factory is working at its peak capacity, an expansion of the facility will be required to further augment productivity. The other main reason explaining an expansion investment is setting up a new factory to achieve strategic objectives, such as enhanced productivity which will allow gaining a more powerful position in the market, meeting demand from customers or reinforcing business in a given location.

Obviously, technology is constantly evolving and sooner or later a modernization investment will have to take place to ensure an optimal level of productivity and the factory remains competitive with regard to other competitors. However, the results from graph 7 explain what was initially supposed, and that is that modernization projects happen once in a while, every few years, as the renewal of machinery or facilities is expensive and there is always the fear that once the newest and latest, most sophisticated machinery is purchased and is working, there already is a new machine model which is better. Technology capacitation is similar to modernization but implies advancing to the next technological levels, for example, moving on to producing purely electric engines for vehicles instead of combustion engines. There is a notorious difference in the components (mainly the huge batteries for electric engines) and a technology jump is required to produce them. Another form of technological capacitation considered in this final project is investing in R+D laboratories that will also help achieving greater technology levels.

Finally, environmental investments are not very popular as results have proved. Companies are still probably more concerned about productivity levels and both revenue and income rather than environmental issues. For a company to work correctly it must enjoy a positive economic situation, so logically this tends to be their priority. Nevertheless, with the increasing

importance of Corporate Social Responsibility, companies tend to fuse their economic objectives with environmental ones. There is an increasing concern over environmental issues and this results in companies taking more care of the surrounding environment. For example, automotive companies are continuously researching to manage ways of producing engines that pollute less. Another example would be the Spanish government with its "Plan PIVE" whose objective is to renew the vehicle fleet in Spain (the average car age in Spain is over 10 years old, according to "Asociación Española de Fabricantes de Automóviles y Camiones"), providing grants and subsidies so that customers receive a discount when purchasing a new, less polluting, car. It is expected that in the next years environmental projects will continue to gain



importance and therefore will become more frequent.

Figure 8. Objective of investments (capital invested)

Source: A. T. Kearney analysis

Figure 8 shows a very similar pattern as Figure 7 exhibits, with similar relative values for each of the five different objectives. However, there is one slight

difference, and this is that both technological capacitation and modernization investments have gained relative importance with respect to figure 7 (15% and 14% from 11% and 10% respectively). This difference is sustained by the fact that technological capacitation and modernization are more expensive projects as purchasing hi tech machinery and the renewal of machinery

Objective	Total capital invested (€mn)	% of total capital	Number of investments	Average cpaital invested per investment (€mn)
Growth	65.789	37,90%	204	322
Expansion	57.358	33,04%	180	319
Technological Capacitation	26.153	15,07%	56	467
Modernization	23.967	13,81%	50	479
Environmental	314	0,18%	4	79

requires a large sum of money (as mentioned in previous paragraphs).

Table 6. Objectives of investments (summary)

Source: A. T. Kearney analysis

Table 6 above is a summary of the data that has been analyzed. As explained in the last paragraph, the results evidence that investments that pursue technological capacitation or modernization involve, on average, larger sums of money.

Source and destination of the investments

Analysis of the source and destination of investments has allowed understanding better which countries have been the main investors and similarly which ones have been the main investment recipients.

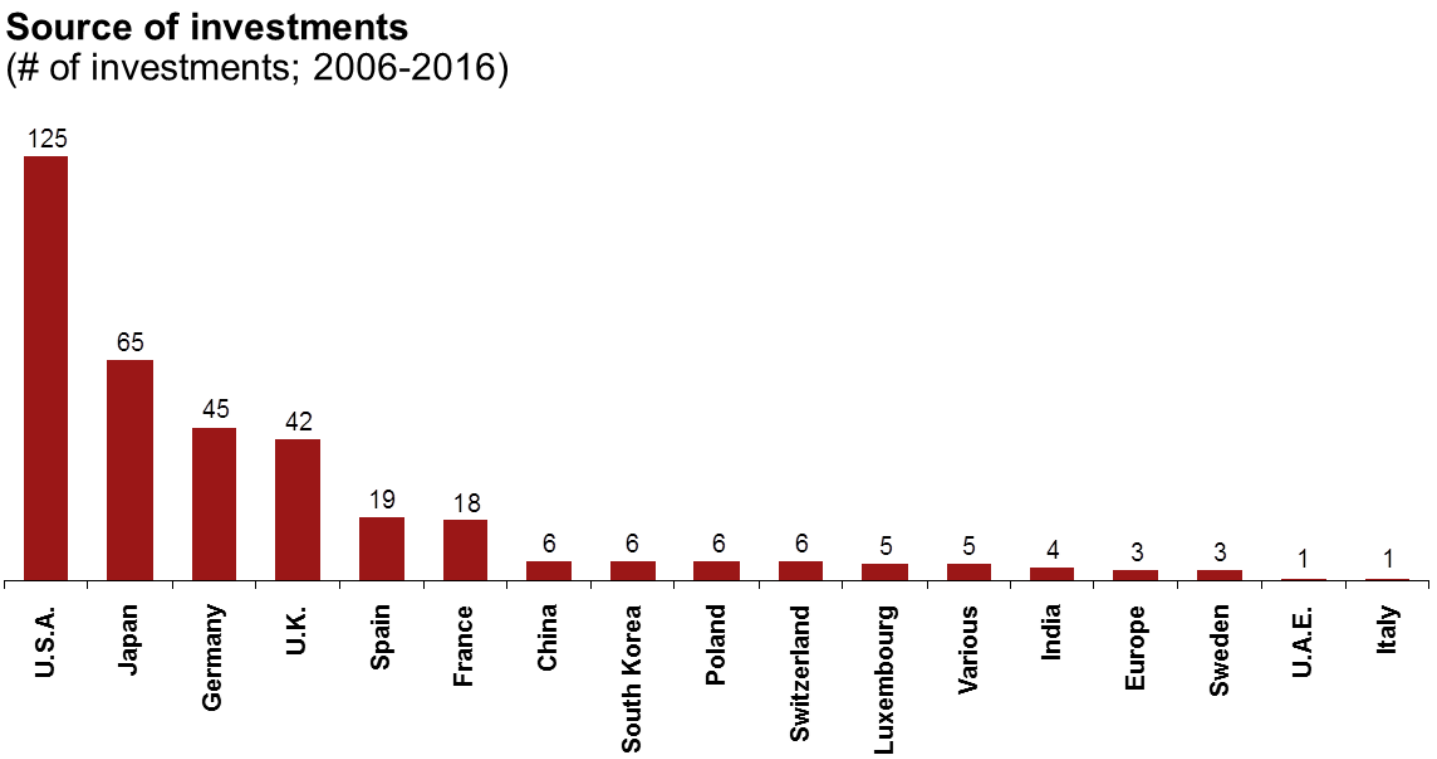


Figure 9. Source of the investments

Source: A. T. Kearney analysis

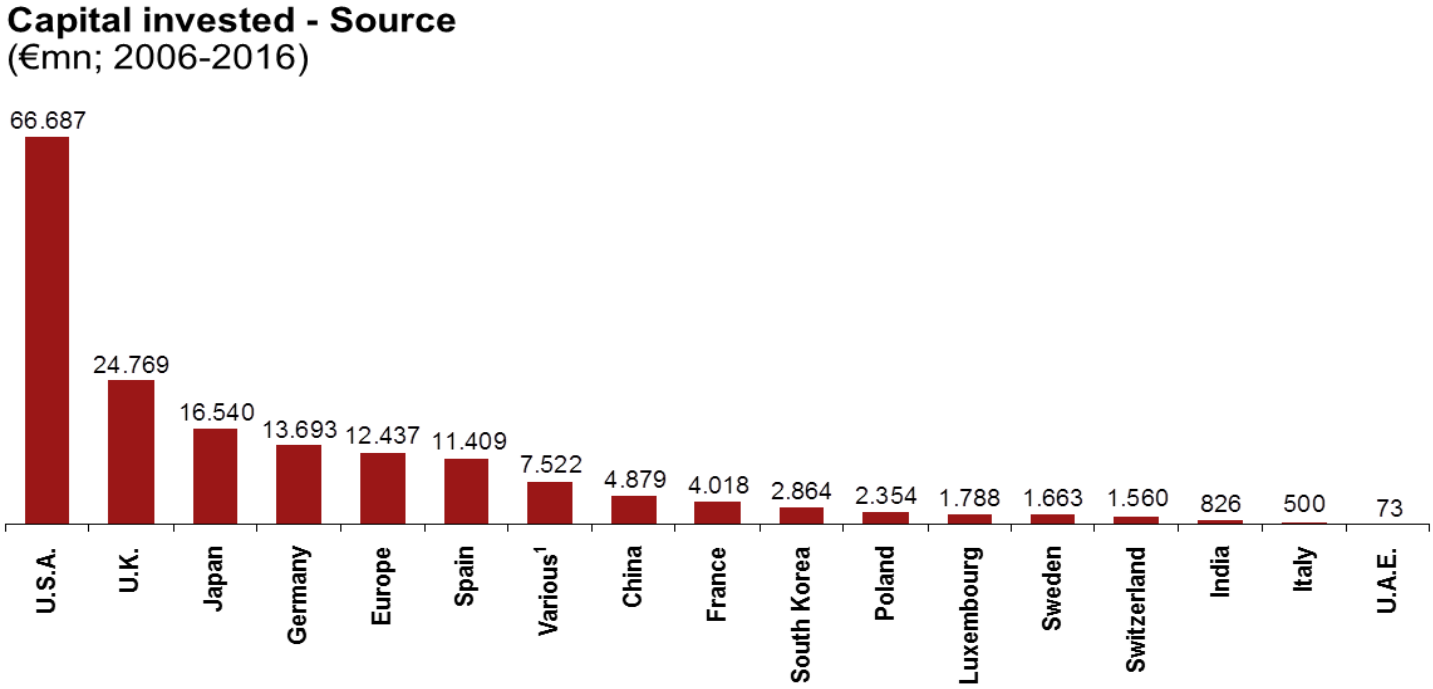


Figure 10. Capital invested - Source

Source: A. T. Kearney analysis

Figures 9 and 10 show the number of investments by countries and the total amount of capital invested. U.S.A. heads both categories, being the country that most investments has carried out and more capital has spent. Other countries following U.S.A. are U.K., Japan, Germany and Spain. This big picture of the investment market is what was expected before performing this analysis as the countries named above are world leading countries and as such are expected to occupy top positions in these categories. Therefore, the data collected evidences that these are the main investors. Nonetheless, it is also important to understand which countries are being the targets of investments and if there is some kind of pattern regarding investing at a national scale or internationally. These issues will be addressed in the following paragraphs, supported by the corresponding graphs. Below is a summary table of countries that invest.

Source of the investment	Number of investments	Total capital invested (€mn)	% of total capital invested	Average capital per investment (€mn)
U.S.A.	125	66.687	38,42%	533
U.K.	42	24.769	14,27%	590
Japan	65	16.540	9,53%	254
Germany	45	13.693	7,89%	304
Europe	3	12.437	7,16%	4146
Spain	19	11.409	6,57%	600
Various	5	7.522	4,33%	1504
China	6	4.879	2,81%	813
France	18	4.018	2,31%	223
South Korea	6	2.864	1,65%	477
Poland	6	2.354	1,36%	392
Luxembourg	5	1.788	1,03%	358
Sweden	3	1.663	0,96%	554
Switzerland	6	1.560	0,90%	260
India	4	826	0,48%	207
Italy	1	500	0,29%	500
U.A.E.	1	73	0,04%	73

Table 7. Sources of investments (summary)

Source: A. T. Kearney analysis

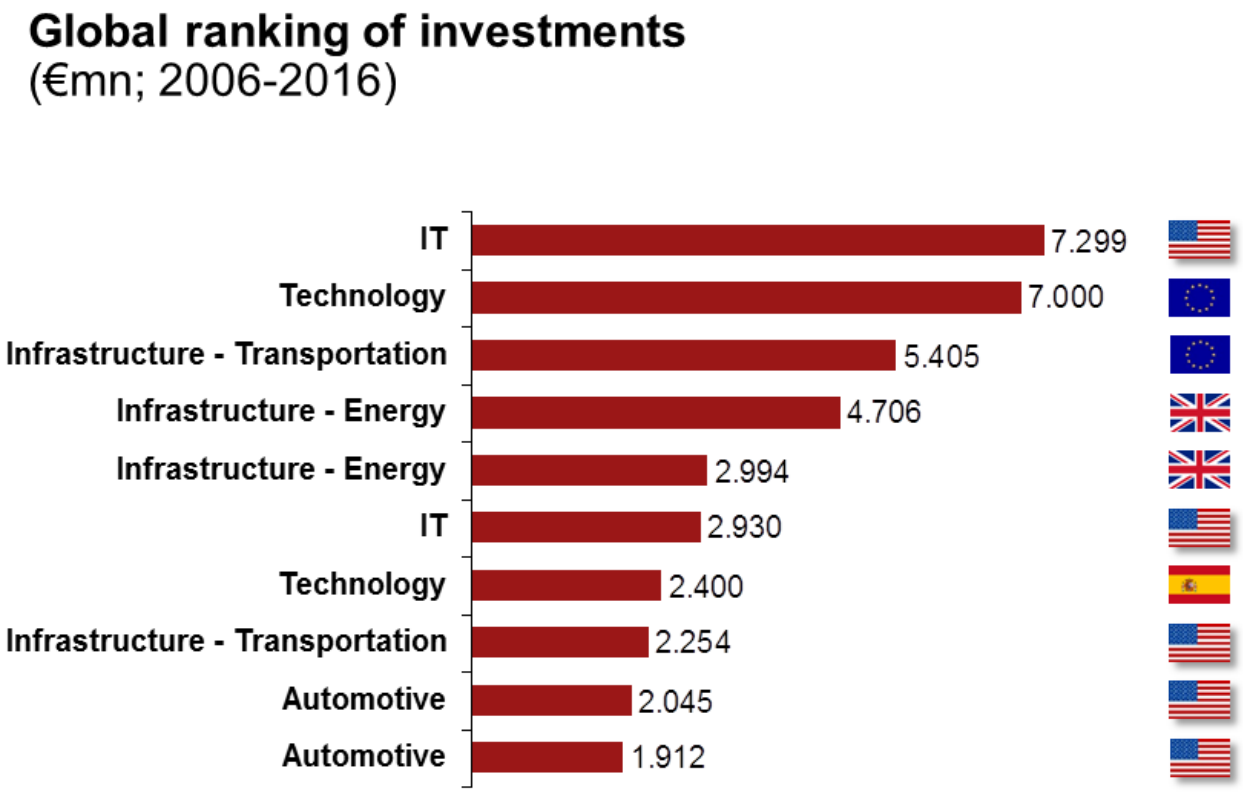


Figure 11. Top 10 Investments (source)

Source: A. T. Kearney analysis

Figure 11 displays a top 10 ranking of investments carried out. As shown, the largest investment carried out belongs to the IT sector and is funded by U.S.A.. Technology, infrastructure, and automotive sectors complete this global ranking in which U.S.A., Europe, U.K. and Spain participate. These countries, as figures 9 and 10 displayed, are some of the main investors.

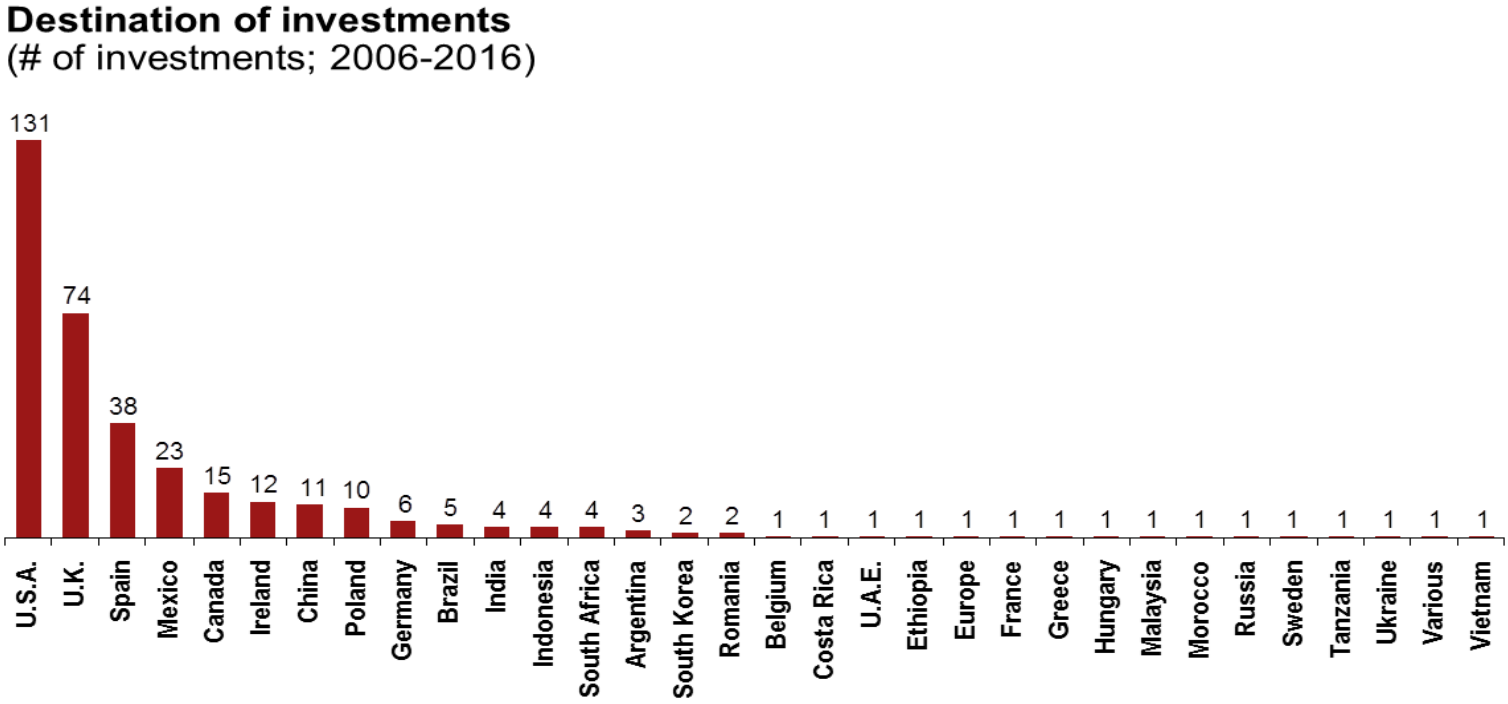


Figure 12. Destination of investments

Source: A. T. Kearney analysis

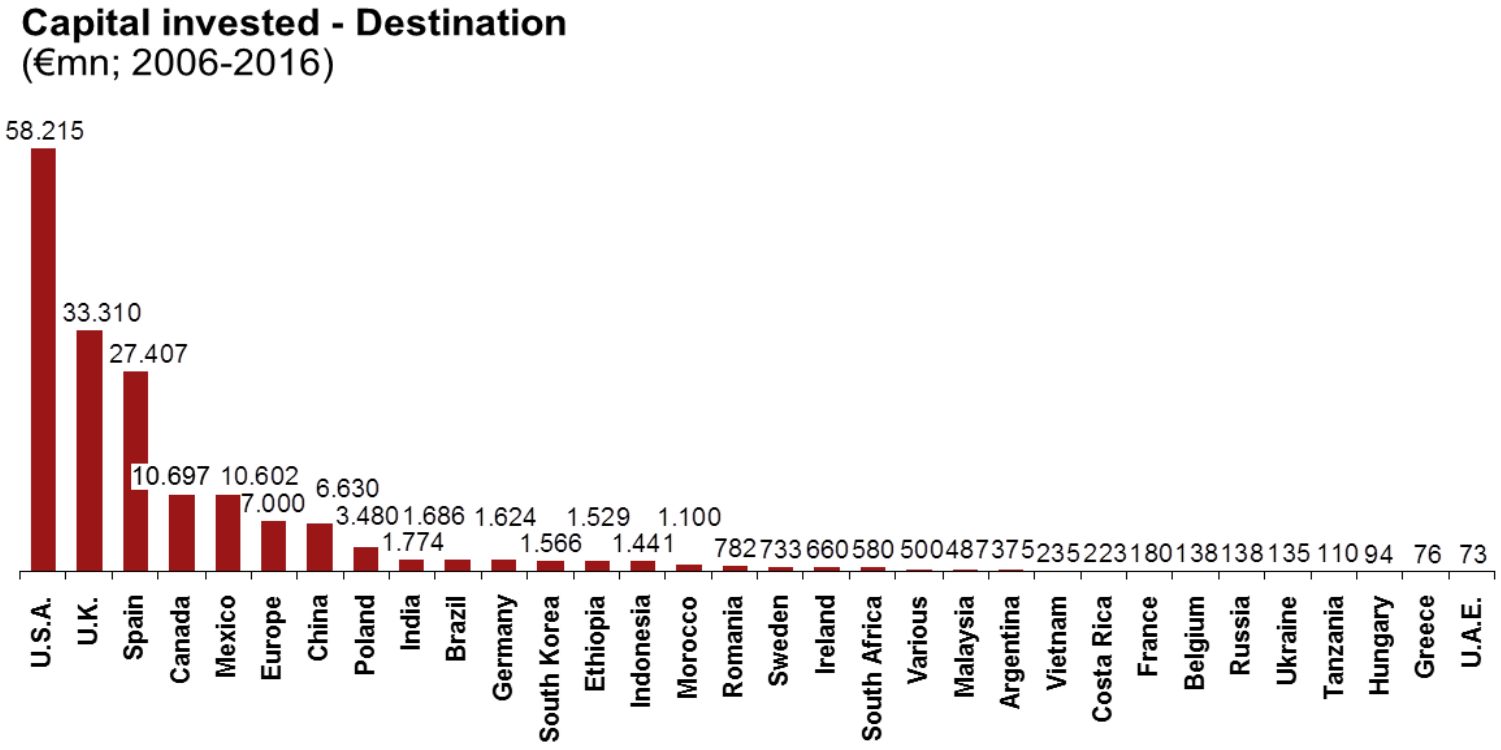


Figure 13. Capital invested - Destination

Source: A. T. Kearney analysis

In a similar was as figures 9 and 10 displayed information regarding the sources of investments and the intensity of capital, figures 12 and 13 reflect the same analysis for destination countries. In this case, there also is a strong correlation between the countries receiving more investments and the total capital injection. The data reflect that U.S.A., U.K., Spain, Canada and Mexico are the main receivers of investments both by number and capital intensity.

Destination of the investment	Number of investments	Total capital received (€mn)	% of total capital	Average capital per investment (€mn)
U.S.A.	131	58.215	33,54%	444
U.K.	74	33.310	19,19%	450
Spain	38	27.407	15,79%	721
Canada	15	10.697	6,16%	713
Mexico	23	10.602	6,11%	461
Europe	1	7.000	4,03%	7.000
China	11	6.630	3,82%	603
Poland	10	3.480	2,00%	348
India	4	1.774	1,02%	443
Brazil	5	1.686	0,97%	337
Germany	6	1.624	0,94%	271
South Korea	2	1.566	0,90%	783
Ethiopia	1	1.529	0,88%	1.529
Indonesia	4	1.441	0,83%	360
Morocco	1	1.100	0,63%	1.100
Romania	2	782	0,45%	391
Sweden	1	733	0,42%	733
Ireland	12	660	0,38%	55
South Africa	4	580	0,33%	145
Various	1	500	0,29%	500
Malaysia	1	487	0,28%	487
Argentina	3	375	0,22%	125
Vietnam	1	235	0,14%	235
Costa Rica	1	223	0,13%	223
France	1	180	0,10%	180
Belgium	1	138	0,08%	138
Russia	1	138	0,08%	138
Ukraine	1	135	0,08%	135
Tanzania	1	110	0,06%	110
Hungary	1	94	0,05%	94
Greece	1	76	0,04%	76
U.A.E.	1	73	0,04%	73

Table 8. Destination of investments (summary)

Source: A. T. Kearney analysis

Figure 14 below shows a comparative graph representing both sources and destination of countries.

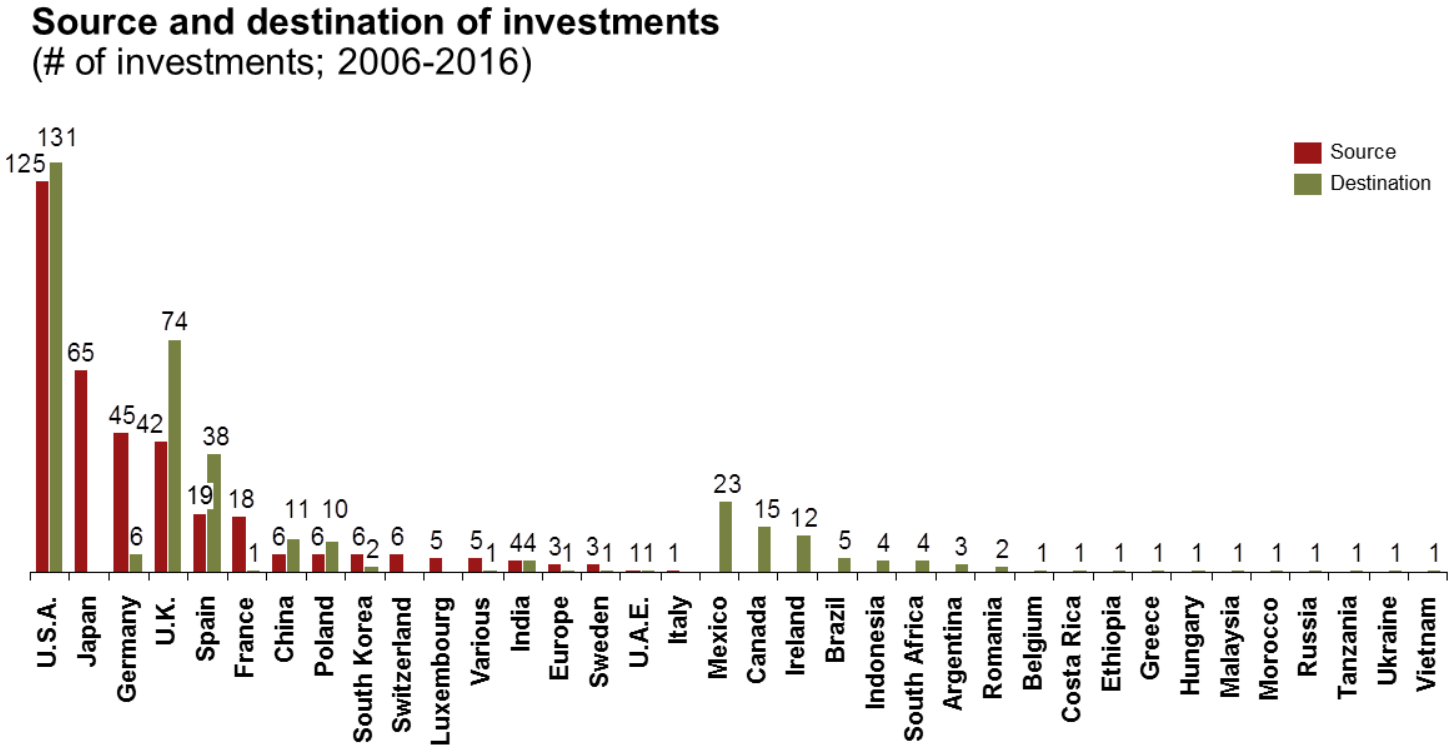


Figure 14. Source and destination of investments

Source: A. T. Kearney analysis

Countries appearing in the first positions of figure 14 are those expected, in other words, the most industrialized countries in the world (U.S.A., Japan, Germany, U.K., Spain, and France) and countries with a very high growth rate such as China. The case of Japan is interesting as the data analyzed reflects that Japan did carry out investments but did not receive any. This is because there are certain Japanese companies, especially those belonging to the automotive sector (which is the focus of this final project) such as Toyota, Nissan and Mazda and other industry related companies (for example Fujitsu, Panasonic, Bridgestone, etc…), that are very strong companies and carry out investments at an international scale. The headquarters of all these companies are in Japan but Toyota, for instance, has car factories all over the world so it will invest heavily abroad when building new factories or hiring

more workers. On the other hand, Mexico is the opposite case, as it only receives investments. Due to its geographical location (acting as a bridge between U.S.A. and South America) and its low labor costs it may probably be an interesting and attractive option for investors when deciding where to invest, explaining these results.

Total number of investments	Investments with same source-destination (national)	Investments with different source-destination (international)
360	147 (41%)	213 (59%)

Table 9. Source – Destination analysis

Source: A. T. Kearney analysis

Another interesting fact is that out of the 360 investments that make up the sample, 59% of them represent international investments against 41% being at a national level. This information is valuable as it reflects that companies invest heavily outside their country by means of Foreign Direct Investment (FDI). Probably in the past these figures would be completely different, as national investments would surely have outnumbered international ones. However, nowadays, due to increasing globalization it is easier and more frequent to invest abroad. Free trade agreements (or reduced trade barriers), better communications, less entry barriers to foreign markets and a global economy promote and encourage international investments. Due to this, now investors must not restrict themselves to look for potential investment opportunities in their home countries but can study other possibilities investing abroad, expanding possibilities. Hence, investors can find a more optimal location where to invest. For example, countries with low labor costs (such as China, India, Pakistan) are very attractive to investors as their production costs will be lower than in other countries with higher labor costs, and this is why it is common to come across high levels of FDI in these type of countries.

Investment by sector

There are significant differences in the results obtained depending on the sector of the industry in which investment is being made. For this reason, it is important to discern between the different sectors. The focus of this final project has been the automotive sector and hence a greater number of investments correspond to this particular sector of the industry. Figure 15 below reflects the data collected.

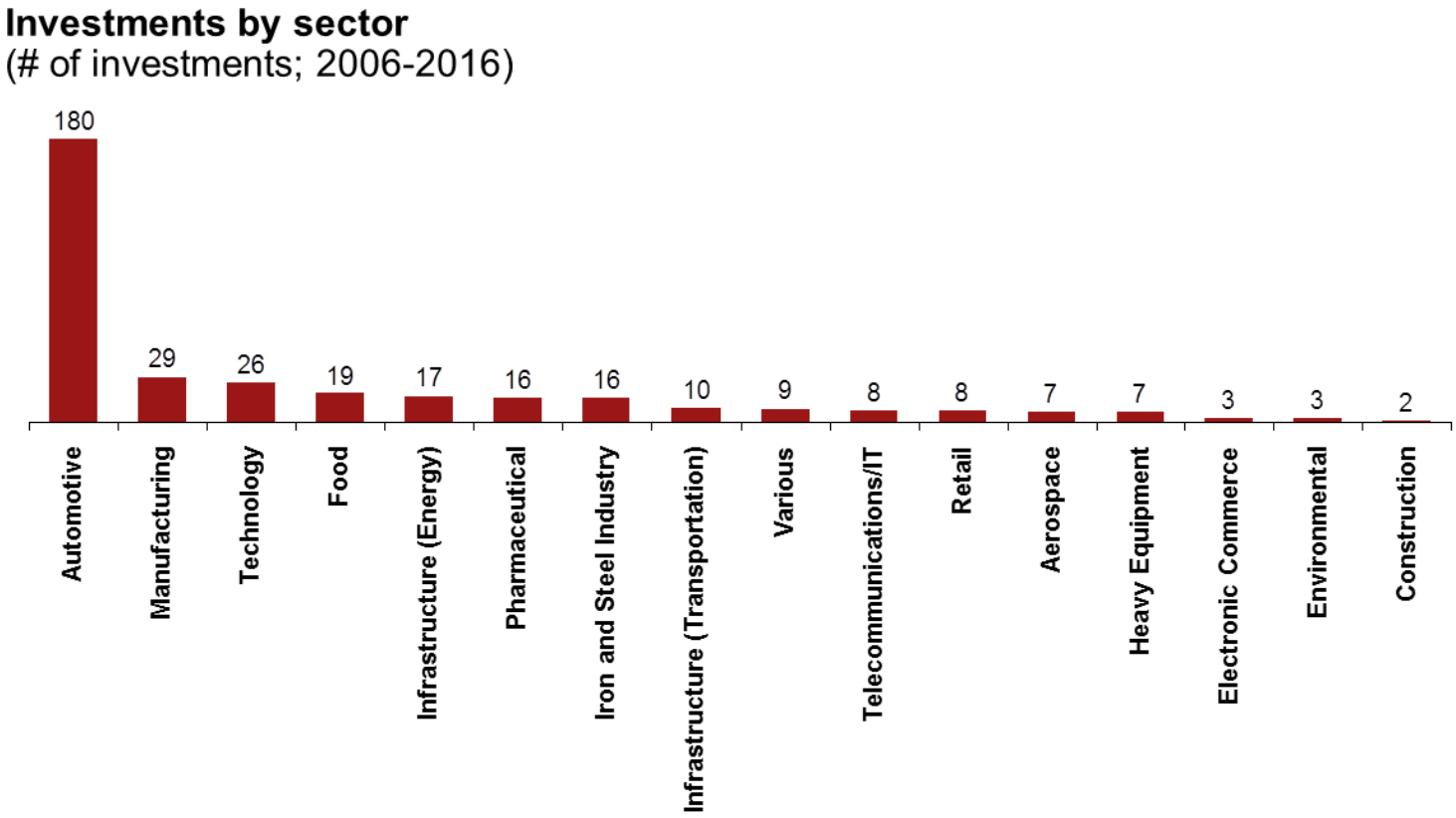


Figure 15. Investments by sector

Source: A. T. Kearney analysis

Out of the 360 investments that make up the sample, 180 of them (50%) belong to the automotive sector. Following the automotive sector comes manufacturing and technology with 29 (8%) and 26 (7%) investments respectively. A model for each of the sectors with enough data will be created further on.

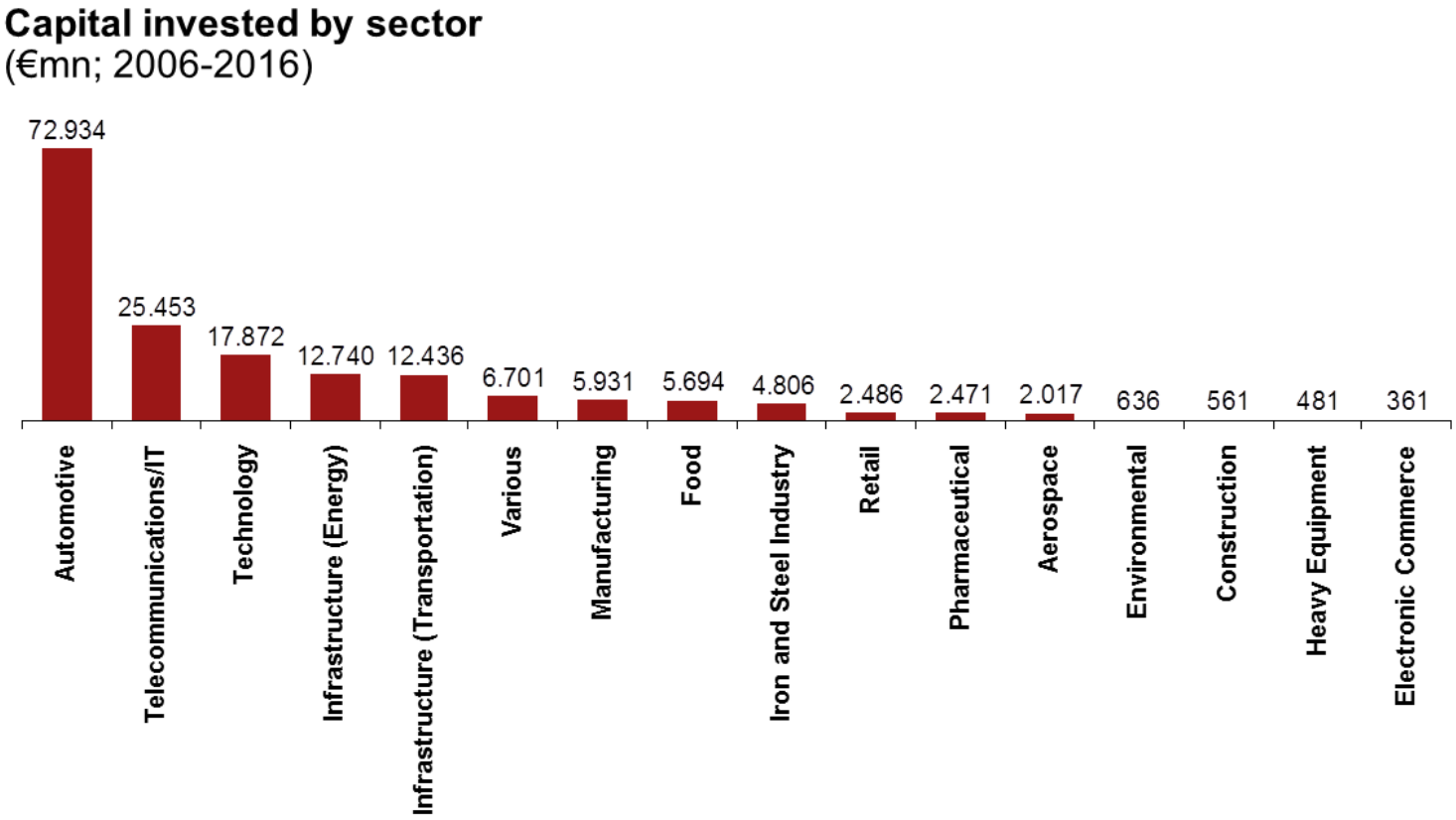


Figure 16. Capital invested by sector

Source: A. T. Kearney analysis

As expected, the automotive sector is the one responsible for the largest sum of capital invested (50% of the investments analyzed belong to this sector). However, even though Telecommunications/IT only accounts for 8 investments, it falls behind in second place regarding capital invested. The next table explains this, as on average, investments in the Telecommunications/IT sector are larger than those of the automotive sector. This may possibly be because this sector requires a greater budget to carry out an investment due to technological specifications which make it more expensive than investing in other sectors.

Sector	Capital invested (€mn)	% of total capital	Number of investments	Average capital per investment (€mn)
Automotive	72.934	42,02%	180	405
Telecommunications/IT	25.453	14,66%	8	3.182
Technology	17.872	10,30%	26	687
Infrastructure (Energy)	12.740	7,34%	17	749
Infrastructure (Transportation)	12.436	7,16%	10	1.244
Various	6.701	3,86%	9	745
Manufacturing	5.931	3,42%	29	205
Food	5.694	3,28%	19	300
Iron and Steel Industry	4.806	2,77%	16	300
Retail	2.486	1,43%	8	311
Pharmaceutical	2.471	1,42%	16	154
Aerospace	2.017	1,16%	7	288
Environmental	636	0,37%	3	212
Construction	561	0,32%	2	281
Heavy Equipment	481	0,28%	7	69
Electronic Commerce	361	0,21%	3	120

Table 10. Capital invested by sector

Source: A. T. Kearney analysis

Projects belonging to the sector of infrastructure (transportation) are on average also expensive, as they usually involve large and complex projects such as building a railway network to link two cities or building a new highway which apart from requiring a long time also requires a high cost.

Public and private investment

It is important to differentiate between investment coming from private firms and investment coming from government or public institutions. The objectives pursued are often different ones as well as the results obtained. There are also projects were private firms provide part of the investment and government are responsible for another part.

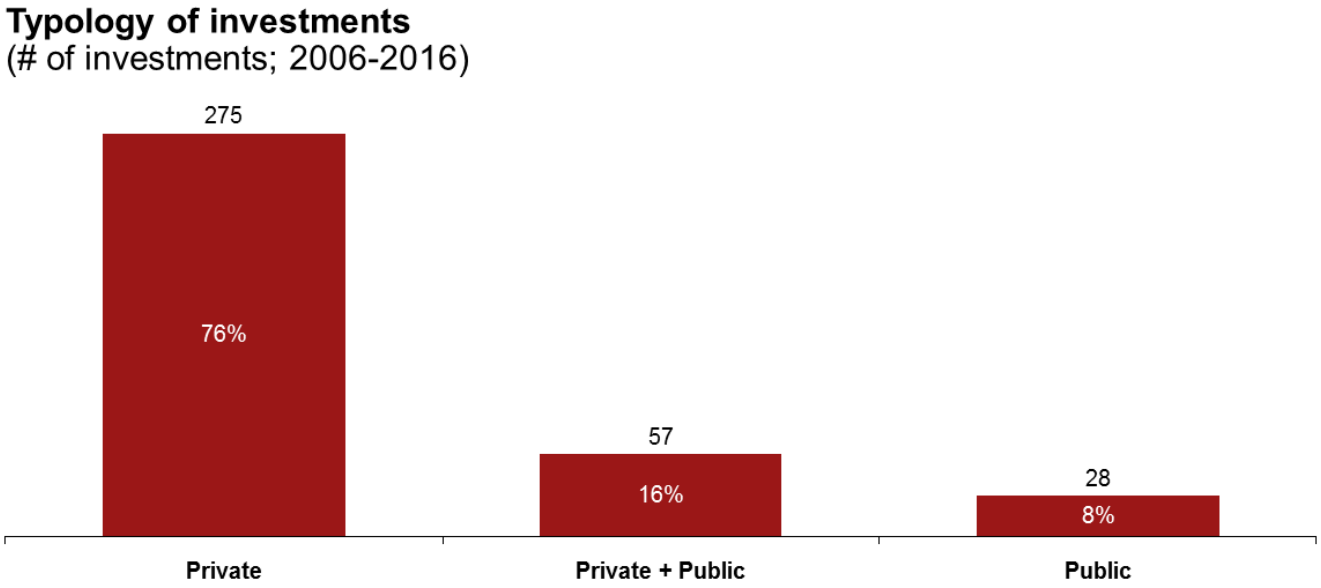


Figure 17. Typology of investments

Source: A. T. Kearney analysis

Figure 17 is a graph comparing the typology of investments in number. 275 out of the 360 (76%) investment of the sample size belong to the private sector while only 28 (8%) are public investments. However, 57 investments (16%) are private and public. In the last case, the general trend is that public governments and organizations contribute to the investment by funding part of the investment (usually a small percentage, 10%). Local governments do so because they are also interested in contributing to a more developed city. For example, if the local government of Madrid contributes 12% towards an investment in a vehicle factory, it will help creating jobs, stimulating the economy, making the city more attractive to other investors and increasing its GDP. Obviously, the objective of local governments is to rule cities in the best possible way and foster economic growth so that everyone benefits.

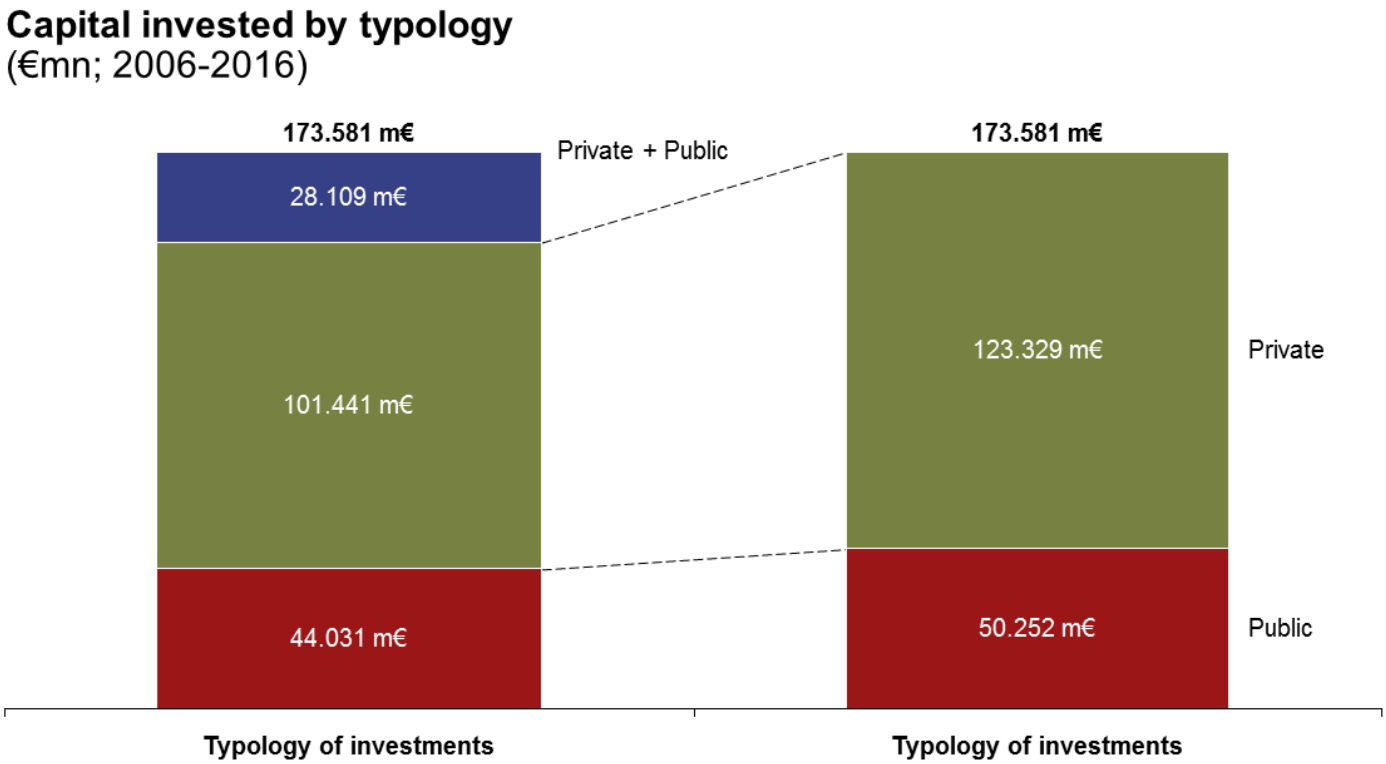


Figure 18. Capital invested by typology

Source: A. T. Kearney analysis

Analyzing capital invested by typology, and following a similar pattern as in figure 17, private investments represent 71% of the total capital, leaving public contribution to 29%.

There are in total 57 combined investments of private and public nature. These investments amount to 28.109 €mn which is divided into 21.888 €mn belonging to private funding and 6.221 €mn to public funding. On average, each combined investment is made up of 493 €mn. Analyzing the average private contribution, it results to be of 83,4% of the total sum of the investment (corresponding to 411 €mn of the 493 €mn), while the average public contribution is of 16,6% (corresponding to 82 €mn of the 493 €mn).

Results of the investment

As explained earlier on in this document, the main objective of this final project is to create a model that will be able to assess and forecast the results of an investment taking place. For this reason it is very important to study the effects produced by the investment, divided in three aspects (job creation, productivity and technological development).

Employment creation

The most important out of the three aspects of the model is employment creation. An analysis will be performed to classify employment creation by country and by sector.

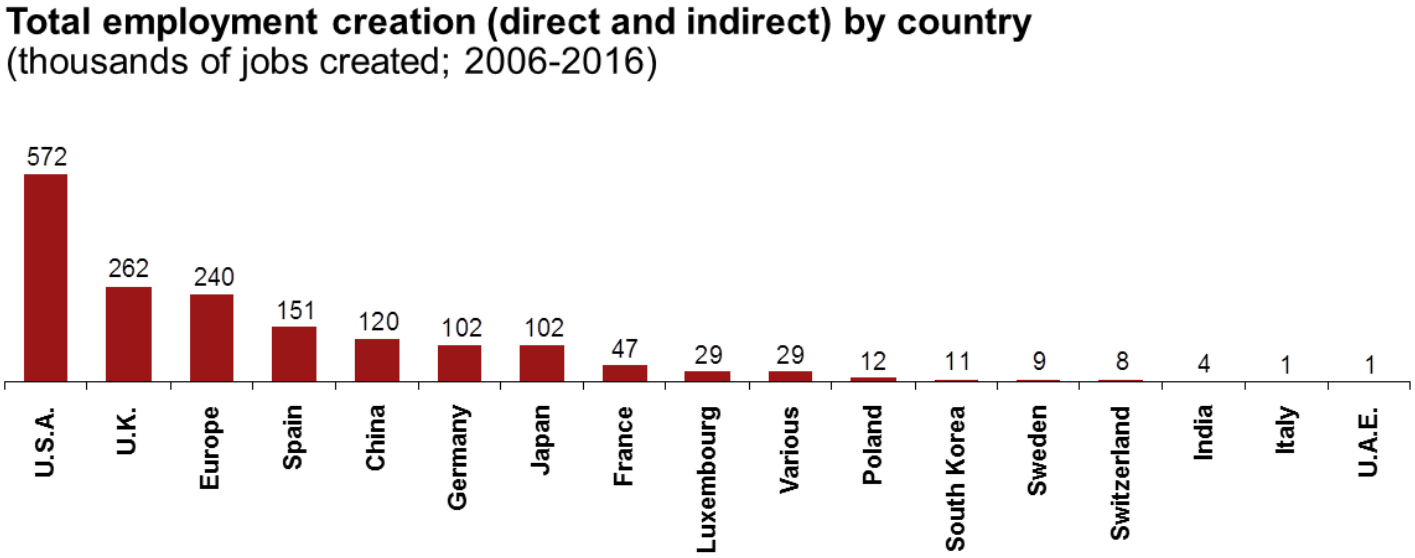


Figure 19. Job creation by country

Source: A. T. Kearney analysis

U.S.A., U.K. and Spain have been the three countries that have seen a greater employment creation within themselves. This agrees with figure 12 in which these three countries are the main targets of investments.

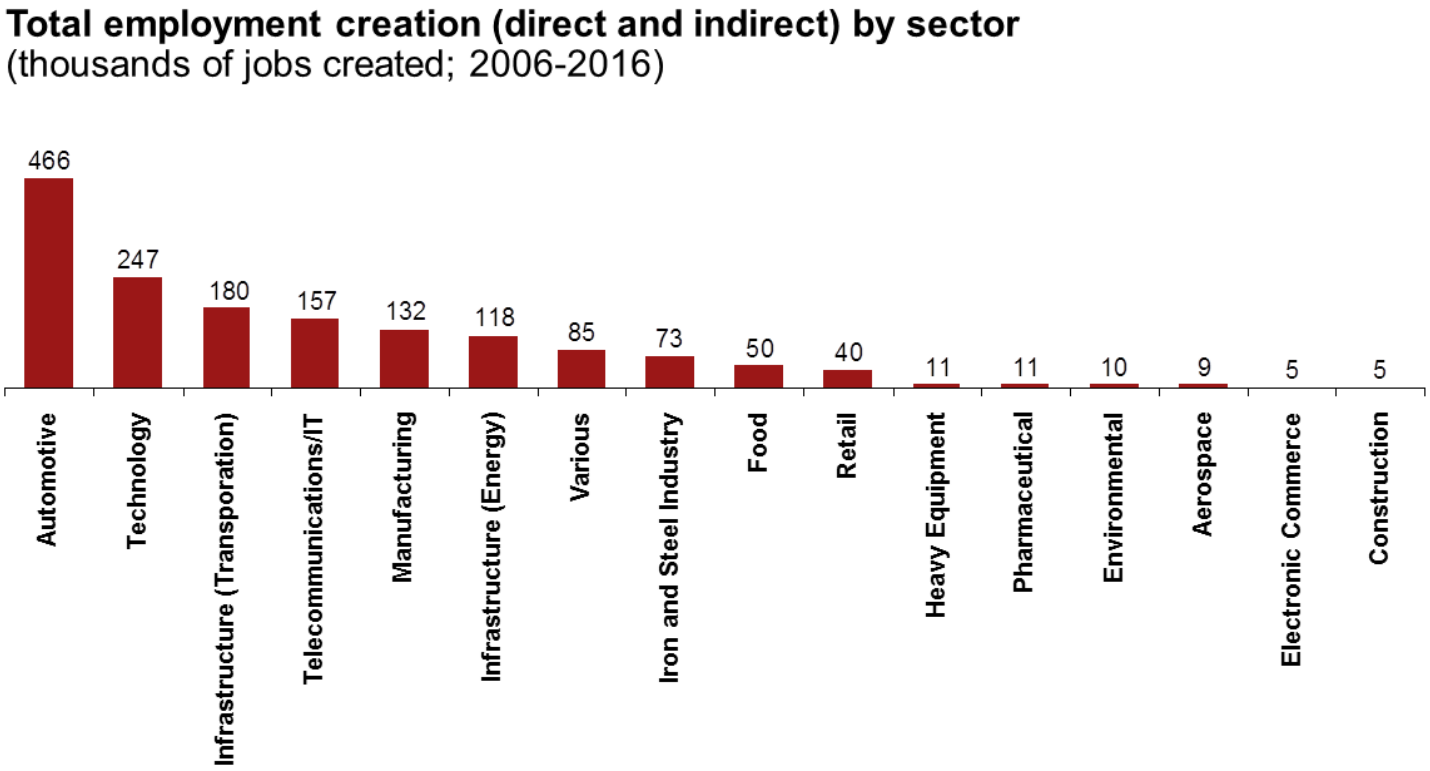


Figure 20. Job creation by sector

Source: A. T. Kearney analysis

When it comes to jobs created by sector, automotive leads the category with 466.000 jobs. The technology sector has 247.000 jobs followed by Infrastructure (Transportation) with 180.000. Figure 20 helps understanding which sectors have been the ones that have benefited most from investments when it comes to employment creation. Automotive and technology sectors have high values because there are many investments belonging to these two sectors in the sample. However, there aren't as many investments regarding the infrastructure (transportation) sector, which proves that projects of this sector tend to be complex and generate a large number of indirect employments which add up to the total number of jobs created.

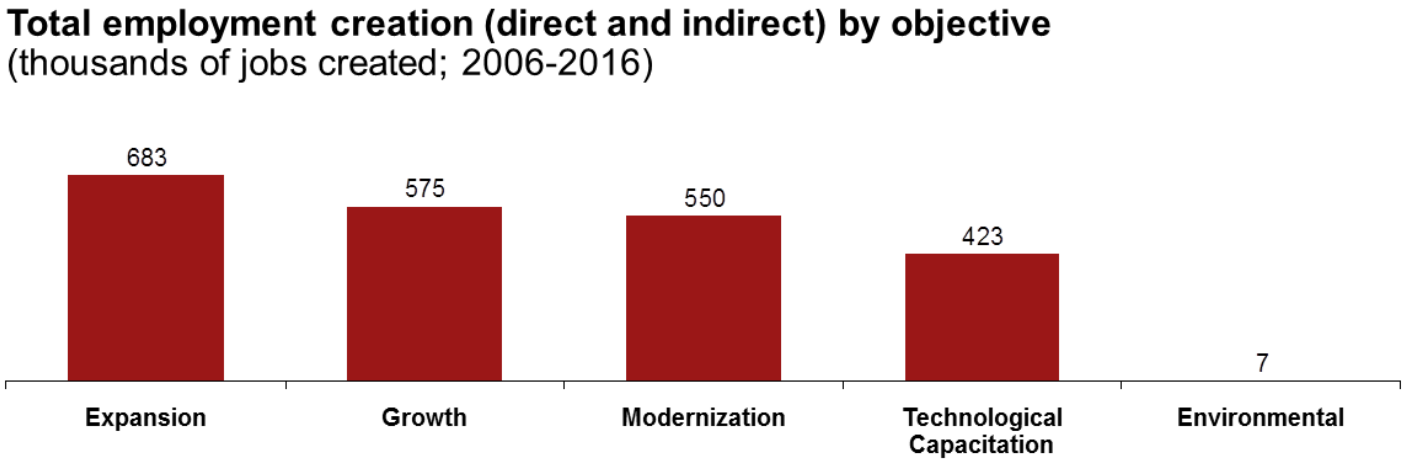


Figure 21. Investments by sector

Source: A. T. Kearney analysis

Figure 21 classifies employment creation by the objective of the investment. Expansion is the objective related to highest employment creation, followed by growth. This makes sense because as discussed previously, modernization and technological capacitation investments on average are more expensive and create a lower number of jobs for a given amount of money spent, as the main objective of these two investments is mainly the renewal of machinery and purchase of hi tech machines, while expansion and growth investments focus on hiring workers in order to increase productivity rates.

3.3. Determination of relationship between investments and their impact and model creation

Technological development

Technological development has proven to be the hardest of the three aspects to quantify when collecting investment data. Technological development is associated to technological capacitation and hence all investments pursuing this objective have had as a result technological development. Below these lines is table 11 which illustrates the number of investments that have resulted in a technology level jump.

Sector	Number of investments	Number of investments with technological development	% of investments with technological development
Automotive	180	24	13,33%
Technology	26	12	46,15%
Infrastructure (Energy)	17	5	29,41%
Telecommunications/IT	8	4	50,00%
Various	9	4	44,44%
Manufacturing	29	2	6,90%
Environmental	3	2	66,67%
Pharmaceutical	16	1	6,25%
Infrastructure (Transportation)	10	1	10,00%
Aerospace	7	-	-
Food	19	-	-
Electronic Commerce	3	-	-
Construction	2	-	-
Heavy Equipment	7	-	-
Retail	8	-	-
Iron and Steel Industry	16	-	-

Table 11. Technological development

Source: A. T. Kearney analysis

In the automotive sector, 24 out of 180 investments (13,33%) included technological capacitation. This typically meant investment in a R+D laboratory or purchasing new hi-tech machinery and upgrading facilities to produce electric vehicles for example. However, other sectors had a higher

percentage of investments with technological capacitation. Environmental, telecommunications/IT and technology investments had technological development in 66,67%, 50,00% and 46,15% of the cases respectively. This can be explained by the fact that these sectors are more dependent on the technology level and hence go through technology jumps more frequently than other industrial sectors. The telecommunications/IT sector for instance is constantly evolving as new technologies are developed, such as the transition from ADSL to optical fiber in the past years or the new 4G mobile technology which is starting to take over.

Productivity

Productivity is usually related to hiring more workers and building a new factory or expanding an existent one in order to increase production rate. Hence the most important productivity gains are associated to growth and expansion investments.

Sector	Number of investments	Number of investments with an increase in productivity	% of investments with an increase in productivity
Automotive	180	49	27,22%
Technology	26	7	26,92%
Food	19	5	26,32%
Steel and Iron Industry	16	4	25,00%
Manufacturing	29	2	6,90%
Aerospace	7	1	14,29%
Electronic Commerce	3	-	-
Telecommunications/IT	8	-	-
Construction	2	-	-
Pharmaceutical	16	-	-
Infrastructure (Energy)	17	-	-
Infrastructure (Transportation)	10	-	-
Heavy Equipment	7	-	-
Environmental	3	-	-
Retail	8	-	-
Various	9	-	-

Table 12. Productivity

Source: A. T. Kearney analysis

Table 12 reflects the results for productivity gains. The automotive, technology, food and steel and iron industry all have similar percentages of investments involving an increase in productivity, all in the range 25-27%. This means that roughly one out of every four investments analyzed clearly stated and quantified the benefits in the form of productivity.

Sector	Estimated productivity increase for every 100 €mn invested
Aerospace	10,3 airplanes per year
Food	260.000 cans per hour
Food	4.235 million bottles of soda per year
Food	357.000 tons of milk per year
Food	133.000 tons of chocolate per year
Automotive	For the automotive sector, see model
Automotive	93.000 engines per year
Automotive	92.000 transmissions per year
Manufacturing	390.000 tires per year
Manufacturing	447.000 tons of pulp paper per year
Steel and Iron Industry	724.000 tons of iron per year
Steel and Iron Industry	1.000.000 tons of metallurgical coke per year
Steel and Iron Industry	331.000 tons of metal per year
Steel and Iron Industry	182.000 tons of steel per year
Technology	6.700 batteries for electric vehicles per year
Technology	144.000 LCD screens per year

Table 13. Estimated productivity increase

Source: A. T. Kearney analysis

An analysis has been carried out to calculate the estimated productivity increases when investing 100 €mn and the results are presented in table 13. The estimated productivity values have been calculated as an average of all the data that make up the sample. For the automotive sector regarding vehicle production, a model has been created as there was enough data to do so.

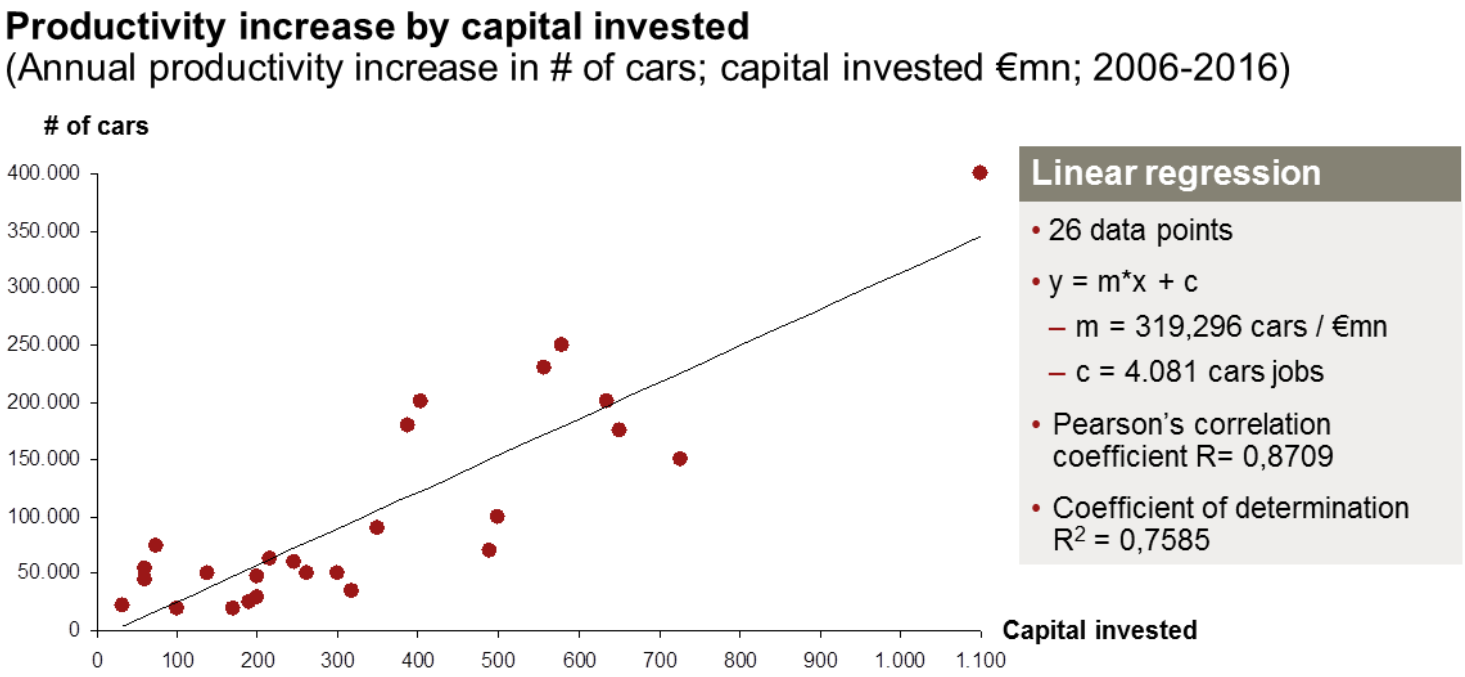


Figure 22. Automotive productivity model

Source: A. T. Kearney analysis

Model

A model has been created by means of a linear regression in order to estimate and forecast the impact of investments on employment creation, productivity and technology development. The main characteristics of the model are presented in table 14.

The structure of the model is as follows:

- Linear regression: $y = m * x + c$
- Correlation coefficient (Pearson) R
- Determination coefficient R^2

Linear regressions are a simple but effective method to estimate results based on a data sample. However, in this case, the value of the independent term c will be related to number of jobs created. For instance, this value could be 50 jobs. Mathematically speaking, the independent term c represents the interception of the regression line with the vertical axis (which in this case will be job creation). The mathematical interpretation of the

value c would mean that for a given investment of 0 €mn, 50 jobs would be created. Obviously, for the purpose of this model, this does not make sense and hence the value of c will have no special meaning other than contributing to the equation.

Pearson's correlation coefficient (R) is a parameter which is used to quantify the linear dependence between two variables (in this case, capital invested and job creation), ranging from values of -1 to 1. A value of 1 indicates a total correlation (positive gradient), a value of 0 indicates no correlation at all and a value of -1 represents that there is a negative correlation (negative gradient). Following the interests of this final project aiming to explain the relationship between capital invested and job creation, the ideal value for Pearson's correlation coefficient would be 1. However, in practice this doesn't occur, although the closer this coefficient is to 1, the better linear regression it will be.

The coefficient of determination (R^2) is a measure of how well a sample of data fits a statistical model. In other words, it is a numerical value indicating of how well the data belonging to the sample is represented by the linear regression. This coefficient is obtained by simply squaring Pearson's correlation coefficient and therefore will range between the values of 0 and 1. Once again, the ideal value to be obtained for this measurement is 1, although in practice this is almost impossible, meaning that the closer to 1 the better the linear regression will be.

As in all statistical samples, outliers have appeared and they have been removed for the purpose of the model creation in order to prevent them from distorting the values of the model as including them would reduce the precision and reliability of the model. This is because the utility of the model relies on being able to estimate the effects of investments in the majority of cases; there are always some outliers and atypical data but these are not going to be analyzed.

A comparison table for the nine models is found after the last model.

Description	Objective	Scope
• The model is based on data collected from various sources (both national and international) covering different industry sector • The automotive industry has been chosen as a focus to be of special interest because of the numerous investments it is receiving currently and being a booming sector with important technology advances	• The objective of the model is to estimate the impact of an investment on three aspects: – Employment creation (direct and indirect) – Productivity – Technological development • Thus, it will have the function of a support tool for investors when making a decision	• A large sample of 360 investments from different industry sectors has been analyzed with a focus on the automotive industry (180 investments) implying that the results provided by the model will have greater validity when applied to investments in this sector • The model consists of a linear regression and the correlation and determination coefficients have been calculated to explain the goodness of fit

Table 14. Main characteristics of the model

Source: A. T. Kearney analysis

Automotive private model (OEM)

This particular model focuses on private investments from the automotive sector which represent the companies known as OEM, Original Equipment Manufacturer. The model is presented below.

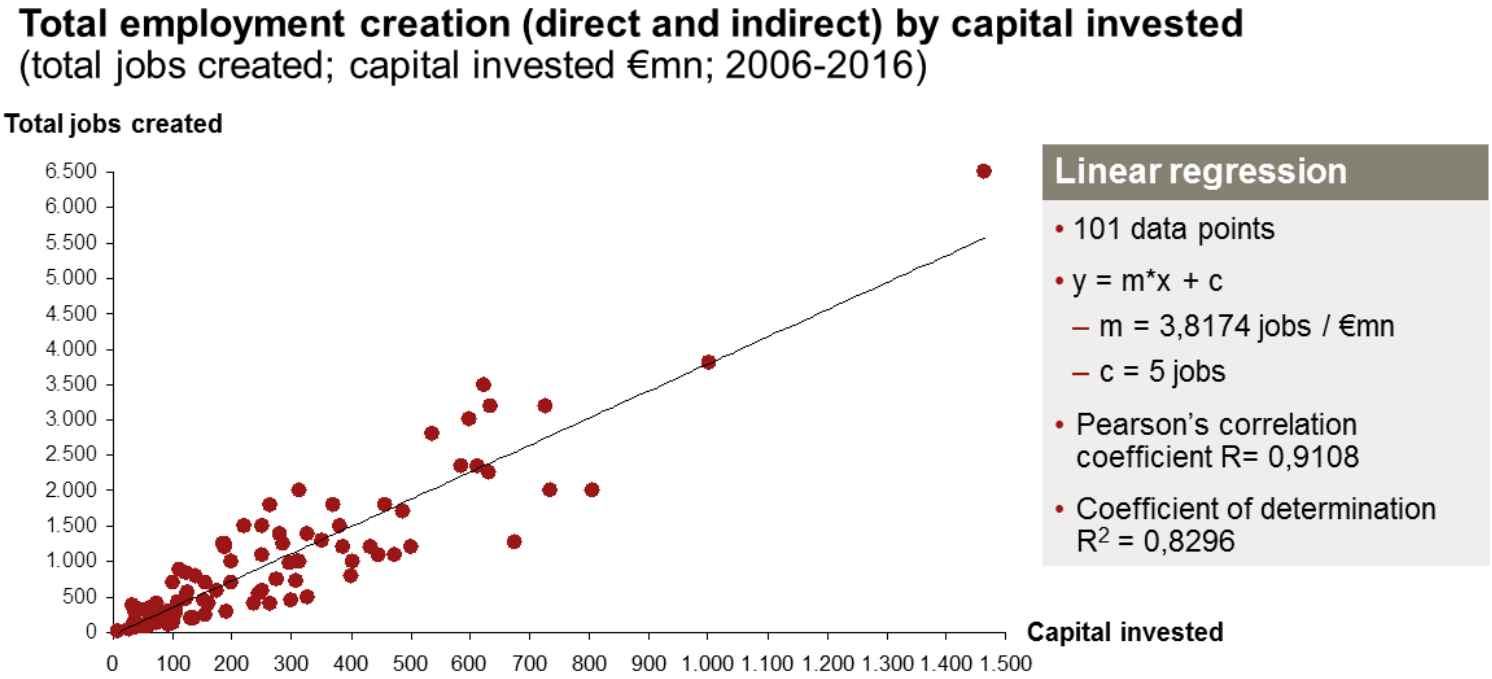


Figure 23. Automotive private model (OEM)

Source: A. T. Kearney analysis

Private model (all industry sectors)

Figure 23 represents the model for all private investments, including all the industry sectors.

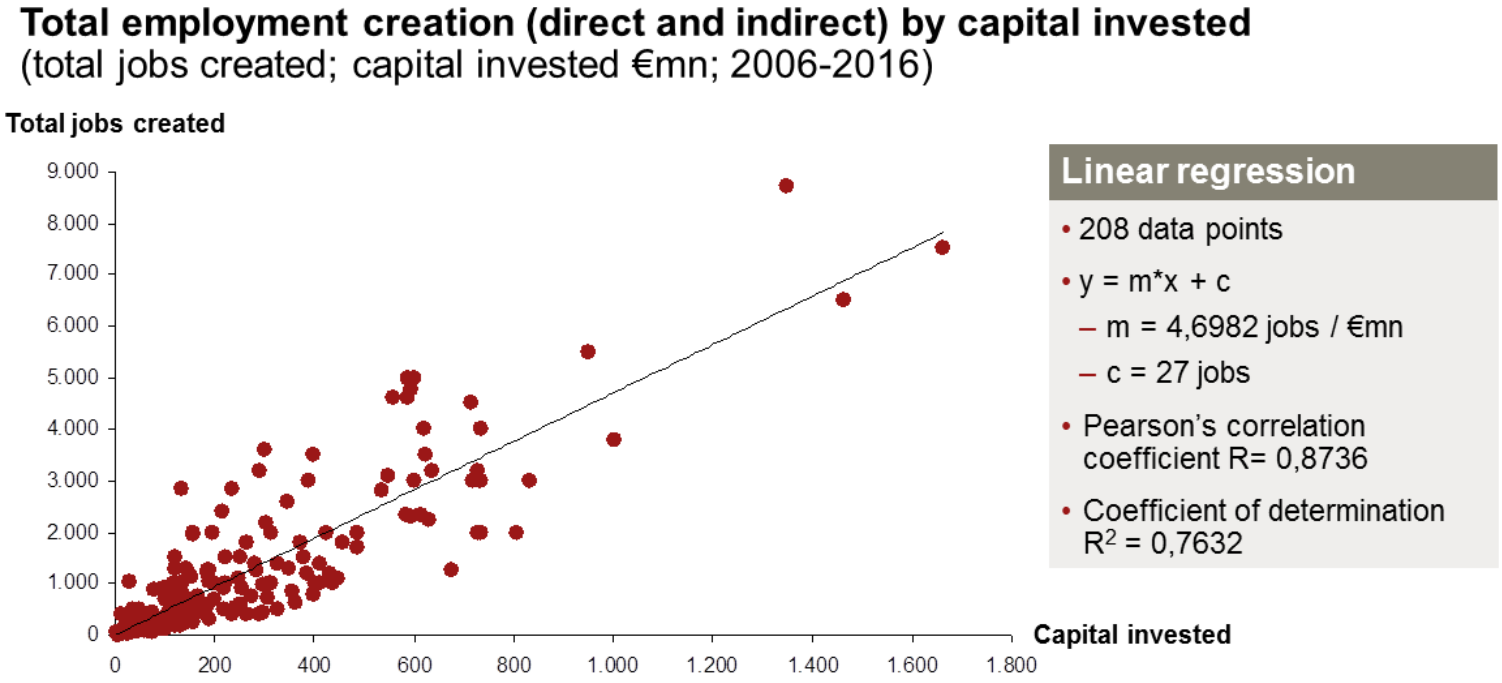


Figure 24. Private model (all industry sectors)

Source: A. T. Kearney analysis

Public model (all industry sectors)

Figure 24 represents the public model considering all industry sectors.

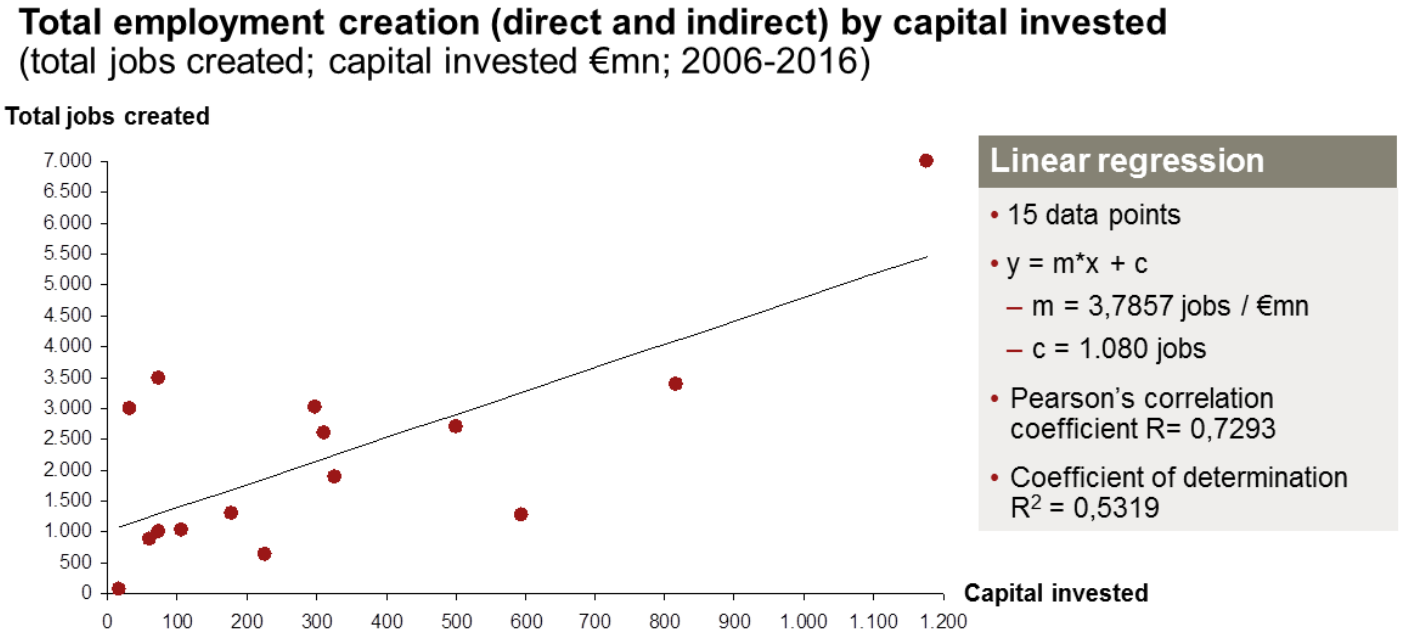


Figure 25. Public model (all industry sectors)

Source: A. T. Kearney analysis

Private + Public model (all industry sectors)

Figure 25 represents the private + public model considering all industry sectors.

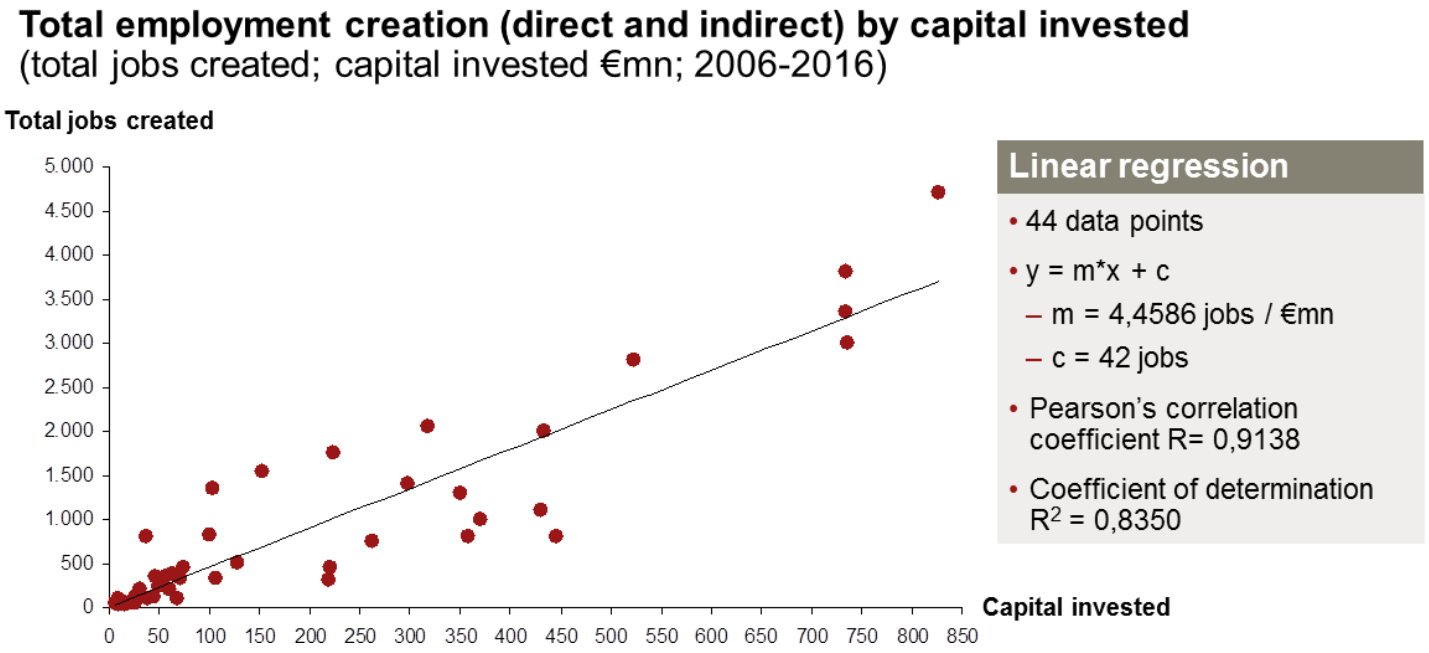


Figure 26. Private + Public model (all industry sectors)

Source: A. T. Kearney analysis

Manufacturing model (all industry sectors)

Figure 26 represents the manufacturing model considering all types of investments.

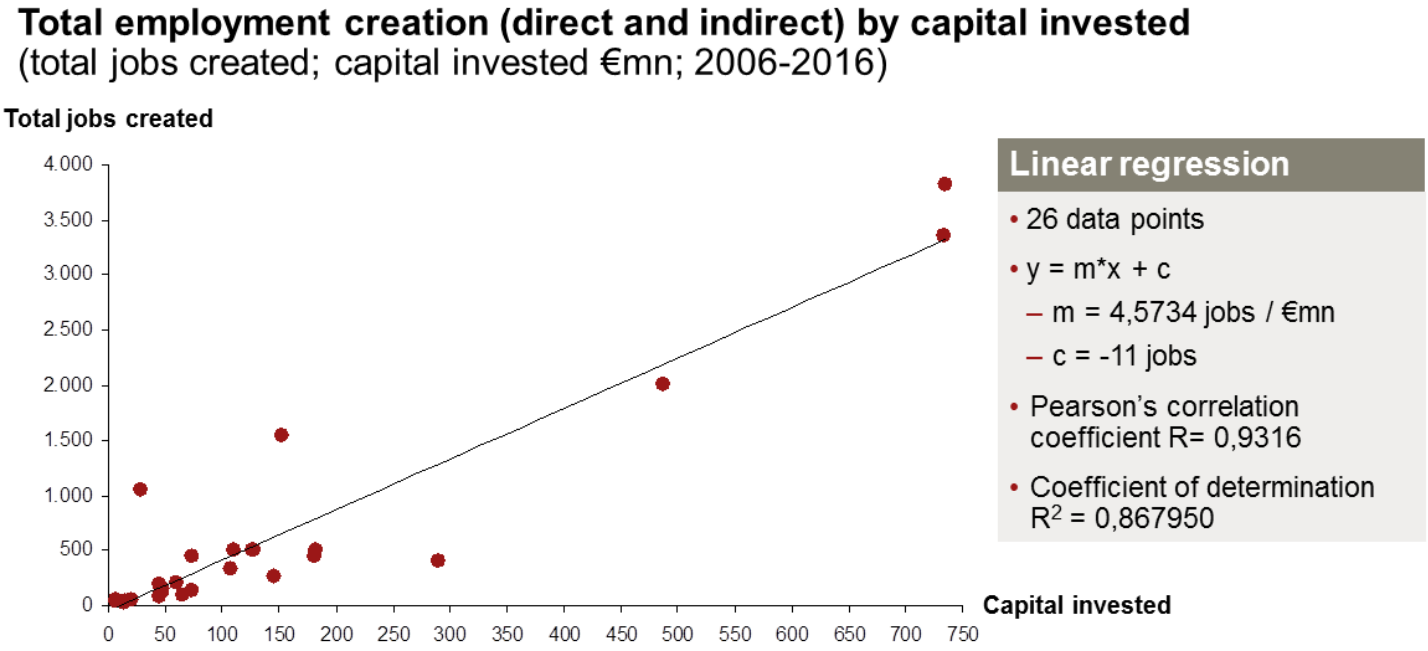


Figure 27. Manufacturing model (all industry sectors)

Source: A. T. Kearney analysis

Technology model (all industry sectors)

Figure 27 represents the technology model considering all types of investments.

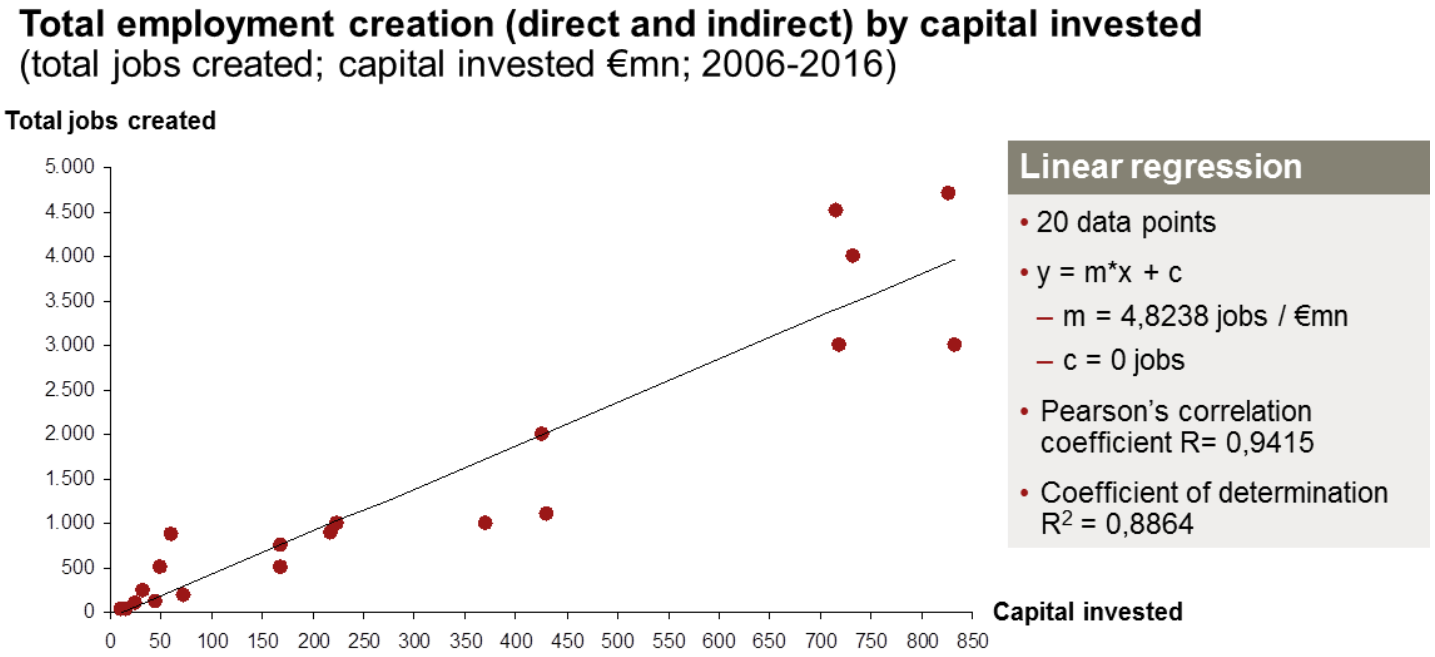


Figure 28. Technology model (all industry sectors)

Source: A. T. Kearney analysis

Infrastructure (Energy) model (all industry sectors)

Figure 28 represents the infrastructure (energy) model considering all types of investments.

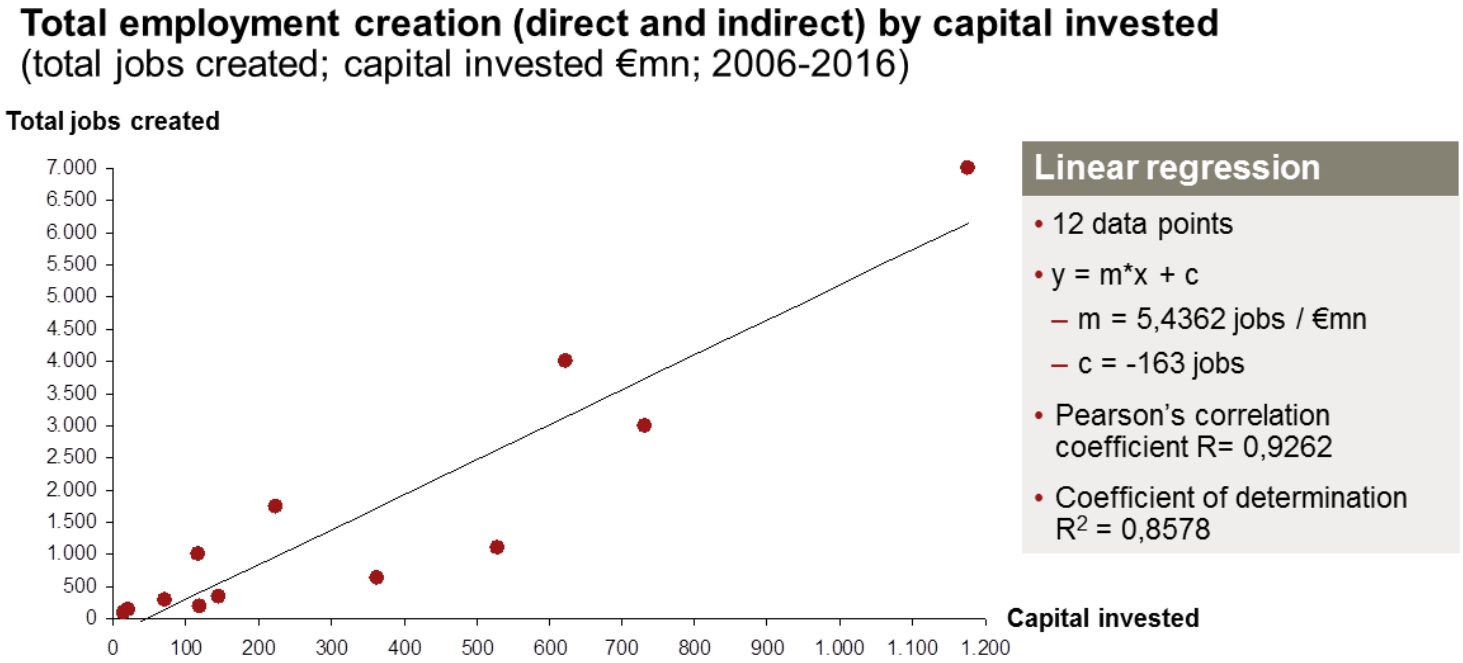


Figure 29. Infrastructure (energy) model (all industry sectors)

Source: A. T. Kearney analysis

Infrastructure (Energy) model (all industry sectors)

Figure 29 represents the pharmaceutical model considering all types of investments.

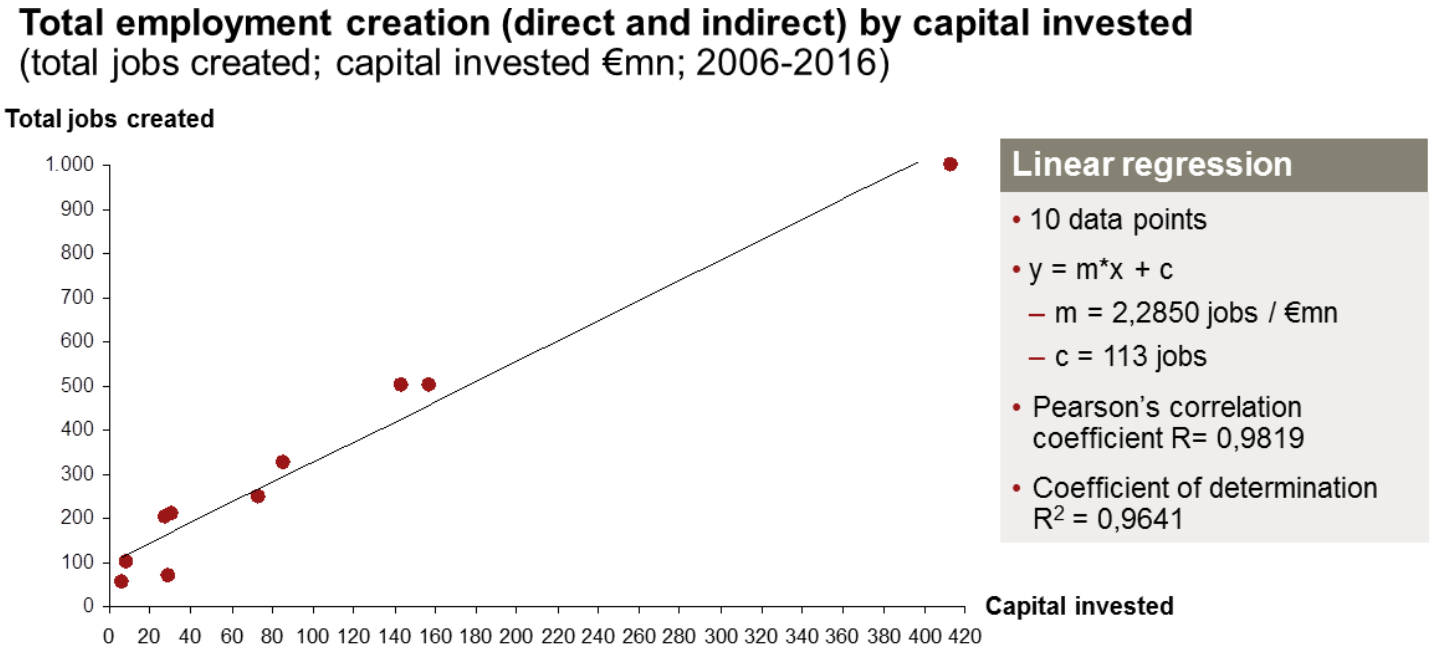


Figure 30. Pharmaceutical model (all industry sectors)

Source: A. T. Kearney analysis

Iron and Steel Industry model (all industry sectors)

Figure 30 represents the iron and steel industry model considering all types of investments.

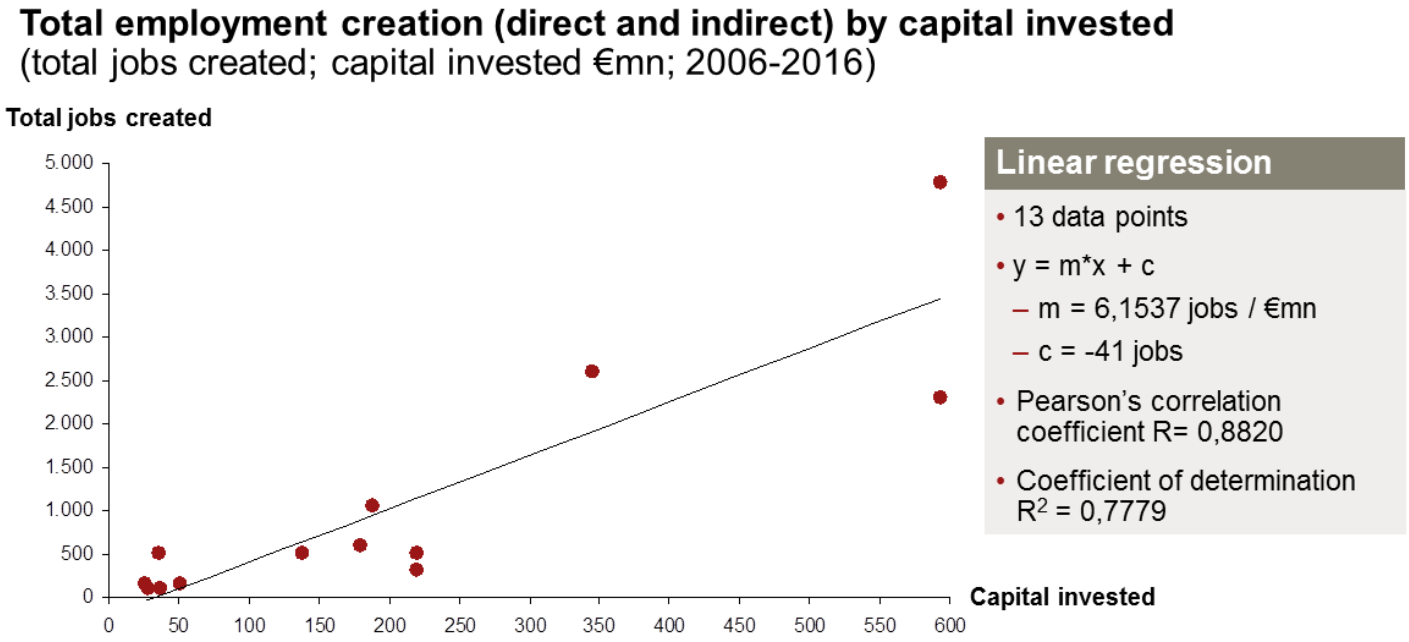


Figure 31. Manufacturing model (all industry sectors)

Source: A. T. Kearney analysis

Model summary

Having built all the different models, it is interesting to compare them and take a closer look at the values of their linear regressions in order to understand the relationship between capital invested and job creation. For this purpose, a summary table is presented below.

Automotive private model (OEM)	Private model (all sectors)	Public model (all sectors)
• 101 data points • y = m*x + c – m = 3,8174 jobs / €mn – c = 5 jobs • Pearson's correlation coefficient R= 0,9108 • Coefficient of determination R^2 = 0,8296	• 208 data points • y = m*x + c – m = 4,6982 jobs / €mn – c = 27 jobs • Pearson's correlation coefficient R= 0,8736 • Coefficient of determination R^2 = 0,7632	• 15 data points • y = m*x + c – m = 3,7857 jobs / €mn – c = 1.080 jobs • Pearson's correlation coefficient R= 0,7293 • Coefficient of determination R^2 = 0,5319
Private + Public model (all sectors)	**Manufacturing model**	**Technology model**
• 44 data points • y = m*x + c – m = 4,4586 jobs / €mn – c = 42 jobs • Pearson's correlation coefficient R= 0,9138 • Coefficient of determination R^2 = 0,8350	• 26 data points • y = m*x + c – m = 4,5734 jobs / €mn – c = -11 jobs • Pearson's correlation coefficient R= 0,9316 • Coefficient of determination R^2 = 0,867950	• 20 data points • y = m*x + c – m = 4,8238 jobs / €mn – c = 0 jobs • Pearson's correlation coefficient R= 0,9415 • Coefficient of determination R^2 = 0,8864
Infrastructure (Energy) model	**Pharmaceutical model**	**Iron and Steel Industry model**
• 12 data points • y = m*x + c – m = 5,4362 jobs / €mn – c = -163 jobs • Pearson's correlation coefficient R= 0,9262 • Coefficient of determination R^2 = 0,8578	• 10 data points • y = m*x + c – m = 2,2850 jobs / €mn – c = 113 jobs • Pearson's correlation coefficient R= 0,9819 • Coefficient of determination R^2 = 0,9641	• 13 data points • y = m*x + c – m = 6,1537 jobs / €mn – c = -41 jobs • Pearson's correlation coefficient R= 0,8820 • Coefficient of determination R^2 = 0,7779

Table 15. Summary of models

Source: A. T. Kearney analysis

Table 15 gathers all the information relevant to the models created. Therefore, an analysis of the results can prove to be very useful. The automotive private model (OEM) is made up of 101 investments which is a large number meaning that the model will be reliable. This model states that for every million euros invested, 3,81 jobs are created in this particular industry. Its corresponding Pearson's correlation coefficient is 0,9108 and its determination coefficient is 0,8296 which means that there is a very strong positive relationship between capital invested and job creation and the data of the 101 investments considered for the model is well represented by the regression line.

Comparing the private, public and private + public models (for all industry sectors) there are several differences that can help to understand the performance of these investments. The private model has the largest number of data points, 208, making it more reliable than the other two models. However, it is the private + public model the one that has best coefficients and therefore represents a more positive correlation between the variables and a better goodness of fit. When analyzing the number of jobs created for every million euros invested, the private model and the private + public models have similar values, 4,70 and 4,46 respectively. On the other hand, the public model states a value of 3,79 which is noticeably lower. These results seem to evidence that public investments are less effective than private investment when it comes to employment generation. This may be because private companies have more knowledge and expertise about their sector than local governments and hence are more effective at creating jobs.

The manufacturing and technology models are very similar in every aspect, although it seems easier to create jobs in the technology sector as for every million euros invested 4,82 jobs are created while 4,57 are created in the case of the manufacturing sector. They both have strong correlations and high values of goodness of fit meaning.

The last three models, infrastructure (energy), pharmaceutical and iron and steel industry models have different results. The pharmaceutical model has

very high values for both coefficients (the best out of the nine models in total) very close to 1, while the other two models have slightly lower coefficients although they still are very good numbers. However, big differences appear when comparing job creation. Iron and steel industry leads with 6,15 jobs per million euros invested, followed by infrastructure (energy) with 5,44 jobs and very far behind falls the pharmaceutical model with only 2,29 jobs. Even though these figures are very different, they actually do make sense, as in the iron and steel industry is a more manual sector where large number of workers are required for the extraction of iron ore for example. On the other side, the pharmaceutical industry is more dependent on technology and complex machinery and the production processes are highly automated, so less workers are required (mainly for supervision tasks) and capital is mainly invested on machinery. These reasons explain the big differences in job creation.

Direct and indirect job creation

Apart from total job creation, it is also of great importance to know the impact that every job has on the economy by means of leading to indirect jobs. Knowing this will allow to estimate the economic impact of any investment on the local economy by taking into account all the jobs created: those directly belonging to the investment and those generated indirectly. Table 16 below exhibits the indirect to direct job creation ratios for different industry sectors.

Sector	Indirect to direct job creation ratio
Iron and Steel Industry	4,652
Food Industry	4,512
Infrastructure (Energy)	4,101
Automotive	3,577
Infrastructure (Transportation)	3,505
Aerospace	3,167
Technology	3,066
Heavy Equipment	2,701
Manufacturing	2,515
Telecommunications/IT	2,509
Pharmaceutical	2,255

Table 16. Indirect to direct job creation ratio

Source: A. T. Kearney analysis

The number of indirect jobs generated by every direct job varies from 4,652 in the iron and steel industry to 2,255 in the pharmaceutical industry. This means that investments in the iron and steel industry will create more than double the number of indirect jobs than investments in the pharmaceutical industry. Hence, the first one will generally have a larger impact on the local economy and foster economic growth in a more intensive way.

In the case of the automotive sector, results state that 3,577 indirect jobs come with the creation of every direct job. This is in line with other information sources such as Hyundai's corporate website which announces that this ratio is 3,8 for every job they create in their businesses in U.S.A.. This same website also states that the average cost of developing a new car in a factory is approximately 500 €mn.

4. Elaboration of conclusions and recommendations

This final phase will aim to write a series of conclusions based on the behavior of the model and regarding other aspects. Having created the model, the next logical step is analyzing its functionality. This will help to understand better how the investment models works and hence will be a useful piece of information for investors using this tool. Conclusions will not only be written on the performance of the model but also on the segmentation of investments carried out in the previous chapter and on the relationship studied between investments and the effects produced on the three areas of interest (technological development, productivity and employment creation). Finally, as the final product of this project is the investment model itself, a set of recommendations addressed at the investors will be written to present some pieces of useful advice to them.

At the same time, this chapter may be divided into sub-questions that will make it easier to focus on each particular aspect of the investments. In this case, it has been decided to address the following sub-issues:

1- Conclusions on segmentation of investments
2- Conclusions on relationship between investments and their impacts
3- Conclusions on best practices
4- Next steps and future development

4.1. Conclusions on segmentation of investments

Having analyzed thoroughly the sample of investments, the next logical step is to obtain the correspondent conclusions. A large effort has been put into collecting as much raw data as possible (reaching 360 investments for the database) in order to make the models as reliable as possible given the timeframe for this final project.

A total of 31 different sources of information have been considered when collection data, including press, reports, governments, organizations and associations and other institutions. This has been done to cover the largest possible range of information and to get an insight from different points of view.

The analysis of the starting dates of investments suggests that the economic crisis is slowly disappearing from investors' mind and companies are feeling more confident about the future and therefore the number of investments is expected to increase gradually over the next years and so will do the total volume of capital invested. This will have repercussion on indicators such as FDI as it will slowly increase in the near future following the recovery of the global economy.

When observing the most popular objectives pursuit by investments, the initial hypothesis has been confirmed by the results as growth and expansion investments have been the main reasons behind investors' decisions, whose main will is to increase productivity rates at the lowest cost. Technological capacitation and modernization investments tend to occur less frequently as they involve renewal of machinery (and companies seek to amortize machinery which may take some time due to its expensive nature) and require a larger sum of capital on average.

The most industrialized and economically developed countries have been the ones responsible for investing the most capital and hence play the main role. These countries have been U.S.A., U.K., Japan, Germany and Spain,

accounting for 75% of total investment. Some of these countries do appear again in top positions when analyzing the destination of investments. U.S.A., U.K. and Spain stay at the top but other countries such as Canada, Mexico, China, Poland, India and Brazil are close. The more economically developed countries do invest at a national level but they also seek other investment opportunities that can arise internationally. A clear example is countries that offer relatively low labor costs and attract the attention of investors. These could be countries like China, India and Mexico that are attracting large sums of capital invested from investors looking for low production costs. Furthermore, due to increasing globalization it is easier and more frequent to invest abroad. Less entry barriers and free trade agreements are fostering FDI figures to increase. In the case of the sample, 59% of the investments were at an international level.

The analysis of the typology of investments revealed that private companies are responsible for the great majority of capital invested. When governments or other public organizations participate in an investment project, they usually fund part of a private investment rather than venture themselves into an investment on their own. Their share in private investments that they fund is around 16%. Governments and public organizations are obviously not related to any private company but rather pursue economic growth of the local economy as a whole. This is why they support investments in order to foster growth of the local economy by creating new jobs (both direct and indirect), and this will further increase the attractiveness of the location to receive more investments.

Expansion and growth investments have been responsible for the greatest employment creation (direct and indirect) due to the nature of these types of investments, focusing mainly on hiring more workers to increase productivity rate. Modernization and technological capacitation investments have created a lower number of jobs as the renewal of a machine will have less impact on creating direct jobs than carrying out an expansion investment of a factory and hiring workers for the new factory.

All these conclusions extracted from the analysis of the database allow to understand better the investment market and the general trends that characterize the market.

4.2. Conclusions on relationship between investments and their impacts

A total of ten models have been created: one to estimate productivity gains in the automotive sector by capital invested and the remaining nine models cover different combinations of typology (private, public, private + public investments) and the different industry sectors.

Out of the nine job creation models, the private automotive (OEM) model is the one of greatest interest due to the focus of the final project on this sector. Private companies are constantly investing money in their factories and the model

Productivity gains from performing investment have been quantified for different sectors. Table 13 in chapter 3 exhibits the estimated productivity increases for a variety of sectors for every 100 €mn invested. Productivity increases across different industry sectors cannot be compared (as producing a computer screen is not the same as building an airplane, for example). In the case of the automotive sector, a linear regression model has been developed to assess the annual productivity increase by capital invested.

Technological development has been the hardest of the three aspects to quantify. This kind of development is associated with researching new technologies and advancing to the next technological level. This means that investment must be made into R+D laboratories and in the purchase of new hi tech machinery that will allow the production of next generation products. A clear example of this can be currently found in the automotive sector where companies are strongly investing in the development of electric vehicles which will become a trend in the near future. The German based company BMW is not only investing in small urban vehicles such as its new BMW i3 electric vehicle but is already moving onto developing luxurious sport cars as its i8 model.

This part of the analysis corresponding to the impact of investments is the most important of the final project as it will allow investors to estimate and

become acquainted about the predicted results derived from their investments in the three aspects considered throughout the whole document: job creation, productivity and technological development. The output from this final project will enable investors to use it as a forecast tool for a variety of industry sectors and therefore has a high potential of being helpful for investors in different markets and situations.

4.3. Conclusions on best practices

Upon completion of this final project, it is also important to elaborate a set of best practices identified. Some of them belong to the public sector and others to the private sector.

An analysis of 30,000 high value-added FDI projects ("Global Investment Promotion Best Practices, 2012", International Finance Corporation) showed that governments that provided information significantly influenced investor decisions to locate in one economy or another. This concept is known as investment facilitation, and it is the responsibility of governments to look after their local economies and do the best they can to attract investors. The same source of information states that for a private sector minded culture it is important to build a staff with both public and private sector experience. Another policy that can increase the attractiveness of a certain location is what is called Online Investment Promotion. Frequently, financial data offered at local economies websites' is not clear and may lead to confusion. This factor obviously acts as a barrier for potential investors. Hence, it is very important to expose financial data and reports in a very clear and intuitive way to avoid losing investment opportunities.

Governments can also help in other ways. Investors sometimes face entry barriers in the form of legal and regulatory policies which negatively affect investment opportunities. Hence, governments can work on reducing legal and regulatory requirements enhancing the attractiveness of their local economies. If governments over-protect their local economies with harsh entry barriers for foreign investments their local market will become less competitive and may lead to slower economic growth. The political and legal environment of a country is definitively another important factor considered by investors. Another case regarding employment creation is happening right now in Spain. Firing costs currently seem too high for the economic situation that is being experienced. With an unemployment rate at approximately 26%, Spain urgently needs to create jobs at a large scale. However, the

Organization for Economic Co-operation and Development (OECD) recommends the Spanish government to reduce firing cost in order to enable and foster job creation. This is another example of how governments can contribute to higher employment generation from investments, as the labor costs would be reduced.

Out of the sample of investments, an important number were private investments supported by public funding. Governments providing grants to private investments will logically attract more investment into the region, so this practice is recommended as it will foster local economic growth.

In order to enhance productivity gains derived from an investment, it is important to count with a skilled and specialized work force. To achieve this, companies should invest in human capital by means of training courses for example, and these training courses should be carried out periodically to grant workers a continuous learning curve. Not only technical knowledge is important but also knowledge of languages is vital to attract investment. A company that has a workforce with an adequate English level will definitively be more attractive for investors, especially due to an increasing globalization.

4.4. Next steps and future development

Upon completion of this final project, it is also important to elaborate a set of guidelines for a future continuation, providing insight and a series of next steps.

Among all the car manufacturing companies, there is a clear difference between competitive strategies of the different companies. Some companies focus on a price – quality strategy while the more luxurious car makers seek to build the most powerful and distinctive vehicles. Therefore, due to the differences between car companies, it could be interesting to classify car makers following a competitive strategy criteria. Car manufacturers from different categories will probably experience different results from investments. A starting point could be the classification of car makers following Bowman's strategy clock, making groups of companies of similar strategies and characteristics. Then, a model for each of these different groups could be built, relating investments to both employment creation and productivity. These new models would be more precise and reliable as instead of being based on the whole automotive industry, they are focused on specific segments of the industry. Another similar approach to this idea would be classifying investment results by type of car (compact, utility, SUV, sports, luxury, etc…).

Type of employment could also be the subject of a future development. It could be interesting to make focus on the number of jobs created by type. For instance, a classification could be made distinguishing between jobs created by the education level required, such as PhD, Bachelor degree, high school, etc… A model could be created in order to estimate how many jobs of each type would be created as a result of an investment. This idea would mainly apply to the estimation of direct jobs, as it currently seems complicated to estimate jobs created by type for indirect jobs.

5. Appendices

This chapter includes the appendices relevant for the completion of this final project.

There are two appendices:

- A: List of largest manufacturing companies by revenue
- B: Linear regression model parameters

Appendix A: List of largest manufacturing companies by revenue

Company	Industry	Revenue ($ mn)	Headquarters
Toyota	Automotive	235,364	Japan
Volkswagen Group	Automotive	221,551	Germany
Samsung Electronics	Electronics	148,944	South Korea
Daimler	Automotive	148,139	Germany
General Electric	Engineering, various	147,616	United States
Ford	Automotive	136,264	United States
Hewlett-Packard	Electronics	127,245	United States
Hitachi	Engineering, various	122,419	Japan
Nissan	Automotive	119,166	Japan
Hon Hai Precision Industry	Electronics	117,514	Taiwan
Exor	Automotive	117,297	Italy
Siemens	Engineering, various	113,349	Germany
Apple	Electronics	108,249	United States
IBM	Electronics	106,916	United States
Cardinal Health	Pharmaceuticals	102,644	United States
BASF	Chemicals	102,194	Germany
Honda	Automotive	100,664	Japan
Panasonic	Engineering, various	99,373	Japan
BMW	Automotive	95,692	Germany
ArcelorMittal	Steel	94,444	Luxembourg
Nestle	Food & Beverages	94,405	Switzerland
Peugeot	Automotive	83,305	France
Procter & Gamble	Consumer goods	82,559	United States
Sony	Electronics	82,237	Japan

Company	Industry	Revenue ($ mn)	Headquarters
Toshiba	Engineering, various	77,261	Japan
Bosch	Engineering, various	71,600	Germany
Sinochem	Chemicals	70,990	China
Mitsubishi	Engineering, various	70,492	Japan
Hyundai Motor Company	Automotive	70,227	South Korea
ThyssenKrupp	Steel	68,791	Germany
Boeing	Aerospace & Defence	68,735	United States
EADS	Aerospace & Defence	68,310	Europe
Pfizer	Pharmaceuticals	67,932	United States
SAIC Motor	Automotive	67,255	China
Mitsui	Engineering, various	66,512	Japan
PepsiCo	Food & Beverages	66,504	United States
Rosatom	Atomic Energy	66,500[1]	Russia
Johnson & Johnson	Personal care products	65,030	United States
Unilever	Consumer goods	64,610	United Kingdom
Dongfeng Motor Group	Automotive	62,911	China
POSCO	Steel	62,230	South Korea
Dell	Electronics	62,071	United States
Caterpillar	Construction equipment	60,138	United States
Dow Chemical	Chemicals	59,985	United States
Novartis	Pharmaceuticals	59,375	Switzerland
Renault	Automotive	59,272	France
Saint-Gobain	Building materials	58,560	France
United Technologies	Engineering, various	58,190	United States

Company	Industry	Revenue ($ mn)	Headquarters
FAW Group	Automotive	57,003	China
Fujitsu	Electronics	56,582	Japan
China Minmetals	Metals	54,509	China
Kraft Foods	Food & Beverages	54,365	United States
Intel	Electronics	53,999	United States
Nokia	Electronics	53,753	Finland
Nippon Steel	Steel	51,812	Japan
LyondellBasell	Chemicals	51,035	Netherlands
Bayer	Pharmaceuticals	50,790	Germany
SABIC	Chemicals	50,639	Saudi Arabia
Hoffmann-La Roche	Pharmaceuticals	49,714	Switzerland
LG Electronics	Electronics	48,977	South Korea
Sanofi	Pharmaceuticals	48,746	France
Hyundai Heavy Industries	Engineering, various	48,485	South Korea
Norinco	Engineering, various	48,154	China
Merck & Co.	Pharmaceuticals	48,047	United States
AB Volvo	Automotive	47,814	Sweden
Lockheed Martin	Aerospace & Defence	46,692	United States
Coca-Cola	Food & Beverages	46,542	United States
Mitsubishi Electric	Engineering, various	46,094	Japan
Koc Holding	Consumer durables	45,098	Turkey
Wilmar International	Food & Beverages	44,710	Singapore
Canon Inc.	Electronics	44,631	Japan
GlaxoSmithKline	Pharmaceuticals	43,907	United Kingdom

Company	Industry	Revenue ($ mn)	Headquarters
Cisco Systems	Telecommunications equipment	43,218	United States
China South Industries Group	Automotive, Electronics	43,160	China
Continental	Tyres	42,416	Germany
Sumitomo	Engineering, various	41,301	Japan
Aviation Industry Corporation of China	Aerospace & Defence	40,835	China
Johnson Controls	Engineering, various	40,833	United States
Mitsubishi Chemical Holdings	Chemicals	40,632	Japan
JFE Holdings	Steel	40,104	Japan
Denso	Engineering, various	39,954	Japan
Anheuser-Busch InBev	Food & Beverages	39,046	Belgium
Kia Motors	Automotive	38,988	South Korea
Abbott Laboratories	Pharmaceuticals	38,851	United States
Hebei Iron & Steel	Steel	38,722	China
DuPont	Chemicals	38,719	United States
NEC	Telecommunications equipment, Electronics	38,462	Japan
ABB	Engineering, various	37,990	Switzerland
Bridgestone	Tyres	37,943	Japan
Quanta Computer	Electronics	37,770	Taiwan
China Metallurgical Group	Engineering, various	37,613	China
Honeywell	Engineering, various	37,059	United States
JBS S.A.	Food & Beverages	36,921	Brazil
Heraeus Holding	Engineering, various	36,406	Germany
Ingram Micro	Electronics	36,329	United States
Shougang Group	Steel	36,117	China

Company	Industry	Revenue ($ mn)	Headquarters
Aluminum Corporation of China	Aluminium	35,839	China
Mitsubishi Heavy Industries	Engineering, various	35,727	Japan
Oracle Corporation	Electronics	35,622	United States
Royal Philips Electronics	Electronics	35,152	Netherlands
Ericsson	Telecommunications equipment, Electronics	34,958	Sweden
Tata Motors	Automotive	34,575	India
Wuhan Iron & Steel	Steel	34,260	China
Christian Dior	Luxury goods	34,244	France
AstraZeneca	Pharmaceuticals	33,591	United Kingdom
Ineos	Chemicals	33,160	Luxembourg
George Weston Limited	Food & Beverages	32,735	Canada
General Dynamics	Defence	32,677	United States
Tyson Foods	Food & Beverages	32,266	United States
Jiangsu Shagang Group	Steel	32,097	China
John Deere	Agricultural equipment	32,013	United States
Suzuki Motor	Automotive	31,817	Japan
Huawei	Telecommunications equipment, Electronics	31,543	China
Schneider Electric	Engineering, various	31,128	France
Sharp Corporation	Electronics	31,104	Japan
Philip Morris International	Tobacco	31,097	United States
China National Building Material Company	Building materials	30,022	China
Sinomach	Engineering, various	29,846	China
3M	Engineering, various	29,611	United States
Lenovo	Electronics	29,574	China

Company	Industry	Revenue ($ mn)	Headquarters
Alfresa Holdings	Pharmaceuticals, Medical equipment	29,551	Japan
Flextronics	Electronics	29,470	Singapore
Aisin Seiki	Automotive components	29,183	Japan
Michelin	Tyres	28,809	France
Magna International	Automotive components	28,748	Canada
BAE Systems	Defence	28,624	United Kingdom
L'Oreal	Cosmetics	28,286	France
COFCO	Food & Beverages	28,190	China
Northrop Grumman	Aerospace & Defence	28,058	United States
Henan Coal & Chemical	Chemicals	27,919	China
Fujifilm	Photographic equipment	27,804	Japan
Tata Steel	Steel	27,739	India
ChemChina	Chemicals	27,707	China
Alstom	Engineering, various	27,417	France
Danone	Food & Beverages	26,861	France
Sumitomo Electric Industries	Electrical cable	26,082	Japan
International Paper	Pulp & Paper	26,034	United States
China Electronics	Electronics	26,023	China
Japan Tobacco	Tobacco	25,759	Japan
Mazda Motor	Automotive	25,749	Japan
China Shipbuilding Industry Corporation	Shipbuilding	25,145	China
CRH	Building materials	25,141	Ireland
Komatsu Limited	Construction equipment	25,099	Japan

Appendix B: Linear regression model parameters

Automotive Private Model (OEM)

Regression Statistics	
Multiple R	0,910818818
R Square	0,829590919
Adjusted R Square	0,827869615
Standard Error	418,1066954
Observations	101

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	84252092,33	84252092,33	481,954956	7,9727E-40
Residual	99	17306507,67	174813,2088		
Total	100	101558600			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-23,13380604	60,56029649	-0,381996248	0,703282892	-143,2985729	97,03096086
X Variable 1	3,817366265	0,173884394	21,95347253	7,9727E-40	3,472341902	4,162390627

Private Model (all sectors)

Regression Statistics	
Multiple R	0,873571505
R Square	0,763127174
Adjusted R Square	0,761977306
Standard Error	692,849713
Observations	208

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	318586215,5	318586215,5	663,6649747	2,38564E-66
Residual	206	98888389,31	480040,7248		
Total	207	417474604,8			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	10,41038407	65,61902354	0,158648872	0,874100943	-118,9605832	139,7813514
X Variable 1	4,696264048	0,182296386	25,76169588	2,38564E-66	4,336858216	5,05566988

Public Model (all sectors)

Regression Statistics	
Multiple R	0,729289839
R Square	0,53186367
Adjusted R Square	0,495853183
Standard Error	1215,582867
Observations	15

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	21824307,53	21824307,53	14,76968836	0,002033829
Residual	13	19209342,2	1477641,708		
Total	14	41033649,73			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1011,922096	444,4197913	2,276951017	0,040346107	51,81150817	1972,032683
X Variable 1	3,785202614	0,98492569	3,843135226	0,002033829	1,657400024	5,913005203

Private + Public Model (all sectors)

Regression Statistics	
Multiple R	0,913764582
R Square	0,834965711
Adjusted R Square	0,831036323
Standard Error	460,8592538
Observations	44

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	45131562,4	45131562,4	212,4925674	4,94338E-18
Residual	42	8920432,577	212391,2518		
Total	43	54051994,98			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	15,88222775	92,8593149	0,171035375	0,865017299	-171,5154566	203,2799121
X Variable 1	4,46035303	0,305983045	14,5771248	4,94338E-18	3,842854246	5,077851814

Manufacturing Model

Regression Statistics	
Multiple R	0,931589505
R Square	0,867859006
Adjusted R Square	0,862353131
Standard Error	364,9543381
Observations	26

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	20994227,83	20994227,83	157,6241818	4,8756E-12
Residual	24	3196600,054	133191,6689		
Total	25	24190827,88			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-40,76824849	90,29394555	-0,451505893	0,655678661	-227,1257928	145,5892959
X Variable 1	4,577323494	0,364586165	12,55484694	4,8756E-12	3,824854633	5,329792355

Technology Model

Regression Statistics	
Multiple R	0,941480619
R Square	0,886385755
Adjusted R Square	0,880073853
Standard Error	535,896259
Observations	20

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	40329602,14	40329602,14	140,4308378	6,17468E-10
Residual	18	5169326,408	287184,8004		
Total	19	45498928,55			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-53,01271035	173,1820429	-0,306109741	0,76303338	-416,8546812	310,8292605
X Variable 1	4,825962934	0,407242166	11,8503518	6,17468E-10	3,970378892	5,681546976

Infrastructure (Energy) Model

Regression Statistics	
Multiple R	0,926188411
R Square	0,857824972
Adjusted R Square	0,84360747
Standard Error	826,1582371
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	41181469,34	41181469,34	60,33584001	1,52294E-05
Residual	10	6825374,327	682537,4327		
Total	11	48006843,67			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-243,2211679	339,3362839	-0,716755559	0,489926474	-999,309526	512,8671901
X Variable 1	5,434754489	0,699668381	7,767614821	1,52294E-05	3,875796185	6,993712793

Pharmaceutical Model

Regression Statistics	
Multiple R	0,981913325
R Square	0,964153778
Adjusted R Square	0,959673
Standard Error	57,51777495
Observations	10

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	711864,0445	711864,0445	215,1755409	4,58095E-07
Residual	8	26466,35548	3308,294435		
Total	9	738330,4			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	99,38797839	23,67082691	4,198753967	0,00300162	44,80295365	153,9730031
X Variable 1	2,285736644	0,155822346	14,66886297	4,58095E-07	1,926409669	2,645063619

Iron and Steel Industry Model

Regression Statistics	
Multiple R	0,882019194
R Square	0,777957858
Adjusted R Square	0,757772208
Standard Error	679,1655699
Observations	13

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	17777253,72	17777253,72	38,54014534	6,64012E-05
Residual	11	5073924,585	461265,8714		
Total	12	22851178,31			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-204,8286475	276,4383157	-0,740956068	0,47424095	-813,265278	403,607983
X Variable 1	6,147457313	0,990236312	6,208070984	6,64012E-05	3,967961886	8,32695274

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