ESSAYS ON OIL: PROJECT EVALUATION AND INVESTMENT IMPACT

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by

Dima Bagh

Department of Economics and Finance

Brunel University, UK

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ABSTRACT

This thesis contains three essays related to fixed investment and crude oil.

The first essay examines the implications of building a cross-border oil infrastructure project within the context of the bargaining problem (the Nash bargaining solution, and the alternating offer bargain of Rubinstein). We examine the viability of the Baku-Tbilisi-Ceyhan oil pipeline project, which is employed as a case study - for the multinational corporation, and the three host countries (Azerbaijan, Turkey, and Georgia) by examining the profitability of the project for each partner with two different bargaining formulations (simultaneous and sequential bargaining). The findings suggest that the project is feasible for the partners when the transit charge is greater than $3 per barrel (this is the Break-Even charge at which the project produces a zero total surplus); but for a tariff charge higher than this rate, the project generates returns for each participant greater than his outside option. Furthermore, the outcomes show how with bargaining over discounted flows, each bargaining scenario results in a different total surplus. Thus, the participants' discount rates, their bargaining orders, and their outside options are the determinants of the gross payoffs they receive over the life of the project.

The second essay examines the effect of oil abundance on domestic investment in 22 oil-exporting non-OECD countries over the period 1996-2010. Employing static and dynamic panel estimators, the oil impact is investigated in light of other investment determinants which reflect government policies including output growth, inflation, the exchange rate, and financial and openness factors. Estimation results indicate that oil abundance exerts an adverse effect on gross domestic investment in these countries, implying the necessity of improving institutional quality and oil

management polices to better exploit oil revenues and direct them towards enhancing domestic investment, thereby sustained economic growth in these countries.

The third essay examines the effect of the oil price and oil price volatility on domestic fixed investment in a group of oil-importing OECD countries from 1970 to 2012 within the framework of the production function. Estimation results indicate that there is a long run relationship running from oil prices and the other control variables (output, trade, inflation, and the exchange rate) to investment where the long run coefficient on the oil price is negative and significant, but the short run coefficient on oil prices is insignificant. Thus, the outcomes of this study indicate that high oil prices are contributing to investment decline, which affirms the importance of adopting long run energy policies that might lessen investment reliance on non-renewable energy sources.

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CHAPTER ONE

INTRODUCTION

Crude oil is a vital energy source and a highly demanded commodity in the global economy, and thus changes in its price might have significant implications on the supply and the demand sides, in oil-exporting/importing economies and in transit countries through which oil is carried by cross-border oil pipelines.

In oil-producing countries, the oil industry, which involves various activities ranging from exploration, development, extraction, refining, transporting and trading petroleum products, is associated with huge capital expenditures, a high level of technological and management expertise, and substantial investment and environmental risks. Given that exports from petroleum products are a key component of merchandise trade in oil-exporting nations, oil revenues account for substantial amounts of their budgets, and thus a higher price of oil can imply significantly larger oil-related incomes. Therefore, these countries aim at managing oil production, maintaining targeted price levels, and channelling oil proceeds towards sustainable economic growth.

The transmission mechanism through which oil prices influence real economic activities includes the supply and demand channels. The supply side impacts are related to the fact that energy is a basic input to production, and therefore an increase in oil prices leads to a rise in the cost of production which in turn induces firms to decrease output. On the demand-side, oil price fluctuations could affect adversely on consumption through its positive relation with disposable income, and on investment by raising firms costs and possibly by increasing uncertainty (see Ferderer, 1996; Lescaroux and Mignon, 2008; Ghalayini, 2011).

The price of crude oil is affected by various factors. Traditionally, changes in the levels of oil supply or oil demand are viewed as the main factors that cause oil price fluctuations. High demand and low supply are expected to drive the price upwards, while low demand and high supply decrease the price. Also, refinery infrastructure, such as oil pipelines, might cause disruptions and thus a temporary loss of oil supply to markets under circumstances of aging, technical problems, and political unrest. Inventory levels can also affect the price of oil since low oil inventories involve uncertainty about the market's ability to meet the required demand which might drive the price of oil upwards. Furthermore, the marginal cost of production and technological changes, such as those related to offshore drilling, are likely to influence the price of crude oil. The price of oil can be also affected by weather conditions, such as hurricanes causing damage to offshore oil fields, pipelines, and refineries.

The crucial role played by crude oil in the global economy has stimulated researchers to investigate factors affecting oil prices, and to examine the implications of oil on the economies of both oil-importing and oil-exporting countries using different methodologies and samples. For instance, some studies (see, e.g., Barsky and Kilian, 2004; Kilian, 2008; and Hamilton, 2008) have focused on the response of output growth and consumer price inflation to oil price shocks in oil-importing economies, while others have examined the impact of oil prices on external balances (see, e.g., Ostry and Reinhart, 1992; Gavin, 1992; and Kilian et.al, 2009). Also, a number of scholars have focused on the micro-level, and thus observed the impacts of oil prices and oil price uncertainty using firm-level data. Yet, only a limited number of studies have paid attention to the implications of oil revenues/prices on domestic fixed investment.

Therefore, this thesis attempts to bridge this gap by focusing on crude oil and domestic fixed investment throughout transit, oil-exporting, and oil-importing countries. It aims at answering the following questions:

- What are the implications of constructing cross-border oil infrastructure projects on the economies of involved transit-countries, and how might different bargaining scenarios affect the revenues from transit-fees that the concerned countries receive for transporting oil through their lands?
- Is oil in oil-rich developing economies often a curse, rather than beneficial, and do these countries well manage their oil revenues and use them to finance capital investment projects?
- How do changes in the price of crude oil affect the economies of oil-importing developed economies, and is there a long run equilibrium relationship between the price of oil and domestic fixed investment in these countries.

The above questions are answered throughout three essays in this thesis, presented in Chapters 2, 3, and 4.

Chapter 2 examines the implications of building an oil-pipeline project on the transit economies through which the pipeline passes by employing the Baku-Tbilisi-Ceyhan (BTC) oil pipeline project as a case study. As a transnational project, building an oil pipeline involves various economic, political, and environmental risks to the transit countries. Hence, setting a wide range of legal and regulatory frameworks, and considering mechanisms that protect human rights, and reduce the prospective environmental risks, are vital for the participants in such cross-border projects. That necessitates reaching a mutually beneficial agreement between the project partners through bargaining.

The chapter, therefore, considers the bargaining problem confronting the multinational corporation, that builds the project, and the three host countries (Azerbaijan, Georgia, and Turkey) at the time that the project agreement was made, to find out the viability of the oil pipeline to the participants. After introducing the bargaining model of the BTC project employing bargaining theory (the Nash bargaining solution, and the alternating offer bargain of Rubinstein), the implications of two different bargaining formulations (simultaneous and sequential bargaining) for the participants are shown. The multinational corporation receives returns from building the oil pipeline, and each of the three host countries expects to get revenues through transit fees. The tariff charge per barrel, however, is unknown by the time of making the agreement, but the parties have to make the decision depending on their future expectations of their forthcoming proceeds. Thus, we find the break-even tariff charge at which a zero surplus would be obtained. The results suggest that the project is feasible for the multinational corporation and the three host countries when the tariff charge is higher than the break-even tariff charge of $3/barrel, which is, in turn, within the tariff range expected by some commentators upon signing the agreement.

Given that we have no available information on the financial agreement between the participants in the deal, we find a range of potential payoffs for the participants by considering both simultaneous and sequential bargaining, assuming a tariff charge higher than the break-even one. In each case, Azerbaijan (the country with the oil deposits) obtains the highest payoff, followed by the multinational corporation, then by Turkey (the country with the oil marine terminal), and finally by Georgia (through which the pipeline runs).

Chapter 3 examines how domestic fixed investment is affected by oil abundance in oil-exporting developing countries. So far, fixed investment-related studies have analysed the linkage between domestic investment and several other macroeconomic variables, such as foreign direct investment, domestic saving, trade openness, financial development, the exchange rate, and exchange rate uncertainty (see e.g. Byrne and Davis, 2005); while natural resource-related literature has often examined the effects of resource abundance on economic growth in oil-rich developing nations. But the relationship between domestic fixed investment and oil abundance in oil-exporting developing countries is yet to be examined.

It has been debated that natural resources can be an important source of funds for financing productive investment projects, and thus boosting sustainable economic growth in oil-rich developing nations. Although the empirical findings of some studies indicate that a resource boom boosts economic growth in these countries, the experience of many of oil-rich developing economies reveals poor governance, great inequality, high levels of corruption, and low economic growth (Karl, 2007).

We thus attempt to provide further analysis on the implications of resource abundance on the economies of developing countries by examining whether oil abundance boosts fixed domestic investment, which is a basic determinant of economic growth, in a panel of 22 oil-exporting economies. By using oil rents and oil exports as proxies for oil abundance, the (static and dynamic) investment model is specified, controlling for other investment determinants. The static model is estimated using Random and Fixed Effects estimators, while the dynamic model is estimated by employing the Arellano-Bond Generalized Method of Moments. In line with the literature which has documented adverse resource effects, our results indicate that oil abundance affects domestic investment adversely.

Chapter 4 examines the effect of the crude oil price on domestic fixed investment in a panel of oil-importing developed economies. Numerous researchers have documented the response of economic growth towards oil price changes. Their findings suggest that higher oil prices affect output growth adversely. At the micro level, the impact of oil price uncertainty on firm-level investment has been investigated, but the results are not conclusive. Classical theory indicates that uncertainty can have a positive effect on investment since entrepreneurs might be able to grab investment opportunities under conditions of uncertainty (Knight, 1921), but several other studies have documented an adverse impact of uncertainty on firm level investment as uncertainty about future oil prices causes delays in business investment. According to option theory, uncertainty affects investment adversely due to the irreversible nature of investment projects (see, e.g. Leahy and Whited, 1996; Bond and Cummins, 2004).

In this context this chapter attempts to analyse the behaviour of fixed investment but at the macro-level, employing a panel set of 12 oil-importing OECD economies. We find that there is a long run equilibrium relationship between domestic fixed investment and the oil price. Therefore, the error correction model is estimated to show both the long and short run effects of the oil price and the other explanatory variables on domestic fixed investment. Although the results do not show a significant short run effect of the oil price on fixed investment, over the long run investment is affected adversely by the oil price.

Chapter 5 includes conclusions of the results obtained in the three essays, and provides suggestions about future research in the area related to investment and oil.

CHAPTER TWO

TRANSNATIONAL PROJECT EVALUATION: THE BARGAINING PROBLEM: THE BTC OIL PIPELINE PROJECT AS A CASE STUDY

2.1. Introduction

Large scale transnational infrastructure projects face massive regulatory, technical and social challenges (physical distance, cultural diversity, language barriers and technological differences). Constructing such projects therefore requires pervasive management of economic, political and environmental risks (Adenfelt, 2010; Sovacool, 2009). Investors must be convinced to invest in such projects by setting consistent legal and regulatory frameworks and by addressing rigorous participatory and transparency mechanisms to ensure that human rights are protected and damage to the natural environment is minimized (Sovacool, 2009). Thus, successful project financing depends on the strength of the project participants' commitments, and contractual undertakings of the host governments are among such important commitments (Sinclair, 1998).

Transnational projects involve signing an intergovernmental agreement, constituting an international treaty between concerned host governments to satisfy project sponsors and their lenders. The project sponsors expect all issues related to compensation, maintenance services, and risk to be addressed. Hence, the investment decision in such projects must be taken by the stakeholders unanimously. Therefore, bargaining, which aims at reaching a mutually beneficial agreement (Sinclair, 1998), is a basic step in signing the project contract.

This chapter therefore focuses on the bargaining problem in transnational infrastructure projects by employing the Baku-Tbilisi-Ceyhan (BTC) oil pipeline project as an example to examine the viability of this project for each concerned party. The chapter comprises four sections. The first section gives an overview of the literature on transnational projects and throws light on difficulties associated with oil and gas transport projects. In the second section, the BTC pipeline project is introduced, and the planning, financing and construction-related details of the project are discussed. The potential positive and negative effects of the project on the host countries (Azerbaijan, Turkey and Georgia) are also considered. In the third section, the bargaining problem is addressed. A bargaining model of the BTC project is introduced, and then the implications of two different formulations of bargaining (simultaneous and sequential bargaining) for stakeholders' profitability are shown. Finally, in the fourth section, using available information on the BTC oil pipeline project, a numerical illustration is provided and the bargaining outcomes are found.

We consider the bargaining problem facing the multinational corporation and the three countries at the time that the project agreement was made. Thus, for example, the tariff charge per barrel that would be obtained in the future, on completion of the project, was unknown. This tariff would depend on future conditions in the world oil market. Nonetheless, the multinational corporation and the three countries had expectations of what the tariff might be and were making decisions accordingly.

Employing the bargaining model, we find that the break-even charge at which the project achieves a zero surplus was $3 per barrel. This is considerably within the tariff price range \$2.58-\$3.30 that some commentators were quoting at the time (Mansley, 2003).

Our calculations using the Nash bargaining model to find the payoffs the participants receive from the project are based on a tariff of \$3.5 per barrel. This price was chosen because it implies positive payoffs - which we assume that the participants in the project expected, given that they agreed the deal.

Information is not available regarding how the participants bargained over the financial arrangements. By considering both simultaneous and sequential bargaining, we obtain a range of potential payoffs for the participants. Using estimates of the relevant variables we are able to throw some light on the differences in payoffs between simultaneous and sequential bargaining. Also, while recognizing that there was considerable uncertainty facing participants when the agreement was made, we can get a broad idea of whether for some participants the project could have been rather marginal in terms of expected payoffs, in which case it is possible that motivations beyond the scope of this dissertation, such as political factors, played a significant role.

2.2. An overview on transnational infrastructure projects

2.2.1. Literature on transnational projects

Transnational infrastructure projects located in two or more countries are associated with high costs and long life. Since the costs and benefits of such projects are distributed between the partners, coordination and building a stable partnership are fundamental issues in establishing viable projects. In this context, bargaining theory is a potentially important tool in elaborating the partnership-related concerns, yet it is hardly applied in the literature on transnational projects. This study therefore attempts to begin filling this gap, approaching transnational projects from the perspective of bargaining theory.

Transnational projects have been examined extensively in the project management literature, focusing on appropriate behaviour in an international work environment, and effective global leadership (House, 2000; Simons et al., 1993). From this perspective, due to the challenges faced in managing and organizing transnational projects, many studies attempt to provide a better understanding of the factors affecting the performance of such projects (Thamhain, 2004; Zakaria et al., 2004). Adenfelt (2010), for instance, shows in his study how knowledge sharing affects performance by using case study data from a transnational project. He shows that transnational project performance is hindered by communication and coordination difficulties.

Furthermore, many authors discuss the outcome-related performance of projects, which refers to the extent to which a project is able to meet scheduled costs, time, and quality objectives (Hoegl and Weinkauf, 2005). The findings of Maznevski and

Chudoba (2000), for example, on transnational project performance, stress the relationship between structure and process, and thereby the pattern of interaction over time.

2.2.2. Investment in oil and gas projects

Investments in oil and gas networks are capital intensive, implying a wide range of economic, social, and environmental impacts on many parties over a long lifespan. Evaluation of such projects is therefore a crucial task before construction. To a great extent, the willingness of investors looking to make a reasonable rate of return on their investment in such projects is related to the legal and regulatory framework (World Bank, 2004)

In a typical oil and gas concession agreement defining a government's obligations with regard to the project, the government gives to a company the right to develop a project in return for payments which could take one or more forms: fixed rents, royalties, profit overrides and/or taxes (Sinclair, 1998). A comprehensive agreement for a large oil and gas project should address the government's obligations to deal with the possible risks such as currency availability and convertibility, and political force majeure events (e.g., civil unrest, general strikes) (Sovacool, 2009; Sinclair, 1998). If the government fails to meet its obligations, financial compensation should be provided to the project sponsors through compensatory reduction of the government's revenue stream or contingent payment obligations, and so the ability of a government to meet its financial and nonfinancial obligations, as stated by Sinclair (1998), could be the factor that determines the project's financeability.

To a large extent, co-operation between concerned countries and the overall political and economic stability of the region have a crucial impact on the effective operation of oil and gas projects (Begoyan, 2004). In developing countries, constructing such projects is associated with many difficulties, among which are the following (Hayes and Victor, 2003):

- The investment climate in the countries involved (the country which owns the oil fields and the transit countries). Relevant factors include government stability, internal conflict, corruption, law and order, ethnic tensions, and bureaucratic quality.
- Complications related to negotiation and management in such cross-border projects and the risk of hold-up once the costs are sunk.
- The volatility of market prices and demand.
- Pipeline routes may pass through countries that have few or no international institutional links that could help in reducing transaction costs and enforcement of contracts. Examples of such links are trade institutions that reflect the degree of commercial integration of the countries and the willingness of the countries to manage such affairs mutually.

2.3. The BTC oil pipeline project

2.3.1. Planning period

After the collapse of the Soviet Union, the energy-rich region in the south Caucasus attracted foreign economic and political interest, but several political problems and violent conflicts slowed down the entrance of foreign investments to the region. However, the establishment of the cease-fire in 1994 between Armenia and Azerbaijan, and between Georgia and Abkhazia opened up the oil rich region for foreign oil companies (see Begoyan, 2004).

On September 20, 1994 the agreement on joint development and production sharing for the Azeri-Chirag-Gunashli (ACG) oil fields located in the Azeri sector of the Caspian Sea was signed between Azerbaijan and AIOC[1] (Azerbaijan International Operating Company - a consortium formed by foreign oil companies and led by BP) (BP, 2010). The 1994 contract granted Western oil companies the right to produce oil for the first time in newly independent Azerbaijan (Peuch, 2005). As a result, the Azeri government would receive approximately 80% of the total profits from a combination of royalties and from the share of the State Oil Company of Azerbaijan Republic (SOCAR), and the remaining 20% of profits would be divided among the other Consortium members (Sagheb and Javadi, 1994). [2]

[1] AIOC includes BP (operator): 34.1%, Chevron: 10.2%, SOCAR: 10% INPEX: 10%, Statoil: 8.6%, ExxonMobil: 8%, TPAO: 6.8%, Devon: 5.6%, ITOCHU: 3.9%, and Hess: 2.7% (BP, 2010). Some AIOC members, including BP, SOCAR, and TPAO have also invested in the construction of the BTC pipeline (See EIA, 2014b).

[2] According to one Azeri official, a preliminary estimate of Azerbaijan's overall profit was $81 billion over 30 years. In addition, the Azeri government would receive a $300 million bonus from the Consortium for signing the agreement (Sagheb and Javadi, 1994).

All transportation routes from the Caspian region during the Soviet era were built through Russia. The Western Early Oil pipeline was built from Azerbaijan to the Georgian Black Sea port of Supsa, but this pipeline cannot carry adequate amounts of oil via the Black Sea and is severely limited by congestion in the Bosporus and Dardanelles straits which separate European from Asian Turkey.

Therefore, three rival plans to exploit the Caspian reserves were drawn up- a northern route through Russia, a southern route through Iran and the central route through the Caucasus to the Mediterranean (Thornton and Howden, 2005). Since Russia and Iran were considered to be unreliable partners for Western companies, the third option was believed to be the most appropriate one (Thornton and Howden 2005), so PLE (a German originated company) was commissioned to perform the feasibility study for the route passing through Georgia. The study was finalised in August 1998 (BTC P/L Project Directorate, 2012).

Figure 2.1 shows the central route, the BTC (Baku-Tbilisi-Ceyhan) oil pipeline, on which the study was carried out:

Figure 2.1. The route of the BTC oil pipeline

Source: International Finance Corporation (IFC, 2006)

It can be seen from the map that the BTC pipeline starts from Azerbaijan, passing through Georgia and Turkey to end up at the Turkish Mediterranean port of Ceyhan. The primary source of oil for the BTC pipeline is the ACG oil fields which are about 100 kilometres off the coast of Baku, and have an estimated 5.4 billion barrels of recoverable resources (Smith, 2004). Besides, Kazakhstan - the largest producer of the oil in the Caspian region - negotiated space in the BTC pipeline to transport its Kashagan oil due to the insufficiency of the existing oil transport infrastructure (ECSSD, 2008), and an intergovernmental agreement on the transport of Kazakh oil by the BTC pipeline was approved by the president of Kazakhstan on 29 May 2008 (Jarosiewicz, 2008)

According to Sovacool (2010), building a pipeline from Azerbaijan to Turkey would create a distribution corridor not only for the current oil, but for any future discoveries in Azerbaijan and the Caspian Sea, especially if Azerbaijan is linked in the future to Kazakhstan (which is rich in oil). Thus, the project is viewed as an important element of an overall plan to turn the Caucasus region into a transport corridor connecting Central Asia to Western Europe.

2.3.2. Pipeline ownership

The 1,768 km BTC oil pipeline project, designed with an initial lifespan of 40 years, was opened officially on 13 July 2006 (Dufey, 2009). The Project is owned by BTC Company - a consortium of eleven national and international oil companies with upstream interests in the Caspian region (Smith, 2004). The shareholders and their equity holdings are shown in the following table.

Table 2.1. Shareholders' shares in the BTC Company

Shareholders in the BTC company	Country	% of Equity
BP	UK	30.10
SOCAR	Azerbaijan	25.00
Unocal	USA	8.90
Statoil	Norway	8.71
TPAO	Turkey	6.53
TotalFinaElf	France	5.00
Eni	Italy	5.00
Itochu	Japan	3.40
ConocoPhillips	USA	2.50
INPEX	Japan	2.50
Hess Corporation	Joint venture of Delta Oil (Saudi Arabia) with Amerada Hess (US)	2.36

Source: (BP, 2006)

It can be seen from Table 2.1 that more than 50% of the equity is held by BP and SOCAR. BP is also the operator and the largest shareholder in AIOC, the consortium extracting the oil from the ACG fields, with 34.10% of the equity (BP, 2010), and the BTC consortium owns the pipeline, with 30.10% of the equity.

2.3.3. Project Agreements

On 29 October 1998, the project gained momentum after the Ankara Declaration was adopted (Baran, 2005). Later on, negotiations between the BP-led consortium and the three countries ended up with a legal regime involving several agreements concerning the pipeline's construction, operation, and the social and environmental standards with which the project must comply as follows (The Corner House, 2011; Hildyard, 2007; Smith, 2004; Peachey, 2011):

I. **The Intergovernmental Agreement (IGA):** The IGA is the trilateral agreement between Azerbaijan, Turkey and Georgia signed on 18 November 1999. The IGA confirmed each country's support for development, construction and operation of the pipeline across its territory. The IGA is essentially a treaty under public international law through which the host governments agree to ensure the security and safety of project personnel, facilities, assets, and in-transit petroleum other than the states' commitments with respect to the application of environmental standards.

II. **The Host Government Agreements (HGAs) - 2000:** Three separate HGAs were signed between BTC Company and each of the three countries (Azerbaijan, Georgia and Turkey). The HGAs define the capital and resources that each participant should provide to the project, the timetable of the project, the standards that must be met, and the domestic legislation to which the project is subject. The HGAs addressed in greater detail the technical, legal and fiscal regime under which BTC Company undertakes the project and the mutual rights and obligations of each government and BTC Company. The HGAs include rights and guarantees from the concerned countries to BTC Company to ensure the success of the project, including land rights for the construction and operation of the pipeline, rights to import and export goods and services, rights to transfer and convert currency, and guarantees of economic stabilization. Besides, the HGAs addressed the terms of the direct financial compensation for each of the host countries, in addition to the process for land acquisition and compensation.

Many concerns were raised by Amnesty International and other NGOs over the HGAs that have been incorporated into domestic law in all the three countries and override domestic laws (other than the national constitutions) where such law conflicts with the terms of the HGAs and the IGA. Furthermore, the agreements impose an obligation to compensate BTC Company for any new social or environmental legislation that might impinge on the economic equilibrium of the project.

In response to pressure from Amnesty International and other non-governmental organisations (NGOs), BTC Company signed a unilateral declaration that it would not invoke the compensation clauses where new legislation was intended to protect human rights. However, the declaration contains a let-out clause whereby BTC retains the right to do so if it deems the action of the host government to constitute rent-seeking.

III.. The Joint Statement -2003: Due to the concerns raised by NGOs, the BTC Company and the host governments signed a Joint Statement guaranteeing adherence to internationally recognized human rights, environmental standards and labour rights, with a commitment to the standards adopted in the Voluntary Principles on Security and Human Rights.

2.3.4. Pipeline financing and constructing

Approximately 30% of the BTC pipeline costs were funded by equity contributions, while the remaining 70% were funded from other parties comprising export credit agencies and political risk insurers[3], a group of 15 commercial banks[4], and multinational lending agencies - the European Bank for Reconstruction and Development: $250 million, and the International Finance Corporation (IFC): $250 million (BP, 2004; Hildyard, 2007).

The pipeline construction continued for three years - from 2003 to 2005 - with a different contractor in each country. The Azerbaijan section was constructed by Consolidated Contractors International of Greece, while a joint venture of France's Spie Capag and US Petrofac constructed the Georgian section (Alexander's Gas and Oil Connections, 2002). In Turkey, BOTAS (the Turkish State Pipeline Company) signed a turnkey agreement under which it committed to build the pipeline for a fixed price even though analysts, according to FFM (2003), had expected the real cost to be more than that price, so the Turkish state took the responsibility of the extra cost, in addition to the cost over-runs.

[3] Export credit agencies and political risk insurers comprised: the Japan Bank for International Co-operation (JBIC) and Nippon Export and Investment Insurance (NEXI) of Japan: $580 million and $120 million respectively, the Export-Import Bank of the United States of America: $160 million, the Export Credits Guarantee Department (ECGD) of the United Kingdom: $106 million, the Overseas Private Investment Corporation (OPIC) of the United States: $142 million, Compagnie Francaise pour le Commerce Exterieur (COFACE) of France: $100 million, Euler Hermes Kreditversicherungs-AG (HERMES) of Germany: $85 million, and SACE S.p.A. – Servizi Assicurativi del Commercio Estero (SACE) of Italy: $50 million (BP, 2004; Hildyard, 2007).

[4] The private banks were: ABN AMRO Bank, Banca Intesa, BNP Paribas, Citibank, Credit Agricole Indosuez, Dexia Credit Local, Bayerische Hypo-und Vereinsbank, ING Bank, KBC Finance Ireland, Mizuho Corporate Bank, Natexis Banques Populaires, the Royal Bank of Scotland, San Paolo IMI, Societe Generale, and West LB (Hildyard, 2007).

2.3.5. Economic Implications of the Pipeline

The pipeline project potentially involves substantial economic benefits to each of the three countries and to the whole region. Azerbaijan gets considerable benefits through royalty and tax proceeds, while Georgia and Turkey receive financial benefits through transit fees (IFC, 2006).

Furthermore, host countries get indirect benefits associated with the purchase of local goods and services, employment, and specific programs designed to encourage the development of small and medium sized enterprises. For example, in 2002, BP opened an Enterprise Centre in Baku in Azerbaijan in order to help local companies to develop their business in support of the BTC development and other major oil and gas developments in the region (IFC, 2006).

According to Guney and Ozdemir (2011), the BTC Pipeline became an important step for bilateral agreements and economic cooperation which would help in creating peace and eliminating ethnic conflicts in the region.

2.3.6. Concerns over the project

2.3.6.1. Human rights and environmental concerns

Financing and construction of the pipeline has triggered several concerns from a range of NGOs including Amnesty International and the World Wildlife Fund regarding social problems, human rights abuses, and environmental damage caused by the oil pipeline.

In April 2003, six environment and human rights groups lodged a complaint against BP under the OECD Guidelines for Multinational Enterprises. Part of the complaint alleged that BTC Company failed to consult adequately with communities affected by the project on pertinent matters. Hence, on 9 March 2010, the UK National Contact Point for the OECD Guidelines (NCP) issued a Revised Final Statement on the BTC Complaint. The NCP finds BTC Company in breach of the OECD Guidelines which recommends adequate and timely consultation by multinationals with local communities impacted by corporate operations (The Corner House, 2011).

In Turkey, an analysis of the Environmental Impact Assessment for the Turkish section of the pipeline by international NGOs in 2003 found violations of the relevant World Bank safeguard policies and the European Bank for Reconstruction and Development (EBRD) operational policies. Environmental baseline studies were inadequate with, for example, only 23 sites studied in Turkey, ignoring migration and seasonal effects, although the pipeline route is 1000 km in Turkey (Hildyard, 2007).

In Georgia, many villages have been affected negatively by the BTC pipeline through traffic or water pollution. The sole water source for Tsemi in the Borjomi District has been polluted since May 2004, causing the abrupt end of the village's tourist industry which was the primary source of income; besides, the pipeline passes through the catchment area for the Tskhratskaro springs leaving tap water muddy brown (FFM, 2005).

Human rights violations alleged by villagers during BTC construction include: illegal use of land without compensation, intimidation, lack of public consultation, involuntary resettlement and damage to land property (Hildyard, 2007). The BTC Company claims to have consulted with all landowners affected by the pipeline, but figures from its own environmental impact assessment reveal that less than 2% had in fact been consulted, besides lack of access to project documentation; misinformation about legal rights and failure to warn villagers of potential dangers of the project (Hildyard, 2007). Thus, the company failed to adequately investigate the complaints of intimidation against affected communities by local security forces.

IFC and the other lenders should be notified of any material changes to project implementation that would result in significant environmental or social impacts that might not have been sufficiently covered in the Environmental and Social Impact Assessments (ESIAs) or catered for in the Environmental and Social Action Plan (ESAP)[5]. Although a specific Management of Change mechanism was included in the ESAP of BTC to notify the lenders about changes, the criteria developed to determine when a change notification to the lenders should be triggered did not work well in practice (IFC, 2006). The criteria were rather ambiguous and led to disagreements between BTC, the lenders and the independent environmental consultant as to what constituted a significant change and whether lender notification was warranted (IFC, 2006).

2.3.6.2. Safety concerns

Several safety concerns were provoked before and during the pipeline construction. BP was highly critical of Turkey's BOTAS which built the BTC pipeline in the Turkish section as a turn-key project. Construction was delayed and was over-budget and BP has always suspected quality-control issues (Guardian, 2010). During construction, the BP's own external monitoring body - the Caspian Development Advisory Panel - warned that the pressure on contractors in Turkey to avoid

[5] An essential component of an Environmental and Social Impact Assessment is the specific measures and actions developed to mitigate and manage the environmental and social impacts identified in the assessment and committed to by the sponsor. These measures are typically organized into a management plan for implementation. IFC and the other lenders required that BTC prepare an ESAP which comprised the environmental and social actions and mitigation measures to be taken for the project before financial closure (IFC, 2006).

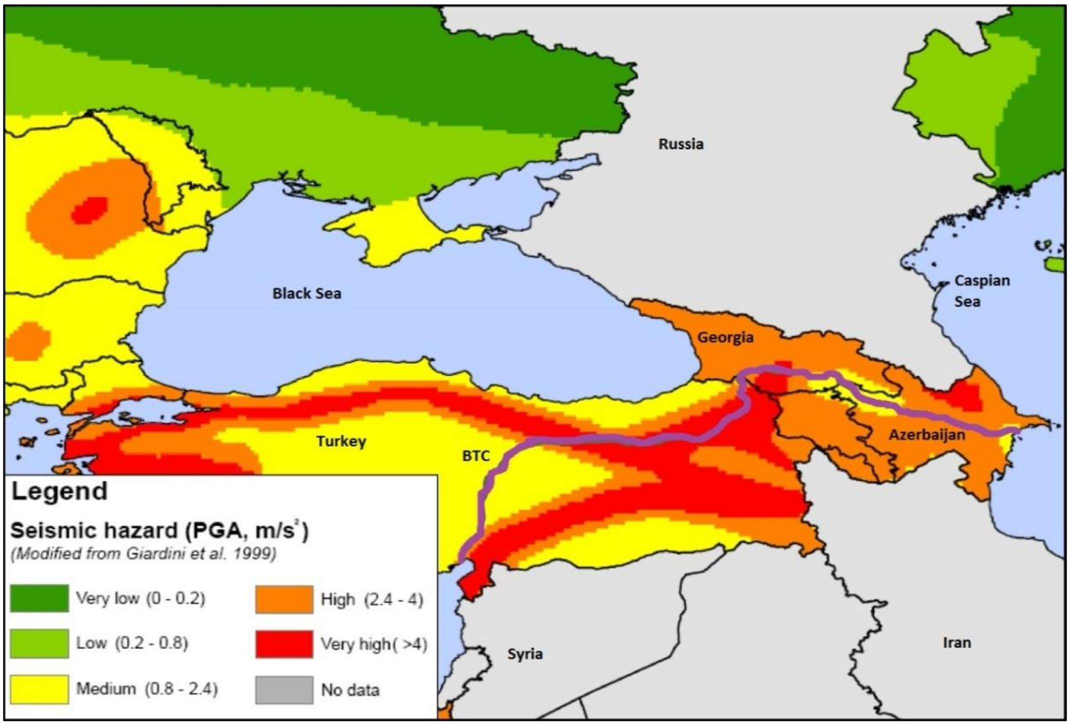
incurring financial penalties created an institutional incentive to cut corners and rush work, particularly over land acquisition and quality control (Hildyard, 2007).

Furthermore, pipeline experts who worked on the Turkish section highlighted a complete absence of many fundamental safety features including not allowing engineers access to construction sites (Hildyard, 2007), as well as the lack of necessary specialists in seismic geology, although the pipeline runs through an area of substantial seismic activity[6] (Mansley, 2003). According to Safak et al. (2008), the pipeline has not been evaluated comprehensively for its seismic safety and risk.

A seismic hazard evaluation is an essential step before constructing infrastructure projects. It involves studying expected ground motions caused by an earthquake calculated on the basis of probability (Natural Resources Canada, 2011). The outcomes of these studies are displayed as seismic hazard maps such as Figure 2.2 which shows the vulnerability of the region through which the BTC pipeline passes, ranging from medium - the yellow colour in the map- to very high - the red colour - seismic hazard.

[6] There have been major earthquakes in the region, at least 17 major earthquakes directly on the pipeline route since 1924 measuring from 5.5 to 7.9 on the Richter scale (Mansley, 2003).

Figure 2.2. Seismic hazard distribution map for the areas through which the BTC oil pipeline passes



Source: (World Health Organization, 2010) - The BTC oil pipeline, the thick purple line was added by the researcher.

It can be seen from the map that the oil pipeline crosses zones that have experienced large earthquakes in the past causing major damage to the existing pipelines - interruption of the flow, huge repair and restoration costs, widespread fires, and environmental pollution (Safak et al., 2008). Noticeably, the majority of zones in which seismic hazard is very high - shown in red colour - are in the Turkish section. Also, the pipeline passes through highly hazardous areas - shown in orange colour - in both Georgia and Azerbaijan.

Another major safety concern was associated with BP's choice of anti-corrosion coating, which had never been used in a similar pipeline, although BP's own consultant warned in 2002 that the chosen coating was inappropriate to protect the pipeline. The coated sections of the pipeline have been therefore subject to extensive cracking (Hildyard, 2007). BP claimed to have resolved the problem but an investigation by Bloomberg, the financial news agency, found that cracking had continued (Gillard, 2004).

Bloomberg also reported that BP had given the monitoring contract for its Azerbaijan assets to Rasco International Ltd., a Baku-based company with no previous pipeline monitoring experience (Hildyard, 2007).

2.3.6.3. Security concerns

National and international NGOs have warned, before and after funding the project, about high risks of conflicts in the region and the possibility that the project would exacerbate such conflicts.

NGOs have raised several inquiries on the adequacy of the assessment conducted by lenders on the risks of conflict, especially after the explosion at one of the valves of the BTC pipeline in the Turkish section on 5 August 2008 and the Russian-Georgian conflict two days after the explosion (Altunsoy, 2008). It has been indicated that the UK's Export Credit Agency did not consider the risks that the pipeline would increase conflict in the region (The Corner House, 2008).

In all host countries, the governments carry security costs as well as any legal liabilities for human rights abuses which can result from security operations (FFM, 2003). The interruption in oil flow through the pipeline after the explosion has led to a debate on whether Turkey should compensate the affected companies. Turkey is responsible for the security of the pipeline except in cases of force majeure. Thus, according to the BTC agreement, if an arbitration tribunal decides that the explosion was due to Turkey's weakness in providing sufficient security, Turkey may have to recompense BTC partners (Altunsoy, 2008).

2.4. The bargaining problem

Bargaining aims at finding a mutual beneficial agreement between stakeholders who have common interest in negotiation. A main focus of any bargaining theory is on two properties: the distribution of the gain from co-operation between the players and the efficiency which is associated with the possibility of failure in reaching an agreement, or reaching an agreement after some costly delay (Muthoo, 2000).

This section shows the relation between the cooperative and the strategic approach of bargaining, and then introduces the bargaining model of the BTC oil pipeline.

2.4.1. The cooperative versus the strategic approach

Bargaining solutions can be found within two main approaches: the cooperative approach under which the outcome satisfies a set of desired properties, and the non-cooperative approach which is based on strategic behaviour assumptions focusing on a precise description of a bargaining procedure (see Kreps, 1990).

The bargaining game in cooperative game theory addresses the problem of two or more players facing a set of feasible outcomes reached by unanimous agreement. If no agreement is reached, a given disagreement outcome will result, but if the feasible outcomes are such that each player can do better than the disagreement outcome, then there is an incentive to reach an agreement; but if at least two players differ over which outcome is the most preferable, there is a need for negotiation over which outcome should be agreed upon.

Nash defined a two-person bargaining problem by considering a pair $\langle F, d \rangle$, where F represents the feasible set (the set of all feasible utility allocations), and d represents the disagreement payoff allocation (the disagreement points of players 1 and 2). F is a closed, convex non-empty, and bounded subset of $\mathbb{R}^2$, and $d = (d_1, d_2)$ is a vector in $\mathbb{R}^2$. Nash looked for a bargaining solution which is an outcome in the feasible set satisfying a set of axioms under which the solution is symmetric, feasible, Pareto optimal, preserved under linear transformations, and independent of irrelevant alternatives (Nagarajan and Sosic, 2008); the solution is obtained by solving: $\arg\max_{X=(x_1, x_2)\epsilon F,\ x\geq d}(x_1 - d_1)(x_2 - d_2)$.

But, with the existence of negotiation weights, the Generalised Nash Bargaining solution can be used by ignoring the axiom of symmetry in the Nash Bargaining game. That is, if α is the first player's bargaining weight, and β is the second player's bargaining weight and the sum of the two weights are equal to one ($\alpha + \beta = 1$), it can be shown (Roth, 1979) that the solution solves:

$$\arg\max_{x\geq d}(x_1 - d_1)^{\alpha}(x_2 - d_2)^{\beta}.$$

In contrast, within the framework of the strategic approach, the bargaining game of alternating offers of Rubinstein is one in which two players take turns in proposing the offers. Player 1 makes an offer which player 2 can accept or reject; if the offer is rejected, player 2 makes another offer which player 1 can accept or reject, and so on; but since time elapses between every offer and counteroffer, both players have an incentive to reach an agreement. In equilibrium, if a solution exists and is offered by player 1, player 2 must be indifferent between accepting and rejecting it (see, Osborne and Rubinstein, 1990). In this bargaining game, the degree of impatience is a key element in determining the shares they get from the overall surplus; thus where r_1 and r_2 are the discount rates of player 1 and player 2 respectively, the solution agreed upon with an infinite number of potential rounds gives each player *i* (*i*=1,2) a proportion σ_i of the overall surplus as follows (Muthoo, 1999):

$$\sigma_1 = \frac{r_2}{r_1+r_2} = \frac{1}{r_1} \Big/ \left(\frac{1}{r_1} + \frac{1}{r_2}\right); \ \sigma_2 = \frac{r_1}{r_1+r_2} = \frac{1}{r_2} \Big/ \left(\frac{1}{r_1} + \frac{1}{r_2}\right).$$

Therefore, $\frac{\sigma_1}{\sigma_2} = \frac{r_2}{r_1}$, and so $\sigma_2 = \frac{\sigma_1 r_1}{r_2}$.

The alternating offers bargain of Rubinstein and the Nash axiomatic approach end up with the same results when there is infinite number of potential rounds, and the time between successive offers is vanishingly small (Muthoo, 1999; Osborne and Rubinstein, 1990); accordingly, in equilibrium, player 1 and 2 receive the proportions:

$$\alpha = \frac{r_2}{r_1+r_2}, \text{ and } \beta = \frac{r_1}{r_1+r_2}.$$

Rubinstein's alternating offers bargain does not have a straightforward formulation for the n-player game. However, Krishna and Serrano (1996) introduced the "the exit option" according to which the players in the n-person game can exit the game with partial agreements and so obtain a unique equilibrium. From this perspective, it can be shown that Nash's axiomatic theory of bargaining extends to n-person games - given that the sum of bargaining weights is equal to 1- by assuming that the relative weights of any two players in the n-person bargaining game are always the same as in a bilateral bargain between these two players; thus the form of the two players solution extends to the n-player case, and it extends to the n-player Nash bargain in the limit.

Accordingly, if $n \geq 2$, then the bargaining weight for player i is $\sigma_i = \frac{\sigma_q r_q}{r_i}$ $\forall q$, but we need $\sum_{q=1}^{n} \sigma_q = 1$. Therefore, we find each player's bargaining weight as follows:

$$\sigma_1 + \frac{\sigma_1 r_1}{r_2} + \frac{\sigma_1 r_1}{r_3} + \cdots + \frac{\sigma_1 r_1}{r_n} = 1 \Rightarrow \quad \sigma_1 = \frac{1}{r_1} \Big/ \left(\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \cdots + \frac{1}{r_n} \right)$$

$$\frac{\sigma_n r_n}{r_1} + \frac{\sigma_n r_n}{r_2} + \frac{\sigma_n r_n}{r_3} + \cdots + \sigma_n = 1 \Rightarrow \quad \sigma_n = \frac{1}{r_n} \Big/ \left(\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \cdots + \frac{1}{r_n} \right)$$

Thus, the bargaining weight for player i in the n- player bargain is:

$$\sigma_i = \frac{1}{r_i} \Big/ \sum_{q=1}^{n} \frac{1}{r_q} \tag{2.1}$$

2.4.2. The BTC oil pipeline bargaining model

In this section, we model the bargaining process for the host countries and the MNC using the Nash/Rubinstein approach. First we assume that the players all bargain simultaneously, and then we assume that the three countries bargain sequentially with the MNC. In the simultaneous case there are four players and so the Krishna-Serrano formulation can be used. However, we are able to simplify the calculations by assuming that three simultaneous two-player bargains taking place - between the MNC and each of the host countries. We show that the overall solution that is then obtained is identical to the solution that would be found by solving the four-player game using Eq (2.1). We can therefore interpret the solution we obtain as the four-player Nash/Rubinstein solution using the Krishna-Serrano assumption.

In the sequential case, there are two players in each Nash bargain and so the 'textbook' Nash /Rubinstein interpretation can be made. (This can be interpreted as a special case of Eq (2.1)).

We start by setting out our assumptions on the project, then we find the net payoffs of the parties with both simultaneous and sequential bargaining, and then we show bargainers' preferences over the two bargaining scenarios with different assumptions on players' discount rates.

2.4.2.1. Assumptions

Consider a multinational corporation (MNC) - the Baku, Tbilisi Ceyhan Company - and three countries: Azerbaijan (A), Turkey (T) and Georgia (G).

Assume that the agreement of the BTC oil pipeline project was signed in year t=0, that the construction phase lasted from year $t = \eta$ to $t = \tau - 1$, and that operations started in year $t = \tau$. r_i is the discount rate of player i (i.e., i=A, T, G, or MNC), and annual costs and revenues are discounted by the discount factor $\frac{1}{(1+r_i)^t}$.

If the participants agree and the project is constructed, the MNC receives revenues from operating the oil pipeline, and incurs construction and operating costs besides the payments to the host countries, where the sizes of these payments are determined by bargaining between the four players. In contrast, each host country receives the payment from the MNC and the wages paid to workers by the MNC over the periods of construction and operations. In addition, there are the net indirect effects to the host countries of the project which could be a positive or negative value. These include benefits, such as the acquisition of skills by local workers, and costs, such as environmental damage. However, in the case of disagreement, each concerned party gets its outside option which is the income that would have been generated by engaging in another project if the BTC project had not been constructed.

Assuming that the initial costs are spent evenly over the construction phase, and annual revenues and costs do not change over the operational phase - with all values specified in real terms - the net payoffs, which represent the differences between what the players receive with and without the agreement are given by:

$$\pi_{MNC} = \varpi_{MNC} - O_{MNC}$$
$$= [\zeta_{MNC}(v - p - w) - z_{MNC}c] - [(z_{MNC}+\zeta_{MNC})o_{MNC}] \qquad (2.2)$$

$$\pi_j = \varpi_j - O_j = [\zeta_j(p_j + w_j - e_j) + z_j c_j] - \zeta_j o_j \qquad (2.3)$$

That is, with the agreement, the pipeline project produces $\varpi_{MNC} = \zeta_{MNC}(v - p - w) - z_{MNC}c$ for the MNC, and $\varpi_j = \zeta_j(p_j + w_j - e_j) + z_j c_j$ for each host country, but if the parties do not agree, the MNC gets $O_{MNC} = (z_{MNC}+\zeta_{MNC})o_{MNC}$, while each host country gets $O_j = \zeta_j o_j$; where the following notations are used:

$r_A, r_T, , r_G$: the discount rates of Azerbaijan, Turkey, and Georgia respectively;

r_{MNC}: the Company's discount rate;

v: Annual revenue from operations from $t = \tau \rightarrow \infty$;

For any player $i\,(MNC, A, T,\ or\ G)$, $\zeta_i = \sum_{t=\tau}^{\infty} \frac{1}{(1+r_i)^t} = \frac{1}{r_i(1+r_i)^{\tau-1}}$ [7], and $z_i = \sum_{t=\eta}^{t=\tau-1} \frac{1}{(1+r_i)^t}$;

p_A, p_T, p_G: annual payments to Azerbaijan, Turkey and Georgia respectively from $t = \tau \rightarrow \infty$ - the sum of the annual payments $p_A + p_T + p_G = p$;

[7] The sum of an infinite geometric series = $\frac{a}{1-\ell}$ (ℓ:the common ratio, a: the first term of the series). Applying to $\sum_{t=\tau}^{\infty} \frac{1}{(1+r_i)^t} = \frac{1}{(1+r_i)^\tau} + \frac{1}{(1+r_i)^{\tau+1}} + \frac{1}{(1+r_i)^{\tau+2}} + \cdots \infty$ we find: $a = \frac{1}{(1+r_i)^\tau}$, while $\ell = \frac{1}{1+r_i} \Rightarrow \sum_{t=\tau}^{\infty} \frac{1}{(1+r_i)^t} = \left[\frac{1}{(1+r_i)^\tau}\right] / \left[1 - \frac{1}{(1+r_i)}\right] = \frac{1}{r_i(1+r_i)^{\tau-1}}$.

w: annual running costs in Azerbaijan, Turkey and Georgia from $t = \tau \rightarrow \infty$;

$w_A,\ w_T,\ w_G$: running incomes received by Azerbaijan, Turkey, Georgia ($w_j > 0$) from wages over the operation period, which are costs for MNC included in the overall operational costs (w) - i.e., $w_j \in w,\ (w_A + w_T + w_G) < w$;

c: investment costs in Azerbaijan, Turkey and Georgia from $t = \eta \rightarrow \tau - 1$;

c_A, c_T, c_G: incomes received by Azerbaijan, Turkey, Georgia ($c_j > 0$) from wages paid during the construction period from $t = \eta \rightarrow \tau - 1$, which are costs for MNC included in the overall investment costs (c) - i.e., $c_j \in c,\ (c_A + c_T + c_G) < c$;

e_A, e_T, e_G: net indirect effects of the project on Azerbaijan, Turkey and Georgia annually from $t = \tau \rightarrow \infty$, which could be positive or negative (i.e., $e_j \lesseqgtr 0$);

o_{MNC}: the annual net income associated with exercising MNC's outside option from $t = \eta \rightarrow \infty$;

o_A, o_T, o_G: annual net incomes associated with exercising the outside options of Azerbaijan, Turkey and Georgia from $t = \tau \rightarrow \infty$.

To simplify the net payoff formulae, they can be rewritten,

$$\pi_{MNC} = \zeta_{MNC}(v - p - w - o_{MNC}) - z_{MNC}(c + o_{MNC})$$

$$= \zeta_{MNC}\left[v - p - w - o_{MNC} - \frac{1}{\zeta_{MNC}} z_{MNC}(c + o_{MNC})\right]; \qquad (2.4)$$

$$\pi_j = \zeta_j(p_j + w_j - e_j - o_j) + z_j c_j$$

$$= \zeta_j \left(p_j + \frac{1}{\zeta_j} z_j c_j + w_j - e_j - o_j \right). \tag{2.5}$$

Now let $\frac{1}{\zeta_i}(z_i) = \Omega_i$, so substituting this in Eq (2.4) and Eq (2.5) the net payoffs for the MNC and each of the three countries will be:

$$\pi_{MNC} = \zeta_{MNC}[v - (c + o_{MNC})\Omega_{MNC} - p - w - o_{MNC}] \tag{2.6}$$

$$\pi_j = \zeta_j(p_j + c_j \Omega_j + w_j - e_j - o_j) \tag{2.7}$$

Information on the financial agreement between the participants is not available. Therefore, using Eq (2.6) and (2.7), in the next section we find the net payoffs of the MNC, Azerbaijan, Turkey, and Georgia, assuming that the bargaining occurred simultaneously, and then in section (2.4.2.3), we find the parties' net payoffs assuming that MNC bargained sequentially with the three countries. Given the lack of information, we assume that the MNC bargains with the parties in order of their significance for the project. Therefore, we assume that it first bargains with Azerbaijan as it owns the oil fields, then with Turkey, since the Turkish section of the pipeline is the longest (61% of the pipeline) and where the pipeline terminates at the Ceyhan marine terminal. Finally, it bargains with Georgia through which only 14% of the pipeline passes.[8]

[8] The fact that Azerbaijan owns 80% of the consortium that accesses the oilfield does not affect the bargaining solution, assuming that there will be potential alternative ways of transporting the oil. This consortium pays BTC a price to transport the oil and, out of BTC's profits, a portion comes back to Azerbaijan, and this is reflected in our bargaining solution.

2.4.2.2. Simultaneous bargaining

In this case, we find bargaining outcomes of the four parties assuming that MNC undertakes simultaneous bilateral bargains with Azerbaijan, Turkey, and Georgia.

Let μ_A, μ_T, μ_G denote MNC's bargaining weights with Azerbaijan, Turkey and Georgia respectively, so the bargaining weight of each host country will be $1-\mu_j$ (j=A, T, or G). Using Eq (2.6) and (2.7), the Nash bargaining solution with any of the three host countries (j) is found by solving:

$$\max_{p_j}[\zeta_{MNC}(v-p-w-o_{MNC}-(c+o_{MNC})\Omega_{MNC})]^{\mu_j}\left[\zeta_j\left(p_j+c_j\Omega_j+w_j-e_j-o_j\right)\right]^{1-\mu_j}.$$

Accordingly, the annual payment (p_j) to country j over the operation phase of the project will be:[9]

$$p_j=\left(1-\mu_j\right)\left(v-(p-p_j)-w-o_{MNC}-(c+o_{MNC})\Omega_{MNC}+c_i\Omega_i+w_j-e_j-o_j\right)-c_j\Omega_j-w_j+e_j+o_j \qquad (2.8)$$

For each bilateral bargain we use the Rubinstein foundation of Nash bargaining when the time between successive offers is very small. Each country's bargaining weight with the MNC is thus $1-\mu_j=\frac{r_{MNC}}{r_{MNC}+r_j}$. Substituting this into Eq (2.8) for each of the three countries, we find:

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[9] For example, the Nash bargaining solution with Azerbaijan is found in the following way:

$$\max_{p_A}\left[\zeta_{MNC}\left(v-p_A-p_G-p_T-w-o_{MNC}-(c+o_{MNC})\Omega_{MNC}\right)\right]^{\mu_A}\left[\zeta_A\left(p_A+c_A\Omega_A+w_A-e_A-o_A\right)\right]^{1-\mu_A} \Rightarrow$$

$$-\mu_A\zeta_{MNC}\left[\zeta_A\left(p_A+c_A\Omega_A+w_A-e_A-o_A\right)\right]+(1-\mu_A)\zeta_A\left[\zeta_{MNC}\left(v-p_A-p_G-p_T-w-o_{MNC}-(c+o_{MNC})\Omega_{MNC}\right)\right]=0 \Rightarrow$$

$$p_A=-\mu_A\left(c_A\Omega_A+w_A-e_A-o_A\right)+\left(1-\mu_A\right)\left[v-(p_G+p_T)-(c+o_{MNC})\Omega_{MNC}-w-o_{MNC}\right]$$

$$=\left(1-\mu_A\right)\left[v-p_G-p_T-(c+o_{MNC})\Omega_{MNC}-w-o_{MNC}\right]-\mu_A\left(c_A\Omega_A+w_A-e_A-o_A\right)$$

$$=\left(1-\mu_A\right)\left[v-p_G-p_T-w-o_{MNC}-(c+o_{MNC})\Omega_{MNC}+c_A\Omega_A+w_A-e_A-o_A\right]-c_A\Omega_A-w_A+e_A+o_A$$

$$p_A = \left(\frac{r_{MNC}}{r_{MNC}+r_A}\right)[v - p_T - p_G - w - o_{MNC} - (c + o_{MNC})\Omega_{MNC} + c_A\Omega_A + w_A - e_A - o_A] - c_A\Omega_A - w_A + e_A + o_A \quad (2.9)$$

$$p_T = \left(\frac{r_{MNC}}{r_{MNC}+r_T}\right)[v - p_A - p_G - w - o_{MNC} - (c + o_{MNC})\Omega_{MNC} + c_T\Omega_T + w_T - e_T - o_T] - c_T\Omega_T - w_T + e_T + o_T \quad (2.10)$$

$$p_G = \left(\frac{r_{MNC}}{r_{MNC}+r_G}\right)[v - p_A - p_T - w - o_{MNC} - (c + o_{MNC})\Omega_{MNC} + c_G\Omega_G + w_G - e_G - o_G] - c_G\Omega_G - w_G + e_G + o_G \quad (2.11)$$

By solving Eq (2.9), (2.10) and (2.11) together, we find that

$$p_j = \left[\frac{1}{r_j} \Big/ \left(\frac{1}{r_{MNC}} + \frac{1}{r_A} + \frac{1}{r_T} + \frac{1}{r_G}\right)\right][v - (c + o_{MNC})\Omega_{MNC} - w - o_{MNC} + c_A\Omega_A + w_A - e_A - o_A + c_T\Omega_T + w_T - e_T - o_T + c_G\Omega_G + w_G - e_G - o_G] - c_j\Omega_j - w_j + e_j + o_j. \quad (2.12)$$

Now, let

$$v - (c + o_{MNC})\Omega_{MNC} - w - o_{MNC} + c_A\Omega_A + w_A - e_A - o_A + c_T\Omega_T + w_T - e_T - o_T + c_G\Omega_G + w_G - e_G - o_G = s,$$

Substituting s into (2.12) we find:

$$p_j = \left[\frac{1}{r_j} \Big/ \left(\frac{1}{r_{MNC}} + \frac{1}{r_A} + \frac{1}{r_T} + \frac{1}{r_G}\right)\right] s - c_j\Omega_j - w_j + e_j + o_j \quad (2.13)$$

Substituting (2.13) into (2.6) and (2.7), we find that the net payoff received by player i is: [10]

$$\pi_i = \left[\frac{1}{r_i} \Big/ \left(\frac{1}{r_{MNC}} + \frac{1}{r_A} + \frac{1}{r_T} + \frac{1}{r_G}\right)\right] \zeta_i s \tag{2.14}$$

Consequently, the outcome found using bilateral bargaining between MNC and each host country is identical to that reached in Eq (2.1) - using the formulation proposed by Krishna and Serrano (1996) for the n-person game.

Thus, if the participants agree, the project produces for each player:

$$\varpi_i = \left[\frac{1}{r_i} \Big/ \left(\frac{1}{r_{MNC}} + \frac{1}{r_A} + \frac{1}{r_T} + \frac{1}{r_G}\right)\right] \zeta_i s + O_i \tag{2.15}$$

2.4.2.3. Sequential Bargaining

In this case, alternative orders of the sequential bargains could be assumed. But we assume that the MNC bargains with countries in order of their practical significance to the project. Thus we assume that the MNC first bargains bilaterally with Azerbaijan as it owns the oil field. Then it bargains with Turkey, the larger of the two transit countries, and the one in which the terminal is built. Finally it bargains with Georgia. Using backward induction, we find the Nash bargaining solution with Georgia, then with Turkey, and then with Azerbaijan.

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[10] For example, for Azerbaijan , by substituting p_A into Eq (2.7) for j=A, i.e., $\pi_A = \zeta_A(p_A + c_A\Omega_A + w_A - e_A - o_A)$ we find:

$$\pi_A = \zeta_A\left(\underbrace{\left[\frac{1}{r_A} \Big/ \left(\frac{1}{r_{MNC}} + \frac{1}{r_A} + \frac{1}{r_T} + \frac{1}{r_G}\right)\right] s - c_A\Omega_A - w_A + e_A + o_A}_{p_A} + c_A\Omega_A + w_A - e_A - o_A\right)$$

$$= \left[\frac{1}{r_A} \Big/ \left(\frac{1}{r_{MNC}} + \frac{1}{r_A} + \frac{1}{r_T} + \frac{1}{r_G}\right)\right] \zeta_A s$$

First, using Eq (2.6) and (2.7) - for j=G - we find the annual payment (p_G) paid by MNC to Georgia by solving:

$$\max_{p_G}[\zeta_{MNC}(v - p - (c + o_{MNC})\Omega_{MNC} - w - o_{MNC})]^{\mu_G}[\zeta_G(p_G + c_G\Omega_G + w_G - e_G - o_G)]^{1-\mu_G}$$

$$\Rightarrow p_G = (1 - \mu_G)[v - p_A - p_T - (c + o_{MNC})\Omega_{MNC} - w - o_{MNC} + c_G\Omega_G + w_G - e_G - o_G]$$

$-c_G\Omega_G - w_G + e_G + o_G$. But $1 - \mu_G = \frac{r_{MNC}}{r_{MNC}+r_G}$; therefore,

$$p_G = \left(\frac{r_{MNC}}{r_{MNC}+r_G}\right)[v - p_A - p_T - (c + o_{MNC})\Omega_{MNC} - w - o_{MNC} + c_G\Omega_G + w_G - e_G - o_G] - c_G\Omega_G - w_G + e_G + o_G \quad (2.16)$$

Substituting from Eq (2.16) into (2.6) for p_G we find:

$$\pi_{MNC} = \left(\frac{r_G}{r_{MNC}+r_G}\right)(\zeta_{MNC})[v - p_A - p_T - (c + o_{MNC})\Omega_{MNC} - w - o_{MNC} + c_G\Omega_G + w_G - e_G - o_G] \quad (2.17)$$

Then, using Eq (2.17) and (2.7) - for j=T - we find the annual payment (p_T) paid by MNC to Turkey, given that the payment to Azerbaijan was agreed upon, so the Nash bargaining solution results in the following outcome:

$p_T = (1 - \mu_T)[v - p_A - (c + o_{MNC})\Omega_{MNC} - w - o_{MNC} + c_G\Omega_G + w_G - e_G - o_G + c_T\Omega_T + w_T - e_T - o_T] - c_T\Omega_T - w_T + e_T + o_T$, but $1 - \mu_T = \frac{r_{MNC}}{r_{MNC}+r_T}$. Therefore,

$$p_T = \left(\frac{r_{MNC}}{r_{MNC}+r_T}\right)[v - p_A - (c + o_{MNC})\Omega_{MNC} - w - o_{MNC} + c_G\Omega_G + w_G - e_G - o_G + c_T\Omega_T + w_T - e_T - o_T] - c_T\Omega_T - w_T + e_T + o_T \, . \quad (2.18)$$

Substituting from Eq (2.18) into (2.17) for p_T we find:

$$\pi_{MNC} = \left(\frac{r_G}{r_{MNC}+r_G}\right)\left(\frac{r_T}{r_{MNC}+r_T}\right)(\zeta_{MNC})[v - p_A - (c + o_{MNC})\Omega_{MNC} - w - o_{MNC} + c_G\Omega_G + w_G - e_G - o_G + c_T\Omega_T + w_T - e_T - o_T]. \tag{2.19}$$

Finally, using Eq (2.19) and (2.7) - for j=A - we find the Nash bargaining solution with Azerbaijan. Thus, we find that the annual payment to Azerbaijan is:

$$\Rightarrow \; p_A = (1 - \mu_A)[v - (c + o_{MNC})\Omega_{MNC} - w - o_{MNC} + c_G\Omega_G + w_G - e_G - o_G + c_T\Omega_T + w_T - e_T - o_T + \; c_A\Omega_A + w_A - e_A - o_A] - c_A\Omega_A - w_A + e_A + o_A \tag{2.20}$$

Now, in order to simplify the formulae, let $v - (c + o_{MNC})\Omega_{MNC} - w - o_{MNC} + c_G\Omega_G + w_G - e_G - o_G + c_T\Omega_T + w_T - e_T - o_T + \; c_A\Omega_A + w_A - e_A - o_A = s$.

By substituting s, and $1 - \mu_A = \frac{r_{MNC}}{r_{MNC}+r_A}$ into Eq (2.20), we find that the annual payment to Azerbaijan is:

$$p_A = \left(\frac{r_{MNC}}{r_{MNC}+r_A}\right)s - \; c_A\Omega_A - w_A + e_A + o_A. \tag{2.21}$$

Substituting (2.21) into (2.18), we find the annual payment to Turkey:

$$p_T = \left(\frac{r_A}{r_{MNC}+r_A}\right)\left(\frac{r_{MNC}}{r_{MNC}+r_T}\right)s - c_T\Omega_T - w_T + e_T + o_T. \tag{2.22}$$

Substituting (2.21) and (2.22) into (2.16), we find the annual payment to Georgia:

$$p_G = \left(\frac{r_{MNC}}{r_{MNC}+r_G}\right)\left(\frac{r_A}{r_{MNC}+r_A}\right)\left(\frac{r_T}{r_{MNC}+r_T}\right) s - c_G\Omega_G - w_G + e_G + o_G. \tag{2.23}$$

Now we find the four parties' net payoffs by substituting the annual payments to the host counties (p_A, p_T, and p_G) from Eq (2.21), (2.22) and (2.23) into Eq (2.6), and Eq (2.7) for j=A, T, and G:[11]

$$\pi_A = \left(\frac{r_{MNC}}{r_{MNC}+r_A}\right) s\zeta_A \tag{2.24}$$

$$\pi_T = \left(\frac{r_A}{r_{MNC}+r_A}\right)\left(\frac{r_{MNC}}{r_{MNC}+r_T}\right) s\zeta_T \tag{2.25}$$

$$\pi_G = \left(\frac{r_{MNC}}{r_{MNC}+r_G}\right)\left(\frac{r_A}{r_{MNC}+r_A}\right)\left(\frac{r_T}{r_{MNC}+r_T}\right) s\zeta_G \tag{2.26}$$

$$\pi_{MNC} = \left(\frac{r_G}{r_{MNC}+r_G}\right)\left(\frac{r_A}{r_{MNC}+r_A}\right)\left(\frac{r_T}{r_{MNC}+r_T}\right) s\zeta_{MNC} \tag{2.27}$$

As a result, sequential bargaining generates outcomes different from that of simultaneous bargaining, and we discuss the differences in the next section.

2.4.2.4. Simultaneous verses sequential bargaining

This section provides a comparison between the outcomes of simultaneous and sequential bargaining found in sections 2.4.2.2 and 2.4.2.3; the outcomes are summarized in the table below, denoting the shares resulting from bargaining simultaneously and sequentially by α_i and β_i, respectively.

[11] For example, for Azerbaijan (j=A), by substituting p_A from Eq (2.21) into Eq (2.7) we find that Azerbaijan receives the following net payoff:

$$\pi_A = \zeta_A\left(\underbrace{\left(\frac{r_{MNC}}{r_{MNC}+r_A}\right) s - c_A\Omega_A - w_A + e_A + o_A}_{p_A \text{ from Eq (2.21)}} + c_A\Omega_A + w_A - e_A - o_A\right) = \left(\frac{r_{MNC}}{r_{MNC}+r_A}\right) s\,\zeta_A.$$

Table 2.2. The outcomes of simultaneous and sequential bargaining between the concerned parties in the BTC project

	p_j	ϖ_i	π_i
Simultaneous	$(\alpha_j s - c_j \Omega_j - w_j + e_j) + o_j$	$\zeta_i \alpha_i s + O_i$	$\zeta_i \alpha_i s$
Sequential	$(\beta_j s - c_j \Omega_j - w_j + e_j) + o_j$	$\zeta_i \beta_i s + O_i$	$\zeta_i \beta_i s$

Where

$s = [v - (c + o_{MNC})\Omega_{MNC} - w - o_{MNC}] + [c_A\Omega_A + w_A - e_A - o_A] + [c_T\Omega_T + w_T - e_T - o_T]$
$+ [c_G\Omega_G + w_G - e_G - o_G]$;

$i =$ Any player, i.e. A, T, G, or MNC;

$j =$ Any host country, i.e. A, T, or G;

$\zeta_i = \sum_{t=\tau}^{\infty} \frac{1}{(1+r_i)^t} = \frac{1}{r_i(1+r_i)^{\tau-1}}$;

$\Omega_i = \sum_{t=\eta}^{t=\tau-1} \frac{1}{(1+r_i)^t} \, r_i(1+r_i)^{\tau-1}$;

$\alpha_i = \frac{1}{r_i} / \left(\frac{1}{r_{MNC}} + \frac{1}{r_A} + \frac{1}{r_T} + \frac{1}{r_G}\right)$ for any player i;

$\beta_A = \left(\frac{r_{MNC}}{r_{MNC}+r_A}\right)$;

$\beta_T = \left(\frac{r_A}{r_{MNC}+r_A}\right)\left(\frac{r_{MNC}}{r_{MNC}+r_T}\right)$;

$\beta_G = \left(\frac{r_{MNC}}{r_{MNC}+r_G}\right)\left(\frac{r_A}{r_{MNC}+r_A}\right)\left(\frac{r_T}{r_{MNC}+r_T}\right)$;

$\beta_{MNC} = \left(\frac{r_A}{r_{MNC}+r_A}\right)\left(\frac{r_T}{r_{MNC}+r_T}\right)\left(\frac{r_G}{r_{MNC}+r_G}\right)$.

The difference between the resulting outcomes with the two bargaining scenarios in Table 2.2 is attributed to the bargaining order, and the impatience degree of each player (i.e., the player's discount rate which defines its bargaining weight and its discount factor used to discount annual cash flows).

When the MNC negotiates with the host countries simultaneously, the net payoff obtained by each player is determined by its bargaining weight, and by its discount factor by which costs and revenues are discounted over the life of the project.

However, the net payoff of each host country in the case of sequential bargaining is determined not only by the impatience degree of each country relative to the others, but also by its bargaining order. This results from the property of Nash bargaining that the participants in the first bargain (MNC, Azerbaijan) receive half of the surplus each. This leaves the MNC with only half the surplus with which it bargains with the second country (Turkey), so each participant in the second bargain receives a quarter of the surplus leaving the MNC with only a quarter of the surplus with which it bargains with the third country (Georgia). Thus, the country which bargains first with the MNC acquires a higher net payoff, but the MNC gets the same net payoff regardless the bargaining order.

In order to examine the impact of the discount rates, assume first that all the players have the same discount rate (r). Accordingly, substituting r into the bargaining outcomes in Table 2.2, we find the following results:

Table 2.3. The net payoffs of the participants in the BTC project when they all have equal discount rates

Net payoffs	Simultaneous bargaining	Sequential bargaining
π_A	$\frac{1}{4}\zeta s$	$\frac{1}{2}\zeta s$
π_T	$\frac{1}{4}\zeta s$	$\frac{1}{4}\zeta s$
π_G	$\frac{1}{4}\zeta s$	$\frac{1}{8}\zeta s$
π_{MNC}	$\frac{1}{4}\zeta s$	$\frac{1}{8}\zeta s$
Sum	ζs	ζs

Table 2.3 shows that the parties receive the same net payoff ($1/4\ \zeta s$) with simultaneous bargaining, but with sequential bargaining Azerbaijan gets $1/2\ \zeta s$ which is half of the overall surplus, while Turkey gets $1/4\ \zeta s$ (half of the remaining

surplus after MNC-Azerbaijan bargaining), and Georgia gets $1/8\ \zeta s$ (half of the remaining surplus after MNC-Azerbaijan, and MNC-Turkey negotiating).

Furthermore, it can be seen from Table 2.3 that the overall surplus - the sum of the net payoffs - with simultaneous bargaining is identical to that with sequential bargaining (ζs) because the players have the same discount rate (r), so costs and revenues are discounted by the same discount factor.

However, when the players have different discount rates, the bargaining outcomes will be as in Table 2.4:

Table 2.4. The net payoffs of the participants in the BTC project when they have different discount rates

Net payoffs	Simultaneous bargaining	Sequential bargaining
π_A	$\zeta_A \alpha_A s$	$\zeta_A \beta_A s$
π_T	$\zeta_T \alpha_T s$	$\zeta_T \beta_T s$
π_G	$\zeta_G \alpha_G s$	$\zeta_G \beta_G s$
π_{MNC}	$\zeta_{MNC} \alpha_{MNC} s$	$\zeta_{MNC} \beta_{MNC}$
Sum	$(\zeta_A \alpha_A + \zeta_T \alpha_T + \zeta_G \alpha_G + \zeta_{MNC} \alpha_{MNC})s$	$(\zeta_A \beta_A + \zeta_T \beta_T + \zeta_G \beta_G + \zeta_{MNC} \beta_{MNC})s$

It can be seen from the table that the overall surplus resulting from simultaneous bargaining is different from that of sequential bargaining, so if the players have different discount rates, portions of the surplus have different values, depending on who receives them due to the different discount rates by which flows discounted over the life of the project. For example, the overall payment to Azerbaijan is $\zeta_{MNC} p_A$ from the MNC's perspective, while it is $\zeta_A p_A$ for Azerbaijan. This implies that $(\zeta_A \alpha_A + \zeta_T \alpha_T + \zeta_G \alpha_G + \zeta_{MNC} \alpha_{MNC})s \neq (\zeta_A \beta_A + \zeta_T \beta_T + \zeta_G \beta_G + \zeta_{MNC} \beta_{MNC})s$ because $r_{MNC} \neq r_A \neq r_T \neq r_G$ and $\zeta_{MNC} \neq \zeta_A \neq \zeta_T \neq \zeta_G$.

In the next section we apply the bargaining outcomes on the BTC oil pipeline project to find participants' net payoffs using available information on the project.

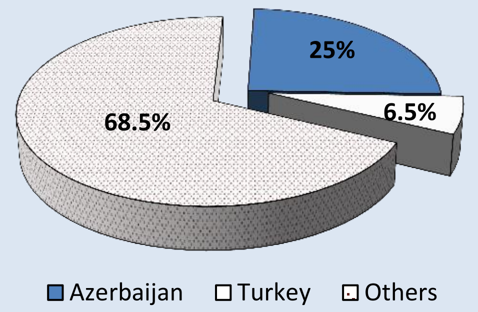
2.5. An application of the bargaining problem - a case study

2.5.1. An empirical example on the BTC pipeline project

This section illustrates the results of the Nash bargain solution - shown previously in Table 2.2 - assuming that bargaining between the concerned parties (MNC, Azerbaijan, Turkey, and Georgia) in the actual project occurred simultaneously, and in order to show the impact of the bargaining order on the surplus distribution, the results are also found with sequential bargaining.

Each concerned party in the project receives revenues from operating the oil pipeline, but it also incurs costs, so to examine the viability of the project for each player we need to find the payments to the host countries (p_j), the returns (ϖ_i) from the project, and the net payoffs (π_i) resulting from bargaining. Hence, we need to estimate the parameters' values in Eq (2.6) and (2.7) by the time when the agreement was signed assuming that all the values are in their real terms.

Figure 2.3. Equity holders in the BTC Company



As was shown previously in Table 2.1, Azerbaijan and Turkey hold together 31.5% of the equity in the BTC Company (i.e., MNC), which is less than one third of the total equity. Therefore, for simplicity, we assume that the behaviour of the company is not affected by the proportions of the equity held by the two countries when the company negotiates with the host countries.

The Host Government Agreement was signed in 2000 ($t = 0$), and construction work was carried out within three years, from 2003 to 2005 ($t = 3 \rightarrow 5$), while operations started in 2006 ($\tau = 6$). Therefore, in the utility functions - Eq (2.6) and (2.7) - where $\Omega_i = \frac{1}{\zeta_i}(z_i)$, we find $\zeta_i = \sum_{t=6}^{\infty} \frac{1}{(1+r_i)^t} = \frac{1}{r_i(1+r_i)^5}$ and $z_i = \sum_3^5 \frac{1}{(1+r_i)^t}$.

The revenue of the BTC pipeline (v) depends on the tariff charge per barrel. In this example, the tariff charge at which the overall surplus of the project is zero is examined (i.e., the Breakeven Point - BEP - is found), and then expected benefits to the stakeholders with tariff charges above BEP are found.

With regard to the pipeline's costs, investment costs (c) were expected to be \$3.6 billion (Mansley, 2003), and BP's expected operational costs to be \$70-90 million a year in Turkey, and around \$30 million a year in both Georgia and Azerbaijan (Mansley, 2003). Furthermore, some other costs including insurance and management charges were estimated at \$20 million a year in the three countries together (Mansley, 2003). Accordingly, annual operational costs (w) are assumed to be $w = 2 \times \$30\text{ m} + (\$70\text{m} + \$90\text{m})/2 + \$20\text{ m} = \$160$ million.

In order to find wages (c_j, w_j) received by the host countries over the construction and operation phases, the number of employees and the annual wage per worker in the three countries - by the time of the agreement - are required. Hence, we use employees' numbers indicated by CSR Network (2003): the pipeline construction created about 2,300, 2,500, and 5,000 jobs in Azerbaijan, Georgia, and Turkey respectively, while operations created 250, 250, and 350 jobs.

Due to the lack of data on wages in the host countries in 2000 (the year in which the agreement was acknowledged), wages were estimated using data from the

International Labour Organization (ILO) database for Azerbaijan and Georgia, where data are available in 2005 (in local currency). But for Turkey, wages in 2010 (in local currency) were taken from the Turkish Statistical Institute (TurkStat) - the results of structure and earnings survey (2010). Then, wages were turned into US$ using official exchange rates available at the World Bank database. In order to estimate wages in 2000, we used per capita GDP growth as a proxy of wages' growth - from 2000 to 2005 for Azerbaijan and Georgia, and from 2000 to 2010 for Turkey - to estimate wages in 2000. Finally, the impact of US$ inflation over the mentioned periods was removed using the US GDP deflator taken from the World Bank database. Accordingly, total annual wages were computed by multiplying the per capital annual wage in 2000 in each of the three countries by the number of workers for both construction and operational phases as follows:

Table 2.5. Total annual wages paid to the workers in the three countries during the construction and operational phases in US$

Country	Per capita annual wage in 2000 (1)	The Number of workers during Construction (2)	The Number of workers during Operation (3)	c_j (Annual wages paid during the construction Phase) (1)* (2)	w_j (Annual wages paid during the operational phase) (1)* (3)
A	1549	2300	250	3,562,558	387,235
T	5053	5000	350	25,267,442	1,768,721
G	1214	2500	250	3,035,841	303,584
sum				31,865,841	2,459,540

Source of the employees' numbers is CSR Network (2003). Total wages have been estimated using the International Labour Organization database, the Turkish Statistical Institute (TurkStat), and the World Bank database.

It can be seen from Table 2.5 that total wages paid to the employees in the three countries are estimated to have reached to $31,865,841 during the construction period (2003- 2005) and $2,459,540 annually since 2006 onwards.

Besides the direct benefits of the project to the host countries, the pipeline project involves different indirect benefits such as developing skills of local businesses, enhancing recruitment and contracting practices, and developing local infrastructure (CSR Network, 2003). However, the project involves also many indirect costs such as security costs, legal liabilities for human rights abuses, and the environmental costs (FFM, 2003). Accordingly, FFM (2003) suggested that the indirect costs cancel out the indirect benefits; therefore, for simplicity, the indirect effects (e_j) of the project on each host country are assumed to be zero in this example.

Costs and revenues in this example are discounted using stakeholders discount rates (r_i) in 2000 - the year in which the agreement was signed. Thus, the real interest rates 6.4%, 20%, and 26.8% are used as discount rates for Azerbaijan, Turkey, and Georgia respectively. For Azerbaijan and Georgia, the rates in 2000 were taken from the World Bank database, but for Turkey the real interest rate is not available at the World Bank database, therefore we considered the rate cited by Kannan (2008). For the MNC, the Weighted Average Cost of Capital (WACC= 10%)[12] is used as a discount rate.

After estimating the parameters, we need to find the bargaining outcomes (shown previously in Table 2.2). Using the discount rates of the parties, we find the shares resulting from bargaining (α_i, β_i) as follows:

[12] This rate represents an industry average WACC, the most accurate for BP Global over the long term. (Source: http://www.wikiwealth.com/wacc-analysis:bp)

Table 2.6. The shares of the surplus which the participants in the BTC project receive with both simultaneous and sequential bargaining

Simultaneous bargaining	Sequential bargaining
$\alpha_A = \frac{1}{r_A} / \left(\frac{1}{r_{MNC}} + \frac{1}{r_A} + \frac{1}{r_T} + \frac{1}{r_G}\right) = 0.45$	$\beta_A = \frac{r_{MNC}}{r_{MNC}+r_A} = 0.61$
$\alpha_T = \frac{1}{r_T} / \left(\frac{1}{r_{MNC}} + \frac{1}{r_A} + \frac{1}{r_T} + \frac{1}{r_G}\right) = 0.15$	$\beta_T = \left(\frac{r_A}{r_{MNC}+r_A}\right)\left(\frac{r_{MNC}}{r_{MNC}+r_T}\right) = 0.13$
$\alpha_G = \frac{1}{r_G} / \left(\frac{1}{r_{MNC}} + \frac{1}{r_A} + \frac{1}{r_T} + \frac{1}{r_G}\right) = 0.11$	$\beta_G = \left(\frac{r_{MNC}}{r_{MNC}+r_G}\right)\left(\frac{r_A}{r_{MNC}+r_A}\right)\left(\frac{r_T}{r_{MNC}+r_T}\right) = 0.07$
$\alpha_{MNC} = \frac{1}{r_{MNC}} / \left(\frac{1}{r_{MNC}} + \frac{1}{r_A} + \frac{1}{r_T} + \frac{1}{r_G}\right) = 0.29$	$\beta_{MNC} = \left(\frac{r_G}{r_{MNC}+r_G}\right)\left(\frac{r_A}{r_{MNC}+r_A}\right)\left(\frac{r_T}{r_{MNC}+r_T}\right) = 0.19$

Now, we find $\Omega_i = \sum_{t=3}^{t=5} \frac{1}{(1+r_i)^t} r_i(1+r_i)^5$ using the parties' discount rates. Thus, we find that Ω_A=0.20 , Ω_T=0.73, Ω_G=1.04, and Ω_{MNC}=0.33.

Then, multiplying Ω_j by wages paid to each of the three countries over the construction period - 2003 to 2005 - we find $\Omega_j c_j$:

Table 2.7. Wages paid to the three countries during the three years construction phase

Country	c_j (Annual wages paid during the construction Phase in US$)	r_j (Discount rates)	Ω_j $[\sum_{t=3}^{t=5} \frac{1}{(1+r_j)^t} r_j(1+r_j)^5]$	$\Omega_j * c_j$
A	3,562,558	6.4%	0.20	712,512
T	25,267,442	20 %	0.73	18,445,233
G	3,035,841	26.8 %	1.04	3,157,274
sum				22,315,018

Finally, we need to estimate the bargainers' outside options (o_A, o_T, o_G, o_{MNC}). Therefore we consider the incomes which would have been obtained by the players if an alternative route to the BTC pipeline had been constructed. Since transporting the oil via Russia or Iran is assumed politically infeasible, we assume that the alternative route crosses Azerbaijan and Georgia and Turkey, but via the Black Sea - as shown in Figure 2.4.

To estimate the profits from such a project, we consider the Baku-Supsa pipeline, which transports oil from Azerbaijan to the Georgian port of Supsa on the Black Sea with a capacity of almost 150,000 barrels a day. We calculate the expected net profits for the four participants in the potential alternative project by assuming its revenues are analogous to that of the Baku-Supsa pipeline but with a capacity of one million barrels a day. Georgia did not share in the costs of this pipeline, but according to Billmeier et al. (2004) received transit revenues of about \$9b per annum in the early 2000s, and so we take this is the annual net profit for Georgia from the Baku-Supsa pipeline. Thus, for the potential alternative to the BTC pipeline, with its larger capacity, we scale up Georgia's annual net profit from the Baku-Supsa pipeline by (1,000,000/150,000). Assuming that the net profits for the participants in the alternative pipeline are in the same proportion as in the BTC pipeline, we therefore obtain an estimate of their outside options.

Figure 2.4. The assumed alternative route to the BTC

Using the shares (α_i) calculated previously in Table 2.6 ($\alpha_A = 45\%$, $\alpha_T = 15\%$, $\alpha_G = 11\%$, $\alpha_{MNC} = 29\%$), the overall transit revenue will be $\$60\,m \times (100/11) \approx \$545\,m$. Hence, the players would have received the following annual revenues from the assumed project - which we use as outside options for the BTC project: $o_A = \$545\,m \times 45\% \approx \$245\,m$, $o_T = \$545\,m \times 15\% \approx \$82\,m$, $o_G = \$60\,m$, and

$o_{MNC} = \$545\, m \times 29\% \approx \$158\, m$.[13] Thus, the sum of the annual outside options of the MNC and the three countries is $o_{MNC} + o_A + o_T + o_G = \$158m + \$245m + \$82m + \$60m = \$545m$. By discounting the annual outside options using the players' discount rates and assuming that the annual flows would have started by year 6 (the year when the pipeline starts to operate) we find the values of the outside options over the life of the project.

Now we find the BEP (the tariff charge per barrel at which $s = 0$, and therefore $\pi_i = 0$) using the previous estimates as follows:

$$s = \underbrace{v}_{BEP \times 365 \times 1m} - o_A - o_T - o_G - o_{MNC} - c\Omega_{MNC} - w + c_A\Omega_A + c_T\Omega_T + c_G\Omega_G + w_A + w_T + w_G = 0.$$

Therefore, $\mathrm{BEP} = \frac{-[-c\Omega_{MNC} - o_A - o_T - o_G - o_{MNC} - w + c_A\Omega_A + c_T\Omega_T + c_G\Omega_G + w_A + w_T + w_G]}{365 \times 1{,}000{,}000}$

$$= \frac{397{,}200{,}000 + 545{,}000{,}000 + 160{,}000{,}000 - 22{,}315{,}018 - 2{,}459{,}540}{365 \times 1{,}000{,}000} = \$3$$

Thus, with the tariff charge equal to \$3/barrel, which is within the range \$2.58 to \$3.30/barrel quoted by some figures, according to Mansley (2003, p.11), the project produces for each player only an income equal to its outside option over the life of the project - i.e., $\varpi_i = \zeta_i\alpha_i s + O_i = 0 + O_i = \zeta_i o_i$. Thus, Azerbaijan receives $\varpi_A = 11.46 \times \$254\mathrm{m} = \$2807\mathrm{m}$; likewise, the MNC, Turkey, and Georgia receive only \$981m, \$165m, and \$68m, respectively, over the life of the project. Hence, the total surplus is equal to zero, and the parties are indifferent between signing the agreement or not.

[13] This assumes that, in the alternative project, the bargaining between the parties occurs simultaneously, and players have zero outside options, so that their revenues are equal to the proportions of the surplus they receive starting from 2006 (i.e., $\tau = 6$).

For the pipeline project to be profitable, the tariff charge is required to be higher than \$3/barrel; therefore, the payments to the host countries and the net payoffs are examined using the tariff charge \$3.5/barrel, which is higher than the BEP, but lower than the charge \$5.5 that actually obtained in 2012 (Interfax, 2012)[14]. Accordingly, the total revenues from the project will be $v = \$3.5 \times 365\text{ day} \times 1\text{m barrel} \approx \$1{,}277\text{m}$, whereas $s \approx \$188\text{ m}$.

By using all the previous estimates and bargaining outcomes in Table 2.2, we find now the annual payments received by the three countries (i.e., $p_j = \alpha_j s - c_j \Omega_j - w_j + o_j$) as follows:

Table 2.8. The payments to Azerbaijan, Turkey, and Georgia when the tariff charge is \$3.5/barrel

	j	Shares of the surplus (s = \$$188m$)				p_j (millions of \$)
Simultaneous	**A**	α_j	45%	$\alpha_j s$	85	329
	T		15%		28	90
	G		11%		21	78
	Sum (total payments)					p =497
Sequential	**A**	β_j	61%	$\beta_j s$	115	359
	T		13%		24	86
	G		07%		13	70
	Sum (total payments)					p =515

The simultaneous bargaining outcomes in Table 2.8 suggest that the MNC pays annually $p = p_A + p_T + p_G = \$497$ million to the three host countries, so it is left with $v - p = \$1277\text{m} - \$497\text{m} = \$780\text{m}$ annually and so $\zeta_{\text{MNC}}(v - p) = \$4{,}844$ million over the life of the project which should be greater than the MNC's

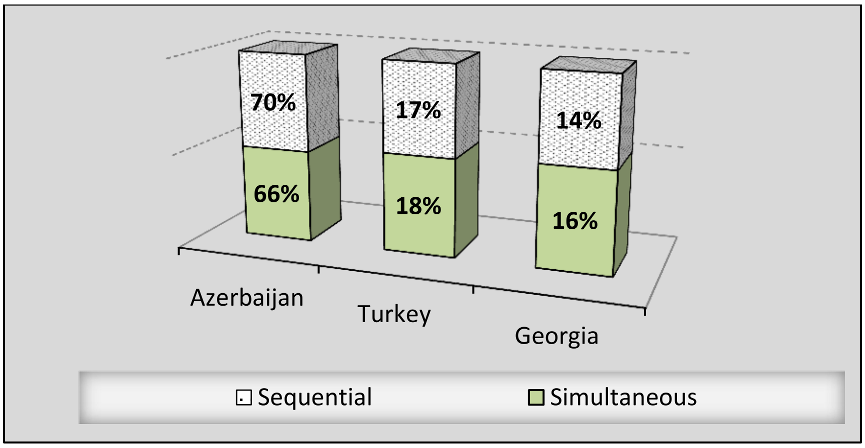
[14] With regard to transporting Kazakhstan's oil via BTC pipeline, the head of Kazakhstan's national welfare fund said that "Transportation has fallen off in recent years for sure, but that is due to the tariff for BTC transportation rising. It was \$4, now it is \$5.5 per barrel" (Interfax, 2012).

outside option (O_{MNC}) after subtracting its construction and operating costs (ζ_{MNC} ($c\Omega_{MNC} + w$)) in order to achieve a net positive payoff ($\pi_{MNC} > 0$).

Elkind (2005, p.49) indicated that the transit fees will produce approximately $200 million annually for Turkey in initial years of operations with a possibility to increase after year 17 up to $290 million. For Georgia, the pipeline will produce $62.5 million annually from transit revenues (Papava, 2005, p. 87).

In contrast, our results in Table 2.8, with simultaneous bargaining, show that Azerbaijan receives the highest annual payments, 66% of the total payments (p) - as is clarified in Figure 2.5 - attributed to owning the oil fields and thus having the greatest outside option, as well as to its low discount rate comparing to that of the other players. In contrast, Turkey receives only $90 million per year (18% of the total payments), while Georgia which has the highest discount rate and the smallest outside option receives $78 million annually (16% of the total payments), but, each host country receives also the incomes from the wages paid to the workers over the construction and operating periods.

Figure 2.5. The payments to the host countries (% the annual total payments)

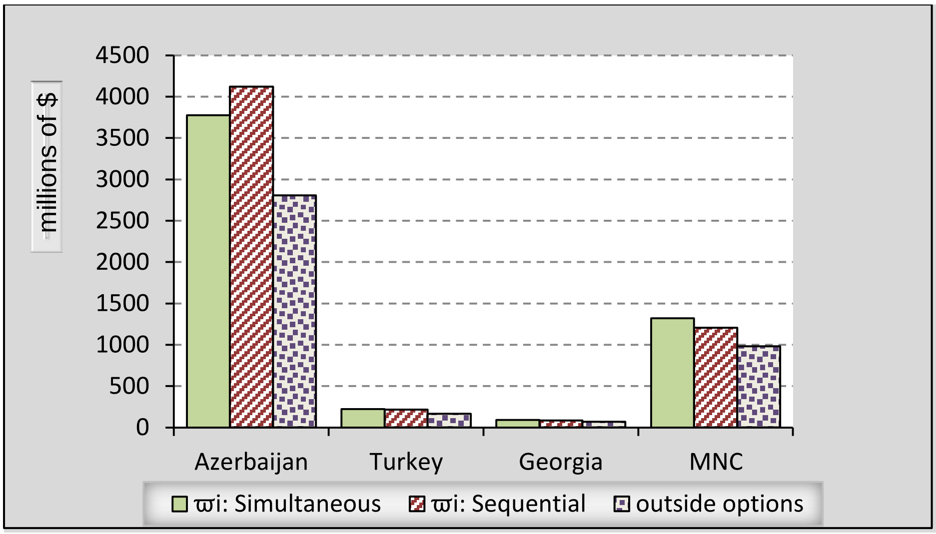


Finally, we find the returns from the project (ϖ_i), and then the net payoff (π_i) for each player which is the difference between ϖ_i and O_i over the life of the project as follows: [15]

Table 2.9. The participants' gross and net payoffs from the BTC project when the tariff charge is \$3.5/barrel

	i	ζ_i	$s * \zeta_i$ (s = \$188m)	Shares of the surplus		Net payoffs (π_i) (millions of \$)		Gross payoffs (ϖ_i) (millions of \$)	
Simultaneous	A	11.46	2,154	α_i	45%	$\zeta_i \alpha_i s$	969	$\zeta_i \alpha_i s + O_i$	3,776
	T	2.01	378		15%		57		222
	G	1.14	214		11%		24		92
	MNC	6.21	1167		29%		339		1,320
	sum				1		1,389		5,410
Sequential	A	11.46	2,154	β_i	61%	$\zeta_i \beta_i s$	1,314	$\zeta_i \beta_i s + O_i$	4,121
	T	2.01	378		13%		49		214
	G	1.14	214		07%		15		83
	MNC	6.21	1,167		19%		222		1,203
	sum				1		1,600		5,621

Figure 2.6. Gross payoffs (ϖ_i) versus the outside options (O_i) when the tariff charge is \$3.5/barrel



[15] For simplicity, we have not taken into account that Azerbaijan owns 25% of BTC and Turkey 6.53%. Given the different discount rates of the players, the relative values of these ownership shares would depend on the timing of the profit distributions. However, if, to get an idea of the broad orders of magnitude, we simply reallocate these percentages of the yield and net payoffs from the BTC project to these two countries, our general conclusions still hold.

Table 2.9 shows that the project is viable for the four participants when the tariff price is higher than $3/barrel - $3.5/barrel in this case - since each of them earns a payoff (ϖ_i) greater than the income from his outside option (O_i) over the life of the project - as it shown in Figure 2.6. That is, $\varpi_i > O_i$ therefore $\pi_i > 0$.

With both bargaining scenarios, Azerbaijan receives the highest return (ϖ_A) over the life of the project followed by the MNC then by Turkey and then by Georgia. However, sequential bargaining is more profitable for Azerbaijan with which it would earn extra 9% of the profits produced with simultaneous bargaining, but for Turkey, Georgia and the MNC, simultaneous bargaining produces extra 4%, 11%, and 10%, respectively, of the profits that would be produced with sequential bargaining.

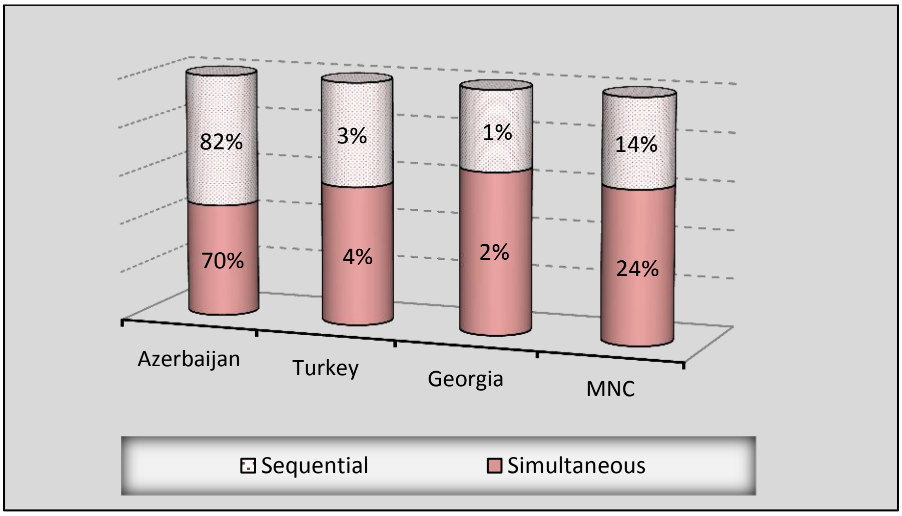
Since Azerbaijan and Turkey are shareholders in the BTC Company (MNC) - as was shown in Table 2.1 - they also earn 25% and 6.5%, respectively, of the MNC's profits (ϖ_{MNC}). Azerbaijan, therefore, acquires $\$1,320 \text{ million} \times 25\% = \$330 \text{ million}$, whereas Turkey gets $\$1,320 \text{ million} \times 6.5\% = \$86 \text{ million}$ over the life of the project.

Consequently, the less the discount rate is, and the greater the outside option is, the higher the player's bargaining power is and therefore the more benefits he can obtain from negotiation.

With regard to the surplus distribution, simultaneous bargaining outcomes in Table 2.9 and Figure 2.7 indicate that Azerbaijan receives the highest net payoff (70% of the total surplus), followed by the MNC with 24% of the total surplus, while the other two transit countries (Turkey and Georgia) get only 4% and 2%, respectively.

However, if the discount rates were identical, the overall surplus would have been distributed evenly between the four players, so each player would receive 25% of the surplus. As a result, when the players bargain simultaneously, their discount rates, and thus their bargaining weights are the determinants in distributing the overall surplus resulting from cooperation.

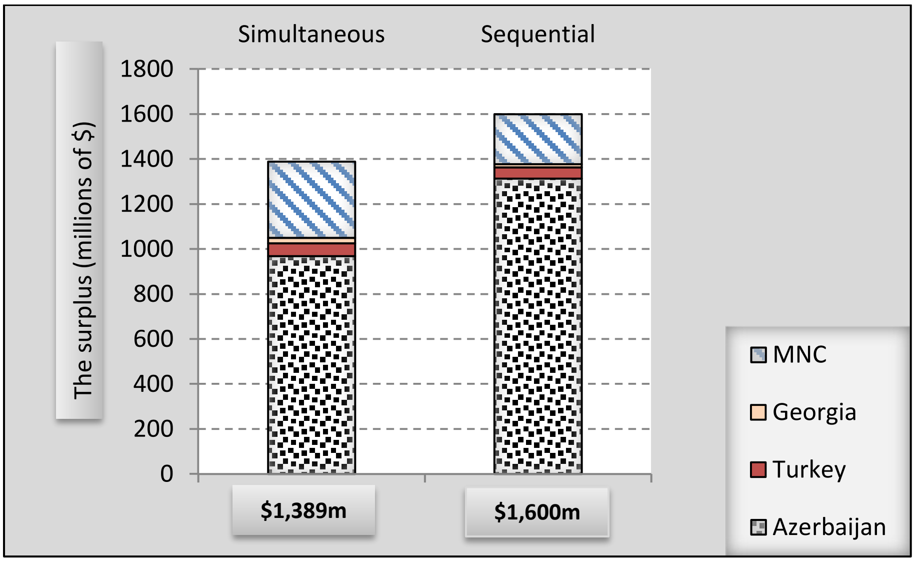
Figure 2.7. Players' proportions of the total surplus with simultaneous and sequential bargaining



In contrast, if the MNC undertakes a sequential bargain with the host countries - Table 2.9 - besides the impact of bargaining weights, the bargaining order affects the distribution of the total surplus between the players. Thus, Azerbaijan gains the greatest net payoff (82% of the overall surplus), while the MNC receives 14%, but Turkey and Georgia gets only 3% and 1%, respectively. Even if the discount rates were identical, the bargainers would not receive equal net payoffs. This implies that the player's impatience and his bargaining order determine the size of the surplus allocated to that player.

Furthermore, it can be noticed that the total surplus with sequential bargaining is greater than with simultaneous bargaining by 15% - see Figure 2.8. The difference, as was shown in section 2.4.2.4, is attributed to discounting players' revenues and costs (flows) over the years using different discount rates. Hence, if the players had identical discount rates, the total surplus would be identical with the two bargaining scenarios.

Figure 2.8. The total surplus with both simultaneous and sequential bargaining



Overall, the bargaining results suggest that the BTC pipeline produces positive net payoffs for the MNC and the three host countries when a tariff charge is higher than $3 per barrel, but the size of each player's net payoff is determined by the bargainer's degree of impatience, and his bargaining order.

In the case of the BTC project, Azerbaijan which bargains first with the MNC - when we the bargaining is sequential - has the lowest discount rate, and Georgia which bargains last with the MNC has the highest discount rate. This raises a question as to how the bargaining outcomes would have changed if the parties have had different discount rates. Therefore, the next section attempts to answer this question based on different assumptions on participants' discount rates.

2.5.2. Sensitivity analysis of bargainers' discount rates

The effects of different possible discount rate configurations on players' net payoffs are demonstrated in this section. The bargainers' preferences for simultaneous or sequential bargaining with different assumptions on their discount rates are shown theoretically, and then bargaining outcomes are illustrated numerically.

Let Turkey, Georgia, and MNC have the same discount rate but different (⋚) from that of Azerbaijan, i.e., $r_T = r_G = r_{MNC} \equiv r \neq r_A$. Allowing for this in the bargaining outcomes in Table 2.2, it can be seen that Azerbaijan's net payoff (π_A) with sequential bargaining will be greater than that with simultaneous bargaining, i.e. $\underbrace{\frac{r}{r+3r_A}\zeta_A s}_{\text{simultaneous}} < \underbrace{\frac{r}{r+r_A}\zeta_A s}_{\text{sequential}}$, because for $\underbrace{\frac{r}{r+3r_A}\zeta_A s}_{\text{simultaneous}} \geq \underbrace{\frac{r}{r+r_A}\zeta_A s}_{\text{sequential}}$ it would be necessary that $r_A \leq 0$, which we rule out by assumption. Therefore, sequential bargaining is the better bargaining scenario for Azerbaijan in this case.

If $r_A = r_T \neq r_G = r_{MNC} = r$, Azerbaijan's net payoffs (π_A) will be greater with sequential bargaining - i.e., $\underbrace{\frac{r}{2(r+r_A)}\zeta_A s}_{\text{simultaneous}} < \underbrace{\frac{r}{(r+r_A)}\zeta_A s}_{\text{sequential}}$. Therefore, sequential bargaining is better than simultaneous bargaining for Azerbaijan, and the same result will be obtained when $r_A = r_G \neq r_T = r_{MNC} = r$.

If $r_A = r_{MNC} \neq r_T = r_G = r$, the bargaining outcomes for Azerbaijan will be:

$\underbrace{\frac{r}{2(r+r_A)}\zeta_A s}_{\text{simultaneous}} < \underbrace{\frac{1}{2}\zeta_A s}_{\text{sequential}}$, therefore sequential bargaining is better for Azerbaijan because for $\underbrace{\frac{r}{2(r+r_A)}\zeta_A s}_{\text{simultaneous}} \geq \underbrace{\frac{1}{2}\zeta_A s}_{\text{sequential}}$ it would be necessary that $r_A \leq 0$, which we rule out by assumption.

Following a similar procedure, it can be shown the bargaining preferences of the other parties using different assumptions on their discount rates (see Appendix B2).

Numerically, the impacts of different configurations of participants' discount rates on the Break Even Point (BEP), on participants' net payoffs, and thus on their bargaining preferences for simultaneous or sequential bargaining are shown using different assumptions in Table 2.10.

In each case in the table, the BEP - Column 1 - at which the project produces a zero total surplus is found, and then a tariff price higher than the BEP, by \$0.5/barrel, is set - Column 2 - to find the associated revenues (v), and $s = v - o_A - o_T - o_G - o_{MNC} - c\Omega_{MNC} - w + c_A\Omega_A + c_T\Omega_T + c_G\Omega_G + w_A + w_T + w_G$, and finally the participants' net payoffs (π_i) with both simultaneous and sequential bargaining.

Case 1 presents the net payoffs using the original real discount rates of the participants - the same as those used in the case study to allow comparison with the following cases in the table.

Contrary to the real discount rates by the time the agreement was made (see Case 1), in Case 2 the first bargainer with the MNC (Azerbaijan) is assumed to have the highest interest rate while the last bargainer (Georgia) has the lowest one, to show how this affects their net payoffs.

As Turkey and Georgia have high discount rates (20% and 26.8%, respectively) in Case 1, in Case 3 the two countries' discount rates are reduced by 0.15, each, to examine how that might affect the BEP. However, the total construction costs are discounted by the MNC's discount rate; therefore, in Case 4, only the MNC's discount rate is reduced to show how it affects the BEP.

In Case 5, the bargainers' discount rates are assumed to be identical in order to compare the net payoffs resulting from simultaneous bargaining - where the players obtain equal net payoffs - with those resulting from sequential bargaining.

Cases 6 to 21 present several other possible assumptions when two or more players have identical discount rates, but different from the others, to show how the partners' net payoffs are affected in each bargaining scenario.

Table 2.10. Net payoffs the bargainers receive with different possible configurations of discount rates

Case		Party	(%)			$/barrel		Millions of US $		
			Discount rate	Shares of the surplus		(1) BEP	(2) Tariff	Revenues	Net payoffs S=$188m	
				Sim	Seq				Sim	Seq
1	$r_A \neq r_T \neq r_G \neq r_{MNC}$	A	6.4	45	61	3.0	3.5	1,277	969	1,314
		T	20	15	13				57	49
		G	26.8	11	7				24	15
		MNC	10	29	19				339	222
2	$r_A \neq r_T \neq r_G \neq r_{MNC}$	A	13	18	43	3.0	3.5	1,276	142	341
		T	11	21	27				217	272
		G	6.4	37	18				792	388
		MNC	10	24	12				275	135
3	$r_A \neq r_T \neq r_G \neq r_{MNC}$	A	6.4	29	61	3.0	3.5	1,281	621	1,311
		T	5	37	26				1,087	765
		G	11.8	16	6				143	54
		MNC	10	18	7				215	82
4	$r_A \neq r_T \neq r_G \neq r_{MNC}$	A	6.4	35	44	2.4	2.9	1,057	757	943
		T	20	11	11				42	42
		G	26.8	8	7				18	15
		MNC	5	45	38				1,326	1,113
5	$r_A = r_T = r_G = r_{MNC}$	A	6.4	25	50	2.6	3.1	1,129	537	1,075
		T	6.4	25	25				537	537
		G	6.4	25	13				537	269
		MNC	6.4	25	13				537	269
6	$r_A = r_{MNC} \neq r_G = r_T$	A	6.4	30	50	2.6	3.1	1,126	655	1,075
		T	10	20	20				227	227
		G	10	20	12				227	139
		MNC	6.4	30	19				655	400
7	$r_A = r_G \neq r_{MNC} = r_T$	A	6.4	30	61	3.0	3.5	1,278	655	1,311
		T	10	20	20				227	227
		G	6.4	30	12				655	256
		MNC	10	20	8				227	89
8	$r_A = r_{MNC} \neq r_T \neq r_G,\ r_T > r_G$	A	6.4	33	50	2.6	3.1	1,121	701	1,075
		T	15	14	15				87	93
		G	10	21	14				243	159
		MNC	6.4	33	21				701	459
9	$r_A = r_{MNC} \neq r_T \neq r_G,\ r_T < r_G$	A	6.4	33	50	2.6	3.1	1,125	701	1,075
		T	10	21	20				243	227
		G	15	14	9				87	57
		MNC	6.4	33	21				701	459
10	$r_A = r_T \neq r_G = r_{MNC}$	A	6.4	30	61	3.0	3.5	1,280	655	1,311
		T	6.4	30	24				655	512
		G	10	20	8				227	89
		MNC	10	20	8				227	89

Case		Party	(%)			$/barrel		Millions of US $		
			Discount rate	Shares of the surplus		(1) BEP	(2) Tariff	Revenues	Net payoffs S=$188m	
				Sim	Seq				Sim	Seq
11	$r_A = r_T = r_G \neq r_{MNC}$	A	6.4	27	61	3.0	3.5	1,281	591	1,311
		T	6.4	27	24				591	512
		G	6.4	27	9				591	200
		MNC	10	18	6				205	69
12	$r_A \neq r_T = r_G = r_{MNC}$	A	6.4	34	61	3.0	3.5	1,277	736	1,311
		T	10	22	20				255	227
		G	10	22	10				255	114
		MNC	10	22	10				255	114
13	$r_A = r_T = r_{MNC} \neq r_G$	A	6.4	31	50	2.6	3.1	1,127	664	1,075
		T	6.4	31	25				664	537
		G	26.8	7	5				16	10
		MNC	6.4	31	20				664	434
14	$r_A=r_{MNC}=r_G=r\neq r_T, r<r_T$	A	6.4	27	50	2.6	3.1	1,126	591	1,075
		T	10	18	20				205	227
		G	6.4	27	15				591	328
		MNC	6.4	27	15				591	328
15	$r_A=r_{MNC}=r_G=r\neq r_T, r>r_T$	A	10	22	50	3.0	3.5	1,280	255	582
		T	6.4	34	30				736	655
		G	10	22	10				255	114
		MNC	10	22	10				255	114
16	$r_A=r_T=r_G=r\neq r_{MNC}, r<r_{MNC}$	A	6.4	27	61	3.0	3.5	1,281	591	1,311
		T	6.4	27	24				591	512
		G	6.4	27	9				591	200
		MNC	10	18	6				205	69
17	$r_A=r_T=r_G=r\neq r_{MNC}, r>r_{MNC}$	A	10	22	39	2.6	3.1	1,125	255	455
		T	10	22	24				255	277
		G	10	22	15				255	169
		MNC	6.4	34	23				736	487
18	$r_A=r_T=r_{MNC}=r\neq r_G, r<r_G$	A	6.4	27	50	2.6	3.1	1,129	591	1,075
		T	6.4	27	25				591	537
		G	10	18	10				205	114
		MNC	6.4	27	15				591	328
19	$r_A=r_T=r_{MNC}=r\neq r_G, r>r_G$	A	10	22	50	3.0	3.5	1,277	255	582
		T	10	22	25				255	291
		G	6.4	34	15				736	328
		MNC	10	22	10				255	114
20	$r_A\neq r_{MNC}=r_T=r_G=r, r>r_A$	A	6.4	34	61	3.0	3.5	1,277	736	1,311
		T	10	22	20				255	227
		G	10	22	10				255	114
		MNC	10	22	10				255	114
21	$r_A\neq r_{MNC}=r_T=r_G=r, r<r_A$	A	10	18	39	2.6	3.1	1,129	205	455
		T	6.4	27	30				591	655
		G	6.4	27	15				591	328
		MNC	6.4	27	15				591	328

Consequently, we find that:

- In all examined cases, the first player that negotiates with the MNC (Azerbaijan) gets a higher net payoff with sequential bargaining than what it would earn with simultaneous bargaining. But, the third player that negotiates with the MNC (Georgia) gets a lower net payoff than it would earn with simultaneous bargaining. However, for the second player (Turkey), the bargaining process with which it gets a higher net payoff depends on bargainers' discount rates.
- In order to get the BEP down, the discount rates, particularly for the MNC, have to be reduced substantially (and maybe unrealistically), as the total construction costs are discounted using r_{MNC}. For example, in Case 3, reducing the discount rates of Turkey and Georgia by 15% ($r_T = 5\%$, and $r_G = 11.8\%$), without changing r_{MNC}, does not get the BEP down. However, reducing r_{MNC} from 10% to 5% in Case 4, brings the level of the BEP down to become $2.4/barrel.
- Turkey is indifferent between simultaneous and sequential bargaining in Cases 5, 6, 7. However its preference is different in the other cases. For example, in Case 14, sequential bargaining is better than simultaneous bargaining for Turkey when $r_T > r$, while simultaneous bargaining is preferred to sequential bargaining, in Case 15, when $r_T < r$.
- Although Azerbaijan is the first country which negotiates with the MNC, it could obtain a lower net payoff than that of another country bargaining later with the MNC when Azerbaijan's discount rate is higher than that of the other bargainer. For example, Azerbaijan gets a lower net payoff than Turkey in Case 15 as $r_A > r_T$.

2.7. Conclusions

This chapter aims at evaluating the BTC oil pipeline project - the first direct transportation pipeline linking between the Caspian and the Mediterranean seas - by employing bargaining theory (the Nash bargaining solution, and the alternating offer bargain of Rubinstein). We have examined the viability of the project for the concerned parties (the MNC, Azerbaijan, Turkey, and Georgia) by verifying the profitability of the project for each party, assuming certainty, with two different bargaining formulations (simultaneous and sequential bargaining).

The findings suggest that the project is feasible for the MNC and the three host countries when the transit charge is greater than the BEP ($3 per barrel) at which the project produces a zero total surplus; thus, for a tariff charge higher than this rate, the project generates returns for each participant greater than his outside option.

With both bargaining scenarios, we find that Azerbaijan, which has the lowest discount rate, and the biggest outside option, obtains the highest proportion of the total surplus, followed by the MNC, then by Turkey, and finally by Georgia which has the highest discount rate and the smallest outside option. But, sequential bargaining is more profitable for Azerbaijan, which bargains first with the MNC, than simultaneous bargaining; whereas for the MNC and the other two transit countries simultaneous bargaining is more beneficial. This suggests that the participants' discount rates, their bargaining orders, and their outside options are the determinants of the gross payoffs they receive over the life of the project.

Furthermore, the outcomes indicate that with bargaining over discounted flows, each bargaining process results in a different total surplus attributed to players' different discount rates by which revenues and costs are discounted over the life of the project.

The results suggest that the payoffs for the two transit countries, Turkey and Georgia, would have appeared relatively small at the time the agreement was made. Given that any major project is undertaken in a context of considerable uncertainty, and that this would have been recognized at the time, it therefore seems possible that other factors, such as political concerns, or other economic agreements not directly part of this project, may have played a role in their participation.

Appendix A2

BTC milestones[16]

- 20 Sep 1994: BP, Statoil, Amoco and other Oil companies sign "the Contract of the Century" (Production Sharing Agreement)
- 1998-1999: US government (backed by Turkey and Azerbaijan) puts heavy pressure on BP and AIOC to support Baku-Ceyhan pipeline
- November 18, 1999: Intergovernmental agreement on oil transportation via BTC pipeline signed among Azerbaijan, Georgia and Turkey
- October 2000: Host Government agreements and BTC turnkey lump-sum agreement signed
- November, 2000: BTC Basic Design commences
- May 21, 2001: BTC Detailed Engineering Phase contract awarded
- August 1, 2002: BTC Pipeline Company formed
- September 12, 2002: BTC construction project sanctioned
- December 4, 2002: All BTC Environmental and Social Impact Assessments approved
- January 23, 2003: First BTC pipe arrives in Azerbaijan
- May 23, 2003: BTC pipeline pump station construction starts
- July 30, 2003: BTC pipe lay commences in Azerbaijan
- November 11, 2003: IFC and EBRD approve BTC pipeline loans
- February 3, 2004: BTC signs Project Finance agreements

[16] See, BP. Project timeline: Get familiar with the major milestones in the history of Azeri-Chirag-Gunashli development. Available at: http://www.bp.com/en_az/caspian/operationsprojects/ACG/projecthistory.html.

- May 10, 2005: BTC line fill starts
- May 25, 2005: Azerbaijan section of BTC inaugurated
- August 11, 2005: Oil crosses the Azerbaijan-Georgian border via BTC
- October 12, 2005: Georgian section of BTC inaugurated
- June 4, 2006: BTC lifts First Oil onto the tanker British Hawthorn from Ceyhan
- July 13, 2006: Turkish section of BTC inaugurated
- April 15, 2007: BTC exports its 100 millionth barrel
- November 6, 2008: First volumes of Kazakhstan oil enter the BTC pipeline

Appendix B2

Bargaining preferences of Turkey, Georgia, and the MNC

By substituting different assumptions on discount rates in the bargaining outcomes - Table 2.2 - we can find players' preferences as follows:

Turkey

If bargainers have the same discount rate ($r_A = r_T = r_G = r_{MNC} \equiv r$), the net payoff ($\pi_T$) received by Turkey with simultaneous bargaining is equal to that with sequential bargaining:

$$\underbrace{\frac{1}{4}s\zeta_T}_{\text{simultaneous}} = \underbrace{\frac{1}{4}s\zeta_T}_{\text{sequential}}$$

Therefore, Turkey, in this case, is indifferent between bargaining sequentially or simultaneously.

However, when $r_A = r_G = r_{MNC} \equiv r > r_T$, then $\underbrace{\frac{r}{(r+3r_T)} s\zeta_T}_{\text{simultaneous}} > \underbrace{\frac{r}{2(r+r_T)} s\zeta_T}_{\text{sequential}}$

therefore simultaneous bargaining is better for Turkey in this case, but if $r_A = r_G = r_{MNC} \equiv r < r_T$, then $\underbrace{\frac{r}{(r+3r_T)} s\zeta_T}_{\text{simultaneous}} < \underbrace{\frac{r}{2(r+r_T)} s\zeta_T}_{\text{sequential}}$, so sequential bargaining is better for Turkey in this case.

If $r_T = r_A < r_G = r_{MNC} = r$, simultaneous bargaining is better for Turkey, in this case, because $\underbrace{\frac{r}{2(r+r_T)} s\zeta_T}_{\text{simultaneous}} > \underbrace{\frac{r r_T}{(r+r_T)^2} s\zeta_T}_{\text{sequential}}$.

But, when $r_T = r_A > r_G = r_{MNC} = r$, then $\underbrace{\frac{r}{2(r+r_T)} s\zeta_T}_{\text{simultaneous}} < \underbrace{\frac{r r_T}{(r+r_T)^2} s\zeta_T}_{\text{sequential}}$ sequential bargaining is better for Turkey.

When $r_T = r_G \neq r_A = r_{MNC} = r$ then the outcomes for Turkey (π_T) will be:

$\underbrace{\frac{r}{2(r+r_T)} s\zeta_T}_{\text{simultaneous}} = \underbrace{\frac{r}{2(r+r_T)} s\zeta_T}_{\text{sequential}}$, so Turkey, in this case, is indifferent between bargaining simultaneously or sequentially, and the same result will be obtained when $r_T = r_{MNC} \neq r_A = r_G = r$

Georgia

If the bargainers have identical discount rates ($r_A = r_T = r_G = r_{MNC} \equiv r$), Georgia prefers bargaining simultaneously through which it receives a greater net payoff (π_G):

$$\underbrace{\frac{1}{4} s\zeta_G}_{\text{simultaneous}} > \underbrace{\frac{1}{8} s\zeta_G}_{\text{sequential}}$$

If $r_A = r_T = r_{MNC} \equiv r \neq r_G$, simultaneous bargaining is also better for Georgia. That is,

$\underbrace{\frac{r}{(r+3r_G)} s\zeta_G}_{\text{simultaneous}} > \underbrace{\frac{r}{4(r+r_G)} s\zeta_G}_{\text{sequential}}$ because for $\underbrace{\frac{r}{(r+3r_G)} s\zeta_G}_{\text{simultaneous}} \leq \underbrace{\frac{r}{4(r+r_G)} s\zeta_G}_{\text{sequential}}$ it would be necessary that $r_G \leq -3r$, but according to our assumptions $r, r_G > 0$, therefore $r_G \nleq -3r$, and so $\underbrace{\frac{r}{(r+3r_G)} s\zeta_G}_{\text{simultaneous}} \nleq \underbrace{\frac{r}{4(r+r_G)} s\zeta_G}_{\text{sequential}}$

If $r_G = r_T \neq r_A = r_{MNC} = r$, Georgia prefers simultaneous bargaining:

$\underbrace{\frac{r}{2(r+r_G)} s\zeta_G}_{\text{simultaneous}} > \underbrace{\frac{r r_G}{2(r+r_G)^2} s\zeta_G}_{\text{sequential}}$ because for $\underbrace{\frac{r}{2(r+r_G)} s\zeta_G}_{\text{simultaneous}} \leq \underbrace{\frac{r r_G}{2(r+r_G)^2} s\zeta_G}_{\text{sequential}}$ it would be necessary that $r \leq 0$ which we rule out in our assumptions. The same result will be obtained when $r_G = r_A \neq r_T = r_{MNC} = r$

If $r_G = r_{MNC} \neq r_A = r_T = r$ then simultaneous bargaining is better in this case, as the net payoff with simultaneous bargaining is greater than that with sequential bargaining: $\underbrace{\frac{r}{2(r+r_G)} s\zeta_G}_{\text{simultaneous}} > \underbrace{\frac{r^2}{2(r+r_G)^2} s\zeta_G}_{\text{sequential}}$ because $\underbrace{\frac{r}{2(r+r_G)} s\zeta_G}_{\text{simultaneous}} \leq \underbrace{\frac{r^2}{2(r+r_G)^2} s\zeta_G}_{\text{sequential}}$ only when $r_G \leq 0$ which we rule out in our assumptions.

MNC

If the four parties have the same discount rate ($r_A = r_T = r_G = r_{MNC} \equiv r$), MNC prefers simultaneous bargaining through which it receives greater net payoff (π_{MNC}):

$$\underbrace{\frac{1}{4} s\zeta_{MNC}}_{\text{simultaneous}} > \underbrace{\frac{1}{8} s\zeta_{MNC}}_{\text{sequential}}$$

If MNC have a discount rate, but different ($\gtreqless$) from that of the host countries ($r_A = r_T = r_G \equiv r \neq r_{MNC}$), simultaneous bargaining is also better for MNC because it results in higher net payoff than that of sequential bargaining:

$\underbrace{\frac{r}{(r+3r_{MNC})}s\zeta_{MNC}}_{\text{simultaneous}} > \underbrace{\frac{r^3}{(r_{MNC}+r)^3}s\zeta_{MNC}}_{\text{sequential}}$, because $\underbrace{\frac{r}{(r+3r_{MNC})}s\zeta_{MNC}}_{\text{simultaneous}} \leq \underbrace{\frac{r^3}{(r_{MNC}+r)^3}s\zeta_{MNC}}_{\text{sequential}}$ only when $r_{MNC} \leq -3r$ which is not possible under our assumptions ($r_{MNC}, r > 0$).

If $r_{MNC} = r_G \neq r_A = r_T = r$, simultaneous bargaining is better for MNC as it results in a greater net payoff:

$\underbrace{\frac{r}{2(r+r_{MNC})}s\zeta_{MNC}}_{\text{simultaneous}} > \underbrace{\frac{r^2}{2(r+r_{MNC})^2}s\zeta_{MNC}}_{\text{sequential}}$, because $\underbrace{\frac{r}{2(r+r_{MNC})}s\zeta_{MNC}}_{\text{simultaneous}} \leq \underbrace{\frac{r^2}{2(r+r_{MNC})^2}s\zeta_{MNC}}_{\text{sequential}}$ implies that $r_{MNC} \leq 0$ which we rule out in our assumptions. The same result will be obtained when $r_{MNC} = r_A \neq r_G = r_T = r$, or $r_{MNC} = r_T \neq r_A = r_G = r$.

CHAPTER THREE

THE ECONOMIC IMPACT OF OIL ON DOMESTIC FIXED INVESTMENT IN NON-OECD OIL-EXPORTING COUNTRIES

3.1. Introduction

Oil proceeds might be a productive source of funding in oil-rich developing countries if they are used carefully and directed towards enhancing capital assets, and constructing infrastructure projects such as railways, roads, schools, hospitals, residential dwellings, and water and power projects. This in turn has the potential to generate job opportunities, raise living standards, and create a platform for sustainable economic growth in these countries.

It has been argued that oil-rich countries can base their development on oil and thereby promote economic growth, create jobs, and increase government revenues and thus enhance poverty alleviation programs. However, the experience of many oil-rich developing countries illustrates negative consequences of oil-led development such as slower than expected economic growth, corruption, poor governance, inequality, and barriers to economic diversification (Karl, 2007).

Within this framework, a wide body of the literature has examined implications of natural resources on economic growth. The findings of several empirical studies indicate that a natural resource boom affects economic growth positively, but some other studies show adverse effects of natural resources on economic activities in resource rich developing economies.

Although many scholars have investigated the determinants of gross domestic investment, or the linkage between domestic investment and financial development, capital flows, political stability, and institutional quality, fewer studies have paid attention to the relationship between gross domestic investment and resource abundance, especifically the effect of oil abundance on domestic investment in oil-exporting developing countries.

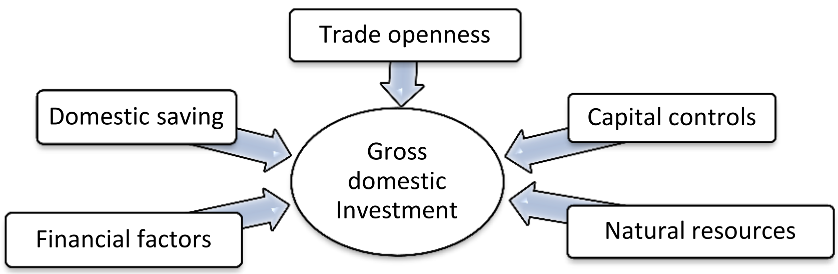
Therefore, this chapter attempts to fill this gap and examines the impact of oil abundance on domestic investment in 22 oil-exporting non-OECD countries over the period 1996-2010. We emphasize *domestic* investment in this study to examine whether the contribution of oil revenues to economic growth works via physical capital accumulation.

This chapter is structured as follows: The first section reviews the work of scholars who documented the relationship between gross domestic investment and factors affecting it, among which are: output growth, gross domestic savings, financial development, capital flows, and trade openness. It also reviews studies which explored the impact of natural resources on economic activities, and channels through which natural wealth might cause the resource curse in developing countries. The second section presents an overview of the study sample by throwing light on the association between oil rents and economic growth in oil-exporting economies included in our sample. It also pays attention to several options through which oil revenues can be used to maximize the oil benefit for the overall economy, and highlights the experience of several countries in the sample in using and managing oil proceeds. The third section introduces the investment model with both static and dynamic specifications, and presents the econometric method used in estimation; it also provides description of data and variables employed in the study. Finally, the fourth section illustrates estimation results of the investment equation and presents a discussion in light of related previous studies.

3.2. Literature review

Since this study aims at examining the oil effect on gross domestic investment in light of other determinants of domestic investment, this section throws light on the work of scholars who addressed the factors affecting domestic investment, and the work of those who documented the association between natural resource abundance and economic activities in oil-rich economies.

Figure 3.1. Factors affecting gross domestic investment



3.2.1. Investment-related literature

A large body of the literature has addressed investment-related aspects ranging from examining the determinants of domestic investment in a specific country or in a set of countries, to focusing on the relationship between domestic investment and a specific factor.

The pre-Keynesian orthodoxy viewed the saving rate as the fundamental determinant of the rate of capital accumulation because it determines the interest rate at which funds will be advanced to finance investment (Pollin, 1997).

Many scholars documented the linkage between domestic investment and domestic saving in both developed and developing economies suggesting a positive significant relationship between the two variables. On the assumption of perfect capital mobility, Feldstein and Horioka (1980) presented an empirical test using data of developed countries. They found that the cross-section saving-investment correlation is quite high suggesting imperfection in the international capital market, and that a large share of domestic savings tends to remain in home countries. In contrast, scholars who used a sample of developing countries found that the estimated coefficient of saving on investment is low or close to zero (Vamvakidis and Wacziarg, 1998; Wong, 1990; Bayoumi, 1990; Dooley et al., 1987; Feldstein and Horioka, 1980) attributed to the inefficient institutions and financial systems which fail in channeling saving into domestic investment in these countries.

The association between domestic investment and financial development was also tackled by many researchers. McKinnon (1973) and Shaw (1973) presented a theoretical and empirical foundation for the relationship between investment and monetary factors. Their hypothesis is based on the assumption that limited access to credit in developing countries forces investors to accumulate enough real balances before they can initiate investment projects. According to Ndikumana (2000) who found a positive relationship between domestic investment and financial development, financial development can stimulate economic growth through capital accumulation. Furthermore, Huang (2009) investigated the causality between private investment and financial development and showed a positive causal effects going in both directions.

Many studies addressed the interaction between domestic investment and FDI. Mody and Murshid (2005), for example, showed that countries with better policies have achieved greater success in absorbing foreign inflows. In contrast, Kim (2013) suggested that the extent to which FDI augments economic growth depends upon the degree of complementarity and substitutability between domestic investment and FDI. His findings indicate that FDI is beneficial for domestic investment in countries starting with low human capital, less-developed financial system, or high corruption. Luca and Spatafora (2012), also, showed that investment is affected positively by net capital inflows, but according to him greater institutional quality does not increase the extent to which capital inflows translate into domestic investment. The findings of empirical analysis conducted by Tang et al. (2008) on China indicate that FDI has a complementary relationship with domestic investment since FDI helps in overcoming the shortages of capital; it, therefore, simulates economic growth.

Several studies examined how trade openness influences domestic investment. Levine and Renelt (1992) suggest that a positive relationship between investment and trade holds whether trade flows are measured by imports, exports or total trade (imports plus exports). Furthermore, Eicher (1999) indicated that openness to trade stimulates domestic investment by encouraging competition in domestic and international markets and generating higher returns on investment through economies of scale. The findings of Bond and Malik (2009), also, showed that countries more open to trade tend to have higher private investment.

In contrast, Kim et al. (2013) suggest that trade appears to have adverse impacts on domestic investment in economies which start with low human capital, low financial development, or high corruption, but positive effects in countries beginning with high human capital, better financial sectors, or low corruption. Thus, if market or institutional imperfection exists, trade openness can lead to under-utilization of human and capital resources, concentration in extractive economic activities, or specialization away from technologically advanced, increasing-return sectors.

3.2.2. Natural resource abundance, economic growth, and investment

Different studies examined the implications of natural resource abundance (oil, gas, minerals and other non-renewable resources) on economic growth and development in the resource-rich developing countries. Some of these studies show that the performance of these countries is poor comparing to other countries which are not endowed with such resources - the problem which is, therefore, called "the resource curse". Within this framework, channels through which natural resource abundance influences economic growth was investigated by many researchers.

A number of studies focused on the "Dutch disease" phenomenon which results in real exchange rate appreciation due to an unexpected increase in foreign exchange revenues from resources, which in turn affects adversely on the non-resource traded sector, mainly manufacturing, making it less competitive.

Ades and Di Tella (1999) suggested that natural rents, such as oil rents, and rents induced by the lack of product market competition foster corruption. Torvik (2002) presented a model of rent-seeking where an increase in resource endowment shifts entrepreneurs from the productive sector to the rent-seeking sector. Karl (2007) argued that countries dependent on oil are often characterized by corruption, poor governance, a culture of rent-seeking, and high incidences of civil conflict and inter-state war. Arezki and Bruckner (2011) found that there is a significant effect of oil rents on corruption in countries with a high share of state participation in oil production while no such link exists in countries where state participation in oil production is low.

Models linking economic growth to natural resources via human capital established contradictory consequences. Gylfason (2001), for example, showed that natural resource abundance crowds out human capital investment affecting adversely on the pace of economic activity; however, Stijns (2006) found a positive correlation between human capital accumulation and natural resource rents per capita.

According to Lowi (2004), in countries where oil is the most important source of state revenue, oil structures political, as well as economic, outcomes. The overall impact of a resource boom on economies depends on the quality of the institutions; the resource curse, therefore, applies only to countries with bad institutions, but countries with good institutions tend to benefit from resource booms (Mehlum et al., 2006; Robinson et al., 2006). Some oil rich developing countries, such as Nigeria and Angola, have mismanaged their oil fortune resulting in damaging effects on economy and politics in these countries (Ovadia, 2013). In contrast, Norway has been successful in efficiently managing its oil revenues and channeling them towards long-term objectives and stabilization goals attributed to the capacity of state institutions to handle the risk of oil price fluctuation. In order to reconcile competing claims for oil revenues, Norway has used its highly consensus-oriented and parliamentary institutions, and has involved interest groups which represent business and labor (Eifert et al., 2003). Furthermore, it has made institutional choices to bring oil wealth under political control, such as strong government involvement in oil production, and a tax regime that guarantees considerable returns to the state from oil production, and the establishment of an oil fund invested abroad (Listhaug, 2005).

Bond and Malik (2009) provided cross-country empirical evidence on the role of natural resources on domestic investment. Different determinants of investment were considered in their study - the quality of political institutions, ethnic diversity, trade openness, political instability, financial development, and macroeconomic volatility. Their results suggest differences between fossil fuels and non-fuel resources; fuel exports tend to increase private investment, but there is also a robust negative effect from a measure of export concentration.

On the other hand, several studies provided evidence that oil boom affects positively on economic activities in oil-exporting countries. Yang and Lam (2008), for example, examines the relationship between oil prices and economic activities for 17 oil-rich developing countries using time series dynamics and employing cointegration analysis and Granger causality models. Their findings indicate that, in the majority of cases, oil booms are followed by increases in both investment and GDP per capita.

Berument et al. (2010) examined the effects of oil price shocks on a number of selected Middle East and North Africa (MENA) countries that are net exporters or importers of oil using a structural vector autoregressive model. Their results indicate that the effects of higher oil prices on GDP of most oil producing countries are positive.

Cavalcanti et al. (2010) used a sample including both developed and developing economies to investigate the oil impact on economic growth. Their results show that oil abundance by itself doesn't seem to be a curse since they found that oil abundance enhances growth in the short-run, and it has a positive impact on the level real income. They suggest the existence of a "volatility curse" rather than a "natural resource curse" since volatility of oil prices and, therefore, that of oil revenues is the reason which might dampen growth and development.

Thus, the effect of natural resource abundance on economic growth, and factors affecting domestic investment were widely analyzed in the literature, but limited attention was paid to the association between domestic investment and natural resource abundance, in general, and oil, in particular, in developing countries which suffer from underinvestment and poor provision of infrastructure. Therefore, this chapter attempts to examine the oil impact on gross domestic investment using a panel data set of 22 non-OECD economies on which we throw light in the next section.

3.3. Overview on Non-OECD oil-exporting economies

The sample employed in this study includes oil-exporting non-OECD countries. Although some oil-exporting countries, such as Nigeria, are excluded due to the lack of data over several years for a number of the variables needed to run the required investment model, other major oil-exporting countries such as Saudi Arabia, Russia, Angola, Kazakhstan, and Azerbaijan are considered, and the robustness of the results is checked using different estimators. Thus, 22 oil-exporting countries[17] are included,

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[17] The sample includes: Algeria, Angola, Argentina, Azerbaijan, Brazil, Cameroon, Colombia, Congo Rep., Ecuador, Egypt, Equatorial Guinea, Indonesia, Kazakhstan, Kuwait, Malaysia, Russia, Saudi Arabia, Syria, Tunisia, Venezuela, Vietnam, and Yemen Rep.

among which are some of the independent states of the former Soviet Union which took their independence in 1991, and so the time period is limited to 15 years (1996-2010).

Our sample includes developing and less developed countries with different types of economies, such as transitional economies and emerging economies. They all produce and export oil, though they have differences in oil reserves, production capacities, and extraction costs.

These countries differ, also, in the share of state participation in oil production, which might influence the degree of association between oil rents and corruption as was indicated by Arezki and Bruckner (2011). For example, the state-run Rosneft is the largest oil producer in Russia; and Algeria's national oil and gas company (Sonatrach) owns the majority of oil and gas projects in Algeria; however, in Azerbaijan, for instance, the State Oil Company of Azerbaijan Republic (SOCAR) produces only about 20 percent of Azerbaijan's total oil output, with the rest produced by international oil companies (EIA, 2014b).

3.3.1. Oil rents versus output growth

This section throws light on the association between oil rents and output growth in oil-exporting countries included in the sample.

The following table presents the growth rate of real GDP, the ratio of gross domestic fixed investment to GDP, and the ratio of oil rents (the difference between the value of crude oil production and total costs of production) to GDP. Variables, for all the 22 countries, were averaged over the last four years (2007-2010) of our study period.

Table 3.1. GDP growth, investment, saving, and oil rents (average over the last four years) for each country in the study sample

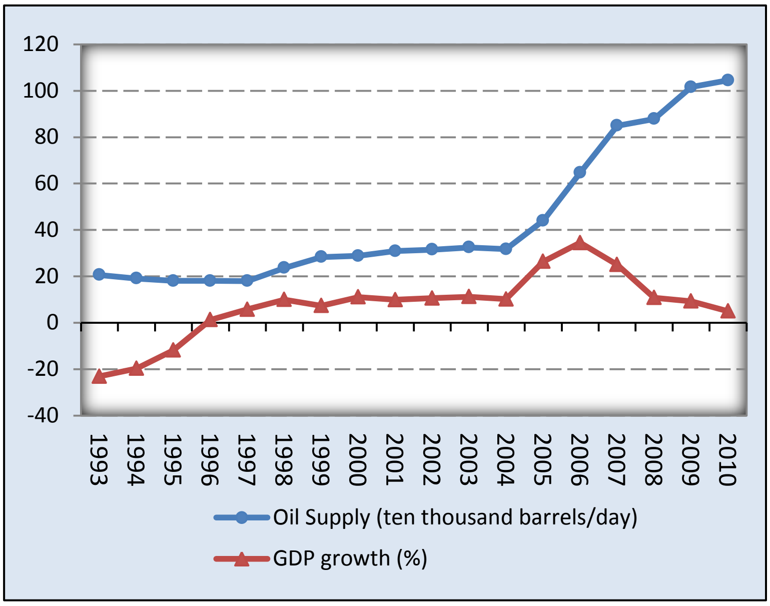
Country	Output growth (%)	Gross domestic investment (% GDP)	Gross domestic saving (% GDP)	Oil rents (% GDP)
Algeria	2.77	30.42	54.04	19.38
Angola	10.56	14.41	34.13	55.07
Argentina	6.36	22.6	26.79	4.86
Azerbaijan	12.54	18.87	55.3	47.2
Brazil	4.62	18.52	19.4	2.62
Cameroon	2.71	16.16	14.1	8.74
Colombia	4.03	22.49	20.25	6.36
Congo, Rep.	5.05	20.48	46.74	61.39
Ecuador	3.31	23.92	23.58	23.56
Egypt	5.15	20.16	14.11	6.3
Equatorial Guinea	9.05	51.28	73.59	53.87
Indonesia	5.8	28.96	31.47	3.82
Kazakhstan	5.17	27.24	41.9	28.65
Kuwait	1.9	18.79	53.74	51.53
Malaysia	4.19	21.8	41.37	7.28
Russia	2.58	21.76	31.24	14.76
Saudi Arabia	2.75	21.07	45.11	52.64
Syria	4.85	18.47	26.75	18.14
Tunisia	4.25	23.81	22.04	4.69
Venezuela	2.34	22.33	32.34	24.49
Vietnam	6.72	35.74	27.04	8.74
Yemen, Rep.	4.64	14.46	7.32	26.69

Source: Annual data over 2007-2010 were obtained from the World Development Indicators, and then we found the average values of each variable over the last four years.

It can be seen from Table 3.1 that several countries attained considerable output growth, but Azerbaijan - the largest producer of oil after Russia and Kazakhstan in the former Soviet countries - realized the highest average rate (12.54%) over the last four years of the study period among the countries included in our sample.

In fact, constructing the Baku-Tbilisi- Ceyhan (BTC) pipeline project was among the factors which, substantially, affected Azerbaijan's oil industry, in particular, and its overall economic activities, in general. The pipeline connects Baku - Azerbaijan's capital from which the first oil was pumped in May 2005 - with the Turkish port of Ceyhan at the Mediterranean Sea.

Figure 3.2. Azerbaijan's oil supply and GDP growth from 1993 to 2010



Data source: World Development Indicators for GDP growth, and EIA (US Energy Information Administration) database for Oil supply

Producing more oil in Azerbaijan was often associated with increases in the real GDP growth rate, Figure 3.2; the Russian-Georgian conflict over 2008-2009, however, affected the functioning of the transit energy corridor in the Caucasus region adversely, so Azerbaijan's GDP growth declined after hitting its highest level in 2006.

Also, Angola, the second-largest oil producer in Sub-Saharan Africa after Nigeria - according to EIA (US Energy Information Administration), witnessed a relatively high average real growth rate (10.56%) in the last four years of the sample period. Equatorial Guinea, whose economy relies on its natural resources (oil and gas) also recorded considerable real growth rate (9.05%).

In contrast, several countries in the sample achieved relatively low real GDP growth rates, though oil production in each of them constitutes a substantial portion of worldwide oil supply. For example, the average real GDP growth of Kuwait was the lowest (1.90%) in the sample, though it is one of the top oil producers in the world and it holds the world's sixth largest oil reserves.

Similarly, the average real GDP growth of Saudi Arabia (2.75%), the world largest oil producer, lagged behind other oil-exporting economies. Russia, also, realized only 2.58% real GDP growth rate, although it is among the top oil producers and it holds the world's largest natural gas reserves, and the second-largest coal reserves. Likewise, Venezuela’s average annual real GDP growth was only 2.34%, though it is among the largest owners of oil and natural gas reserves in the world. It was the world's eighth-largest net oil exporter in 2010, according to EIA.

Although oil represents wealth it also exposes exporting countries to great uncertainty due to fluctuations in oil prices causing positive or negative shocks. This raises a question on using and managing oil income in oil-rich developing countries, the problem on which we throw light in the next section.

3.3.2. Using oil rents

The broad consensus which research on the oil curse reached suggests that oil wealth is likely to be a useful factor in economies of oil-exporters when these countries have good governance, and efficient human capital. Thus, oil money can, if managed accountably and effectively, stimulate economic development. However, weak institutions, mismanagement of oil revenues, and corruption hinder this path.

There are different options to use oil revenues in oil-exporting countries. Revenues can be transferred to citizens in several ways, such as reducing non-oil taxes or providing subsidies or grants, employment or investment subsidies, such options involve tradeoffs among possible objectives: efficiency, equity, and sustainability (Gelb and Grasmann, 2010).

A low-tax environment is likely to encourage business climate and investments to diversify the non-oil economy by compensating the adverse effect of exchange rate appreciation caused by oil exports. However, it is argued that the need for a state to tax its citizens has been essential for developing state capabilities and for encouraging the demand for public accountability (Brautigam, Fjeldstad and Moore 2008).

Another widely-used approach is to subsidize domestic prices for petroleum derivatives, other energy, and other essentials below world market levels. This option, however, does not provide for a transparent linkage between the levels of rents and transfers.

The approach which is more widely used in the Middle East than elsewhere involves expanded levels of public employment for nationals. In Kuwait, for example, employment for nationals is virtually guaranteed, as well as a wide range of benefits including housing loans, marriage bonuses and retirement income (Gelb and Grasmann, 2010).

Fewer developing economy oil exporters look to direct distribution. Direct transfers to citizens, or citizen groups, can be provided in different ways. Community-based programs can offer one way to distribute oil rents effectively and create a constituency with an interest in their effective management (Moreen 2007). Such programs have been used effectively on a large scale in Indonesia via INPRES[18]

[18] INPRES denotes the presidential instruction - in Indonesian instruksi presiden (Azis, 1992).

which is among the most important central-regional transfers in Indonesia, triggered primarily by the unprecedented surplus of oil revenues flowing into Indonesia following the oil boom of the mid-1970s (Azis, 1992). INPRES has probably been the main centrally controlled fiscal mechanism determining spatial distribution of the aggregate gains to Indonesia from the oil boom. The scheme is regarded as the most important fiscal instrument capable of achieving a more equitable regional distribution of income in Indonesia (Azis, 1992).

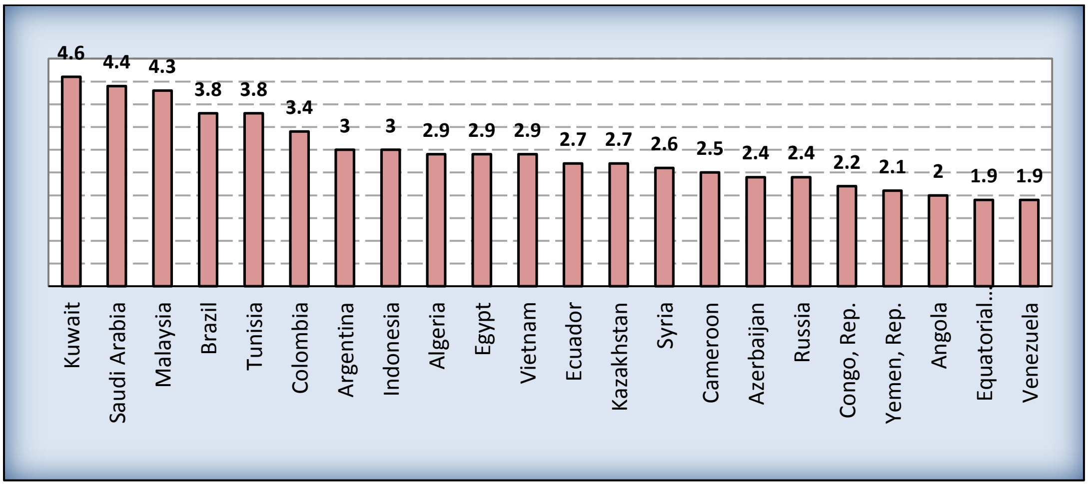
Direct transfer programs can also be used to distribute rents on an individual basis. Some developing countries, such as Brazil, implement conditional cash transfer schemes by providing payments to poor families conditional on specified child behavior, for example, attending school or receiving essential health services, including vaccinations. Although the design of such systems and country conditions might affect the outcomes, impact evaluations suggest that they can be an effective way to improve living conditions and widen access to a range of services (Behrman, Sengupta and Todd, 2005; Soares, Ribas and Osório, 2007).

Some scholars argue that wealth distribution should not be targeted or conditional, but direct since resource rents are considered to be the property of all citizens (e.g. Sandbu 2006, Moss and Young 2009). Direct transfers might increase government accountability since it gives citizens a direct interest in the amount of oil revenues channeled into the budget. However, direct transfers might discourage labor supply and reduce the incentive to enhance skills.

Diversifying the non-oil economy has been the objective for many oil exporters. Malaysia and Indonesia are among the countries which diversified their economies towards manufactured exports (Coxhead, 2007). Malaysia sustained a high and relatively stable savings rate, and implemented land development and replanting schemes to expand and modernize the production of rubber and palm oil. It also undertook investments in technology and infrastructure, particularly energy, communications and transport, leading to rapid industrial transformation. Indonesia has also exerted considerable efforts to use its hydrocarbon resources in order to support agriculture. This is attributed to government policies including using oil income to develop natural gas resources, both for export to Japan and as an input to fertilizer production; and then fertilizer was distributed at subsidized prices (Gelb and Grasmann, 2010).

While Malaysia and Indonesia provide good examples in employing prudent policies in using oil money, most countries in our sample may be seen as rife with corruption - as it can be seen from Figure 3.3 - which is one of the factors that can seriously distort economic development, and cause, besides other factors, the resource-curse in oil-rich developing economies, as has been established by several researchers.

Figure 3.3. Corruption Perceptions Index 2011 for the countries included in our sample



Source: Transparency International (2011)

Figure 3.3 shows the corruption perceptions index for the countries in the sample according to The Transparency International (2011) which ranks 182 developed and developing countries based on how corrupt their public sector is perceived to be. The score points to the perceived level of public sector corruption on a scale of 0 - 10, where 0 means that a country is perceived as highly corrupt while 10 means that a country is perceived as very clean. 8% of the 182 countries recorded scores from 8-10, while the scores for 26% of the countries were over 5. However, the economies included in our sample were among the countries which recorded below 5 as it shown in the figure.

Most of the countries in the sample were scored below 4 in clean government practices. Rather, Equatorial Guinea and Venezuela, recorded the lowest scores in the sample, are among the worst 12 countries in the world that scored less than 2. Also, the corruption levels in the former Soviet states are considerably high, while only the scores of Kuwait, Saudi Arabia, and Malaysia are over 4 - being among 10% of the countries which recorded between 4 and 5.

From the countries with high levels in corruption in our sample, we throw light on the experience of Azerbaijan and Angola, which heavily rely on oil income, in managing and using oil revenues.

Angola suffers from persistent poverty and under-development. The 2013 Human Development Report ranked Angola at 148th out of 187 countries - in the low human development category. This is attributed, other than the influence of the civil war that ended in 2002, to corruption and rent-seeking encouraged by the large oil revenues. Corruption and the lack of transparency in government management of oil revenues have resulted in wasting these revenues that could have been used to reduce poverty and promote development (Global Witness, OSISA Angola, 2011).

Although the government responded to the concerns about the lack of transparency by publishing official data on oil production and exports and oil revenues flowing to the state since 2004, transparency is not only about the publication of raw data, but it is also about the publication of reliable, comprehensive, and timely data accessible by the public in a way that enables concerned citizens to monitor oil proceeds and urge the government to account for oil management (Global Witness, OSISA Angola, 2011).

Another example of misusing oil income is Azerbaijan, a former state of Soviet Union, where the state budget is substantially based on the oil sector. Hence, sharp changes in oil prices and oil revenues due to fluctuating supply and non-flexible demand for oil have caused Azerbaijan’s economic situation to remain dependent on global oil market stability (CESD, 2010).

Although Azerbaijan created the State Oil Fund of Azerbaijan (SOFAZ) in December 1999 in order to accumulate revenues from oil and preserve it for current and future generations, transparency and accountability in the oil sector and public financial management has fallen in comparison with other sectors of the economy. According to a report prepared by Center for Economic and Social Development (CESD) in Azerbaijan (2010), the money is being spent from the Fund with no clear criteria measuring the effectiveness of the spending decisions against alternative ways of using the Fund. This implies the need for clearer resource management principles to ensure that the Fund is operated transparently.

Thus, the poor practice in managing and using oil proceeds in many oil-exporting economies in our sample suggests the need of these countries for effective regulative, legal and financial procedures which would enable them to use their oil money rationally in a way that maximizes the benefit to the overall economy, promote structural change, and shift the distribution away from political elite of resource appropriators towards entrepreneurs.

After having a look at some possible options in deploying oil income, and highlighting the experiences of some countries in managing oil money, the next section examines whether oil proceeds enhance aggregate domestic fixed investment in oil-exporting countries in our sample. It introduces the methodology of the study and provides descriptions of regressors involved in the model and data sources.

3.4. Model specification, methodology and data

3.4.1. Model specification

This study aims at investigating whether oil revenues are channeled into infrastructure and other investment projects, and since the participation of the private sector in infrastructure projects is limited in oil-exporting developing countries, we examine the oil-effect on the aggregate domestic fixed investment without separation between private and public fixed investment.

A number of studies have provided considerable insights into the factors that influence capital formation in developing countries, such as the tax system, foreign exchange, informational constraints, and the internal flow of funds. The theoretical framework adopted was a combination of neoclassical and flexible accelerator models with additional variables to capture the effects of government policies. In line with these studies, domestic fixed investment is modelled as a function of output growth, and other factors expected to affect capital formation in these countries.

We argue that oil rents are among determinants which might have a significant influence on aggregate fixed investment in oil-exporting non-OECD countries. Thus, we specify an investment model in which a proxy for oil abundance is included as an explanatory variable in the estimation equation, controlling for other factors that determine domestic investment including output growth, the exchange rate, inflation, trade openness, and financial development.

Oil rents are employed in this study to account not only for oil prices but also for production costs which differ from country to another depending on the geographical location of the oil field from where oil is extracted; but in order to check the robustness of the outcomes, the effect of crude oil exports is also examined.

Thus, the empirical investment model can be written in its static form as follows:

$$I_{i,t} = \alpha + \lambda Oil_{i,t-1} + \beta Z_{i,t} + u_{i,t} \quad (3.1)$$

Where

α is the intercept;

$I_{i,t}$ denotes the ratio of domestic investment to GDP in country i in year t;

$Oil_{i,t-1}$ is a measure of oil abundance using two proxies: $Rent_{i,t-1}$ denotes the lagged ratio of oil rents to GDP, $X_{i,t-1}$ refers to the lagged ratio of oil exports to GDP;

Matrix ($Z_{i,t}$) includes the following determinants of domestic investment, as was established by previous studies, though the choice of variables is constrained by data availability: $GDP_{i,t}$, $CrdBank_{i,t}$, $CrdPvt_{i,t}$, $Exch_{i,t}$, $Inf_{i,t}$, $Trade_{i,t}$, $FDI_{i,t}$, $Liq_{i,t}$. In this section we explain what these variables are and discuss their roles in the analyses, leaving more precise definitions to section 3.4.3.

$GDP_{i,t}$ is real output growth which reflects changes in the aggregate demand for output that investors seek to meet. Ratios of domestic credit provided by the banking sector to GDP ($CrdBank_{i,t}$), and domestic credit provided to the private sector to GDP ($CrdPvt_{i,t}$) are indicators of financial factors. $Exch_{i,t}$ is the change in the exchange rate which might have a significant influence on investment. In theory, exchange rate changes might have two opposite effects on domestic investment. On one side, when the domestic currency depreciates, the marginal profit of investing an additional unit of capital is expected to increase due to higher revenues from both domestic and foreign sales, but on the other side the prices of the imported capital assets would get higher. Hence, theoretical models provide no clear indication as to which effect is dominant (Harchaoui, et al., 2005).

The real interest rate is, also, among the variables which have considerable impacts on investment, but we do not include it due to the missing data in many countries in our sample. We use inflation ($Inf_{i,t}$) since high inflation rates increase the degree of uncertainty about the macroeconomic environment (Bond and Malik, 2009), making calculating the rate of return on new fixed investments uncertain. Thus, inflation is expected to have a negative impact on domestic investment.

Exports are a source of foreign exchange necessary for purchasing capital goods; meanwhile imports can simulate investment if they imply greater access to investment goods in the international markets, but when imports mainly consist of consumer goods, the effect could be negative on investment. Accordingly, trade might be a significant determinant of domestic investment. We, therefore, estimate the investment model controlling for trade openness, represented, in our model, by the ratio of trade to GDP ($Trade_{i,t}$) which refers to the sum of exports and imports as a percentage of GDP.

Furthermore, FDI might simulate domestic investment, or might substitute for it, so the ratio of net inflows of foreign direct investment to GDP ($FDI_{i,t}$) is considered in the estimation equation.

λ and β are the coefficients of $Oil_{i,t-1}$, and $Z_{i,t}$, respectively; while $u_{i,t}$ is the error term: $u_{i,t} = \delta_i + \vartheta_t + \varepsilon_{i,t}$ where δ_i denotes the group fixed effect, while ϑ_t is the time fixed effect, and $\varepsilon_{i,t}$ is the random disturbance.

We, also, consider a dynamic investment model, in accordance with the studies, such as Mileva, 2008; and Mody and Murshid, 2005, by supplementing the estimation equation by the ratio of lagged domestic investment to GDP ($I_{i,t-1}$) which can, therefore, be written as follows:

$$I_{i,t} = \delta I_{i,t-1} + \lambda Oil_{i,t-1} + \beta Z_{i,t} + u_{i,t} \tag{3.2}$$

Where δ is the coefficient on $I_{i,t-1}$, while the rest of the regressors are as specified in Eq (3.1).

Estimating Eq (3.2) is associated with the endogeneity problem associated with some explanatory variables might be correlated with the error term including $GDP_{i,t}$, $FDI_{i,t}$, and $I_{i,t-1}$.

Endogeneity could result from a two-way causation between the dependent and the explanatory variable in the estimation model, but it also can be caused with the existence of unobserved common factors that affect both the dependent variable and the endogenous explanatory variable.

FDI might be an endogenous variable because the causality between domestic investment and FDI can run in both directions, as was shown in several studies (Lautier and Moreaub, 2012; Mody and Murshid, 2005; Ndikumana and Verick, 2008). Many studies showed how domestic investment could affect FDI positively.

For example, Lautier and Moreaub (2012) and Loree and Guisinger (1995) showed that countries with more developed infrastructure stimulate and attract more FDI.

Likewise, domestic investment is an essential determinant in the macro production function and fluctuations in investment have substantial impacts on economic activities and long-term economic growth (Kim et al. 2013). Therefore, GDP growth is assumed to be an endogenous variable in our estimation.

3.4.2. Methodology

Although the specified investment model includes a proxy of oil abundance in addition to several macroeconomic determinants of domestic investment (output growth, inflation, openness and financial factors), there might be other time invariant factors affecting domestic investment in each country, as well as time-specific effects which are invariant among countries. Country-specific effects include different factors, among which are demographic and geographic factors, the level of institutional development, natural resources (other than oil), and particular domestic political factors, while time-specific effects include factors such as the transition effect in some countries, and the volatility of oil-price.

The static model - Eq (3.1) - can be estimated using static panel estimators such as the Random or/and the Fixed Effects estimators. This depends on the structure of the error term. Under the random effects assumption individual specific effects are uncorrelated with the regressors, unlike the fixed effects assumption with which there is correlation between the effects and independent variables.

In order to estimate the model using an appropriate estimator, we employ the Hausman test designed to measure the difference between the Fixed and the Random

Effects estimators. The null hypothesis of the test suggests that there is no significant difference between the two estimators, but rejecting the null hypothesis implies that only the Fixed Effects estimator is the consistent and efficient.

Concerning the dynamic model - Eq (3.2) - estimators used to estimate coefficients in the static model are inefficient in estimating the dynamic specification because the lagged dependent variable is one of the regressors, so static panel estimators might result in biased estimates of the parameters.

Therefore, in order to cope with the endogeneity problem in the dynamic investment equation in this study we use the Generalized Method of Moments (GMM) which is a statistical method for estimating the parameters in the model correcting the bias caused by endogenous explanatory variables.

The Arellano-Bond (1991) and Arellano-Bover (1995)/Blundell-Bond (1998) dynamic panel estimators are designed for panel data with fixed individual effects; and with heteroskedasticity and autocorrelation within cross sections. These estimators are relevant for panel data with a single dependent variable that depends on its own past realizations, and explanatory variables that are not strictly exogenous - i.e., correlated with past and possibly current realizations of the error (Roodman, 2006).

We can distinguish between the Difference GMM (Arellano-Bond estimation), and the System GMM (Arellano-Bover/Blundell-Bond estimator). The Arellano-Bond difference GMM estimator uses first differences for estimating the dynamic model, so Eq (3.2) is transformed into

$$\Delta I_{i,t} = \delta \Delta I_{i,t-1} + \lambda \Delta Oil_{i,t-1} + \beta \Delta Z_{i,t} + \Delta u_{i,t} \qquad (3.3)$$

Thus, the fixed country effect is removed by differencing the regressors.

Meanwhile, in the System GMM an additional assumption is made according to which first differences of instrument variables are uncorrelated with the fixed effects which allows the introduction of more instruments, and can dramatically improve efficiency. It is based on building a system of two equations - the original equation as well as the transformed one (Roodman, 2006).

3.4.3. Data

We estimate the static and the dynamic models using both total and domestic fixed investment as a dependent variable since there is a considerable difference between the values of the two variables in some countries. Domestic fixed investment (gross domestic fixed formation) represents the outlays on additions to the fixed assets of the economy includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Total domestic investment (gross capital formation) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and “work in progress”. According to the 1993 SNA (the System of National Accounts), net acquisitions of valuables are also considered capital formation (see World Development Indicators, 2013).

The explanatory variables for investment in our estimation equations are the following (for detailed definitions of all regressors, except for oil exports, see World Development Indicators, 2013):

- Oil exports (% GDP): Oil exports were found by multiplying the crude oil price by the annual quantities of crude oil exports.
- Oil rents (% GDP): Oil rents refer to the difference between the value of crude oil production at world prices and total costs of production[19].
- Real GDP growth: refers to the annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2000 US dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.
- Foreign direct investment[20] (% GDP): Foreign direct investment (FDI) refers to net inflows of investment to acquire a lasting interest in or management control

[19] "This definition of economic rent differs from that used in the System of National Accounts, where rents are a form of property income, consisting of payments to landowners by a tenant for the use of the land or payments to the owners of subsoil assets by institutional units permitting them to extract subsoil deposits" (World Development Indicators, World Bank, 2013).
"The estimates of natural resources rents are calculated as the difference between the price of a commodity and the average cost of producing it. This is done by estimating the world price of units of specific commodities and subtracting estimates of average unit costs of extraction or harvesting costs (including a normal return on capital). These unit rents are then multiplied by the physical quantities countries extract or harvest to determine the rents for each commodity as a share of gross domestic product" (World Development Indicators, World Bank, 2013).

[20] Gross capital formation consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories, while foreign direct investment (FDI) relates to financing – i.e., the purchase of shares in foreign companies where the buyer has a lasting interest (10 percent or more of voting stock). FDI can be used to finance fixed capital formation, however it can also be used to cover a deficit in the company or paying off a loan. Thus, it cannot be presumed that FDI is always included in gross fixed capital formation (World Bank. Is foreign direct investment (FDI) included in gross fixed capital formation? Available at: https://datahelpdesk.worldbank.org/knowledgebase/articles/195312-is-foreign-direct-investment-fdi-included-in-gro).

over an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvested earnings, other long-term capital, and short-term capital, as shown in the balance of payments. We use net inflows in this study, i.e., the new investment inflows less disinvestment[21].

- Trade openness (% GDP): Trade represents the sum of exports and imports of goods and services produced in the economy.
- Domestic credit provided by the banking sector (% GDP): Domestic credit provided by the banking sector includes all credit to various sectors on a gross basis, with the exception of credit to the central government, which is net. The banking sector includes monetary authorities and deposit money banks, as well as other banking institutions where data are available (including institutions that do not accept transferable deposits but do incur such liabilities as time and savings deposits). Examples of other banking institutions are savings and mortgage loan institutions and building and loan associations.
- Domestic credit to private sector (% GDP): Refers to financial resources provided to the private sector (through loans, purchases of non-equity securities, and trade credits and other accounts receivable that establish a claim for repayment) as a share of GDP.
- Inflation: Inflation is measured by the annual growth rate of the GDP implicit deflator. It shows the rate of price change in the economy as a whole, whereas the GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency.

[21] Direct investments may take the form of greenfield investment, where the investor starts a new venture in a foreign country by constructing new operational facilities; joint venture, where the investor enters into a partnership agreement with a company abroad to establish a new enterprise; or merger and acquisition, where the investor acquires an existing enterprise abroad. The IMF suggests that investments should account for at least 10 percent of voting stock to be counted as FDI. In practice many countries set a higher threshold (see World Development Indicators, 2013).

- Liquidity - proxied by M2 (% GDP). M2 refers to money and quasi money comprise the sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government.
- The change in the official exchange rate: The official exchange rate refers to the exchange rate determined by national authorities or to the rate determined in the legally sanctioned exchange market. It is calculated as an annual average based on monthly averages (local currency units relative to the US dollar).

Data for gross domestic investment, oil rents, output growth, financial and openness factors were obtained from the database of the World Bank Development Indicators, while data for the quantities of crude oil exports were derived from the database of EIA, and the crude oil price is the price of Brent crude, obtained from the British Petroleum (BP) database, Statistical Review of World Energy 2014.

The following table throws light on the main statistics of the explanatory variables used in estimation including the mean, minimum, and maximum values of the variables used in estimation over the period 1996-2010.

Table 3.2. Main statistics about the variables used in the investment model

Variable	Symbol	Mean	Standard Deviation	Minimum	Maximu m
Total investment (lag, % GDP)	GCF_1	24.32	11.39	8.79	113.58
Fixed investment (lag, % GDP)	I_1	23.30	11.25	8.79	113.58
GDP growth	GDP	5.65	7.74	-16.20	71.19
Inflation	Inf	14.70	41.30	-29.99	556.94
Exchange rate	Exch	11.33	48.81	-99.98	610.42
Credit by banking (%GDP)	CrdBank	39.06	35.41	-24.37	163.36
Credit to private sector (%GDP)	CrdPvt	29.85	29.38	1.17	158.51
Liquidity (%GDP)	Liq	43.44	29.62	4.83	139.17
FDI (%GDP)	FDI	6.00	14.94	-4.31	145.20
Trade (%GDP)	Trade	82.94	46.43	14.93	275.23
Oil rents (%GDP, lagged)	Rent_1	24.55	26.01	0.34	209.48
Oil exports (%GDP, lagged)	X_1	21.82	25.25	0.00	138.92

It can be seen from the table that there are considerable differences between the minimum and the maximum values for most variables. The maximum inflation rate over the period, for example, was in Angola where it reached to 556.93% in 1999, while the minimum rate (-29.99%) was in Equatorial Guinea in 1999. The exchange rate is also among the variables which witnessed remarkable changes over time and between countries which use different types of exchange rate regimes, such as fixed, floating exchange rates (Brazil), or managed floating exchange rate (Malaysia, Angola, Indonesia, Algeria, Egypt). Although oil rents differ between countries depending on oil abundance, the mean value of oil rents (24.55%) indicates that oil proceeds constitute a considerable source of funds which might have a significant influence on domestic investment of these countries.

Total investment - including the change in inventory - was considerably higher than fixed investment in some countries, while the two where equal or with small differences in some other economies, so the table reports identical maximum and minimum values of the two variables, but the mean value of total investment was 24.32 (% of GDP) while it was 23.30 (% of GDP) for fixed investment over the period.

In order to include the appropriate regressors in the estimation equation, we check the correlation between each two explanatory variables to avoid the multicollinearity[22] problem.

Table 3.3. Correlation coefficients between the explanatory variables used in the investment model

Variable	GCF_1	I_1	GDP	Inf	Exch	CrdBank	CrdPvt	LIQ	FDI	Trade	Rent_1	X_1
GCF_1	1.00											
I_1	0.98***	1.00										
GDP	0.56***	0.58***	1.00									
Inf	0.07	0.08	-0.00	1.00								
Exch	-0.01	-0.00	-0.15***	0.83***	1.00							
CrdBank	-0.14**	-0.14**	-0.17***	-0.17***	-0.09	1.00						
CrdPvt	-0.03	-0.03	-0.12**	-0.15**	-0.11*	0.88***	1.00					
LIQ	-0.12**	-0.14**	-0.18***	-0.14**	-0.11**	0.86***	0.84***	1.00				
FDI	0.34***	0.36***	0.28***	0.45***	0.39***	-0.19***	-0.16***	-0.20***	1.00			
Trade	0.50***	0.53***	0.40***	0.16***	0.11**	0.13**	0.34***	0.24***	0.40***	1.00		
Rent_1	0.20***	0.23***	0.26***	0.56***	0.41***	-0.47***	-0.33***	-0.32***	0.52***	0.47***	1.00	
X_1	0.33***	0.36***	0.39***	0.18***	0.09*	-0.52***	-0.36***	-0.40***	0.38***	0.53***	0.85***	1.00

Note: ***, **, * denote estimation is significant at the 1%, 5%, and 10% significance level, respectively.

The table shows that, in few cases, the bivariate correlation coefficients are relatively high, such as that between each pair of the financial indicators ($CrdBank$, Liq

[22] Multicollinearity refers to the case in which the explanatory variables are highly correlated so one variable can be predicted from the other, which might make the statistical inference made about the data unreliable.

and $CrdPvt$) where the coefficients are more than 0.80, and between the lagged oil rents ($Rent\_1$) and the lagged oil exports (X_1) which is 0.85, as well as that between the exchange rate ($Exch$) and inflation (Inf) which is 0.83. Hence, in order to avoid multicollinearity, we do not include the mentioned highly correlated variables in the same estimation equation. Rather, we run the regression several times and consider the highly correlated explanatory variables separately in different estimations.

It can also be seen from the table that the correlations, in most cases, are significant but the coefficients are less than 0.60, so including the variables which are not highly correlated in the same regression is not expected to result in biased estimations. Although *Trade* includes all traded goods and services, among which are oil exports, the correlation coefficient between trade and oil exports is 0.53, so it is still acceptable to be included in the same estimation equation. We avoid subtracting oil exports from trade since the crude oil price we used in finding oil exports might not be identical to prices of the exported goods and services according to the World Development Indicators from which data on trade were obtained.

The next section presents the outcomes of estimating the static model of domestic investment using static panel estimators (Random and Fixed Effects estimators), and the dynamic investment model employing the Arellano-Bond difference GMM estimator.

3.5. Estimation results

3.5.1. Outcomes of the static specification

We start by running the static regression (Eq 3.1) using the two-way Random Effects estimator since the Hausman test for random effects is automatically generated, and then if the test refers to a significant difference between the Fixed and the Random Effects estimators, we re-estimate the investment model using the fixed effects estimator with which the F-test for no fixed time and cross sectional effects is generated.

The results are illustrated in Table 3.4 where the effect of oil abundance on both fixed and total investment was examined controlling for other determinants of investment, as was indicated by previous studies. The regression is run four times including the lagged oil rents or the lagged oil exports, while other regressors are real output growth, inflation, domestic credit provided to the private sector, FDI, and trade openness.

Columns 1 and 3 in Table 3.4 report the effect of the lagged oil rents on total and fixed investment, respectively, while Columns 2 and 4 show the impact of the lagged crude oil exports on total and fixed investment, respectively. For the explanatory variables, the upper value in each cell refers to the coefficient, while the value in the parentheses is the standard error. For the test, the upper value in each sell refers to the test statistic, while the lower value in the square bracket is the p-value showing whether the null hypothesis of the test is rejected or not.

Table 3.4. The effect of oil and other control variables on gross domestic investment using Random Two-Way Estimates

Number of cross sections= 22 Time series length= 15				
Explanatory variables	**Dependent variable: Total investment (% GDP)**		**Dependent variable: Fixed investment (% GDP)**	
	1	2	3	4
Intercept	10.42088*** (2.4358)	9.733856*** (2.4497)	11.143*** (2.365)	10.18953*** (2.3498)
Output growth	0.172371*** (0.0453)	0.184298*** (0.0462)	0.0770* (0.042)	0.08965** (0.0433)
Inflation	-0.02123* (0.0115)	-0.0486*** (0.00858)	-0.017 (0.011)	-0.04855*** (0.00806)
Credit provided to the private sector (% GDP)	0.084044*** (0.0245)	0.080205*** (0.0247)	0.0738*** (0.023)	0.068518*** (0.0233)
FDI (% GDP)	0.309428*** (0.0250)	0.293001*** (0.0249)	0.3015*** (0.023)	0.283181*** (0.0234)
Trade (% GDP)	0.139688*** (0.0198)	0.137412*** (0.0200)	0.1334*** (0.019)	0.130934*** (0.0188)
Oil rents (lag, % GDP)	-0.11313*** (0.0333)	-	-0.128*** (0.032)	-
Oil exports (lag, % GDP)	-	-0.06157* (0.0356)	-	-0.06081* (0.0339)
Hausman Test for Random Effects	13.24 [0.039]	11.88 [0.065]	13.49 [0.036]	11.82 [0.066]
R^2	0.57	0.56	0.56	0.55

Note: ***, **, * denote estimation is significant at 1%, 5%, 10%, respectively. For the explanatory variables, the values in parentheses refer to the standard errors. The values in square brackets refer to the p-values of the Hausman test.

The values of R^2 in Columns 1, 2, 3, and 4 in Table 3.4 indicate that the fits explain 55-57% of the variations of data about the average..

The outcomes indicate that both oil rents and oil exports exert significant negative effects on domestic investment, but the effect of oil rents is highly significant (at a

1% significance level) on both total and domestic fixed investment in Columns 1 and 3, while oil exports are significant at a 10% level in Columns 2 and 4.

The table also shows that domestic investment (total and fixed) is significantly and positively affected by trade openness, FDI, output growth, and domestic credit provided to the private sector. Inflation, however, affects domestic investment negatively in Column1, 2, and 4, while the effect seems insignificant in Column 3.

The Hausman test in Table 3.4 indicates that the null hypothesis of random effects is rejected at a 5% significance level in Columns 1 and 3 and at a 10% level in Columns 2 and 4 suggesting that the Fixed Effects estimator might be preferred over the Random Effects estimator.

Therefore, we re-estimate the four equations employing the two-way Fixed Effects estimator to account for both time and country specific fixed effects, so we obtain the following results:

Table 3.5. The effect of oil and other control variables on gross domestic investment using Fixed Two-Way Estimates

Number of cross sections= 22 Time series length= 15				
Explanatory variables	**Dependent variable: Total investment (% GDP)**		**Dependent variable: Fixed investment (% GDP)**	
	1	2	3	4
Intercept	9.387765*** (2.3335)	8.52044*** (2.4411)	9.399*** (2.160)	8.330472*** (2.2776)
Output growth	0.165087*** (0.0468)	0.1764*** (0.0478)	0.074* (0.043)	0.085136* (0.0446)
Inflation	-0.01124 (0.0136)	-0.04696*** (0.00890)	-0.007 (0.013)	-0.04694*** (0.00830)
Credit provided to the private sector (% GDP)	0.099642*** (0.0272)	0.096507*** (0.0277)	0.090*** (0.025)	0.086116*** (0.0259)
FDI (% GDP)	0.296625*** (0.0261)	0.276397*** (0.0258)	0.291*** (0.024)	0.267997*** (0.0241)
Trade (% GDP)	0.156916*** (0.0218)	0.157277*** (0.0221)	0.144*** (0.020)	0.144837*** (0.0207)
Oil rents (lag, % GDP)	-0.13938*** (0.0413)	-	-0.157*** (0.038)	-
Oil exports (lag, % GDP)	-	-0.06675 (0.0437)	-	-0.07043* (0.0407)
F Test for no fixed effects	15.54 [<.0001]	15.97 [<.0001]	17.68 [0.000]	17.75 [<.000]
R^2	0.85	0.85	0.87	0.86

Note: ***, **, * denote estimation is significant at 1%, 5%, and 10%, respectively. For the explanatory variables, the values in parentheses refer to the standard errors. The values in square brackets refer to the p-values of the F-test.

It can be seen from Table 3.5 that the values of R^2 increased to greater than 84% in the four equations using the Fixed Effects estimator, comparing to 55-57% with the Random Effects estimator.

The table also reports the results of the F test designed to check the significance of time and country specific effects under a null hypothesis of no fixed time and cross sectional effects. The test results in the four columns indicate that both time and cross sectional fixed effects are highly significant (at a significance level of 1%), so the null hypothesis of poolability is rejected the four regressions.

With regard to the effect of oil abundance, Table 3.5 shows that the coefficients on oil rents in Columns 1 and 3 are negative and significant at the 1% significance level. Although the effect of oil exports on total domestic investment seems insignificant in Column 2, but it is negative and significant at the 10% significance level in Column 4 using fixed investment as dependent variable.

The outcomes in Table 3.5 also indicate that domestic investment (total and fixed) is enhanced by openness factors including trade and FDI, and by output growth and by credit provided to the private sector, while the effect of inflation seems to be significant and negative in Columns 2 and 4 and insignificant in Columns 1 and 3.

Thus, both static panel estimators used in estimation (the Random and Fixed Effects estimators) report similar results for most regressors in terms of the coefficients' signs and the significance of the variables, though the values of coefficients are slightly different using the two estimators.

Although the results of the Hausman Test and the F test reported in Tables 3.4 and 3.5, respectively, and the relatively high values of R^2 in Table 3.5 indicate that the Fixed Effects estimator is an efficient and consistent method for estimating the static model of investment, the Fixed Effects estimator does not take into account that some regressors can be correlated with the error term, which might turn the estimator to be biased.

Previous research establishes that output growth and FDI are endogenous determinants of domestic investment, as was clarified in section 3-1. Furthermore, the values of domestic investment are probably affected by their past realizations. We, therefore, estimate the dynamic investment model in which the lagged dependent variable is added as one of the regressors using the two-step difference GMM estimation method.

3.5.2. Outcomes of the dynamic specification

In order to estimate the dynamic model we instrument the third period lagged values of output growth and FDI. These instruments are believed to be valid and informative[23] since each of them affects the regressor for which it has been instrumented, but it is not correlated with the error term. For the lagged dependent variable which is expected to be correlated with the error term we use the DEPVAR[24] option which specifies that a dependent variable be used at an appropriate lag as an instrument.

In order to check the validity of the instruments employed in estimation, the GMM estimator generates the Sargan test under which the null hypothesis indicates that over-identifying restrictions are valid.

First, we examine the effect of oil rents on domestic investment (total and fixed) in light of other macroeconomic determinants of domestic investment (Table 3.6), then, in order to check the robustness of the oil-impact we examine, in Table 3.7, the impact of crude oil exports on gross domestic investment (total and fixed).

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[23] The instrumental variable should be valid (uncorrelated with the error term), and informative (correlated with the endogenous regressor).

[24] DEPVAR, is an option that can be used with the INSTRUMENT statement in SAS (software).

To check whether the effect of oil rents on total investment is influenced by adding different regressors, we estimate the investment model four times. We first estimate the dynamic investment model by running a regression which comprises the lagged dependent variable, the lagged oil rents, output growth, and inflation in Column 1/Table 3.6. Beside the lagged dependent variable, output growth, and oil rents, domestic credit provided by the banking sector and FDI are added to the model in Column 2, and inflation, liquidity, trade and FDI in Column 3, while the exchange rate, and domestic credit provided to the private sector are added in Column 4.

In Columns 5-8, we re-estimate the four regressions (Columns 1-4) using domestic fixed investment as a dependent variable instead of total investment. Thus, the outcomes in Table 3.6 are obtained where - as in the previous two tables - the upper value in each cell refers to the coefficient of the concerned regressor, while the value in the parentheses is the standard error. For the tests, the upper value in each cell refers to the test statistic, while the lower value in the square bracket is the p-value.

Table 3.6. The effect of oil rents on gross domestic investment controlling for other explanatory variables using the GMM estimation method

Number of cross sections= 22 **Time series length= 15**								
Explanatory variables	**Dependent variable: Total investment**				**Dependent variable: Fixed investment**			
	1	2	3	4	5	6	7	8
Total investment (lag, % GDP)	0.100*** (0.0144)	0.199*** (0.00960)	0.150*** (0.0311)	0.037 (0.0341)	-	-	-	-
Fixed investment (lag, % GDP)	-	-	-	-	0.114*** (0.0213)	0.168*** (0.00742)	0.267*** (0.0508)	0.086* (0.0513)
GDP growth	0.094*** (0.0111)	0.088*** (0.0141)	0.047*** (0.0171)	0.148*** (0.0208)	0.048*** (0.00172)	0.092*** (0.0152)	-0.031 (0.0216)	0.109*** (0.0390)
Inflation	-0.026*** (0.00176)	-	0.003 (0.0151)	-	-0.043*** (0.00407)	-	-0.028* (0.0164)	-
Exchange rate	-	-	-	0.052*** (0.0161)	-	-	-	0.060*** (0.00888)
Credit by banking (%GDP)		0.029** (0.0129)	-	-	-	0.135*** (0.0164)	-	-
Credit to private sector (%GDP)	-	-	-	0.152*** (0.0490)	-	-	-	0.311*** (0.0457)
Liquidity (%GDP)	-	-	0.150*** (0.0541)	-	-	-	0.091 (0.0588)	-
FDI (%GDP)	-	0.3858*** (0.00435)	0.271*** (0.0716)	0.272*** (0.0158)	-	0.380*** (0.0143)	0.326*** (0.0491)	0.321*** (0.0266)
Trade (%GDP)	-	-	0.252*** (0.0499)	0.220*** (0.0235)	-	-	0.125** (0.0551)	0.117*** (0.0329)
Oil rents (%GDP, lagged)	-0.239*** (0.0114)	-0.084*** (0.00726)	-0.166*** (0.0180)	-0.140*** (0.0147)	-0.280*** (0.0152)	-0.076*** (0.0141)	-0.131*** (0.0203)	-0.124*** (0.0262)
Test for 1st order serial correlation	-0.95 [0.8281]	-1.42 [0.9227]	-1.63 [0.9481]	-1.83 [0.9663]	-0.93 [0.8234]	-1.25 [0.8943]	-1.47 [0.9287]	-1.75 [0.9604]
Test for 2nd order serial correlation	0.21 [0.4179]	-0.73 [0.7663]	-0.95 [0.8295]	-2.61 [0.9954]	0.09 [0.4654]	-0.72 [0.7644]	0.19 [0.4259]	-1.63 [0.9482]
Sargan Test	20.43 [0.4941]	21.60 [0.9362]	20.20 [0.9315]	18.67 [0.9602]	19.66 [0.5428]	20.27 [0.9596]	12.56 [0.9987]	12.41 [0.9988]

Note: ***, **, * denote estimation is significant at 1%, 5%, and 10%, respectively. For the explanatory variables, the values in parentheses refer to the standard errors. The values in square brackets refer to the p-values of the tests. Regressions 1-4 were estimated using the Arellano–Bond two-step first-difference GMM estimator.

Estimation outcomes in Table 3.6 indicate that the null hypothesis of the Arellano-Bond test of no first and second order serial correlation in the residuals cannot be rejected in the four columns since all p-values of the test are greater than a 1% significance level. The table also reports the results of the Sargan test suggesting that the null hypothesis of the test cannot be rejected in all the columns (1-8), so the instrumental variables used in estimations are valid.

Concerning the significance of the regressors in estimation, the outcomes in Table 3.6 indicate that domestic investment depends on its past realizations. Although the coefficient of lagged total investment is insignificant in Column 4, estimating the same equation using fixed investment as a dependent variable, in Column 8, shows that fixed investment is affected positively and significantly by its past values.

Similar to what was found in the static specification, the coefficients of lagged oil rents in Columns 1-8/ Table 3.6 are negative and significant at a 1% significance level. Thus, oil rents exert an adverse effect on domestic investment (total and fixed), and supplementing the investment model with the exchange rate, and different financial and openness indicators, does not change the negative influence of oil rents.

Furthermore, the table shows that domestic investment is augmented by output growth, FDI, trade openness, domestic credit provided by banking, and domestic credit provided to the private sector. In contrast, inflation has a negative effect on domestic investment, so an increase in the inflation rate is associated with less domestic investment. The impact of the exchange rate is significant and positive indicating that the exchange rate appreciation affects domestic investment negatively. Such consequence is expected in oil-exporting economies prone to domestic currency appreciation, resulting in an adverse impact on the manufacturing sector since the sector becomes less competitive.

Thus, explanatory variables used in Table 3.6 in the eight equations (Column 1-8) are significant determinants of domestic investment in oil-exporting countries. Although the effects of output growth and liquidity on fixed investment are insignificant in Column 7, their effects are positive and highly significant on total investment in Column 3. Likewise, the coefficient of inflation in Column 3 is insignificant, but it is negative and significant in Column 7.

In order to check the robustness of the negative oil effect on domestic investment, we re-estimate the previous eight equations, but using crude oil-exports instead of oil-rents and the results are reported in Table 3.7.

In Columns 1 and 5 / Table 3.7 the lagged dependent variable, the lagged crude oil-exports, output growth, and inflation are included. Other regressors are included in the remaining columns to examine how different specifications might alter the effect of crude oil-exports.

Table 3.7. The effect of oil exports on gross domestic investment controlling for other explanatory variables using the GMM estimation method

Number of cross sections= 22 Time series length= 15								
Explanatory variables	**Dependent variable: Total investment**				**Dependent variable: Fixed investment**			
	1	2	3	4	5	6	7	8
Total investment (lag, % GDP)	0.092*** (0.0159)	0.154*** (0.0160)	0.152*** (0.0394)	0.152*** (0.0551)	-	-	-	-
Fixed investment (lag, % GDP)	-	-	-	-	0.090*** (0.0112)	0.111*** (0.0176)	0.264*** (0.0762)	0.011 (0.0559)
GDP growth	0.180*** (0.0193)	0.155*** (0.0141)	0.088*** (0.0194)	0.143*** (0.0194)	0.131*** (0.0102)	0.132*** (0.0222)	-0.003 (0.0296)	0.194*** (0.0329)
Inflation	-0.043*** (0.00384)	-	-0.024*** (0.00353)	-	-0.060*** (0.00200)		-0.032*** (0.00672)	
Exchange rate	-	-	-	0.143 (0.0194)	-	-	-	0.027*** (0.00617)
Credit by banking (%GDP)	-	0.1074*** (0.0138)	-	-	-	0.202*** (0.0142)	-	-
Credit to private sector (%GDP)	-	-	-	0.138*** (0.0523)	-	-	-	0.230*** (0.0497)
Liquidity (%GDP)	-	-	0.131*** (0.0407)	-	-	-	0.198*** (0.0449)	-
FDI (%GDP)	-	0.359*** (0.00714)	0.291*** (0.0313)	0.258*** (0.0223)	-	0.362*** (0.0181)	0.242*** (0.0193)	0.248*** (0.0268)
Trade (%GDP)	-	-	0.194*** (0.0273)	0.158*** (0.0314)	-	-	0.256*** (0.0195)	0.166*** (0.0189)
Oil exports (%GDP, lagged)	-0.208*** (0.0121)	-0.077*** (0.00989)	-0.091*** (0.0272)	-0.080*** (0.0283)	-0.222*** (0.0216)	-0.082*** (0.0231)	-0.061* (0.0327)	-0.151*** (0.0400)
Test for 1st order serial correlation	-0.95 [0.8301]	-1.30 [0.9037]	-1.44 [0.9253]	-1.35 [0.9111]	-0.93 [0.8239]	-1.15 [0.8744]	-1.20 [0.8854]	-1.49 [0.9322]
Test for 2nd order serial correlation	0.64 [0.2606]	-0.42 [0.6631]	-0.21 [0.5837]	-0.16 [0.5650]	0.68 [0.2484]	-0.41 [0.6584]	0.69 [0.2455]	-0.37 [0.6444]
Sargan Test	20.98 [0.4600]	20.25 [0.9598]	14.12 [0.9960]	19.45 [0.9470]	19.05 [0.5819]	18.81 [0.9774]	18.29 [0.9658]	17.47 [0.9758]

Note: ***, **, * denote estimation is significant at 1%, 5%, and 10%, respectively. For the explanatory variables, the values in parentheses refer to the standard errors. The values in square brackets refer to the p-values of the tests. Regressions 1-4 were estimated using the Arellano–Bond two-step first-difference GMM estimator.

The results of the Arellano-bond test in Table 3.7 suggest that the null hypothesis of no first and second order serial correlation in the residuals cannot be rejected in the four specifications. Also, the results of the Sargan Test indicate that the null hypothesis that over identifying restrictions is valid cannot be rejected in the eight columns suggesting the validity of the instruments employed in estimation.

Similar to what was found with oil-rents, oil-exports exert an adverse effect on domestic investment in the countries included in our sample, and estimating the model including different determinants of domestic investment does not change the negative impact of oil-exports on domestic investment.

The outcomes in Tables 3.7 indicate also that domestic investment is affected significantly and positively by its past values, suggesting that domestic investment is better specified by a dynamic model.

In line with the previous literature, and similar to what was found in the static specifications (Tables 3.4, and 3.5) and in the dynamic specification including oil-rents (Table 3.6) the outcomes suggest that domestic investment is augmented by output growth, and financial factors - domestic credit to the private sector, liquidity, and domestic credit by banking. It is also enhanced by FDI and trade openness. However, inflation has a negative impact on domestic investment, and exchange rate appreciation is accompanied by less investment.

Overall, oil abundance appears to affect gross domestic investment adversely in oil-exporting non-OECD countries. Although some researchers, such as Yang and Lam (2008), and Berument et al. (2010), showed a positive impact of the oil boom on economic activities in oil-exporting developing economies, our results with both the static and the dynamic specifications of the investment model, and with the two variables used as measurements for oil abundance (oil rents, and oil exports) are consistent with the oil curse literature indicating that these countries fail in channeling oil proceeds into economic growth via capital accumulation.

This suggests poor performance by governments with regard to resource management, and formulating rational economic and financial policies necessary to direct oil proceeds towards acquiring capital assets needed for production, and constructing feasible infrastructure projects that will improve domestic investment environment and create, thereby, a mechanism to promote sustained economic growth in these countries. Furthermore, oil companies, including state oil companies, should provide information about their operation to help in tackling corruption and improving accountability.

Concerning the implications with regard to other macroeconomic variables included in our estimation equation on gross domestic investment, our results confirm the positive effect of output growth on domestic investment, which is consistent with both the neoclassical investment theory, and the empirical findings of many studies (e.g. Mileva, 2008; Fielding, 1997; Greene and Villanueva, 1991) since an increase in output growth represents an increase of the demand for produced goods and services which in turn stimulates investment to meet the required products.

Furthermore, our findings indicate that FDI affects domestic investment positively in these countries, so FDI might stimulate new downstream or upstream investments that would not have taken place in their absence through externalities and spillovers of technology and management, improving the domestic investment environment, and creating channels for marketing products internationally. Thus, contrary to the scholars who have argued that FDI crowds out domestic investment, our results are consistent with the findings of a number of studies which show that FDI complements domestic investment in host economies (Tang et al., 2008; Mileva, 2008; Luca and Spatafora, 2012; Bosworth and Collins, 1999).

The outcomes, also, indicate that domestic investment is positively influenced by trade openness, which is consistent with the findings of a number of studies (Wacziarg, 2001; Bond and Malik, 2009; Salahuddin and Islam, 2008; Harrison, 1996; Levine and Renelt, 1992). Thus, trade might stimulate domestic investment by providing access to international markets to obtain capital goods necessary for production, and encourage competition in domestic and worldwide markets.

Furthermore, consistent with the results of several studies (see, for example, Bond and Malik, 2009; Ndikumana, 2000) our results show that inflation affects domestic investment adversely since it increases the risks associated with investment planning which in turn discourage fixed investment spending.

With regard to the exchange rate, the outcomes show that the coefficient of the exchange rate is positive and significant. This result agree with the oil-curse literature suggesting that the negative impact of oil abundance might be channeled into domestic investment in oil-rich developing economies via exchange rate appreciation affecting the manufacturing sector adversely since domestic products become more expensive in the foreign markets.

Thus, the adverse oil effect on domestic investment is revealed directly through the negative impact of oil rents or oil exports, and indirectly via exchange rate appreciation which might be caused by increasing oil revenues (the Dutch disease).

3.6. Conclusions

A wide literature has addressed investment-related aspects ranging from examining the determinants of domestic investment, to focusing on the relationship between domestic investment and capital controls, the financial system, institutional quality, and political stability. There is, also, a large literature on the effect of resource abundance on economic growth. However, limited attention has been paid to the association between domestic investment and natural resources in developing countries which suffer from underinvestment and poor provision of infrastructure.

Therefore, this chapter pays attention to the impact of oil abundance on domestic investment in a group of oil-exporting developing economies (non-OECD countries) over 15 years (1996-2010) using static and dynamic specifications in which we included a proxy for oil abundance (oil rents, and oil exports) as an explanatory variable in addition to several other determinants of domestic investment in line with what has been established in the literature, including output growth, inflation, domestic credit provided by the banking sector, domestic credit provided to the private sector, liquidity, the exchange rate, FDI, and trade openness.

In the static specification of the model, the Random and the Fixed Effects estimators were employed. Past realizations of domestic investment are expected to be a significant determinant of investment, but are likely to be to be correlated with the error term which static estimators do not take into account; the investment model was therefore re-estimated with dynamic specification by employing the Arellano-Bond difference GMM estimator.

In accordance with the resource curse literature, estimation results with both the static and the dynamic specifications indicate that gross domestic investment is affected adversely by oil abundance in the countries included in our sample. This suggests that improving resource management practices, institutional quality, and government accountability would better channel oil proceeds towards infrastructure and capital investment projects which would drive sustained economic growth in oil-rich developing economies.

The findings also show, similar to what was established by previous studies, that domestic investment in these countries is augmented by output growth, financial development, FDI and trade openness, but it is adversely affected by inflation. Furthermore, exchange rate appreciation, which might result from increasing oil revenues, affects domestic investment negatively.

CHAPTER FOUR

OIL AND INVESTMENT IN OIL-IMPORTING OECD COUNTRIES

4.1. Introduction

Energy price fluctuations could be a source of instability in the global economy. The importance of energy costs to economic growth has motivated numerous researchers to document the implications of energy price changes on the economies of developed and developing countries.

Crude oil is one of the most important natural sources of energy as its components are used for manufacturing, electric power generation, and fuelling vehicles and airplanes. Hence, changes in the price of crude oil may affect economies of both oil-importing and exporting nations. While higher crude oil prices entail additional revenues for oil-exporting economies, they involve higher costs to oil-importing countries since oil price increases drive the prices of refined petroleum products, such as gasoline, heating oil, kerosene, and asphalt, upwards.

Many studies have examined the impact of the oil price fluctuations on output growth using time series or panel data analysis. The results, however, are sensitive to the sample size, the model specification, and the employed methodology, but the conclusion upon which it has been agreed suggests that the impacts of oil price increases are more important than that of oil price decreases (Ashley and Tsang, 2013).

Theoretical work suggests that oil market disturbances could affect adversely the macroeconomy not only because increases in the level of the oil price, but also because they result in raising oil price volatility (Ferderer, 1996). Thus, some researchers have documented the effects of oil price uncertainty on firm level investment. The results, however, are not conclusive. Early studies, within the framework of classical theory, pointed out that entrepreneurs could snatch investment opportunities in conditions of uncertainty (Knight, 1921). Other studies, such as Hartman (1972), Abel (1983), and Abel & Blanchard (1986) also showed that higher levels of uncertainty would boost the expected profit margin of capital and therefore increase investment. However, models specified by other researchers showed that large oil price changes involve uncertainty about future prices, which cause delays in business investments (see Pindyck, 1991).

This study contributes to this literature by investigating the impact of oil price changes and oil price volatility on fixed investment, but from the macro level, an approach which has been ignored in the existing literature. We applied our study on a panel of 12 OECD oil-importing economies over the period 1970-2012 within the framework of the neoclassical production function by employing different econometric techniques (the Fixed and the Random Effects estimators, and the Generalized Method of Moments estimator). First, the investment model was estimated using differenced variables to examine the impact of oil price changes and oil price volatility on investment. Then, the panel unit root test and the panel cointegration tests were implemented. Finally, the long and short run effect of oil price was examined by estimating the Error Correction Model.

The chapter is organized as follows. The first section reviews literature related to the effect of oil prices on both macroeconomic activities and firm level investment. The second section specifies the investment model within the framework of the production function, and throws light on the study sample and data sources, and provides definitions of the study variables. The third section views the employed methodology used to examine the effect of the oil price on fixed investment including the panel unit root test, the panel cointegration test, the Error Correction Model. The fourth section provides conclusions about the estimation outcomes of the study.

4.2. Literature review

4.2.1. Oil prices and macro level economic activities

A large body of literature has examined the macroeconomic effects of oil price fluctuations on oil-exporting and oil-importing economies. Many studies focussed on implications of oil price changes on US output growth, and several studies examined the interaction between oil price changes and macroeconomic and financial variables including output, unemployment, inflation, and share prices in different countries.

In this context, Hamilton (1983) observed that all but one of the recessions in the United States between the end of the Second World War and 1973 were preceded by a dramatic rise in oil prices. His analysis showed that oil prices Granger-caused aggregate output. Hamilton (1988) provided a theoretical framework on the asymmetric relationship between oil prices and output. According to him, increasing the growth rate of oil prices reduces the durable consumption growth since consumers postpone their purchases, but dropping oil prices is not necessarily associated with rising consumption growth.

More recent empirical studies have shown that oil price changes have asymmetric effects on the macroeconomy. Mork (1989), for example, found that oil price increases had a significant negative impact on the growth of the Gross National Products in the US economy, but oil price decreases did not drive economic growth upwards. Furthermore, Mork et al., (1994) show that this asymmetry also exists in most other OECD countries.

Hooker (1996) showed that lagged oil price changes do not explain current output growth after 1973. According to him, the 1973 oil price shock had a large and significant impact on the macro economy, while that of 1979 was significant but incomplete in explaining the dynamics of the recession over 1980-82. Analysis of the late 1980s indicates that the oil price-macroeconomy relationship has changed in a way not well represented by a simple price increase/price decrease asymmetry.

The empirical findings of Ferderer (1996) showed oil price volatility helps to forecast the aggregate output movements in the US economy, and part of the asymmetric relationship between oil price changes and output growth can be explained by the response of the economy to oil price volatility. The interaction of oil price volatility and oil price changes may create offsetting effects. If negative oil price changes affect oil price volatility positively, and where oil price volatility has an adverse effect on the economy, the effects might be offsetting and thus create an asymmetric response to oil price changes.

Ashley and Tsang (2013) considered the persistence of changes in oil prices. They used quarterly data from 1976 – 2007 on each of six developed countries. They argue that the output growth rate responds differently to a temporary change in the growth rate of oil than to a relatively more persistent one. They found that changes in the growth rate of oil prices which persist for more than four years have a large and statistically significant impact on future output growth, whereas changes lasting more than one year but less than four years do not seem to affect output growth significantly. However, ‘temporary’ fluctuations in the oil price growth rate - persisting for only a year or less - have a statistically significant impact on output growth for most of these countries.

Kilian (2009) used a structural VAR model to distinguish oil price movements that are induced by structural demand or supply shocks, arguing that these two shocks have different effects on income growth. Accordingly, during periods when the two types of shocks are present, it is problematic to treat oil price changes as exogenous and only consider one-directional causality from oil price to income.

Kilian’s (2009) approach has been employed by several studies showing how oil price shocks influence stock markets and real economic activities. Thus, it has been shown that considering the origin of oil price shocks is important since different shocks in the oil market have diverse impacts on real economic activities and stock market returns (see, Kilian and Park, 2009; Apergis and Miller, 2009; Yoshizaki and Hamori, 2013).

According to Blanchard and Gali (2009) large increases in the price of oil were associated with sharp decreases in output and large increases in inflation. In the 2000s, even larger increases in the price of oil were associated with much milder movements in output and inflation. Blanchard and Gali (2009) argued that this reflects a change in the causal relation from the price of oil to output and inflation. They then argued that this change could be due to a combination of three factors: a smaller share of oil in production and consumption, lower real wage rigidity, and better monetary policy. Their argument, based on simulations of a simple new-Keynesian model, was informal. Thus by using a structural VAR approach and estimating impulse response functions for the United States, both for the pre-1984 and the post-1984 periods, they concluded that the post-1984 effects of the price of oil on either output or the price level were almost equal to one-third of those for the pre-1984 period.

Ghalayini (2011) investigated the relationship between the oil price changes and economic growth in both oil-exporting and oil-importing economies. For oil-exporting countries, the outcomes show that oil price increases did not enhance economic growth since the inflows of oil returns after oil price increases find their way outside these countries, suggesting the need to develop institutions capable to drive oil returns towards profitable economic projects. For oil-importing countries, Ghalayini showed that oil price increases have a negative impact on output because of the negative effects on producers and consumers demand.

Lescaroux and Mignon (2008) examined short-run and long-run interactions between oil prices and various macroeconomic and financial variables (output, the consumer price index, household consumption, the unemployment rate and share prices) for oil-exporting countries and oil-importing countries. Their results indicate that the causality runs from oil prices to the considered macroeconomic variables in the short run, especially for share prices. An oil price increase leads to a reduction of profits of non-oil exporting firms leading to a decrease in share prices. Over the long run, the causality runs from oil prices to output and the other macroeconomic variables.

Various other studies have examined the impact of oil price uncertainty. Jo (2012) looked at the effect of oil price uncertainty on global real economic activity using a VAR model with time-varying stochastic volatilely in mean. His findings indicate that oil price uncertainty affect industrial production adversely. Contrary to the earlier studies, high oil price uncertainty can reduce industrial production, independent of actual price level changes. Aizenman and Marion (1993) examined the relation between policy uncertainty and real per capita output in a group of developing countries over the period 1970-1985. Their results indicate that uncertainty could have a negative effect on economic growth via reduced investment.

Elder and Serletis (2010) and Bredin et al. (2011), measured the effect of oil price uncertainty on economic activity for the United States and G-7 countries and found that an increase in oil price uncertainty decreases real economic activity, measured by output, investment, and consumption in the US and four G-7 countries. Their results indicate that the price surge has been rather steady and continuous, keeping oil price uncertainty at a very low level. Thus, the overall change in the price of oil was less disruptive than previous oil price disturbances and did not drive an immediate economic recession.

4.2.2. Oil prices and firm level investment

Uncertainty which might result from economic or political shocks can affect the price of oil and therefore output growth and capital investment. Therefore, the relationship between firm level investment and uncertainty has been widely addressed in the literature. The results, however, are not conclusive; some researchers have argued that uncertainty would enhance investment, but others showed that investment is influenced adversely by uncertainty.

The classical theory of Knight (1921) suggests that under uncertainty entrepreneurs have the ability to seize investment opportunities and make profits. Economic models developed by Hartman (1972) and Abel (1983) suggest that a higher level of uncertainty would boost the expected profit margin of capital and therefore increase investment. Abel and Blanchard (1986) provided empirical evidence for this proposition.

However, other researchers argue that investments drop with an increasing level of uncertainty. Kellogg (2010), for example, examined the responsiveness of investment decisions by firms to changes in uncertainty using Texas oil well drilling data and expectations of future oil price volatility. His findings indicate that firms decrease their drilling activity with rising the expected volatility. Similarly, several recent studies (Baker et al., 2013; Gulen and Ion, 2013; Julio and Yook, 2012) showed that uncertainty results in reduced corporate investment during the global financial crisis.

Edo (2013) investigated the impact of oil booms on the manufacturing sector of Nigeria over the period 1970–2009 employing a vector autoregression model to show the relationship between three sectors: the resource, manufacturing and the service sectors. His results suggest that oil booms led to significant stagnation in the manufacturing sector and a marginal decline in the service sector.

Wang et al. (2014) examined the relationship between economic policy uncertainty and corporate investment at the firm level in China using a panel of Chinese publicly listed firms from 2003-2012. They found that uncertainty affects corporate investment in China in a different way. Policy-related economic uncertainty might reduce corporate investment, and firms with heterogeneous characteristics were found to respond differently towards policy uncertainty. Firms which enjoy a higher return on invested capital rely more on internal finance and are non-state-owned, are better positioned to mitigate the negative impact of uncertainty on corporate investments.

Real options arguments also reached the same conclusion due to the irreversible nature of investment projects. That is, investors compare the expected profit from current and future investment, so the higher the degree of uncertainty, the higher is the value on the option of waiting. As a result, investors tend to reduce current the investment spending (see Caballero and Pindyck, 1996; Leahy and Whited, 1996; Bond and Cummins, 2004).

Having reviewed the literature on the impact of oil prices on macroeconomic activities and firm level investment, in the next section we give some background on the pricing of crude oil and throw light on major oil disturbances since the 1970s.

4.3. Overview on oil shocks since the 1970s

4.3.1. Pricing crude oils

Although economic activities rely on different sources of energy, including oil, natural gas, coal, renewable energy sources, and nuclear power, oil remains the world's dominant fuel (BP, 2014). Besides, the price of crude oil is the most significant factor that determines the prices of petroleum products; the price of gasoline, for example, is largely determined by the worldwide demand and supply of crude oil (Levine et al., 2014).

Crude oil, as was defined by EIA (US Energy Information Administration)[25], is a mixture of hydrocarbons[26] that exists as a liquid in natural underground reservoirs and remains a liquid when brought to the surface. Crude oil is refined to produce various petroleum products, such as heating oils; gasoline, diesel, jet fuels; asphalt and many other products used for their energy or chemical content.

Energy-intensive industries, such as food, bulk chemicals, glass, cement, iron and steel, and aluminum, use the largest amount of energy per unit of output, and thus are particularly sensitive to energy prices. Thus, analysis of the industrial sector shows links between energy prices and industrial production, with production declining when energy prices increase (EIA, 2014a).

Oil prices, however, do not only affect industrial production, but also other sectors in the economy (for example, transportation, residential and commercial consumption,

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[25] See EIA Energy Glossary.

[26] A hydrocarbon is any organic chemical compound of hydrogen and carbon in the gaseous, liquid, or solid phase. The molecular structure of hydrocarbon compounds varies from the simplest (methane, a constituent of natural gas) to the very heavy and very complex (Levine et al., 2014).

and electric power generation). Furthermore, the price of oil is among the factors affecting the price of natural gas (EIA, 2014a). Hence, changes in the price of oil could have direct and indirect implications on the economy.

Price differences between crude oils based on quality characteristics of the crude oil - i.e, the lightness of the crude oil measured in degrees of API[27], and the percentage of sulphur content by weight. Lighter crudes produce a larger number of lighter products, such as gasoline, with a higher resale value. When other qualities are equal, lighter crudes are expected to be sold at a premium over heavier crudes. A high sulphur content affects adversely the value of the crude since it is entails higher operating costs for refineries, owing to special processing and maintenance requirements. Furthermore, new legislation in many countries mandates lower sulphur content for gasoline and diesel. Therefore, a high-sulfur crude (Sour crude) is expected to sell at a discount comparing to a low-sulfur (sweet crude) of the same API. Another key property is acidity measured by the total acid number (TAN), where above certain limit acidity has a corrosive impact on refineries, but blending a low TAN with a high TAN would deal with this problem, though it increases the related logistical costs. Crudes with a high TAN, are likely to command a discount (Bacon and Tordo, 2004).

There are several benchmark crude oils with different quality characteristics - also known as "marker crude oils" - used as references for pricing oils (Levine et al., 2014). Two of the most important benchmarks are West Texas Intermediate and Brent crude oil. *West Texas Intermediate (WTI)* consists of a blend of several US

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[27] API indicates the American Petroleum Institute's scale for measuring the specific gravity of crude oil or condensate; the higher the API gravity, the lighter the petroleum (Levine et.al, 2014).

domestic streams[28] of light sweet crude oil traded in the domestic spot market at Cushing, Oklahoma, a transshipment point with many pipelines, storage facilities and easy access to refiners and suppliers (CME group, 2013). *Brent crude* is a light sweet crude stream, though not as light and sweet as WTI, produced in the North Sea region, and it is typically refined in Northwest Europe. Brent crude price is considered as a reference or "marker" for pricing a number of other crude streams (EIA).

Prices of Brent and WTI crude oil tracked closely before 2011, with Brent crude oil priced at a slight discount to WTI crude oil due to the quality characteristics and delivery costs to transport Brent crude oil into the US market. However, in early 2011, WTI crude oil was priced at a discount to Brent crude oil, attributed, according to EIA, to the increased production of US light sweet crude oil, beside the limited pipeline capacity to move the crude from production fields and storage locations to refining centers. More recently, expansions in US crude oil infrastructure have reduced the downward pressure on the price of WTI making it possible to transport barrels from production areas, such as Texas and North Dakota, to refinery centers without passing through the hub (EIA, 2013).

[28] Crude oil stream: Crude oil produced in a particular field or a collection of crude oils with similar qualities from fields in close proximity, which the petroleum industry usually describes with a specific name, such as West Texas Intermediate or Saudi Light (EIA Energy Glossary).

Other well-known crude prices include *OPEC Basket* (a weighted average of prices for petroleum blends produced by OPEC[29] countries), Dubai crude, and Urals crude (a reference for pricing the Russian oil).

Crude oil can be traded in *spot market* or future markets. A spot market is more likely to develop at a location with many pipeline interconnections allowing for a large number of buyers and sellers. Crude oil and petroleum products are traded in the spot market for immediate or very near-term delivery - generally within or less than 30 days. Cushing Oklahoma is one important spot market for crude oil - specifically the WTI benchmark. Crude oil can be also traded via *futures contracts*. A futures contract is a binding, legal agreement between a buyer and a seller for delivery of a particular quantity of a commodity at a specified time, place, and price. These contracts are traded on regulated exchanges and are settled daily based on their current value in the marketplace. Many oil contracts traded on the New York Mercantile Exchange (NYMEX) and other exchanges end without actual physical delivery of the commodity (Levine, et.al, 2014).

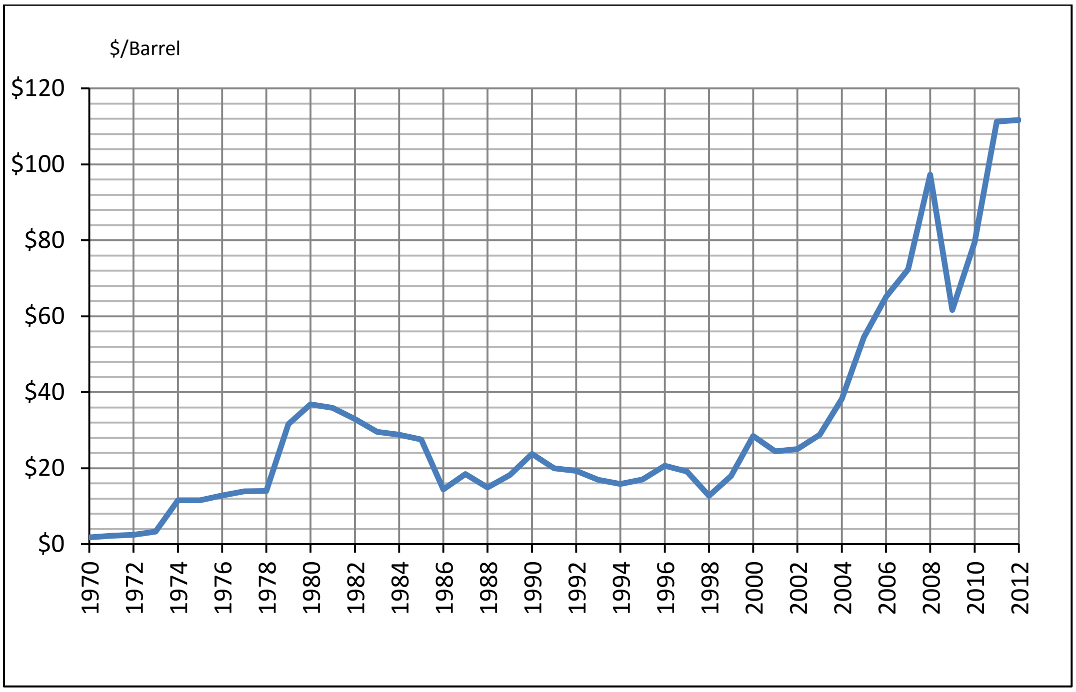
4.3.2. Oil shocks since the 1970s

Crude oil is viewed as an essential input to the production function, but being a scarce commodity and a non-renewable source of energy makes its price prone to fluctuation as a response to political, economic, and financial turmoil. It can be seen

[29] OPEC (Organization of the Petroleum Exporting Countries): An intergovernmental organization whose stated objective is to "coordinate and unify the petroleum policies of member countries." It was created at the Baghdad Conference on September 10-14, 1960. Current members (with years of membership) include: Algeria (1969-present), Angola (2007-present), Ecuador (1973-1992 and 2007-present), Iran (1960-present), Iraq (1960-present), Kuwait (1960-present), Libya (1962-present), Nigeria (1971-present), Qatar (1961-present), Saudi Arabia (1960-present), United Arab Emirates (1967-present), and Venezuela (1960-present). Countries no longer members of OPEC include: Gabon (1975-1994), and Indonesia (1962-2008) (IEA).

from Figures 4.1 and 4.2 how dramatic events took place in history from 1970 to 2012 resulted in sharp changes in the price of oil and thus on economic activities.

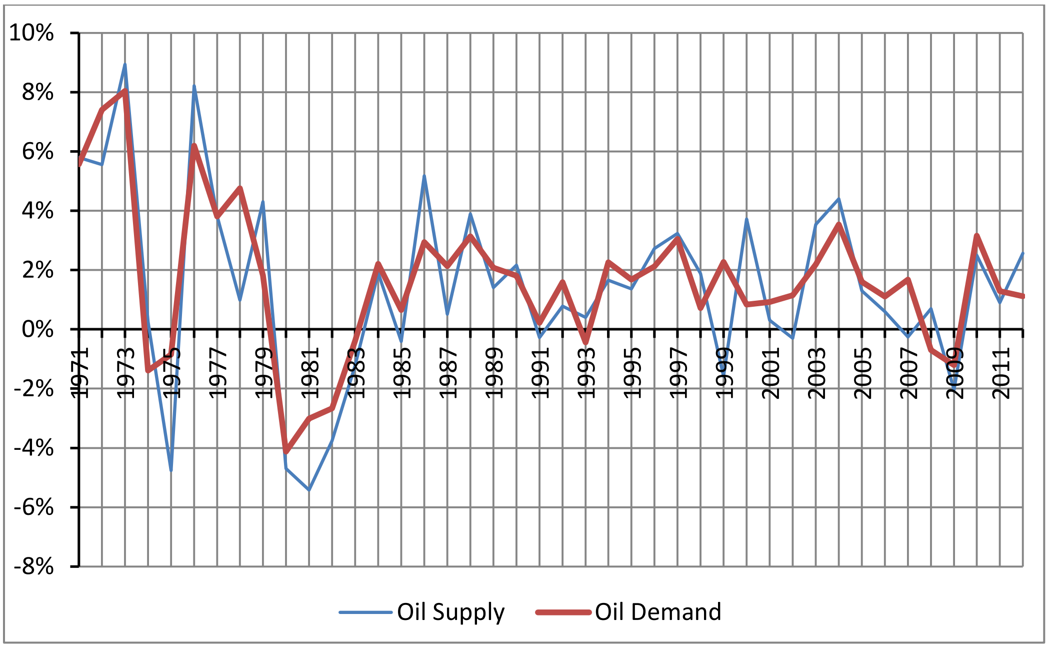
Figure 4.1. Crude oil spot prices



Source: BP, Statistical Review of World Energy 2014 - Historical data workbook.
1970-1983 The price of Arabian Light posted at Ras Tanura[30]
1984-2012 The price of Brent crude

[30] Ras Tanura is a city in Saudi Arabia serves as a major oil port, and oil operations center for Saudi Aramco (the Arabian-American oil company).

Figure 4.2. Growth rates of global crude oil supply and demand between 1970 and 2012



Source of oil demand and supply is BP, Statistical Review of World Energy 2014 - Historical data workbook. Growth rates are computed by the researcher.

Total World oil production: Includes crude oil, tight oil, oil sands and NGLs (the liquid content of natural gas where this is recovered separately). Excludes liquid fuels from other sources such as biomass and derivatives of coal and natural gas.
Total World oil consumption: Inland demand plus international aviation and marine bunkers and refinery fuel and loss. Consumption of biogasoline (such as ethanol), biodiesel and derivatives of coal and natural gas are also included.

During 1973-1974 the price of crude oil increased due to the Arab embargo more than four times (from $2.5/barrel in 1972 to about $12/barrel in 1974), with a negative average growth rate (-2.25%) of crude oil production between 1973 and 1975.

The Iranian revolution in 1979-1980 also resulted in reducing oil production by 4.8 million barrel/day (7% of global production at the time) (Hamilton, 2011), where the growth rate of oil production was negative (-5%). Although Iranian production had returned to about half of its pre-revolutionary levels later in 1979, it fell again due to Iraqi-Iranian war in September 1980. Consequently, the price of oil increased from $14/barrel in 1978 to $37/barrel in 1980.

However, the price of oil dropped sharply from $28/barrel in 1985 to $14.4/barrel in 1986 following the netback pricing[31] adopted by Saudi Arabia (see Mabro, 1987). Also, in 1997-1998 the oil price witnessed another collapse where it dropped from $20.6/barrel in 1996 to $12.7/barrel by the end of 1998 due to the Asian crisis, which resulted in major financial and economic implications in a number of Asian countries. The Asian crisis did not continue for long time but back to grow soon. Thus, petroleum consumption returned to strong growth during 1999-2000, and the price of oil increased to $28.5/barrel in 2000.

Over December 2002 and January 2003, the Venezuelan unrest resulted in reducing Venezuela's oil production by around 2.1 million barrel/day due to the strike took place that time (Hamilton, 2011); the oil price thus increased from $24/barrel in 2001 to $29/barrel in 2003.

During 2007-2008, the demand for oil increased dramatically as the global economy witnessed a noticeable growth. Hence, the price of oil went upward from $65 in 2006 to $97/barrel in 2008.

The Arab Spring over 2010-2011 affected the oil price as it increased from $62/barrel in 2009 to about $111/barrel in 2011, marking the first time the global benchmark averaged more than $100 per barrel for a year (EIA, 2012).

Having highlighted the oil-related disturbances since the 1970s, in the next section, we examine the effect of oil price changes on domestic fixed investment. We view

[31] The netback price of a barrel of crude is "the gross product worth of the refined products at the refinery gate, minus the costs incurred in transporting the barrel from export terminal (or the oilfield in the case of domestic crude) to the refinery, and minus refining costs; the gross product worth is the sum of product prices weighted by refining yield" (Mabro, 1987, p. 6).

the investment model, define the variables, present the methodology and then find estimation results.

4.4. Model specification and data

4.4.1. The investment model

Investment behaviour has been analysed in the literature using different approaches such as the Keynesian model, the cash flow model, and the neoclassical model (the Jorgenson model). In this study investment behaviour is modelled within the framework of the neoclassical approach according to which a firm produces output Q with capital stock K and labour, and energy consumption EC.

Before proceeding to the empirical specification of domestic investment, we highlight the theoretical relation between output and investment and therefore the justification of including energy prices which affect output, as was viewed by theories of energy economics. In this specification, the production function is aggregated over all firms to obtain macroeconomic variables.

Let K_t be the aggregate capital stock at the end of period t which can be expressed as $K_t = (1-\delta)K_{t-1} + I_t$ where K_{t-1} is the capital stock at the end of the previous period, δ is the rate of depreciation, and I_t is gross investment. δK_{t-1} is replacement investment. Net investment $(K_t - K_{t-1})$ equals to total investment minus replacement investment $(I_t - \delta K_{t-1})$. Theories of investment behaviour view the demand for new investment, such as a plant and equipment, as the gap between the desired or optimal amount of capital (K_t^*) and the actual amount of capital. Hence, gross investment can be written as follows: $I_t = \theta_t(K_t^* - K_{t-1}) + \delta K_{t-1}$ where θ_t is the speed of adjustment between K_t^* and K_{t-1} (see Lensink et al., 2001).

Investment is viewed as a function of output (Y), and the user cost of capital (u). But since energy consumption and therefore energy prices (EP) affect output and thus capital stock, energy prices are expected to influence investment. When energy prices go upwards this increases production cost and might affect consumption adversely which in turn reduces the demand for produced goods and services in the economy. Hence, the investment model can be written as follows:

$$I = f(Y, EP, u) \tag{4.1}$$

In order to estimate the model the crude oil price is used as a proxy for energy prices. The data on the user cost of capital are, however, not available. In a few studies, which have considered firm level investment, the user cost of capital was computed by the researchers, or it was proxied by the real interest rates; whereas in other studies, the user cost of capital was considered as an unobserved variable which can be addressed employing appropriate econometric techniques. In our panel set, there is lack in data on real interest rates for some cross sections, and we do not have all the required information to compute the user cost of capital at the macro level. We, therefore, assume the user cost of capital as one of the unobservable variables in the investment model, and thus employ estimators which can capture the unobservable cross sectional effects.

Since investment is affected also by other macroeconomic variables, Eq (4.1) can be supplemented by other determinants of investment which has been used in the literature as follows:

$$I_{it} = \lambda_0 + \lambda_1 Y_{it} + \lambda_2 P_{it} + \lambda_3 Trade_{it} + \lambda_4 Inf_{it} + \lambda_5 Exch_{it} + \varepsilon_{it} \tag{4.2}$$

Where

λ_0: The intercept;

I_{it}: The logarithm of real fixed investment in country i in year t;

Y_{it}: The logarithm of real gross domestic products (GDP);

P_{it}: The logarithm of real oil price (the nominal oil price deflated by the GDP deflator of each country);

Other control variables include the real exchange rate ($\mathrm{Exch_{it}}$), Inflation measured as a GDP deflator ($\mathrm{Inf_{it}}$), and trade ($\mathrm{Trade_{it}}$) which is real exports plus real imports as a percentage of real GDP - all in their logarithmic form.

$\lambda_1, \lambda_2, \ldots, \lambda_5$ are the coefficients of the explanatory variables;

ε_{it}: The error term.

The model was also estimated including the oil price uncertainty (Vol_{it}).

4.4.2. Data

The sample of this study covers 12 OECD[32] countries (Belgium, Finland, France, Germany, Greece, Italy, Japan, Korea Rep., Netherlands, Portugal, Spain, and Sweden). Major oil producers such as the United States and the United Kingdom were excluded. Small economies were also ruled out. Thus, the focus of this study is on larger oil-importing OECD economies. In order to capture the implications of the major oil crisis that took place in the 1970s and oil price shocks post 1970s on investment our study covers the period from 1970 to 2012.

Studies related to oil prices have used a variety of oil prices, but mostly WTI and Brent prices.

[32] OECD (Organization For Economic Co-operation and Development) includes: Europe: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Republic of Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom. Other member countries: Australia, Canada, Chile, Israel, Japan, Mexico, New Zealand, South Korea, and US.

In this study, in order to cover the required period from 1970 to 2012, we use the crude price which is provided by the BP Historical Data Workbook - as shown in Figure 4.1 - where the price of Arabian Light posted at Ras Tanura covers the period 1970-1983, while the Brent crude price covers the period 1984-2012.

In order to avoid the impact of inflation, following some researchers, such as Robinson (2005), and Baumeister and Robays (2010), the nominal crude oil price was deflated by the GDP deflator of each country in our sample. The GDP deflator represents the ratio of GDP in current local currency to GDP in constant local currency (WDI, 2014).

The rest of the variables used in estimation were derived from the World Bank database - World Development Indicators (WDI). Fixed investment, output, exports, and imports were used in their real prices while Trade represents the sum of real imports and real exports divided by real output.

Regarding exchange rates, official exchange rates were deflated using the GDP deflator in each country since the data on real effective exchange rates are not available for some countries in different years.

Inflation is measured by the annual growth rate of the GDP implicit deflator and it shows the rate of price change in the economy as a whole (WDI, 2014).

Gross fixed capital formation (known as gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings.

Since we have a multiple regression model, we check the correlation between the explanatory variables as we need to avoid multicollinearity. The following table reports the correlation coefficients.

Table 4.1. The Correlation coefficients between the explanatory variables in the investment model

Variable	P	Y	$Trade$	$Exch$	Inf	Vol
P	1	-0.37179 <.0001	-0.35956 <.0001	0.40359 <.0001	0.57408 <.0001	0.15196 0.0006
Y	-	1	-0.19275 <.0001	-0.09135 0.0753	-0.39822 <.0001	-0.04445 0.3193
$Trade$	-	-	1	-0.42174 <.0001	-0.48233 <.0001	-0.05189 0.2449
$Exch$	-	-	-	1	0.46418 <.0001	0.04279 0.4055
Inf	-	-	-	-	1	0.07827 0.0874
Vol	-	-	-	-	-	1

Note: The upper value in each cell refers to the Pearson Correlation Coefficient, while the lower value is the probability where the null hypothesis indicates that the correlation is insignificant (Prob > |r| under H0: Rho=0).

It can be seen from Table 4.1 that the coefficient on the correlation between oil price and output, and that between oil price and trade is negative, while it is positive for that between oil price and each of the exchange rate, inflation, and volatility. Although most variables are significantly correlated, as shown in the table, the coefficients are less than 0.50, except that between oil price and inflation is 0.57. This suggests that the variables can be included in the model avoiding substantial multicollinearity.

In order to find oil price volatility, autocorrelation (serial correlation) of the residuals in each country's oil price series was checked. Since oil price series are non-stationary - as will be shown in the next section - the differenced oil price series was considered for each country:

$$\Delta P_{it} = \sigma_i t + Res_{it} \tag{4.3}$$

Where ΔP_{it} is the differenced oil price for country i in year t, σ_i is the coefficient of the time trend, and Res_{it} refers to the residuals.

Autocorrelation - the case in which the residuals are correlated with their past values - was tested using the Durbin Watson (DW) test which has a null hypothesis of no autocorrelation in the residuals, and the following results were obtained.

Table 4.2. Durbin-Watson Statistics to check the autocorrelation between the residuals of the differenced oil price series in each country in the sample

Durbin-Watson Statistics				
Country	**Order**	**DW**	**Pr < DW**	**Pr > DW**
Belgium	1	2.0902	0.6157	0.3843
	2	2.1245	0.7151	0.2849
Finland	1	2.1008	0.6289	0.3711
	2	2.0996	0.6868	0.3132
France	1	2.0804	0.6035	0.3965
	2	2.0965	0.6832	0.3168
Germany	1	2.0795	0.6023	0.3977
	2	2.0939	0.6802	0.3198
Greece	1	1.8315	0.2909	0.7091
	2	1.8207	0.3355	0.6645
Italy	1	2.0243	0.5316	0.4684
	2	2.0311	0.6037	0.3963
Japan	1	2.1351	0.6705	0.3295
	2	2.1352	0.7268	0.2732
Korea, Rep.	1	2.1497	0.6876	0.3124
	2	2.1485	0.7411	0.2589
Netherlands	1	2.1497	0.6876	0.3124
	2	2.1905	0.7837	0.2163
Portugal	1	1.8599	0.3236	0.6764
	2	1.8902	0.4219	0.5781
Spain	1	2.0543	0.5703	0.4297
	2	2.0666	0.6476	0.3524
Sweden	1	2.0701	0.5905	0.4095
	2	2.0677	0.6490	0.3510

Note 1: Pr<DW is the p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing negative autocorrelation.

The test results in Table 4.2 indicate that there is no autocorrelation in the residuals of the differenced oil price series in all countries since the null hypothesis of no autocorrelation cannot be rejected at the 1% significance level in all cross sections.

We also checked the autoregressive conditional heteroscedastic (ARCH) effects in oil price's series employing the ARCH test which has the null hypothesis of no ARCH effect. The results are reported in the following table.

Table 4.3. Tests for ARCH disturbances based on OLS Residuals for the residuals of the differenced oil price series in each country in the sample

Tests for ARCH Disturbances Based on OLS Residuals					
Country	**Order**	**Q**	**Pr > Q**	**LM**	**Pr > LM**
Belgium	1	0.3866	0.5341	0.3241	0.5692
	2	1.0952	0.5783	0.9397	0.6251
Finland	1	0.5401	0.4624	0.4529	0.5010
	2	1.1120	0.5735	0.9581	0.6194
France	1	0.3261	0.5680	0.2707	0.6028
	2	0.9660	0.6169	0.8119	0.6663
Germany	1	0.4764	0.4901	0.4039	0.5251
	2	1.1428	0.5647	1.0069	0.6044
Greece	1	0.8339	0.3611	0.7291	0.3932
	2	1.3618	0.5062	1.2628	0.5318
Italy	1	0.3936	0.5304	0.3252	0.5685
	2	1.0362	0.5957	0.8626	0.6497
Japan	1	0.6138	0.4334	0.5175	0.4719
	2	1.3391	0.5119	1.1771	0.5551
Korea, Rep.	1	0.1666	0.6832	0.1213	0.7277
	2	0.9606	0.6186	0.7135	0.6999
Netherlands	1	0.3790	0.5382	0.3171	0.5733
	2	1.0421	0.5939	0.8953	0.6391
Portugal	1	0.3895	0.5325	0.3253	0.5684
	2	0.9214	0.6308	0.7683	0.6810
Spain	1	0.3346	0.5630	0.2771	0.5986
	2	0.9391	0.6253	0.7825	0.6762
Sweden	1	0.3409	0.5593	0.2840	0.5941
	2	0.9558	0.6201	0.8084	0.6675

The test results for all countries indicate that the null hypothesis of no ARCH effect cannot be rejected at the 1% significance level, with both Lagrange Multiplier (LM) and the Ljung-Box Q statistics. Therefore, instead of considering volatility based on ARCH, we used the deviation from the trend. That is, the square root of the squared residuals saved from the differenced oil price series - Eq (4.3) - for each individual country.

Thus, the oil price volatility in country i in year t is given by $Vol_{it} = \sqrt{{Res_{it}}^2}$.

4.5. Methodology

4.5.1. Panel unit root tests

The finding that many macro time series might contain a unit root has urged the development of the theory of non-stationary time series analysis.

The first step in our analysis is to check the integration of the series in our dataset using panel unit root tests since panel based unit root tests have higher power than the tests which are based on individual time series (Mahadevan and Asafu-Adjaye, 2007). There are several panel unit root tests including Breitung (2000), Hadri (2000), Levin, Lin and Chu (2002), and Im, Pesaran and Shin (2003).

Consider the following autoregressive model (see Mahadevan and Asafu-Adjaye, 2007)

$$x_{it} = \rho_i x_{it-1} + \delta_i Z_{it} + \varepsilon_{it} \tag{4.4}$$

where i=1, 2, …, N refer to the cross section over the periods t=1, 2, …, T, Z_{it} includes the exogenous regressors, including any fixed effects or individual trend. ρ_i

is the autoregressive coefficient, while ε_{it} is the error term which is a stationary process. If $\rho_i < 1$ then x_i is weakly trend-stationary. However, if $\rho_i = 1$, then x_i contains a unit root.

In this study we use both the Levin, Lin, and Chu (LLC) and the Im, Pesaran test, and Shin (IPS) test. Before considering the results we highlight the differences between the panel unit root tests.

The LLC, Breitung, and Hadri, panel unit root tests assume that ε_{it} is IID $(0, \sigma_\varepsilon^2)$ - i.e., the error term is independent and identically distributed with a zero mean and variance σ_ε^2. They also assume that the autoregressive coefficient is identical among the cross sections, so $\rho_i = \rho$ for all i which implies that the coefficient of x_{it-1} is homogeneous among all cross sections.

Compared to the LLC, Breitung and Hadri tests, the IPS panel unit root test allows for heterogeneous autoregressive coefficients which could be attributed to the different economic conditions and stages of economic development in each country. IPS propose averaging the augmented Dickey-Fuller (ADF) test, so that $\varepsilon_{it} = \sum_{k=1}^{p_i} \varepsilon_{it-k} + u_{it}$, while allowing for different orders of serial correlation. By substituting this in Eq (4.4) the model can be written as follows:

$$x_{it} = \rho_i x_{it-1} + \delta_i Z_{it} + \sum_{k=1}^{p_i} \varepsilon_{it-k} + u_{it} \tag{4.5}$$

Where p_i refers to the number of lags in the ADF representation. The null hypothesis of the test is that each series in the panel contains a unit root. That is, $\rho_i = 1$ for all i, while the alternative hypothesis is that at least one of the individual series in the panel is stationary. That is, $\rho_i < 1$ for at least one i. IPS define t-bar statistics as the average of the individual ADF statistics as follows: $\vec{t} = \frac{1}{N}\sum_{i=1}^{N} t_{\rho_i}$ where t_{ρ_i} is the individual t-statistic for testing the null hypothesis that $\rho_i = 1$ for all i. The $\vec{t}$ statistic has been shown to be normally distributed under the null hypothesis and critical values for given values of N and T are given in Im et al. (2003).

We employ the homogenous based panel test of LLC, and the heterogeneous panel test of IPS. Both tests (LLC and IPS) have been applied on Investment, Oil price, Output, and Trade. For Exchange rates and Inflation the data is not strongly balanced so the LLC test cannot be performed, and so only the IPS test is applied. For the rest of the variables both tests have been applied. The panel unit root test has been applied for three cases: cross section fixed effects (CS Fixed), cross section fixed effects with trend (CS Fixed, Time), and both cross section and time effects with trend (CS Fixed, Time). The outcomes of the two tests are reported in Tables 4.4 and 4.5.

Table 4.4. LLC panel unit root test of the variables in their level forms

The variable	CS Fixed		CS Fixed, Time		CS, TS Fixed, Time	
	Adjusted t	Pr < Adj t	Adjusted t	Pr < Adj t	Adjusted t	Pr < Adj t
I	-1.31	0.0944	2.24	0.9875	1.30	0.9027
P	-1.11	0.1330	8.16	1.0000	0.56	0.7108
Y	-5.28	<.0001	3.17	0.9992	1.57	0.9416
$Trade$	0.62	0.7320	0.37	0.6433	1.72	0.9570
Vol	-22.80	<.0001	-23.12	<.0001	-12.93	<.0001

Note: ADF Lags is set to be MAIC (Modified Akaike Information Criteria).
Kernel is not specified for LLC test. It is set to be Quadratic.
Bandwidth Method is not specified for LLC test. It is set to be LLC Bandwidth.

Table 4.5. IPS panel unit root test of the variables in their level forms

The variable	CS Fixed		CS Fixed, Time		CS, TS Fixed, Time	
	Zt-bar	**Pr < Zt-bar**	**Zt-bar**	**Pr < Zt-bar**	**Zt-bar**	**Pr < Zt-bar**
I	2.40	0.9918	4.51	1.0000	3.93	1.0000
P	0.01	0.5058	8.23	1.0000	4.91	1.0000
Y	-0.91	0.1825	6.45	1.0000	5.91	1.0000
$Trade$	5.10	1.0000	1.58	0.9433	3.56	0.9998
Inf	4.60	1.0000	2.57	0.9950	2.27	0.9883
$Exch$	-0.64	0.2604	0.88	0.8109	1.45	0.9261
Vol	-19.21	<.0001	-19.53	<.0001	-9.49	<.0001

Note: ADF Lags is set to be MAIC (Modified Akaike Information Criteria).

The test results in Tables 4.4 and 4.5 indicate that the variables - except volatility - are non-stationary in their level form since the null hypotheses of the unit root cannot be rejected in the three cases (CS Fixed; CS Fixed, Time; and CS, TS Fixed, Time). Therefore, we need to take the first differences of the variables and then apply the test again. Although output (Y) seems stationary in one case (CS Fixed) according to the LLC test in Table 4.4, when the trend is added it turns out to be non-stationary. It is also non-stationary according to the IPS results.

The next step is to check the stationarity of the variables in their differenced forms. As before, both the LLC and IPS tests were applied, and the outcomes are reported in Tables 4.6 and 4.7.

Table 4.6. LLC unit root test for the differenced variables

The variable	CS Fixed		CS Fixed, Time		CS, TS Fixed, Time	
	Adjusted t	Pr < Adj t	Adjusted t	Pr < Adj t	Adjusted t	Pr < Adj t
ΔI	-9.19	<.0001	-10.96	<.0001	-10.95	<.0001
ΔP	-0.57	0.2855	-23.38	<.0001	-4.54	<.0001
ΔY	-9.67	<.0001	-13.43	<.0001	-11.26	<.0001
$\Delta Trade$	-11.92	<.0001	-13.39	<.0001	20.32	<.0001

Note: ADF Lags is set to be MAIC (Modified Akaike Information Criteria).
Kernel is not specified for LLC test. It is set to be Quadratic.
Bandwidth Method is not specified for LLC test. It is set to be LLC Bandwidth.

Table 4.7. IPS unit root test for the differenced variables

The variable	CS Fixed		CS Fixed, Time		CS, TS Fixed, Time	
	Zt-bar	Pr < Zt-bar	Zt-bar	Pr < Zt-bar	Zt-bar	Pr < Zt-bar
ΔI	-5.77	<.0001	-6.03	<.0001	-6.86	<.0001
ΔP	-0.64	0.2595	-19.54	<.0001	-4.50	<.0001
ΔY	-6.33	<.0001	-9.43	<.0001	-7.81	<.0001
$\Delta Trade$	-7.09	<.0001	-6.54	<.0001	-16.05	<.0001
ΔInf	-15.31	<.0001	-14.08	<.0001	-18.37	<.0001
$\Delta Exch$	-9.39	<.0001	-8.86	<.0001	-11.54	<.0001

Note: ADF Lags is set to be MAIC (Modified Akaike Information Criteria).

It can be seen that the null hypothesis of both the LLC and IPS tests, which refers to the presence of the unit root, is strongly rejected for Investment, Output, Trade, Inflation, and Exchange rates. For the Oil price, although the differenced oil price is non-stationary in the case (CS Fixed), it is stationary with the two other cases (CS Fixed, Time), and (CS, TS Fixed, Time). This suggests that the variables are stationary in their differenced forms and so they are integrated of order one I(1) in their level forms.

4.5.2. Estimating the differenced investment model

4.5.2.1. The static specification

In this section we investigate whether investment changes as a response to the oil price change, controlling for other explanatory variables, by estimating the following investment model.

$$\Delta I_{it} = \lambda_0 + \lambda_1 \Delta Y_{it} + \lambda_2 \Delta P_{it} + \lambda_3 \Delta Trade_{it} + \lambda_4 \Delta Inf_{it} + \lambda_5 \Delta Exch_{it} + \varepsilon_{it} \qquad (4.6)$$

All the variables in Eq (4.6) are the same as in Eq (4.2), but in their differenced forms (Δ).

The appropriate method for estimating Eq (4.6) depends on the error structure, so in order to figure out whether unobservable effects are correlated with the explanatory variables the Hausman test was employed. This tests the null hypothesis of the non-existence of correlation between individual and time specific effects and investment determinants, against the alternative hypothesis of existence of correlation. Rejecting the null hypothesis indicates that the panel Fixed Effects model is preferred for estimating the investment model.

The Hausman test[33] results, reported in Table 4.8, indicate that the model can be better estimated by employing the Fixed Effects estimator as the null hypothesis of random effects is rejected at the 1% significance level in Columns 1 and 2.

Estimating results using the Fixed Effects estimator are shown in Table 4.8 / Column 1 in which the dependent variable is the change in investment, while regressors

[33] The Hausman test can be generated automatically by estimating the model with the Random Effects estimator, but since the null hypothesis of the test is rejected, estimation results using Random effects estimator have not been reported, but the Hausman test statistic and p-value is reported.

include the change in each of the following regressors: oil price, output, trade, inflation, and the exchange rate. Then, we re-estimated the equation after supplementing the model with the volatility of oil prices over time (Table 4.8 / Column 2).

Table 4.8. Fixed Two-Way Estimates of the static investment model using differenced variables

Variable	1			2		
	Estimate	**S.E.**	**Pr > |t|**	**Estimate**	**S.E.**	**Pr > |t|**
Intercept	0.010251	0.0280	0.7145	0.01102	0.0280	0.6947
ΔP_t	-0.01351	0.0803	0.8666	-0.03512	0.0868	0.6862
ΔY_t	2.339413	0.1138	<.0001	2.343255	0.1140	<.0001
$\Delta Exch_t$	-0.19176	0.0385	<.0001	-0.1891	0.0387	<.0001
ΔInf_t	0.006635	0.00549	0.2274	0.006666	0.00549	0.2257
$\Delta Trade_t$	0.119652	0.0687	0.0827	0.116561	0.0689	0.0919
Vol_t	-	-	-	-0.05376	0.0816	0.5103
Hausman Test for Random Effects	m Value		Pr > m	m Value		Pr > m
	36.53		<.0001	53.64		<.0001
F Test for No Fixed Effects	F Value		Pr > F	F Value		Pr > F
	3.15		<.0001	3.03		<.0001
R^2	0.7703			0.7707		

Estimation outcomes in Table 4.8 show that the null hypothesis of the F test of insignificant time and cross sectional effects is rejected at the 1% significance level in both columns, so both the time and cross sectional effects are significant. The value of R^2 in both columns shows that the explanatory variables explain about 77% of the variation in investment. The results also show that the coefficients on both the oil price change and oil price volatility are negative but insignificant. These results could be attributed to using contemporaneous values of the variables, but the change in oil price in the previous period could influence investment in the current period.

Therefore, we re-estimate the investment model using lagged regressors instead of contemporaneous ones. The estimation outcomes are reported in the following table.

Table 4.9. The Two-Way Random Effects estimates of the static investment model using lagged differenced variables

Variable	1			2		
	Estimate	**S.E.**	**Pr > |t|**	**Estimate**	**S.E.**	**Pr > |t|**
Intercept	-0.00984	0.00704	0.1630	0.007717	0.00891	0.3870
ΔP_{t-1}	-0.03543	0.0192	0.0661	-0.03648	0.0182	0.0455
ΔY_{t-1}	1.166489	0.1088	<.0001	1.182783	0.1083	<.0001
$\Delta Exch_{t-1}$	-0.01671	0.0400	0.6765	-0.02237	0.0394	0.5700
ΔInf_{t-1}	0.007537	0.00508	0.1384	0.007449	0.00505	0.1409
$\Delta Trade_{t-1}$	-0.06844	0.0776	0.3780	-0.06133	0.0768	0.4250
Vol_t	-	-	-	-0.08236	0.0276	0.0030
R-Square	0.2060			0.2201		
Hausman Test for Random Effects	m Value		Pr > m	m Value		Pr > m
	5.26		0.3847	6.85		0.3350

The null hypothesis of the Hausman test in Table 4.9 cannot be rejected, indicating that the unobservable country and time specific effects are not correlated with the explanatory variables. Therefore, the model can be estimated using the two-way Random Effects estimator. Estimation outcomes in the table indicate that the change in oil price in the previous period affects domestic investment significantly and negatively at the 10% significance level in Column 1 and at the 5% level in Column 2. Furthermore, the coefficient on lagged oil price volatility is also negative and highly significant. The table also shows that the change of output in the last period affects investment significantly and positively.

We check the robustness of the results by estimating the dynamic investment model using two panel estimators.

4.5.2.2. The dynamic specification of the investment model

Fixed investment is expected to be significantly affected by its past realizations; therefore, in this section, we estimate the dynamic model where the lagged depended variable (ΔI_{it-1}) is added as an explanatory variable as well as the other regressors which are specified in the static model. Thus, the investment model can be written as follows.

$$\Delta I_{it} = \lambda_0 + \lambda_1 \Delta I_{it-1} + \lambda_2 \Delta Y_{it-1} + \lambda_3 \Delta P_{it-1} + \lambda_4 \Delta Trade_{it-1} + \lambda_5 Inf_{it-1} + \lambda_6 \Delta Exch_{it-1} + \varepsilon_{it} \quad (4.7)$$

The model can be estimated using the Random Effects estimator if the null hypothesis of the Hausman test cannot be rejected, but the lagged dependent variable might be correlated with the error term making the estimator biased. We therefore check whether such bias is considerable by re-estimating the dynamic model using the Generalized Method of Moments (GMM) estimator based on instrumental variables.

The Random Effects results are reported in Table 4.10, while the GMM estimating results are reported in Table 4.11.

Table 4.10. Random Effects estimates of the dynamic investment model with lagged differenced explanatory variables

Variable	1			2		
	Estimate	**S.E.**	**Pr > |t|**	**Estimate**	**S.E.**	**Pr > |t|**
Intercept	-0.00541	0.00739	0.4643	0.011705	0.00910	0.1989
ΔI_{t-1}	0.115458	0.0663	0.0822	0.11352	0.0659	0.0855
ΔP_{t-1}	-0.03334	0.0190	0.0797	-0.03432	0.0180	0.0569
ΔY_{t-1}	0.944651	0.1675	<.0001	0.965017	0.1666	<.0001
$\Delta Exch_{t-1}$	-0.00199	0.0407	0.9610	-0.00821	0.0400	0.8373
ΔInf_{t-1}	0.006571	0.00510	0.1978	0.006495	0.00507	0.2006
$\Delta Trade_{t-1}$	-0.07433	0.0774	0.3375	-0.06705	0.0767	0.3823
Vol_t	-	-	-	-0.08089	0.0272	0.0031
R^2	0.2109			0.2251		
Hausman Test for Random Effects	m Value		Pr > m	m Value		Pr > m
	8.90		0.1796	11.14		0.1327

The null hypothesis of the Hausman test in Columns 1 and 2/ Table 4.10 cannot be rejected indicating that the Random Effects estimator is a more appropriate estimator than the Fixed Effects estimator. The outcomes in the table indicate that investment is boosted as a result of the oil price drop (at the 10% level), and the output increase (at the 1% level) in the previous period. However, changes in trade, inflation, and the exchange rate do not exert significant impacts on investment. The coefficient on the lagged investment is also positive and significant at the 10% level.

Now we re-estimate the dynamic model employing the GMM estimator to cope with the endogeneity problem which could result from including the lagged dependent variable as an explanatory variable in the model. The following results were obtained:

Table 4.11. Parameters estimates of the investment model with lagged differenced explanatory variables using the two-step GMM estimator

Variable	Estimate	S.E.	Pr > |t|	Estimate	S.E.	Pr > |t|
ΔI_{t-1}	0.232734	0.0799	0.0038	0.201535	0.1062	0.0584
ΔP_{t-1}	-0.02522	0.0103	0.0150	-0.02827	0.0141	0.0461
ΔY_{t-1}	0.782855	0.1577	<.0001	0.968585	0.2511	0.0001
$\Delta Exch_{t-1}$	0.043409	0.0400	0.2785	0.00353	0.0434	0.9352
ΔInf_{t-1}	-0.02646	0.00615	<.0001	-0.02702	0.00865	0.0019
$\Delta Trade_{t-1}$	-0.10631	0.0926	0.2516	-0.03193	0.1483	0.8296
Vol_t	-	-	-	-0.05258	0.0124	<.0001
AR(m) test	Statistic		Pr > Statistic	Statistic		Pr > Statistic
Lag 1	-2.31		0.9896	-2.39		0.9916
Lag 2	-1.06		0.8560	-0.98		0.8362
Sargan Test	Statistic		Prob > ChiSq	Statistic		Prob > ChiSq
	18.71		1.0000	22.26		1.0000

The null hypothesis of the Sargan test in both columns cannot be rejected indicating that over identifying is acceptable. The coefficient on the lagged investment is also significant and positive, suggesting that the model can be better specified by including the lagged dependent variable.

The outcomes also show that the change in the oil price affects investment adversely at the 5% significance level in both columns. Also, the change in output affects investment positively, while both volatility and inflation affect investment adversely.

4.5.3. Panel cointegration test

Engle and Granger (1987) found that if two or more time series are integrated of the same order and the linear combination between those series is stationary then these non-stationary time series are said to be cointegrated, and so there is a long run equilibrium relationship between these series. This long run relationship is the equilibrium which the system converges to over time. Thus, the residuals from regressing one variable on the other represent the deviation from the long run equilibrium or the error of disequilibrium at time *t* (Johnston and Dinardo, 1997).

Given that the variables in level are integrated of order one, as was reported by the panel unit root tests, we proceed to examine the existence of a long run equilibrium relationship between these variables using panel data cointegration tests. In this study we adopt two panel cointegration tests: The Pedroni test, and the Kao test.

Pedroni (1999, 2004) proposed two sets of residual-based tests. The first set is based on the within dimension approach including the panel v- statistic, panel ρ-statistic, panel PP-statistic, and panel ADF-statistic. These statistics are based on pooling the residuals of the regression within-group. The second set of the Pedroni cointegration test is based on the between dimension approach including three statistics: The group ρ-statistic, group PP-statistic, and group ADF-statistic. Group statistics are based on pooling the residuals between-group. Each of these tests considers the individual specific short-run dynamics, the individual specific fixed effects, the deterministic trends, and the individual specific slope coefficients (Pedroni, 2004). Thus, Pedroni (1999) makes use of the estimated residuals from the long run regression which can be specified in our study as follows:

$$I_{it} = \mu_i + \sigma_i t + \lambda_{1i} Y_{it} + \lambda_{2i} P_{it} + \lambda_{3i} Trade_{it} + \lambda_{4i} Inf_{it} + \lambda_{5i} Exch_{it} + \varepsilon_{it} \qquad (4.8)$$

In this specification, μ_i allows for the country-specific effects, σ_i is a trend parameter, while ε_{it} refers to the estimated residuals representing the deviation from the long run equilibrium. The coefficients of the regressors $(\lambda_{1i}, .., \lambda_{5i})$ are allowed to differ across countries. Evidence of cointegration is provided when ε_{it} is stationary. That is, the null hypothesis of no cointegration is tested against the alternative hypothesis of cointegration so that where $\varepsilon_{it} = \rho_i \varepsilon_{it-1} + u_{it}$, the null hypothesis of no cointegration implies that $\rho_i = 1$.

By applying the test on the variables of this study[34], the following outcomes are obtained.

Table 4.12. Pedroni cointegration test results

Series: *I P Y Trade Inf Exch*
Sample: 1971- 2012
Included observations: 504
Cross-sections included: 12
Null Hypothesis: No cointegration
Trend assumption: Deterministic intercept and trend
Automatic lag length selection based on SIC with lags from 3 to 9
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.
Panel v-Statistic	3.459238	0.0003
Panel rho-Statistic	2.471256	0.9933
Panel PP-Statistic	-0.922574	0.1781
Panel ADF-Statistic	-3.011699	0.0013

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	4.055087	1.0000
Group PP-Statistic	-0.495797	0.3100
Group ADF-Statistic	-2.328892	0.0099

The results in Table 4.12 indicate that domestic investment, oil price, output, trade, inflation and the exchange rate are cointegrated according to three tests (the Panel v-

[34] Oil price volatility is excluded from the cointegration test as the variable is stationary.

Statistic, Panel ADF-Statistic, and Group ADF-Statistic) at a 5% significance level since the null hypothesis of no cointegration is rejected in the three tests.

We also checked the long run relationship using the Kao test though it is less powerful than the Pedroni cointegration test. The following table reports the cointegration results according to the Kao test:

Table 4.13. Kao cointegration test results

Kao Residual Cointegration Test Series: *I P Y Trade Inf Exch* Sample: 1971- 2012 Included observations: 504 Null Hypothesis: No cointegration Trend assumption: No deterministic trend Automatic lag length selection based on SIC with a max lag of 5 Newey-West automatic bandwidth selection and Bartlett kernel		
	t-Statistic	Prob.
ADF	-6.541540	0.0000
Residual variance	0.002561	

It can be seen from Table 4.13 that the null hypothesis of no cointegration according to the Kao panel cointegration test is rejected at a 1% significance level confirming the long run equilibrium relationship between the considered variables.

The existence of a cointegration relationship between two variables means that at least one of the two variables Granger-causes the other (Lescaroux and Mignon, 2008). Our previous cointegration tests show the existence of the long run relationship between investment and the explanatory variables, but for the purpose of this study, it would be also interesting to test the long run equilibrium between investment and only the oil price using the same two tests (Pedroni, and Kao). Accordingly, the following results are obtained.

Table 4.14. Pedroni cointegration test results (*I* /*P*)

Null Hypothesis: No cointegration Trend assumption: Deterministic intercept and trend Automatic lag length selection based on SIC with a max lag of 9 Newey-West automatic bandwidth selection and Bartlett kernel		
Within-dimension	**Statistic**	**Prob.**
Panel v-Statistic	3.977258	0.0000
Panel rho-Statistic	0.202069	0.5801
Panel PP-Statistic	0.107432	0.5428
Panel ADF-Statistic	-2.619464	0.0044
Between-dimension	**Statistic**	**Prob.**
Group rho-Statistic	1.519354	0.9357
Group PP-Statistic	0.899933	0.8159
Group ADF-Statistic	-3.046354	0.0012

Table 4.15. Kao cointegration test results (I /P)

Null Hypothesis: No cointegration Trend assumption: No deterministic trend Automatic lag length selection based on SIC with a max lag of 9 Newey-West automatic bandwidth selection and Bartlett kernel		
	t-Statistic	**Prob.**
ADF	-2.651102	0.0040

It can be seen from Tables 4.14 and 4.15 that there is a cointegration relationship between investment and the oil price according to the results of the Kao test and three statistics of the Pedroni test (Panel v-Statistic, Panel ADF-Statistic, and Group ADF-Statistic).

4.5.4. Estimating the long run coefficients

Given that domestic investment, oil price, output, trade, inflation, and the exchange rate are cointegrated, the long run effect of the oil price and the other explanatory variables on domestic investment for each individual country in the sample can be examined by estimating Eq (4.8) in which the country-specific fixed effects and time trend are considered. The model is estimated using the AUTOREG procedure in the SAS system which enables us to estimate the equation for each individual country using the ordinary least square (OLS) estimates as shown in the following table, which reports the long run coefficients of the regressors for each country in our sample.

Table 4.16: The long run coefficients of the individual countries

Country		Intercept	P	Y	TRADE	EXCH	INF	Trend	Total R^2
Belgium	Estimate	83.015	-0.1021	2.198	0.8146	-0.2054	0.0134	-0.0578	94.14%
	S.E.	12.6724	0.033	0.9959	0.347	0.0835	0.0255	0.0174	
	Pr	<.0001	0.0055	0.0386	0.0288	0.0227	0.6053	0.0033	
Finland	Estimate	73.7582	-0.0844	2.4358	-0.0313	-0.0218	0.0217	-0.0561	90.97%
	S.E.	27.9413	0.0306	0.362	0.2716	0.0962	0.0402	0.0171	
	Pr	0.0157	0.0121	<.0001	0.9093	0.8227	0.5954	0.0037	
France	Estimate	87.54	-0.0655	1.7073	0.5837	-0.1108	-0.0524	-0.0542	94.16%
	S.E.	14.059	0.0318	0.4829	0.2084	0.0666	0.0368	0.0115	
	Pr	<.0001	0.0522	0.002	0.0107	0.1111	0.1697	0.0001	
Germany	Estimate	48.0363	-0.0808	2.0514	0.3409	-0.0013	0.0075	-0.0397	97.17%
	S.E.	11.5545	0.0138	0.4974	0.2468	0.0634	0.0173	0.00847	
	Pr	0.0004	<.0001	0.0005	0.1816	0.984	0.6688	0.0001	
Greece	Estimate	114.517	-0.0959	2.725	0.3648	-0.057	-0.1619	-0.08	82.82%
	S.E.	30.5694	0.0365	0.4276	0.2552	0.1094	0.0271	0.0163	
	Pr	0.0011	0.0151	<.0001	0.1664	0.6076	<.0001	<.0001	
Italy	Estimate	62.2558	-0.0525	0.7379	0.4896	-0.1733	0.0323	-0.0274	96.28%
	S.E.	13.4378	0.0285	0.3965	0.1658	0.0647	0.0364	0.0108	
	Pr	0.0001	0.0799	0.0768	0.0076	0.014	0.3853	0.0189	
Japan	Estimate	78.3625	-0.1238	1.8541	0.6301	-0.0683	0.011	-0.0515	98.86%
	S.E.	25.4767	0.0216	0.3463	0.2754	0.0601	0.0157	0.017	
	Pr	0.0068	<.0001	<.0001	0.0352	0.272	0.4937	0.0076	
Korea, Rep.	Estimate	81.3826	-0.051	1.4143	0.1056	-0.4383	0.0344	-0.0452	99.81%
	S.E.	17.4885	0.0294	0.1911	0.1129	0.0652	0.016	0.0111	
	Pr	<.0001	0.0915	<.0001	0.3566	<.0001	0.0387	0.0003	
Netherlands	Estimate	59.6146	-0.1376	2.6415	0.262	0.0502	-0.0159	-0.0526	97.40%
	S.E.	13.1176	0.0228	0.556	0.3354	0.0671	0.0142	0.00971	
	Pr	0.0002	<.0001	0.0001	0.4438	0.4634	0.275	<.0001	
Portugal	Estimate	51.8373	0.0396	2.2525	0.171	0.0546	-0.1263	-0.043	96.00%
	S.E.	17.5426	0.0356	0.45	0.213	0.1015	0.0394	0.0128	
	Pr	0.0076	0.2789	<.0001	0.4311	0.5963	0.0043	0.0031	
Spain	Estimate	100.908	-0.0844	3.2827	0.1467	-0.0527	-0.1005	-0.0822	98.44%
	S.E.	16.06	0.0221	0.2795	0.1817	0.0549	0.04	0.00739	
	Pr	<.0001	0.001	<.0001	0.4286	0.3476	0.0203	<.0001	
Sweden	Estimate	22.0866	-0.0407	3.0632	-0.1899	-0.0052	0.0228	-0.0392	97.13%
	S.E.	10.4004	0.0155	0.3121	0.1788	0.0519	0.0162	0.00714	
	Pr	0.0408	0.0125	<.0001	0.2956	0.9203	0.1673	<.0001	

The table shows that the long run coefficient of the oil price is negative and strongly significant at the 1% significance level in Belgium, Germany, Japan, Netherlands, and Spain. It is also significant and negative at the 5% significance level in Finland, Greece, and Sweden, while it is significant and negative at the 10% significance level in France, Italy, and South Korea. The coefficient of oil price is insignificant only for Portugal. Thus, oil price increases influence domestic investment adversely in the oil-importing OECD economies.

The long run coefficient of output is positive and significant in all countries so increases in the level of output would boost domestic investment in these countries.

The estimation results also show that the coefficient of the time trend is highly significant for all the cross section, and the intercept is significant for all countries indicating that there are unobservable cross sectional effects influencing investment. However, the effects of the exchange rate and inflation are insignificant in most countries in the sample.

Although the literature indicates that trade openness has the potential to boost investment, the results in the table show that the coefficient on trade is positive and significant only in four countries (Belgium, France, Italy, and Japan), but it is insignificant in the rest of the countries. Such outcomes might be due to considering current values of the variables while investment could respond in the next period. Therefore, the long run coefficients of the variables for the panel have been examined using both current values of the regressors, and then the lagged ones.

The coefficients on the explanatory variables have been estimated for the panel using the Random Effects model, since the null hypothesis of the Hausman test cannot be rejected at the 5% significance level, suggesting that using the Random Effects estimator for the model is more efficient than the Fixed Effects estimator. The panel dynamic long run model (including lagged investment) was also estimated using the two-step system GMM estimator to cope with the possible endogeneity of the lagged dependent variable. The results are reported in the following table.

Table 4.17. Estimating the long run coefficients using the One-way Random Effects estimator

Explanatory variables	One-way Random Effects estimates		
	Estimate	**S.E.**	**Pr > |t|**
Intercept	27.19629	4.4556	<.0001
P_t	-0.01706	0.00829	0.0404
Y_t	1.300723	0.0305	<.0001
$Trade_t$	0.085207	0.0545	0.1191
$Exch_t$	-0.03331	0.0229	0.1473
Inf_t	-0.01383	0.00946	0.1446
$Trend$	-0.01837	0.00222	<.0001
R-square	93.63%		
Hausman test	m Value		Pr > m
	8.73		0.1892

Note: The one-way Random Effects estimator was used because the Hausman statistic cannot be calculated as different variables were dropped in the Random Effects model than in the Fixed Effects model.

It can be seen from the table that the long run coefficient of oil price is negative and significant at the 5% significance level, indicating that a 1 percent increase in oil price reduces investment by about 0.02 percent in our sample. The table also shows that output has a highly significant positive influence on investment, but the coefficients of inflation, exchange rates and trade are not significant.

To further check whether using lagged explanatory variables within the dynamic framework might alter the results, the model was re-estimated using the GMM estimator where the third lag of the lagged dependent variable, the second lag of oil price, and the constant term were instrumented allowing three lags of each instrument in the estimation. Thus, the following results were obtained.

Table 4.18. Estimating the long run coefficients using the two-step system GMM estimator

Explanatory variables	GMM estimates		
	Estimate	**S.E.**	**Pr > |t|**
Intercept	17.13314	8.5988	0.0469
I_{t-1}	0.509542	0.0984	<.0001
P_{t-1}	-0.02924	0.00919	0.0016
Y_{t-1}	0.215495	0.0999	0.0314
$Trade_{t-1}$	0.258245	0.1278	0.0438
$Exch_{t-1}$	-0.01822	0.0128	0.1556
Inf_{t-1}	-0.03655	0.0238	0.1249
$Trend$	-0.00501	0.00472	0.2890
Sargan Test	Statistic		Prob > ChiSq
	544.06		0.94
AR(m) test	Statistic		Pr > Statistic
Lag 1	0.98		0.1641
Lag 2	0.98		0.1641

The null hypothesis of the Sargan test in Table 4.18 cannot be rejected indicating that over identifying of the instruments is acceptable. Also, the Autocorrelation test (AR test) of the residuals shows that there is no serial correlation in either the first or second lags of the residuals.

Similar to the results found in the static specification using current values of the explanatory variables, estimation outcomes in Table 4.18 indicate that a 1 percent increase in oil price reduces investment by about 0.03 percent in the next period. The table also shows that the lagged dependent variable, and output are significant determinants of investment. The coefficients on the exchange rate and inflation are still insignificant using lagged values, but the coefficient on trade is positive and significant.

4.5.5. The long and short run effect of oil prices on investment

Having established that the variables in the investment model are cointegrated, we estimate a panel-based error correction model (ECM) in order to examine the short and long run effects of the oil price and other variables on investment. Thus we estimate the ECM using the two-step procedure from the Engle and Granger (1987) model. The first step is to estimate the long run model - Eq (4.8) - and save the estimated residuals (ε_{it}) which represent the deviation from the long run equilibrium.

The second is to estimate the following panel data error-correction representation of the cointegrated variables as was established by Engle and Granger (1987).

$$\Delta I_{it} = \beta_1 \sum_{j=1}^{p} \Delta I_{it-j} + \beta_2 \sum_{j=1}^{p} \Delta Y_{it-j_{it}} + \beta_3 \sum_{j=1}^{p} \Delta P_{it-j}$$

$$+\beta_4 \sum_{j=1}^{p} \Delta X_{it-j} + \beta_5 ECT_{t-1} + \varepsilon_{it} \quad (4.9)$$

where $j = 0, \dots, p$ refers to the number of lags included in the model, β_5 is the speed at which the system converges to its equilibrium relationship and its sign is expected to be negative and significant. ECT_{t-1} is the lagged Error Correction Term which represents the residuals saved from the long run equilibrium relationship between the variables in Eq (4.8). Since the variables are cointegrated, the coefficient on ECT_{t-1} is expected to be significant and negative referring to speed of adjustment to the equilibrium.

All the variables in Eq (4.9) are stationary as the explanatory variables are in their differenced forms. The ECT is also supposed to be stationary since the panel cointegration tests suggest the long run equilibrium relationship between the variables. To further check the staionarity of the *ECT* the IPS panel unit root test was applied on the series. Accordingly, the test outcomes confirm the stationarity of the *ECT* as it shown in Table 4.19 since the null hypothesis of unit root is strongly rejected at the 1% significance level.

Table 4.19. IPS panel unit root on the Error Correction Term (ADF lags are set to be MAIC)

Deterministic Variables	**Zt-bar Test**	
	Zt-bar	**Pr < Zt-bar**
CS Fixed	-8.13	<.0001
CS Fixed, Time	-3.09	0.0010
CS, TS Fixed	-7.41	<.0001
CS, TS Fixed, Time	-2.92	0.0018

Now we estimate the error correction model in order to check the short and long run impact of oil price on domestic investment in our data set. In the panel data set, estimating the ECM using the pooled OLS would result in a bias since it does not account for the country and time specific effects. Therefore, the ECM is estimated using the panel two-way Random Effects estimator to account for the cross sectional and time specific effects. The Hausman test indicates that the Random Effects estimator is more appropriate than the Fixed Effects estimator since the null hypothesis of the random effects cannot be rejected. We estimate the model including two lags of each regressor such that there is no autocorrelation in the residuals. The following table illustrates the parameter estimates of the ECM.

Table 4.20. Parameter estimates of the ECM using the Two-way Random Effects estimator

Variable	Estimate	S.E.	Pr > |t|
Intercept	-0.00158	0.0204	0.9384
ΔI_{t-1}	0.305243	0.0790	0.0001
ΔI_{t-2}	-0.10346	0.0780	0.1858
ΔP_{t-1}	-0.00179	0.0511	0.9721
ΔP_{t-2}	-0.04778	0.0514	0.3531
ΔY_{t-1}	0.274588	0.2179	0.2085
ΔY_{t-2}	0.395277	0.2064	0.0563
$\Delta Trade_{t-1}$	-0.12718	0.0895	0.1562
$\Delta Trade_{t-2}$	0.172693	0.0904	0.0569
ΔInf_{t-1}	0.000183	0.00755	0.9806
ΔInf_{t-2}	-0.00999	0.00776	0.1987
$\Delta Exch_{t-1}$	0.057527	0.0516	0.2658
$\Delta Exch_{t-2}$	-0.04959	0.0537	0.3564
ECT_{t-1}	-0.72574	0.0906	<.0001
R^2	0.3587		
Hausman Test for Random Effects	m Value		Pr > m
	9.20		0.7574

The table shows that the long run coefficient is negative and highly significant indicating that oil price and the explanatory variables exert a significant effect on domestic investment over the long run.

Since two lags are included in the ECM estimation we need to test the joint significance of the coefficients on the first and second lag for each explanatory variable. Therefore, the Wald test is implemented. The null hypothesis of this test indicates that the coefficients on the first and the second lag are jointly insignificant. The following table reports the test results:

Table 4.21. Wald test for the joint significance of the coefficient estimates resulted from using the Two-way Random Effects estimator

Test	Statistic	Pr > ChiSq
$\Delta I_{t-1} = \Delta I_{t-2} = 0$	16.00	0.0003
$\Delta P_{t-1} = \Delta P_{t-2} = 0$	1.11	0.5733
$\Delta Y_{t-1} = \Delta Y_{t-2} = 0$	8.22	0.0164
$\Delta Trade_{t-1} = \Delta Trade_{t-2} = 0$	5.05	0.0800
$\Delta Inf_{t-1} = \Delta Inf_{t-2} = 0$	1.71	0.4259
$\Delta Exch_{t-1} = \Delta Exch_{t-2} = 0$	2.02	0.3648

The test results show that the oil price does not affect investment over the short term since the null hypothesis of Wald test cannot be rejected indicating that the coefficients on the first and the second lag are jointly insignificant. The outcomes also show that output and trade augment investment over the short run but only at the 10% significance level. However, the results in both tables indicate that the exchange rate and inflation do not exert a significant impact on investment in the short run.

Since the ECM includes the lagged dependent variable which could be correlated to the error, the ECM has been re-estimated by employing the GMM estimator, to check whether such bias is significant. The constant term and ΔY_{t-5} are instrumented allowing for two periods. The Wald test is also implemented. The ECM parameter estimates and the results of the Wald test are reported in the following two tables.

Table 4.22. Parameter estimates of the ECM using the GMM estimator

Variable	Estimate	S.E.	Pr > |t|
Intercept	0.077159	0.0285	0.0071
ΔI_{t-1}	1.373177	0.3212	<.0001
ΔI_{t-2}	-0.15822	0.1030	0.1256
ΔP_{t-1}	-0.00452	0.0475	0.9243
ΔP_{t-2}	-0.02948	0.0179	0.0998
ΔY_{t-1}	-2.67063	1.1166	0.0173
ΔY_{t-2}	0.618705	0.2690	0.0221
$\Delta Trade_{t-1}$	0.052334	0.2127	0.8058
$\Delta Trade_{t-2}$	-0.39806	0.3152	0.2075
ΔInf_{t-1}	0.007884	0.0152	0.6047
ΔInf_{t-2}	0.027554	0.0226	0.2231
$\Delta Exch_{t-1}$	0.142278	0.0695	0.0414
$\Delta Exch_{t-2}$	-0.10947	0.0731	0.1353
ECT_{t-1}	-1.02567	0.4104	0.0129
Sargan Test	Statistic		Prob > ChiSq
	472.10		0.9928
Maximum Number of Time Periods			2
Estimate Stage			2

Table 4.23. Wald test for the joint significance of the coefficient estimates using GMM

Test	Statistic	Pr > ChiSq
$\Delta I_{t-1} = \Delta I_{t-2} = 0$	19.68	<.0001
$\Delta P_{t-1} = \Delta P_{t-2} = 0$	2.87	0.2380
$\Delta Y_{t-1} = \Delta Y_{t-2} = 0$	7.72	0.0211
$\Delta Trade_{t-1} = \Delta Trade_{t-2} = 0$	1.90	0.3868
$\Delta Inf_{t-1} = \Delta Inf_{t-2} = 0$	2.01	0.3663
$\Delta Exch_{t-1} = \Delta Exch_{t-2} = 0$	8.06	0.0177

It can be seen from Table 4.22 that the coefficient on the ECT is negative and significant suggesting that there is a long run relationship running from the oil price and the other regressors to investment. Although the second lag of the differenced oil price is negative and significant at the 10% level in Table 4.22, but similar to what has been found using the Random Effects estimator, the Wald test in Table 4.23 indicates that the coefficients on the oil price are jointly insignificant suggesting that oil price does not cause investment over the short run. But output causes investment over the short run. Unlike the Random Effects results, trade does not cause investment over the short run, but the coefficients on the exchange rate are jointly significant.

Overall, there a long run equilibrium relationship between investment and the explanatory variables including the oil price, and the significant and negative coefficient on the ECT in the estimated ECM confirms this long run relationship which runs from oil price, output, trade, the exchange rate, and inflation towards investment. In line with the firm-level literature, which show that the oil price increases influence firm investment adversely, our estimation outcomes show that the long run coefficient on the oil price for the panel set and for all individual countries at the macroeconomic level is significant and negative - except Portugal where the coefficient is insignificant. This result is expected since the oil price increases represent a demand shock which affects adversely on capital accumulation over the long run, and therefore on investment. Estimation of the investment model using differenced variables the outcomes indicate that the change in the oil price affect adversely on investment in the next period. However, the estimation outcomes of the Error Correction Model show that the oil price does not cause investment over the short run.

Furthermore, output increases augment investment over the long and short run. However, trade, the exchange rate, and inflation do not cause investment over the short run.

4.6. Conclusions

Literature related to oil prices considers mainly the effect of oil price changes on output and the effect of oil price changes on firm level investment. This study has examined the impact of the oil price and oil price volatility on aggrigate fixed investment in a group of oil-importing OECD economies over the period 1970-2012 employing various estimation techniques.

We first checked the stationarity of the variables by employing two panel unit root tests (IPS, LLC). The test results show that the level variables are integrated of order one, but they turn out to be stationary by differencing. Then, we analysed investment behaviour in our data set within the framework of the production function using differenced contemporaneous variables, but the results did not show a significant impact of oil price changes on investment. By re-estimating the model including lagged explanatory variables, the outcomes indicate that oil price changes and oil price volatility affect investment adversely.

Since the variables are integrated of order one, we checked the cointegration between the level variables by employing panel cointegration tests. Accordingly, the Kao, and three statistics of the Pedroni tests show that there is a long run equilibrium relationship between investment, oil price, output, trade, inflation, and the exchange rate. Therefore, we estimate the Error Correction Model using both the Random Effects estimator and the GMM estimator, and found that the oil price and the other explanatory variables cause investment on the long run, but the oil price does not cause investment in the short run. By estimating the long run equation for the panel set and for the individual countries we found that the long run coefficient on the oil price is negative and significant for each individual country, and for the panel set.

CHAPTER FIVE

CONCLUDING REMARKS

The crucial role played by crude oil in the global economy has motivated researchers to investigate various aspects in the oil industry and its effects on the economies of both oil-exporting and oil-importing countries, employing various econometric methods, using both time series and panel data sets. A large proportion of oil-related literature has focused on the linkage between oil prices and output growth. Some studies have investigated drivers of oil prices, mainly within the framework of supply and demand. Other have assessed the implications of oil-abundance on the economies of oil-rich developing countries, focusing on transmission channels through which resource proceeds might exert adverse impacts on the developing economies.

However, the economic implications of oil-infrastructure projects on transit countries, the impacts of oil abundance on domestic investment in oil-rich developing countries, and the effects of oil prices on domestic fixed investment at the macroeconomic level have been hardly addressed in previous research.

Hence, this study contributes to the literature by examining the economic implications of the oil industry for domestic fixed investment in three groups of countries: transit countries which receive revenues from transit fees for allowing crude oil to be carried through their lands by cross-border oil pipelines; oil-rich developing economies which receive revenues from exporting crude oil; and oil-importing developed economies in which crude oil is one of the substantial source of fuel for industry and transportation, and electric power generation. These issues have been examined throughout three essays.

The first essay examined the implications of constructing a cross-border oil pipeline project on the countries through which the pipeline passes. We employed the BTC pipeline as a case study and assessed the viability of the project for the Multinational Corporation (MNC), led by the UK's BP, and the three host countries (Azerbaijan, Turkey, and Georgia) within the framework of the bargaining problem (the Nash bargaining solution, and the alternating offer bargain of Rubinstein). We found the Break-even transit charge at which a zero total surplus would be obtained, and then we computed the proportions of the total surplus which the participants would receive from operating the pipeline with two bargaining formulations: simultaneous, and sequential bargaining.

The outcomes indicate that the project would generate a zero total surplus when the transit charge is equal to $3 per barrel, so with a rate higher than the break-even charge, each partner would receive revenues higher than his outside option. The results also suggest that with the two bargaining scenarios, Azerbaijan, which owns the oil field, and has the lowest discount rate and the biggest outside option, would receive the highest proportion of the total surplus, followed by the MNC, then by Turkey, and finally by Georgia, which has the highest discount rate and the smallest outside option. However, Azerbaijan, which bargains first with the MNC, would receive higher payoffs with sequential bargaining than with simultaneous bargaining; whereas for the other three partners, simultaneous bargaining is more beneficial. This suggests that the gross payoffs received by the participants are affected by their discount rates, their outside options, and their bargaining orders. Furthermore, the outcomes show that with bargaining over discounted flows, each bargaining process produces a different total surplus, which is attributed to players' different discount rates by which revenues and costs are discounted over the life of the project.

The second essay examined the impacts of oil abundance on domestic investment in oil-exporting developing non-OECD economies from 1996 to 2010. Domestic investment was modelled with both static and dynamic specifications, where oil rents and oil exports were used as proxies for oil abundance. The model was also supplemented with other controlling variables which have been used in the previous literature as determinants of domestic investment, including output growth, inflation, liquidity, the exchange rate, FDI, trade openness, and financial development - proxied by domestic credit provided by banking, and domestic credited provided by the private sector

To estimate the investment model, panel data methods were employed including, Fixed and the Random Effects estimators, and the Arellano-Bond difference GMM. The model was estimated first including oil rents, and then using oil exports, in order to check the robustness of the results.

In line with the resource curse literature which has documented adverse impacts of natural resource abundance on the resource-rich developing economies through different channels, such as the Dutch disease, revenue volatility, declining terms of trade, and rent-seeking and corruption, our results suggest that oil-abundance exerts adverse effects on the economies of oil-rich economies, but via its negative implications on domestic investment.

This reflects the poor performance of these countries' governments concerning accountability and resource management, suggesting the necessity of setting an appropriate regulatory framework, and establishing accountability and transparency principles capable to well use oil revenues, and thus to channel them towards viable investment projects which, in turn, would drive sustainable development in these countries.

Beside the significant effect of oil abundance, our results show that domestic investment is positively affected by output growth, FDI, financial development, and trade openness, but negatively influenced by inflation. These results are consistent with what has been established in the literature.

The third essay examined the effect of the oil price and oil price volatility on domestic investment in 12 oil-importing OECD countries over 1970-2012. The investment model was specified within the framework of the production function where the explanatory variables include the oil price, oil price volatility, output, trade openness, inflation, and the exchange rate.

First, we investigated the existence of the unit root in each variable by employing two panel unit root tests, namely, the Levin, Lin and Chu (LLC) and the Im, Pesaran, and Shin (IPS) tests. The test results thus indicate that all the variables are non-stationary in level, but with differencing they turn out to be stationary. Afterwards, the investment model was estimated using the differenced variables, with both static and dynamic specifications, to examine the impacts of oil price changes and oil price volatility on investment, employing Fixed and Random Effects estimators, and the system GMM. Although the impacts of the contemporaneous values of the oil price change and oil price volatility on investment are insignificant, but estimation results using lagged variables indicate that both the lagged differenced oil price, and oil price volatility exert significant and adverse effects on domestic investment.

Having found that the variables are integrated of order one, we could investigate the existence of the long run relationship between the oil price/oil price volatility, and the other explanatory variables on domestic investment. Therefore, the Pedroni and the Kao panel cointegration tests were conducted. The outcomes of the Kao test and three statistics of the Pedroni test indicate that there is a long run equilibrium relationship between domestic investment, the oil price, and the other control variables.

Hence, the long and short run effects of the oil price, output, trade openness, inflation, and the exchange rate were examined by estimating the Error Correction Model. The findings thus suggest that the oil price and the other controlling variables Granger cause investment over the long run; whereas the outcomes do not show clear evidence of the short run impact of the oil price on domestic investment.

We also estimated the long run investment model for the panel set and for the individual countries. The findings indicate that the long run coefficient on the oil price is negative and significant for each individual country - except Portugal, in which the coefficient is insignificant - and for the entire panel set.

Consequently, our findings are consistent with the firm-level literature, which has documented adverse effects of oil prices and oil price volatility on firm investment, but our analysis is at the macroeconomic level. Furthermore, given that investment is a basic determinant of output growth, our outcomes agree with the studies which found that output growth is adversely affected by higher oil prices, but in our analysis via reducing investment.

Future research can be implemented on assessing the viability of investment projects by employing the multilateral bargaining problem taking uncertainty into account. Also, the hold-up problem can be addressed within the framework of multilateral bargaining. Furthermore, it would be possible to conduct further research on the impact of oil-price and oil price uncertainty on investment at the firm level in a panel set of oil-rich developing economies. It would be also interesting to examine the linkage between oil revenues and domestic saving in oil-rich developing economies.

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