The Role of Institutions on R&D, FDI, and Economic Growth

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

This thesis broadly consists of three essays examining the impact of institutions on firm R&D, Foreign Direct Investment (FDI) activity, and economic growth. The focus of each paper is unique in its contribution. The first chapter examines the evolving role of domestic Intellectual Property Rights (IPR) in the context of increasing globalization, where the R&D incentives of firms are framed not only by the IPR regime in their home country, but also by the IPR in its export markets. This paper first reviews the literature related to the classical relationship between IPR and innovation. Contributing to the growing literature, this paper exploits the exogenous variation in partner IPR as a mechanism to interpret the causal impact of IPR on private sector R&D investments. By merging datasets on R&D, production, trade, and IPR to construct an export-weighted index of trade partner IPR by country-industry-year, this paper explores whether firms respond to trade partner IPR. After including numerous controls as well as industry, year, and country fixed effects, the results of this essay suggest a positive relationship between domestic IPR and private sector R&D. Similarly, the results also suggest that there is a positive and significant relationship between export partner IPR and domestic R&D activity. These results are further confirmed when constructing a firm-level export-weighted index of trade partner IPR from a unique Canadian firm-level export dataset. The results not only suggest a causal link between IPR and firm R&D, they also highlight the need to consider domestic IPR policy as but one piece of the IPR regime that firms face.

The second chapter assesses the impact of democratization on corresponding economic growth. It is important as it is undeniable that political institutions, the quality of bureaucracy, mode of governance and an efficient rule of law should have a direct effect on per capita income and economic growth. The essay first reviews the academic literature related to democracy and economic growth, while discussing the characteristics associated with both democratic and non-democratic regimes. The analysis begins by employing an annual panel data consisting of 43 developing economies in Africa, Latin America, and Asia between 1970 and 1999. The results in this essay suggest that countries moving towards democracy experience lower levels of economic growth. These findings are robust across OLS, fixed effects, and IV estimates. More importantly, a more thorough analysis indicates that an over investment in public goods from democratic regimes may be driving these results. Furthermore, this research is the first to offer empirical evidence on the magnitude of differential effects that the type of governance has - whether a democracy or dictatorship - on country specific economic growth.

Lastly, the final chapter examines the locational choices of multinational firms in the presence of political risk. Following a real options approach, the results suggest that the vertical integration strategy of firms divest from institutional uncertainty, while government officials combat domestic country risk by providing overly generous incentive packages to attract foreign investors. Furthermore, through a numerical example, our results suggest that tax credits may be a more suitable method to attract FDI, as FDI not only tends to respond more to changes in tax credits than investment subsidies, but it is also significantly less costly for the host government to implement.

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Dedication

To my wife and family: Thank you for everything.

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Chapter 1

Introduction

The role of incentives is central to the study of economics. The ability to influence behaviour through effective policy is crucial for economies to prosper. More so, the economic framework of institutions is instrumental in maximizing social welfare. This thesis examines the impact of economic and political institutions on their evolving role in incentivizing private sector R&D, attracting Foreign Direct Investment (FDI), and promoting economic growth. Each chapter of this thesis carefully explores the social impact of such political and economic institutions, where good governance is essential for countries to successfully integrate into today's world economy and help alleviate global poverty.

The legal system helps support a healthy competitive business environment. In the context of this thesis, we refer to the institutional support through strong enforcement mechanisms in intellectual property (IP) law that encourages innovators to continue to invest in Research & Development (R&D). In the case of Intellectual Property Rights (IPR), it has long been recognized that while IPR mechanisms generate a temporary monopoly to the innovator, there is also the added benefit for innovators to secure a future stream of profits. Therefore, a strong IPR system creates a diffusion of knowledge by encouraging firms to innovate.

The benefits arising from a strong IPR framework have been identified as one of the main drivers of economic growth in the EU. A 2013 report by the European Patent Office confirm that during 2008-2010, R&D intensive industries accounted for 89% of the EUs total trade but only 72% of the trade deficit, indicating a positive contribution to the trade balance. Furthermore, IPR-intensive industries in the EU have generated 26% of all jobs while contributing 39% of GDP.[1]

As technological innovation is arguably a precursor to job creation, export growth, and economic activity, there is a growing need to understand the incentives of firms to ensure their continued investment in R&D. While the general consensus of economists is that some property right protection may be welfare enhancing, the empirical literature has yet to discover conclusive evidence linking IPR and innovation. In some instances where empirical results have found a positive correlation between IPR and innovation, the results may not necessarily be interpreted as causal. It may be the case that R&D intensive firms lobby the government to strengthen IPR. Alternatively, it may be the case that policy makers put in place a level of IPR to match the level of R&D activity in the country.

The aim of the first chapter is to empirically investigate the causal impact of IPR on R&D activity by exploiting export-partner IPR as a source of exogenous variation. Particularly, the results in this chapter find evidence of alternative channels to promote R&D investment, where domestic R&D responds positively not only to domestic IPR, but also the IPR of its export-partner. These results not only justify the inclusion of the Trade Related Aspects of Intellectual Property Rights (TRIPS) agreement into the WTO mandate, but also highlight the need to consider an IPR regime in a globalized environment.

While promoting IPR (and in particular, promoting the harmonization of IPR globally) is one of many channels policy makers can choose to spur economic growth, there are other initiatives a country can take to improve its level of economic development. For example, a large body of literature in political science and economics has studied the empirical linkages between political regime types and economic outcomes. In particular, over the past thirty years there has been a global shift towards more democratic regimes. While democratic regimes stress the importance of a representative institution where redistributive policies are beneficial to the masses, the end result may not necessarily be welfare enhancing. In terms of GDP per capita, while some evidence has shown that democracy fosters economic activity through lower political instability and output volatility, there is equally supporting evidence of democracies being associated with low private investment and high government spending, which in turn hinder economic activity.[2] Moreover, any

[1] The positive outcome of IPR reforms on innovation and growth has also been documented in prior studies. For example, a 2012 report by the United States Patent and Trademark Office show that in 2010, IPR intensive industries in the United States have generated almost a fifth of all jobs while contributing 35% to GDP. This has also created a wage premium of 42% over non-R&D-intensive industries.

[2] Tavares and Wacziarg (2001)

potential positive relationship between democracy and economic growth may be attributed to reverse causality. Papers as early as Lipset (1959) points out that wealthier countries tend to be more democratic, as wealth is a sign of modernization.

The second chapter of this thesis attempts to measure the impact of political institutions on per capita income by instrumenting democracy with various classification measures of political regime types. We argue that political regimes that are associated with more democratic features are more likely to implement welfare enhancing policies to the masses, which would directly impact per capita income. By employing an unbalanced panel consisting of 43 developing countries for a period between 1970 and 1999, we find that countries with democratic characteristics are associated with approximately 10% to 12% in lower levels of per capita income. Further analysis suggests that countries with democratic institutions are correlated with higher incidences in public goods. These results may provide mild (albeit weak) evidence to support previous theories that democratic regimes tend to overinvest in public goods at the expense of more favourable social choices, which may lead to a decline in per capita.

While the type of political regime may have a direct impact on economic activity, the political and social infrastructure of the country may also play an important role towards fostering economic activity. For example, while both the supply side (labor skill and cost) and demand side (market size) of a host country attract foreign capital, the quality of the legal, political, and institutional environment also plays a significant role in the amount of FDI a country receives. Furthermore, the host country also benefits from the inflow of foreign capital. These benefits include, but are not limited to, job creation and human capital formation, increased market competition, and technological spillovers.

However, while government effectiveness and an efficient judicial system help firms more easily set up in the host country, excessive bureaucracy and delays have the opposite effect. More so, a poor institutional environment where informal modes of governance are present, corruption, either through bribes, extortion, or other illegal methods of market distortion, may be rampant. This creates strong investment barriers to foreigners and nationals alike, as there is now an additional cost to consider. Furthermore, poor institutional quality may also be associated with political and institutional instability, where staged coups, civil wars, or more generally, internal conflicts, impact the flows of FDI.

The aim of the last chapter is to closely examine the impact of the socio-institutional environment on the firms decision to pursue FDI. Specifically, the impact of institutional uncertainty on FDI is analyzed from the perspective of the firm, the host country, and the home country. Not only do we derive optimal investment conditions for the firm to switch production abroad, but we also derive infrastructure subsidies and tax credits that potential host countries can implement to combat its own unfavourable environment and continue to attract FDI. We further investigate the effect of FDI on the tax base from the home country.

By implementing a real options approach to model FDI behaviour, the results from the first chapter are consistent with the empirical findings that political risk negatively impacts FDI inflows. Furthermore, the first chapter also finds that the size of the subsidy is considerably large relative to the case when institutional uncertainty is absent. The results from this chapter further suggest that tax credits may be a more favourable method to attract FDI, as firms not only respond more to tax credits than infrastructure subsidies, the cost to implement the tax credits makes it a more favourable choice for host countries. This could partially explain the vast literature in tax competition and FDI.

Chapter 2

Intellectual Property Rights and Firm R&D in a Globalized World

2.1 Introduction

Intellectual property rights (IPR) are among the key institutions that influence private innovative activity. They allow firms to appropriate their creations, thereby providing increased incentive to innovate. Given the importance of IPR in an increasingly knowledge-based economy, it is perhaps not surprising that IPR regimes have been strengthened across the globe. Yet IPR, and patent protection in particular, are coming under increased criticism amid speculation that, in their current form, they may be stifling innovation (Jaffe and Lerner (2011)). This paper empirically examines this relationship between IPR and private sector R&D, using partner country IPR as an exogenous source of variation to establish a causal relationship.

The use of IPR as a means of inducing private sector innovation dates back to at least 1474 when Venice introduced the first formal patent code (Granstrand (2005)). Patent protection thereafter spread quickly within Europe, at times generating controversy. But it is not until recently that patent protection became the subject of strong and widespread criticism, from industry, academia, and government. For example, Hall (2007) cites numerous reports by firms, governments, and quasi-government agencies that call for patent and IPR reform. This increased controversy around patent protection, coincides with, or is the result of, a significant increase in protection towards the end of the 20th century, an era dubbed the pro-patent era. Over this period, stronger enforcement of ever-broader

IPR were instituted, and strong IPR regimes spread globally through such agreements as the Trade-Related aspects of Intellectual Property Rights (TRIPS). And this, despite the fact that there is no consensus around the relative merits of strong IPR.

The case for patent protection begins with the understanding that innovation and knowledge are unlike other goods. Innovations are non-rival and only partially excludable. To the extent that the knowledge underlying an innovation is a public good, innovation will be underprovided by the market due to a positive information externality. Patent protection seeks to address this problem by allowing inventors to exclude others from using the innovation for a period of time. The theoretical literature on optimal patent protection has long recognized that a policy of stronger IPR trades off static welfare losses (due to the temporary monopoly) with dynamic welfare gains (due to increased incentives for innovation) (Arrow (1962); Nordhaus (1969)).[1] Crucially, then, any argument in favor of stronger IPR rests on the case that it will result in a significantly higher level of innovation.

Yet the empirical evidence in this regard remains mixed. In a survey of U.S. patent reforms and their impact on innovation, Jaffe (2000) concludes that there is little empirical evidence to support the theory that stronger IPR increases innovation. Ginarte and Park (1997) examine a panel of countries and find that the strength of a country's IPR is positively correlated with R&D, though only for developed countries. Kanwar and Evenson (2003) and Allred and Park (2007), using a similar methodology to that of Ginarte and Park (1997), also find a positive correlation between a countrys IPR and R&D. However, in a paper that exploits the 1988 expansion of patent scope in Japan, Sakakibara and Branstetter (1999) find no effect of stronger patent protection on R&D. And focusing on the pharmaceutical industry, Qian (2007) finds that stronger IPR do not increase the R&D of firms, except at higher levels of economic development, and then only up to a point.

A concern common to all of the above papers is the possibility of an omitted variable bias that could account for some of the positive findings. For example, the correlation between IPR and R&D could arise because firms that expect to ramp up R&D expenditures lobby the government for increased IPR so as to better protect their investment. Alternatively, governments may enact stronger IPR protection in response to some expectation of increased domestic R&D. Qian (2007) partially addresses such scenarios by employing a nonparametric matching method that controls for some of the covariates that could be associated with a country's innovative potential.

[1] More recent models examine situations where innovation is cumulative and/or complementary (Green and Scotchmer (1995);Lemley and Shapiro (2006); Bessen and Maskin (2009)). In such cases, patent protection could result in lower rates of innovation due to such issues as holdup and coordination problems.

In this paper we propose to address endogeneity using the IPR regime of a country's trade partner as an exogenous source of variation. The premise is that a firm that is considering whether to undertake the development of a new product, compares the costs of R&D with the expected profit stream that the product is to earn, not just domestically, but also in foreign markets. To the extent that the firm will enjoy stronger patent protection in its export markets, the firm has a greater expected foreign income stream associated with the innovation, and will therefore have a stronger incentive to perform R&D.

We test whether R&D responds to the IPR regime of export markets by constructing an export-weighted foreign IPR measure. In section 2.2, we construct this variable at the country/industry/year level for a sample of 20 countries. Controlling for numerous covariates, as well as country, industry, and year fixed effects, we find unambiguous evidence that R&D responds not only to the domestic IPR regime, but also to the IPR regime in its export markets. The latter result, since it is not subject to the same concerns of endogeneity, provides strong evidence that firms do indeed perform more R&D in response to stronger IPR. Notwithstanding, we do find that there are diminishing returns to stronger IPR in terms of its positive impact on R&D. In section 2.4, we perform a similar analysis on a sample of Canadian export-oriented firms, constructing the export partner IPR measure at the firm/industry/year level, and obtain almost identical results.

While the primary contribution of this paper is to use foreign IPR as an exogenous source of variation to show that private sector R&D responds to the IPR regime, the relationship between domestic R&D and trade partner IPR is also interesting in and of itself, and constitutes a second contribution of this paper. There is a significant theoretical literature addressing the topic, primarily within the context of a North-South model (Helpman (1992);Lai (1998); Glass and Saggi (2002);Branstetter and Saggi (2011) ; Dinopoulos and Segerstrom (2010)). Although for the most part these models predict a positive relationship between Northern innovation and Southern IPR, the result depends on the channel that is being examined and the particulars of the model. For example, Glass and Saggi (2002) find that stronger foreign IPR results in imitation being more difficult, which leads to resource wasting, lower levels of FDI, and reduced domestic innovation.

In contrast to the theoretical literature, empirical work in this area is in its relative infancy. In perhaps the first empirical paper examining how innovation responds to foreign IPR, Qiu and Yu (2010) find that U.S. patenting rates increased in response to the implementation of the TRIPS Agreement. However, they do not find U.S. patenting rates to be affected by the strengthening of patent protection by individual or small groups of countries. While these are important findings, the use of patents as a measure of innovation could potentially be problematic in this context. For instance, the findings are consistent with U.S. firms responding to stronger global IPR, not by increasing innovation, but by maintaining the same level of innovation and switching to protecting their intellectual property through patents instead of through other means. Hence, it would seem that for the purpose of analyzing the relationship between innovation and IPR, R&D expenditures (an input measure of innovation) would be a more appropriate measure.

Most recently, in a paper employing a related methodology to this one, Park (2012) examines whether Southern intellectual property rights affect Northern innovation using a micro-database of U.S. multinationals and their foreign affiliates. He finds that the R&D expenditures of these U.S. firms do not respond significantly to the level of IPR in developing countries, instead responding to the level of IPR in other developed countries. To arrive at this result, he separately constructs a trade-weighted index of foreign IPR for developing and developed partner countries, using the U.S. national share of exports to any particular country as weights (because firm-level exports were unobserved).

Relative to Park (2012), our paper has a different focus in that foreign IPR are used as an exogenous source of variation to establish a causal relationship between IPR and R&D. In addition, our data allows us to use a more robust methodology. We merge private sector R&D, production, and trade data, at the level of a country-industry-year for 20 countries, 45 industries, and for the years 1988 to 2005. We examine the relationship between private sector R&D and the export-weighted foreign IPR regime, both of which vary by country, industry, and year. As such, our methodology, which includes numerous controls as well as country, industry, and year fixed effects, allows us to identify the relationship based on differences across countries, industries, and time. For example, we find that otherwise similar industries in the same country perform different levels of R&D as a function of having exports that are tilted towards different markets with different levels of IPR. We also address the potential issue of endogeneity in the choice of export partners (and hence of the export-weighted foreign IPR measure) by fixing the country/industry export shares at pre-sample levels. In addition, we repeat our analysis on a micro-dataset of Canadian firms and find almost identical results, concluding that, indeed, firms perform more R&D in response to stronger IPR.

The remainder of this paper is organized as follows. Section 2.2 discusses our primary dataset, methodology, and presents summary statistics. Section 2.3 presents and discusses our empirical results for the full sample of countries. Section 2.4 discusses our micro-dataset of Canadian firms, discusses our methodology, and presents our results for that analysis. Finally, section 2.5 concludes.

2.2 Dataset and Empirical Design

To examine the impact of export partner IPR on domestic innovation, we will be using business enterprise R&D expenditure (BERD) by industry for 20 countries. The dataset is from the OECD Main Science & Technology Indicators (MSTI) database. The data are from 1987 to 2005, where the industry classifications are defined by 2 and 4 digit ISIC rev. 3. Due to confidentiality issues, national statistical regulations prevent publication of R&D activity for industries where there are very few firms. Therefore, this database is the limiting factor that creates our unbalanced panel.

To calculate R&D intensity by industry, country, and year, we use the UNIDO Industrial Statistics database for production measured as value added output. The data is at both the 2 and 4 digit ISIC rev. 3 from 1988-2005.

To calculate the export-weighted index of trade partner IPR, we use trade data from the UN Comtrade database at the 2 and 4-digit SITC Rev. 3. A concordance from SITC rev 3 to ISIC rev 3 from the United Nations is used to match the data accordingly.

The measure of IPR that will be used in this paper is the patent protection index developed by Ginarte and Park (1997) and updated in Park (2008). The IPR index provides scores for 122 countries between the years 1960 to 2010. To ensure IPR can be compared across country and time, the strength of national patent rights is measured through the aggregate score of five factors:

1. Membership in international treaties
2. Coverage
3. Enforcement Mechanisms
4. Loss of Rights
5. Duration

Each factor has a value ranging between 0 and 1, for an aggregate score ranging between 0 (weakest) to 5 (strongest). As IPR scores change slowly over time, Park (2008) evaluates IPR for each country at every 5 year interval. For a more extensive review of the creation of this index, please refer to the appendix.

The export-weighted IPR (EIPR) index is constructed as the weighted average of the export partners IPR by using the proportion of exports for each industry, country, and time period, as weights. Or more formally, if I define X_{ijkt} as the exports for country i at time t in industry k exporting to country j, where $j = 1...J$, and $\Sigma_{j \neq i} X_{ijkt}$ as the total exports to j countries, then:

$$EIPR_{ikt} = \sum_{j \neq i}^{J} \frac{X_{ijkt} * IPR_{jt}}{\Sigma_{j \neq i} X_{ijkt}} \tag{2.1}$$

Therefore, equation 2.1 is a function of two components that vary over time: the dynamic trade flows and the IPR regime of the export country. Similar to Park (2012), the construction of our index may be endogenous as exports may be flowing to countries with characteristics that are highly correlated with patent protection levels (ie economic development).[2] Or more generally, the dynamics of exports may be flowing to countries that have characteristics that are completely *unrelated* to IPR. Here we refer to the variables that are typically associated with the gravity model of trade: geographical distance, cultural similarity, size of markets, etc. To ensure we do not capture other factors in our index presented in equation 2.1, we propose to construct an export-weighted IPR index using fixed trade flows from one year *before* our sample begins. The reasoning to implement this method is quite straight forward. The proportion of exports prior to our sample size should theoretically capture all the proposed factors that affect trade flows between countries. Therefore, in our sample size, with a fixed trade flow, any changes to the index over time will be due to changes in the partner IPR and not changes in trade flows. As IPR move slowly over time, we use 5 year intervals for our data set; specifically we use the years, 1988, 1990, 1995, 2000, and 2005. Therefore, we can rewrite equation 2.1 as:

$$FEIPR_{ikt} = \sum_{j \neq i}^{J} \frac{X_{ijk87} * IPR_{jt}}{\Sigma_{j \neq i} X_{ijk87}} \tag{2.2}$$

It may be reasonable to assume that domestic R&D intensity does not respond immediately to changes in export partner IPR. To account for any lags, we calculate the forward average of R&D intensity. For example, the 1990 value of R&D intensity would represent the average R&D intensity for the years between 1990 and 1994, inclusive.[3]

[2]This can be seen in table 3 of the Appendix. The average IPR score is correlated with each countries income classification level.

[3]For the year 1988, we use the average R&D intensity values for the years 1988 and 1989. As the R&D dataset is highly unbalanced, we decided to include the 1988 data to increase the amount of observations in our final dataset. If we restrict our sample for data between 1990 and 2005, the results presented in

The final dataset is comprised of 20 countries across 45 manufacturing sectors for the years 1988, 1990, 1995, 2000, and 2005. The unbalanced dataset has a total of 1474 observations.

There are several important considerations related to the creation of the R&D intensity and partner IPR measure. First, production data may be misallocated across industries, which would either over or underestimate the true output and thereby over or underestimate R&D intensity. Secondly, there could be discrepancies between the year of production of the good and the year it was exported. It may be that a good was produced one year and exported the following year. Lastly, some countries in our sample may only report production in the formal economy, where the informal sector of a country may be vast.

We should further note that while this paper examines the impact of patent protection on R&D activity for manufacturing industries only, the results presented in this section do not necessarily imply that these industries will respond more to IPR for product patents than process patents. In fact, the IPR measure used in this paper does not distinguish between product or process patents, as they are virtually synonymous. For instance, the TRIPS agreements state that a process patent protection must give rights not only over use of the process but also over products obtained directly by the process. Thus, as manufacturing firms typically patent either the process to produce the product or the product itself, the results presented here can be interpreted as the impact of general patent protection levels on private sector R&D activity[4].

Descriptive Statistics

Table 2.1 below provides descriptive statistics of the variables of interest and the control variables used in this study, whereas table 2.2 shows the correlation matrix between our main variables of interest. Lastly, table 4 and 5 in the appendix list the 20 OECD countries and the 45 manufacturing industries in our sample. As expected, table 2.1 indicates that the average domestic IPR score is relatively high for our sample size of 20 OECD countries. As table 2.2 shows that our measures of trade partner IPR are positively correlated, irrespective of which measure of export partner IPR we use, the average mean

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this section are still robust to the exclusion of the 1988 data. For consistency, forward averages were also calculated for each control variable.

[4]The analysis can be extended also to service based industries that pursue R&D activity. For example, the mining and quarrying industry may invest in R&D to develop a more efficient extraction technique, which may lead to inventing a new device. Therefore, the firm would patent both the process and the device.

value of both partner IPR scores reflect the trade flows from the 45 industries across 20 countries. Specifically we see that exports are flowing towards countries that are correlated with relatively high IPR scores (ie among developed countries).

Table 2.1: Descriptive Statistics: R&D Intensity and IPR

Variable	Obs	Mean	Std. Dev.	Min	Max
Ln(R&D Intensity)	1472	-5.365	2.802	-13.647	0.140
IPR	1472	3.961	0.671	1.66	4.88
EIPR	1472	4.010	0.443	0.933	4.843
FEIPR	1472	4.068	0.508	1.620	4.851
Control Variables					
Trade Openness	1472	0.905	5.337	0.0001	194.2219
Export Partner GDP per Capita	1472	24171.63	7741.35	2722.093	55854.26
Government Expenditure	1472	19.55833	4.061863	10.29273	27.81523
Education	1472	5.329647	1.15308	3.04419	7.99846

Table 2.2: Correlation Matrix: Dynamic Partner IPR and Fixed Partner IPR- Industry Level

	EIPR	**FEIPR**
EIPR	1	
FEIPR	0.6763	1

More importantly, figure 1 in the appendix below confirms that irrespective of which measure of partner IPR is used, stronger partner IPR is associated with high levels of private sector R&D, whereas figure 2 in the appendix further suggests the positive relationship between R&D intensity and domestic levels of patent protection.

The control variables introduced in this paper vary at the country-year and industry-country-year level. At the industry-country-level, we created a measure of trade openness, which is calculated as the ratio of total exports to total production output. It can be argued that the trade orientation of specific industries and countries can be an important determinant in the propensity to innovate. It may be that relatively open economies, or industries located in relatively open economies, face more competition, and are thus more likely to invest into R&D to remain competitive. While this measure of trade openness is not quite precise due to issues relating to matching production output and exports (as can be seen by the maximum value), it is still a reasonable measure to further analyze how relatively open and closed R&D intensive economies react to changes in partner IPR.

A growing concern when measuring the impact of IPR on innovation is that the IPR index may be highly correlated with the level of economic development of the respective country. As we are capturing the relationship between IPR and innovation through partner IPR, we also calculate the *fixed* export weighted index of partner *GDP per capita* as a control variable. This is to ensure that the estimated coefficient when regressing R&D intensity on partner IPR is not biased by capturing other factors that are positively related to the IPR index. As we see in table 2.1, the average partner GDP per capita is relatively high at $24,171.63, indicating that exports tend to flow towards relatively rich countries.

Other standard country-year control variables include total government expenditure (as a % of GDP) and human capital, expressed as the total enrollment in tertiary education as a % of the population. These control variables are used primarily to provide a reasonable estimation on the effect of domestic IPR on R&D intensity. While the estimate of domestic IPR may be endogenous, it may still provide some insightful results as to the degree of responsiveness of R&D investments on domestic patent protection.

2.3 Empirical Estimation

To examine the relationship between partner IPR and R&D intensity, the econometric model will take the following form:

$$Log(\frac{R\&D}{Output})_{ikt} = \beta_1 IPR_{it} + \beta_2 EIPR_{ikt} + \mathbf{X}'_{i,t}\mathbf{\Gamma} + \iota_i + \eta_k + \nu_t + \epsilon_{ikt} \tag{2.3}$$

Where β_1 represents the degree of responsiveness of innovation to domestic IPR and β_2 measures the degree of responsiveness of domestic innovation to export partners IPR[5]. $\mathbf{X}'_{i,t}\mathbf{\Gamma}$ represents the control variables presented in table 2.1, whereas ν_t are the year dummies that pick up unobservable changes that directly affect R&D intensity over time. η_k account for the industry specific unobservable characteristics that directly affect R&D intensity,

[5]We must take careful consideration when interpreting the results from estimating equation 2.3. For example, while we argue that β_2 is exogenous, β_1 is still a biased estimator due to reverse causality, which in turn, also impacts the precision of our other estimated coefficients, namely β_2. While we cannot drop IPR as a covariate (as we would be trading off a simultaneity bias for an omitted variable bias), this paper is more concerned with the expected sign of β_1 and β_2.

whereas ι_i represents the time-consistent country fixed effects. For simpler interpretation, a logarithmic transformation to both domestic and export partner IPR is applied. Table 2.3 presents the results of estimating equation 2.3. Table 2.3 also estimates the impact of IPR on R&D intensity for industries that are both relatively open and close. We define an open industry if it exports more than 50% of its production. This is calculated using the trade openness variable.

Table 2.3: OLS Estimates: Impact of IPR on R&D Investments

	Full Sample				Open Industries	Closed Industries
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A						
Ln(IPR)	1.631***	3.668***	3.327***	0.871***	0.798	1.069**
	(0.309)	(0.375)	(0.352)	(0.299)	(0.540)	(0.454)
Ln(EIPR)	-0.408	2.748***	2.296**	0.123	0.136	-0.128
	(0.814)	(0.937)	(0.914)	(0.364)	(0.610)	(0.441)
Panel B						
Ln(IPR)	1.565***	3.990***	3.640***	0.951***	0.719	1.141**
	(0.312)	(0.382)	(0.362)	(0.297)	(0.522)	(0.454)
Ln(FEIPR)	0.958	5.618***	5.238***	1.413***	2.176**	0.498
	(0.783)	(0.970)	(0.915)	(0.472)	(0.964)	(0.557)
Observations	1472	1472	1472	1472	682	790
Year Effects	No	Yes	Yes	Yes	Yes	Yes
Industry Effects	No	No	Yes	Yes	Yes	Yes
Country Effects	No	No	No	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors correcting for heteroskedasticity. Sample size consists of 20 countries across 45 industries for the years 1987, 1990, 1995, 2000, and 2005.
* $p < .10$, ** $p < .05$, *** $p < .01$

Column (1) presents the regression with domestic IPR, export partner IPR, and the set of control variables as regressors only. Column (2) adds in year fixed effects, whereas column (3) adds in year and industry fixed effects. Lastly, column (4) is the fully specified model by including the set of control variables, year, industry, and country fixed effects.

Panel A presents the results for our biased measure of partner IPR, whereas Panel B presents the results for the corrected measure of partner IPR. For instance, by adding the year fixed effects to the model, our variable of interest presented in Panel B, $Ln(FEIPR)$, changes from a statistically insignificant coefficient to a large, positive, and significant coefficient. By incorporating the year fixed effects into the model, it now identifies the downward-trend of R&D intensity over time. Furthermore, by shifting focus from column (2) to (3) and incorporating industry fixed effects, we see that the magnitude of our estimated coefficient has decreased slightly, while still significant at the 1% level. This can be reasonably expected. As the manufacturing industries in our sample have varying degrees of innovative capacities, some industries rely heavily on R&D activities and patent protection to maintain its global competitiveness.

After controlling for year, industry, and country fixed effects, our results presented in column (4) suggest that export partner IPR still maintains a positive and significant effect on domestic innovation. Specifically, we see that a 1% increase in export-partner IPR is associated with a 1.4% increase in domestic innovation. This relationship is statistically significant at the 1% level. While we observe that the degree of responsiveness of domestic R&D intensity to export partner IPR is not as large as the results presented in column (3), by incorporating country-fixed effects we capture the unobservable country factors that directly affect R&D spending of firms. It is reasonable to assume that time-invariant country factors such as the legal institution of the countries play a significant role in promoting R&D activities. This also holds true when analysing the impact of domestic IPR (measured by the variable IPR) on domestic innovation. The effect is still positive and statistically significant, but the magnitude of the impact has been reduced significantly when moving from column (3) to column (4).

Similarly, the results presented in Panel A show a positive (but statistically insignificant) relationship between the endogenous measure of partner IPR and R&D activity. While the estimated coefficient remains positive in the fully specified model, given the results in Rafiquzzaman (2002), we would expect that $Ln(EIPR)$ to be biased upwards. Specifically, we hypothesized that R&D intensive firms would export to countries with stronger patent protection levels, as the innovative products are now more protected in these countries. However, our results indicate that our estimated coefficient is actually biased *downwards*. While puzzling, it may be that other country factors (size of the market, business environment, etc) are more dominant features than patent protection levels to R&D intensive firms when exporting abroad.

Columns (5) and (6) present the impact of partner IPR on domestic innovation for either relatively open or closed industries. As expected, column (5) indicates that open industries respond strongly to partner IPR but not domestic IPR[6]. Specifically, we find that a 1% increase in partner IPR is associated with an increase in R&D intensity of 2.2%. These results are statistically significant at the 5% level.

The results in column (5) are in line with what we hypothesized. For instance, suppose an R&D intensive firm located in a small open economy, such as Singapore, exports 90% of its production to the U.K. It is likely that the Singaporean firms may be influenced by changes in U.K. IPR. And crucially, since the Singaporean firms are unlikely to exert influence on U.K. government policy, changes in U.K. IPR represent a quasi-natural experiment. Hence, this strong relationship between U.K. IPR and Singaporean R&D can be readily interpreted as causal. We would therefore expect that open industries, or industries located in relatively open economies, would respond more to changes in partner IPR than domestic IPR.

Conversely, for relatively closed industries, we would expect that domestic IPR would influence domestic R&D activity more than partner IPR. This is exactly what we see in column (6). For relatively closed industries, a 1% increase in domestic IPR is associated with a 1.14% increase in R&D intensity. We further see that there is a statistically insignificant relationship between partner IPR and R&D activity for industries that export less than 50% of its production.

Therefore, the results presented here provide unique evidence on specific global factors that can impact domestic innovation, where the level of trade openness by industry and country also impact how firms respond to IPR. These results can potentially provide an alternative avenue for policy-makers to promote domestic innovation.

2.3.1 Non-Linear Relationship between IPR and R&D

Previous theoretical and empirical literature has addressed the possibility that IPR and innovation may have a non-linear relationship. For instance, papers as early as Helpman (2003) claim that marginally stronger patent protection may in fact inhibit innovation. Empirically, Allred and Park (2007) explore the possibility that an inverted U-relationship

[6]Ideally, the interaction between the trade openness variable and partner IPR would be used to test the idea that smaller economies respond more to partner IPR. However, in doing so, the interaction and the trade openness variable are almost perfectly correlated (a correlation coefficient of .999). Alternatively, we used the size of the country (the population from 1987) as a proxy for the level of trade openness of a country

may exist between R&D intensity and IPR. They find that at lower levels of IPR, strengthening patent rights will results in more firm-level innovation, whereas too strong IPR might hinder innovation, as firms cannot innovate without other technology that is patented by competitors. The reasoning is that with further strengthening of patents, firms who choose to innovate may now require licences for multiple patents from multiples sources, which creates delays while also increasing firm costs. This ultimately impedes innovation. By taking into account this possibility, the econometric model may now take the following form:

$$Log(\frac{R\&D}{Output})_{ikt} = \beta_1 IPR_{it} + \beta_2 IPR_{it}^2 + \beta_3 EIPR_{ikt} + \beta_3 EIPR_{ikt}^2 + \mathbf{X}'_{i,t}\mathbf{\Gamma} + \iota_i + \eta_k + \nu_t + \epsilon_{ikt} \quad (2.4)$$

Table 2.4 provides the results for the above regression, where column (4) presents the results of the fully specified model and column (5) and (6) present the results for open and closed industries, respectively. Our results suggest that there is evidence of a non-linear, concave relationship between export partner IPR and R&D activity. Specifically, we find that a 1% increase in export-partner IPR is associated with an 1.4% increase in domestic innovation. The results in this table also support the idea of diminishing returns to strengthening domestic IPR. Column (5) further confirms our previous result suggesting that open industries respond more to partner IPR than domestic IPR, where we also find that there are diminishing returns to stronger partner IPR. Similarly, column (6) indicates that closed economies respond positively to domestic IPR more than partner IPR, where the relationship between domestic IPR and R&D is significant at the 5% level. While we do observe a non-linear relationship between domestic IPR and R&D intensity, it is statistically indistinguishable from zero.

Table 2.4: OLS Estimates: Non-Linear Relationship between IPR and R&D

	Full Sample				Open Industries	Closed Industries
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln(IPR)$	1.756***	3.965***	3.623***	0.933***	0.874*	1.086**
	(0.326)	(0.385)	(0.363)	(0.296)	(0.517)	(0.452)
$\ln(IPR^2)$	0.185***	0.127***	0.117***	-0.0302*	-0.064	-0.0342
	(0.0381)	(0.0393)	(0.0378)	(0.0183)	(0.030)	(0.023)
$\ln(FEIPR)$	1.880**	5.685***	5.221***	1.383***	2.03**	0.508
	(0.869)	(1.024)	(0.958)	(0.473)	(0.990)	(0.554)
$\ln(FEIPR^2)$	0.003	0.003	-0.026	-0.103**	-0.157**	-0.058
	(0.0773)	(0.104)	(0.0977)	(0.0414)	(0.069)	(0.053)
Observations	1458	1458	1458	1458	670	788
Year Effects	No	Yes	Yes	Yes	Yes	Yes
Industry Effects	No	No	Yes	Yes	Yes	Yes
Country Effects	No	No	No	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors correcting for heteroskedasticity. Sample size consists of 20 countries across 45 industries for the years 1987, 1990, 1995, 2000, and 2005.
* $p < .10$, ** $p < .05$, *** $p < .01$

2.4 Evidence from Canadian Firms

While our results are robust for a sample size of 20 countries across 45 industries, a natural question arises whether the impact of export-partner IPR on private sector R&D spending are more pronounced for firms located in small, export oriented economies, such as Canada. As our *a priori* suggests that the innovative activities of export-oriented firms should reflect the IPR regime of their export market, this link may entirely depend on the organizational structure of firms, or more importantly, the size of the firm. For instance, due to the highly complex structure of multinational firms, where global value chains span across numerous countries, the link between foreign IPR and domestic innovation may not be so clear. It may be the case that smaller firms, where the R&D activities can be reasonably linked to export products, innovate according to the level of IP protection of their foreign market. Therefore, due to the relative simplicity of the organizational structure of small firms, we focus our analysis to export-oriented small Canadian firms in R&D intensive industries.

2.4.1 Dataset

To examine the impact of export partner IPR on Canadian innovation, we use the T2-LEAP-Export Registry Database linked to the Research & Development in Canadian Industry (RDCI) database. The merged dataset compiles all incorporated export-oriented business enterprises in Canada that have also pursued R&D investments. RDCI defines total R&D expenditure as the summation of current and capital expenditures. Current expenditures refer to wages, salaries, and other current costs, such as contracts and services required to carry out R&D,[7] whereas capital expenditures refer to costs of land, building, and equipment.

The database covers the years between 2000 and 2008, inclusive. The T2-LEAP-Export Registry database covers all financial information related to the incorporated businesses, the 8-digit Harmonized System (HS) industry code of the export product, the export country, and the value of the export. Table 2.5 for instance provides an over view of the various industries in our sample size, aggregated at the 2 digit Harmonized System (HS) codes[8].

Table 2.5: R&D Intensive Sectors in Firm-Level Study

HS	Industry
30-37	Chemicals & Allied Industries
40	Rubbers & Plastics
52-59	Textiles
64-67	Footwear/Headgear
84-85	Machinery/Electrical
90-97	Miscellaneous

To focus on the global competitiveness of Canadian small firms, we restrict our sample to firms that have on average less than 100 employees over the sample period.

Similar to the country-industry-year index, this export-weighted IPR index (EIPR) is constructed as the weighted average of the export partners IPR, by using the proportion of exports for each firm, for products in each industry, country, and time period, as weights. Or more formally, if I define X_{ijkt} as the value of exports from firm i at time t, exporting in industry k to j countries, where $j = 1...J$, we have:

[7] Other current costs exclude contracts for R&D

[8] Miscellaneous refers to medical and surgical instruments, sports equipment, and arms and ammunition

$$EIPR_{ikt} = \sum_{j}^{J} \frac{X_{ijkt} * IPR_{jt}}{\Sigma_j X_{ijkt}} \tag{2.5}$$

As $\sum \frac{X_{ijkt}}{\Sigma_j X_{ijkt}} = 1$,this is simply a weighted average using the proportion of exports as weights. Similarly, to avoid endogeniety issues, we define our fixed-trade flow EIPR (FEIPR) index as:

$$FEIPR_{ikt} = \sum_{j}^{J} \frac{X_{ijk99} * IPR_{jt}}{\Sigma_j X_{ijk99}} \tag{2.6}$$

Where the export trade flows for each firm i, exporting goods from industry k to country j, where $j = 1...J$, are from the year 1999. This will ensure that changes in the index are driven by changes in export partner IPR. As IPR move slowly over time, we use 5 year intervals for our data set; specifically we use the years, 2000, 2005, and 2008.[9]

Similarly, as it is reasonable to assume that domestic R&D intensity may not respond immediately to changes in export partners IPR, we calculate the forward averages of R&D intensity (measured as the ratio of R&D expenditure to Sales). In this case, the value of R&D intensity for the year 2000 would represent the average R&D intensity for the years between 2000 and 2004, inclusive. Therefore, the final dataset is comprised of 416 Canadian firms across 275 industries for the years 2000, 2005, and 2008. The unbalanced dataset has a total of 2231 observations.

Limitations

Due to limitations of the dataset, we can only analyse the effect of Canadian-firm level innovation to changes in their export partners' IPR after the year 2000. As the inclusion of the TRIPS agreement caused changes to the IPR system for WTO members in 1994, the strengthening of patent protection is reflected in the IPR index for the years 1995 and 2000, whereas very little reforms have occurred since. For instance, of the 122 recorded countries in the IPR index, 40 countries have had changes to IPR reforms from 2005 to

[9] As this dataset begins in 2000, the majority of variation in IPR from 2000 onwards were from developing countries. Therefore, the results presented here can reasonably be interpreted as how the R&D activity of small Canadian firms respond to the IPR of its export developing countries.

2008, where 12 are from Latin America, 8 African economies, 8 small European countries, 4 from Asia, and 8 from South-East Asia. Of these countries, neither has been considered one of Canada's top ten exporting countries destinations. Therefore, there will be very little variation across time. Any variation across time will be due to changes in IPR from these economies.[10]

Furthermore, to calculate our FEIPR variable, our dataset is restricted to businesses that have been exporting to the same subsets of countries since 1999. Our data does not account for new international markets the business enterprises have entered after 1999, or for new firms born after 1999, or firms that exported in 1999 and died during the our time frame.

2.4.2 Descriptive Statistics and Empirical Design

Tables 2.6 and 2.7 provide descriptive statistics and the correlation matrix of the variables of interest. Of the 416 SMEs, they all cumulatively export to 117 countries globally.

Table 2.6: Descriptive Statistics of Canadian Firm Level Analysis: R&D Intensity and IPR

Variable	Obs	Mean	SD
ln(R&D Intensity)	2231	-10.475	1.256
EIPR	2231	4.685	0.3838
FEIPR	2231	3.79	1.257

Table 2.7: Correlation Matrix: Dynamic Trade Partner IPR and Fixed Trade Partner IPR

	EIPR	**FEIPR**
EIPR	1	
FEIPR	0.3026	1

The tables below confirm our previous concerns of the EIPR measure as biased. Specifically, if we account for dynamic changes in firm-level exports, there is a larger deviation in the variable, which these changes may not necessarily be due to the export country's IPR, but rather other factors (possibly unobservable) that are driving these results. For

[10] We therefore also had to drop firms that export exclusively to the United States, as there have not been major US IPR reforms since 2000.

example, changes in the foreign markets' preferences or technical inefficiencies within the firm may cause shifts in trade flows each year. While the former can bias our results, our firm fixed effect model can control the latter.

To examine the relationship between partner IPR and Canadian innovation, the econometric model will take the following form:[11]

$$Log(\frac{R\&D}{Sales})_{ikt} = \beta_0 + \beta_1 EIPR_{ikt} + \iota_i + \eta_k + \nu_t + \epsilon_{ikt} \tag{2.7}$$

Where β_1 represents the degree of responsiveness of innovation to export-partner IPR, ι_i are the year dummies that pick up unobservable changes that directly affect R&D intensity over time, η_k account for the industry specific unobservable characteristics that directly affect R&D intensity whereas ν_t represents the firm fixed effects. For simpler interpretation, a logarithmic transformation to export partner IPR is applied to equation 2.7. Table 2.8 presents the results of estimating equation 2.7 using both EIPR and FEIPR.

Column (1) represents the regression with export partner IPR only. Column (2) controls for year fixed effects, whereas column (3) controls for year and industry fixed effects. Lastly, column (4) is the fully specified model by controlling for year, industry, and firm fixed effects.

We see that after controlling for year, industry, and country fixed effects, export partner IPR has a large and significant effect on Canadian innovation. Specifically, using the EIPR measure, we see that a 10% increase in export partner IPR represents an increase of about 8.37% in domestic innovation. This result is robust across different specification models and significant at the 5% level. While our EIPR measure is endogenous, we focus on our results presented in panel B. By using the FEIPR measure, we see that in the fully specified model, the relationship between export partner IPR and domestic innovation is significant at the 5% level. Specifically, we find that a 10% increase in the export-partner IPR is associated with a 1% increase in Canadian innovation.[12]

[11] Typically the IPR index of Canada would be included in this model. However, according to the five factors in which the IPR index was constructed, there has not been any major reforms to Canadian IPR. Therefore, the effect of Canadian IPR on Canadian innovation would be absorbed by the constant β_0 in the model.

[12] We also explored the possibility that export-partner IPR and innovation may have a non-linear relationship. The reasoning is that with further strengthening of patents, firms may innovate around existing patents, which increases costs and reduces the appropriation of innovation. While we still do find a positive and statistically significant relationship between export-partner IPR and Canadian innovation, we fail to find an inverse-U relationship between the two.

Table 2.8: OLS Estimates: Impact of IPR on Firm-Level R&D

	(1)	(2)	(3)	(4)
Panel A				
Ln(EIPR)	1.336***	1.319***	.824	.837***
	(0.503)	(0.504)	(0.734)	(0.395)
Panel B				
Ln(FEIPR)	.197***	.197***	.160***	.096**
	(0.0585)	(.0585)	(.0582)	(.0456)
Observations	2231	2231	2231	2231
Year Effects	No	Yes	Yes	Yes
Industry Effects	No	No	Yes	Yes
Firm Effects	No	No	No	Yes

Note: Robust standard errors clustered by firm. Sample size consists of 416 firms across 169 industries for the years 2000, 2005, and 2008.
* $p < .10$, ** $p < .05$, *** $p < .01$

2.4.3 What Factors Are Driving These Results?

While we see that a strong patent protection score of Canadian export-partners positively affect Canadian private sector innovation, it is still important to understand specifically what factors are driving these results. For instance, of the five factors that creates the weighted patent protection index, is there a subset of factors that Canadian firms tend to respond to more? To test this idea, we similarly create an export-weighted index for each factor that comprises the patent protection index and regress R&D intensity on each of these factors separately. Mathematically, this can be expressed as follows:

$$Log(\frac{R\&D}{Sales})_{ikt} = \beta_0 + \beta_1 Log(FIPR_{ikt}) + \iota_i + \eta_k + \nu_t + \epsilon_{ikt} \tag{2.8}$$

Where $FIPR_{ikt}$ represents the export-weighted index (using fixed trade flows) of one of the following five factors in the IPR index: duration, loss of rights, enforcement, membership, and coverage. The results are presented below in Table 2.9.[13]

For brevity, the results presented in table 2.9 control for year, industry, and firm fixed effects. The results presented above suggest that the enforcement mechanisms of the export

[13]For brevity, the results presented here reflect the export-weighted index constructed using fixed trade flows from 1999. The results are similar when using dynamic trade flows as weights.

Table 2.9: OLS Estimates: Factors That May Impact Firm-level R&D

	Loss of Rights	Enforcement	Membership	Coverage	Duration
FIPR	.078*	.100**	2.28e-17	.0962**	.0883**
	(0.0455)	(.0449)	(.197)	(.0453)	(.0447)
Observations	2231	2231	2231	2231	2231
Year Effects	Yes	Yes	Yes	Yes	Yes
Industry Effects	Yes	Yes	Yes	Yes	Yes
Firm Effects	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors clustered by firm. Sample size consists of 416 firms across 169 industries for the years 2000, 2005, and 2008.
* $p < .10$, ** $p < .05$, *** $p < .01$

country's legal institution related to intellectual property and the vast coverage of industries protected by patents are strong determinants of Canadian innovation. Specifically, we see that a 10% increase in industry coverage and enforcement protection of patents lead to an associated increase in small firm Canadian innovation by .9% and 1%, respectively.

While the duration of patents play an important role in promoting innovation, it appears that Canadian firms may not necessarily be motivated to innovate if their target export country has entered into a new treaty agreement. Canadian firms perhaps respond more to factors related to legal institutions, or factors that directly affect their business. For instance, firms may be reluctant to export a technologically advanced good to target countries with weak IP protection due to lack of judicial repercussions to alleged infringer's.

Furthermore, as costs associated to patenting goods or processes are typically relatively significant to small Canadian firms, it seems reasonable that small firms would be increasingly sensitive to changes in these factors. The investment from small Canadian firms to patent their export product in the target country is profit enhancing only if the export country can legally, and credibly, commit to persecuting innovators who infringe on their intellectual property. This explains the positive, and statistically significant, relationship seen in the above table.

2.5 Conclusion

Our results provide new insight on the incentive structure of private sector R&D in the context of globalization. Particularly, we find that export market IPR is now driving global innovation. These results support the inclusion of the Trade Related Aspects of Intellectual Property Rights (TRIPS) into the World Trade Mandate (WTO), while also justifying the inclusion of the newly created highly controversial Anti-Counterfeiting Trade Agreement (ACTA). It would further assist policy makers to design a more optimal national property right regime. For instance, rather than standard IPR initiatives, tax incentives, or programs support, it would allow for policy-makers to explore alternative channels that promote domestic innovation.

In terms of Canadian public policy, the Canadian governments' recent domestic initiatives to encourage innovation across Canada should consider alternative channels to support the growth of Canadian firms. However, as close to 70% of Canadians are employed by small firms, the government must recognize that innovative Canadian firms not only necessarily respond to Canadian IPR mandates, but rather to global IPR regimes. These results suggest that export partner IPR should be of priority when negotiating multilateral trade agreements. Our results suggest that strengthening IPR in trade agreements can be mutually beneficial. This is confirmed through our analysis of 20 countries across 45 industries.

Chapter 3

Estimating the Effects of Democracy on Economic Growth: Evidence from an Unbalanced Panel

3.1 Introduction

The question of political institutions and its effects evokes ambiguous responses. Economic prosperity does not necessarily coincide with democracy. More importantly, while currently rich countries are governed by democratic institutions, the direction of causality remains unclear. Proponents of democracy argue that its institutions have greater control in promoting and implementing policies that stimulate economic activity.[1] Conversely, past researchers (Przeworski et al. (2000), Barro (1999), among others) argue that human capital based policies, which either democratic or autocratic institutions can implement, will not only lead to economic growth, but will also lead to a more effective government. They argue that an increase in education expenditure increases societal awareness among its citizens, which would then expose government malfeasance. This would theoretically lead to a more adept, capable governing body that shapes policies and social choices that are in the country's best interest.

Since Lipset (1959), a popular view in political economy remained that wealthier countries usually tend to be more democratic. Lipset (1959) argues that since wealth is a sign

[1]For instance, entering into international trade agreements or investing into human and physical capital

of modernization, modernization would also increase a citizens demand for political participation. This school of thought remained persistent throughout the literature in political economy. For instance, Huntington (1991) argues that higher per capita income levels were one of the key factors during the 'third wave' of democratization, whereas Londregan and Poole (1996), through a country fixed effects model, not only finds a positive correlation between income and democracy, but also finds that differing levels of income are also correlated with regime type. Barro (1999) further contributes to this literature with his seminal paper on the determinants of democracy. By implementing a seemingly unrelated cross-country regression with several country specific characteristics, Barro (1999) finds that, among other factors, countries with higher income levels tend to be more democratic. These results are also seen by Przeworski et al. (2000), where they investigate the likelihood that democracies thrive during periods of economic prosperity. They find that since dictatorships fall for various reasons, there are income thresholds where countries are more likely to transition towards democracy.

While other recent papers support the modernization theory (see Epstein et al. (2006), Papaioannou and Siourounis (2008), Moral-Benito and Bartolucci (2012), Heid et al. (2012), and Che et al. (2013)), Acemoglu et al. (2008) refute the modernization theory and conclude that there is no statistical relationship between income and levels of democracy. Acemoglu et al. (2009) furthers this claim by arguing that transitions to and from democracy have no effect on income. They applied several forms of country fixed effect regressions, IV estimation methods, and double hazard models (which accommodate for country fixed effects). Related to the literature, Brückner and Ciccone (2011) find that by applying rainfall as a source of a transitory income shock, there is a consistent negative association between rainfall and democratic institutional improvement in Sub-saharan Africa.

While this stream of literature is still continuing to develop, this paper attempts to contribute to the literature by examining the impact of democracy on economic growth through the channel of differing political regime types. The premise is that political regimes associated with more democratic features are more likely to implement welfare enhancing policies to the masses. Specifically, if the head of state was elected into office, the incumbent has an incentive to heed voters' interest to stay in power. We therefore argue that the political regime types may not necessarily be the driving force behind economic activity, but rather it's the complex interworking of these institutions that allow for socially optimal policies to be implemented.

For example, supporters of democratic regimes argue that democracy provides greater extensive property rights than its autocratic counterpart, which would lead to more economic stability. Theoretically, this democratic environment that promotes profit-maximizing activity by its citizens would lead to greater economic growth. In addition, democratic supporters argue that authoritarian regimes are more prone to corrupt rulers that implement wildly inconsistent policies, which in turn, would lead to a volatile economy. However, pro-authoritarians argue that democracies are prone to social and ethnic conflicts, whereby autocratic regimes can suppress these conflicts while implementing coercive policies that are necessary for economic prosperity.

While the political structure may greatly differ between democratic and non-democratic institutions, it is important to understand the social constructs of good governance; particularly, the framework of governance that allows for these institutional equilibriums to exist.

3.1.1 Modes of Governance

The underlying driver of governance in either a democratic or non-democratic country is the dominance of either the formal or informal governance structure. It may be that the underlying structure of governance only differ in the level of formal governance. Dixit (2009) defines two forms of governance in our society: the formal governmental institution of governance, comprised by the social and legal institutions, and its informal counterpart.

The formal institutional mode of governance is defined by its national constitution, where the legislative assembly (or higher authority) provides statutes in accordance to the constitution, which then the governmental agencies, such as the police, courts, and regulatory officials, interpret and enforce these rules. Similarly, the informal institutional modes of governance provide informal assurance that the norms of society are being followed, where possible sanctions are enforced for violations of behavioural norms. Both modes of governance play a special role in securing the three essential prerequisites of a healthy functioning market economy: property right protection, contract enforcement, and collective action.

Property Right Protection

The formal and informal modes of governance play a crucial role in protecting property rights. If the formal governmental institutions does not provide sufficient property rights to the public, or if the public perceives that they are not receiving adequate protection, the public has several alternatives from either private or social institutions. In the absence of sufficient property right protection from the formal government, a common deterrent to reduce property right violations are private security services and safe haven regions.

However, a private order method of reducing property right infringements has some harmful effects. For one, it may actually increase the likelihood of property right violations for those who either opt out or cannot afford these modes of private property protection. This spillover effect triggers other agents in the economy to further inquire and purchase these methods of crime deterrence, which then increases the demand for these services and ultimately drives the prices for these services upwards. More importantly, the mechanism that drives this loss of consumer welfare for citizens in this economy is due to the lack of efficient formal governance. In addition, the presence of a weak economic governance structure may deter foreign investors due to the additional costs in protecting property rights. This additional cost would reduce the flow of foreign capital, which may hinder further local economic activity.

While these methods of deterrence are common in all societies, these issues are more likely to arise in developing and transitional economies, where weak governance is present. However, the underlying issue behind a weak economic governance may be the selfish preferences of the head of state, where their political actions may either benefit their self serving preferences or benefit preferences of a subgroup of the population. This type of behaviour is more commonly seen in autocratic economies. In either case, the state laws and actual order, presented by the formal and informal modes of governance, are crucial for a flourishing economy.

Enforcement of Contracts

The set of statutes provided by a governing body allows for its citizens to reasonably expect that the government will effectively enforce the law. By contrast, for a functioning society to exist, the formal institutions of the state requires their citizens to have a certain level of trust and believe in credible legal repercussions. Otherwise, citizens may constantly renege on contractual obligations. If this is the case, this would deter future economic exchanges, and hinder future economic activity. It is therefore crucial for the governing body to sustain this social equilibrium where the selfish are punished and the cooperators mutually benefit. However, in the absence of strong contractual protection, citizens may view private governance methods as a viable alternative. Unlike the formal mode of governance, private governance of contract enforcements may entail those that are involved in nefarious activities, which through rent seeking behaviour, may deter economic activity to occur in the long run. It is in this instance where prosocial preferences must be instilled by the government so as to create a situation where the predominate strategy is to reciprocate mutually beneficial behaviour and penalize the selfish. Otherwise, selfish behaviour leads to political and corporate corruption. Firms, political figures, and legal agencies, may all find that the behavioural norm is to maximize their own wealth through endowments outside of their establishments. Clearly, this can make business costly for domestic and foreign firms.

Bureaucratic corruption also produces various negative externalities. For instance, it may alter the selection process of choosing optimal productive government expenditures, which in turn is detrimental to economic growth[2]. For successful, efficient, and productive order to occur, these economic institutions rely heavily on altruistic behaviour from its citizens to encourage economic activity and induce economic growth[3].

Collective Action

Collective action is necessary for both property rights and enforcement of contracts. Successful systems of collective action often involve an established group where transparent information is provided to its members. Generally, the group provides its member information on the member list, their rights and responsibilities, and consequences of any misbehaviours. The transparency of this information helps members to adhere to the norms of the group. Thus, collective action provides a mechanism that disciplines members where formal governance may not operate, or may be too troublesome to enter. For example, social groups or industry leaders may have a comparative advantage in knowledge and expertise in a certain field that the government may find too complex to resolve. An example of this include experts in certain fields called in to court for litigation proceedings.

While the underpinning of governance has been briefly covered, the differences between democratic and autocratic institutions can be described by the level of (in)efficient formal economic governance they provide to society. The consequences of these factors are a result of the type of political institutions that are currently in place, where an eventual transition of efficient markets is reflected in the transitions within political regimes. The following section will extensively cover the political construct of several formal economic governance systems, their definition, and how their divergent paths to political office are associated with economic growth.

[2] Hillman et al. (2004)

[3] Acemoglu and Verdier (1998) argue that if corruption is costly, there is a maximizing level of corruption that can have a positive effect on growth

3.1.2 Classification of Regime Types

Democratic Institutions

We define democratic regimes as institutions where government offices are appointed through a contested election. Specifically, the chief executive office and the legislative body must be chosen by its citizens. A contested election of a democracy has three distinct features. First, the outcome of the election must be uncertain. Second, the chosen official ex post is irreversible; that is, the chosen official cannot be removed after the election. Third, elections will typically take place at regular and known time periods. Given these generalized features of democracy, sub democratic regimes differ only in the relationship between the chief executive office and the legislative body.

In a presidential democracy, the president is separate from the legislative body, whereas a parliamentary democracy, the chief executive, such as the prime minister, is part of the legislative assembly. The presidential system allows for the president and the legislative body to be elected by its citizens separately, whereas the legislature is elected by the people and the legislative body appoint, or recommend one of its members as a chief executive. As conflicting parties may be represented in the presidency and in the legislative assembly, generally, amendments to current statutes or implementing new provisions may be more difficult to enforce in a presidential system than a parliamentary system. A semi presidential (or mixed democratic) system is a mix of both the parliamentary and the presidential system. The chief executive officer reports to the legislative assembly but is also elected as head of state.

Autocratic Institutions

The classifications of nondemocratic regimes in this section are based from Cheibub et al. (2010). They argue that aside from a monarchist dictatorship, there are notable distinctions between military and civilian dictatorships. Particularly, past researchers have often grouped both sub authoritarian regimes together. While the motive for staging coups may vary among military dictatorships, the rebellious group typically feel the need to obstruct their country's political agenda in a strong coercive manner, where they consider their actions beneficial to the country. Their interference in the country's political agenda is often justified due to their affiliation or support from the national armed forces, which typically control their country through violence.

Unlike military dictatorships, civilian dictatorships usually have no formal affiliation with an official organization, but rather build support through a regime party. Cheibub et al. (2010) refers to this regime group as an instrument that can penetrate and control society. In essence, we define a civilian dictatorship through a process of elimination. If there is no hereditary successor (or title of king as the head of state) and the effective head of state is neither a current or past member of the national armed forces, then the political institutions is deemed as a civilian dictatorship. This distinction is important for our identification strategy in the econometric results we present in the empirical component of this paper. While the aim of this paper is to measure the effect of democracy (applying political regime types as instruments) on economic growth, to stay consistent with the current literature in political economics, democratic regimes will also be grouped together as instruments for democracy.

3.2 Literature Review

While the literature is vast in this field, there is still an ongoing debate over the economic implications of democratization. A recent summary of the academic literature by Gerring et al. (2005) states that "democracy has either a negative effect on GDP growth or no overall effect". Furthermore, a meta-analysis conducted by Doucouliagos and Ulubaşoğlu (2008) reveal that of the currently 84 published democracy-growth studies (with a total of 483 regression estimates), 15% of the estimates conclude there is a negative and statistically significant association between democracy and economic growth, 21% are negative and statistically insignificant, 27% are positive and statistically significant, while 37% of the estimates are positive but statistically insignificant. The large variations in results are due to several factors. Mainly, the approach on how to capture the relationship greatly differs. Some researchers focus on physical investment, human capital, or political stability channels for inferences, while others provide estimates on well specified structural models. The differences in estimates are further amplified when taking into account the different data sources, estimation methodologies, sample size, and time period. For the purpose of this paper, we focus on previous empirical work that has captured the democracy-economic growth relationship measured through institutional quality and political governance.

Papers as early as Helliwell (1994) studied the two-way linkage between democracy and economic growth. By applying an augmented Solow growth model for a panel data that consists of 125 countries between 1960-1985, the author concludes that a democratic regime has an indirect positive effect on economic growth through investment and physical capital, whereas the direct effect of democracy (while statistically insignificant) is found to hinder economic growth. Przeworski and Limongi (1993) find that democratic regimes may affect economic growth, but it appears that the results may be negligible. More recently, Papaioannou and Siourounis (2008) implement a difference-in-difference methodology to capture differences in economic growth between permanent democratic economies and non democratic economies. They found that those economies that abandoned an autocratic institution, its annual economic growth accelerated after the transition by approximately 1%. These results are similar to Persson and Tabellini (2007), whereby they implemented a semi-parametric difference-in-difference estimator and found that economic growth may decrease as much as by 2% when abandoning a democratic regime.

The work by Rodrik and Wacziarg (2005) closely resembles our work in that it uses annual frequency data to capture within-country effects of democracy by using similar methods. While their methodology mitigates omitted variable bias through country fixed and time effects, they fail to address the issue of reverse causality between economic growth and democracy. Furthermore, they exclude standard neoclassical growth determinants as control variables to isolate the effects of democracy on economic growth. This is typically seen in the literature today, with other notable examples such as Aghion et al. (2007), Glaeser et al. (2004), and more recently Acemoglu et al. (2014), where they employ OLS models with (sometimes) fixed effect models excluding known growth determinants and reverse causality issues. While other papers (Barro (1996), Acemoglu et al. (2008), and Tavares and Wacziarg (2001)) do address the issue of reverse causality and include known growth determinants, their results either suffer from severe small sample bias or focus on long term affects of democracy, while ignoring the short term effects of developing countries transitioning towards democracy.

We attempt to contribute to this growing literature by revisiting the short run economic effects of democratization for a subset of developing countries. Specifically, our analysis is centred over a time period where a wave of democratization had occurred in the Asian, Latin American, and African continents. During this time frame, the transitions towards democracy were initially proposed to strengthen a countries inherently weak political institution by instating 'participatory' politics to ensure redistributive policies were enacted. This would theoretically enhance economic activity. However, by instrumenting democracy with political regimes types, in addition to including numerous control variables, our results indicate that in the short run, developing countries that transitioned to a more democratic state are associated with lower levels of per capita income. These results suggest that over the short run, transitions towards a more democratic regime perhaps creates more political instability, which in turn, deters economic activity.

3.3 Model Specification and Data

3.3.1 Data

Our annual panel data consists of 43 developing countries located in Africa, Latin America, and Asia, for the years between 1970 and 1999. Table 6 in the appendix lists the countries within each region that is included in this cross-country study. Our main democracy measure is the Polity IV index[4]. The polity index captures qualities associated with democratic and autocratic authorities in governing institutions. This measure of government institutions is comprised of the following three key features of the current elected head of state: qualities of executive recruitment, constraints on executive authority, and political competition. The Polity score is on a 21 point scale, ranging from a hereditary monarchist (-10) to a consolidated democracy (+10). For a simpler interpretation, the polity index has been normalized from 0 to 1. Figure 3.1 below graphs the demeaned and detrended relationship between log of real GDP per Capita and the Polity index[5]. This simple graph illustrates the underlying results of this section. Particularly, we find that countries with higher levels of democratic characteristics are correlated with lower levels of per capita income. These results provide anecdotal evidence to support previous arguments that newly democratic regimes may allow for a suboptimal amount of re-distributional policies to be implemented[6]. However, to closely examine the impact of democratic regimes on economic growth, we first need to address the issue of reverse causality.

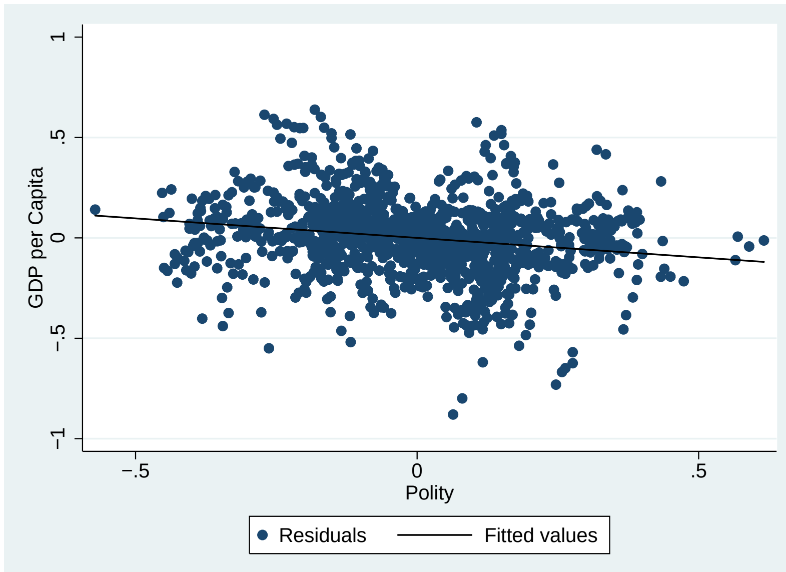
To examine the impact of democracy on economic growth, we propose to instrument our democracy measure with the classification of government regime types created by Cheibub et al. (2010). Cheibub et al. (2010) classifies the head of states as the following: parliamentary, mixed, and presidential democracies, or civilian, military, and royal dictatorships. The idea to use political regime types as an instrument is quite intuitive. We argue that the official political regime types may not necessarily matter for growth, but rather the policies that these newly appointed political regimes can enact. Specifically, if the head of state has high executive constraint (measured through the polity index), the elected official has an incentive to enact more redistributive policies to satisfy their voters and remain in

[4]The Freedom house index was also used as a measure of democracy in this study. Table 3.1 presents the results for the initial OLS regressions. As the polity and freedom house indices are highly correlated (.87), results using this measure have been omitted in future findings.

[5]Both measures were regressed on country and time fixed effects, and the unobserved variation, the residuals, were extracted.

[6]Aghion et al. (2004) find that redistributive pressures from a democracy may actually be harmful to growth

Figure 3.1: Log of Real per Capita Income and Democracy: Demeaned by Country Fixed and Time Effects



power. Therefore, these types of policies would be correlated with the democracy measure through the executive constraint channel[7].

For robustness checks, other instruments used in this model will follow the standard analysis in the political economy literature, where sub categories of democratic (and autocratic) regimes are not differentiated, and thus treated homogeneously[8]. We therefore introduce the democratic regime instrument as a binary variable where its value is one if the country is parliamentary, mixed, or a presidential democracy, and zero otherwise[9].

[7]While the classification of regime types is arguably another measure for democracy, the instruments used in this paper are quite mechanical in nature. For instance, while we cannot test the exclusion restriction, we use the Hansen-J and F-statistics to test the validity and relevance of the instruments, respectively.

[8]Gerring et al. (2009) argue that parliamentary systems provide good governance, and perhaps advantages over presidential systems, while Knutsen (2011) refute these claims arguing that the results driven by Gerring et al. (2009) are based on personal power concentration in new, low quality presidential democracies

[9]Democracy dummy's have been used in growth regressions in the past, but without much success. Papaioannou and Siourounis (2008) argues that a democratic indicator variable may be biased. For instance, if regime switching is occurring when economic times are favourable, the democracy indicator may be biased upwards capturing a positive trend, whereas if there is anticipation of a regime switch, an increase in economic activity may be made before the political change and the indicator variable may be

We further use lagged dummies of democracy, autocratic regime dummies, and dummy variables for each classification of political regime types as instruments. We find that irrespective of which instrument is used, our model produces near identical results.

To convince the reader of our instruments, figures 3 through 5 in the appendix illustrate the average polity score for democratic (defined by the democracy binary instrument variable) versus non-democratic countries in each of the three continents of interests, for each decade. To further provide transparency with the data, each graph corresponds with a related graph indicating the amount of countries that were sampled for the polity score average. The complementary graphs show that from 1975 to 1995, there has been a clear shift towards democratic regimes for all regions. However, surprisingly, the average polity score are very similar between democratic and non democratic countries within Latin American in 1995. These results are driven by the non-democratic countries Mexico and Paraguay, where their current head of states, Ernesto Zedillo of Mexico and Juan Wasmosy of Paraguay, were affiliated with nationalistic political parties with more democratic features. Therefore, both countries were labelled as a civilian dictatorship.

Conversely, to further illustrate the validity of the instruments used in this study, we can also examine the changes in income levels due to differences in political institutions between government regimes within continents. This can be seen in figures 6, 7, and 8 in the Appendix. These figures illustrate the log of real GDP over time for each type of political institution in each continent between 1970-1999. Similarly, for transparency of data, we also graphed the number of economies that were included in each specific regime between 1970-1999. These figures can be seen as a zero-sum game; That is, for every reduction in the amount of countries in a type of political regime within a continent, there is corresponding increase in a different political regime. For instance, in Latin America, the significant drop in military dictatorship regimes between 1977 to 1990 corresponds to an increase in economies transitioning towards a Presidential democracy within that same time period. While figure 6 may illustrate that a civilian dictatorship is almost a strictly dominate regime (measured in per capita income) for Latin American economies, the variation of this regime is almost exclusively due to Mexico. Particularly, the large jump in log of real GDP in 1971 to 1972 was due to Ecuador switching regimes from a civilian to a military dictatorship, leaving only Mexico in this regime from 1972-1978. Conversely, the large drop between 1978-1980 in this regime was due to Nicaragua and El Salvador switching into a civilian dictatorship from a military dictatorship. More importantly, we see that over the thirty year time period, there was a natural movement transitioning away from authoritarian regimes and moving towards presidential democracy. Despite these

biased downwards.

movements, there is little evidence linking political regime types and per capita income within Latin America.

Similarly, the evidence is not so clear for economies located in Africa. While we see that royal dictatorships have one of the higher relative average income levels over time, this variation is caused predominantly by Morocco. But also during this time period, civilian and military dictatorships are the most popular method of government regime, where the average log of Real GDP are both equally increasing relatively over time. While these authoritarian regimes are more common in Africa, the work of Knutsen (2010) provides empirical evidence that democracy increases economic growth in Africa for economies with weak state institutions, but these returns to democracy dwindle, and perhaps disappear for economies with high state institutions. In this paper, we find that in our sample size the overall effect of democracy may actually hurt national income levels for African nations, but only for nations that have a moderate level of democracy. These results are confirmed in figure 8 in the appendix, where there may not be a particular form of government institution that dominates, with or without biases in the sample size.

3.3.2 Empirical Design

To examine the impact of democracy on per capita income, our econometric strategy takes the following form:

$$Dem_{i,t} = \theta Instrument_{i,t} + \mathbf{X}'_{i,t}\mathbf{\Gamma} + \nu_i + \eta_t + \upsilon_{i,t} \tag{3.1a}$$
$$y_{i,t} = \alpha + \beta Dem_{i,t} + \mathbf{X}'_{i,t}\mathbf{\Gamma} + \nu_i + \eta_t + \epsilon_{i,t} \tag{3.1b}$$

Where 3.1a is the reduce form equation projecting the instruments onto the polity index, $Dem_{i,t}$, and $\mathbf{X}'_{i,t}$ represents the following standard set of time varying cross-country growth covariates: investment, tertiary education, savings, imports, exports, population (total population, population over 65, and teen population), war binary variable, mortality rate, exchange rates, and unemployment rates. ν_i and η_t represent the country and year-fixed effects that control for time invariant country characteristics and the global trend of democratization during this time period. Equation 3.1b is the second stage estimation where the dependent variable $y_{i,t}$ is the logarithm of Real GDP per capita of country i at time t. The data were compiled from several resources. We merged the dataset from Acemoglu et al. (2008) and Cheibub (2006) while extracting additional variables from the World Development Indicators (WDI). The model will be estimated via two-stage least squares. While standard fixed effect regression will yield biased results, it will be presented in the following section as a base specification model. This will provide an early indication as to the possible relationship between democracy and economic growth.

3.4 Results and Discussion

The model proposed in equations 3.1a and 3.1b will not only be applied to the full dataset but also to each region (Latin America, Africa, and Asia) in our dataset. For brevity, only the covariates of interest are recorded. All standard errors are clustered by country. The following tables present results for OLS and two-stage least squares for the full sample size.

Column (1) presents the results of a simple regression between democracy and per capita income, whereas column (2) adds in year fixed effects and our set of control variables. Lastly, columns (3) and (4) in table 3.1 present the fully specified model with country fixed effects. The standard errors in column (3) are clustered by country, whereas the standard errors in column (4) are adjusted for heteroskedasticity and arbitrary serial correlation for one period. In the absence of control variables, we find that democracy is positively correlated with per capita income. This is to be expected, as countries in our sample are transitioning towards democracy while also becoming wealthier over time. In the absence of year fixed effects and our control variables, our estimated coefficient in column (1) is biased upwards. By including the numerous control variables and year fixed effects, we find our estimated coefficient becomes negative and statistically significant at the 10% level. However, in the absence of country fixed effects, there may be time-invariant country characteristics that impact both national income and democracy. For example, if a country is rich in natural resources, this positively impacts per capita income but may negatively impact our democracy measure, as the head of state may use coercive measures to remain in power and extort the countries wealth for its own personal gain. In this example, if an omitted time-invariant variable, such as a natural resource binary variable, is positively correlated with national income but negatively correlated with democracy, the estimated coefficient for our democracy variable will be biased downwards.

Lastly, the results of the fully specified model in column (3) find that with 95% certainty, countries that exude democratic traits are associated with a decline in per capita income between 12.8% and 13.4%. While the results presented in table 3.1 are all biased (due to simultaneity issues), we find that the estimates obtained from the two stage least squared approach provide near identical results.

Table 3.1: OLS Estimates: Impact of Democracy on Economic Growth

	OLS			
Panel A				
Polity	0.493**	-0.179*	-0.134**	-0.134***
	(0.186)	(0.100)	(0.0619)	(0.035)
Observations	727	727	727	727
No. Countries	43	43	43	43
Panel B				
Freedom House	0.566**	-0.0928	-0.128**	-0.128***
	(0.217)	(0.107)	(0.0608)	(0.0342)
Observations	709	709	709	709
No. Countries	43	43	43	43
Controls	No	No	Yes	Yes
Country Effects	No	Yes	Yes	Yes
Year Effects	No	Yes	Yes	Yes

Note: Robust standard errors clustered by country in columns 1-3, where as Newey-West standard errors in column 4. The control variables include gross domestic savings, measured as a % GDP, tertiary education, measured as a % of the total labor force, imports and exports as a % of GDP, population (total population, population over 65, and teen population), a war binary variable, coded 1 when the country is involved in an interstate war or an interstate intermediate armed conflict (Gleditsch et al. 2002), infant mortality rate, measured as the number of infants dying before reaching one year of age, per 1,000 live births in a given year, contemporaneous exchange rates, measured in $ US per unit of local currency, and total unemployment rate, measured as a % of the total labor force that is without work but available for and seeking employment. With the exception of the war dummy variable, all controls are from the World Development Indicator (WDI) database.

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 3.2 estimates the effect of democracy on per capita income by using the democracy dummy variable and its lag of up to two years as instruments. While the instruments are quite mechanical in nature, Table 3.2 shows that the first stage F-statistics indicate that the instrument is relevant. The second stage estimated suggest that more democratic features in a countries political institution are associated with lower real per capita income of about 9% to upwards of 20%. These results are significant at both the 1% and 10% level, respectively. While these results seem unusually high, it may be that the average treatment effect of the 38 countries listed in columns (2) and (3) are over estimating the democratic effect on income levels. It may be that the low quality institutions that transitions towards democracy are driving these results.

Table 3.2: IV Estimates: Instrumenting Polity Index with Democracy Binary Variable

	Ln GDP		
Instruments	Democracy	1 Year Lag	2 Year Lag
First Stage Estimates			
	.490***	.428***	.341***
	(.022)	(.036)	(0.053)
F-Statistic	499.43	139.61	41.02
Second Stage Estimates			
Polity	-0.09***	-0.144***	-0.204*
	(0.034)	(0.044)	(0.122)
Observations	727	610	579
No. Countries	43	38	38
Controls	Yes	Yes	Yes
Country Effects	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes

Note: Robust standard errors clustered by country All controls remain the same. * $p < .10$, ** $p < .05$, *** $p < .01$

Column (1) and (2) in table 3.3 instrument democracy with the two most popular political regimes in democracy and autocracy, respectively, whereas column (3) use all classification of political regime types as instruments. Irrespective of the instrument used in this model, we similarly find that the instruments are also relevant[10]. The results presented here are similar to the standard OLS fixed effects model, where a more democratic political institution is associated with a decrease in per capita income between 10% and 12%. These results are significant at the 10% level, whereas instrumenting democracy with autocratic

[10]In the case of the democratic regimes as instruments, we can reject the notion at the 10% that these instruments are valid.

Table 3.3: IV Estimates: Instrumenting Polity Index with Political Regime Types

	IV		
Instruments	Democratic Regimes	Autocratic Regimes	All
First Stage			
Parliamentary Democracy	.33***		.401***
	(.063)		(.072)
Presidential Democracy	.55***		.611***
	(.053)		(.046)
Civilian Dictatorship		-.369***	.179**
		(.035)	(.091)
Military Dictatorship		-.556***	
		(.024)	
Polity	-0.116*	-0.101***	-0.124*
	(0.0678)	(0.0342)	(0.0663)
Observations	727	727	727
No. Countries	43	43	43
First Stage F-Stat	58.17	300.9	62.71
Hansen J-statistics	0.0893	0.177	0.160
Controls	Yes	Yes	Yes
Country Effects	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes

Note: Robust standard errors clustered by country. All control variables remain the same. * $p < .10$, ** $p < .05$, *** $p < .01$

regimes is statistically significant at the 1%.

As these results are capturing the relationship between democratic features of governing bodies and per capita income, it is also important to question whether the relationship between democracy and income differ across regions, or whether there are 'critical levels' of democratic characteristics that are associated with different levels of income. Tables 7, 8, and 9 located in the appendix show the results when estimating the impact of democracy on national income for countries located in Africa, Latin America, and Asia, respectively. The results presented in table 7 provide evidence opposing the results shown by Knutsen (2010), where democratic transitions are negatively correlated with economic performance in African countries. Specifically, the results imply that a democratic regime is associated with lower levels of per capita income by as much as 40%. In Latin America, when instrumenting democracy with autocratic regime dummy variables, we find a negative correlation between democracy and per capita income of about 13%. However, these results are not robust to changes in instruments. Similarly, table 9 presents the results for a sub sample of countries located in Asia, and find that the estimated coefficients are statistically indistinguishable from zero.

3.4.1 Non-Linear Relationship Between Democracy and Economic Activity

While these past results are estimating the impact of democracy on per capita income linearly, there is a growing literature measuring the potential non-linear relationship between the two variables. Papers by Barro (1996), Comeau (2003), and Plümper and Martin (2003) provide evidence that 'moderate' levels of democracy is optimal, as there is a trade off between rent seeking governmental institutions and public support of redistribution. They argue that transitioning away from an autocratic ruler, where the head of state use rent seeking behaviour as its primary method to achieve political power, will surely induce economic activity. However, they argue that in a pure democracy, there may be an incentive for the government to over invest in the provision of public goods, which may hinder economic growth. To account for this non-linearity effect between democracy and income, tables 11 and 12 in the appendix represent simple OLS regressions of differing levels of democracy on per capita income. For instance, column (1) in both tables divide the polity index into quintile binary variables, where the lowest 20% in the polity are excluded. Column (2) implements the the three-part political categorization defined by the Polity IV project. The categorizations are autocracies, anocracies, or democracies. To stay consistent with the previous column, the autocratic category will be excluded. Finally, for comparison purposes, column (3) is the country fixed effects estimate, free of control variables, to capture the correlation between democracy and per capita income.

Table 11 captures a non-linear relationship, but it may not necessarily support a strict inverse U-shape relationship. By dividing the polity index into quintiles, our results suggest that countries who transition towards a more moderate level of democracy (level of polity between .4 and .6), or a high functioning democracy (a normalized polity level between .8 and 1), are associated with a reduction in real gdp per capita as high as 18% to as low as 17% than an autocratic institution would have otherwise. These results are statistically significant at the 1% and 5% level, respectively. Furthermore, seen in column (2), we find that at moderate levels of democracy, anocratic regimes are correlated with 13% less real per capita income than its autocratic counterpart.

Table 12 has the same structure as the previous table, but now distinguishes the non linear effect by regions. Column (1) provides similar results in that moderate levels of democracies (normalized polity score between .4 and .6), on average are associated with a reduction of income levels in Asia and Africa by 14% and 28% less than countries within the same region with low levels of the polity scores. These results are both statistically significant at the 10% and 1% level, respectively. However, within Latin America, lower to moderate levels of democracy (normalized polity score between .2 and .4) are correlated with a 22% increase in real per capita income than autocratic countries within the same region. Within this region we find mild evidence to support the inverse U-shape relationship between democracy and economic activity.

3.4.2 Provision of Public Goods in a Democratic Regime

While these tables provide mild evidence of a nonlinear relationship between democracy and per capita income, we can further investigate the differences in public good expenditures between democratic and nondemocratic regimes. The idea is that in non-democracies where political influence is highly concentrated, the head of state has an incentive to transfer the public budget primarily to politically influential groups, whereas in a democracy, a large fraction of the population would be required to receive the direct transfer of the public good. In order for each citizen to receive a non-negligible benefit of the public good, there may be larger public budgets in democracies than autocracies. This is seen by Deacon (2009), where he concludes that democratic provisions exceed autocracies by about 25-50% for public goods in safe water, sanitation, and education. While past papers by Lott (1998) and Lake and Baum (2001) are in accordance with the results presented in Deacon (2009), it is only natural to investigate in our dataset whether more democratic regimes are investing heavily in pubic goods.

To test the relationship between public goods and democracy, we can use the following econometric model[11]

$$Public\ Good_{i,t} = \alpha + \beta Dem_{i,t} + \mathbf{X}'_{i,t}\mathbf{\Gamma} + \nu_i + \eta_t + \epsilon_{i,t} \tag{3.2}$$

Where the dependent variable $Public\ Good_{i,t}$ in our model will be tertiary educational attainment, gross domestic savings, infant mortality rate, and the unemployment rate for country i at time t. The independent variable $Dem_{i,t}$ will be measured as the normalized polity index score, the normalized freedom house index, and the democracy dummy

[11] This proposed model should not be interpreted as causal, but rather as a modified difference in means test.

variable. $\mathbf{X}'_{i,t}\Gamma$ is a set of control variables of the population (total population, the % of population over 65, and % of teen in population), whereas ν_i and η_t are country and time fixed effects, respectively. The results of the model are presented in table 3.4.

Table 3.4: OLS Estimates: Impact of Democracy on Public Goods

	(1) Savings	(2) School	(3) Mortality	(4) Unemployment
Panel A				
Polity	-2.612	4.528**	2.217	1.064
	(2.185)	(2.189)	(4.232)	(0.895)
Observations	728	728	728	728
Panel B				
Freedom House	0.437	5.698***	2.729	0.322
	(2.106)	(1.670)	(3.368)	(0.684)
Observations	709	709	709	709
Panel C				
Dem	-0.691	3.440**	2.033	0.387
	(1.363)	(1.314)	(2.520)	(0.465)
Observations	728	728	728	728
No. Countries	43	43	43	43
Controls	Yes	Yes	Yes	Yes
Country Effects	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes

Note: Robust standard errors clustered by country. Controls include only population variables (total population, population over 65, and teen population)
* $p < .10$, ** $p < .05$, *** $p < .01$

We should first note that the results presented in table 3.4 should not be interpreted as causal, but rather as a modified difference in means test. For example, regardless of the type of democratic measure we use, more democratic institutions are correlated with higher educational attainments of about 3.4% to 5.7% than its autocratic counterparts. Similar to a difference in means test, these results do not suggest that a democratic regime leads to higher levels of educational attainment, but rather we observe that democratic institutions have higher educational attainment. However, these results are consistent with Deacon (2009), where he finds that democratic countries are correlated with 5.6% higher level of educational attainment than non-democratic countries.

After controlling for time invariant country specific characteristics, while statistically insignificant, it appears that political institutions with more democratic features may be correlated with higher unemployment and mortality rates, while having lower domestic savings. Although our results indicate that a democracy have higher levels of educational attainment, this section provides anecdotal evidence that democratic regimes may overinvest in public goods at the expense of other investments, which could possibly hinder per capita income in the short run.

3.5 Conclusion

This paper attempts to measure the impact of democracy on economic growth by instrumenting democracy with different classifications of political regime types. By restricting our dataset to developing countries during a period of global democratic reform, our results indicate that in the short run, democratic regimes from Asia, Latin America, and Africa, are on average, associated with lower per capita income of roughly a 10% to 12%. These results are robust across several specification models and subsets of the dataset. Further analysis indicates that democratic regimes tend to have higher levels of educational attainment. These results provide anecdotal evidence that developing economies may be heavily investing in public goods (at perhaps the expense of more favourable social choices) in the short run. However, as this paper is centered on a subset of developing countries with typically weak institutional properties during a specific time period of global democratic reform, the results from this section do not imply that a democratic process is harmful to growth, but rather the short run implications of transitioning towards a democracy may cause unintended consequences that hinder economic activity. For example, it may be that developing countries will reap the benefits of the investment in human capital in the long run rather than in the short run.

Chapter 4

Attracting FDI in the Presence of Political Uncertainty: A Real Options Analysis

4.1 Introduction

The World Bank defines a foreign direct investment (FDI) as a capital investment to acquire a long lasting management interest in a company operating in an economy other than that of the investor. The growth of such FDI activities by multinational firms has led to a recent revival of interest in the locational choices firms face when investing abroad. More so, government institutions are aggressively competing to attract foreign capital in hopes to stimulate the local economy. The benefits of job creation, technological innovation, and arguably economic growth, are salient FDI features that policy makers consider when crafting policies to attract foreign investment. For instance, Airbus, a prominent airline manufacturer based in France, announced on July 2nd 2012 that they plan to invest $600 million to build and equip a new assembly line in Mobile, Alabama. This new plant, to be constructed in 2015, would not only create thousands of new jobs in Alabama, but would also allow for Airbus to compete directly against Boeing to service the US market. The state of Alabama would in turn provide an array of benefits to Airbus, including but not limited to, tax breaks and job training.

There are numerous factors which will impact a firm's decision to undertake FDI. Generous government incentives are clearly an important factor, but, in addition, cost differences due to differences in input costs, corporate tax rates, and other costs of doing business may play an important role in determining a suitable location for a FDI. Furthermore, the political climate of the prospective host for FDI is also a consideration, with some nations being unattractive hosts due to the potential risk of expropriation or social instability. However, some nations with high political instability provide generous financial incentives to combat this additional risk. For instance, Iran, during a period of political unrest, has set aside funds exclusively to aid foreign firms to invest into the region. Despite their current international sanctions, in February of 2013, the sovereign wealth fund (SWF) announced that more than $20 billion worth of funds will be allocated to selected foreign projects to spur economic growth. These funds are set aside to provide financial benefits ranging from loans at favourable rates, to subsidizing future infrastructure within Iran. Moreover, the proactive approach from the Iranian government to attract FDI has allowed for Iran to be less dependent on the oil and mining industries and focus more on the manufacturing and agricultural sectors, where the SWF would help support projects.

The Ecuadorean president Rafael Correa has also taken a similar stance to that of Iran in attracting FDI. Re-elected to office in February of 2013, President Correa has sought provisions to mining laws that would make FDI more attractive to firms in the mining sector. These changes in policies are occurring during a period where foreign investors are in fear of nationalistic motives, which might result in future expropriations.

These recent events provide evidence of initiatives from prospective host countries to attract multinational firms. However, the importance of institutional quality and political stability of a host country also plays a crucial role when attracting foreign investors. The highly cited work of Busse and Hefeker (2007) explore how the many facets of political uncertainty impact aggregate foreign inflows. Specifically, using a cross-country empirical model, which spans over twenty years, they find that government stability, enforcement of contracts, and the absence of internal conflict are strong determinants in attracting FDI. While other related papers by Aizenman and Marion (2004) and Jinjarak (2007) provide empirical support for the importance of sovereign risk when attracting various modes of FDI, very little attention has been given to government proposals that attract FDI in an attempt to combat this risk. While recent papers by Chen and Funke (2011) and Corato (2013) have proposed real option models to quantify how sensitive firms are to institutional uncertainty and potential nationalisation risk, Danielova and Sarkar (2011) and Sarkar (2012) are the first papers to address potential government incentive packages in a real options setting to attract FDI. There has yet, to my knowledge, been no research that addresses these two issues contemporaneously; that is, examining how political risk impacts FDI and government subsidies, from the perspective of both the firm and the host country.

This paper contributes to the literature by examining the dynamic decision when considering FDI, where the multinational firm takes into account the uncertainties related to costs and the political climate of the prospective host country, which are crucial in many FDI decisions. More importantly, this paper makes a contribution to the growing literature on *vertical* FDI, where there exists a gap in understanding the determinants of the vertical investment[1]. Due to the rising integration of global markets through trade, there has been an associated rise in the trade of intermediate goods. Supply chains of multinational firms are now spanning globally. For firms that seek to internalize their cross-border production[2], there is a growing need to understand the impact of institutional uncertainty in the prospective host country on the decision for multinational firms to invest internationally. This paper therefore considers the impact of FDI from both the perspective of the firm and the perspective of the potential host country.

I first begin the analysis by considering the optimal actions of the firm under various assumptions about the nature of costs and political uncertainty. Similar to Chen and Funke (2011), I will be applying a real options model to capture the optimal timing of a vertical FDI. The vertical FDI will be driven by uncertain cost differentials between the home and foreign country, while also considering the political climate of the foreign country. However, unlike Chen and Funke (2011), I also incorporate the issue of international transfer pricing decisions unique to multinational firms.

Transfer pricing, defined as the internal value placed on goods or services that flow between related entities *across* borders, plays a crucial role for firms to strategically minimize their tax liability and manipulate its total profits.[3] As firms have strong incentives to minimize their tax liability, when there are no restrictions to transfer pricing methods, or no authorities that can effectively enforce appropriate transfer pricing methods, transfer pricing becomes a mechanism for pure tax evasion. This behaviour in turn reduces the tax

[1]FDI can be broadly be categorized as either a 'horizontal' or 'vertical' investment. A vertical foreign investment is defined as a resource seeking investment that is driven by differences in factor costs, whereas a horizontal FDI seeks new markets to replicate certain production processes. While the literature related to horizontal FDI is vast, very little work has focused on the determinants of vertical FDI.

[2]Dunning et al. (1976) define the 'OLI' paradigm in a FDI framework. They discuss the three general advantages of FDI: ownership, location, and internalization

[3]For example, if the corporate tax rate in the foreign country is less than the corporate tax rate from the home country, the multinational firm has an incentive to sell goods produced within the foreign country to the home country at a higher price to repatriate profits to the foreign country to reduce the overall tax burden.

base of high tax countries.

To help reduce profit-shifting behaviour from multinational firms, the OECD has published a set of guidelines to help tax authorities and multinationals alike to reach a mutually satisfactory agreement.(OECD (2001)). The basic idea of the guidelines is to ensure the transfer price is in accordance with the notion of an *arm's length price*, which is defined as the 'price two unrelated parties would reach under a competitive environment'. As governments have given authorization for tax authorities to interfere with business operations by adjusting aggressive transfer prices,[4] which would then increase the cost of doing business, this model also incorporates this additional cost imposed to the firm from the home countries tax authorities. Therefore, this paper now incorporates the impact of FDI from the perspective of the firm, the host country, *and* the home country.

By developing a simple model of the firm's decision to pursue a vertical FDI, I assume that the firm can reasonably forecast the costs in the home country, while the costs in the prospective host country follows a simple process of geometric brownian motion (GBM). This base case analysis provides a threshold cost level that can be derived analytically, at which it is optimal for the firm to switch production from the home to the host country through FDI.

The motive for the firm to switch production from the home to the host country is a critically important assumption, as we assume that the benefits for internalizing production through FDI outweighs the efficiency gains through outsourcing. This assumption is based on the seminal work of Grossman and Helpman (2003). They find that while international outsourcing is a cheaper mode of production, the contractual obligations of the supplier through incomplete contracts may cause frictions in the relationship between the supplier and the firm. Therefore, the cost of contractual incompleteness outweighs the benefits of outsourcing, which would then lead to firms to internalize its production through FDI[5].

In order to explore the impact of political instability, I extend the analysis where the cost function in the prospective host country may change abruptly. This may represent sudden changes to the business environment that positively or negatively affect the cost of doing business in the foreign country. This basic extension would be modelled through a jump-diffusion process. In this model I also derive the new threshold cost level that allows for the firm to switch production towards the host country, while also determining

[4] OECD (2001)

[5] Antràs (2003) and Ottaviano and Turrini (2007) further provide an excellent theoretical overview of the relative profitability of FDI versus international outsourcing

an incentive package the government can provide to the firm to help reduce this potential risk and invest immediately into the host country.

To further generalize the risk of political instability, rather than assuming that the cost structure may change unexpectedly, it may be the case that changes in the political climate fluctuates over a good and bad state. For instance, suppose rare events such as spikes in the crime rate, political corruption, or an up rise of a military coup suddenly occur, this state would represent the regime with a high cost structure. Similarly, suppose there is a change in the head of state where sudden positive reforms are enacted, this may in fact decrease the costs to the firm. If these two types of states occur randomly over time, while also reasonably expecting that these states may change randomly, then this dynamic cost structure can be captured through a regime switching model. However, due to the highly complex nature of the regime-switching model, I numerically solve for the conditional threshold cost that allows for firms to optimally switch production from the home to the host country[6]

As a preview to my results, I first calculate the optimal transfer price that maximizes profits across jurisdictions. I find that the optimal transfer price is only a function of the home and host corporate tax rates and completely independent of the costs and political environment of the host country. Also, given the set of assumptions, I also find that firms are more sensitive to political instability relative to the GBM case, where the model suggests that foreign government agencies are more likely to allocate larger subsidies and tax credits to attract foreign investors. These results are presented numerically in section 4.4.2. The results presented from this section may lend support to the recent proactive approach of the Iranian and Ecuadorian governments.

The rest of the paper is organized as followed. I first review the relevant literature related to this paper. This primarily includes results from topics in vertical FDI determinants, optimal investment subsidies, and FDI decisions under uncertainty. I then derive analytical results when political risk is absent. This includes deriving the firm profit function, its optimal investment policy, and the governments subsidy policies that ensures immediate investment. I similarly present results when the prospective host country faces various types of political instability, which is modelled by both a jump-diffusion and regime-switching model, respectively. Through numerical examples, the model suggests that host

[6]While the regime-switching model is a generalized version of the jump diffusion model, the regime switching model can only be solved numerically, which creates difficulties when comparing results to the base case GBM model that is solved analytically. As the jump diffusion model has an analytical solution, it is therefore advantageous to incorporate the results into our analysis

countries are more likely to provide generous investment subsidies to multinational firms in the presence of additional country risk.

4.2 Literature Review

4.2.1 Evidence Regarding the Importance of vertical FDI

The motivation for a vertical FDI was first described by Helpman (1984). He constructed a general equilibrium model in which the locational choices of firms are associated with cross country differences in relative factor endowments. This seminal paper argues that multinational firms emerge as a result of differences in input costs, where the primary motive for firms to relocate is to minimize costs. However, subsequent theoretical work by Horstmann and Markusen (1987), Horstmann and Markusen (1992), and Markusen and Venables (1998) emphasize horizontal investments, as empirical firm level analysis provides very little support for vertical investments. Such empirical papers that support horizontal investments are Brainard (1993), Ekholm (1998), and Carr et al. (2001). These papers have all the same premise: multinational activities are concentrated among nations that are similar in size and relative endowments.

However, building on the foundations of Helpman (1984), Markusen et al. (1996) and Markusen (1997) provide a more general theoretical framework, where country specific factor endowments predict where vertical or horizontal investments are more likely to occur. For instance, the model predicts that multinational firms are to relocate production of R&D activities where high skilled labor is cheap while relocating manufacturing facilities where unskilled labor is cheap. This theory explains the emergence of foreign subsidiaries as a function of the characteristics of both the host and home country. Yeaple (2003a) further examined the complex strategies that arise for multinational firms when examining potential host countries. His model predicts that a reduction in transport costs among countries may increase the vertical or horizontal investments in prospective countries. While the theoretical model by Yeaple (2003a) only took into account one country as a prospective host for FDI, Grossman et al. (2006) provides a general framework when the firms faces a wide variety of potential hosts for FDI. The advancement in the theory of the multinational firm has led to a growing literature that empirically tests these ideas. Carr et al. (2001) was the first to empirically test the theory of Markusen et al. (1996) and Markusen (1997). Carr et al. (2001) found evidence for vertical integration, which had otherwise been largely neglected in past empirical papers.

Yeaple (2003b) further found strong empirical evidence for vertical FDI. Yeaple (2003b) argues that the econometric framework in past studies failed to properly capture differences in factor intensities as determinants for production plants. More recent papers by Alfaro and Charlton (2007) and Davies (2008) further support these claims.

With recent evidence suggesting the importance of this type of investment, there is now a growing field within the FDI literature focusing on the type of factor endowments which are important for vertical FDI. Braconier et al. (2005) explicitly model the effects of differentials in labor costs as a fundamental determinant of vertical FDI. Braconier et al. (2005) show that the volume of sales from multinationals is driven by the wage costs from the host country. Recent papers by Bellak et al. (2008) , Fukao and Wei (2008) , and Braunerhjelm and Thulin (2009) further contribute to the literature that labor costs play a significant role in locational choices of multinationals. However, in spite of the strong recent empirical support indicating the role of vertical FDI for multinational firms, very little research has examined the determinants of vertical FDI, and more importantly, the impact political risk may have on vertical FDI. Aizenman and Marion (2004) found that bureaucratic quality, investment risk, and the strength of the legal system are important determinants in attracting horizontal and vertical investments. In addition, Jinjarak (2007) found that both types of FDI are equally sensitive to countries with low institutional qualities.

While these aforementioned papers provide evidence about institutional uncertainty and vertical FDI, these studies do not address the decision rule that multinational firms face when seeking potential host countries for FDI. Specifically, it does not capture the dynamic decision of the firm when evaluating specific uncertainties that could impact the value of the FDI opportunity. It is in this instance where a real options approach to vertical FDI can contribute to this growing literature.

4.2.2 Optimal Decision Making for FDI Under Uncertainty

The decision to undertake FDI fits well in the real options framework. The FDI decision usually entails a relatively large investment, which is at least partially irreversible. Moreover, the imperfect information regarding foreign markets creates a high level of uncertainty as to when to proceed with an FDI. Specifically, current market conditions, national regulations, and the political climate of foreign countries create much uncertainty as to the profitability of a FDI. Furthermore, the firm views FDI as an opportunity with a relatively flexible time schedule as to when to undertake a FDI. It is clear that the dynamic decision the firm's face to pursue a FDI coincide with the stylized features of a real options model. Therefore, the papers presented in this section focus on the *optimal timing* to pursue a project.

The work of McDonald and Siegel (1986) provides the foundation for modelling the value of a FDI opportunity. They proposed a real options model where both the project and the investment cost are stochastic, where they then determine an optimal investment rule to exercise the option to proceed with the FDI. However, additional complexities arise when considering a cross-border investment, mainly the addition of foreign country risk.

Capel (1992) first tackled this idea by proposing a real options model on how to optimally service a foreign market (through FDI). Her model first analysed adjustment costs from switching between home and foreign production, with the cost savings as stochastic. She further assumed that the drift component of the stochastic process would reasonably reflect market growth and potential real exchange rate depreciation. She determined optimal timing barriers to switch between home and foreign production. She then extends her model to add real exchange rate uncertainty. With the added complexity, she then solves this model using stochastic dynamic programming assuming both market and real exchange rate uncertainty follow a binomial distribution. While Capel (1992) focuses on FDI of the 'horizontal' type, this paper provides intuition regarding the motivation for firms to optimally service new markets.

Ewald and Wang (2010) explore the uncertainty of horizontal foreign investments associated with currency risk. They modelled the exchange rate between home and host country through a mean reversion continuous time process where the value of the option is fixed (in terms of the foreign currency). This technical paper analyses the price sensitivity of the FDI option by assuming other functional forms of the stochastic process which describes the uncertainty associated with the FDI. Through simulations, Ewald and Wang (2010) show that a misspecified real options model can severely bias the value of the foreign investment when exposed to currency risk.

While these past papers focus on the value to pursue a horizontal FDI by modelling uncertainty through a real options setting, there has been very little research that explores the political uncertainties associated with FDI, or more importantly, how political uncertainties impact the opportunity to pursue a vertical FDI. Chen and Funke (2011) are the first to address this issue, where the potential host country faces positive or negative shocks to productivity. These productivity shocks are captured through jump processes that measure institutional risk. While this paper lays a strong foundation on how to capture institutional risk in a real options setting, my paper takes a completely different approach, where the motivation for firms to pursue a vertical FDI are due to differential in costs between home and host country. Furthermore, this paper also explores various incentive packages that government agencies can offer to ensure immediate inflow of foreign capital. The methods to model government subsidies follow Sarkar (2012), where he constructs subsidies that are large enough to ensure immediate investment. Unlike Sarkar (2012), I will be focusing on incentive packages that could be used to combat political risk, whereas Sarkar (2012) focused on incentive packages for an investment where the profitability follows a standard GBM.

This paper further captures political instability both through a jump-diffusion and a regime switching model. Similar to Chen and Funke (2011), I will assume that there may be abrupt changes to the business environment that create either upward or downward jumps in costs. For example, it may be that sudden spikes in crime, either through bribes or extortion, cause an immediate rise in costs. This level of uncertainty may increase the incidence of abrupt intervention of government officials that coercively enforce the rule of law, which may suddenly cause a temporary downward jump in costs.

Alternatively, the dynamic cost structure may also be similarly captured through a regime-switching process. It may be the case that changes in the political head of states are causing internal conflicts to arise in the foreign country. Internal conflicts may lead to a rise in the costs of production through production delays, a rigid labour supply, or additional costs associated with private property right protection. Periods of political unrest followed by periods of political stability can be reasonably modelled through a regime-switching model. Therefore, this paper captures different types of institutional risk by modelling costs through either a jump diffusion model or a regime switching model.

In the following section, we discuss a subset of real option papers that have modelled either profitability or firm uncertainty through a regime-switching model.

Regime-Switching Uncertainty

Several papers examine the impact of switching between uncertain economic regimes on optimal investment timing. For example, the work of Driffill et al. (2003) show the importance of detecting periods of economic booms and busts on the profitability of a firm. Driffill et al. (2003) present the dynamics of a business cycle as a two state Markov process to study the entry and exit decisions of firms. They then calibrate the model to industry data of US and UK firms to show the importance of business cycle conditions on the decision to either enter or exit the market. They find that firms are more likely to engage in new activities during an economic boom, while reducing their business activities during a recession. Guo et al. (2005) expands this model by solving a model of irreversible investment with regime shifts. In this paper, the regime shifts reflect the dynamics of a business cycle, with periods of prosperity (high cash flow) and decline (low business cash flow). Given these differing states, they propose an investment policy that maximizes the expected present value of profit, conditional on the probability of changes in regimes. The analysis of Guo et al. (2005) provides a thorough examination of the persistence of regimes on investment policies.

Regime-switching uncertainty is further investigated by Elliott et al. (2009), Nishide and Nomi (2009), and Hainaut (2012). Elliott et al. (2009) model the initial investment cost as a hidden Markov-chain process. Their results suggest that the optimal investment strategies derived ensure more value to the firm, as the critical threshold calculated to invest into the project increases the likelihood that the project will be exercised. Conversely, Nishide and Nomi (2009) derives the optimal investment decision when a regime change is expected at a predetermined future date, but there is uncertainty over what the new regime will be. This model provides an investment policy where the profits depend on changes to national policies that directly impact the firm investment. An example of this would be during a presidential election, when the election date is known in advance and specific economic policies are associated with each presidential candidate, where each economic policy has a different impact on the firms future cash flow.

Lastly, Hainaut (2012) propose a regime-switching model to plan entry and exit strategies for firms influenced by business cycles. He then incorporates the idea that once a firm decides to commit to the investment, there is still a delay between the initial investment and expected future cash flow. Hainaut (2012) then calibrates the model with managerial decisions observed from the health industry.

While these past papers provide intuition on how firms may react when confronted with various types of regime-switching uncertainty, there is yet to my knowledge, research that explores the type of investment policies foreign governments can implement to attract investors that face this type of risk. While Pennings (2000), Pennings (2005), and more recently, Sarkar (2012), have focused on infrastructure and/or corporate taxation subsidies in a real options setting, this paper aims to contribute to the FDI literature by filling the gap between current FDI foreign policy that is attempting to combat country risk, and optimal investment behaviour by firms.

4.3 Model Specification

4.3.1 Assumptions

Consider a multinational firm that intends to expand internationally. Specifically, the multinational is considering a vertical FDI, where they are seeking to relocate their production facility to a country that can produce an intermediate good at the lowest cost. The new manufacturing plant will produce this intermediate good that is an input to the production of the final good in the home country. For simplicity, I assume that there is no demand for this intermediate good in the prospective host country, and that all intermediate goods are exported back to the home country.

As is the case in a vertical FDI, the firm is driven by differences in factor endowments between countries. As the firm may anticipate that cross country differences in factor costs may be quite substantial, the firm is seeking to minimize its per unit variable cost of production by seeking a potential host of vertical FDI. I define C_F^m as the per unit variable cost of the intermediate good produced in the mth foreign country, where $m = 1, ...M$. I further assume that the dynamics of the per unit variable cost of the potential M host countries take the following form:

$$\frac{dC_F^m}{C_F^m} = \alpha_F^m dt + \sigma_F^m dZ_F \tag{4.1}$$

where α_F^m denotes the instantaneous expected percentage change in C_F^m per unit time. The volatility parameter σ_F^m represent shocks that directly affect the production of the intermediate good. This can be viewed as the various shocks to input production capacity that allow for the variable cost to vary over time. These shocks may range from labour supply shocks and unanticipated capital equipment adjustments or failures, to country risk factors. Z_t is the standard Brownian motion term where $E(dZ_F) = 0$, $E(dZ_F^2 = dt)$. Furthermore, as the fluctuations in variable cost are caused by variation in either the labor or rental cost of capital, I can reasonably assume that the same dynamics would affect the cost of the initial investment. For simplicity, I define the initial *per unit of output* fixed investment cost into country m as a proportion of the variable cost as $\kappa_m C_F^m$ for $\kappa_m \gg 1$.

The domestic variable cost of the firm follows a more predictive pattern. For simplicity, I assume that the firm can reasonably forecast its domestic variable cost so that the dynamics of the differential in costs between home and host countries are driven only by the uncertainty of the host country. This assumption allows us to analyse both the decision behaviour of the firm while also analysing the response function of foreign government officials in the presence of its country risk. Therefore, the per unit variable cost in the domestic setting takes the following form:

$$\frac{dC_H}{C_H} = \alpha_H dt \tag{4.2}$$

Where α_H is the expected percentage change in the variable cost for domestic production. Thus, for a any given time period, the firm can estimate its future per unit variable cost as $C_{t,H} = C_{0,H}e^{\alpha_H t}$, and calculate the present per unit variable cost as $\int_t^\infty C_{t,H}e^{-(r-\alpha_H)(s-t)}\,\mathrm{ds}$, discounted at the risk-free rate r. Similarly, the discounted per unit variable cost when production of the intermediate good occurs abroad can be represented as $E\left[\int_t^\infty C_{t,F}e^{-(\mu-\alpha_F)(s-t)}\,\mathrm{ds}\right]$, discounted at some risk adjusted rate μ. Therefore, the firm has the option where if exercised, the expected payoff would be the after tax incremental profit (loss) generated by the differential in its cost expenditure. By calculating the present value of the per unit variable cost of production for both the home and the target country, the expected incremental profit (loss) of the FDI can be expressed as follows:

$$F(C_H, C_F^m) = (1-\tau_H)\left[\frac{C_H}{r-\alpha_H} - \frac{C_F^m}{\mu-\alpha_F^m}\right] - \kappa_m C_F^m \tag{4.3}$$

Where $F(C_H, C_F^m)$ is the expected payoff of the FDI in the *mth* country taxed at the domestic rate τ_H. However, as the firm is considering expanding across borders into country m, the payoff structure would need to incorporate transfer pricing techniques to ensure that it complies with international tax guidelines (such as those presented by the OECD).

As firms have an incentive to shift profits or income between countries to reduce its tax expenditure,[7] I address this behaviour by modelling the transfer price, P_m^T, as a function of the tax rates of both the home and host country.

Specifically, the transfer price method applied will simply be a *markup* to the cost of the intermediate good, where the markup itself will be a function of the tax rates of the

[7] As a numerical example, suppose the firm can costlessly produce a final good in the foreign country where the corporate tax rate in the home and foreign country are $\tau_H = 30\%$ and $\tau_F^m = 10\%$, respectively. Further suppose that the global price of the final good is \$1. The firm has an incentive to sell the good from its foreign production plant to the home plant at a price greater than the cost (of zero) so as to shift the tax expenditure from the home to the foreign country. Therefore, if the foreign plant sells the final good to the home plant for \$1, the firm would only paying \$.10 in taxes in the foreign country and \$0 in the home country. Had the internal price been the true production cost of zero, the multinational firm would have paid \$.30 in taxes in the home country and \$0 in the foreign country.

home and host country. According to the OECD, the most appropriate transfer pricing method for a tangible property transaction between related companies is the Cost Plus (CP) method (OECD (2001)). The CP method is defined as the markup added to the cost incurred by the supplier of the tangible property, where the appropriate profit reflects the function performed, risks assumed, assets used, and the market conditions. Therefore, for simplicity, the markup in this paper will reflect the market conditions of the host country (foreign tax rate) and the home tax rate (to reflect the behaviour of firms to shift profits across jurisdictions).

For simplicity, if we assume that the foreign corporate tax rate is less than the home countries tax rate[8], so that $\tau_H > \tau_F^m > 0$, the transfer price of the intermediate good flowing from country m to the home country can be modelled as:

$$P_m^T = \varphi C_F^m \tag{4.4}$$

where φ, the markup, can be expressed as:

$$\varphi = \frac{\tau_H}{\tau_F^m}\varsigma \tag{4.5}$$

for some exogenously parameter ς. As the home and foreign tax rates are given, this model allows the firm the flexibility in pursuing an aggressive transfer price (through larger values in ς) to minimize its tax liability.

However, from the perspective of the home country, for a relatively high domestic tax rate, the profit shifting behaviour from firms reduce the tax base of the home country. As tax authorities have authorization to interfere with business operations that implement aggressive transfer prices,[9] the tax authorities have the power to adjust the intra-company transfer price to recover some of its loss tax revenue. This adjustment imposed by the domestic tax authorities increases the cost of doing business for the firm. To incorporate this additional business cost, suppose the firm is costlessly being audited continuously by

[8] This assumption can be relaxed so that τ_H and τ_F^m are simply greater than zero. However, for the case that $\tau_F^m > \tau_H$, the firms optimal markup would be *negative*, or more formally, $\varsigma^* < 1$. This implies that the multinational firm would sell the intermediate good back to the home country at *less* than the production cost so as to minimize its total tax liability. This would be a cause for concern as the foreign corporate tax base is now reduced. We would therefore need to incorporate the foreign tax authorities into the model to address this issue. This additional complexity provides a very marginal contribution to the model

[9] OECD (2001)

the home government. Furthermore, suppose that the home government can impose a tax penalty on the multinational firm if the multinational sells the intermediate good at any value higher than the actual cost to produce the good in the foreign country.[10] Specifically, assume that the size of the penalty is proportional to the size of the mark up cost, so that more aggressive transfer prices are associated with larger penalties.[11]

Therefore, the home government imposes a penalty of size $\frac{(P_m^T - C_F^m)^2}{\mu - \alpha_F^m}$, which is the present value of the *per unit* cost of the penalty. This penalty captures the behaviour of the tax authority, where larger transfer prices are punished more fiercely. The firms expected payoff function represented in (4.3) now transforms to:

$$F(C_H, C_F^m) = (1 - \tau_H)\left[\frac{C_H}{r - \alpha_H} - \frac{P_m^T}{\mu - \alpha_F^m}\right] + (1 - \tau_F^m)\left[\frac{P_m^T - C_F^m}{\mu - \alpha_F^m}\right] - \left[\kappa_m C_F^m + \frac{(P_m^T - C_F^m)^2}{\mu - \alpha_F^m}\right] \tag{4.6}$$

Where τ_F^m is the foreign corporate tax rate for country m. Therefore, the per unit after tax profit from the vertical FDI is comprised of four components. The first component is the present value of the *incremental* after tax profit due to the differences between the domestic cost of production and the transfer price of the intermediate good. The second component measures the after tax profitability in country m due to the differential in the per unit variable cost and the intra-company transfer price. Or more formally, the after tax profit that can be generated when selling the intermediate good back to the parent company at a different price than what it cost to produce. The third component is simply the initial per unit fixed investment cost when entering country m, while the final component is the financial penalty imposed from the home government to the firm due to any differences between the cost of producing the good and the transfer price of the good.

Interestingly, given that ς affects the total after tax profitability of the firm while also impacting the magnitude of the tax penalty imposed by the home government agency, the firm can optimally choose ς^* so as to maximize total profits. By maximizing equation 4.6 with respect to ς, we get $\varsigma^* = \left[\frac{\tau_H - \tau_F}{2} + 1\right]\frac{\tau_F}{\tau_H}$. Therefore, we see that ς^* is completely independent of the cost uncertainties associated with country m[12].

[10] For instance, if the corporate tax rate in home country is 30% and the foreign tax rate is 10%, for $\varsigma > 1/3$, will result in a penalty.

[11] This is consistent with the behaviour of tax authorities, where firms with slightly higher transfer prices than what is deemed reasonable only receive an adjustment to pay additional taxes, whereas an unreasonably high transfer price will lead to court proceedings.

[12] However, if the home government decides to impose a penalty of magnitude $\tau_H(\varphi - 1)\, C_F^m / \mu - \alpha_F^m$, the

The following section will now examine the value of the vertical FDI opportunity from the perspective of both the firm and the host country. Specifically, I first examine the firm's optimal investment strategy to enter the host country, where then the foreign government can credibly provide an incentive package (either through an investment subsidy or corporate tax credits) to ensure immediate investment from the multinational.

4.3.2 Single Regime

Value of the FDI Project

As the expected value of the vertical FDI into country m is a function of the dynamic cost structure in both the home and host country, vertical FDI can be appealing if the the costs in country m are relatively low or if the domestic costs are relatively high. The decision to undertake an FDI would then depend on the ratio between the two costs.

Therefore, by defining $C_m = {}^{C_H}/_{C_F^m}$ as the cost ratio between home and host country m, then the value of the FDI option can be rewritten as $f(C_m) = F\frac{1}{C_F^m}(C_H, C_F^m)$. Therefore, by defining the value of the FDI option as $f(C_m)$, which is now a function of the cost ratio between home and host country, then through standard contingent claims analysis and successive differentiation, the option value must satisfy the following equation[13].

$$\frac{\sigma_F^2 C_m^2}{2} f_{C_m C_m} + (\delta_F - \delta_H)\, C_m f_{C_m} - \delta_F f = 0 \qquad C_m < C_m^* \quad (4.7a)$$

$$f(C_m) = (1-\tau_H)\left[\frac{C_m}{\delta_H} - \frac{\varphi}{\delta_F}\right] + (1-\tau_F)\left[\frac{(\varphi-1)}{\delta_F}\right] - \kappa_m - \frac{(\varphi-1)^2}{\delta_F} \qquad C_m > C_m^* \quad (4.7b)$$

Where C_m^* is the threshold investment ratio trigger rate[14], σ_F is the volatility rate of the asset that spans C_F, and δ is the convenience yield, which represents the additional cost savings (or revenue generated) accrued to the holder of the FDI but not the holder of

exact tax revenue lost due to the intra-company mark up cost, the government would always collect tax revenues equal to $\tau_H\left(\frac{C_H}{r-\alpha_H} - \frac{C_F^m}{\mu-\alpha_F^m}\right)$. The firms total tax expenditure would then be the domestic tax expenditure seen in equation 4.3 *in addition to* the taxes paid in the foreign country. In fact, for values where $\varsigma > {}^{\tau_F}/_{\tau_H}$, the tax incidences of the multinational firm is increasing. Therefore, if the government introduces this type of penalty, the firm would optimally minimize tax expenditure with $\varsigma^* = {}^{\tau_F}/_{\tau_H}$ which equates $\varphi = 1$, and the payoff function transforms to equation 4.3.

[13]The derivation of a similar problem to equation 4.7a can be found on page 210 in Dixit (1994)

[14]If the ratio between costs is above this ratio, it is optimal to exercise this option and invest into country m

the option of the FDI. δ_F (δ_H) is measured as the difference between μ (r), the expected rate of return from holding the asset (or portfolio of assets) that spans C_F (C_H), and α_F (α_H), the expected percentage rate of change of C_F (C_H), ie. $\delta_F = \mu - \alpha$ and $\delta_F = r - \alpha$. For a solution to hold, I need $\delta > 0$, or the firm would never exercise their option to invest internationally.[15]

In the event that there are no assets or portfolios of assets that are perfectly correlated with C_F^m, this problem can be resolved alternatively through the use of dynamic programming. The dynamic programming approach is formulated as an optimal stopping problem, where the firm has the option in each period to either invest immediately into the foreign country or delay production until the following period. This optimal stopping decision can be modelled through a Hamilton-Jacobi Bellman equation. The appendix provides a thorough examination where under certain conditions, the contingent claims and the dynamic programming approach provide the same analytical solution.

For the remainder of this section, for continuity and consistency purposes, unless otherwise stated, I will assume that the markets are sufficiently complete, and there exists assets or a portfolio of assets which are perfectly correlated with the dynamics of C_m.

Solution for Optimal Investment

For the ODE derived through contingent claims analysis, the general solution to 4.7a is now:

$$f(C_m) = \Omega_1 C_m^{\lambda_1} + \Omega_2 C_m^{\lambda_2} \tag{4.8}$$

Where Ω_1 and Ω_2 are constants yet to be determined and λ_1 and λ_2 are the roots to the following fundamental quadratic equation:

$$\frac{1}{2}\sigma_F^2 \lambda(\lambda - 1) + (\delta_F - \delta_H)\lambda - \delta_F = 0 \tag{4.9}$$

The value of the option must satisfy the following three conditions:

$$f(C_m)_{C^m \to 0} = 0 \tag{4.10a}$$

[15] δ can also be viewed as the opportunity cost of delaying the FDI; That is, the additional flow of savings if the firm were to relocate.

$$f(C_m^*) = (1 - \tau_H)\left[\frac{C_m^*}{\delta_H} - \frac{\varphi}{\delta_F}\right] + (1 - \tau_F)\,\frac{\varphi - 1}{\delta_F} - \kappa_m - \frac{(\varphi - 1)^2}{\delta_F^m} \tag{4.10b}$$

$$\frac{\partial f}{\partial C_m^*} = \frac{1 - \tau_H}{\delta_H} \tag{4.10c}$$

Conditions 4.10b and 4.10c are referred to the value matching and smooth pasting conditions, respectively. Intuitively, condition 4.10a states that when the relative cost of producing the intermediate good in country m is sufficiently high, the value of the option to invest internationally becomes worthless. It is not in the firm's best interest to go ahead with the foreign investment when the costs in the foreign economy is significantly higher than its domestic variable costs.

Condition 4.10b simply states that upon exercising the option, the firm receives the payout presented in 4.6. In essence, the optimal time to exercise this option is only feasible when there is a notable difference in factor costs between home and host country, measured by the ratio C_m. The option would optimally be exercised only if the incremental profits generated from relocating the production facility and the local after tax profits are greater than both the per unit fixed investment cost and the financial penalty from the home regulatory agencies. Otherwise, the firm decides to hold off the project and wait.

Lastly, condition 4.10c states that the threshold C_m^* is optimally chosen so condition 4.10b holds. Condition 4.10a requires Ω_2 in equation 4.8 to be zero. Thus, using conditions 4.10b and 4.10c, the optimal ratio C_m^* is:[16]

$$C_m^* = \frac{\lambda_1}{\lambda_1 - 1}\left[\left(\kappa_m + \frac{(\varphi - 1)^2}{\delta_F^m}\right)\frac{\delta_H}{1 - \tau_H} + \frac{\delta_H}{\delta_F^m}\left(\frac{(1 - \tau_F) - \varphi(\tau_H - \tau_F)}{1 - \tau_H}\right)\right] \tag{4.11}$$

where the optimal cost ratio represented in 4.11 can be interpreted as a fraction of the fixed cost κ_m and the penalty cost projected by the home government, less the after tax present value of the incremental profit generated *in* country m, all as a proportion of the present value of the incremental after tax profits from the home production[17]. I can then write the value of the option as:

[16]The optimal cost ratio expressed in equation 4.11 follows the methods presented on page 210 in Dixit (1994)

[17]If the intra-company transaction price equates to the cost of producing the good in country m, we could use the payoff structure in equation 4.3 , and the optimal cost ratio strategy would simply be $\frac{\lambda_1}{\lambda_1 - 1}\left[\frac{1/\delta_F^m + \kappa_m}{1 - \tau_H/\delta_H}\right]$ Which is a simplified version of 4.11, where the optimal strategy is the ratio of the total per unit cost to the after tax profit of the project.

$$f(C_m^*) = \begin{cases} \left((1-\tau_H)\left[\frac{C_m}{\delta_H} - \frac{\varphi}{\delta_F}\right] + (1-\tau_F)\frac{\varphi-1}{\delta_F} - \kappa - \frac{(\varphi-1)^2}{\delta_F^m}\right)\left(\frac{C_m}{C_m^*}\right)^{\lambda_1} & if\ C_m < C_m^* \\ (1-\tau_H)\left[\frac{C_m}{\delta_H} - \frac{\varphi}{\delta_F}\right] + (1-\tau_F)\frac{\varphi-1}{\delta_F} - \kappa - \frac{(\varphi-1)^2}{\delta_F^m} & if\ C_m \geq C_m^* \end{cases}$$

Intuitively, the option to pursue a vertical FDI is optimally constructed so that there is a positive after tax profit on each intermediate good produced, where the after tax profits are shared between both home and host country. Given the results of pricing this FDI opportunity, the following section will focus on different types of incentive packages that government agencies can provide to ensure multinational firms invest immediately.

Government Incentives and Potential Subsidy Packages

From the perspective of the government agencies, they have a keen interest in attracting foreign investors by persuading firms with various forms of subsidies. While the government could possibly wait for the multinational firm to invest eventually, Sarkar (2012) suggests that government officials may want to attract foreign capital quickly due to the political costs of high unemployment, which can be reduced through job creation by the FDI. In addition to the benefits of job creation, technological spillovers and increased market competition, there are also financial benefits associated with the inflow of FDI, where the government can generate revenue through corporate taxation. Therefore, in addition to the non-pecuniary benefits of FDI, the expected present value of the per unit tax revenue generated by the FDI would be $\frac{\tau_F^m (P_m^T - C_F^m)}{\mu - \alpha_F^m}$.

However, to ensure immediate investment from the multinational firm, the government may need to offer an attractive financial incentive to ensure the firm's optimal action is immediate investment. One possibility is a subsidy for infrastructure and other capital costs[18]. However, this form of subsidy implicitly assumes that the government has full information on the firm's decision to invest abroad[19], where the multinational firm will credibly commit to its investment if the government can manipulate the firm's investment

[18]The Mercedes-Benz plant in Alabama was offered free land, while the Motorola plant in Quebec was offered heavily subsidized work space in 1999.

[19]As the foreign government can manipulate the firm's investment policy through subsidizing upfront capital costs, this form of subsidy further assumes that the government can credibly commit to these subsidies. While these assumptions may be restrictive, for simplicity purposes, it allows us to analytically solve the size of the investment that ensures immediate investment

policy such that $C_m = C_m^*$. Therefore, if κ_m^* is the proportion of the per unit fixed cost that equates the critical C_m^* with the current cost ratio C_m, then setting $C_m = C_m^*$ I have:

$$C_m = \frac{\lambda_1}{\lambda_1 - 1}\left[\left(\kappa_m^* + \frac{(\varphi-1)^2}{\delta_F^m}\right)\frac{\delta_H}{1-\tau_H} + \varphi\frac{\delta_H}{\delta_F} - \frac{1-\tau_F}{1-\tau_H}\frac{\delta_H}{\delta_F}(\varphi-1)\right] \tag{4.12}$$

By rearranging equation 4.12, the size of the per unit fixed investment cost which ensures immediate investment can be found as:

$$\kappa_m^* = \frac{1-\tau_H}{\delta_H}\left[C_m\frac{\lambda_1-1}{\lambda_1} + \frac{1-\tau_F}{1-\tau_H}\frac{\delta_H}{\delta_F}(\varphi-1) - \frac{\delta_H}{\delta_F}\varphi\right] - \frac{(\varphi-1)^2}{\delta_F^m} \tag{4.13}$$

As shown by Sarkar (2012), the size of the investment subsidy can be measured as the difference between κ_m and κ_m^*. Or, if I define the subsidy as a fraction of the initial per unit fixed investment cost, then I have:

$$s = 1 - \frac{1-\tau_H}{\kappa_m\delta_H}\left[C_m\frac{\lambda_1-1}{\lambda_1} + \frac{1-\tau_F}{1-\tau_H}\frac{\delta_H}{\delta_F}(\varphi-1) - \frac{\delta_H}{\delta_F}\varphi - \frac{(\varphi-1)^2}{\delta_F^m}\frac{\delta_H}{1-\tau_H}\right] \tag{4.14}$$

This form of cost subsidy can represent several types of funding that has been seen empirically. For instance, this subsidy can be in the form of favourable loan rates to the firm, land purchase assistance, or property tax abatements. All these types of government incentives reduce the final cost of relocating a production facility, which can be measured through subsidizing κ.

Tax credits are another popular policy used to attract foreign investment. There is a large literature related to the relationship between corporate tax rates and FDI[20]. However, the tax credits in this model have the same distinct features than that of the infrastructure subsidy, where the foreign government has access to full information on the firms decision to invest. Therefore, the size of the tax credits in this model is only a function of the optimal investment policy by the firm. We omit the possibility that the size of the tax credits can be influenced through foreign tax competition or other exogenous factors. While this

[20] Feld and Heckemeyer (2011) provide an overview on the numerous studies related to corporate taxation and FDI. Feld and Heckemeyer (2011) conduct a meta-analysis and through several robustness checks, conclude that tax rates play a predominant role for location decisions of FDI.

method to model tax credits is quite restrictive, it allows for direct comparability with the infrastructure subsidy to determine which mode is more effective in attracting FDI.

Therefore, similar to the cost subsidy, it is very straight forward to implement corporate tax credits in this model. Suppose τ_F^* is the foreign corporate tax rate that equates the firm's critical cost ratio, C_m^*, to the current cost ratio, the investment policy can be expressed as:

$$C_m = \frac{\lambda_1}{\lambda_1 - 1}\left[\left(\kappa_m + \frac{(\tau_H/\tau_F^*\varsigma)^2}{\delta_F^m}\right)\frac{\delta_H}{1-\tau_H} + \frac{\tau_H}{\tau_F^*}\varsigma\frac{\delta_H}{\delta_F} - \frac{1-\tau_F^*}{1-\tau_H}\frac{\delta_H}{\delta_F}\left(\frac{\tau_H}{\tau_F^*}\varsigma - 1\right)\right] \tag{4.15}$$

The foreign government can choose a level of corporate taxation τ_F such that $C_m^* = C_m$. By doing so, the foreign tax rate that ensures immediate investment from a multinational firm can be found by solving the following cubic function:

$$\tau^{*3}_F + \tau^{*2}_F\left[\left(C_m\frac{\lambda_1 - 1}{\lambda_1} - \kappa\frac{\delta_H}{1-\tau_H}\right)\frac{\delta_F(1-\tau_H)}{\delta_H} - \tau_H\varsigma - 2\right] + \tau_F^*\left[\tau_H\varsigma(2+\tau_H)\right] - \tau_H^2\varsigma^2 = 0 \tag{4.16}$$

The following section will now focus on the optimal investment policy of a multinational when facing institutional uncertainty. With the additional uncertainty, government agencies now need to be more aggressive in providing generous subsidies to ensure immediate investment from firms.

4.3.3 Institutional Uncertainty

The objective of this section is to determine how institutional uncertainty distorts the investment timing of the FDI, while also measuring the magnitude of the subsidies that are required to ensure that firms do not divest from countries with high levels of political uncertainty. In this section, we model institutional uncertainty through both positive and negative jumps in costs. This can be formally represented by:

$$\frac{dC_F^m}{C_F^m} = \alpha_F^m dt + \sigma_F^m dZ_F + (1+\phi_1)dq_1^m - (1-\phi_2)dq_2^m \tag{4.17}$$

Where dq_1^m and dq_2^m provide sudden jumps in the level of C_F^m. dq_1^m and dq_2^m follow a Poisson distribution with mean arrival rates of λ_1 and λ_2 and a fixed jump size equal to

ϕ_1 and ϕ_2, respectively. At each time interval dt, the cost function will increase (decrease) by $\phi_1 C_F^m$ ($\phi_2 C_F^m$) with probability $\lambda_1 dt$ ($\lambda_2 dt$). For simplicity, I assume that the all types of institutional uncertainty shocks are completely independent, so that $E(dZ_F, dq_1) = E(dZ_F, dq_2) = E(dq_1, dq_2) = 0$. This cost structure presented in equation 4.17 captures both the potential benefits and costs when investing into a unstable country. For instance, negative shocks that may lead to a sudden increase in the variable cost of producing the good in country m may include sudden increase in social or political unrest, corruption, or international trade shocks such as trade embargos or discontinuous changes in trade policies. Wei (2000) shows empirically the negative impact of institutional uncertainty on FDI inflows, where incidences in corruption are almost akin to an additional tax to foreign investors. Furthermore, the recent working paper of Bekaert et al. (2013) show how political risk of a host country reduces the net present value of FDI. Their new measure of political risk, derived from sovereign yield spreads, provide further evidence that political instability negatively affects the profitability of foreign investments. Therefore, it is not unreasonable to measure political risk, corruption, or more generally, institutional uncertainty as sudden jumps that increase costs and deter foreign investors. Conversely, sudden drops in the cost structure of the intermediate good may be a function of technological shocks which increases productivity, or perhaps provisions in statutes that benefit the multinational.

As is presented in Bekaert et al. (2013), I assume that all information related to the foreign cost structure is available to the firm, so that the firm can reasonably change its expectations on the present value of its per unit cost of producing the intermediate good in country m. Discounting future costs at the risk adjusted rate μ, the present value of a per unit variable cost can be represented by $\int_0^\infty E(dC_F^m)e^{-\mu t}\,\mathrm{d}t = C_F^m g_F$ for $g_F = \frac{1}{\mu - \alpha_f^m + \phi_2\lambda_2 - \phi_1\lambda_1}$. The expected payoff of a firm pursuing an FDI in a country with political instability can be modelled as:

$$F(C_H, C_F) = (1-\tau_H)\left[\frac{C_H}{\delta_H} - P_m^T g_F\right] + (1-\tau_F^m)\left[(P_m^T - C_F^m)g_F\right] - \kappa_m C_F^m - (P_m^T - C_F^m)^2 g_F \tag{4.18}$$

Similarly, to ensure that the value of the FDI option is homogeneous of the first degree in C_m, I can rewrite $F(C_H, C_F^m)$, the value of the FDI option, as $f(C_m) = F\frac{1}{C_F^m}(C_H, C_F^m)$. Through successive differentiation, the value of the FDI option must satisfy the following equation:[21]

$$\frac{\sigma_F^2 C_m^2}{2} f_{C_m C_m} + (\delta_F - \delta_H)\, C_m f_{C_m} + \lambda_1\left[f(1+\phi_1) - f\right] - \lambda_2\left[f - f(1-\phi_2)\right] - \delta_F f = 0 \qquad C_m < C_m^* \tag{4.19a}$$

[21] The derivation of equation 4.19a is located in the Appendix

$$f(C_m) = (1-\tau_H)\left[\frac{C_m}{\delta_H} - \varphi g_F\right] + (1-\tau_F)\left[(\varphi-1)g_F\right] - \kappa - (\varphi-1)^2 g_F \quad C_m > C_m^* \quad (4.19b)$$

Where $f = f(C_m)$. Similar to the previous section, the homogeneous part of the partial differential equation has a general solution of the form:

$$f(C_m) = \Omega_1 C_m^{\beta_1} + \Omega_2 C_m^{\beta_2} \quad (4.20)$$

Where Ω_1 and Ω_2 are constants yet to be determined and β_1 and β_2 are the solution to the nonlinear equation:

$$\frac{1}{2}\sigma_F^2\beta_1(\beta_1-1) + (\delta_F-\delta_H)\beta_1 + \lambda_1\left[(1+\phi_1)^{-\beta_1}-1\right] - \lambda_2\left[1-(1-\phi_2)^{-\beta_1}\right] - \delta_F = 0 \quad (4.21)$$

Given the additional risk due to country instability, the value of the FDI should satisfy the following three conditions:

$$f(C_m)_{C_m \to 0} = 0 \quad (4.22a)$$

$$f(C_m^*) = (1-\tau_H)\left[\frac{C_m^*}{\delta_H} - \varphi g_F\right] + (1-\tau_F)\left[(\varphi-1)g_F\right] - \kappa - (\varphi-1)^2 g_F \quad (4.22b)$$

$$\frac{\partial f}{\partial C_m^*} = \frac{1-\tau_H}{\delta_H} \quad (4.22c)$$

As was the case in the previous section, conditions 4.22b and 4.22c are referred to as the value matching and smooth pasting conditions, respectively. Similarly, condition 4.22a states that when the variable cost of producing the intermediate good in country m is relatively high, which may be caused due to a sudden jump in the variable cost, the value of the option to produce the intermediate good in country m is of no value. This boundary condition now plays a much larger role in the pricing of the FDI opportunity for larger values in ϕ_1.

Condition 4.22b refers to the per unit after tax profit from optimally exercising the option of the FDI. However, the present value of the per unit cost in producing the good in country m takes into account the infrequent positive and negative jumps in cost. Intuitively, a large upward jump in cost of size ϕ_1 increases the expected present value of future per unit costs. Conversely, a large infrequent downward jump in cost of size ϕ_2 decreases the expected value of future costs. This additional uncertainty in the cost structure of producing a good internationally now affects the after tax incremental profits from the FDI. However, the net effect of incorporating both types of jumps is ambiguous, and is largely dependent on the size of the jumps and the frequency of the rare events that lead to abrupt changes in the cost structure.

Finally, as condition 4.22c states that the threshold C_m^* is optimally chosen, using conditions 4.22b and 4.22c, the optimal cost ratio C_m^* is now:

$$C_m^* = \frac{\beta_1}{\beta_1 - 1}\left[\left(\kappa_m + (\varphi-1)^2 g_F\right)\frac{\delta_H}{1-\tau_H} + \varphi\delta_H g_F - \frac{1-\tau_F}{1-\tau_H}\delta_H g_F(\varphi-1)\right] \tag{4.23}$$

Where the value of the option can now be represented by:

$$f(C_m^*) = \begin{cases} \left((1-\tau_H)\left[\frac{C_m^*}{\delta_H} - \varphi g_F\right] + (1-\tau_F)\left[(\varphi-1)g_F\right] - \kappa - (\varphi-1)^2 g_F\right)\left(\frac{C_m}{C_m^*}\right)^{\lambda_1} & if\ C_m < C_m^* \\ (1-\tau_H)\left[\frac{C_m^*}{\delta_H} - \varphi g_F\right] + (1-\tau_F)\left[(\varphi-1)g_F\right] - \kappa - (\varphi-1)^2 g_F & if\ C_m \geq C_m^* \end{cases}$$

The optimal cost ratio represented in 4.23 has the same interpretation as before. Comparative statics show $\frac{\partial C_m^*}{\partial g_F}\frac{\partial g_F}{\partial \lambda_1} > 0$ and $\frac{\partial C_m^*}{\partial g_F}\frac{\partial g_F}{\partial \lambda_2} < 0$, indicating that higher incidences in events that cause a large upwards (downwards) spike in the cost structure shifts the trigger rate C_m^* upwards (downwards). In the event of a sudden negative shock which costs increase discontinuously, the multinational firm takes into account the frequency of these events and adjust their optimal investment policy accordingly. In this case, the cost ratio trigger rate would increase, indicating that firms are only entering country m if the gap in costs between both countries is now much greater than in the absence of this new risk. Similarly, the fixed size of the jump ϕ_1 and ϕ_2 have similar interpretations, where comparative statics show $\frac{\partial C_m^*}{\partial d_F}\frac{\partial d_F}{\partial \phi_1} > 0$ and $\frac{\partial C_m^*}{\partial d_F}\frac{\partial d_F}{\partial \phi_2} < 0$.

Potential Incentive Packages

If we assume that foreign governments cannot control its own country risk, then government agencies can reasonably combat its own country risk by providing large enough subsidies that compensate firms for the additional risk. By applying the same methodology as before, κ_m^* denotes the proportion of the per unit fixed cost that equates the firms investment threshold to the current cost ratio C_m. Through similar steps, the level of per unit fixed investment that ensures immediate investment is:

$$\kappa_m^* = \frac{1-\tau_H}{\delta_H}\left[C_m \frac{\beta_1 - 1}{\beta_1} + \frac{1-\tau_F}{1-\tau_H}\delta_H(\varphi-1)g_F - \delta_H \varphi g_F\right] - (\varphi-1)^2 g_F \tag{4.24}$$

Where the subsidy, measured as a fraction of the initial per unit fixed investment cost, can be represented by:

$$s = 1 - \frac{1-\tau_H}{\kappa_m \delta_H}\left[C_m \frac{\beta_1 - 1}{\beta_1} + \frac{1-\tau_F}{1-\tau_H}\delta_H(\varphi-1)g_F - \delta_H \varphi g_F - (\varphi-1)^2 g_F \frac{\delta_H}{1-\tau_H}\right] \tag{4.25}$$

Similarly to the infrastructure subsidy, the government chooses a level of corporate taxation τ_F such that $C_m^* = C_m$. By doing so, the foreign tax rate that ensures immediate investment from a multinational firm can be found by solving the following cubic expression:

$$\tau^{*3}_F + \tau^{*2}_F\left[\left(C_m \frac{\beta_1 - 1}{\beta_1} - \kappa \frac{\delta_H}{1-\tau_H}\right)\frac{\delta_F(1-\tau_H)}{\delta_H} - \tau_H \varsigma - 2\right] + \tau_F^*\left[\tau_H \varsigma (2+\tau_H)\right] - \tau_H^2 \varsigma^2 = 0 \tag{4.26}$$

4.3.4 Regime Uncertainty

Value of the FDI Project

In this section, I generalize the jump diffusion model so that the target country may be affected by unobservable periods of high and low political instability, which directly affects the cost structure of producing the intermediate good. This may include periods of political corruption, armed conflicts, or episodes of political violence, which may increase the cost of doing business in the potential host country. Conversely, factors such as changes in the head of state, reforms to improve the business environment, or new government initiatives could temporarily reduce the cost of production.

In this model, I assume that each state will have its own independent drift and volatility rate. However, it may be the case that staged coups and political unrest may randomly rise after unpopular policies from the head of state. To account for this, I will assume that the regimes can switch randomly between high and low periods of political risk. By defining the type of governance structure, G, as low and high states of political risk, denoted by l and h respectively, the cost structure of the foreign country can be represented by:

$$\frac{dC_G}{C_G} = \alpha_G dt + \sigma_G dZ \qquad\qquad for\ G \in \{l, h\} \tag{4.27}$$

Equation 4.27 states that there are now two possible states in the foreign economy. The probability of shifting from a high political risk state to a low political risk state during a given interval dt is ϕdt, whereas the probability of shifting from low country risk state to a high country risk state in a given interval dt is θdt. Assume there is an asset or portfolio that is perfectly correlated with C_G, then through standard contingent claims analysis, the following differential equations are defined:[22]

$$\frac{1}{2}\sigma_F^{2,h} C_m^2 f_{C_m C_m}^h + (\delta_h - \delta_H) C_m f_{C_m}^h + \phi\left[f^l - f^h\right] - \delta_h f^h = 0 \tag{4.28}$$

$$\frac{1}{2}\sigma_F^{2,l} C_m^2 f_{C_m C_m}^l + (\delta_l - \delta_H) C_m f_{C_m}^l + \theta\left[f^h - f^l\right] - \delta_l f^l = 0 \tag{4.29}$$

Where $\delta^G = \mu - \alpha^G$. To evaluate the fundamental cost of the vertical FDI, which is simply the expected present value of the future per unit costs, the appropriate perpetuity factor would first need to be calculated[23].

The general solutions to equations 4.28 and 4.29 consist of the particular integral and it's respective solution to the characteristic function. In this case, the particular integral that gives the expected present value of future costs is of the form:

$$F^G(C_F^G) = g_G C_F^G \qquad\qquad for\ G \in \{h, h\} \tag{4.30}$$

For some risk adjusted discount rate g_G. By substituting equation 4.30 into both equations 4.28 and 4.29 and solving for g_l and g_h, the risk adjusted discount rate, conditional on a given state is now:

$$g_l = \frac{\delta_h + \phi + \theta}{(\delta_h + \phi)(\delta_l + \theta) - \theta\phi} \tag{4.31a}$$

[22] The method presented in the Appendix to derive the differential equation shown in equation 4.19a can be used to derive equations 4.28 and 4.29

[23] A solution to a similar regime switching investment problem is provided by Ruiz-Aliseda and Wu (2012) and Driffill et al. (2013). Ruiz-Aliseda and Wu (2012) calculate the expected flow of profits for periods of either growth or decline, whereas Driffill et al. (2013) models the expected cash flows due to changes in either economic policy regimes or the competitive business climate.

$$g_h = \frac{\delta_l + \theta + \phi}{(\delta_h + \phi)(\delta_l + \theta) - \theta\phi} \tag{4.31b}$$

Thus, if the probability of transitions converge to zero in both states, then the discount rate of the fundamental future per unit costs now collapses to $\frac{1}{\delta}$, which was used in the first section.

As the fundamental cost of the FDI has now been calculated, the next step is to find the general solution to retrieve the characteristic function. The general solutions to 4.28 and 4.29 may take the form of :

$$f^H(C_m) = \Phi C_m^{\lambda} \tag{4.32a}$$

$$f^L(C_m) = \Psi C_m^{\lambda} \tag{4.32b}$$

By substituting these general solutions to equations 4.28 and 4.29, and eliminating Φ and Ψ, I now have the following quartic characteristic function:

$$\left[(\delta_h - \phi) - (\delta_h - \delta_H)\lambda - \frac{1}{2}\sigma^{2^h}\lambda(\lambda - 1)\right]\left[(\delta_l - \theta) - (\delta_h - \delta_L)\lambda - \frac{1}{2}\sigma^{2^l}\lambda(\lambda - 1)\right] = \phi\theta \tag{4.33}$$

As λ has four real roots(two positive and two negative), the general solution for $f^H(C_m)$ and $f^L(C_m)$ can be rewritten as $\sum_{i=1}^{4}\Phi_i C_m^{\lambda_i}$ and $\sum_{i=1}^{4}\Psi_i C_m^{\lambda_i}$, respectively. For completeness, I will define the 4 roots to equation 4.33 as $\lambda_1 > \lambda_2 > 0 > \lambda_3 > \lambda_4$. Similar to the case with only one regime, the regime switching option must satisfy the following boundary conditions:

$$f^G_{C_m \to 0} = 0 \tag{4.34a}$$

$$f^G(C_m^*) = (1 - \tau_H)\left[\frac{C_m^*}{\delta_H} - \varphi g_G\right] + (1 - \tau_F)(\varphi - 1)g_G - \kappa_G - (\varphi - 1)^2 g_G \tag{4.34b}$$

$$\frac{\partial f^G}{\partial C_m^*} = \frac{1 - \tau_H}{\delta_H} \tag{4.34c}$$

By the boundary condition set in 4.34a, Φ_3 , Φ_4, Ψ_3, and Ψ_4 must equal to zero. I now have the following system of equations:

$$(1 - \tau_H)\left[\frac{C_H^*}{\delta_H} - \varphi g_h\right] + (1 - \tau_F)(\varphi - 1)g_h - \kappa_H - (\varphi - 1)^2 g_H = \Phi_3 C_H^{*\lambda_3} + \Phi_4 C_H^{*\lambda_4} \tag{4.35a}$$

$$\frac{1 - \tau_H}{\delta_H} = (\lambda_3)\Phi_3 C_H^{*\lambda_3 - 1} + (\lambda_4)\Phi_4 C_H^{*\lambda_4 - 1} \tag{4.35b}$$

$$(1-\tau_H)\left[\frac{C_L^*}{\delta_H}-\varphi g_L\right]+(1-\tau_F)(\varphi-1)g_l-\kappa_l-(\varphi-1)^2 g_L=\Psi_3 C_L^{*\lambda_3}+\Psi_4 C_L^{*\lambda_4} \quad (4.35c)$$

$$\frac{1-\tau_H}{\delta_H}=(\lambda_3)\Psi_3 C_L^{*\lambda_3-1}+(\lambda_4)\Psi_4 C_L^{*\lambda_4-1} \quad (4.35d)$$

However, the above has 6 unknowns in a system of 4 equations. To solve this , I can substitute the general solutions 4.32a and 4.32b into 4.28 and 4.29, and express Ψ in terms of Φ. If I define:

$$P_3=\frac{\left((\delta_h+\phi)-(\delta_h-\delta_H)\lambda_3-\frac{1}{2}\sigma^{2^H}\lambda_3(\lambda_3-1)\right)}{\phi} \quad (4.36a)$$

$$P_4=\frac{\theta}{\left((\delta_l+\theta)-(\delta_l-\delta_L)\lambda_4-\frac{1}{2}\sigma^{2^L}\lambda_4(\lambda_4-1)\right)} \quad (4.36b)$$

Then I can rewrite the solution as a system of 4 equations with 4 unknowns:

$$(1-\tau_H)\left[\frac{C_H^*}{\delta_H}-\varphi g_H\right]+(1-\tau_F)(\varphi-1)g_H-\kappa_H-(\varphi-1)^2 g_H=\Phi_3 C_H^{*\lambda_3}+\Phi_4 C_H^{*\lambda_4} \quad (4.37a)$$

$$\frac{1-\tau_H}{\delta_H}=(\lambda_3)\Phi_3 C_H^{*\lambda_3-1}+(\lambda_4)\Phi_4 C_H^{*\lambda_4-1} \quad (4.37b)$$

$$(1-\tau_H)\left[\frac{C_L^*}{\delta_H}-\varphi g_L\right]+(1-\tau_F)(\varphi-1)g_L-\kappa_L-(\varphi-1)^2 g_L=P_3\Phi_3 C_L^{*\lambda_3}+P_4\Phi_4 C_L^{*\lambda_4} \quad (4.37c)$$

$$\frac{1-\tau_H}{\delta_H}=(\lambda_3)P_3\Phi_3 C_L^{*\lambda_3-1}+(\lambda_4)P_4\Phi_4 C_L^{*\lambda_4-1} \quad (4.37d)$$

Due to the highly non-linearity in this systems of equations, for a given set of parameters in $r,\psi,\theta,\delta^H,\delta^L,\lambda_3,\lambda_4,\sigma_m^{2^H}$ and $\sigma_m^{2^L}$, this system of four equations with four unknowns can now be numerically solved for the optimal investment policy, conditional on regime type C_L^*, C_H^*, and Φ_3, and Φ_4. Therefore, C_L^* and C_H^*, the value-maximizing threshold, represents the optimal cost ratio between home and host country, conditional on episodes of either low or high country risk, respectively.

4.4 Numerical Examples

4.4.1 Optimal Investment Policy Simulations

The complexity of the regime switching model requires numerical simulations as closed-form solutions cannot be derived. While the benchmark case and its extension, the GBM and the jump diffusion model, do have analytical solutions, the regime-switching model results will be presented relative to the benchmark case. Given the set of assumptions, the numerical examples presented in this section will help us understand how institutional uncertainty may impact both the decision to pursue a FDI and the size of the infrastructure subsidies and tax credits to ensure immediate investment. To ensure that the results presented in this section are robust, we perform extensive sensitivity analysis. For instance, given a baseline set of parameters, we see how changes in the current relative costs impact the size of the infrastructure subsidy and tax credits. The baseline parameters are shown in Table 4.1.

For simplicity, we assumed that the effective corporate tax rate of the foreign country is 20%, whereas the home corporate tax rate is at 35%. ς^* is thus calculated at .6143, where the optimal intra-company markup for the intermediate good 1.075. In both the base case model and the jump diffusion model, we assume that σ^2, the uncertainty associated with the variable cost abroad, is $.30^2$. Furthermore, we assume that the *per unit* fixed cost, κ, is roughly 5 times the per unit variable cost.

In terms of the jump-diffusion model, I assume that there is a possibility of a sudden upward jump in the variable cost of 105%. I further assume that there is a possibility of a downward jump in cost of 90%. For simplicity, I assume that the mean arrival rate for the upward and downward jumps are .05 and .1, respectively.

Lastly, for the regime switching model, the regime with high political risk assumes the same parameters for σ^2 and δ from the base case, $.3^2$ and .04, respectively. The increase in δ in the high political risk state can be interpreted as the net marginal convenience yield from storing (or holding onto) the intermediate good produced abroad. In particular, these benefits include avoiding stockouts and continuing the production processes even in the presence of political risk. As the value chain now spans across borders, the benefits of avoiding production delays are more valuable than before.

For periods of low political risk, the delta is the same as the home country, .01, whereas the variance is lower at $.1^2$. The probability of transitioning from a high to low state, and vice-versa, are chosen at .01 and .02, respectively.

Table 4.1: Parameter Values for Simulation

	Base Case	Jump Diffusion	Regime Switching
τ_f	0.2	0.2	0.2
τ_h	0.35	0.35	0.35
ς^*	0.6143	0.6143	0.6143
φ	1.075	1.075	1.075
δ_f	0.04	0.04	
δ_h	0.01	0.01	0.01
σ^2	$.3^2$	$.3^2$	
κ	5	5	5
ϕ_1		1.05	
ϕ_2		0.1	
λ_1		0.05	
λ_2		0.1	
ϕ			0.01
θ			0.02
δ_L			0.01
δ_H			0.04
σ_L^2			$.10^2$
σ_H^2			$.3^2$

Given these sets of parameters, table 4.2 presents the firms optimal investment policy. Figure 9 in the Appendix illustrates the optimal investment strategy for the base case and the jump diffusion case, whereas figure 10 illustrates the optimal investment strategy for the regime switching case. Specifically, the optimal strategy is graphically represented when the value of the FDI option is tangent to the basic option pay out of the FDI itself.

Table 4.2: Optimal Investment Policy Estimates for Different Specification Models

	Base Case	Jump Diffusion	Regime Switching	
			High	Low
C_m^*	2.942	3.223	3.873	2.697

Note: Results based on the parameters shown in Table 4.1

The results from table 4.2 suggest that in the absence of modelling country risk through a jump process, the investment policy when using the GBM model may allow for firms to pursue FDI too early. When modeling country risk via a jump-process, figure 11 illustrates how sensitive the firms optimal investment policy is to changes in the *magnitude* of upwards and downward jumps. Figure 12 further confirms our intuition that an increase in incidences of upward (downward) jumps pushes the optimal investments upwards (downwards). Therefore, if the frequency of upward jumps is more likely to occur over time, our model suggests that multinational firms adjust its expectations and wait until the cost ratio between the home and foreign country is relatively high. Conversely, if the incidences of downward jumps tend to occur more frequently, our model intuitively shows that multinational firms adjust its optimal investment policy accordingly, as the firm anticipates that costs may drop over time.

More importantly, given the dynamics of the regime switching model, our results suggest that conditional on the regime state, the firms' optimal investment policy greatly differ. For example, if country m is in a high country risk regime, the real option model dictates that the optimal investment policy is much higher than in the low political regime state. The intuition is quite clear: The firm would like to be compensated for the additional risk associated when investing into a risky state. By measuring political risk through a two-state regime process, it provides multinational firms with a lower and upper bound for its optimal investment policy.

4.4.2 Infrastructure Subsidies and Tax Credit Simulations

While the previous section examined the impact of political risk on the optimal investment strategy of a multinational firm, this section is dedicated to measuring the impact of political risk on the size of the subsidies given to firms. Figure 13 graphs the size of the infrastructure subsidy for various current cost ratios for both the base case and the jump diffusion case, whereas figure 14 shows the total cost of implementing the subsidy. As expected, in figure 13, our model indicates that as the current cost ratio increases, the size of the subsidy infrastructure decreases. More importantly, our model seems to indicate that the effect of incorporating political risk in the model drives the foreign government to provide extremely generous infrastructure subsidies to attract foreign capital, which in turn cost significantly more than the subsidies provided in the absence of political risk. This can be seen in figure 14, where it illustrates the cost of an infrastructure subsidy for various current foreign costs.[24]

To illustrate the magnitude of the infrastructure, suppose the current cost ratio is 2.5. In the absence of political risk, the size of the infrastructure subsidy to ensure immediate investment would be 63% of the per unit fixed investment cost. However, if we do

[24]For simplicity, the current domestic cost was normalized at \$1.

incorporate political risk into the analysis, the size of the infrastructure subsidy to ensure immediate investment is now 600% of the per unit fixed cost. In this case, by incorporating political risk in the model, it has increased infrastructure subsidies by almost a factor of 10. Figure 13 shows that the 'political risk' premium, measured as the difference in infrastructure subsidies, increases as the current cost is low and decreases when the current cost is high.

Figure 13 also illustrates the various levels of foreign tax rates that would ensure immediate investment, whereas figure 14 presents the total cost of implementing such tax credits. While it may be surprising that for lower cost ratios the jump diffusion model would require *less* tax credits than the base model, the marginal effect of tax credits to ensure immediate investment is large. In fact, conditional on a 20% foreign corporate tax rate, it would only require a maximum of a 10% tax credit to ensure immediate investment from foreign investors[25]. More importantly, our model suggests that the cost of implementing tax credits to attract immediate FDI is much less than implementing an infrastructure subsidy. This can be seen in figure 15 in the Appendix[26]. Figure 15 compares the total cost of tax credits versus infrastructure subsidies for both the GBM case and the jump diffusion case. In either case, we find that providing infrastructure subsidy is strictly more expensive than providing tax credits.

While the base case and the jump diffusion models do have relatively simple solutions to estimate infrastructure subsidies to ensure immediate investment from multinationals, the regime switching model does not provide such simple solutions. In order to examine the impact of these subsidies in the regime switching case, we can estimate how changes in κ, and changes in the foreign tax rate, τ_f, impact the optimal investment strategy of the firm for each regime. Figure 16 graphs the relationship between changes in κ and τ_f on the optimal investment policy, conditional on each regime. Consistent with our previous results, the results suggest that as firms face higher fixed investment costs (or higher foreign taxes), the optimal cost ratio rises. Interestingly, the optimal investment policy in the low regime tends to be more sensitive to marginal changes in the fixed costs. This can be seen by the negative relationship between κ and the ratio of optimal investments, $\frac{C_H^*}{C_L^*}$. This result is primarily driven by what I refer to as the 'fixed cost effect' dominating the 'low variance effect', where low variance of the stochastic variable typically drives the optimal investment policy to lower threshold values, whereas larger fixed costs drive the optimal

[25]This is assuming the current ratio lies between 0 and 3

[26]the cost of the infrastructure subsidy is calculated as $s^*\kappa C_F^m$, whereas the cost of the tax credit is calculated as $\frac{(\tau_F^m - \tau^*)C_F^m}{\delta}$ for the base case and $(\tau_F^m - \tau^*)C_F^m g_F$ for the jump diffusion case, which is simply the expected present value of the loss in tax revenue due to the tax credit.

investment threshold at higher values.

These results are further seen in the second subfigure in figure 16. However, the high state regime threshold is now more responsive to changes in foreign taxes relative to the low state regime case. For higher foreign tax rates there is an associated lower value in φ, which implicitly suggests that there are less profits to be shifted. For example, suppose that $\tau_f = \tau_h$, then the payoff of the FDI would only rely on the stochastic changes of the foreign variable costs. As the high-state regime also has a higher variance, the optimal investment threshold value would be much higher than that of the lower-regime. More importantly, as the foreign taxes converge to the home corporate tax rate, the FDI loses additional profits from the intra-company transaction. This explains why during a high-state regime, the firms optimal investment policy is more sensitive to changes foreign tax rates: it loses another channel to extract profits.

4.5 Summary Remarks and Conclusion

This paper examines the impact of political risk on the locational choice of a vertical FDI. Following a real options approach, the results from our model are consistent with empirical findings that institutional uncertainty has a considerable negative impact on inflow FDI. I find that in the presence of country risk, our real options model suggests that government officials provide overly generous incentive packages in order to attract foreign investors. Specifically, the incentive package, either through infrastructure subsidies or tax credits, are considerably larger relative to the base case model when political risk is not present.

Furthermore, as vertical FDI is a mechanism to internalize production facilities and stretch the supply chain across borders, I incorporate transfer pricing as a further consideration when firms invest internationally. By incorporating transfer pricing into the model, the numerical examples expressed in the previous section suggest that tax credits may be a more suitable method to attract foreign investors, as foreign investors tend to respond more to changes in tax credits than investment subsidies. However, these results should be taken with caution, as our results are based on a set of rather restrictive assumptions. As the construction of the incentive package is simply a function of the firms optimal investment policy, one can relax this assumption and create new incentive packages that take into account other factors, such as tax competition or revenue generation through product outsourcing. Future research can further include Nash bargaining techniques to capture the relationship between the firm and the foreign government. These are all but a few ideas for extensions in this field.

APPENDIX

.1 Chapter 2

The Park (2008) patent protection index is a function of 5 equally weighted factors. Each component within each factor is equally weighted. The 5 factors that create the index are:

1. Membership of 5 international treaties
   - Paris convention and revisions
   - Patent cooperation treaty
   - Protection of new varieties treaty
   - Budapest treaty (microorganism deposits)
   - Trade related aspects of intellectual property rights
2. Coverage of industries that can patent goods or processes:
   - Pharmaceuticals
   - Chemicals
   - Food
   - Surgical Products
   - Microorganisms
   - Utility models
   - Software
   - Plant and Animal Varieties
3. Duration of Protection
   - Value of 1 if 20 years, otherwise the duration of the patent (normalized as a fraction of 20 years)
4. Enforcement Mechanisms
   - Preliminary (pre-trial) injunctions

- Contributory infringement
- Burden of proof reversal

5. Restrictions on Patent Rights

    - Working requirements
    - Compulsory licensing
    - Revocation of patents

Table 3: Average IPR by Income levels: 1987-2005

High Income	**IPR**	**Upper Middle Income**	**IPR**	**Lower-Middle Income**	**IPR**	**Low Income**	**IPR**
Australia	3.75	Algeria	2.66	Angola	0.63	Bangladesh	1.54
Austria	4.00	Argentina	2.50	Bolivia	2.12	Benin	2.05
Belgium	4.46	Botswana	2.37	Cameroon	2.20	Burkina Faso	2.05
Canada	3.97	Brazil	2.18	Congo	1.72	Burundi	1.95
Cyprus	2.98	Bulgaria	3.06	Cote d'Ivoire	2.11	C.A.R.	2.13
Czech Republic	3.50	Chile	3.42	Egypt	1.86	Chad	2.04
Denmark	4.28	China	2.39	El Salvador	2.65	Ethiopia	0.83
Finland	4.05	Colombia	2.24	Ghana	2.50	Haiti	2.71
France	4.30	Costa Rica	1.94	Guatemala	1.43	Kenya	2.43
Germany	4.36	Dom. Rep.	2.23	Guyana	1.17	Liberia	2.07
Greece	3.52	Ecuador	2.30	Honduras	1.98	Madagascar	1.70
Hungary	3.55	Gabon	2.20	India	1.87	Malawi	1.70
Iceland	2.68	Iran	1.91	Indonesia	1.44	Mali	2.08
Ireland	3.53	Jamaica	2.92	Iraq	2.05	Mozambique	0.76
Israel	3.29	Jordan	1.57	Mauritania	2.26	Myanmar	0.12
Italy	4.27	Lithuania	2.70	Morocco	2.23	Nepal	1.87
Japan	4.21	Malaysia	2.64	Nicaragua	1.32	Niger	2.01
Luxembourg	3.49	Mauritius	1.98	Nigeria	2.60	Rwanda	1.96
Malta	2.21	Mexico	2.27	Pakistan	1.52	Sierra Leone	2.63
Netherlands	4.37	New Guinea	1.07	Paraguay	1.81	Somalia	1.38
New Zealand	3.15	Panama	2.17	Philippines	2.97	Togo	2.05
Norway	3.65	Peru	1.96	Senegal	2.13	Uganda	2.57
Poland	3.03	Romania	3.06	Sri Lanka	2.95	Tanzania	2.35
Portugal	2.99	Russia	2.73	Sudan	2.32	Zimbabwe	2.21
Korea	3.71	South Africa	3.33	Syria	1.91		
Saudi Arabia	1.81	Thailand	1.90	Ukraine	2.47		
Singapore	3.17	Tunisia	2.02	Viet Nam	2.02		
Slovakia	2.51	Turkey	2.61	Zambia	1.56		
Spain	3.68	Uruguay	2.32				
Sweden	4.17	Venezuela	2.16				
Switzerland	4.04						
Taiwan	2.54						
UK	4.37						
USA	4.80						
Average	**3.59**	**Average**	**2.36**	**Average**	**1.99**	**Average**	**1.88**

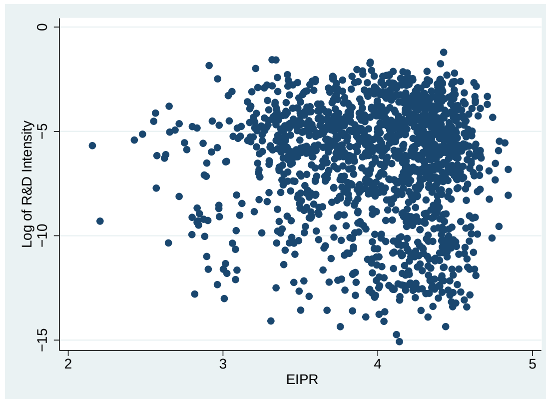
Table 4: Sample of Countries: R&D Study

Australia	Italy
Austria	Japan
Belgium	Korea
Canada	Norway
Denmark	Portugal
Finland	Singapore
France	Spain
Hungary	Sweden
Iceland	Switzerland
Ireland	United States

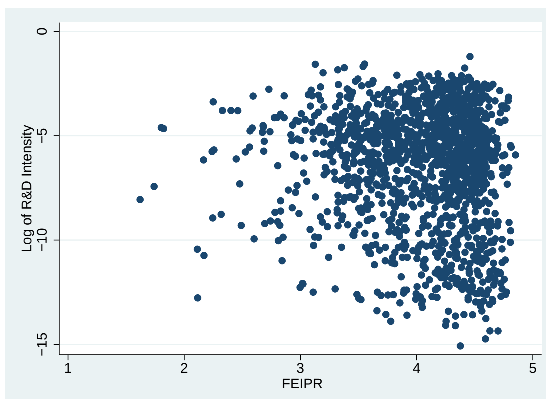
Table 5: Manufacturing Industry Sectors in R&D Study

Food and beverages	Transport equipment n.e.c.
Textiles	Refined petroleum products
Wearing apparel, fur	Pharmaceuticals, medicinal chemicals, etc.
Leather, leather products and footwear	Basic iron and steel
Wood products (excl. furniture)	Basic precious and non-ferrous metals
Paper and paper products	Engines & turbines (not for transport equipment)
Printing and publishing	Machine tools
Coke,refined petroleum products,nuclear fuel	Weapons and ammunition
Chemicals and chemical products	Electric motors, generators and transformers
Rubber and plastics products	Accumulators, primary cells and batteries
Non-metallic mineral products	Lighting equipment and electric lamps
Basic metals	Other electrical equipment n.e.c.
Fabricated metal products	Electronic valves, tubes, etc.
Machinery and equipment n.e.c.	TV/radio transmitters; line comm. apparatus
Office, accounting and computing machinery	TV and radio receivers and associated goods
Electrical machinery and apparatus	Medical, surgical and orthopaedic equipment
Radio,television and communication equipment	Measuring/testing/navigating appliances,etc.
Medical, precision and optical instruments	Optical instruments & photographic equipment
Motor vehicles, trailers, semi-trailers	Watches and clocks
Other transport equipment	Railway/tramway locomotives & rolling stock
Special purpose machinery	Aircraft and spacecraft
Building and repairing of ships and boats	Furniture
	Other manufacturing n.e.c.

Figure 1: R&D Intensity and Export-Partner IPR

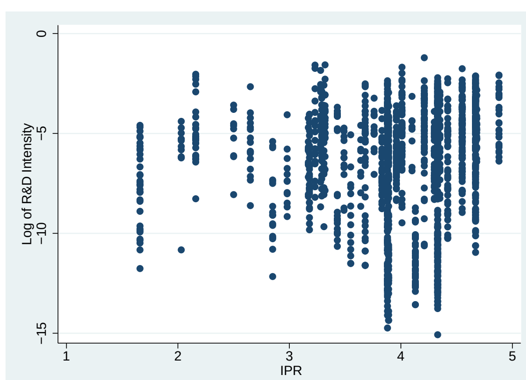


(a) Dynamic Trade Flows



(b) Fixed Trade Flows

Figure 2: R&D Intensity and Domestic IPR



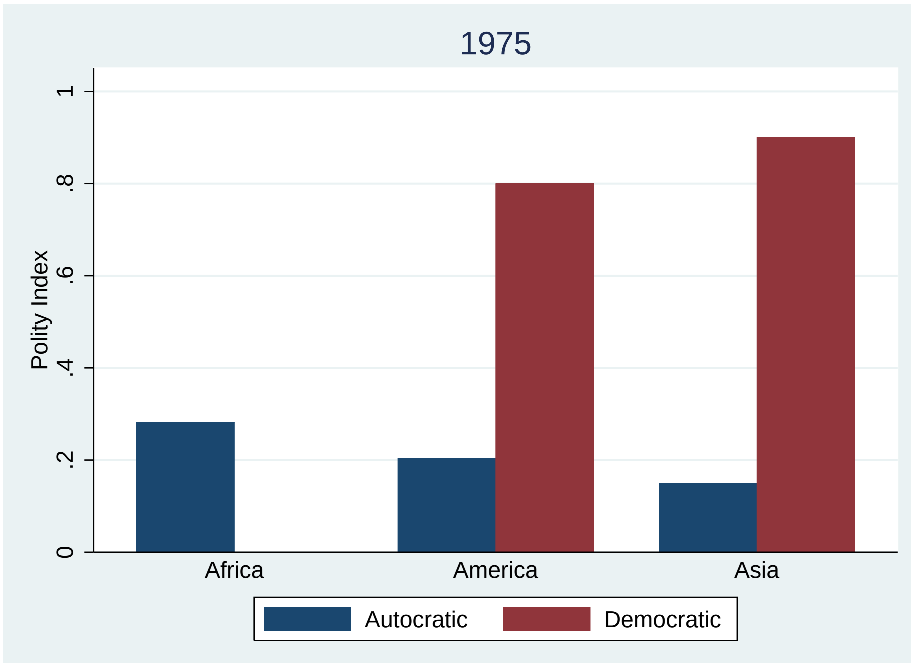
.2 Chapter 3

Table 6: Sample of Developing Countries: Democracy and Economic Growth Study

America	**Asia**	**Africa**
Argentina	Bangladesh	Algeria
Bolivia	China	Burkina Faso
Brazil	India	Botswana
Colombia	Indonesia	Cote d'Ivoire
Costa Rica	Iran	Egypt
Nicaragua	Israel	Ethiopia
Ecuador	Jordan	Mauritius
El Salvador	Korea, Rep.	Morocco
Guatemala	Malaysia	South Africa
Honduras	Pakistan	Tunisia
Mexico	Philippines	Zambia
Panama	Sri Lanka	Zimbabwe
Paraguay	Syrian Arab Republic	
Peru	Thailand	
Uruguay	Vietnam	
Venezuela		

Figure 3: Average Polity Score by Continent: 1975

(a) Avg Polity by Continent



(b) No. Countries in Avg by Continent

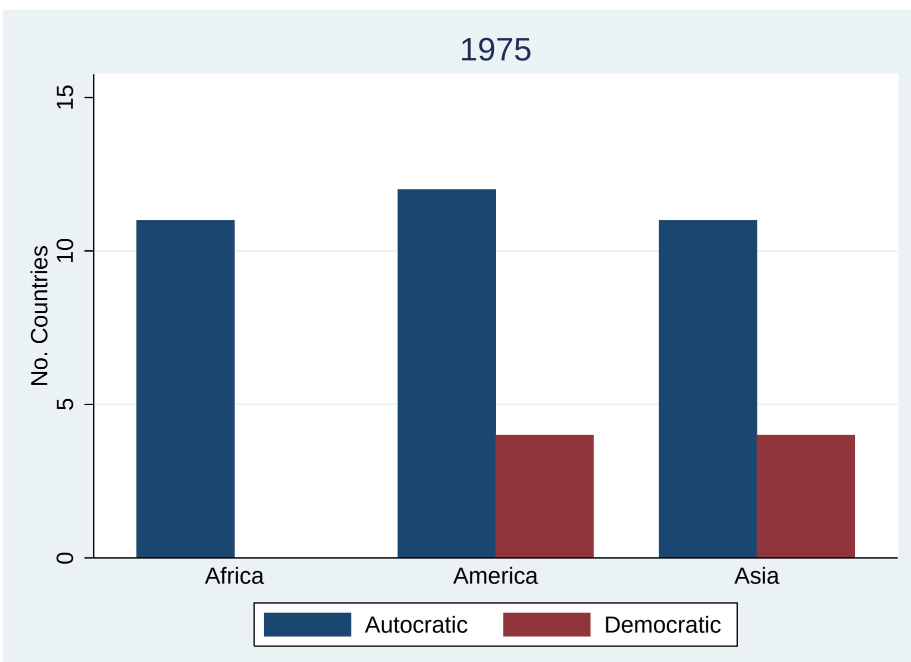
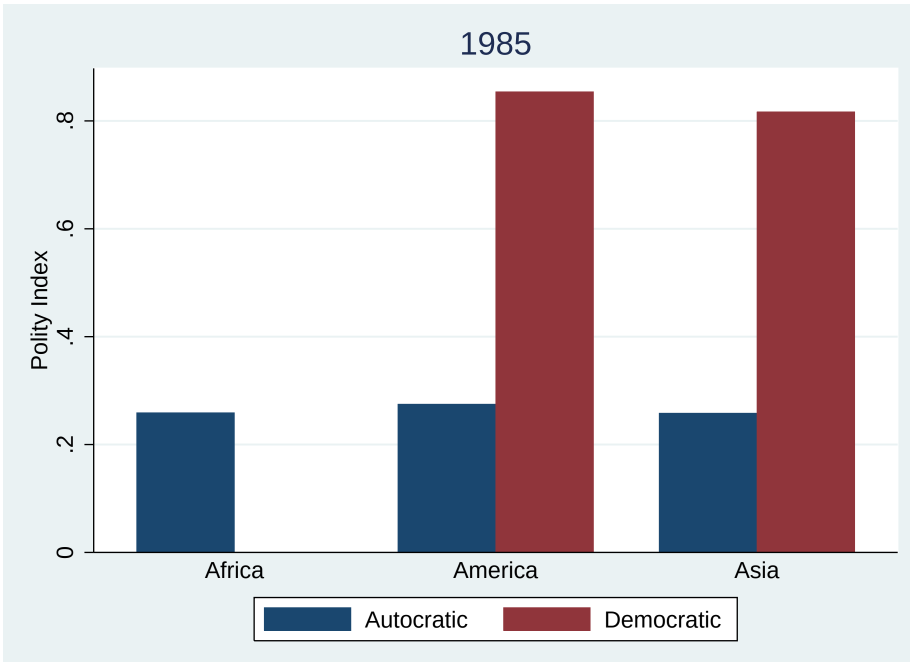


Figure 4: Average Polity Score by Continent: 1985

(a) Avg Polity by Continent



(b) No. Countries in Avg by Continent

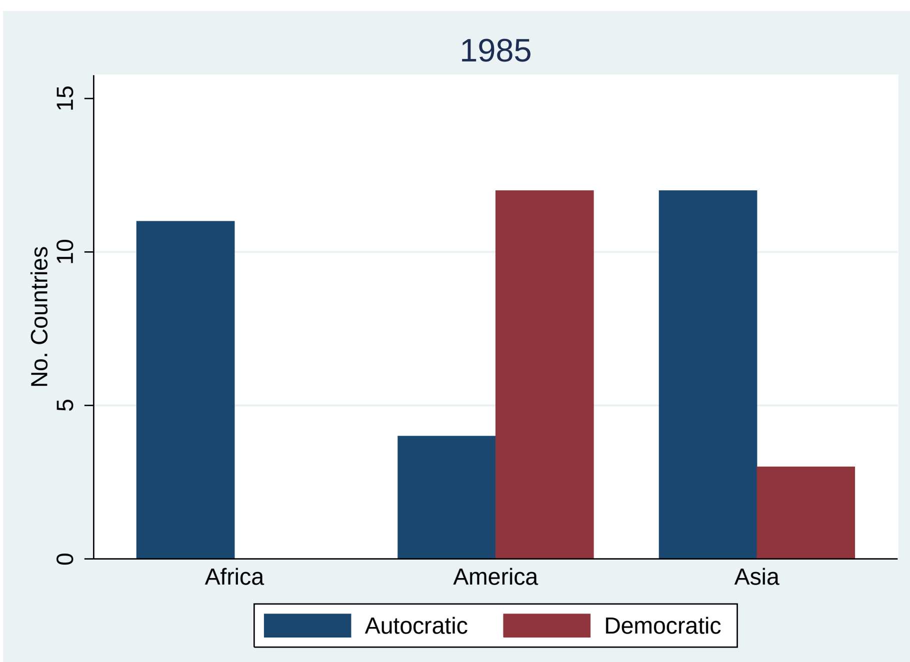
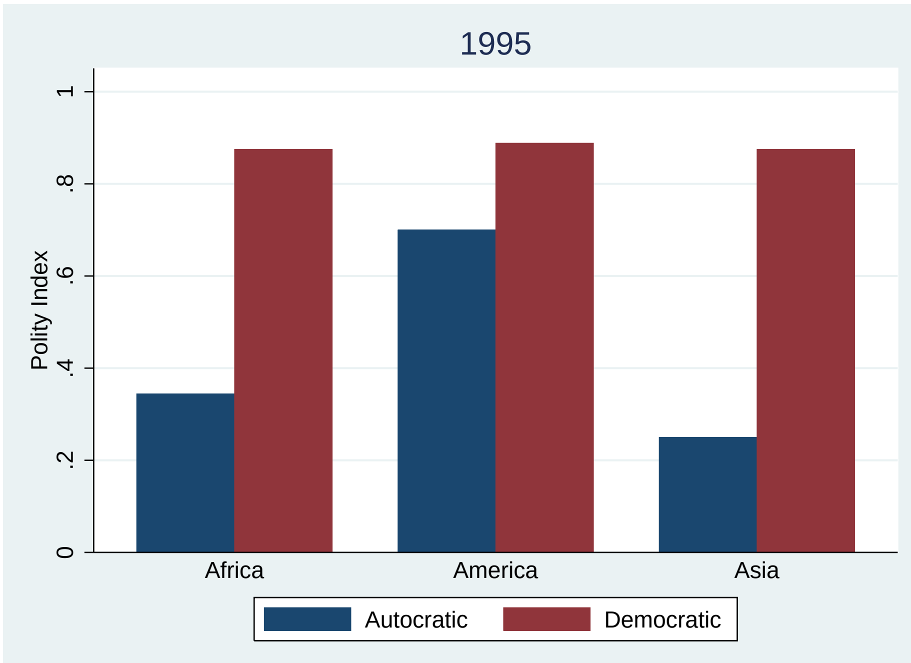


Figure 5: Average Polity Score by Continent: 1995

(a) Avg Polity by Continent



(b) No. Countries in Avg by Continent

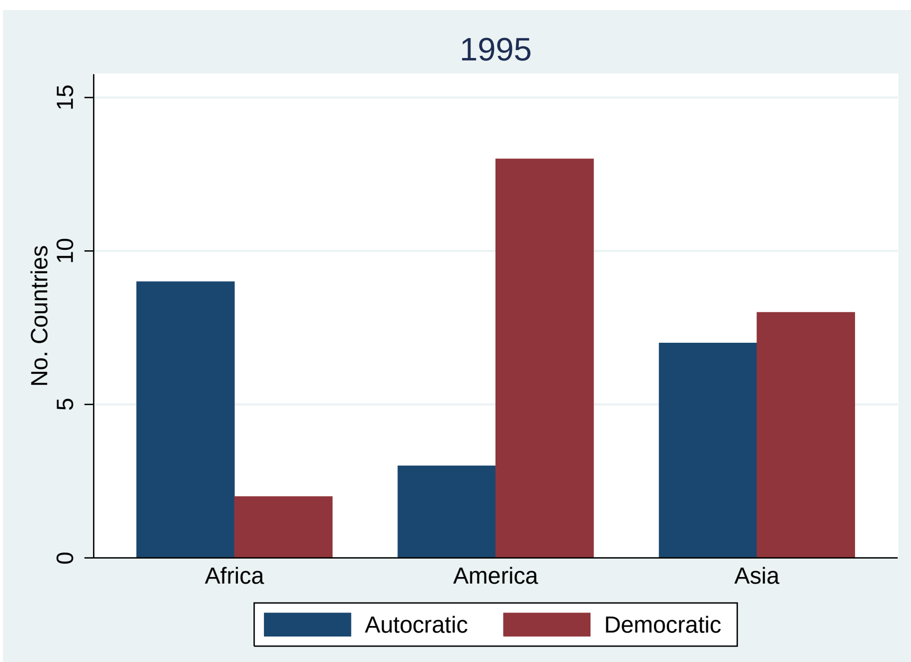
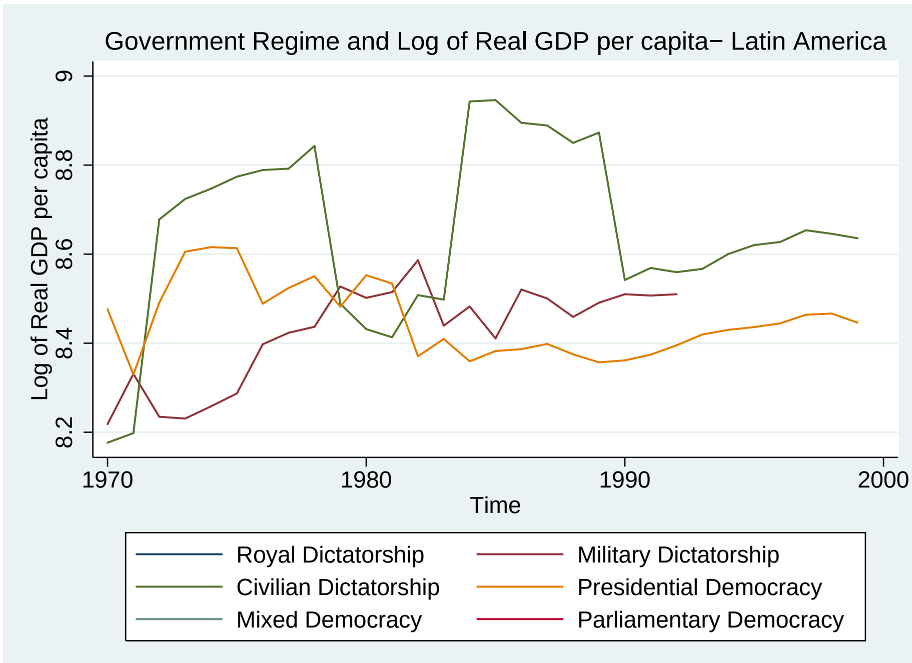


Figure 6: Per Capita Income over time by Political Regime Type: Latin America

(a) log of Real GDP



(b) Average

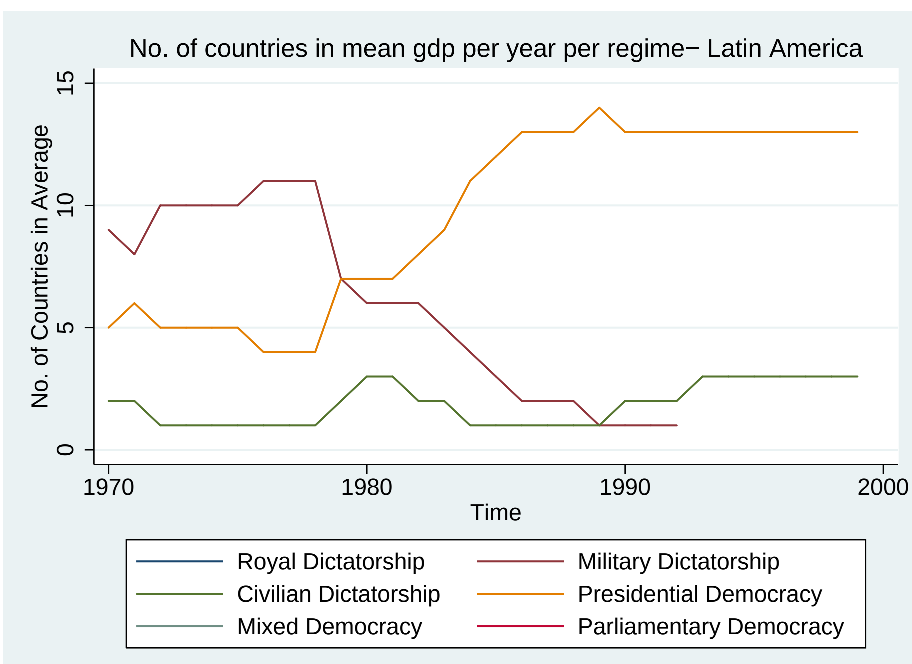
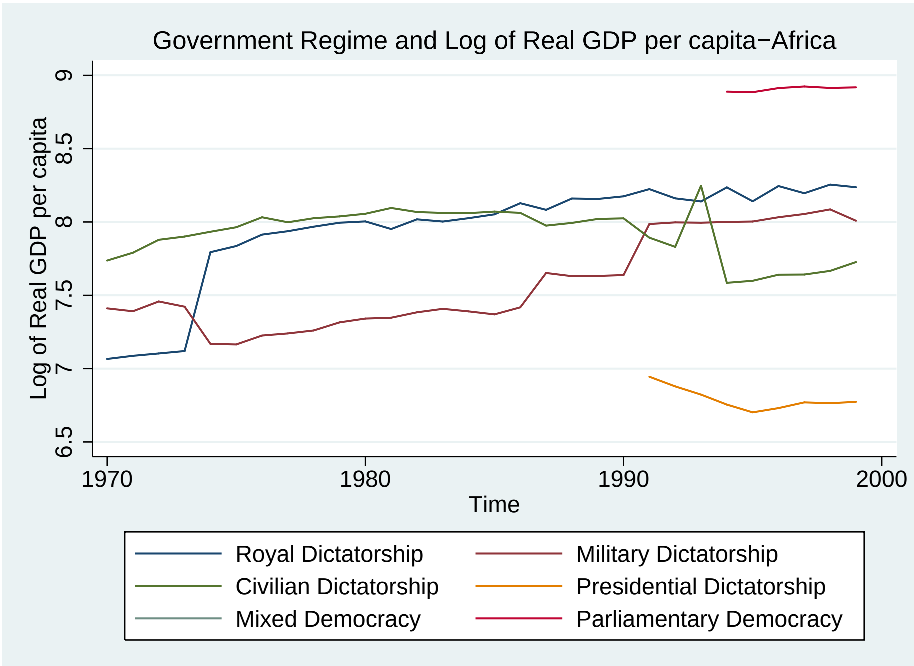


Figure 7: Per Capita Income over time by Political Regime Type: Africa

(a) log of Real GDP



(b) Average

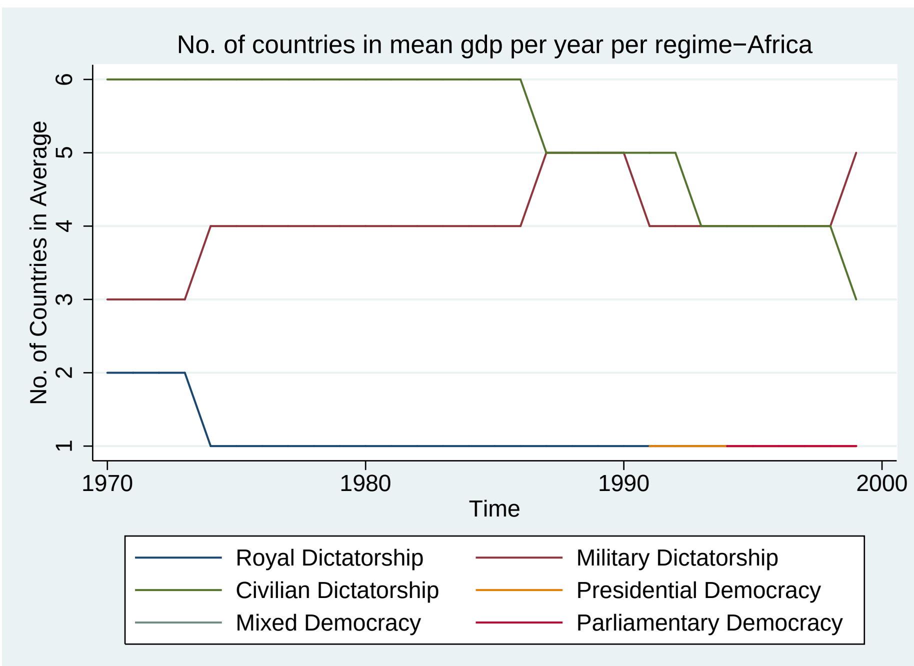
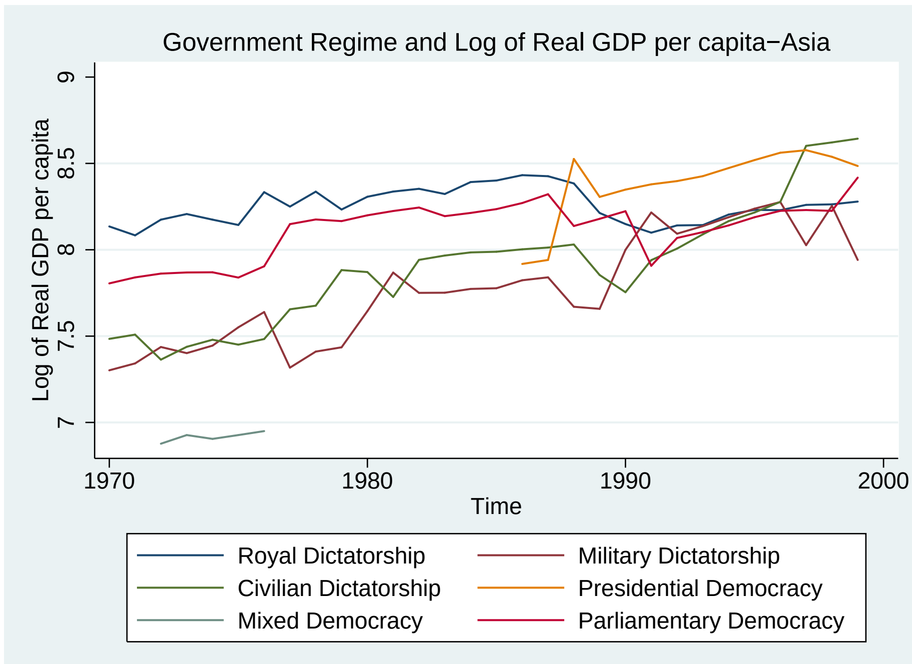


Figure 8: Per Capita Income over time by Political Regime Type: Asia

(a) log of Real GDP



(b) Average

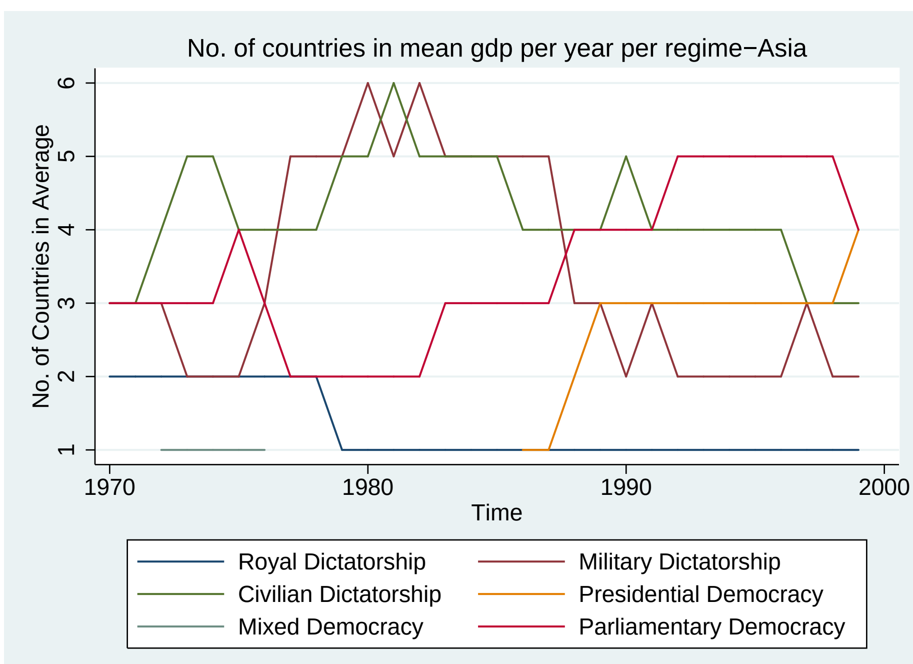


Table 7: OLS and IV Estimation: Impact of Democracy on Per Capita Income - Africa

	OLS	IV			
Instruments		Democracy	Democracy Binary	Autocratic Binary	All
Polity IV	0.0770	-0.417***	-0.379***	-0.360***	-0.332**
	(0.198)	(0.148)	(0.126)	(0.127)	(0.135)
Observations	169	169	169	169	169
No. Countries	12	12	12	12	12
Hansen J-Statistics			0.727	0.527	0.813
First Stage F-stat		39.70	21.62	25.86	18.71
Country Effects	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors clustered by country. All control variables remain the same. * $p < .10$, ** $p < .05$, *** $p < .01$

Table 8: OLS and IV Estimation: Impact of Democracy on Per Capita Income - Latin America

	(1) OLS	(2) Democracy	(3) Autocratic Binary
Polity	-0.0677	-0.0948	-0.127**
	(0.0486)	(0.0712)	(0.0559)
Observations	309	309	309
No. Countries	16	16	16
Hansen J-Statistics			0.199
First Stage F-stat		77.29	49.62
Country Effects	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes

Note: Robust standard errors clustered by country. All control variables remain the same. * $p < .10$, ** $p < .05$, *** $p < .01$

Table 9: OLS and IV Estimation: Impact of Democracy on Per Capita Income - Asia

	(1) OLS	(2) Democracy	(3) Democracy Binary	(4) Autocratic Binary	(5) All
Polity	-0.0446	0.0463	0.00203	0.0455	-0.00316
	(0.0622)	(0.108)	(0.0890)	(0.103)	(0.0831)
Observations	235	235	235	235	235
No. Countries	15	15	15	15	15
Hansen J-Statistics			0.200	0.951	0.413
First Stage F-stat		12.81	9.670	10.08	15.36
Country Effects	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors clustered by country. All control variables remain the same.
* $p < .10$, ** $p < .05$, *** $p < .01$

Table 10: IV Estimates: Impact of Democracy on Economic Growth: Instrumenting Polity Index with Lagged Democracy Measures

	(1) Democracy		(2) Democratic Regimes		(3) Autocratic Regime		(4) All	
Panel A								
Polity	0.0469	-0.103	0.126	-0.132*	0.0477	-0.121	0.121	-0.148**
	(0.146)	(0.0784)	(0.157)	(0.0762)	(0.117)	(0.0779)	(0.134)	(0.0748)
Observations	2178	720	2178	720	2178	720	2178	720
First Stage F-stat	178.5	71.06	80.74	53.71	74.86	48.74	60.86	50.46
Panel B								
Freedom House	0.107	-0.108	0.174	-0.123	0.0763	-0.129	0.159	-0.143*
	(0.157)	(0.0887)	(0.185)	(0.0879)	(0.118)	(0.0847)	(0.169)	(0.0837)
Observations	2187	693	2187	693	2187	693	2187	693
First Stage F-stat	121.0	75.15	51.55	54.90	68.59	59.66	33.95	104.2
No. Countries	88	44	88	44	88	44	88	44
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Country Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses
* $p < .10$, ** $p < .05$, *** $p < .01$

Table 11: OLS Estimates: Non-Linear Relationship between Democracy and Economic Growth

	(1) Quintile	(2) Polity	(3) OLS
Polity(.2-.4)	-0.0849		
	(0.0600)		
Polity(.4-.6)	-0.188***		
	(0.0644)		
Polity(.6-.8)	-0.0808		
	(0.0900)		
Polity(.8-1)	-0.169**		
	(0.0725)		
Polity (Anocracy)		-0.134**	
		(0.0589)	
Polity (Democracy)		-0.0923	
		(0.0766)	
Polity IV			-0.179*
			(0.100)
Observations	727	727	727
No. Countries	43	43	43
Controls	No	No	No
Country Effects	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes

Note: Robust standard errors clustered by country. Controls refer to population (total population, population over 65, and teen population) variables * $p < .10$, ** $p < .05$, *** $p < .01$

Table 12: OLS Estimates: Non-Linear Relationship between Democracy and Economic Growth - By Region

	(1) Quintile	(2) Polity	(3) OLS
Asia Polity(.2-.4)	-0.256***		
	(0.0949)		
Asia Polity(.4-.6)	-0.140*		
	(0.0805)		
Asia Polity(.6-.8)	0.00143		
	(0.151)		
Asia Polity(.8-1)	0.0207		
	(0.211)		
Africa Polity(.2-.4)	0.224		
	(0.133)		
Africa Polity(.4-.6)	-0.281***		
	(0.0917)		
Africa Polity(.6-.8)	0.382**		
	(0.167)		
Africa Polity(.8-1)	0.168		
	(0.223)		
America Polity(.2-.4)	0.223**		
	(0.107)		
America Polity(.4-.6)	-0.0175		
	(0.116)		
America Polity(.6-.8)	-0.196		
	(0.167)		
America Polity(.8-1)	-0.264		
	(0.223)		
Asia Polity(Anocracy)		0.0195	
		(0.153)	
Asia Polity(Democracy)		0.144	
		(0.181)	
Africa Polity(Anocracy)		-0.186	
		(0.285)	
Africa Polity(Democracy)		-0.496	
		(0.300)	
America Polity(Anocracy)		-0.186	
		(0.161)	
America Polity(Democracy)		-0.341*	
		(0.195)	
Asia Polity			0.101
			(0.271)
Africa Polity			-0.326
			(0.414)
America Polity			-0.394
			(0.285)
Observations	727	727	727
No. Countries	43	43	43
Controls	No	No	No
Country Effects	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes

Note: Robust standard errors clustered by country. Controls refer to population (total population, population over 65, and teen population) variables * $p < .10$, ** $p < .05$, *** $p < .01$

.3 Chapter 4

The decision for the firm to pursue an FDI can alternatively be modelled through dynamic programming. Specifically, the Hamilton-Jacobi Bellman equation can be presented as followed:

$$F(C_m, t) = max\left\{\varphi(C_m, t), (1+\rho dt)^{-1}E[F(C_m + dC_m, t+dt)]|C_m\right\} \tag{38}$$

Where $\varphi(C_m, t)$ is the immediate payoff $(1-\tau_H)\left[\frac{C_{m,t}}{\delta_H} - \frac{\varphi}{\delta_F^m}\right] + (1-\tau_F)\frac{(\varphi-1)}{\delta_F} - \kappa - \frac{(\varphi-1)^2}{\delta_F^m}$ and the second term on the right hand side of the equation is the value of delaying the project, discounted by the exogenous rate factor ρ. The value of delaying this investment opportunity yields no cash flows for holding onto the investment, but rather through capital appreciation (the additional savings when investing internationally). Thus, in this region, the bellman equation is now:

$$\rho F(C_m)dt = E\left(df(C_m)\right) \tag{39}$$

Which states that for a specific time frame dt, the total expected return of the FDI opportunity is equal to the expected rate of future savings when allocating into country m. Through Ito's lemma and simplifying equation 39 we now have the following ODE :

$$\frac{\varphi^2\sigma_F^2 C_m^2}{2} F_{C_m C_m} + (\alpha_F^m - \alpha_H)C_m f_{C_m} - (\rho - \alpha_H)f = 0 \tag{40}$$

An issue arises in exogenously choosing ρ. If the firm discounts cash flows at the risk free rate where $\rho = r$, while $\alpha = \rho - \delta$, then either contingent claims (as seen in equation 4.7a) or dynamic programming (equation 40) provide the same analytical results.

Derivation of Jump Diffusion ODE

Given the dynamics of the foreign cost structure, through Ito's Lemma, the differential equation for the value of the FDI option can be represented as:

$$\frac{\sigma_F^2 C_F^2}{2}\frac{\partial^2 F}{\partial C_F^2} + (r-\delta_H)\frac{\partial F}{\partial C_H}C_H + (r-\delta_F)C_F\frac{\partial F}{\partial C_F} + \lambda_1\left[F(C_F(1+\phi_1)) - F\right] - \lambda_2[F - F[C_F(1-\phi_2)]] - rF = 0 \tag{41}$$

Where $F(C_H, C_F) = C_F f(C_m)$. If we define the following set of partial differentiations:

$\frac{\partial F}{\partial C_H} = f_{C_m} \quad \frac{\partial F}{\partial C_F} = -\frac{C_H}{C_F} + f \quad \frac{\partial^2 F}{\partial C_F^2} = (\frac{C_H}{C_F})^2 \frac{1}{C_F} f_{C_m,C_m}$

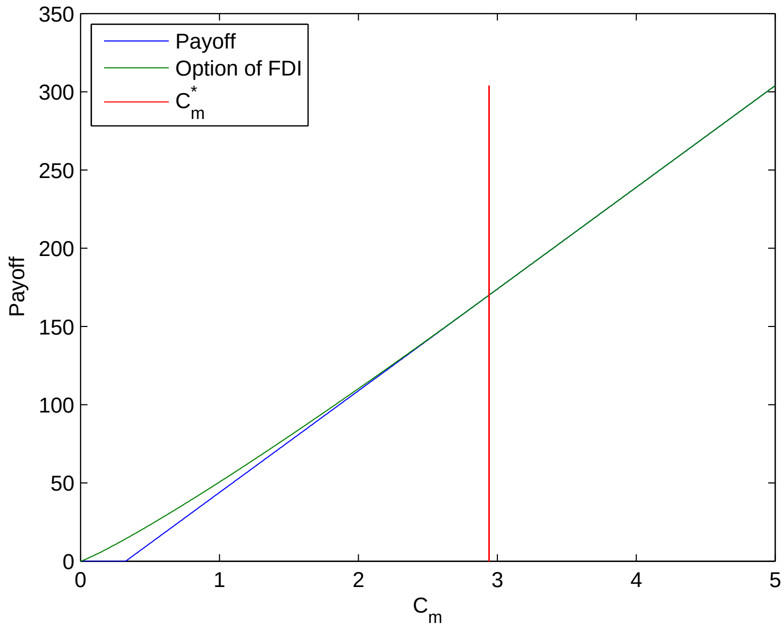
By substituting the above partial differentiations into 41 and multiplying by $\frac{1}{C_F}$, we get:

$$\frac{\sigma_F^2 C_m^2}{2} f_{C_m C_m} + (\delta_F - \delta_H) C_m f_{C_m} + \lambda_1 [f(1+\phi_1) - f] - \lambda_2 [f - f(1-\phi_2)] - \delta_F f = 0 \qquad C_m < C_m^*$$

Which is the ODE presented in equation 4.19a, section 4.3.3.

Figure 9: Optimal Investment Strategy: GBM and Jump Diffusion Model

(a) Base Case



(b) Jump Diffusion

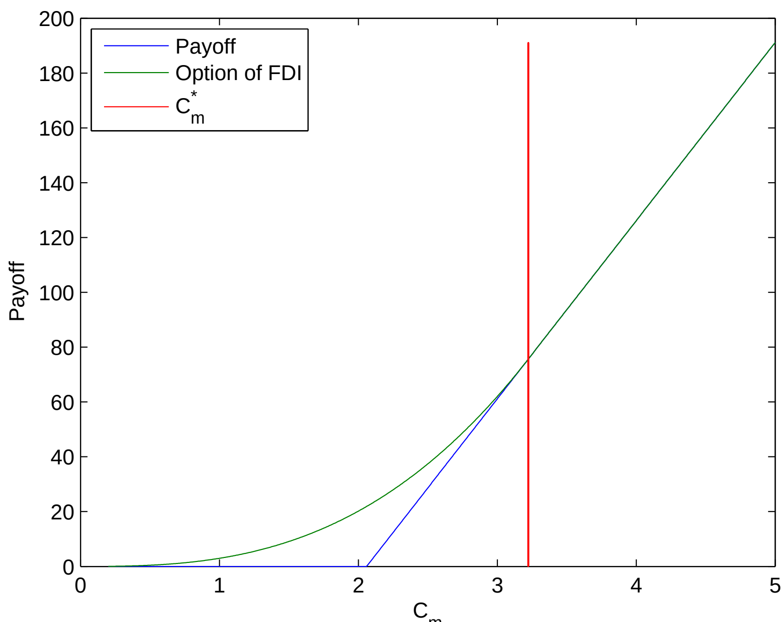
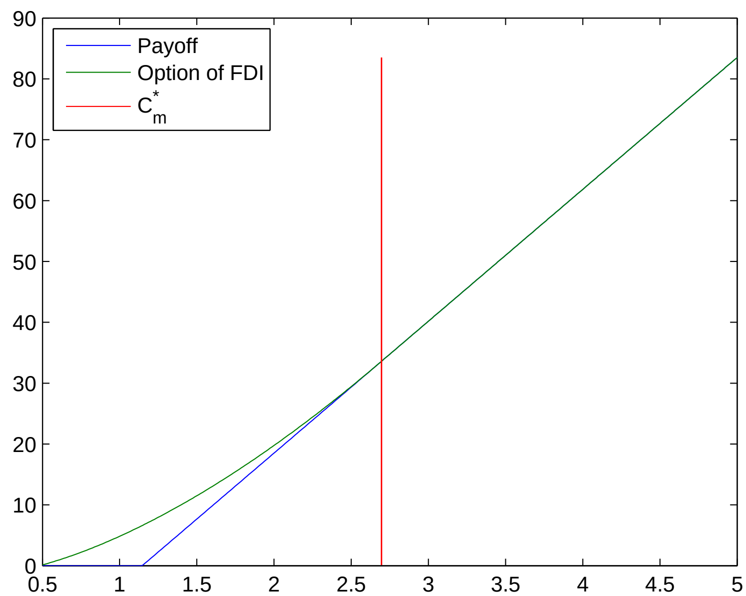


Figure 10: Optimal Investment Strategy: Regime Switching Case

(a) Low Political Risk



(b) High Political Risk

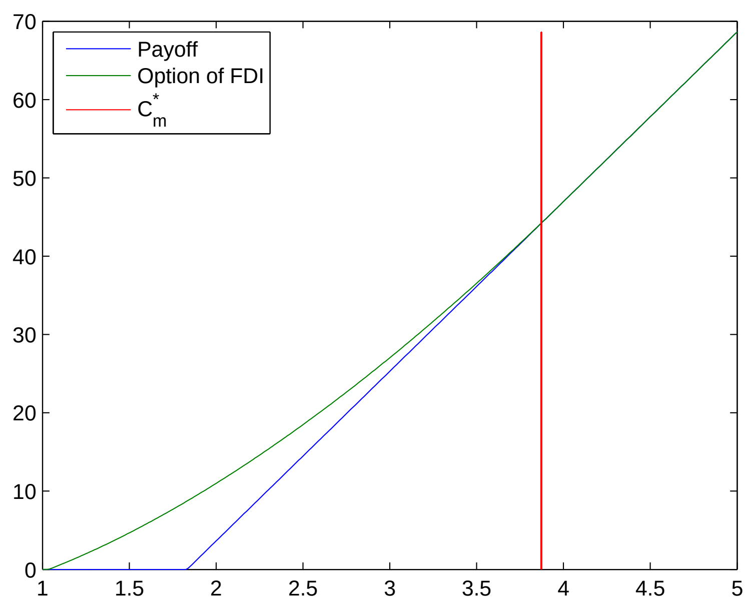
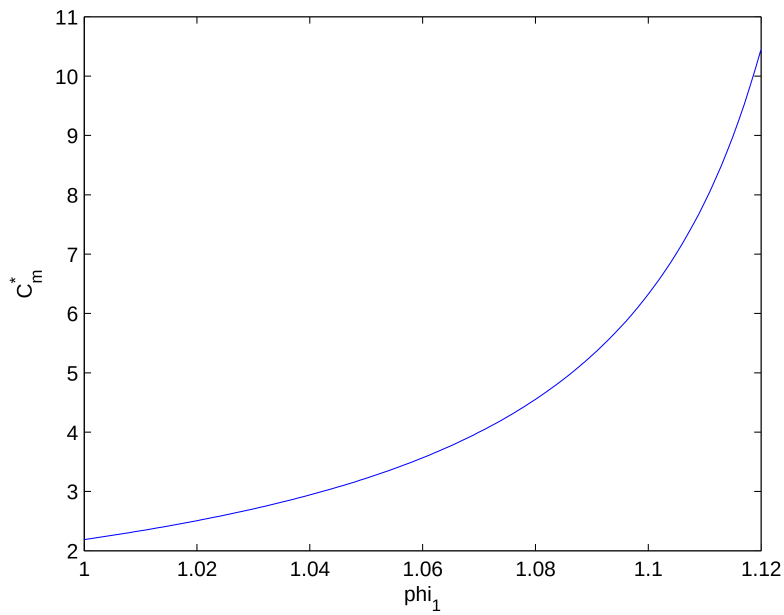


Figure 11: Sensitivity Analysis: Size of Jump and its Impact on the Optimal Investment Strategy

(a) Upwards Jump



(b) Downwards Jump

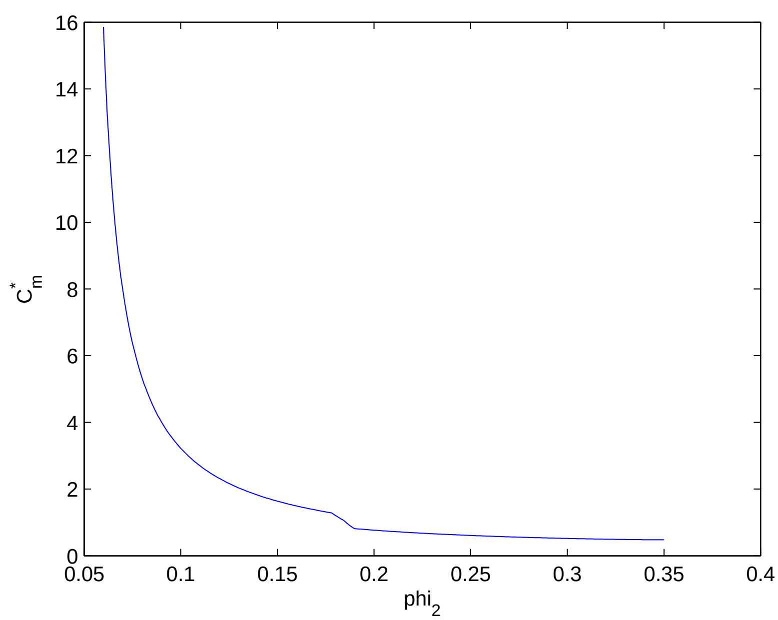
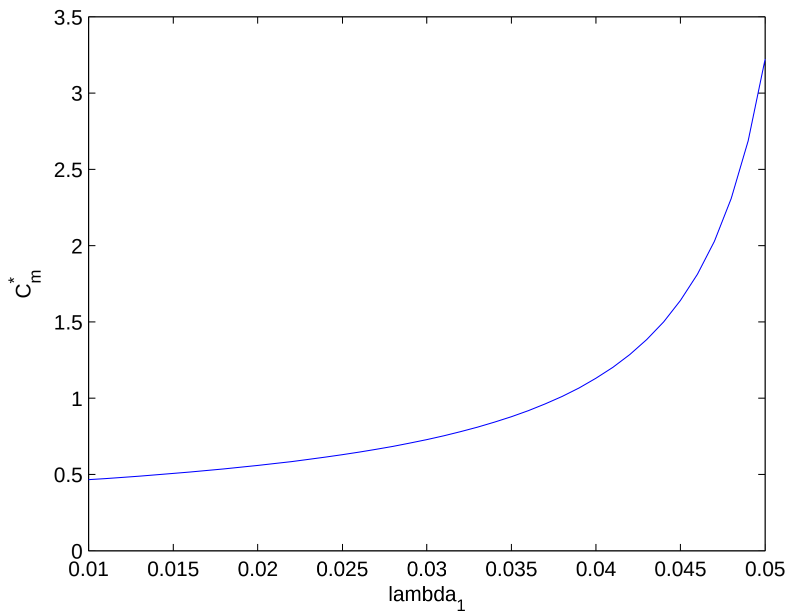


Figure 12: Sensitivity Analysis: Frequency of Jumps and its Impact on the Optimal Investment Strategy

(a) Upwards Jump



(b) Downwards Jump

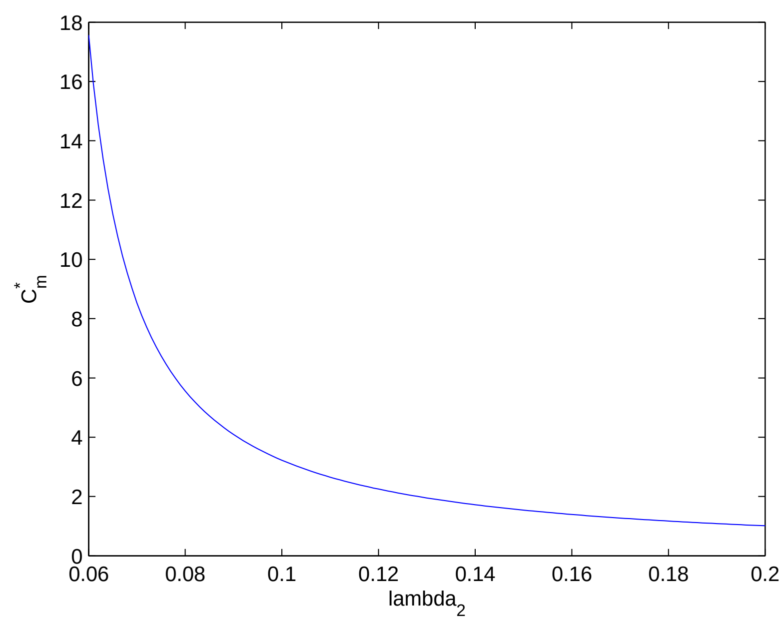
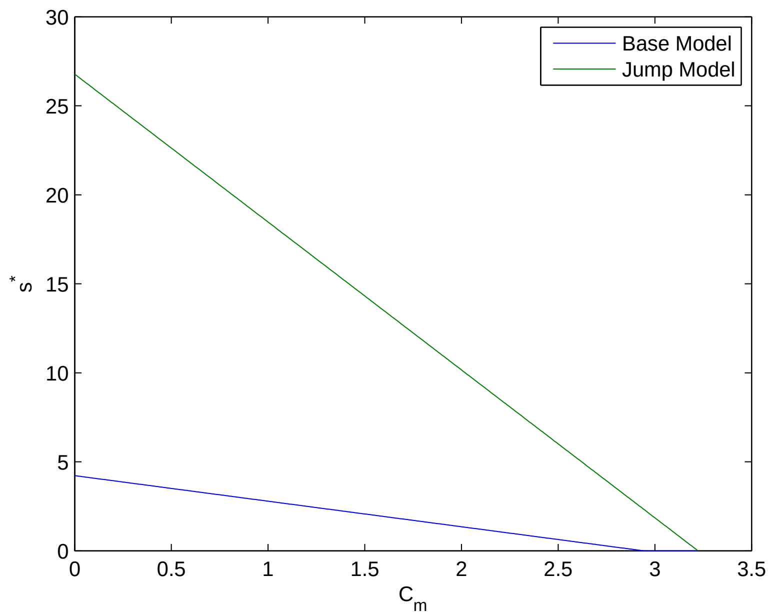


Figure 13: Incentive Package to ensure Immediate Investment: Tax Credits and Infrastructure Subsidy

(a) Infrastructure Subsidy



(b) Tax Credits

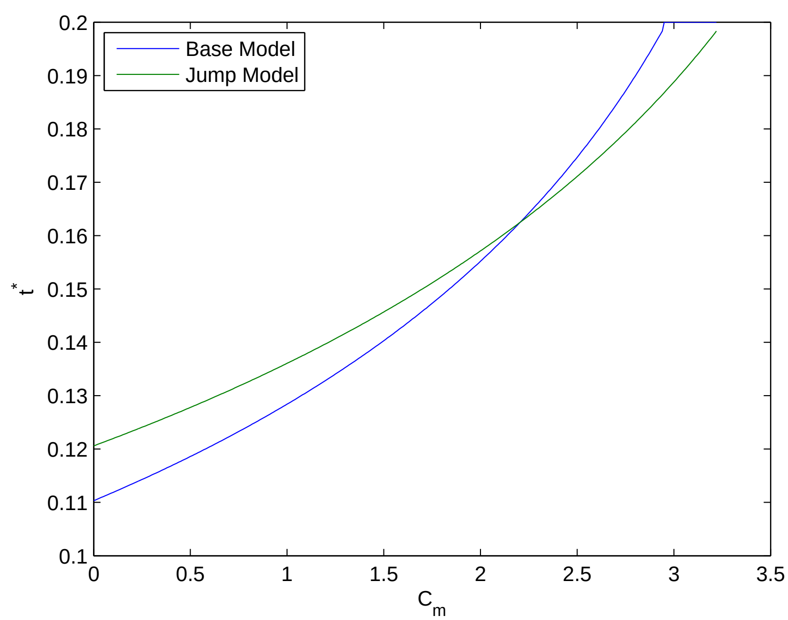
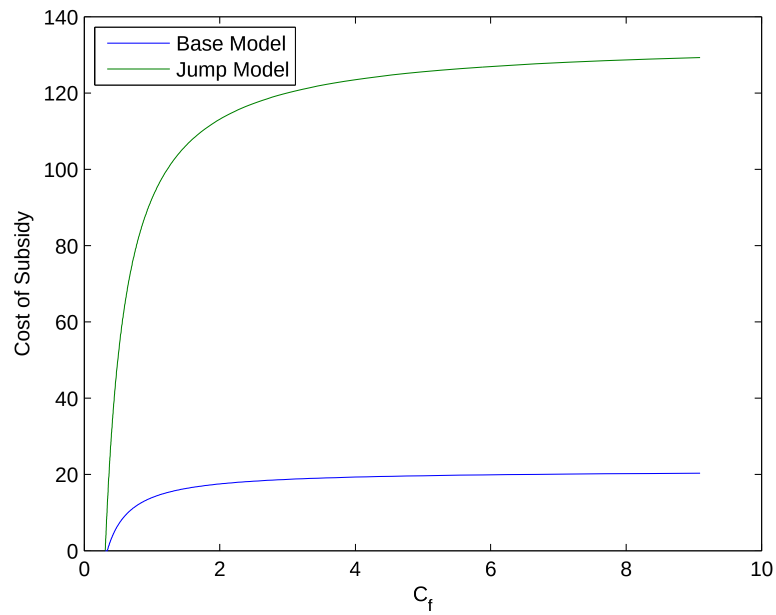


Figure 14: Per Unit Cost Of Subsidies and Tax Credits

(a) Infrastructure Subsidy Cost



(b) Tax Credit Cost

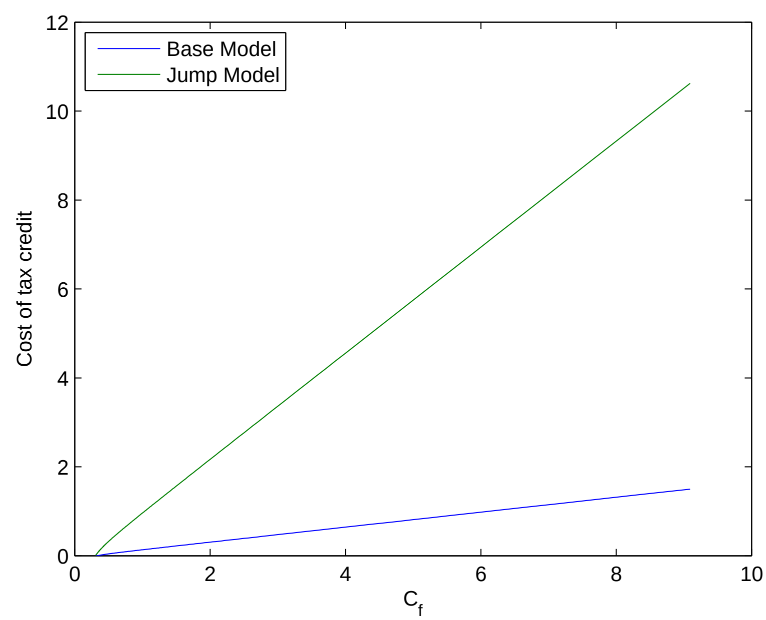
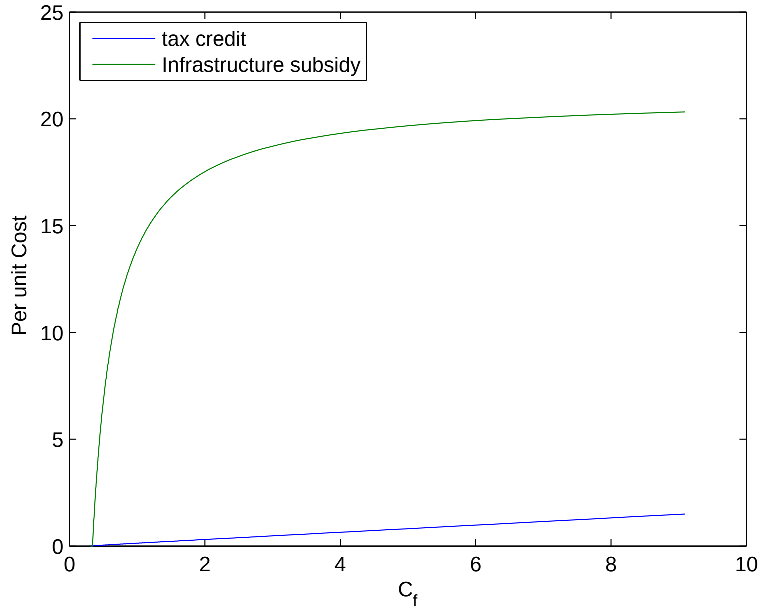


Figure 15: Infrastructure Versus Tax Credit

(a) Base Case



(b) Jump Case

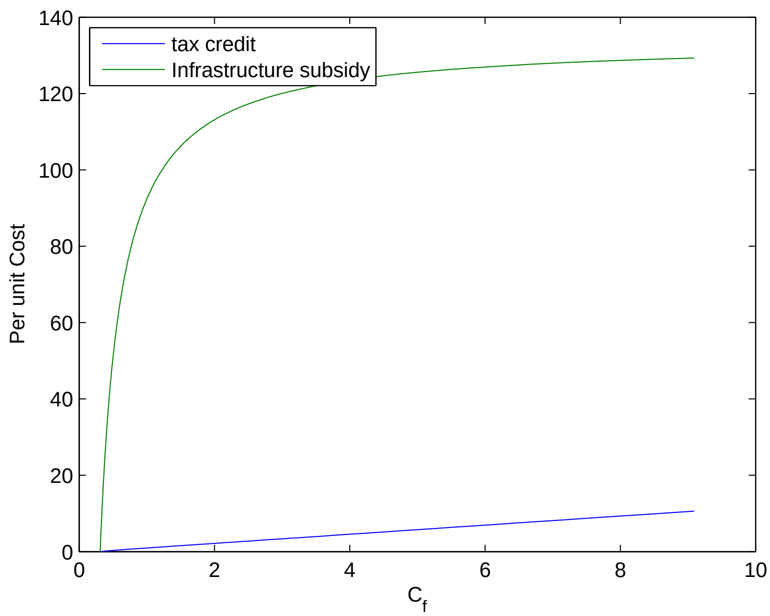
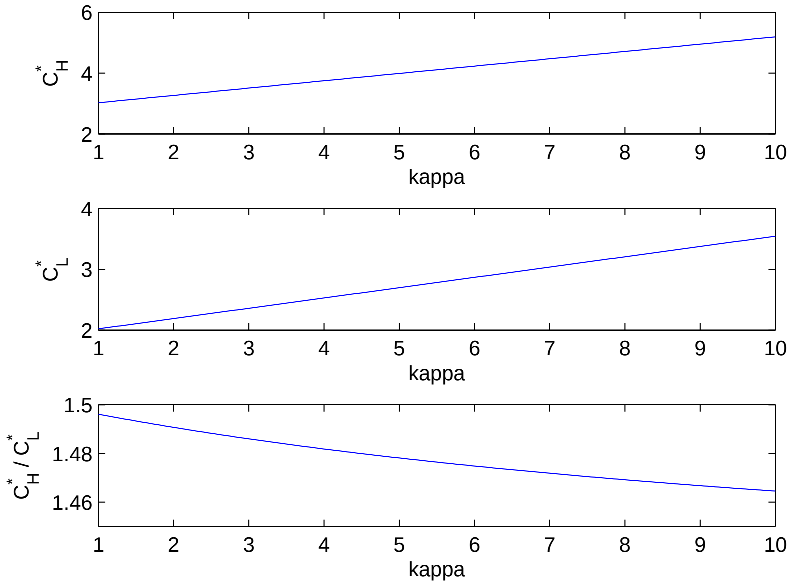
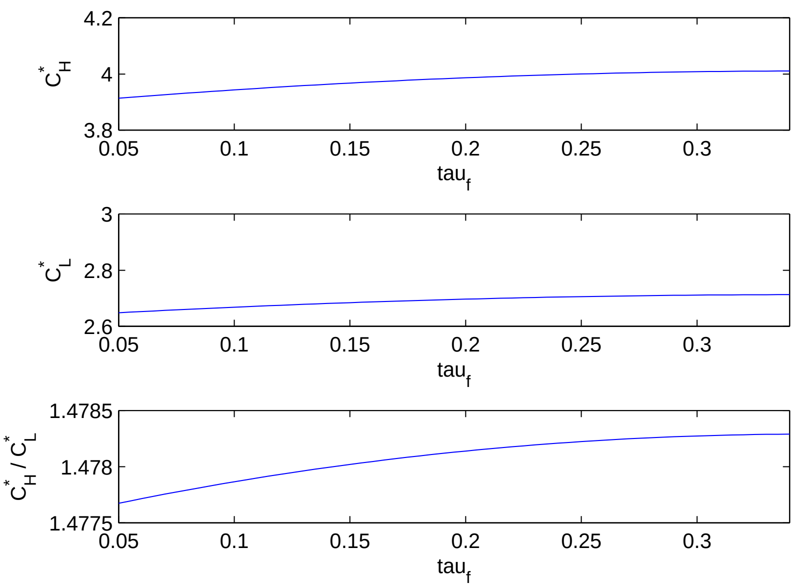


Figure 16: Impact of Infrastructure Subsidies and Tax Credits on Optimal Investment Strategy: Regime-Switching Case

(a) Infrastructure Subsidy



(b) Tax Credit



References

Acemoglu, D., Johnson, S., Robinson, J. A., and Yared, P. (2008). Income and democracy. *The American Economic Review*, pages 808–842.

Acemoglu, D., Johnson, S., Robinson, J. A., and Yared, P. (2009). Reevaluating the modernization hypothesis. *Journal of Monetary Economics*, 56(8):1043–1058.

Acemoglu, D., Naidu, S., Restrepo, P., and Robinson, J. A. (2014). Democracy does cause growth. Technical report, National Bureau of Economic Research.

Acemoglu, D. and Verdier, T. (1998). Property rights, corruption and the allocation of talent: a general equilibrium approach. *The Economic Journal*, 108(450):1381–1403.

Aghion, P., Alesina, A., and Trebbi, F. (2004). Endogenous political institutions. *The Quarterly Journal of Economics*, 119(2):565–611.

Aghion, P., Alesina, A. F., and Trebbi, F. (2007). Democracy, technology, and growth.

Aizenman, J. and Marion, N. (2004). The merits of horizontal versus vertical fdi in the presence of uncertainty. *Journal of International economics*, 62(1):125–148.

Alfaro, L. and Charlton, A. (2007). Intra-industry foreign direct investment. Technical report, National Bureau of Economic Research.

Allred, B. B. and Park, W. G. (2007). Patent rights and innovative activity: evidence from national and firm-level data. *Journal of International Business Studies*, 38(6):878–900.

Antràs, P. (2003). Firms, contracts, and trade structure. Technical report, National Bureau of Economic Research.

Arrow, K. (1962). Economic welfare and the allocation of resources for invention. In *The rate and direction of inventive activity: Economic and social factors*, pages 609–626. Nber.

Barro, R. J. (1996). Democracy and growth. *Journal of economic growth*, 1(1):1–27.

Barro, R. J. (1999). Determinants of democracy. *Journal of Political economy*, 107(S6):S158–S183.

Bekaert, G., Harvey, C. R., Lundblad, C. T., and Siegel, S. (2013). Political risk spreads. *Available at SSRN*.

Bellak, C., Leibrecht, M., and Riedl, A. (2008). Labour costs and fdi flows into central and eastern european countries: A survey of the literature and empirical evidence. *Structural Change and Economic Dynamics*, 19(1):17–37.

Bessen, J. and Maskin, E. (2009). Sequential innovation, patents, and imitation. *The RAND Journal of Economics*, 40(4):611–635.

Braconier, H., Norbäck, P.-J., and Urban, D. (2005). Multinational enterprises and wage costs: vertical fdi revisited. *Journal of International Economics*, 67(2):446–470.

Brainard, S. L. (1993). An empirical assessment of the proximity-concentration tradeoff between multinational sales and trade. Technical report, National Bureau of Economic Research.

Branstetter, L. and Saggi, K. (2011). Intellectual property rights, foreign direct investment and industrial development*. *The Economic Journal*, 121(555):1161–1191.

Braunerhjelm, P. and Thulin, P. (2009). Agglomeration, relative wage costs and foreign direct investmentevidence from swedish mncs 1974–1998. *Journal of industry, competition and trade*, 9(3):197–217.

Brückner, M. and Ciccone, A. (2011). Rain and the democratic window of opportunity. *Econometrica*, 79(3):923–947.

Busse, M. and Hefeker, C. (2007). Political risk, institutions and foreign direct investment. *European Journal of Political Economy*, 23(2):397–415.

Capel, J. (1992). How to service a foreign market under uncertainty: a real option approach. *European journal of political economy*, 8(3):455–475.

Carr, D. L., Markusen, J. R., and Maskus, K. E. (2001). Estimating the knowledge-capital model of the multinational enterprise. *The American Economic Review*, 91(3):693–708.

Che, Y., Lu, Y., Tao, Z., and Wang, P. (2013). The impact of income on democracy revisited. *Journal of Comparative Economics*, 41(1):159–169.

Cheibub, J. A. (2006). Presidentialism, electoral identifiability, and budget balances in democratic systems. *American Political Science Review*, 100(3):353.

Cheibub, J. A., Gandhi, J., and Vreeland, J. R. (2010). Democracy and dictatorship revisited. *Public Choice*, 143(1-2):67–101.

Chen, Y.-F. and Funke, M. (2011). Institutional uncertainty, economic integration, and vertical foreign direct investment decisions. *Open Economies Review*, 22(4):593–612.

Comeau, L. (2003). Democracy and growth: A relationship revisited. *Eastern Economic Journal*, 29(1):1–21.

Corato, L. D. (2013). Profit sharing under the threat of nationalization. *Resource and Energy Economics*.

Danielova, A. and Sarkar, S. (2011). The effect of leverage on the tax-cut versus investment-subsidy argument. *Review of Financial Economics*, 20(4):123–129.

Davies, R. B. (2008). Hunting high and low for vertical fdi. *Review of International Economics*, 16(2):250–267.

Deacon, R. T. (2009). Public good provision under dictatorship and democracy. *Public Choice*, 139(1-2):241–262.

Dinopoulos, E. and Segerstrom, P. (2010). Intellectual property rights, multinational firms and economic growth. *Journal of Development Economics*, 92(1):13–27.

Dixit, A. (2009). Governance institutions and economic activity. *The American Economic Review*, 99(1):3–24.

Dixit, A. K. (1994). *Investment under uncertainty*. Princeton university press.

Doucouliagos, H. and Ulubaşoğlu, M. A. (2008). Democracy and economic growth: a meta-analysis. *American Journal of Political Science*, 52(1):61–83.

Driffill, J., Kenc, T., and Sola, M. (2013). Real options with priced regime-switching risk. *International Journal of Theoretical and Applied Finance*, 16(05).

Driffill, J., Raybaudi, M., and Sola, M. (2003). Investment under uncertainty with stochastically switching profit streams: Entry and exit over the business cycle. *Studies in Nonlinear Dynamics & Econometrics*, 7(1).

Dunning, J. H. et al. (1976). *Trade, location of economic activity and the MNE: A search for an eclectic approach.* University of Reading, Department of Economics.

Ekholm, K. (1998). Proximity advantages, scale economies, and the location of production. In *The geography of multinational firms*, pages 59–76. Springer.

Elliott, R. J., Miao, H., and Yu, J. (2009). Investment timing under regime switching. *International Journal of Theoretical and Applied Finance*, 12(04):443–463.

Epstein, D. L., Bates, R., Goldstone, J., Kristensen, I., and O'Halloran, S. (2006). Democratic transitions. *American journal of political science*, 50(3):551–569.

Ewald, C.-O. and Wang, W.-K. (2010). Irreversible investment with cox–ingersoll–ross type mean reversion. *Mathematical Social Sciences*, 59(3):314–318.

Feld, L. P. and Heckemeyer, J. H. (2011). Fdi and taxation: A meta-study. *Journal of economic surveys*, 25(2):233–272.

Fukao, K. and Wei, Y. (2008). How do the location determinants of vertical fdi and horizontal fdi differ? *Hi-Stat Discussion Paper Series*, (233).

Gerring, J., Bond, P., Barndt, W. T., and Moreno, C. (2005). Democracy and economic growth. *World Politics*, 57(3):323–364.

Gerring, J., Thacker, S. C., and Moreno, C. (2009). Are parliamentary systems better? *Comparative Political Studies*, 42(3):327–359.

Ginarte, J. C. and Park, W. G. (1997). Determinants of patent rights: A cross-national study. *Research policy*, 26(3):283–301.

Glaeser, E. L., La Porta, R., Lopez-de Silanes, F., and Shleifer, A. (2004). Do institutions cause growth? *Journal of economic Growth*, 9(3):271–303.

Glass, A. J. and Saggi, K. (2002). Intellectual property rights and foreign direct investment. *Journal of International economics*, 56(2):387–410.

Granstrand, O. (2005). Innovation and intellectual property rights. *The Oxford handbook of innovation.*

Green, J. R. and Scotchmer, S. (1995). On the division of profit in sequential innovation. *The RAND Journal of Economics*, pages 20–33.

Grossman, G. M. and Helpman, E. (2003). Outsourcing versus fdi in industry equilibrium. *Journal of the European Economic Association*, 1(2-3):317–327.

Grossman, G. M., Helpman, E., and Szeidl, A. (2006). Optimal integration strategies for the multinational firm. *Journal of International Economics*, 70(1):216–238.

Guo, X., Miao, J., and Morellec, E. (2005). Irreversible investment with regime shifts. *Journal of Economic Theory*, 122(1):37–59.

Hainaut, D. (2012). Entry and exit decisions with switching regime cash flows. *International Journal of Managerial Finance*, 8(1):58–72.

Hall, B. H. (2007). Patents and patent policy. *Oxford Review of Economic Policy*, 23(4):568–587.

Heid, B., Langer, J., and Larch, M. (2012). Income and democracy: Evidence from system gmm estimates. *Economics Letters*, 116(2):166–169.

Helliwell, J. F. (1994). Empirical linkages between democracy and economic growth. *British journal of political science*, 24(02):225–248.

Helpman, E. (1984). A simple theory of international trade with multinational corporations. *The Journal of Political Economy*, pages 451–471.

Helpman, E. (1992). Innovation, imitation, and intellectual property rights. Technical report, National Bureau of Economic Research.

Hillman, A. J., Keim, G. D., and Schuler, D. (2004). Corporate political activity: A review and research agenda. *Journal of Management*, 30(6):837–857.

Horstmann, I. J. and Markusen, J. R. (1987). Strategic investments and the development of multinationals. *International Economic Review*, 28(1):109–121.

Horstmann, I. J. and Markusen, J. R. (1992). Endogenous market structures in international trade (natura facit saltum). *Journal of International Economics*, 32(1):109–129.

Huntington, S. P. (1991). *The third wave: Democratization in the late twentieth century*, volume 4. University of Oklahoma Press.

Jaffe, A. B. (2000). The us patent system in transition: policy innovation and the innovation process. *Research policy*, 29(4):531–557.

Jaffe, A. B. and Lerner, J. (2011). *Innovation and its discontents: How our broken patent system is endangering innovation and progress, and what to do about it.* Princeton University Press.

Jinjarak, Y. (2007). Foreign direct investment and macroeconomic risk. *Journal of Comparative Economics*, 35(3):509–519.

Kanwar, S. and Evenson, R. (2003). Does intellectual property protection spur technological change? *Oxford Economic Papers*, 55(2):235–264.

Knutsen, C. H. (2010). Measuring effective democracy. *International Political Science Review*, 31(2):109–128.

Knutsen, C. H. (2011). Which democracies prosper? electoral rules, form of government and economic growth. *Electoral Studies*, 30(1):83–90.

Lai, E. L.-C. (1998). International intellectual property rights protection and the rate of product innovation. *Journal of Development economics*, 55(1):133–153.

Lake, D. A. and Baum, M. A. (2001). The invisible hand of democracy political control and the provision of public services. *Comparative Political Studies*, 34(6):587–621.

Lemley, M. A. and Shapiro, C. (2006). Patent holdup and royalty stacking. *Tex. L. Rev.*, 85:1991.

Lipset, S. M. (1959). Some social requisites of democracy: Economic development and political legitimacy. *The American political science review*, 53(1):69–105.

Londregan, J. B. and Poole, K. T. (1996). Does high income promote democracy? *World politics*, 49:1–30.

Lott, J. (1998). Public schooling, indoctrination, and totalitarianism. *Journal of Political Economy*, 107(6 Part 2):S127–S157.

Markusen, J. R. (1997). Trade versus investment liberalization. Technical report, National Bureau of Economic Research.

Markusen, J. R. and Venables, A. J. (1998). Multinational firms and the new trade theory. *Journal of international economics*, 46(2):183–203.

Markusen, J. R., Venables, A. J., Konan, D. E., and Zhang, K. H. (1996). A unified treatment of horizontal direct investment, vertical direct investment, and the pattern of trade in goods and services. Technical report, National Bureau of Economic Research.

McDonald, R. and Siegel, D. (1986). The value of waiting to invest. *The Quarterly Journal of Economics*, 101(4):707–727.

Moral-Benito, E. and Bartolucci, C. (2012). Income and democracy: revisiting the evidence. *Economics Letters*, 117(3):844–847.

Nishide, K. and Nomi, E. K. (2009). Regime uncertainty and optimal investment timing. *Journal of Economic Dynamics and Control*, 33(10):1796–1807.

Nordhaus, W. D. (1969). *Invention, growth, and welfare: A theoretical treatment of technological change*. MIT press Cambridge, MA.

OECD (2001). Transfer pricing guidelines for multinational enterprises and tax administration. *OECD Publications*.

Ottaviano, G. I. and Turrini, A. (2007). Distance and foreign direct investment when contracts are incomplete. *Journal of the European Economic Association*, 5(4):796–822.

Papaioannou, E. and Siourounis, G. (2008). Democratisation and growth*. *The Economic Journal*, 118(532):1520–1551.

Park, W. G. (2008). International patent protection: 1960–2005. *Research policy*, 37(4):761–766.

Park, W. G. (2012). North–south models of intellectual property rights: an empirical critique. *Review of World Economics*, 148(1):151–180.

Pennings, E. (2000). Taxes and stimuli of investment under uncertainty. *European Economic Review*, 44(2):383–391.

Pennings, E. (2005). How to maximize domestic benefits from foreign investments: the effect of irreversibility and uncertainty. *Journal of Economic Dynamics and Control*, 29(5):873–889.

Persson, T. and Tabellini, G. (2007). The growth effect of democracy: Is it heterogenous and how can it be estimated?

Plümper, T. and Martin, C. W. (2003). Democracy, government spending, and economic growth: A political-economic explanation of the barro-effect. *Public Choice*, 117(1-2):27–50.

Przeworski, A., Alvarez, M. E., Cheibub, J. A., and Limongi, F. (2000). *Democracy and development: political institutions and well-being in the world, 1950-1990*, volume 3. Cambridge University Press.

Przeworski, A. and Limongi, F. (1993). Political regimes and economic growth. *The journal of economic perspectives*, 7(3):51–69.

Qian, Y. (2007). Do national patent laws stimulate domestic innovation in a global patenting environment? a cross-country analysis of pharmaceutical patent protection, 1978-2002. *The Review of Economics and Statistics*, 89(3):436–453.

Qiu, L. D. and Yu, H. (2010). Does the protection of foreign intellectual property rights stimulate innovation in the us? *Review of International Economics*, 18(5):882–895.

Rafiquzzaman, M. (2002). The impact of patent rights on international trade: Evidence from canada. *Canadian Journal of Economics/Revue canadienne d'économique*, 35(2):307–330.

Rodrik, D. and Wacziarg, R. (2005). Do democratic transitions produce bad economic outcomes? *The American economic review*, 95(2):50–55.

Ruiz-Aliseda, F. and Wu, J. (2012). Irreversible investment in stochastically cyclical markets. *Journal of Economics & Management Strategy*, 21(3):801–847.

Sakakibara, M. and Branstetter, L. (1999). Do stronger patents induce more innovation? evidence from the 1988 japanese patent law reforms. Technical report, National bureau of economic research.

Sarkar, S. (2012). Attracting private investment: Tax reduction, investment subsidy, or both? *Economic Modelling*, 29(5):1780–1785.

Tavares, J. and Wacziarg, R. (2001). How democracy affects growth. *European Economic Review*, 45(8):1341–1378.

Wei, S.-J. (2000). How taxing is corruption on international investors? *Review of economics and statistics*, 82(1):1–11.

Yeaple, S. R. (2003a). The complex integration strategies of multinationals and cross country dependencies in the structure of foreign direct investment. *Journal of International Economics*, 60(2):293–314.

Yeaple, S. R. (2003b). The role of skill endowments in the structure of us outward foreign direct investment. *Review of Economics and Statistics*, 85(3):726–734.