Examining Investment in Natural Gas Infrastructure: Governability, Policy and Regulatory Analysis in Qualitative Perspective

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A mis padres, mi hermano, mi esposa y mi hija dedico esta tesis…por siempre mi agradecimiento y amor

Contents

List of Abbreviations

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ASEA	National Agency of Industrial Security and Environment Protection of the Hydrocarbons Sector (Mexico)
BcF	Billion cubic feet
CENACE	National Center of Energy Control (Mexico)
CENAGAS	Centro de Control Nacional de Gas Natural (Mexico)
CFE	Federal Electricity Commission (Mexico)
CNH	National Commission of Hydrocarbons (Mexico)
CO2	Carbon dioxide
CRE	Energy Regulatory Commission (Mexico)
DCCE	Department of Climate Change and Energy Efficiency (Australia)
DFAT	Australian Department of Foreign Affairs
DRET	Department of Resources, Energy and Tourism (Australia)
EC	European Commission
EI	Energy Markets Inspectorate (Sweden)
EIA	U.S. Energy Information Administration
EU	European Union
FINGI	Financial investment in natural gas infrastructure
GDP	Gross domestic product
GFC	Global financial crisis
GI	Governing interactions
GS	Governance system
GWh	Gigawatt hour
IEA	International Energy Agency
IVA	Royal Swedish Academy of Engineering Sciences
LNG	Liquefied natural Gas
LPG	Liquefied petroleum gas
MMCF/D	Million cubic feet per day
NAFTA	North American Free Trade Agreement
OECD	Organisation for Economic Cooperation and Development
PGPB	Pemex Gas y Petroquímica Básica (Mexico)
PND	National Development Plan (Mexico)
POLCON	Political Constraints Index
SEA	Swedish Energy Agency
SEK	Swedish Krona
SENER	Secretariat of Energy (Mexico)
SNG	National Pipeline System (Mexico)
SWFI	Sovereign Wealth Fund Institute
SG	System-to-be-governed
Tcf	Trillion cubic feet
TWh	Terawatt hour(s)

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Abstract

This thesis consists of three articles that study qualitatively investment in natural gas infrastructure with emphasis on regulatory governance, regulatory and energy policies and governability using different research methodologies. The explanandum is multi-dimensional, multidisciplinary, comparable and relevant to the social and political sciences. The main objective is generating knowledge about the explanandum. The first article studies the link between the energy transition, regulatory and energy policies and investment in natural gas infrastructure in Sweden. The second article studies if Mexico's transmission pipelines are becoming governable and the sorts of governability components (ie system-to-be-governed, governance system and governing interactions) that attracted investment in natural gas infrastructure over the period 1995-2015. The third article is a case comparison that studies Australia and Sweden during the 2000-10 period focused on the process surrounding investment in natural gas infrastructure with emphasis on institutional conditions, regulatory governance and regulatory and energy policies.

Resumen

Esta tesis consiste en tres artículos que estudian cualitativamente inversión en infraestructura de gas natural con énfasis en gobernanza regulatoria, políticas energéticas y regulatorias y gobernabilidad utilizando diferentes metodologías de investigación. El explanandum es multidimensional, multidisciplinario, comparable y de relevancia para las Ciencias Políticas y Sociales. El objetivo principal es generar conocimiento sobre el explanandum. El primer artículo estudia el vínculo entre la transición energética, las políticas energéticas y regulatorias y la inversión en infraestructura de gas natural en Suecia. El segundo artículo estudia si los gaseoductos de transmisión en México se están volviendo gobernables y los tipos de componente de gobernabilidad (ie sistema a ser gobernado, sistema de gobernanza e interacciones gobernantes) que atrajeron inversión en infraestructura de gas natural en el periodo 1995-2015. El tercer artículo es una comparación de casos que estudia Australia y Suecia en el periodo 2000-10 enfocado en el proceso que rodea a la inversión en infraestructura de gas natural con énfasis en las condiciones institucionales, la gobernanza regulatoria y las políticas regulatorias y energéticas.

1. INTRODUCTION

Financial investment in natural gas infrastructure (FINGI) is the explanandum of this thesis. The gas industry is divided into the upstream, midstream and downstream sectors and FINGI belongs to the midstream sector. The latter is composed of "transmission pipelines, storage facilities, and in some parlance, gathering and processing facilities" (Pierce 2014:1) and the focus of FINGI is on transmission pipelines with some references to the other components.

FINGI is required to develop the infrastructure needed to transport natural gas and is the outcome of a complex process with multiple dimensions that is best studied from a multidisciplinary approach. Investment in natural gas infrastructure has been less explored than investment in infrastructure in other utilities (ie telecommunications, electricity and water). The explanandum studies a strategic sector that is important in the real world as it "significantly affects many people's lives" (King et al. 1994:15) and that is relevant to political science due to the way in which it is studied.

This thesis is a compilation of three original articles. These articles study FINGI in constant evolution. The study of this explanandum is relevant because it allows the transportation of natural gas, which nowadays represents approximately a fifth of the world energy consumption. Energy and energy taxation policies targeting reductions of CO2 emissions are undergoing a global diffusion process and natural gas is envisioned as part of the solution in present and future scenarios due to its environmentally friendly characteristics and proven reliability. Nonetheless methane is a potent greenhouse gas and flaring and venting of natural gas is frequently part of its production. In addition the production of unconventional gas (ie shale gas, coal seam gas and tight gas) using fracking poses serious environmental challenges and liquefied natural gas projects are on the rise. These conditions urge for regulation to guarantee best practice.

FINGI is studied in practice with a focus on the impact of regulatory governance and energy, energy taxation and regulatory policies on the explanandum. The analysis of industry conditions is also relevant in the current development of a global gas market which has restructured ownership, market organization and structure, and supply and

demand (EIA 2014). Investment in gas infrastructure is no more the sole responsibility of the state and it is no longer dominated by public investment. Financial capital is nowadays "the main source of investment in natural gas infrastructure" (Hernández Ibarzábal 2011:231). However it is unclear to which degree the scale characteristics have prevailed in gas transportation.

Contrary to regulatory and liberalisation reforms fostering competition, the cases studied showed that natural gas transportation has preserved and even accentuated some of its scale characteristics. A primary objective of the reforms in the gas sector in Mexico since 1995 has been to foster competition and to attract investment in gas transportation infrastructure and ownership is fast-changing after the 2014 reform.

The explanandum is studied with a focus on the conditions of the interactions of the explanatory variables that have attracted FINGI in Australia, Mexico and Sweden. Political science provided methodological approaches such as historical and sociological institutionalism and interactive governance theory. In addition, literature on regulatory governance, energy policy and private investment in utilities' infrastructure provided the theoretical core of this research.

The explanandum is comparable across time, it has timely measurable variance, and the research question is concrete and limited by place and time. The research question in the first and third articles is under what conditions the interaction of national and international experience, institutional conditions, general economic conditions, input markets, industrial conditions, energy, energy taxation and regulatory policies and regulatory governance attracted FINGI in Australia and Sweden during the 2000-2010 period. The second article puts the research question of what sorts of governability components attracted investment in gas infrastructure in Mexico over the period 1995-2015. The central hypothesis is that these interactions impacted on the variance of the explanandum.

The Swedish and Mexican cases were studied individually in the first and second articles, respectively, whereas the third article is a study of the Swedish and the Australian cases in comparative perspective. The focus in all articles is on practice with a qualitative approach. All three articles were enriched by *in situ* interviews and close-ended interviews with representatives of regulatory agencies, government and industry. These interviews gave

further insight of the regulatory practice and helped understanding the originating process of the explanandum.

The three articles contributed in generating knowledge about its common explanandum and its methodological study. This research developed from explanatory variables that proved significant in Pargal (2003) and in a model developed by Berg (2001) which provided methodological coherence. These variables were adapted into the natural gas sector, which has characteristics of its own. Moreover, some of the explanatory variables that proved relevant in the studies of FINGI in Australia and Sweden (Hernández Ibarzábal 2009, 2011, 2012, 2015) were incorporated into the Mexican case study (second article).

Henisz and Zelner (2001), Pargal (2003) and Gutiérrez (2002) used panel data studies to prove the impact of governance and political counterbalances on private investment in infrastructure. Inspired by this literature, this research studies in practice the variables that form part of the FINGI process and tests the results in a qualitative perspective.

The focus on practice aims to provide an integral comprehension of FINGI beyond the conclusions by panel data studies on regulatory governance and investment in utilities' infrastructure. These studies have demonstrated that the establishment of an independent regulatory agency has an impact on attracting private investment in infrastructure and this thesis tests this finding from a qualitative perspective. This approach on regulatory is time-consuming and unexplored however it led to the development of a model to study investment in gas infrastructure which could be applied to other infrastructures. The contribution of this model is significant for the study of FINGI, regulatory governance, regulatory and energy policies and investment in utilities infrastructure. This model was tested in comparative fashion in the third article.

The Mexican case identified the governance dynamics in FINGI and showed that transportation pipelines are inherently difficult to govern from an interactive governance perspective.

The coherence of the articles compiled in this thesis is further substantiated by the continuous definition of the explanatory variables and the analysis of their interaction in

practice. Some results are applicable to other infrastructures and countries and set the ground for other qualitative and quantitative comparisons. This thesis created knowledge and advanced in the study of FINGI and its regulatory governance.

In October 2012 I graduated from the PhD in Government at the University of Canberra (UCU) with the thesis *Financial Investment in Natural Gas Infrastructure, Natural Gas Regulation and Competition: The Australian Experience in International Perspective* (Hernández Ibarzábal 2012). There is cross-referencing among the 2012 thesis and the three articles that form this thesis.

1.1 Theory and Positioning Section

Stigler (1971, 1975) argued that regulatory agencies that are "captured" by producers regulate in their favour which is detrimental for competition. Peltzman (1976) reviewed Stigler (1971) and recognised that regulation has engendered resource misallocation and the influence of opposition groups (ie consumer groups) on policy decision making. According to Peltzman (1976:35), regulators "seek a structure of costs and benefits that maximizes political returns". Becker (1983) argued that special interest groups compete for increasing their political influence in order to achieve regulation that favours their interests and government subsidies. Austen-Smith and Wright (1992, 1994) maintained that interest groups lobby politicians whose interests are not aligned with them and also those politicians whose interests are actually aligned with them in order to counter the effects of opposition lobby groups.

Incentives are a key explanatory element in the principal-agent theory. The principal delegates a task to the agent, however the latter has different objectives and "this task is problematic when information about the agent is imperfect" (Laffont and Martimor 2001:12). In this process the agent has private information which provides costs that the principal ignores or the agent performs activities that are not observed by the principal.

Laffont and Tirole (1991, 1993) and Laffont (2003) highlighted that asymmetric information in the principal-agent relation allows firms rent extraction and maximisation. According to these authors there could be a relation in which the agent is the regulator that could have amongst its functions price regulation and a principal in congress, in which the

former could distort or hide information from the principal in order to benefit regulated firms or obtain more budget. In this dynamic the agent could also be offered incentive benefits by the regulated firms.

The principal-agent theory is identified by Henisz and Zelner (2001) and Henisz (2002) as possible explanatory cores of private investment in communications infrastructure. In their analysis the agent finds more attractive investing in an infrastructure in a context in which government commitments have more credibility. Henisz and Zelner (2001) identified catch-up and institutions and commitment as two scholarly literature categories that explain their hypothesis. In the former the emphasis is on technological diffusion across countries and on economic convergence, and one of the main postulates is that those countries in which infrastructure is relatively lagged would observe higher infrastructure growth rate. According to the institutions and commitment tradition a requisite to assign investment to laggard infrastructure countries is the provision of guarantees against discretional measures.

The panel data study by Henisz and Zelner (2001:144) to quantify the influence of political institutions over infrastructure deployment concluded that "the effect of political constraints on investment may be moderated by a number of factors" (ie technological availability and political and regulatory experience) and that the institutional environment to impede discretional action in a laggard country impacts favourably in attracting investment in telecommunications infrastructure. Political counterbalances and GDP growth were used in this thesis as explanatory variables.

Henisz (2000:3) linked the cross national variance of growth rates with political counterbalances. He proposed that private investors could stop investing, change the nature of their investment, demand bigger returns and invest in safeguards against policy changes when they face arbitrary change of regulatory, economic or fiscal policies. Investment in infrastructure, which require sunk costs, is particularly impacted by policy changes.

Henisz (2004:2) highlighted the relevance of the institutional environment to generate economic results and urges of further research "on the role that international business can have on the development of national institutions over time", and this thesis sheds light on this issue in practice. According to Henisz (2004:2), international business have been

studied traditionally by sociology and economy, however the "study of business activity which is already an inherently interdisciplinary activity concerning the organization of economic activity among individuals grouped in teams, firms, alliances and networks now spans the disciplinary boundary of political science as well". This statement highlights the relevance of this thesis for political science.

Gilardi (2005) considered that the principal-agent theory is limited in its explanation of delegation to independent agencies. The independence is part of the government design, whereas the principal-agent rationality that would address such design would be focused on creating precise mechanisms of control. In this context, Gilardi studied the establishment of independent agencies under the new institutionalisms (historical, sociological and rational choice).

In rational choice, institutions (see North 1991) are result of a deliberate design and limit maximisation of profits. Behaviour election is critical to understanding the actions of decision-making units. According to Gilardi (2005), rational choice explains the establishment of independent regulatory agencies as government mechanisms to reinforce credibility, especially to limit the control of officials with short term objectives and in order to shield policies after major elections change.

The sociological institutionalism is an emergent social paradigm that encompasses comparative institutional analysis and purposive action. Nee (2003:23) considered that institutions are more than the formal and informal restrictions stated by North (1991) and define them as a "system of interrelated informal and formal elements—custom, shared beliefs, conventions, norms, and rules—governing social relationships within which actors pursue and fix the limits of legitimate interests".

The establishment of regulatory agencies is explained by the sociological institutionalism by their symbolic characteristics (Gilardi 2005). It is assumed that this is the right or correct type of regulator in a context of increasing government interdependency, which is the basis for policy diffusion (Meseguer and Gilardi 2008, 2009).

The historical institutionalism stands half way between rational choice and sociological institutionalism in the sense that "human beings are both norm abiding rule followers and

self-interested rational actors" (Steinmo 2008:163). This approach identifies private investment as an outcome of good regulatory policies and links the latter with regulatory governance and institutional conditions.

Pargal (2003) concluded that the approval of legislation that liberalises an investment regime is the determinant factor to attract private investment in utilities. Pargal (2003:23) concluded that "private investment is positively associated with the independence and credibility of the regulator, particularly its ability to commit" highlighting the need of investors for stability. One of the explanatory variables used in her panel data study is the presence of a regulatory body. In addition to Pargal's findings, Hernández Ibarzábal (2015:11) concluded that independent judiciary is better suited to thwart discretionary behavior than independent regulatory agencies and therefore "a more relevant determining factor in attracting investment in gas infrastructure flows".

The IEA (2012:9) acknowledged that in unconventional gas "governments need to devise appropriate regulatory regimes, based on sound science and high-quality data, with sufficient compliance staff and guaranteed public access to information". In 2011 the IEA (2011:47) identified the factors determining the viability of natural gas developments as resource size and access, extraction technology, regulatory framework and market access.

Berg's (2001:6) model for explaining the effect of institutions on public policy and sector performance included experience, institutional conditions, international perceptions, general economic conditions, input markets, industry conditions, structure, regulatory policies, regulatory governance and behaviour, and provided an initial account of the mechanisms part of this interaction. These variables are consistent with studies on private investment in infrastructure in different utilities (Henisz 2002, Pargal 2003, Maiorano and Stern 2007, Gutiérrez 2002). In this thesis these variables were converted to study FINGI, analysed methodologically in Sweden, Australia and Mexico and tested in comparative perspective in the third article following a specific natural gas model.

1.2 Study and Research Objects

This is a study about the conditions that influence FINGI. The quest to identify these conditions and their operating mechanisms is the genesis of this thesis.

FINGI is relevant, its study is relevant to the social and political sciences, it is underexplored and better studied from a multidisciplinary approach because the process from which it originates has multiple dimensions and factors.

FINGI is required to secure gas supply, which is an energy policy of the highest significance, particularly in a context in which natural gas represents around one fifth of the world energy consumption and around a fifth of world's electricity is produced from natural gas. Predominant public investment in FINGI has given way to other types of investment, including public-private hybrids, and after decades of reforms fostering competition in gas transportation Sweden and Australia are following a trend of joint ownership and management that have accentuated the scale characteristics. Further research in this direction may shed light on how ownership is behaving on a broader context.

Most FINGI is currently being directed towards the development of unconventional gas (including coal seam gas, tight gas and shale gas) projects and its study is relevant from a regulatory perspective. Unconventional gas production poses the challenge of balancing economically and environmentally efficient supply in a context of low oil and gas prices, and regulation could provide steering mechanisms to balance this equation.

The case selection of the article on the Swedish case study was based upon the availability of data. The author did an 8-month research stance at the Institute for Futures Studies (Stockholm), which provided the access required by the study.

At the end of 2012 my doctoral thesis at the University of Canberra was examined by Prof David Levi Faur, and in his view the model presented could be generalised to other countries and infrastructures. Thus, I planned to test this model further. In 2013 I had been studying Sweden for more than seven years and Australia likewise. I knew that the conditions for FINGI in these two cases were similar, other than regarding energy and energy tax policies, electricity produced from gas and resource base. Conditions in both cases throughout the period 2000-2010 were characterised by "having strong institutional conditions and high judicial independence, solid regulatory governance and agency independence, stable regulatory policies, good general economic conditions (more stable in

Australia), robust global competitiveness and increasing competition as a result of regulatory and liberalizing reforms in the natural gas sector" (Hernandez Ibarzabal 2015:2). Thus, the selection of these two cases aimed "to recognize if these conditions are an integral part of the mixture of conditions that produces the result (Ragin & Sonnet 2004)" (idem).

In 2013 I started conducting research on the governability mechanisms that attracted FINGI in Mexico since 1995, and the body of this article was written in that year. In August 2013 Mexico's president presented an energy reform to the congress, and this constitutional reform deeply reshuffled the energy landscape in order to attract substantial investment (ie FINGI). The Mexican case was selected in order to shed light on the issues facing the governance of gas transportation and assessing the system's capacity for governance under the energy reform.

1.3 Thesis Outline

1.3.1 First Article: Energy Policy and Regulatory Challenges in Natural Gas Infrastructure and Supply in the Energy Transition in Sweden (2009)

This article was published in September 2009 in the Working Paper Series of the Institute for Futures Studies. The study towards this article started with a research stance at the Institute of Future Studies (October 2005-May 2006) under the joint supervision of Joakim Palme.

This article came back and forth from descriptive to causal inferences and represents the first attempt to find the "pieces of the puzzle", the relevant explanatory variables taking part in the FINGI process and put them together.

The agency responsible for regulating the natural gas network, the Energy Markets Inspectorate (EI), was founded in 2005 as part of the Swedish Energy Agency coinciding with the year in which this research began. The latter agency published reports that helped the investigation with analysis and data, while the interviews with their representatives were critical towards an integral understanding of the subject studied.

The Berg (2001) model provided the departing methodological basis to identify the explanatory variables part of the FINGI process and their acting mechanisms, some of which were analysed in practice. Other studies in investment in utilities infrastructure (Pargal 2003, Gutiérrez 2002, Henisz and Zelner 2001) and regulatory governance (Jordana and Levi-Faur 2005, Stern and Cubbin 2005) provided the literature core to focus this investigation on independent regulation and competition as main explanatory variables. This article studied under what conditions the interaction of these variables attracted FINGI in Sweden. The main outcome of this article was further understanding of how the variables that have proved significant in panel data studies perform and impact on the explanandum in practice. This article also shed light on how path dependence in energy and regulatory policies is created.

1.3.2 Second Article: Becoming Governable? Examining Governability of Mexico's Natural Gas Transmission Pipelines Under the 2014 Energy Reform (2015)

In this article the interactive governance approach is applied to the study of natural gas infrastructure with emphasis on governance challenges under the 2014 energy reform. The latter reshuffled the governance system in order to attract substantial investment and has generated broad scholarly attention. This reengineering included the creation of an independent system operator, an independent transmission system operator and an industrial security and environment protection agency, and provided new roles to the regulators.

The study of the types of governability mechanisms that attracted investment in gas infrastructure over the period 1995-2015 showed that under the energy reform the governance system is well-resourced to govern transmission pipelines once the molecule is inside national territory. Nonetheless, this study highlighted potential supply issues and proposed specific policies to address them. It also discovered that transmission pipelines are inherently difficult to govern and the complexity of the Mexican case makes them particularly difficult to be governed.

1.3.3 Third Article: Modelling Investment in Natural Gas Infrastructure: Australia and Sweden in Comparative Perspective (2015)

This article studied the developments in Australia and Sweden as a test-bed for analysing the interaction of the variables that have proved to be significant in practice in previous FINGI studies. After studying FINGI in Sweden and Australia since 2005, and having written a doctoral thesis (PhD-UCU) and two articles about this topic, I considered relevant comparing both cases methodologically and testing the conclusions obtained so far. The leading explanatory variables were regulatory governance and energy tax, regulatory, and energy policies. The conclusions of this article set the ground for comparisons with more cases in the gas sector and in other infrastructures.

This article confirmed the explanatory relevance of historical institutionalism, particularly of path dependence, in developing energy policies as well as the explanatory relevance of sociological institutionalism for the establishment of independent regulatory agencies. It also undermined the explanatory power of the natural gas reserves in the context of strong institutional conditions and path dependence of energy policies fostering renewable and nuclear energy in Sweden, and highlighted the relevance of judicial independence.

1.4 Data Sources and Methodological Experiences

1.4.1 Data Sources

The three articles presented in this thesis identified and assessed variables that impact upon FINGI. The departing point towards identifying these variables was following variables that proved relevant in investment in infrastructure in other utilities (ie telecommunications, electricity and water). The studies of Maiorano and Stern (2007), Pargal (2003), Jordana and Levi-Faur (2005), Stern and Cubbin (2005) Gutiérrez (2002), Henisz and Zelner (2001) and Henisz (2002 & 2004) were particular relevant as a departing point and a constant guidance throughout. The model developed by Berg (2001) also provided methodological coherence for testing the above mentioned variables.

The Berg (2001) model was followed in the Swedish case study towards identifying the conditions that favour FINGI. This qualitative case study included close and open-ended interviews with regulators, government representatives and scholars, historical analysis and a comprehensive analysis of the conditions whose interaction impacted on attracting financial investment in Sweden in the 2000-2009 period. This study was challenging because there were scarce sources and overall limited information about the FINGI

process. The availability of reports in English and the willingness of the regulators and scholars to provide insight were very helpful though. Due to the dominance of energy produced from nuclear and renewable sources FINGI had not received too much attention thus far. This explanandum was analysed under the broader context of the energy transition.

An article from Brook and Qvist (2015) came to my attention recently and I was glad to discover that they shared the concerns posed in my article regarding the lack of alternative energy plan in case of a nuclear phase-out.

The interactive governance model by Kooiman (2008:174) provided the Mexican case study article with methodological soundness. This model was followed with a minimal modification based on a model by Di Lucia (2013:84) that included factors external to the system. Kooiman (2008) invites scholars to apply his model in different areas and I did so in Mexico's network of transmission pipelines. To my knowledge this is the first time that Kooiman's (2008) model is applied to natural gas transportation. Besides, literature on coastal and marine regions (Bavinck et al. 2015), coastal shellfisheries (Castilla and Defeo 2012), public health functions (Kutty and Varghese 2012) and transport biofuels (Di Lucia 2013) following governability frameworks inspired this article. This article was further enriched by interviews with regulators and government officials.

The third article (chapter four of this thesis), a comparison between Sweden and Australia, was written in 2013 as follow up on the Swedish case study referred in previous paragraphs and the Australian case study, which was thoroughly analysed in the doctoral thesis at the University of Canberra throughout 2007-2012. The model developed in the latter provided the methodological coherence for testing these cases. Further to the mentioned interviews in Sweden, the Australian case study also included interviews with regulators, government representatives, industry and scholars. These interviews benefited the study of practice, and this article was further enriched with the empirical data collected.

1.4.2 Methodological Experiences

The sole existence of an independent regulatory agency has been tested as a factor that impacts upon determining the flows of investment in infrastructure in utilities, and this thesis undertook the task to test if this was the case in natural gas in practice. The diffusion

of autonomous regulatory agencies generated high expectations in the gas sector. In my experience the Swedish and the Mexican regulators believed that their agencies could have an impact on the price of gas, and their operation has proved to have a very limited capacity upon market supply and demand, particularly under an increasingly globalised market. Moreover, as the third article (chapter four of this thesis) demonstrated there are other factors, such as an independent judiciary, which could have a higher impact than autonomous regulatory agencies attracting FINGI.

When I began studying regulation I immediately came across the postulates of agency capture and of groups competing to achieve regulation that favours them. The oil, gas and electricity companies are amongst the most powerful companies in the world. It is therefore expected that they would have extensive resources to capture agencies and to compete for favourable regulation. Whereas this was an issue that I kept an eye for in this thesis, I acknowledge that it is difficult to study in practice as no actor (ie industry, government or regulators) is interested in disclosing capture or political influence, which could have implications at other levels, and is therefore complicated to produce evidence in this regard. This is an area in which the relevance of accountability mechanism from a regulatory governance perspective is highlighted and an area in which more research could be undertaken. Political will, the revolving door and accountability mechanisms are other factors in which further research could be conducted.

Interviews proved to be critical for an insight into practice regarding regulatory governance and regulatory and energy policies. For example, in an interview with a representative from the Swedish Energy Agency it came to my attention the dynamic in which directives from the European Commission were followed by governmental Bills to Parliament and reflected in new Natural Gas Acts. In an interview with a Queensland regulator it came to my attention the potential impacts to water resources from fracking. In the Mexican case study I highlight the insight into the state of the natural gas and LPG markets that Lorenzo Meyer Falcón kindly provided and the insight into the plans of the Mexican government to create a nationwide gas market and its implications for investment in gas infrastructure provided by Dr David Madero Suárez.

I acknowledge this thesis is to some extent autobiographical and I have studied some of the countries in which I have lived and developed research. This has allowed me though a

deeper search into the cases studied and to develop a holistic approach to knowledge building into the multiple dimensions of the explanandum.

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2. ENERGY POLICY AND REGULATORY CHALLENGES IN NATURAL GAS INFRASTRUCTURE AND SUPPLY IN THE ENERGY TRANSITION IN SWEDEN

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Summary: *Energy policy and regulatory challenges in natural gas infrastructure and supply in the energy transition in Sweden* is undergoing a major energy transition in which the present regulatory, competition and energy decisions will determine future involvement in the "oil and gas game" after decades of successful implementation of non-fossil fuel dependence policies. Contrary to major energy policies implemented since the oil crisis of the 70's, higher natural gas investment in infrastructure – in particular regarding offshore pipelines – is not an outcome of a consented agreement between the government and private firms. The lack of clear governmental definition towards the time to phase out nuclear terminals, and how this source of energy would be replaced, is leading the country towards an energy bottleneck that could condition future energy supply, thus governance. Under these conditions, crucial decisions shall be taken in the near future regarding granting permissions to pipelines that connect to the Russian natural gas fields following an EU trend, to the Norwegian natural gas reserves on the trail of a Nordic energy path-dependence, or to both, sharing potential benefits and risks.

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2. ENERGY POLICY AND REGULATORY CHALLENGES IN NATURAL GAS INFRASTRUCTURE AND SUPPLY IN THE ENERGY TRANSITION IN SWEDEN

2.1 Introduction

Sweden has independent regulatory agencies,[1] increasing competition in its deregulated sectors (as electricity) and in the natural gas sector, a total fossil energy dependence (there is no production of natural gas, oil or coal) and historical judicial independence. These conditions favor private investment on infrastructure, but up to now private investment in natural gas infrastructure has been quite low, an outcome that could be partially explained because other sources aided by governmental support have the capacity to fulfil the actual energy needs.

Private investment in natural gas infrastructure without full support from the government would introduce changes in the traditional energy model, in which the government and private firms work together closely. Higher private investment in natural gas infrastructure and consumption would push forward towards the introduction of changes in the traditional Swedish Ownership Model, in which "the controlling ownership in firms is

typically concentrated to one or two owners. Often, but not always, these owners are Swedish families" (Henrekson & Jakobsson 2003, 5). A more complex natural gas industry would certainly have Swedish and foreign owners, public and private owners, at its different levels. It will be particularly interesting to follow the role of the municipalities in the new arrangements.

This paper will study energy policy and regulatory challenges in natural gas infrastructure and supply in the context of an energy transition in Sweden, emphasising on its current and historical Nordic energy links while considering the presence of diffusion mechanisms in the region.[2] The Swedish case was studied from October 2005, in which time apart from bibliographical and field research in Stockholm, Uppsala and Eskilstuna, different open-ended interviews were held. The research paid special attention to the exogenous influences driving change in the natural gas sector in Sweden. The results obtained raise more questions than answers regarding energy policy and regulation in natural gas infrastructure and supply, changing issues that could condition governance and redefine the relation with different Nordic, communitarian and European institutions in the near future.

The current energy transition in Sweden could be synthesized in the following way: the main energy source will be phased out, and renewable energy sources at this point cannot fill this gap themselves yet, and a more extended network and use of natural gas could reverse a path-dependence (Pierson 2000) of non-reliance in fossil fuels. As a result of the implementation of non-oil dependence policies, fossil fuels have been substituted in the residential and service sectors with nuclear and hydro energy and more recently, and in a lower degree, with renewable energy sources; in the heating market for residential and commercial buildings oil has been gradually replaced by district heating.

In 1970 the total oil use within the residential and the service sectors of Sweden was 118.6 TWh, in 1985 was 49.4 TWh and in 2005 was 15.9 TWh. In the same years, the final electricity use in these sectors was 21.9TWh in 1970, 61.9 TWh in 1985 and 71.6 in 2005 (Swedish Energy Agency 2006, 10-11). These figures reflect Sweden's reliance on electricity in the last decades, and also the way in which it has tried and to some extent managed to avoid dependence on fossil fuels in sectors other than transport.

As a result of a referendum conducted in 1980 all nuclear terminals should be phased out with no further construction; nuclear energy represented in 2006 30%, 210TWh out of 630 TWh, of the total energy supplied in the country (Swedish Energy Agency 2006, 6). The 1980 referendum required voters to choose between 3 ways for phasing out nuclear energy; the possibility to go further with the nuclear power program was not an option. The most voted decision was to continue with the operation of active and under construction plants until "the end of their normal operating lives (assumed to be 25 years). Parliament decided then to embargo further expansion of nuclear power and aim for decommissioning the 12 plants by 2010 if new energy sources were available realistically to replace them" (Nuclear Energy Association 2008).

Phasing out nuclear terminals means another energy source will replace nuclear energy, the second source of energy (after oil crude oil and oil products) nationwide. Natural gas is the most plausible source of energy to replace nuclear energy in electricity production, and right now is the paradigmatic moment in which different projects in natural gas infrastructure could be approved by the government in order to fulfil the future energy demand. For this to happen private companies would have to invest heavily in natural gas infrastructure, and their projects would have to comply with the EU and Sweden's competition regulations and environmental codes and with all the international treaties Sweden has signed.

2.2 Fossil Fuels, Renewable Fuels or Nuclear Energy?

Following the oil crisis of the 70´s, Sweden decided to rely less on oil and more in their own and renewable fuels.[3] In this process, district heating played a fundamental role in replacing oil in the heating of buildings, and other fuels played a major role in replacing oil in district heating production.

"District heating is the generation and distribution of hot water in a pipeline system for the collective heating of commercial and residential buildings (Swedish Energy Agency 2005, 45)." The primary tendency in the energy input for district heating has been substituting oil for biofuels, waste heat, heat pumps and natural gas. In 1970, from a total energy input for district heating of 14.6 TWh, oil accounted for 14.3 TWh and biofuels accounted only for 0.3 TWh; in 1980 the former accounted for 30.9 TWh, the latter for 2.3 TWh and waste

heat for 0.6 TWh of a total of 34.5 TWh; in 2006 oil accounted for 3.2 TWh, biofuels for 36.2 TWh, natural gas (including LPG) for 2.2 TWh, heat pumps for 5.6 TWh and waste heat for 4.6 TWh of a total energy input for district heating of 55.4 TWh (Swedish Energy Agency 2007b, 24-25).

In 1978, oil accounted for 60% of the heating market for residential and commercial buildings, whereas district heating represented around 10%; in 2003 the numbers had inverted and district heating accounted for 50% of the share of the market and oil for approximately 10%.

From 1970-2007, the development of heat pumps in district heating and natural gas and gasworks gas followed a similar path; the former started in 1980 and in 2006 accounted for 6 TWh of the total energy supply, whereas the latter started in 1985 and in 2006 represented 11 TWh (Swedish Energy Agency 2007b, 11).

However, the major obstacle towards a higher natural gas use in Sweden since the last quarter of the 20th century has been nuclear power, its major competitor. The main player in the natural gas market in the period 1985- 1995 was SwedeGas, which was controlled by the electric power industry (Agfors 1995, 227). This type of ownership pleads for more research focusing on the possible capture by the incumbent electricity firm – what could be catalogued as self or endogenous capture – that could have blocked a higher natural gas development in order to maintain its market profits.

Capture theory states that either regulation is supplied in response to the industry's demand for regulation or the regulatory agency comes to be controlled by the industry over time (Bernstein 1955). Stigler (1971) identified 4 types of policies an industry would like to influence: government subsidies to the industry, government-created barriers to (market) entry, policies that affect substitutes or complements to the industry and government's fixing price to prevent price competition (Laffont & Tirole 1993). This argumentation considers that regulation can sometimes benefit certain firms, i.e. by raising barriers to entry competitors (Coglianese et al 2004, 24).

On the other hand, natural gas was the fuel whose supply grew the most amongst oil, LPG, biofuels, coal, coke oven gas and blast furnace gas in the supply of fuel for electricity

production in the period 1983-1993; it increased from 54 GWh to 962 GWh, respectively (Swedish Energy Agency2007b, 20-21).

The future of natural gas supply and infrastructure is intrinsically related with competition, but is also a matter of governmental certainty and energy policy definition. The decision to phase out the nuclear reactors has been delayed repeatedly; a responsible decision considering there wasn't any other plausible source to replace nuclear energy, and it is still not clear which energy source will replace nuclear energy.

In the last two decades, energy policies have focused on setting a dateline for phasing out nuclear energy, while stopping the use of rivers for hydro power generation, fostering the use of biofuels, introducing higher taxation on coal and oil targeting the reduction of CO2 emissions and following EU emissions targets and directives towards more natural gas competition. These policies are guiding Sweden to an energy bottleneck that urgently needs a clearer decision about the moment in which nuclear terminals will be phased out.

In 2006, 46.4% of the electricity production came from nuclear energy (Swedish Energy Agency 2007b, 20), and in 2005 Sweden produced 8016 kWh per person from nuclear energy, whereas France produced 7201 kWh even though nuclear energy accounts for more than 75% of their electricity production (Idem, 22). This data reflects how heavily Sweden relies on nuclear energy, how difficult it will be to replace and also the importance of making the right choices regarding the new source/s and supplier/s.

Annual electricity consumption in Sweden is increasing yearly around 1%, and the current production exceeds the consumption by 30%, providing the government with an important margin of action. This energy surplus will disappear with the nuclear energy, which will be phased out sooner or later. The governmental approach to this dilemma has been to delay the decision perhaps waiting for new technologies to come or for more powerful renewable sources, but this behavior is now incompatible with securing the future energy supply and governance.

If nuclear power is phased out by 2020, natural gas is the most feasible energy for replacing it in electricity production, and this would need further network development, as well as private investment in infrastructure. If the reactors are phased out in 60 years, as foreseen

by the Climate in Focus Scenario (Royal Swedish Academy of Engineering Sciences (IVA) 2003), nuclear energy would be replaced by new carbon-dioxide-free electricity production, and in this case natural gas could be used through CO2 sequestration.

Energy Foresight – Sweden in Europe (IVA 2003, 7) reminds us that "The traditional Swedish model of developing and building large technical systems has often seen close cooperation between Government and industry (e.g. Vattenfall and Asea, and Televerket and Ericsson)". This cooperation played a major role in the last three decades in determining nuclear energy as the main power generator, and has not encouraged a higher use of fossil fuels.

An electricity certificate system that started in May 2003 to promote electricity production from renewable sources and peat has the objective for 2016 to produce 17 TWh, relative to production from these sources in 2002. The Swedish Energy Agency and Svenska Kraftnät are responsible for the operation of this certificate system working towards a more environmentally friendly energy system that will be active until 2030. The way in which the system operates is based on close coordination between producers of renewable electricity and peat, electricity suppliers and the government (Swedish Energy Agency 2008b). Its production aims are plausible, even conservative, and alternative electricity production will ease the nuclear transition. That is to say, the electricity certificate system could act as a complementary factor in the nuclear transition, but will not replace nuclear energy in the next decade.

A mechanism that the Swedish government applied since 1991 with the aim of encouraging the use of biofuels over fossil fuels was the implementation of a carbon dioxide tax, which is still in use. In 2003, the CO2 tax in Sweden was 14 times higher than in Germany, 4 times higher than in Norway and 2.5 times higher than in the Netherlands (IVA 2003, 12); this tax was too high to permit a competitive integration in the communitarian market.[4]

Unlike bunker oil and coal, natural gas was exempted from paying sulphur taxes in 2007 (Swedish Energy Agency 2007a). However, natural gas does pay energy and carbon dioxide taxes (excluding VAT), which accounted in 2005 for around 30% of the total price for industrial consumers and 50% for domestic consumers (Swedish Energy Agency 2005, 35). The tax system operates in accordance to communitarian directives, such as the Act

Concerning Taxation of Energy that entered into force in 1994, and the EU Emissions Trading System, which foster the use of natural gas over coal and oil because it produces less CO2 emissions when is burnt.[5]

Reducing taxes on unemployment and increasing taxes on energy use and emissions in 2000, the Swedish government expected to raise up to SEK 30,000 million and to reduce emissions (Swedish Energy Agency 2004, 12). Though environmentally friendly, this energy tax raise constitutes another barrier towards developing a competitive natural gas market at the national and communitarian levels.

Natural gas has great potential in replacing nuclear power in electricity production, a process that could be done at different stages and periods of time. The report *Energy Foresight– Sweden in Europe* (IVA 2003) suggests that instead of replacing nuclear power definitively natural gas could also be used as a "temporal" bridge on the way to a solar and hydrogen society.

Different scenarios in *Energy Foresight – Sweden in Europe* (IVA 2003) foresee that hydrogen will play a fundamental role in the energy future after 2020. Sweden has more probabilities to achieve a hydrogen-driven society than countries with higher dependence of fossil fuels. And the less dependence in fossil fuels the higher these probabilities will maintain. But even in the case of a hydrogen-driven society a bigger natural gas network will be needed because natural gas could either act as a bridge towards hydrogen or be used in its production.

Energy Foresight – Sweden in Europe (IVA 2003) also predicts higher energy consumption in the transport sector, which relies on fossil fuels as its primary energy source. This fossil fuel dependence makes it more difficult to transition to a transportation system based on electricity, hybrid cars, hydrogen and solar energy. All these energy sources will increase its actual potential in the future, but for the moment it is too risky to consider that they will have enough capacity for replacing oil; it would be equivalent to considering that nuclear power could be replaced in the future with wind power because of technological improvements. The most plausible scenario is that other fossil fuels will play a major role in replacing oil in the next decades.

Energy scenarios that are not considered in *Energy Foresight – Sweden in Europe* (IVA 2003) are a process of energy re-regulation, a more decisive role of the society and a more passive role of the government in deciding the energy policies, much higher energy needs in the immediate future (i.e. in the case of the establishment of new industries and services), energy consumption changes in the pulp and paper industries and rocketing oil prices.

The residential and service sectors actually represent around 40% of the total use of energy, so apart from taxes, more media and information campaigns would help in the process of saving energy, an objective that both citizens and government share. Formulas that do not necessarily represent more taxes paid by the domestic consumers must be explored.

2.3 Natural Gas: A Nordic Tradition

Natural gas was first used in Sweden in 1985, since then its use has been growing at different paces and it may increase importantly in the next decades due to several undergoing changes in energy and natural gas at the national, Nordic, communitarian and European levels. Traditionally, this country has relied on the Nordic countries (mainly Norway and Denmark) to fulfil its energy needs, and it is most probable that new energy and natural gas suppliers will appear in this or the next decades. In the whole changing issue, the influence of the EU representatives and institutions together with its regulatory reforms constitute two specific exogenous influences redefining the equilibrium towards more competition and openness in the natural gas sector.

Sweden does not produce any natural gas, and all the gas that it consumes is imported from a pipeline coming from Denmark. In this sense, the more natural gas Sweden imports the less control it has in its own energy supply and the greater the dependency on foreign suppliers. These are key elements to be considered for understanding why a bigger natural gas market and network has not been developed yet. It is possible that non-fossil dependence and energy sovereignty policies, in conjunction with the promotion of renewable sources of energy and an extended use of nuclear energy haven't encouraged the diversification of energy sources.

Refraining from a more extended natural gas network and use constitutes a very effective way to be protected from the continuous shocks in the rising oil prices, which depend on

external shocks such as wars, invasions, regime changes, institutional crises, strikes, natural disasters, terrorist attacks, accidents, disruption of supply and social and political instability in countries and regions, among others. Thus, a remarkable outcome of the non-fossil fuel dependence policies together with policies promoting nuclear energy has been securing a safe energy supply.

Natural gas and oil prices are indexed and behave in a similar way; the Swedish policy to rely more on their own energy sources rather than in fossil fuels in general and natural gas in particular has secured higher protection to the continuous price variances than other countries without national fossil fuels resources (like most of the EU countries). Electricity production in Sweden is cheap and oil prices are mounting, two specific factors not favoring more natural gas consumption.

Murray (2005, 8) explained that "Sweden's current electricity supply is based on relatively high capital cost/low operating costing technologies (specifically hydroelectricity and nuclear power). […] this makes it relatively immune to rising primary energy prices, because the fuels – water and uranium – represent a much lower percentage of the kilowatt hour cost than is the case for fossil fuels". Using primarily electricity instead of natural gas has also saved Sweden a lot of money; the price of a Brent crude oil barrel was 19.49 USD in the first semester of 2002, 59.66 USD in the last trimester of 2005 and 125 USD in the second trimester of 2008 (Bloomberg 2008).

The Swedish Energy Agency had the expectation in 2005 that greater competition in the natural gas sector would be translated into lower prices (Swedish Energy Agency 2005, 35), and in 2007 stated that "The underlying purpose of deregulation of the natural gas markets around the world has been to create the right conditions for effective utilization of resources, and thus keep down gas prices" (Swedish Energy Agency 2007a, 45). The evolution in the price of natural gas from 2005 to the second trimester of 2008, parallel to several deregulatory reforms worldwide, has been the contrary: more competition and deregulation in the natural gas market have been accompanied by higher prices. As long as the price of natural gas is indexed to the price of crude oil, higher competition in the Swedish market or anywhere else cannot affect the latter. Nevertheless, a higher competition in the natural gas market has given more options to the clients and new

growth perspectives to the industry. Competition has had a qualitative impact on the natural gas market in Sweden.

In the context of increasing investment in commodities in the stock markets, oil and natural gas prices are predicted to continue increasing. Furthermore, there is no insurance policy against the external shocks that have an impact on price variances. In this sense, Sweden has to consider if entering the "oil and natural gas game" will be part of the solution or part of the problem for its current energy transition. In the case that it is part of the solution, it is important to focus on the mechanisms that will connect its solid institutional background with the future natural gas supply.

Sweden has a 200-year tradition of bureaucracy built in semi-autonomous agencies (Gilardi 2003, 13) as well as very strong political constraints, a Parliamentary system with a highly consolidated independence of the judiciary, an autonomous energy regulator, total fossil energy dependence and increasing competition in the sector. Following the model *The Effect of Institutions on Public Policy and Sector Performance* (Berg 2001, 6),[6] these conditions favor private investment in infrastructure, and in conjunction with the ongoing energy transition could foster higher private investment in natural gas infrastructure in the years to come.

A more extensive natural gas network will lead towards more consumption, and will condition the role of natural gas in the energy future. The expansion of the current natural gas network depends on formal conditions such as the national and communitarian regulations and informal conditions such as political will, to an extent that is very difficult to determine from the academy. The capacity of the Swedish government and the regulatory agencies to determine a national energy future in the context of increasing EU regulations fostering competition needs further study.

Denmark, Norway and Sweden share a common energy history that includes gas, first introduced in Sweden through its municipalities.[7] The first pipes, transporting gas based on pit coal and cast iron, were built under the streets and used for street lighting. Gasworks were first built in Sweden in October 1818 by Gustaf Magnus, a professor of the Royal Academy of Science in Stockholm, who three decades later installed them in institutions, businesses and factories (Hyldoft 1995, 78).

The gasworks rapidly spread around the Nordic countries throughout the middle of the XIX century following a diffusion process. Two driving forces leading the process of building new gas networks in the Nordic cities were the private companies and the municipalities, in that chronological order. Nordic countries were the paradigmatic case in Europe in which the municipalities owned and ran the gasworks. Still in 2005 the municipalities owned around 60% of Swedish district heating supplies; apart from Nova Naturgas and Dong, all gas companies belong to energy companies having other activities in the electricity and/or district heating in Sweden (Swedish Energy Agency 2005, 39). This double ownership could be part of what was described in p.5 as self or endogenous capture.

After an initial boom of gasworks, followed by the creation of national expertise, the lack of better technology and funding impeded the development of more extended regional and national networks; it is possible that these are still acting mechanisms.[8]

The period 1855-1870 went through a parallel boom in the construction of municipal gasworks in Copenhagen, Malmo, Schleswig, Stockholm, Gothenburg, Oslo and Helsingfors (Hyldoft 1995, 96). This process could be understood through the hypothesis tested by Jordana & Levi-Faur (2005), in which within sector transnational diffusion had more significant results than diffusion across sectors of the same country. Some exogenous obstacles for a Nordic natural gas network in the XX century were the First and Second World Wars, as well as the Cold War.[9] For example, Russia supplied Finland with gas since the 1950's and with natural gas since 1974, and this connection thwarted the integration of the latter in the Nordic energy market.[10]

Since the beginning of the XIX century, innovations in energy such as the use of gaslight were being studied separately in Denmark and Sweden. If from this time the Nordic countries would have constructed systematic cooperation mechanisms to create knowledge based on common energy needs they would have found a broader range of common solutions. On the other hand, private companies have repeatedly presented plans for a more extended natural gas network development in Sweden, and have frequently encountered political resistance at different levels.

The Nordic natural gas connection is still present in Sweden and there are important plans to expand and redefine it in the near future. Supply from the gas fields in offshore Jutland will decline in the next years, and a way to substitute the Danish natural gas supply with another Nordic supplier would be following the plans from energy companies to import LNG from Norway and get connected to its field reserves through a pipeline. Plans for building a natural gas pipeline connecting Sweden and Norway existed before 1990, but until now they have met the necessary conditions to start its construction.

One of the main projects in natural gas infrastructure is the construction of the Skanled gas pipeline, a gas transmission pipeline that would connect the Kårstö processing plant, located at the Norwegian West coast, with Sweden and Denmark. In the case that the project is approved by the Norwegian, Swedish and Danish authorities the construction would start in 2010, in parallel to the Nord Stream Pipeline**.** The intended route of the Skanled pipeline would be from Kårstö to Rafnes, in East Norway, to western Sweden and Denmark (Gassco & DNV 2007, 1).

The Skanled pipeline is led by Gassco, the Norwegian state operator that transports Norwegian gas to Europe and the UK worth more than USD 10 billion "through a 6,600-km network of pipelines" (Pipeline and Gas Journal 2006, 16-17), whereas Swedegas and Energynet.dk participate as partners (Gassco & DNV 2007, 4). Nowadays 11 users and 10 investors have signed letters of intent to participate in the pipeline or as shippers.[11] These companies initially reached an agreement with Gassco in which 7 of them would own 70% of the pipeline, and 9 of them would pay for the right for using the transportation system (Norwegian Ministry of Petroleum and Energy 2007).

Norway is, after Russia, the second largest natural gas supplier to the EU, and the Skanled pipeline seems to be the ideal way to substitute the Danish supply and to keep alive the Nordic energy connection. A shared energy history in the region and closeness between Norway and Sweden at different levels may represent higher security of supply and less risk of discretionary energy policies than in the case of getting connected to other sources.

In 2007, natural gas supply covered 30 Swedish municipalities and accounted for only 2% of the national energy use, while through the EU the comparable use was around 20% (Swedish Energy Agency 2007a, 44). One of the main reasons for this disparity is that its

current natural gas network does not reach the whole country. In the following years gas transmission pipelines will reach Stockholm and other important areas, which will bring a boom in the natural gas consumption; i.e. the natural gas consumption in the above mentioned 30 municipalities is very close to the EU average.

Since the adoption in 1998 of the Gas Market Directive by the European Commission, Sweden has implemented legislation in the form of Natural Gas Acts towards participating in a single energy market. The natural gas market has become more competitive with each communitarian directive, which have always been followed by governmental Bills to Parliament and reflected in new Natural Gas Acts. As a result of the Natural Gas Directive (European Union 2003) approved in June 2003, the Parliament implemented a Natural Gas Act in 2005 that introduced competitive elements in the market, such as the separation between trading activities and network activities in order to prevent cross-subsidisation (Swedish Energy Agency 2005, 7). Thanks to 2 different Natural Gas Acts, in July 2005 all nondomestic consumers were free to choose their suppliers and in July 2007 the natural gas market was fully deregulated.

Further directives from the Commission are expected to have a renewed repercussion in governmental Bills handled to the Parliament and to be translated into new Natural Gas Acts. In synthesis, the EU has been acting as an exogenous influence towards more competition in the Swedish natural gas market, which is still operated as a legal monopoly.

2.4 The Natural Gas Market: Actors and Future

The Swedish Energy Agency "was created in 1998 and works towards transforming the Swedish energy system into an ecological and economically sustainable system though guiding state capital towards the area of energy" (The Swedish Energy Agency 2008). In 2001, The Swedish Energy Agency created the Network Oil and Gas (2008), a forum that actively exchanges expertise about oil and gas.

The Energy Market Inspectorate was created in 2005 and is the regulatory body within the Swedish Energy Agency in charge of supervising that electricity, natural gas and district heating markets operate efficiently, and of monitoring the compliance with the Electricity and Natural Gas Acts. Another objective is assisting the consumers and a more integrated

Nordic market in the natural gas sector. Thus, the Market Inspectorate acts on one hand towards additional Communitarian integration and on the other towards more Nordic and Baltic integration. These aims are defining Sweden's natural gas and energy future, and only then it will be clear how compatible these objectives are in practice.

The natural gas market has been gradually opened to competition after different EU Natural Gas Directives came into force; i.e. unbundling[12] was adopted in the Natural Gas Act that was legally binding in July 2005. The way in which unbundling was adopted is another example of how European Commission directives have led some of the natural gas reforms proposed by the government to Parliament.

As a result of the continuous reforms introduced in the natural gas sector, in the context of an energy transition, higher natural gas use is expected in the following years and decades. Some areas with the greatest potential are: transportation, industry, residential use, electricity production,[13] power-heating plants and district heating. In the latter, natural gas and biogas could replace centrals operated with coal and biofuels, an issue that could generate tensions between the local producers of biofuels and the natural gas companies.

The first 8 years after the introduction of natural gas in 1985 resulted in an average growth of 1 TWh per year, and since 1993 to date the average growth of natural gas use has been around 0.1 TWh per year. When the time comes for natural gas to reach Stockholm, it will probably equal or increase its initial growth average. Higher natural gas demand will need supply from sources other than the Danish sector of the North Sea and new pipelines to be built.

The natural gas system is composed within Sweden of 3,000 kilometres of distributional pipelines and 540 kilometres of transmission pipelines, and its capacity exceeds its current use. The capacity of the system could be increased using compressors, and greater natural gas use is expected due to the demand from cogeneration plants in Gothenburg and Malmo (with planned start up in 2009), that in a full load could use approximately 8.5 TWh per year (Swedish Energy Agency 2005, 36). Swede Gas AB owns much of the trunk grid of the network, which extends from Trelleborg to Gothenburg; in 2004, Swede Gas sold its trading activities to Dong Natural Gas. The responsibility for the main branch in southern Sweden is with EON Gas Sweden AB, and the overall responsibility for the national gas

market is with the state utility Svenska Kraftnät, which excludes the operation of the system and focuses only on "short-term maintenance of the balance between supply of natural gas to the national system and delivery of gas from it (Swedish Energy Agency 2007a, 44)".

In 2007, the Energy Market Inspectorate had received 3 applications for extension of the natural gas network; the first 2 are extensions from Gislaved/Gnosjö to Oxelösund via Jönköping and Boxholm. The concession for the extension via Jönköping is being prepared by the Cabinet Officers after it was approved by the Inspectorate. The other concession extension is for a transmission pipeline called The Baltic Gas Interconnector, which received permission from the government in 2004. The Baltic Gas Interconnector includes offshore and onshore sectors and will connect the natural gas networks of Sweden, Denmark and Germany. The participants are Verbundnetz Gas, Sjællandske Kraftværker and Norsk Hydro, E.ON Gas Sweden AB (Swedish Energy Agency 2007a).

In December 2007 the Swedish government received an application from Nord Stream "for a permit to lay two pipelines on the continental shelf and an application for a permit to construct and use a service platform in the Swedish Exclusive Economic Zone (Daoson & Bystedt 2008, 1)". The applications were being processed under the Continental Shelf Act and the Swedish Exclusive Economic Zone Act, international conventions signed by Sweden and environmental codes and acts such as The Espoo Convention, the Swedish Exclusive Economic Zone Act, and the Swedish Environmental Code.

In February 2008 these applications were considered incomplete by the Swedish Ministry of the Environment and the Swedish Ministry of Enterprise, Energy and Communications; the main reasons were a lack of a general environmental assessment that takes into consideration the Espoo Convention,[14] and other environmental and international codes for the service platforms. The government also wanted to know the final result of ongoing or non-conclusive investigations (i.e. an investigation about the existence of World War II munitions in the route of the pipeline) before going forward with the project and needed alternative locations for the service platform and alternative routes for pipelines, in order to consider different environmental scenarios.

The Nord Stream pipeline is planned to be a 1220 km off-shore pipeline, and is a joint venture of OAO Gazprom, Wintershall AG/ BASF SE, E.ON Ruhrgas AG / E.ON AG and N.V. Nederlandse Gasunie. This 7.4 billion "TEN-E project of European interest"[15] will initially connect Russia and Germany through a pipeline built under the Baltic Sea. Planned offshoots will link the pipeline with Sweden after 2010. This off-shore natural gas pipeline project in conjunction with the Skanled pipeline project (discussed in previous chapters) will play a decisive role in the future of natural gas use in the participants countries and in the energy transition in Sweden.

One of the main advantages of the Nord Stream project is that it will travel directly through the Baltic Sea, avoiding transit through countries such as Ukraine, Belarus and Poland, which has raised tensions in the last years. The Nord Stream pipeline also represents higher security of supply from the Russian reserves. Less than 2% of the world gas reserves are in the EU, whose natural gas imports are expected to raise from 41% in 2005 to 75% in 2030 (Global Insight 2007). Relying on Russia and Norway is a way in which Sweden will be able to supply its future natural gas demand and avoid depending on the instable Middle East countries, as different communitarian countries do.

Russia is expected to supply more than 50% of the European gas demand after 2020, so much of the stability and governance of the EU will depend on their energy policies (James A. Baker III Institute for Public Policy 2005). A future higher energy dependence derived from a more extended use of natural gas in Sweden is conditioned by a context in which the Russian government has frequently used natural gas supply as a geopolitical tool, and used institutions arbitrarily to regain control of its formerly privatized natural resources. In words of Larsson (2005, 3) "Russia also sees energy as a tool to avert geopolitical macroeconomic and other threats".

The Russian energy companies, such as LUKOIL, Rosneft and Gazprom, operate accordingly to the state's interests in the "oil and gas game" and in the past have acted as agents to impose pressure and achieve political and economic objectives within the Russian zone of influence, which increasingly extends throughout Europe.

Thus, being connected to the Russian natural gas network is also a way in which the EU – Sweden included – could suffer geopolitical pressures and discretionary energy policies.

One way to assure higher certainty of non-discretionary actions from the Russian state companies is having the Energy Charter Treaty ratified by the Duma.

Investment in natural gas infrastructure is by definition a long-term investment that needs guarantees from both ends of the pipeline. Sweden is an ideal client due to its healthy economy and living standards, accountability from political institutions, independent regulators, compliance with the Natural Gas Directives and increasing competition in the natural gas sector, and Russia has the natural gas that Sweden could need in the future. But, how will Russia assure non-political interference in the natural gas supply in the short, middle and long terms?

Natural gas supply is closely linked to the political links and alliances between the supplier and consumer countries. This interaction could prove beneficial in some cases, i.e. increasing economic and political ties between Germany and Russia are favoring natural gas supply security and pipeline projects; or it could also be damaging, i.e. Russia's neighbors are aware that more integration with the European Union, independence from Russia or participating in NATO ventures could be reflected in their gas bill.

The close links between Germany and Russia are not free of conflict of interests, an issue that jeopardizes natural gas competition and energy policy accountability in the EU. A few days before the elections in Germany were celebrated the former German chancellor Gerhard Schroeder signed the initial agreement to build the Nord Stream pipeline between his country and Russia. On December 2005, approximately three months after losing the elections and having resigned to his seat in Parliament, he accepted the post as chairman of the consortium, a decision that *de facto* legitimated Gazprom's political interference in the energy market.

Schroeder's participation in the Nord Stream pipeline first as a chancellor and then as a chairman, in the context of constant communitarian directives pushing towards more natural gas openness and competition at the national level, was a "collaborative, interactive form of mixing", and involved "an ability to achieve synergies between involved persons and organizations" (Wettenhall 2007, 5), which are specific conditions of a public-private partnership. This case invites further study considering that Nord Stream, a major

European player as a big infrastructure investment project, could have "captured" the German government and different communitarian institutions.

Russia uses its natural gas and oil reserves, managed by their national energy companies,[16] to achieve its national interests. This mechanism is frequently applied in different degrees by different countries, depending on their energy policies, potential of their natural resources, strength of their institutions and state companies, independence of their regulators and internal and supranational counter balances among others. Russia is increasing its geopolitical influence in Europe due to their greater than ever natural gas supply and due to the tight control exercised over its national energy companies. Getting connected to the Nord Stream pipeline is a way in which Sweden will guarantee its future natural gas supply and will be closer to the EU, its competition policies, regulations and suppliers, but also to Russia's "oil and gas game".

2.5 Conclusions

This paper studies the link between the current energy transition, regulatory and energy policy and natural gas infrastructure and supply in Sweden. Analyzing the energy transition in relation to geopolitics, competition and governance, and connecting it to the conditions for future natural gas infrastructure and supply is the main innovative element of the research.

The analysis places special emphasis on the acting mechanisms operating between the national and communitarian regulatory frameworks with different energy sources and its implication for future governance due to security in energy supply.

Sweden used in 2007 more electricity than oil: the total final use per energy carrier for electricity was 132 TWh and for oil was 131 TWh (Swedish Energy Agency 2008a, 10), and nuclear energy accounted for 44.3% of this electricity. This data reflects the importance of phasing out nuclear terminals and helps to contextualize why this decision has been repetitively postponed and encounters resistance from industry and government.

Natural gas is environmentally friendly and has great potential towards replacing nuclear energy when the terminals are phased out; however, private investment in natural gas

infrastructure followed by an exponential consumption could partly reverse a history of non-fossil fuel reliance and a traditional energy ownership model in which government and companies work closely together. As long as natural gas is not produced in the country, more natural gas supply/consumption would also represent higher dependence on foreign suppliers. Moreover, high taxation is still a barrier for the development of a truly competitive natural gas market.

Under the actual conditions characterized by volatility in oil/natural gas prices, continue utilization of nuclear energy seems to be the most cautious decision if accompanied by a constant renovation of the terminals that permits applying the new technology to make them as safe as possible.

Conversely, if terminals are slowly phased out and replaced gradually with natural gas, there would have to be special attention in designating the supplier; the energy surplus that nuclear energy provides represents valuable extra time to choose this supplier. In the context of a common energy history and strong Nordic links, Norway seems more reliable than Russia to be the next main natural gas supplier after a decline in the Danish reserves. In addition, non-discretionary binding guarantees have to be defined before permission is granted to the Nord Stream to operate in Sweden as a vaccine for future Russia's geopolitical pressure.

NOTES

1 Gilardi (2003, 13) discovered that competition, electricity, environment, financial markets, food, pharmaceuticals and telecoms regulated in Sweden through independent agencies present important variation in their level of autonomy.

2 According to Jordana & Levi Faur (2005) diffusion mechanisms are related to a specific region, but act stronger between neighbor countries, or countries with a common history.

3 As a result, Sweden had in 2005 the third lowest emissions rates of tones of CO2 per inhabitant in the OECD (OECD 2007).

4 The Competitiveness Rankings (World Economic Forum 2003, 172) reported that tax rates and tax regulations, respectively, were the first 2 Most Problematic Factors for Doing Business in Sweden. On the other hand, Sweden ranked 9/102 in the category judicial independence, which represents an ideal condition for attracting private investment in

natural gas infrastructure. Independence of the judiciary is essential for guaranteeing fairness in the appellate processes and ensuring credibility towards the international financial capital, which is the main source of natural gas investment in infrastructure.

5 "For the same amount of energy released, carbon dioxide emissions from the combustion of natural gas are 40% less than from combustion of coal and 20% less than from oil combustion" (The Swedish Energy Agency 2005, 37).

6 This model explains the impact of institutional conditions, regulatory governance and regulatory policies, amongst other factors, on private investment in infrastructure, and identifies the institutional actors involved in a complex process, the acting mechanisms and the causal direction.

7 The debate between private or municipal participation in natural gas projects is still alive. Though, private companies are basic actors working towards more openness in the natural gas Swedish sector and the expansion of its network.

8 "Mechanisms are frequently occurring and easily recognizable causal patterns that are triggered under generally unknown conditions or with indeterminate consequences. They allow us to explain but not to predict" (Elster 1998, 45).

9 Agfors (1995, 223) identifies competition of oil and electricity in the decades after the Second World War as factors for closing the urban gas systems within Sweden.

10 Russia still provides most of the natural gas used in Finland for domestic consumption, and it is expected to supply more than 50% of the European natural gas demand after 2020, so the stability of the continent will increasingly depend on its energy policies (James A. Baker III Institute for Public Policy 2005).

11 The users that signed the letters of intention are Kerling (Hydro Polymers), Borealis, Yara, Statoil, E.ON Ruhrgas, Göteborg Energy, Preem Petroleum, Perstorp Oxo, SIGC (Swedish Industrial Gas Consortium), and the signing investors are Skagerack Energy, Östfold Energi, Hafslund, Agder Energy, E.ON Ruhrgas, Göteborg Energy, Swedegas, Preem Petroleum, Energinet.dk and PGNiG (Gassco & DNV 2007, 1).

12 In Sweden, the separation of sales and transport of the natural gas required in 2004 that "the reports and accounts of the two activities must be separated" (Swedish Energy Agency 2004, 37).

13 Due to the Act Concerning Taxation of Energy, natural gas used for electricity is free of tax (Swedish Energy Agency 2005, 35).

14 "The Espoo (EIA) Convention sets out the obligations of Parties to assess the environmental impact of certain activities at an early stage of planning" (Convention on Environmental Impact Assessment 2008).

15 According to the EU Trans-European Energy Networks legislation (European Union 2006, 2) "Appropriate priority for funding under Regulation (EC) No 2236/95 should be given to projects declared to be of European interest".

16 "LUKOIL is number one in the world in terms of oil reserves, and number three in terms of total reserves […] Rosneft is number one in the world amongst private companies in terms of reserves to production ratio (28 years)" (Poussenkova 2007, 88).

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3. BECOMING GOVERNABLE? EXAMINING GOVERNABILITY OF MEXICO'S NATURAL GAS TRANSMISSION PIPELINES UNDER THE 2014 ENERGY REFORM©

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Highlights

- Transmission pipelines are inherently difficult to govern.
- The Mexican case is especially difficult to govern due to its high complexity.
- The governance system is well-equipped to govern the transmission pipelines once the molecule has reached Mexico under the 2014 energy reform.
- Balancing economically and environmentally efficient supply is the main challenge for governability of natural gas.

Abstract

Mexico's energy liberalization reform has reshaped the natural gas sector landscape, including the governance system of transmission pipelines, with the objective to attract substantial investment. This article will address the question of what sorts of governability components attracted investment in gas infrastructure over the period 1995-2015. Governability will be examined in order to recognize challenges in the governance regime

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based on interactive governance theory. The main objective is analyzing the system's comprehensive capacity for governance under the 2014 energy reform.

Keywords

Mexico energy reform
Mexico natural gas regulation
Investment in gas infrastructure
Governability of transmission pipelines

3.1 Introduction

Are Mexico's natural gas transmission pipelines becoming governable? The energy reform proposed by President Peña Nieto was approved by the congress and its secondary laws were adopted into law in August 2014. The aims of this reform include modernizing the energy sector and attracting investment in order to embrace the country's energy potential in a sustainable manner and spread the economic benefits among the population.

The majority of interest in the 2014 energy reform has concentrated on exploration and production of natural gas and oil that are expected to attract major investment projects. However the gas upstream sector will require infrastructure in the midstream sector able to "meet demand and keep pace with production" (Pierce 2014:1), which will also bring investment opportunities in transmission pipelines. Moreover substantial investment in midstream infrastructure is required to meet demand of growing imports of natural gas (Lajous 2014).

Natural gas transmission pipelines have been operating in recent years close to maximum capacity due to restricted investment in the sector. An outdated[2] and underdeveloped network of transmission pipelines prompted natural gas shortages in 2013 that "accounted for a loss of 0.3 percent of GDP growth during the second quarter of that year (Bank of Mexico, 2013)" (Alvarez & Valencia 2015:9). Rosanety Barrios, Coordinator of Industrial Transformation Policies at the Secretariat of Energy (SENER), explained in an interview

[2] The average age of the public transmission pipelines is 36 years old.

that when shortages were triggered in 2012 and 2013 Pemex and the Federal Electricity Commission (CFE) slowed down their gas consumption in order to lessen its impact on industrial production.

Private investment has been allowed in transportation pipelines since the 1995 reform of the gas sector when Pemex gave up a complete monopoly it had since the 1940's (Halpern & Rosellon 2001). The 2014 energy reform aims to encourage further participation in gas midstream infrastructure investment from private enterprises and public-private partnerships. After Mexico's expropriation of foreign oil holdings in 1938 (Huesca 1988; Maurer 2011; Meyer 1972), this reform is arguably the most important in the energy sector. This reform is part of an integral package of reforms that was signed into law by the president in December 2013, and most of these reforms were enacted in two years from President Peña Nieto taking office.

The federal government received international recognition for the political will to put the energy reform forward and for arranging the political cooperation needed for its approval,[3] and has promoted it as a means to guarantee security of natural gas supply. Meanwhile competitiveness challenges at the national level have exacerbated the complexity of implementing this reform. Although these challenges emerge from the external environment, the governance system in the energy sector has steering mechanisms to address them. On the other hand there are supply challenges emerging from the international environment in which the capacity of the governance system to provide solutions is limited. Thus the focus of this article will be on the governability of the gas transportation sector which will condition the implementation of the energy reform and its long-term sustainability.

3.2 Governability and Interactive Governance Theory

Governability based upon the interactive governance approach is examined in this article. Governability can be reckoned as the disposition for successful governance of a societal system and subsequently defined as "the overall capacity for governance of any societal entity or system" (Kooiman 2008:173, Bavinck et al. 2008:3). According to Kooiman

[3] The Pact for Mexico, a governance agreement and bargaining mechanism amongst the three major political parties, allowed the president to enact some of his most relevant reforms. PRI and PAN agreed on most proposals of the energy reform, but the PRD's opposition to the energy reform triggered its exit from the pact.

(2008) a governance system (GS), a system-to-be-governed (SG) and the governing interactions (GI) are the three main sets of variables of governability. Frameworks following interactive governance theory have been applied for the assessment of public health functions (Kutty & Varghese 2012), coastal and marine regions (Bavinck et al. 2015), capture fisheries and aquaculture (Bavinck et al. 2005) and transport biofuels (Di Lucia 2013). These studies contributed to the analysis of governability of natural gas transmission pipelines as a societal system.

Interactive governance is focused on governing interactions and governability is defined by the quality of these interactions (Kooiman 2003). Interactive governance theory establishes that in a dynamic and complex area of societal activity (ie natural gas transmission pipelines), effective and legitimate governance "is achieved by the creation of interactive, social-political structures and processes stimulating communication between actors involved, and the creation of common responsibilities next to individual and separate ones" (Kooiman 2003:3). Thus no single actor (ie agency) would have the information, the knowledge or the action potential to deal with such an area of societal activity.

The solution in the 2014 energy reform was to design a new institutional framework and expect it will be capable of governing the energy landscape. This article goes beyond this classic approach and studies the interactions of those governed in order to examine the system's propensity for achieving effective and legitimate governance. According to the interactive governance theory private and public 'governors' interact to create opportunities and solve problems (Kooiman 2003). Institutions are "considered to be vital for any governance interaction" (Bavinck et al. 2008:3) and are attended "as contexts for these governing interactions" (Kooiman 2003: 14).

Interactions are those reciprocally impelling relationships between a couple or more actors (Kooiman 2003:23) and the main types identified by Kooiman (2008:184) are collaborative, participatory and policy interactions. Participatory interactions are characterized by the organized collective action of social political entities, collaborative interactions are focused on the shared activities of organizations, groups and authorities for governance purposes and policy interactions "are the collective variables for all hierarchical interactions by GS (governance system) aimed at having an impact on SG (system-to-be-governed)" (Kooiman 2008:185).

3.3 Analytical Framework and Model

The three components of governability (governance system (GS), system-to-be-governed (SG) and governing interactions (GI)) are identified and presented in a model and analyzed under the interactive governance theory. The integrated framework for governability employed by Kooiman (2008:174) and the three-system model developed by Di Lucia (2013:84) work as the analytical framework engaged in this article. The framework by Kooiman (2008:174) identifies policies and interactions as the main type of variables of the governing interactions. In this framework, state, civil society and market are the three elements of the governance system whereas cultural, social, ecological and economic factors compose the system-to-be-governed.

Mexico's system-to-be-governed is partly social and partly natural and its qualities will determine its needs for governance (Di Lucia 2013:84). The social sub-system is composed of a system of users, stakeholders and investors and the natural sub-system consists of the network of transmission pipelines and the transported gas. The governance system, those governing the system-to-be-governed (Kooiman 2008:173), has been in constant evolution and currently consists of an institutional framework composed of a security agency, SENER, independent operators, state-owned companies, Presidency of the Republic and independent regulators. Governing interactions analyze the changing interactions between the system-to-be-governed and the governance system.

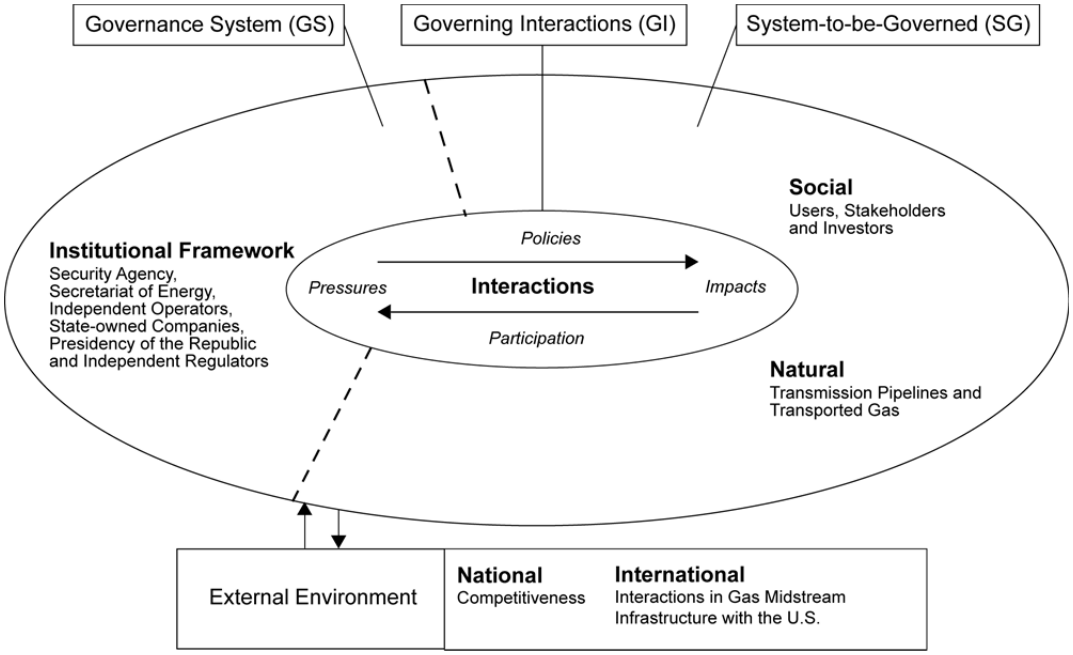
The Di Lucia (2013) model includes in the external environment those factors that interact with the three systems analyzed and impact upon governability. In this article the external environment will examine factors of the national and international experience. At an international level the interactions in midstream infrastructure with the U.S. gas sector are explored and at the national level four indicators of competitiveness are considered.

Competitiveness can be defined "as the set of institutions, policies, and factors that determine the level of productivity of a country" (Schwab ed. 2014:4), and is therefore embedded in governability which is a common situation in the interactive governance theory. Competitiveness is considered by the actors of the social component of the system-to-be-governed before committing long-term investment in natural gas infrastructure. The

focus on competitiveness will be on business costs of crime and violence, corruption, judicial independence and regulatory quality.

Figure 1. Interactive Governance Framework for Governability of Natural Gas Transmission Pipelines

Source: Author's illustration based on Kooiman (2008:174) and Di Lucia (2013:84)



SG, GS and GI are studied considering its diversity, complexity, dynamics and scale qualities (Kooiman 2003; Di Lucia 2013:84). Only some of these qualities are examined in the external environment. Conducive to providing a logic thread the natural sub-system of the system-to-be-governed (natural) will be first studied and then the article will follow the configuration of the model counterclockwise (system-to-be-governed (social) –> governance system –> governing interactions –> external environment (national –> international)).

3.4 System-to-be-Governed

3.4.1 Natural – Transmission Pipelines and Transported Gas

The natural sub-system encompasses the transmission pipelines and gas transported. Mexico's gas pipeline network is composed of 11,542km. In the period 1996-2013

investors obtained 20 permits (SENER 2013a:23) and developed approximately 2,500km of pipelines. Throughout this period, and to date, the public transmission pipelines were the National Pipeline System (SNG) (8,704km) and the Naco-Hermosillo System (333km) (CENAGAS 2015), and the length of the public liquefied natural gas (LNG) pipelines was 1,632km (PGPB 2015a). In the period 2003-2014 the gas transported by the public pipelines increased slowly from 3,659 millions of cubic feet per day to 4,884 millions of cubic feet per day and the LNG transported decreased (PGPB 2015b). The diversity of this sub-system consists of gas and LNG pipelines with public, private and public-private ownership.

The geographical scale of the natural sub-system is limited within inland Mexico, mainly in the eastern and central states. The plans by SENER to achieve nationwide coverage of natural gas will change the scale of the natural sub-system by way of reaching more states.[4] The scale will also include the Gulf of Mexico when the construction of an underwater pipeline linking South Texas to Tuxpan (Veracruz) is completed.

Also part of the geographical scale, the Mexican pipeline network has at least 13 major interconnections with the U.S. (IEA 2014a) and no interconnections with its southern neighbors, which will change when a pipeline linking Salina Cruz (Oaxaca) to Escuintla (Guatemala) is built in the next few years. As of 2012 natural gas imports by pipeline from the U.S. totaled 779 billion cubic feet (Bcf), and LNG imports, mainly from Qatar, Nigeria and Peru, summed 224 Bcf (IEA 2014a:11).

Gas imports in Mexico tripled in the period 2002-2012 and in 2011-2012 grew 21.7 percent (SENER 2013a:132). The natural gas exports from U.S. "to Mexico accounted for over 38% of total U.S. natural gas exports, and nearly 80% of Mexico's natural gas imports" (EIA 2014a:11), which highlights the relevance of studying the governability of transmission pipelines for the region.

With regard to the dynamics of the natural sub-system, the main driver of the expansion of the gas transmission network was electricity generation.[5] In the period 1990-2012 the use of

[4] As of 2014 only Baja California Sur, Sinaloa and Quintana Roo did not use natural gas (SENER 2013a:242); the first two are expected to start using gas in 2016 and the latter in 2018 (SENER 2013a:243).
[5] Other drivers of natural gas demand are the oil sector and the industrial sector, which represented 34 percent and 17.7 percent, respectively, of demand in 2012 (SENER 2013a:22). In 2012 the industry sector had the most dynamic demand with a 4.6 percent yearly increase (SENER 2013a:22).

natural gas in electricity generation increased from 12.5 to 51.4 percent, and increased 55.6 percent in 2012-2013 (World Bank 2015), and in 2012 Mexico's electricity produced from natural gas ranked fifth in the world (IEA 2014b:25). While the national production of natural gas has remained flat (Lajous 2014, BP 2015:23) the increasing demand of gas for electricity and oil production has been supplied by imports that require more infrastructure.

The configuration of the relations among transmission pipelines with storage, production or imports, regasification plants, distribution, sales and the use of gas in the electricity, oil and industrial sectors make this natural sub-system "highly complex due to the inclusion of both direct and indirect relations simultaneously affecting its development" (Di Lucia 2013:84).

3.4.2 Social – Users, Stakeholders and Investors

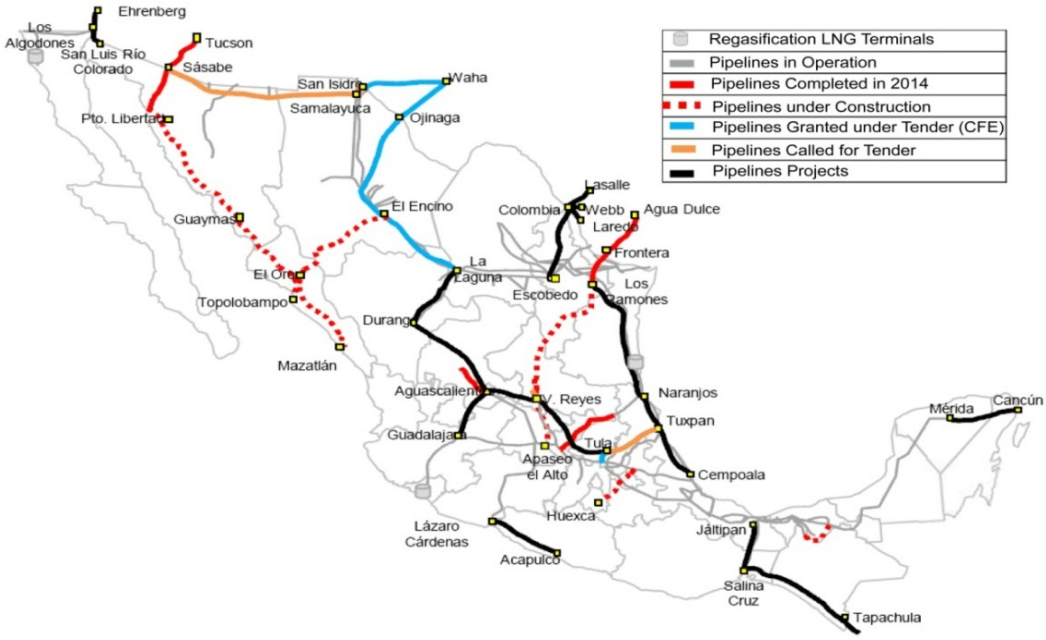
The social sub-system is composed of the users, stakeholders and investors in Mexico's natural gas network of transmission pipelines. Since the 1995 reform of the gas sector the diversity of the social sub-system encompasses private and public actors and public-private partnerships. The public actors were Pemex and CFE, and the private actors were Mexican companies and foreign companies and its Mexican subsidiaries. The public-private partnerships included hybrids between the public and private actors, particularly PGPB partnering with the subsidiary of a foreign company.

PGPB owned and operated the National Pipeline System and the Naco-Hermosillo System and had stakes in other projects. PGPB is a subsidiary of Pemex (2015), the state-owned petrol company that is "the largest tax contributor to the Mexican government". In the period 1995-2013 the electricity and oil sectors (interchangeably), and in third place the industry sector, were the biggest gas consumers.

The role of the CFE has been pivotal in the development of the gas transmission network. CFE has opened up tenders for gas transportation projects before the 2014 energy reform was promulgated making gas transportation the most mature sector of the reform. This sector has experienced immediate investment after the reform following CFE's tenders because it was already embedded in this dynamic previous to its promulgation.

Figure 2. Expansion of the National System of Pipelines Towards 2018

Source: CENAGAS (2015:23) (translated)



In the private sector IEnova, which is part of the San Diego-based Sempra Group, was identified as one of the main players. IEnova started operations in 1997, coinciding with the 1995 liberalization reform, and since then has invested over US$3.5 billion in projects and assets in Mexico (PRNewswire 2015). This company owns and operates over 500km of pipelines (IEnova 2015a) that account for "19 percent of the market's transportation capacity" (IEnova 2015b:8) and its subsidiaries have won major projects to provide CFE gas transportation services under long-term contracts (Martin 2014a).

The interactions between the public and the private sector changed since the 1995 liberalization reform of the gas sector and some public-private partnerships have since been created. Such is the case of the partnership between MGI Enterprises US LLC, a wholly owned affiliate of PGPB, and the Japanese Mitsui Corporation to build a pipeline that transports gas from Tucson to Sasabe. PGPB also established a 50/50 partnership with IEnova in Los Ramones Pipeline through the creation of Gasoductos de Chihuahua. In July 2015, approximately one year after the enactment of the secondary laws of the energy reform, IEnova acquired "Pemex's 50-percent equity interest in the Gasoductos de Chihuahua joint venture for US$1.325 billion" (PRNewswire 2015).

Other major players in the period 1995-2014 were TransCanada, Engie and Kinder Morgan. The latter's subsidiary, KM Mexico, owns the Mier-Monterrey Pipeline which is a 153km system that connects since 2003 a power plant near Monterrey and PGPB to "Kinder Morgan's intrastate pipeline system in Starr County, Texas" (KM 2004). TransCanada constructed and later sold "the first (two) non-Pemex pipelines in Mexico" (Pipeline & Gas Journal 2009). This Calgary-based company also constructed, owns and operates 765km of pipelines that link LNG terminals in the east and west coasts to gas supplies and have entered into long-term contracts with CFE (TransCanada 2005). TransCanada also owns and operates two other projects in the Northwest region, one of which "is supported by a 25-year natural gas transportation service contract with the CFE" (TransCanada 2012). Altogether TransCanada's investment in Mexico since the 1990's is US$2.6 billion approximately.

Engie (2015) is a French multinational that owns 100 percent of Gasoductos del Bajío Pipeline (200km) and owns and operates 67.5 percent of Energía Mayakan Pipeline (700km). Both pipelines were purchased from TransCanada in 2003. The other 32.5 percent of Energía Mayakan Pipeline belongs to GE Energy Financial Services, a division of General Electric Company which is headquartered in Connecticut. In 2013 Energía Mayakan announced an extension to connect Nuevo Pemex Gas Processing Plant owned by PGPB with the Mayakan Pipeline in Macuspana. CFE "contracted with PGPB to use 300 MMcf/d of gas through this new 30-inch pipeline in order to switch power plants in the Yucatan from diesel and fuel oil to natural gas" (Pipeline & Gas Journal 2013).

After the 2014 reform new players and existent players have been awarded pipeline projects in public tenders by CFE. In December 2014 the Mexican company Fermaca was awarded the contract for El Encino-La Laguna Pipeline, a 414km project that will transport gas to two CFE's terminals (Martin 2014b). In January 2015 a consortium formed by U.S. companies MasTec Inc, Energy Transfer Partners and Mexico's Carso Energy was awarded the Waha-Presidio Pipeline, a US$767 million project that will supply gas from the CFE Waha Header to Presidio (TX) near the border with Mexico (Martin 2015). In March 2015 Black Rock and First Reserve entered into an agreement with Pemex's subsidiary PMI to purchase 45 percent equity interest in Los Ramones II (First Reserve 2015). The latter will transport gas from the Eagle Ford shale in Texas through 744km of pipelines (idem) and

the investment by Black Rock Inc. and First Reserve Corp. was around US$900 million (Ilif 2015). In June 2015 CFE declared the bidding process for eight gas pipelines that plans adding 2,385km to the network. The South Texas-Tuxpan Marine Pipeline that will transport gas for 800km is valued at US$3.1 billion and was the biggest project in this round (Passut 2015).

The social sub-system experienced a dynamic in which the private pipeline owners entered into long-term contracts with PGPB and CFE consistent with the transition "from burning fuel oil to natural gas in power generation from the 1990s to the present" (Morales 2013:8). This is a line of action contained in the National Infrastructure Program 2014-2018 (GR 2013a:71) and CFE have tendered multiple pipeline projects following this dynamic.

In the 1995-2015 period the scale, or spatial dimension of the sub-system (Di Lucia 2013), was national (Mexican) with strong regional (North American) features and the addition of a few international players from other regions. The 2014 reform has accentuated the regional scale features. The diversity previous to the 2014 reform was medium-high because there were only a few public and private players following collaborative interactions. After this reform the diversity is high due to the inclusion of new private players and new public-private partnerships. The complexity of this sub-system pre-reform (2014) was high considering the interactions among suppliers, transporters, Pemex and CFE. The complexity was topped after the reform when previous and new operators won multiple projects towards the creation of a national gas market that will prompt an exponential increase of the pipeline network.

3.5 Governance System – Institutional Framework

In the period 1995-2015 the governance system was composed of the Presidency of the Republic, SENER, Energy Regulatory Commission (CRE) (regulator), National Commission of Hydrocarbons (CNH) (regulator) and Pemex. The 2014 reform created other institutions.

The National Development Plan 2013-2018 (PND), put together by President Peña Nieto, proposed strengthening natural gas transportation infrastructure in order to secure supply (GR 2013b:137). This plan established the creation of the National Infrastructure Program

2014-2018 which sets the calendar for the tenders that will create an additional 5,448km of transportation pipelines for 2018 (GR 2013a:70) attracting over US$10 billion (CENAGAS 2014:23).

The PND (2013b:137) proposed the "strengthening of the execution capacity of Pemex" however in practice PGPB's capacity has been gradually limited since the 1995 reform of the gas sector, and after the 2014 reform ownership of the public pipelines was transferred to a new entity. Pemex had its monopoly on gas transportation ended under the 1995 reform that was enacted soon after the NAFTA came into force (Morales 2013) and President Zedillo started his mandate. The 1995 and 2014 reforms and the signature of NAFTA are consistent with a broader dynamic initiated in 1982 in which nationalism was replaced by neoliberalism in the Federal Public Administration. The postulates of neoliberalism were first adopted by President Miguel de la Madrid (1982-88) and have been applied by the federal government since then with special emphasis on privatization of most areas of the state and opening the economy to the international markets (Babb 2001). As part of this dynamic Mexico signed the General Agreement on Tariffs and Trade (GATT) in 1986 which is the immediate precedent to NAFTA.

Under the 1995 gas-sector reform "private participants may build, own and operate natural gas transportation" (OECD 2004:201). In 1995 the Oil and Gas Ruling Law was amended and the *Reglamento de Gas Natural* was presented increasing the complexity of the system by changing the market architecture. Private transporters and Pemex would get 30-year permits from the regulatory authority, the same for operators that proposed to build pipelines for their private usage, and "Pemex was to focus on maintaining its existing large transportation network and gas exploration and production" (Halpern & Rosellon 2001:7). To date this network has been maintained without extensions.

As part of the 1995 reform the Energy Regulatory Commission (CRE) was assigned to grant permits[6] for gas transportation. The CRE was created as a result of the 1992 reform of the electricity sector and the publication of the Law of the CRE in 1995 gave the CRE responsibilities in natural gas regulation.

[6] Halpern & Rosellon (2001:8) highlight the relevance of the permit regime "as a fundamental regulatory instrument because it provides certainty to investors".

The vertical integration of Pemex outlasted the 1995 reform and in 2000 the CRE issued a directive for Pemex to unbundle gas transportation, production and marketing activities (Halpern & Rosellon 2001:25). In 2008 the energy reform presented by President Calderon created the CNH with the aim to guarantee energy security (Cortes 2013:8). The CNH was provided with operative and technical autonomy under the CNH Law, regulating transport activities directly related with the extraction and exploration of hydrocarbons (idem). The 2008 reform granted the CRE management and decision autonomy and gave "teeth" to CRE, SENER and CNH "to impede the commission of illicit conduct by the powerful subjects regulated" (Lujambio 2013:18).

CNH and SENER oversee the transport of gas and LNG. SENER dictates the planning, policy and supervision of gas. It is also responsible for setting the social and economic directives for the public energy sector, has the faculty to cancel permits and promotes private participation in the gas industry (SENER 2013b:64-65). When transport permits are cancelled CRE will ask SENER to secure supply.

PGPB was responsible for the transport of gas liquids, natural gas and artificial gas (SENER 2013a:67) and owned the SNG and Naco-Hermosillo System until the 2014 energy reform was enacted. A presidential decree issued on 28 of August 2014 created the National Center for the Control of Natural Gas (CENAGAS) as a "decentralized public organization of the Public Federal Administration, sectored to SENER" (DOF 2014a:1) and ruled that Pemex would transfer to CENAGAS all gas pipelines and storage infrastructure to own and manage (DOF 2014a).

Under the secondary laws of the 2014 energy reform CFE and Pemex became state productive enterprises with exclusive property of the federal government and the Hydrocarbons Law was promulgated. The latter regulates transport of natural gas, including the pipelines that import gas and the interconnection of transportation and storage pipelines known as "integrated systems". Under this law open access is regulated by the CRE in order to provide transparency to this process. This law sets the rules to meet the regulated subjects and prohibits public servants from SENER and the National Agency of Industrial Security and Environment Protection of the Hydrocarbons Sector (ASEA)[7] from accepting gifts and other payments. Besides, CRE and CNH will be subjected to the

[7] This agency will guarantee the protection of the environment, people and installations of the hydrocarbons and will regulate the control of polluting emissions and waste, industrial and operative security (DOF 2014e).

Federal Transparency and Access Governmental Public Information Law (DOF 2014d). Furthermore all contracts will be subjected to laws combating corruption and persons and companies participating in permits or contracts regulated under the Hydrocarbons Law that incur in practices such as offering or giving money, engaging in behavior to dodge the rules, intervening for people banned for engaging in public contracts and using political power to obtain benefit will be punished (DOF 2014b).

The Hydrocarbons Law mandates that the CRE will be responsible for permits of gas systems and defines the role of CENAGAS as an independent manager and administrator of the Integrated National Gas System with the objective to guarantee the security and continuity of provision of services (DOF 2014b). CENAGAS will also guarantee that the operation of the permissioned system is consistent with open access principles and without affecting existing contracts that reserve gas capacity.[8] To date CFE was still calling for tenders in gas infrastructure projects however CENAGAS will assume control of this activity in the near future.

In an interview with Dr. David Madero Suárez, general director of CENAGAS, he identified long-term ownership of the new transmission pipelines, solid regulatory governance that provides certainty to investors and the plans to develop an integrated gas with nationwide coverage as some of the incentives for investment in this sector. One of the challenges for investment in Mexico's network of transmission pipelines identified by Dr. Madero Suárez is obtaining right of way for the fast-growing network, particularly because the general public is used to interacting with Pemex in this regard and not as much with private investors. This research has also identified the right of way could be challenged when crossing paths with pre-Hispanic vestiges and traditionally-ruled land.

The *Ley de la Industria Eléctrica* came into effect in August 2014 allowing private participation in the sale and generation of electricity, which is expected to increase demand for gas in electricity production. This law created a wholesale electricity market that will be operated by the National Center of Energy Control (CENACE). The latter's foundational objectives are enhancing and modernizing the (electricity) National Transmission Network and controlling the National Electricity System. The creation of CENACE and

[8] CENAGAS will determine and manage the capacity of the system, coordinate the commercialization of the transmission networks capacity, propose the development of the infrastructure of this network and supervise the compliance with the transport permits (DOF 2015).

CENAGAS are matched in its conditions as decentralized public organizations sectored to SENER. The coordination of these centers will be of major relevance for the governance system due increasing demand of electricity produced from natural gas.

The scale of the governance system was restricted to Mexico. Each of the reforms (1995, 2008 and 2014) reshuffled the architecture of the governance system and increased its complexity. The latest liberalization reform created ASEA, CENACE and CENAGAS[9] increasing the diversity of the governance system. The leading dynamic in the period 1995-2015 was the promulgation of reforms that have restructured the governance system.

3.6 Governing Interactions

The dynamics have been top-down policy interventions in the means of reforms orchestrated from the Presidency of the Republic that have redefined the governance system.

The governing interactions since 1995 have been operating towards the liberalization of the system-to-be-governed allowing private and public-private ventures to participate in gas transportation. Whereas considerable investment has been attracted to date, the infrastructure has not been enough to satisfy the increasing gas demands, an issue that the latest reform tries to remedy. An alternative to the importation of gas via pipeline has been the importation of LNG from a variety of countries however this option is currently not economically efficient considering the availability of low price gas from the U.S.

The diversity of the governance system increased with the creation of regulatory bodies after the 1995, 2008 and 2014 reforms and its complexity increased with the introduction of regulations that broadened the interactions among the actors of the governance system. The latter was foremost a federal matter with no identified role of the states, and the policy interventions by the 2014 reform are consistent with the SENER strategy to develop a network with nationwide coverage and securing natural gas supply.

[9] CENACE and CENAGAS are a new type of socio-political institution in the Mexican energy sector inspired in the independent system operators and independent transmission system operators, respectively. The differentiation is based on ownership; CENACE does not own any wires whereas CENAGAS owns pipelines (Pollitt 2011).

Regarding the geographical scale, the interactions with the U.S. have become more frequent since the signature of NAFTA. These interactions have triggered higher gas dependence of the U.S. which is a trend likely to continue in the near future. The governance system jurisdiction is restricted within the Mexican borders and the gas transported is increasingly imported from the U.S. where the governance system has no jurisdiction. These conditions have increased the complexity of the system and therefore it is expected to be less governable (Chuepagdee 2011).

3.7 External Environment

3.7.1 National - Competitiveness

According to the Global Competitiveness Report the "benefits of the many adopted reforms intended to increase the level of competition and efficiency in the functioning of Mexico's markets have not yet materialized, highlighting the need for effective implementation that should not be delayed" (Schwab ed. 2014:33). Business costs of crime and violence, corruption, judicial independence and regulatory quality are the indicators of competitiveness that will be analyzed as part of the national experience. The selection of these indicators was done considering its relevance to the governability of the system studied.

Crime and violence are of major concern for Mexican citizens. The 2013 National Poll for the Quality and Impact of the Government (INEGI 2014:41) showed that 70.4 percent of respondents considered insecurity and crime as the most important problem in the state they live in, followed by unemployment (51 percent) and corruption (48.5 percent). Almost half of the respondents believed corruption was very frequent and 40 percent answered frequent (INEGI 2014:41). Corruption is defined by Transparency International (2015) as "the abuse of entrusted power for private gain". Mexico ranked 103 out of 174 countries in the Corruption Perceptions Index, corruption is the most problematic factor for doing business (Schwab ed. 2014:270) and on average households used 14 percent of their income to pay the costs of corruption in 2010 (Transparencia Mexicana 2011:6). Casar (2015:61) proposed the need to prioritize the combat of corruption in Mexico as a means to foster economic growth and achieve competitive advantages in the international markets. Corruption correlates negatively with economic growth and investment (Herciu 2006:13), and attracting investment is a primary objective of the energy reform.

In recent years the illegal extraction of hydrocarbons has grown exponentially in Mexico. The high pressure used by the transmission pipelines and the gaseous state of the molecule transported makes this practice less common in this sector. Nonetheless the natural gas transmission pipelines interact with storage, exploration and production, distribution, and sales of gas and investors in these areas are susceptible to organized crime and the costs of crime and violence. Out of 144 countries Mexico's costs of crime and violence ranked 135 and organized crime 140 in 2014 (Schwab ed. 2014:271). Mexico's violence containment costs per person represented 10 percent of the GDP in 2014 (IEP 2015a:114) and the total economic impact of violence in Mexico is equivalent to 17.3 percent of the GDP (IEP 2015b:7). Peña Nieto's government has managed to reduce the level of organized crime by 25 percent and homicide rate by 30 percent in the last two years (IEP 2015b:2). Thus the actual government is to some extent part of the solution of a problem inherited from the Calderon Government in which the U.S. could give a hand stopping illegal trafficking of weapons and ammunition across the Mexican border.

The plans for national coverage of the pipeline networks could face legal challenges when interacting with pre-Hispanic vestiges[10] and traditionally-governed zones. The ultimate guarantor of investment at the national level is the judiciary and its independence, defined as "law enforcement not being subordinated to political power bodies" (Sánchez Cordero de García Villegas 2000:1), will be critical in attracting investment in transportation pipelines. Mexico's judicial independence is much improvable; in a 1 to 7 (best) scale graded 3.2 and ranked 98 out of 144 countries (Schwab ed. 2014:271). There was a judicial reform in 2008 and another part of the structural reforms of President Peña Nieto, however the low levels of judicial independence highlight that the success of these reforms depends on its implementation and not on its promulgation.

The promotion of regulatory coherence is relevant for attracting investment and avoiding corruption (García Villarreal 2010). There are encouraging signs of regulatory strength. Of the six indicators that compose the World Wide Governance Indicators on Mexico, regulatory quality obtained the highest results in the period 1996-2013. Regulatory quality is one of the strongest competitiveness areas of Mexico.

[10] This situation will require better collaboration among the social sub-system, the governance system and the National Institute of Anthropology and History.

The main dynamic identified was that corruption and business costs of crime and violence represent a substantial amount of the GDP, and the economic benefits of the energy reform will pay first for these costs before spreading among the population, as planned in its promulgation. On a higher note, the solid performance of regulatory quality is expected to have a positive influence on the energy regulators of the governance system following a dynamic of diffusion (Jordana & Levi-Faur 2005; Meseguer & Gilardi 2008).

3.7.2 International – Interactions in Gas Midstream Infrastructure with the U.S.

Since NAFTA came into force in 1994 natural gas exports from U.S. to Mexico have increased 15 times in 20 years (EIA 2015). The most notable rise in this time was in the period 2010-2014, in which exports to Mexico via pipeline doubled partly due to the increasing production trend of shale gas since 2010 that created weak gas prices.[11] Mexico has benefited from these prices as much as its limited transportation infrastructure has allowed. However prices in the U.S. might change soon. In the next months this country will dispatch "its first major shipment of liquefied natural gas" (Rahemtulla 2015) and LNG exports could link domestic prices to international prices. Whereas exports to Mexico have accounted for three percent of the U.S. natural gas production and are expected to account for five percent in 2030, LNG exports "by 2030 will make up about 16 percent of U.S. production" (Shogren 2015).

There are other conditions that could fire up U.S. gas prices soon, such as gas demand will increase faster than expected, the number of rigs has experienced a substantial decline and "demand growth set to outpace supply growth" (To 2015).

The U.S. interstate and intrastate transmission pipelines network is 40 times bigger than Mexico's network of transmission pipelines (EIA 2008) and the former could "transport natural gas to and from nearly any location in the lower 48 States" (idem). In 2013 the states that consumed the most gas were Texas, California, Louisiana, New York and Florida (EIA 2013a), and most of the locations that export gas to Mexico were located in Texas and California.

[11] The U.S. produced approximately 20 percent of the world total dry natural gas in 2012, from which 40 percent came from shale gas (EIA 2014b:32).

Under these dynamics Mexico is poised to price increases in the U.S. in the short term and in the medium term Mexico's transportation pipelines may find themselves competing for gas that could be liquefied and sold for higher prices or used within the 48 lower states, particularly in the states that consume the most natural gas.

3.8 Discussion and Conclusions

3.8.1 Governability Assessment

This section identifies the challenges for the performance of the governance system and its capabilities (Chuenpagdee & Jentfot 2013).

The critical juncture in the Public Federal Administration was the transition from nationalism to neoliberalism which had a "profound influence on subsequent events" (Mahoney 2001:1) creating path-dependence processes and has been followed by reform policies which have reached the natural gas sector. After the signature of NAFTA there has been a significant increase in gas exports via pipeline from the U.S. Parallel to this dynamic since 1994 each Mexican president, with the exception of President Fox, has proposed liberalizing reforms with the objective to attract private investment in the transmission network. These dynamics have generated increasing returns (Arthur 1994; Mahoney 2000; Pierson 2000) towards liberalization and dependence of Mexico for gas from the U.S. As a result demand for gas in Mexico has increased and the network of pipelines has been directed to the U.S. to meet this demand.

The tenders by CFE addressed the need for gas in electricity production and started a dynamic of tenders that continued after the 2014 reform. In other sectors, such as production and exploration of gas, there was a state monopoly previous to this reform. The 2014 reform had historical and governance implications by redefining the role of Pemex and creating an independent transmission system operator.

Governability of Mexico's gas network of transmission pipelines is highly complex because it is embedded within multiple interacting and fast-changing systems. The governability of natural gas transmission pipelines is influenced by acts of governance but also by external factors (national and international) in which its governing system has limited control

(Bavinck et al. 2008). Whereas the costs of crime and violence, corruption and judicial independence challenges have not prevented the development of private pipelines before or after the 2014 energy reform, the success of the latter's implementation could be compromised if these areas are not improved.

The increasing natural (interconnections, pipelines directed to the U.S. and gas imported from the U.S.) and social (U.S. companies and their subsidiaries) interactions urge for bilateral government, regulatory and business collaboration and cooperation that give certainty in both sides of the border. These interactions should be informal and formal, transparent and vertical, and focused on information exchange and security of supply.

Ownership in the system began changing with the 1995 gas sector reform and is fast-changing since the 2014 energy reform. This dynamic has given rise to increasing interactions between the social sub-system composed of powerful subjects regulated (Lujambio 2013:19) and a governance system that experienced a major reshuffle under the 2014 reform along with the creation of new institutions. Turbulence in this novel policy sector could create "pressures for more direct involvement on the part of the president" (Ramió & Jordana 2010:22) which would compromise the independence of the regulatory agencies. Thus the implementation of the steering mechanisms by the governance system will be critical to prevent the risk of capture of the regulatory agencies (Braithwaite & Makkai 1992; Stigler 1971, 1975) and to interact with groups competing for political influence to pursue favorable regulation (Becker 1983). These risks could increase the complexity of the system making it less governable (Chuepagdee 2011).

Soon Mexico will experience the recovery of gas prices in the U.S. and nationwide coverage of gas transportation will increase demand for gas, including in domestic consumption. An increase in the prices of U.S. gas will also increase the prices of natural gas and of the goods and services dependent on natural gas in Mexico. Increasing imports of gas have diminished the capacity of the governance system to secure gas supply and its control over prices increasing the complexity of the system and becoming less governable. The governance outcomes are nowadays a bilateral issue. Prices and supply increasingly depend on the external environment (international) and the foreign investors and stakeholders in the social sub-system.

There are two (complementary) options for Mexico to secure supply of natural gas, and a combination of both is the most probable outcome. The first option is importing more gas from the U.S. via pipelines and in the mid-term importing LNG from this country which would decrease the governance capacity over supply and control over prices. The second option is the massive production of Mexico's large unconventional gas reserves[12] which would provide more control over supply and over prices nonetheless it would pose unprecedented governability challenges. In such scenario the environmental regulatory challenges would be the biggest yet and water availability and pollution would be major issues that could easily become part of a governance problem rather than a solution. The lax enforcement of environmental regulations and low performance in management of water resources already make Mexico's competitiveness unsustainable (Schwab 2014:71) and massive production of its large unconventional gas reserves would put even more pressure on this issue possibly making this option economically but not environmentally efficient. Thus, balancing economically and environmentally efficient supply is the main challenge for governability of natural gas.

3.8.2 Conclusions

This study has examined the evolution of natural gas transmission pipelines governance in Mexico from 1995 to date in order to recognize challenges and opportunities for enhancing the quality of the governance system. The analysis shows that this system is considerably more challenging to govern today than it was in 1995. The reasons for this are partly related to qualities of the system-to-be governed that has become more complex and diverse. There are more actors involved in the social sub-system of the system-to-be governed, most of which are foreign, predominantly U.S.-based.

The qualities of the external environment also increased the difficulty to govern this system. Upon consideration of the qualities of the external environment (international), in which more natural gas is imported from the U.S, and the social sub-system, in which more foreign stakeholders are investing in gas transmission pipelines, the need to strengthen the governing capacity at a regional (North American) level is highlighted. Even though the

[12] Mexico's shale gas resource base, estimated in 545 trillion cubic feet, is "potentially larger than the country's proven conventional reserves" and is among the world's largest reserves (EIA 2013b:136). Other than low scale production by Pemex with mixed results there has not been massive production of the unconventional reserves yet.

interactions between the governance system and those governed are consistent with liberalization of gas transportation the lack of formal, transparent and accountable international collaboration makes the system difficult to govern.

The transmission network is still largely underdeveloped and lagging demand for gas. The lack of security of supply and limited infrastructure capacity has triggered critical alerts in recent years and governability of the system should encourage security of supply. The introduction of this article posed the question whether Mexico's natural gas transmission pipelines are becoming governable. The answer is that the governance system is well-equipped to govern this network once the natural gas has reached Mexico and efforts to achieve a sound governance system should be celebrated. However, this system is embedded within dynamics in the areas of technology and safety, industry, market, input markets, governance, regulatory and energy policies and external environment (national and international) that increase its complexity and diminish the capacity of the governance system to effectively govern this system. These dynamics make transmission pipelines inherently difficult to govern and the Mexican case is especially difficult to govern due to its high complexity.

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4. MODELLING INVESTMENT IN NATURAL GAS INFRASTRUCTURE: AUSTRALIA AND SWEDEN IN COMPARATIVE PERSPECTIVE

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Dedicated to Emeritus Professor Roger Wettenhall AM. His time, his advice and his kindness inspire the quest to better findings.

Abstract

This article constructs a model of the natural gas sector and then applies it to analyze the cases of Sweden and Australia over the 2000-10 period. This qualitative case comparison is focused on the multidimensional and multidisciplinary process surrounding financial (or private) investment in natural gas infrastructure with special emphasis on institutional conditions, regulatory governance and regulatory, energy and energy tax policies. The main objectives are to test a model that could be generalized to other countries and infrastructures; to generate knowledge in these areas on a theoretical level; and to present a comparison of two case study countries.

Keywords

Regulatory governance for natural gas
Investment in gas infrastructure
Australia natural gas
Sweden natural gas

4.1 Introduction

Natural gas is becoming an increasingly important source of energy across the world. Thus, investment in natural gas infrastructure and regulatory governance for natural gas have necessarily attracted much attention. The world natural gas demand in the period 2012-2035 is expected to rise by up to 44 percent (IEA 2014a:24). Demand in Asia, particularly from China, is growing faster than in other regions (IEA 2014b). Investment needed to supply this demand in the period 2014-2035 is calculated in $8771 billion (USD), from which upstream will account for 70 percent, transmission and distribution for 22 percent and liquefied natural gas (LNG) for 8 percent (IEA 2014a:23).

Policymakers and regulators play important roles in attracting long-term investment in transmission pipelines and LNG projects.

Regulation is also required to reduce the environmental effects of hydraulic fracturing. Regulation that acknowledges the environmental impact of unconventional gas development (Brady & Crannell 2012; Rahm 2011) has been urged for greater protection of local communities hosting gas projects. Unconventional gas reserves have been recently discovered in Australia and Sweden and each country has had different regulatory and policy approaches towards their development.

The process that generates investment in transmission pipelines and LNG plants is multidisciplinary, multidimensional and contains specific explanatory factors and mechanisms that are studied throughout this article in order to assess their qualitative impact. The measurable variance of this investment makes it comparable (Ragin 1989). The search for diversity (Lijphart 1971) and variance in financial investment in natural gas infrastructure is the *raison d'etre* for the selection of the cases of Australia and Sweden for this comparative analysis.

This qualitative case comparison focuses on the conditions surrounding investment in natural gas infrastructure with special emphasis on institutional conditions, regulatory governance and regulatory, energy and energy tax policies. The objectives of this comparison are testing a model of the gas sector that could be generalized to other

countries and infrastructures, generating knowledge in these areas on a theoretical level and presenting a comparison of two case studies.

4.2 Analytical Framework and Model

Considering that global financial flows placed on natural gas infrastructure are not simply private nevertheless they will be attracted to similar conditions as private investment in utilities infrastructure, this type of investment will be referred to as financial (Hernández Ibarzábal 2011, 2012).

Financial investment in gas infrastructure is long term and is particularly susceptible to discretionary changes in regulatory, energy and tax policies (Henisz 2000, 2002; Levy & Spiller 1996). Henisz & Zelner (2001:131) empirically demonstrated in telecommunications that "the rate at which infrastructure penetration grows is positively related to limits on the feasibility of policy change (constraints on political discretion), *ceteris paribus*", and Henisz (2000:20) proposed that in sectors characterized by environmental concern (i.e. unconventional natural gas) regulatory bodies can be included as supplementary veto points.

There is a long-standing debate if utilities – or segments of – are to be considered "natural monopolies" (DiLorenzo 1996; Goodman 1951; Kahn 1970a, 1970b; Trebing 1980), as well as scholarly attention drawn into gas regulation (Harrington et al 2005; Laffont & Tirole 1993; Stigler 1971) and towards the impact of independent regulation in attracting private investment in telecommunications and electricity infrastructure (Cubbin & Stern 2005; Holder & Stern 1999; Maiorano & Stern 2007; Pargal 2003).

Regulation and environmental impact of hydraulic fracturing have recently attracted attention (Boersma & Johnson 2013; Brady & Carnell 2012; Rahm 2011). However, the qualitative impact of institutional conditions, regulatory policies and the creation of autonomous regulatory agencies on investment in gas infrastructure remains widely unexplored.

The research question seeks to determine under what conditions has the interaction of industry conditions, input markets, general economic conditions, national and international

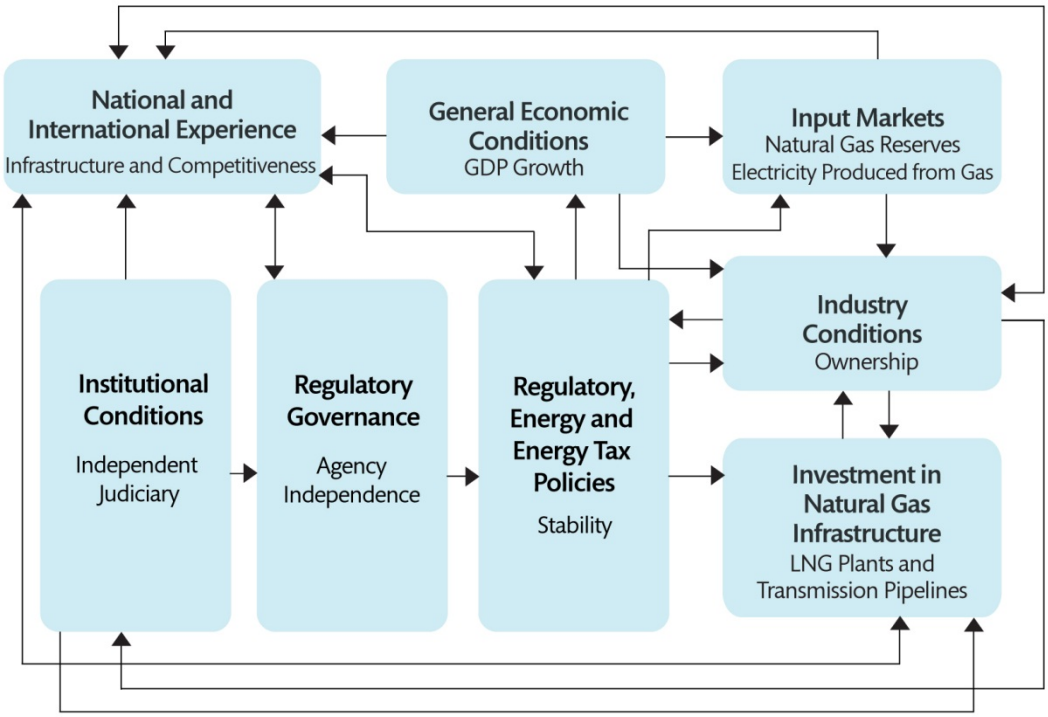
experience, institutional conditions, regulatory governance and regulatory, energy and energy tax policies, attracted financial investment in natural gas infrastructure - transmission pipelines and LNG projects - in Sweden and Australia during the 2000-10 period. The main hypothesis is that such interaction impacts on the variance of investment in gas infrastructure.

During the time frame 2000-10 the conditions for investment in Australia and Sweden were closely matched with each other and differed mostly in two causal conditions. This case selection aims to recognize if these conditions are an integral part of the mixture of conditions that produces the result (Ragin & Sonnet 2004). These cases were nearly matched in having an independent judiciary, solid regulatory governance and agency independence, stable regulatory policies, good general economic conditions and liberalizing reforms in the natural gas sector. In contrast, Sweden and Australia differed widely in input markets (resource base and electricity produced from gas) and in energy and energy tax policies, which is the main reason behind the selection of these cases.

The original contribution of this article is to put forward a comparative and qualitative analysis following a model of investment in gas infrastructure that contributes to a systematic study of the area (Keohane et al 1996:17).

The model set out in Figure 1 provides an analytical device that enables understanding of the effects of regulatory governance and policies on investment in natural gas infrastructure and provides the methodology for this article.[i] This model incorporates factors specific to the gas sector and was developed chiefly on a model by Berg (2001:6) and on variables that proved significant in Henisz (2000, 2002) and Pargal (2003).

Figure 1. The Effects of Regulatory Governance and Policies on Investment in Natural Gas Infrastructure



In order to provide a logic thread, industry conditions will be first analysed and then the article will follow the structure of the model counterclockwise. The focus on industry conditions is on ownership of the gas transmission network and LNG plants with special emphasis on the impact of competition and unbundling reforms and the national and international experience. Financial investment in natural gas infrastructure includes sovereign wealth funds, state-backed and state-owned entities, which have stretched the boundaries between private and public investment that has increased the difficulty in determining the changing ownership and in regulating competition and entry conditions.

Natural gas reserves and electricity produced from gas account for input markets. The World Energy Outlook Special Report (IEA 2011a) and Golden Rules for a Golden Age of Gas (IEA 2012) confirmed the relevance of the resource base and access, regulatory framework and market access in the process of developing and producing natural gas. Electricity generation is the largest natural gas consuming sector, and electricity produced from gas is conditioned by regulatory, energy and energy tax policies.

The focus on GDP growth when analyzing general economic conditions relies on economic activity being considered by the International Energy Agency (IEA 2011a) as the factor of major influence over natural gas demand in countries in which its use is established.

Investment in gas infrastructure has an impact on the international experience. Investors study "trends or patterns that influence perceptions and affect the political will to create a sustainable (and effective) regulatory system. Executives consider the benefits and costs of projects in various countries or jurisdictions" (Berg 2001:8). Competitiveness reports assist investors assessing risks and returns in an increasingly interconnected global gas market. As part of the national experience, maritime ports and road infrastructure facilitate investment in gas infrastructure.

Discretionary behavior by governments (ie expropriation) can severely damage performance in transmission pipelines and LNG plants, which involve high-sunk costs and are sensitive to policy and regulatory changes. Therefore, stable regulatory, energy and energy tax policies are expected to encourage investment.

An independent judiciary is expected to have an impact on attracting investment, on regulatory agency independence - by diffusion of autonomy in a context of increasing government interdependency (Meseguer & Gilardi 2008, 2009) - and on shaping a competitive national experience.

Araujo et al (2011:22) identified the factors influencing investment in infrastructure in OECD countries and found that "the provision of infrastructure when accompanied by a supporting regulatory environment can boost investment".

4.3 Industry Conditions

The gas transmission network increased in Sweden from 478km in 2004 to 620km in 2010 (IEA 2004; EI 2011). With access to only 30 municipalities and without access to Stockholm, historically only a few vertically-integrated actors have participated in the Swedish natural gas market (EI 2011). In the municipalities that have access to natural gas

it represents approximately 20 percent of all energy consumption, which is similar to the European Union average (Hernández Ibarzábal 2009; EI 2011).

Natural gas use increased in Sweden from 7.9 terawatt hours (TWh) in 2000 to 12.7 TWh in 2009 and to 17.6 TWh in 2010 (SEA 2011a:5). This surge was related to the opening in 2009 of a gas-fired cogeneration plant owned by E.ON in Malmö that represented a $300 million (EUR) investment (COSPP 2009; EI 2011). Gas consumption is expected to keep rising due to the construction in Gothenburg of two gasification plants for biofuels (the first was finalized in 2012 and the second will deliver gas starting in 2016) and a LNG terminal in Gothenburg (expected to start operations in 2015 (Port of Gothenburg 2015)) to supply the vessels in transit and with the capacity to supply local consumers (EI 2011, 2012).

In 2009, Sweden authorized the construction of the Nord Stream (2014) twin pipelines in its territorial sea, which connect the Russian gas reserves to Europe through the Baltic Sea. This project is part of the integration of the European Union energy market.[ii] Sweden permitted its construction and decided not to connect to these pipelines (EI 2011). This stand reflects to some extent Sweden's approach to the European Union "aims to fully integrate national energy gas markets by 2014" (EC 2014).

In 2008, Shell secured exploration permits and later decided not to proceed with this project. In 2010, Gripen Gas initially secured five exploration licenses (EIA 2011), and for August 2014 had secured 27 licenses (Gripen Gas 2014). Shale gas projects have encountered anti-fracking activism and political resistance from the centre-right coalition of Prime Minister Fredrik Reinfeldt (re-elected in 2010), and from the opposition alliance of the Left Party, Greens and Social Democrats. The latter declared in 2010 that "a red-green government will not engage in large-scale fossil fuel extraction in Sweden" (Natural Gas Europe 2010).

Until the end of 2009, Swedegas owned the trunkline for the gas transmission network and E.ON Gas Sverige owned the branches. In December 2009, EQT acquired Swedegas through its infrastructure fund and in July 2011 bought the rest of the transmission network (PEI 2011). EQT Infrastructure currently owns and operates the entire gas transmission network.

Infrastructure funds are also investing in Australia in gas transmission pipelines. ANZ Infrastructure Services, a private sector entity, and Victoria Funds Management Corporation acquired lengthy and unregulated transmission pipelines (AER 2011:91; Hernández Ibarzábal 2012). Victoria Funds Management Corporation (VFMC 2014a, 2014b) is a body corporate and public authority owned by the Victorian government and ruled by a board of independent directors that invests in infrastructure and other equities and ventures. The increasing presence of financial entities investing in gas infrastructure reinforces cataloguing this type of investment as financial.

Temasek Holdings (Singapore government sovereign wealth fund with assets valued in $177 billion (USD) (SWFI 2014) secured a semi-monopoly position as owner and operator of the Australian transmission network during the 2000-10 period (AER 2011; Hernández Ibarzábal 2011, 2012). State-owned Asian companies are partners in some of the biggest unconventional gas projects approved to date (ie Sinopec in Australia Pacific LNG, and Kogas and Petronas in Santos GLNG), which reinforces the scale characteristics of this economy.

An unexpected outcome of investment in infrastructure in Australia was an increase in gas prices due to the linkage of the domestic to the international market (Hernández Ibarzábal 2011). The other costs could be environmental. Hydraulic fracturing could have "serious hazards, including the potential for air pollution and for contamination of surface and groundwater" (IEA 2012:9) for the local communities. The process has generated considerable political opposition in rural communities.

The regulatory reforms implemented in Sweden and Australia have had limited impact on fostering competition in the transmission network. Sweden's return to joint ownership and management by EQT Infrastructure and Temasek Holding's semi-monopoly position as operator and owner in Australia confirm so. The changing ownership in both countries has accentuated the financial and scale characteristics of investment in gas infrastructure.

In Sweden, Shell's decision not to go ahead with a shale gas project and the latter granting of licenses to Gripen Gas is part of an international experience in which investors asses "risk on the basis of historical experience and expectations regarding the future" (Berg

2001:8). Even though this experience pertains to the upstream sector (ie exploration), it set a precedent for investment in unconventional gas projects.

4.4 Input Markets

Sweden in 2009 had the ninth biggest installed capacity of nuclear electricity (IEA 2011b:17) and was in 2007 the OECD country with the second lowest emissions (per capita tonnes of carbon dioxide). Emissions in this country decreased 12.4 percent during the period 2007-1990; in contrast, Australia's emissions grew by 52.5 percent in the same period and were the third highest emissions per capita in the OECD in 2007 (SEA 2010a:7). Australia has no nuclear facilities producing electricity, although it is a major uranium producer and hosts extensive uranium resources (655, 840 petajoules in 2010 (DRET 2011:4)).

Sweden hosts a total 41 trillion cubic feet (Tcf) of technically recoverable shale gas resources and "164 Tcf of risked shale gas in-place" (EIA 2011:221), and has not yet produced shale gas. Fossil fuel reserves are abundant in Australia;[iii] natural gas reserves increased 63.5 percent from 2000-10 (82,240 petajoules to 134,504 petajoules, respectively (ABS 2014). The increase of the resource base was particularly important in attracting investment in gas infrastructure in the Australian case.

Natural gas use in Sweden increased in all sectors throughout the period of 2000-10; supply of natural gas in electricity production increased tenfold (SEA 2011a:18) and still represented only a fraction of the production from nuclear power. The latter provided 38 percent of the total electricity production in 2000 and in 2010 (SEA 2011a:17). Increasing demand in Sweden for gas in electricity production, district heating and gasworks and particularly for the production of "upgraded" biogas (natural gas mixed with biogas)[iv], fostered investment in infrastructure.

Electricity produced from natural gas sources in Australia increased 110 percent from 2000-09 (17.2 to 36.2 kilowatt hour billons, respectively), which was influenced by energy targets established by state governments. The Queensland government required 15 percent of all electricity supplied to the state grid to be generated by gas "by 2010 and 18 percent by 2020" (Geoscience Australia 2014). In 2008-2009, gas accounted for 15 percent and

black and brown coal amounted to 76.7 percent of total electricity generation in Australia (DRET 2011:21), which explains why nationwide the majority of the stationary energy emissions are produced by coal (DCCE 2011).

Australia's gas reserves will be pivotal supplying gas for electricity generation in South East Asia. The latter is expected to grow from 307 TWh to 523 TWh in the period 2011-2035, whereas electricity produced from coal is forecast to increase from 217 TWh to 914 TWh (IEA 2013:45), which raises the issue of reducing carbon dioxide emissions while ensuring energy supply.

Growing gas demand in Asia (IEA 2011a) is an exogenous factor favoring investment in infrastructure in Australia. According to the International Energy Agency (IEA 2011a), the new gas projects will position Australia as the second biggest LNG exporter in this decade and will change the geopolitical balance in the region.

The Queensland government's target was identified as an energy policy that influenced electricity produced from gas. The increase of the resource base and rising gas demand in Asia for electricity production were significant factors favoring investment in gas infrastructure in Australia. In Sweden, the resource base by itself was not significant enough for attracting investment, particularly due to the robust installed nuclear capacity and lack of political support. The rise in "upgraded" biogas production, accompanied by favorable energy tax policies, did have an impact on the rise of natural gas demand.

The Swedish case highlighted that following the discovery of large shale gas reserves governments are capable of deciding when and how to produce unconventional gas beyond industry expectations.

4.5 General Economic Conditions

As a result of the global financial crisis, approximately 21 percent of global investment budgets in upstream oil and gas were cut in 2009 compared to 2008, and 20 planned projects valued over $170 billion (USD) were deferred or cancelled (IEA 2009:3). For instance, the Skanled project that intended to build a pipeline that would have transported

gas from Norway to Denmark and Sweden was cancelled in 2009 due to a slower than expected market outlook (IEA 2009).

Worldwide, electricity production from natural gas increased 57.6 percent in 2000-08, and natural gas was the energy resource with the biggest increase in electricity production amongst oil, coal and coke, nuclear power and hydropower (SEA 2011a:40).

The global average elasticity GDP-increase in gas use in electricity production indicates that "each 1 percent increase in GDP led to a 1 percent increase in gas use in the power sector" (IEA 2011a:82). GDP growth from 2000-07 was steady in Australia and Sweden, and was impacted by the global financial crisis. Sweden had a negative real GDP growth in 2008 (-0.6 percent) that deepened in 2009 (-5.3 percent) and bounced back in 2010 (6.6 percent) (OECD 2014b). Australia's real GDP growth in 2008 was 1.7 percent, 2.0 percent in 2009 and 2.2 percent in 2010 (OECD 2013a). The soundness of the banking system and the government response to the global financial crisis allowed Australia to struggle less than other advanced economies (Wettenhall 2011). On the other hand, Sweden was identified in 2007-2009 as a borderline case of systemic banking crisis (IMF 2010:144).

The worldwide average elasticity GDP-increase in gas use in electricity production (IEA 2011a) was surpassed in Australia and Sweden in the period 2000-10. Whereas the global financial crisis impacted upon both economies, other conditions pushed for a rise in demand for gas for electricity production.

GDP growth in Australia in the period 2000-10 coincided with more electricity produced from natural gas sources and with the finding of gas reserves. The latter could have also influenced the rise of electricity produced from gas. In Sweden, the cancellation of the Skanled project occurred after the global financial crisis due to weaker than estimated market conditions, which highlighted the impact of GDP growth on electricity produced from gas. Still, the overall GDP growth in 2000-2010 occurred simultaneously with higher use of gas for electricity generation.

4.6 National and International Experience

Australia and Sweden were regarded as highly competitive and business friendly during the period 2000-10, which favored investment in gas infrastructure. On a scale of one to ten strength of investor protection in Sweden varied from 4.3 in 2005, 5.6 from 2006 to 2009 and 6.3 in 2010, whereas in Australia averaged 5.6 from 2005 to 2010 (World Data Bank 2014). Economic competitiveness in Australia decreased in the Global Competitiveness Report from ninth in 2001 (Schwab (ed) 2001:2) to sixteenth in 2010 (Schwab (ed) 2010:84), whereas Swedish economic competitiveness improved from fourth in 2001 to second in 2010 (idem).

Australia, as exporter and consumer of natural gas, and Sweden, as importer with increasing consumer demand, required ports capable of boosting investment in gas infrastructure (i.e. LNG plants) and roads in good conditions for the maintenance and building of transmission networks and for the transit of the gas tanker fleet. Likewise, road infrastructure is relevant in the production of unconventional gas due to intensive transportation of water, chemicals and sand.

Investment in road infrastructure in Australia almost tripled during 2000-10 and investment in maritime ports infrastructure increased 1695 percent (ITF 2014). Meanwhile, the value of coal exports grew 274.4 percent ("rose from $12.5 billion (AUSD) in 2001 to $46.8 billion (AUSD) in 2011" (DFAT 2012:1)). Black coal is found in New South Wales and Queensland (56 and 40 percent, respectively (Geoscience Australia & ABARE 2010:131)), where coal seam gas reserves are also located. Thus, improvements in road and ports infrastructure are expected to have a favorable impact on coal seam gas production.

Sweden's investment in maritime ports and road infrastructure almost doubled from 2000-10 (Schwab (ed) 2010:311). These conditions will facilitate the projects planned for Malmö and Gothenburg and future gas projects. Investment in gas infrastructure in Sweden, and particularly in Australia, was bolstered by investment in maritime ports and road infrastructure. Besides, unconventional gas projects usually attract investment in maritime ports and road infrastructure. This evidences the two-way link in the model (see figure 1) between the national experience and investment in gas infrastructure.

4.7 Institutional Conditions

From 2007 to 2009, Sweden averaged 0.77 and Australia 0.87 in POLCON (Henisz 2010), and from 1946 to 2010 both were considered fully institutionalized democracies in the Polity Index (Cole & Marshall 2011:8).

Judicial independence protects investment in gas infrastructure against expropriation risks and can reverse regulatory decisions. The High Court of Australia can nullify regulatory decisions and rule them invalid. Judicial independence has been tested in recent times in Australia by controversies surrounding gas projects in land owned by traditional indigenous owners. For example, "the WA Supreme Court ruled invalid on December 2011 the notices of intention issued by the WA Lands Minister to take control of the land of the gas site" (Hernández Ibarzábal 2012:85). This decision put on hold Woodside's Browse LNG Development, which was expected to generate $7.5 billion (AUSD) in taxation revenue and $50 billion (AUSD) in GDP to the economy (Woodside Energy 2012).

The Global Competitiveness Report ranked eighth Australia's judicial independence in 2008 (Schwab (ed) 2008:93), fifth in 2009 (Schwab (ed) 2009:75) and ninth in 2010 (Schwab (ed) 2010:85). Sweden's judicial independence ranked third in 2008 (Schwab (ed) 2008:311) and second in 2009 and 2010 (Schwab (ed) 2009:291; Schwab (ed) 2010:311, respectively).

Pargal (2003:3) hypothesized that independent agencies play a significant role in minimizing expropriation risks and that this is a very important element of private investment. Instead, the study in practice of independent regulatory agencies in the natural gas sector suggests that the judiciary is better equipped – and is within its capacities – to deal with, or act as deterrent of, expropriation attempts. Therefore, judicial independence has in practice a higher impact than the establishment of autonomous agencies on diminishing expropriation risks as ultimate institutional guarantor at a national level.

This finding remains sceptical about the capacity in practice of independent regulatory agencies to thwart expropriation and suggests that an independent judiciary plays a critical role in determining the volume of investment flows. Founding an autonomous agency

within an institutional environment characterized by solid judicial independence may be beneficial for investment though.

At an international level, the Energy Charter Treaty and the International Centre for Settlement of Investment Disputes can solve disputes related to investment in gas projects, and its adherence provides additional guarantees to investors in gas infrastructure. Australia and Sweden are signatories of the Energy Charter Treaty (2014) and of the International Centre for Settlement of Investment Disputes (2014) and to date neither have acted as respondent in any proceeding in these institutions.

In the cases studied, the history in the Energy Charter Treaty and the International Centre for Settlement of Investment Disputes, along with high ranked judicial independence, impacted favorably on investment in gas infrastructure.

The presence of an independent judiciary in Sweden and Australia could have impacted agency independence following a process of diffusion of autonomy. The inclusion of judicial independence by the Global Competitiveness Report illustrates the link in the model (see figure 1) between institutional conditions and international experience.

4.8 Regulatory Governance

The establishment of independent regulatory agencies is a mechanism against discretionary government decisions and economic and political interference in the regulatory process. Nevertheless, every country requires energy supply in order to "keep walking" and governments are often tempted or arguably "forced" – alleging in some cases national security reasons or market failures – to intervene in gas regulatory processes and trade. Telecommunications, water and electricity are also basic for the daily operation of most countries the difference though with natural gas relies on the current globalization of its market. Rising global demand for gas, particularly for liquefied natural gas, and the surge of geopolitical and financial power of actors investing in a sector that frequently holds investments in oil and electricity has amplified their resources, capacity to capture regulatory agencies (Bernstein 1955; Laffont & Tirole 1993; Stigler 1971) and influence over government decision-making (Becker 1983). The incursion of sovereign wealth funds

and infrastructure funds investing in gas infrastructure has also increased the influence of investors over government and regulatory agencies.

The Worldwide Governance Indicator reports on six combined regulatory quality indicators on an index 0 (low) to 1 (high) in which Australia scored 0.96 in 2000, 0.90 in 2002 and 0.98 in 2008 and 2009 (Kaufmann (ed) 2012a), and Sweden scored 0.90 in 2000, 0.96 in 2003 and 2004, 0.92 in 2006 and 0.97 in 2009 (Kaufmann (ed) 2012b). In synthesis, both countries had solid regulatory governance.

The Australian Energy Regulator (AER), which is part of the Australian Competition and Consumer Commission, is responsible for the independent economic regulation of all "covered" transmission pipelines since 2008. "Uncovered" (unregulated) pipelines "are not subjected to access determinations or arrangements in regard to the terms and conditions by the AER" (Hernández Ibarzábal 2012:95), and most of the transmission network was unregulated in 2011 (AER 2011:90-91).[v] International pipelines "can apply for a 15-year no-coverage determination before the pipeline is commissioned" and "have the option of applying for a 15-year price regulation exemption before the pipeline is commissioned" (AER 2009:7).

The Energy Market Inspectorate, the Swedish agency responsible for the regulation of the gas network (EI 2005), was created as part of the Swedish Energy Agency in 2005 and is subordinated to the Ministry of Enterprise, Energy and Communications. The main responsibilities for the Energy Market Inspectorate are supervising and approving network costs and regulatory policy under the Natural Gas Act and Pipelines Act (EI 2011).[vi]

Sweden's regulatory regime followed closely the European Union guidelines during the 2000-10 period,[vii] which constituted an exogenous factor fostering competition and gas infrastructure penetration towards the "full integration of the internal energy market" (EC 2011:2). The European Commission directives are binding and have "been followed by governmental Bills to Parliament and reflected in new Natural Gas Acts" (Hernández Ibarzábal 2009:13).

In 2005, the Natural Gas Act introduced further liberalization in the natural gas market and since then all companies (non-household customers) can choose their gas provider (EI

2005:5). From 2007, all private customers can also choose their gas supplier (EC 2008:346). The 2007 Natural Gas Act required unbundling ("separation and transport and sales of the gas and can operate at various levels" (SEA 2008:102)), from which distributors "serving less than 100,000 connected customers" (Johansson & Wilkens 2010:129) are exempted. The Swedish gas market comprised in 2010 only approximately 48,000 customers (idem), thus the gas transmission network is deregulated and vertically integrated.

Regulatory governance in Sweden and Australia conditioned regulatory policies, as the link in the model (see figure 1) shows. Good regulatory governance in both countries impacted positively on the international experience (competitiveness), which is relevant considering that "if suppliers of financial capital believe that the regulatory process will yield symmetric treatment, funds will be available at a lower cost" (Berg 2001:10). The European Union (international experience) played a relevant part in influencing Sweden's regulatory regime and regulatory policies.

Whereas Australia and Sweden had solid gas regulatory governance and the creation of paramount regulatory agencies coincided with higher investment in the sector, in practice both transmission networks were mostly deregulated.

4.9 Regulatory, Energy and Energy Tax Policies

The most important energy decision in Sweden since 2000 was decommissioning, or not, the nuclear terminals and defining the source that would fill that energy gap. This decision could have reversed energy and energy tax policies focused on lowering the use of fossil fuels and dependence on oil since the 1970's. This path dependence ("a social process grounded in a dynamic of "increasing returns" (Pierson 2000:251)) was not interrupted. In 2010, the Swedish Parliament approved to repeal the Act (1997:1320) to phasing out nuclear power production, lifted the ban on the Act (1984:3) towards construction of new terminals and opened the scope for the construction of ten new reactors to replace existing reactors (SEA 2010b:11).

This parliamentary decision is consistent with the policy of energy supply security. The Swedish government can control all aspects of nuclear power production whereas all gas used is imported from Denmark. Therefore, natural gas supply depends on a third country,

particularly after the government banned massive production of shale gas reserves. Danish gas reserves may have already peaked and due to the cancelation of the Skanled pipeline the other natural gas supply option for Sweden is to get connected to the Russian reserves through the Nord Stream pipelines and to a new geopolitical interaction.

The Swedish energy policies have been stable since the seventies and have created increasing returns (Arthur 1994; Mahoney 2000; Pierson 2000) towards security of energy supply and the use of nuclear energy, biofuels and renewable energy (Hernández Ibarzábal 2009). These policies successfully targeted reducing dependence on oil and carbon dioxide emissions. During the period 2000-10, supply of biofuels and peat increased from 91 TWh in 2000 to 141 TWh in 2010, wind power increased 600 percent and supply of natural gas and gasworks augmented 122.8 percent (SEA 2011a:5). Whereas in 1972 biofuels – peat - supplied 40 TWh, nuclear energy supplied 4 TWh and crude oil and products supplied 332 TWh, in 2010 biofuels – peat - supplied 141 TWh, nuclear energy supplied 166 TWh and crude oil and products supplied 187 TWh (idem). This transition can only be understood considering the energy policies implemented in Sweden.

High carbon dioxide emissions taxation accompanied by an energy policy for sustainable development has resulted in Sweden occupying in 2010 the first place of the OECD in the Climate Change Performance Index and in an integral approach to energy that prioritizes human health, conservation of diversity and recovery of ecosystems (SEA 2010b:136).

In Australia, energy and energy tax policies were reshuffled in the 2000-10 period after a major election and a prime minister challenge. In 2006, former Prime Minister John Howard initiated a debate about establishing nuclear plants in Australia. This proposal had minor popular support and when Kevin Rudd was named leader of the Labor Party in December 2006, he rallied against nuclear energy production (Macintosh 2007). This debate continued into the 2007 federal election, when John Howard was replaced by Kevin Rudd as prime minister after four consecutive terms. This result thwarted the nuclear prospects and changed energy policy.

Once elected prime minister, Kevin Rudd proposed a tax scheme in which each ton of carbon would pay $20 (AUSD) to $40 (AUSD). The main opposition to these policies came from the industry, which started a fierce media campaign in alliance with other

political parties that ended with a successful leadership challenge from Julia Gillard in 2010 (Hernández Ibarzábal 2011, 2012). Some of the most relevant energy and energy tax policies proposed in the Rudd era entered an impasse and were eventually abandoned.

Contrary to the findings of Henisz (2000, 2002, 2004), policy change in energy and energy tax policies did not translate into less investment in natural gas infrastructure in Australia. The concessions to international pipelines, rising Asian gas demand, stable regulatory policies, solid regulatory governance and the large resource base impacted favorably on attracting investment. More recently though, changing state regulatory and energy policies have had an impact on coal seam gas projects; in 2013, major companies (i.e. Metgasco, Arrow Energy and AGL) retrieved their planned investments for New South Wales.

Regulatory and energy policies in Sweden were led by European Union directives, but the latter did not change the path-dependence of energy tax policies concentrated on lowering the use of fossil fuels and ensuring energy security. Thus, change in energy and energy tax policy, electricity produced from gas and investment in infrastructure was limited in the Nordic country. Whereas in Australia the industry (industry conditions in the model (see figure 1)) was able to influence energy tax policies, in the Swedish experience it could not.

4.10 Conclusions and Overview of the Relevance of the Findings for Asia

Analyzing the impact of regulatory and energy policies on investment in gas infrastructure in Australia and Sweden contributed "to the transition of the empirical macro-political economy literature from macro-macro (using existing political science measures to predict national variation in macroeconomic outcomes) to micro-micro" (Henisz 2000:20).

In Australia and Sweden regulatory governance was solid and transmission pipelines were predominantly deregulated in practice, which coincided with higher investment in gas infrastructure. Investors may have been interested in a deregulated sector under solid regulatory governance and institutional conditions.

Path dependence proved useful in explaining energy and energy tax policies. In Australia, a major election and a leadership contest were crucial for the transition towards leaving a

certain path of energy and energy tax policies, and the large resource base had a significant impact on attracting large investment in gas infrastructure. In this case, "political struggle and conflict between aggregate groups" (Mahoney 2001:136) resulted in a new energy regime. On the contrary, the discovery of shale gas reserves in Sweden was not accompanied by political change or struggle and did not lead to massive investment in the sector. The latter case undermined the explanatory power of the resource base to attract investment under energy and energy tax policies that for decades promoted energy security and lowering the use of fossil fuels generating increasing returns.

Both cases experienced the return to joint ownership and operation of the gas transmission network, which overall reinforced its scale characteristics. The changing ownership of gas investment also increased the capacity of the stakeholders to capture regulatory agencies.

A conclusion that needs further research is that an independent judiciary is better equipped to deal with discretionary government behaviour (ie expropriation) than independent regulatory agencies. Therefore, the former could be considered a more relevant determining factor in attracting investment in gas infrastructure flows than the latter.

Whereas much attention has been drawn upon regulatory governance and regulatory policies, the qualitative relevance of energy and energy tax policies and judicial independence in the multidimensional process surrounding investment in gas infrastructure was highlighted throughout the article. The significance of energy tax policies is consistent with conclusions from Henisz (2000, 2002, 2004) and with the global diffusion of emissions trading schemes.

Advancing investment in gas infrastructure modelling represents a solid contribution to the literature of private investment in infrastructure. The model tested in this article could be generalized to other countries and infrastructures accompanied by sector-specific configurations.

The relevance of the findings for Asia are: 1) The state-backed Asian companies investing in LNG plants and the transmission network in Australia are operating within the context of strong regulatory framework and an independent judiciary. Higher stability of energy and energy tax policies would definitely provide more certainty to investors; 2) Australia is

becoming a major LNG supplier in Asia and more regional cooperation and expertise creation is needed in developing the gas sector; 3) Southeast Asia will experience higher gas production over 2011-2035, mainly from Indonesia, Malaysia and Myanmar, and will need to attract approximately $460 billion (USD) of financial investment to support gas projects (IEA 2013:63). The findings in investment in gas infrastructure are therefore relevant for this region. Moreover, Vietnam and Thailand plan to produce electricity from nuclear power after 2020 (idem). The Swedish experience, balancing energy security and the use of natural gas, renewable energy and nuclear energy in electricity generation, is particularly relevant for these countries.

NOTES

i An earlier version of this model has been previously tested in Australia as part of a PhD research program (see Hernández Ibarzábal 2012). I acknowledge the valuable contributions of the thesis supervisor, Emeritus Professor Roger Wettenhall AM, to this model.

ii A security report concluded that Nord Stream will increase Russia's leverage over various European countries and "cannot be seen as a common European project as the project goes against the priorities of several EU members" (Larsson 2007:6).

iii Australia is "the fourth largest producer, the largest exporter, and has the fourth largest reserves of coal in the world" (Geoscience Australia & ABARE 2010:131).

iv Tax exemptions to biogas in aviation fuels from 2008 and a tax exemption that will follow the gas all the way to the end user adopted in 2011 (SEA 2011b:27) favour the use of biogas.

v Other institutions part of the regulatory regime are the Australian Energy Market Operator (since 2009 operator of the Australian Energy Market and the "retail and wholesale gas markets in South-East Australia, and the Victorian gas declared transmission system" (AEMO, 2014)) and the Australian Energy Market Commission (independent body established in 2005, is responsible for the rule making of the natural gas market (AEMC 2014)).

vi Another institution part of the regulatory governance is the Swedish Energy Agency, which is responsible for national energy policy issues (SEA 2011b).

vii See Knill and Lehmkuhl (2002) for an analysis of the adaptation mechanisms of European Union guidelines within the national regulatory policies.

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5. SUMMARY OF THE RESULTS, DISCUSSION AND GLOBAL CONCLUSIONS

5.1 Summary of the Results and Discussion

The three articles form together the study of financial investment in natural gas infrastructure (FINGI) in constant evolution. The three articles presented hereto showcase the evolution in the study of FINGI which translated into continuous generation of knowledge.

The picture shown by these three articles depicts an underexplored, fast-changing and relevant explandum embedded within the interaction of multiple factors that requires a multidisciplinary approach. There is common agreement that regulation is a factor that determines to some extent investment in utilities infrastructure and recently the models from international agencies have cited regulation as relevant factor attracting FINGI. However how this happens in the natural gas sector is still unexplored and this thesis advanced in generating knowledge in this direction.

This thesis has demonstrated how regulatory, energy and energy tax policies impact upon ownership of gas infrastructure, electricity produced from gas, the national and international experience (ie competitiveness) and directly upon FINGI, and how policies are conditioned by regulatory governance, in which agency independence is one of its main elements.

The model that was tested in the third article is a key contribution towards the study of FINGI because it could be used in the study of other countries and infrastructures. This thesis was kindly examined by Prof Lykke Margot Ricard, and in her view this model is "a key contribution showing that many explanatory factors shape the capacity to attract investment in regional and national natural gas infrastructure".

This thesis highlighted the formal and informal mechanisms that government and industry have to influence the regulatory governance and regulatory and energy policies. Some level of influence in the crafting of regulatory policies may be recommendable nonetheless excessive influence can easily translate into discretional behaviour that damages the credibility of regulators which could be detrimental for investment.

At an informal level, political will was identified as a mechanism used by the governments to favour their choice of energy. Studying political will in practice can be challenging however its influence is consistent with the responsibility of governments to secure energy supply. The study of the influence of political will on energy and regulatory policies pinpoints an issue that requires further study.

In Sweden, the interviews demonstrated that communitarian regulatory and energy policies were introduced as a symbolic way to formally comply with the EC directives. The institutions that form the regulatory governance have limited functions in the natural gas sector in practice. Transectorial diffusion of policies (Jordana and Levi-Faur 2005, Meseguer and Gilardi 2008, 2009), especially across Scandinavia and more recently across the EU, was a major theoretical explanation for the historical development of energy policies in Sweden.

The Swedish case brought attention to the explanatory relevance of path dependence in a context of solid institutional conditions over the explanatory power of the reserve base. An ample resource base is generally needed to attract substantial FINGI. The Swedish case proved that the sole existence of unconventional gas reserves does not necessarily translates into its massive production which underlined the relevance of energy policies and the explanatory power of path dependence. In Australia the discovery of unconventional gas reserves triggered large massive investment in FINGI and in Mexico its massive production is on the table as a means to supply the increasing demand of gas.

The Swedish case demonstrated that a limited gas use in electricity production does not favour FINGI. It also proved relevant including natural gas use in electricity production as part of the input markets. This allows the governments to influence this specific category of input markets (natural gas use in electricity production). Whereas otherwise the only influence on the resource base the governments had is the expedition of exploration

licenses. In other utilities (ie telecommunications and electricity) governments have a higher capacity to influence infrastructure deployment. However, in natural gas the reserves are a relevant conditioning factor of the investment flows.

This research identified an ongoing worldwide diffusion process of emissions taxation and emissions trading schemes. Emissions taxation was also identified as having increasing impact over FINGI, and these mechanisms could be used by the governments to favour a specific source of energy.

This thesis demonstrated that natural gas regulation has characteristics of its own and advanced in the understanding of the FINGI process. It also provided an integral comprehension of investors in natural gas as risk averting entities. Regulatory and liberalisation reforms allowed financial investment in the sector and separated ownership and management in Sweden and Australia. The current tendency though is to have joint ownership and management in the transmission sector and increasingly state-backed and state-owned entities investing in this sector, which reinforced its scale characteristics.

The analysis of Australia under the GFC showed the significance of having a solid banking system (Hernández Ibarzábal 2011, 2012, 2015), which allowed this country to keep financing gas projects under economic pressure. Conversely, the banking system in Sweden was catalogued as a borderline crisis case in 2007-2009 and the recovery from the GFC was not as good. This finding pinpoints good banking regulation, which acts as a guarantee for investors in tough economic times, as a favourable factor for attracting FINGI.

Another FINGI trend identified was the presence of "traditional" financial entities investing in the three cases analysed. This trend further justified the characterisation of this type of investment as 'financial'. To the author's knowledge the identification of investment in utilities' infrastructure as 'financial' was first proposed in Hernández Ibarzábal (2011), and this is a major contribution to the regulatory governance and investment in utilities' infrastructure literature.

The empirical data gathered is relevant and identified some non-patterns in the case comparison (third article). For example, in Sweden the increasing biogas use is aligned with energy policies that foster renewable energies and energy sufficiency. Whereas in Australia

the development of gas projects in traditionally-owned land posed challenges to judiciary independence and impacted on the national and international experience. The identification of non-patterns contributed towards an integral understanding of the conditions surrounding the FINGI process.

This thesis emphasised the exogenous factors influencing regulatory governance, energy, energy tax and regulatory policies and industry conditions. In the development of a global gas market the influence of the international environment on (national) regulatory governance is increasing, and options for international regulatory governance were proposed in the Mexican case. The latter highlighted the increasing interactions with the U.S. by means of imports of natural gas and by U.S.-based investors participating in gas infrastructure projects in Mexico which highlighted the absence of formal, accountable and transparent mechanisms of collaboration.

The Mexican case also emphasized the relevance of the implementation of the reforms over its promulgation and confirmed the impact of competitiveness, as part of the national experience, in attracting investment in natural gas infrastructure. Competitiveness also proved relevant in the study of the Swedish and Australian cases.

Finally, the thesis identified the influence of investment in infrastructure in roads and maritime ports on the explanandum. Investment in roads infrastructure is particularly relevant for unconventional gas projects whereas investment in maritime ports infrastructure is for LNG projects.

5.2 Global Conclusions

In the three cases analysed the creation of paramount regulatory agencies coincided with higher FINGI. In Sweden and Australia regulatory governance, national experience, industry conditions and the general economic conditions were solid, and investors chose to invest in a sector that is mostly deregulated in practice. Thus, it is possible that investors may have found attractive investing in a deregulated sector, and this is a primary finding of this thesis.

In Mexico the surge in FINGI started after a series of liberalization reforms that preceded the 2014 energy reform. This increase was mostly triggered by market dynamics and by policies implemented by state-owned companies. The market conditions were higher demand for gas in electricity, oil and industrial production and low natural gas prices in the U.S. The policies implemented were the public tender of long-term projects to transport gas for electricity and oil production. The 2014 reform reshuffled the governance system which included the transfer of public pipelines to a newly created independent system operator. This ended the historical ownership and operation of pipelines of Pemex, the state-owned company, since the 1940's and its position as a dominant incumbent.

Security of supply was an energy policy relevant in the three case studies. In the Swedish case the option was to rely on nuclear energy or in natural gas for electricity production. Sweden has control over nuclear production and has historically implemented the policy not to depend on foreign sources of energy, such as (imported) natural gas. Australia chose to rely on its fossil fuels, particularly coal and natural gas, and initially fostered the massive production of unconventional gas. Mexico hosts some of the largest unconventional gas reserves in the world and its 2014 reform opened the door for private investment in exploration and production of gas. The massive production of the Mexican unconventional gas reserves is an option to secure the natural gas supply for the increasing demand, however this would pose unprecedented governability challenges. The other option is to rely on supply from the U.S. and increase its dependence, which would diminish the capacity of the governance system to secure supply.

There are serious concerns for the environmental consequences of the production of unconventional gas using fracking. This production requires strict environmental regulations and specialised regulatory governance in order to prevent pollution of aquifers and the atmosphere which has significant repercussion on many people's lives. Natural gas is mostly composed of methane and around 3.6 percent to 7.9 percent "of the methane from shale-gas production escapes to the atmosphere in venting and leaks over the lifetime of a well" (Howarth et al. 2011:1). Regulatory policies need to reduce venting in natural gas production, particularly in the production of unconventional gas. However the economics of capturing gas are not favourable considering the current low prices of gas. The environmental impact of unconventional gas production is an area of potential conflict amongst hosting communities, regulators and producers. The main challenges for agencies

regulating natural gas are securing environmental efficiency and best practice in order to make production sustainable and securing an economically efficient supply in a global market of gas. These findings were highlighted throughout this thesis and more research in this direction will be developed in the years to come.

The establishment of IRA's in Sweden, Mexico and Australia could have improved credibility towards investors in FINGI which is coherent with the rational choice postulates. Alternatively, the sociological institutionalism would account for the establishment of IRA's due to its symbolic characteristics, because IRA's are meant to be the correct type of regulator, or as a way to allow further liberalisation (Gilardi 2005). Consistent with this explanation, the main objective of the reforms in the natural gas transmission pipelines in Mexico since 1995 has been its liberalization.

The development of energy policies was better explained by path dependence theory, and in Australia a major election was a contingent event (Mahoney 2000) towards leaving a certain path of policies. The explanatory power of path dependence was reinforced after the discovery of shale gas reserves in Sweden did not lead to its immediate production.

In the Mexican case, the signature of NAFTA in 1994 created increasing returns towards more imports from the U.S. and since then 15 times more gas has been exported. In addition each Mexican president since 1995, with one exception, has put forward reforms that have liberalized gas transportation. These dynamics created increasing returns that attracted investment and prepared the sector for the 2014 energy reform. Both dynamics are consistent with the embracement of neoliberalism by the federal government since 1982. This economic model has been strictly followed since then and has had a deep impact on latter events (Mahoney 2001:1) creating path-dependence processes. Thus, the relevance of historical institutionalism was also highlighted in the Mexican case.

Henisz (2000) concluded that an environment of discretional change in the regulatory, economic and fiscal policies could have adverse effects on private investment in infrastructure and the thesis showed that this argument is applicable to FINGI. Policy stability (Henisz 2000, 2002, 2004, Henisz and Zelner 2001) proved to be significant for attracting FINGI in practice. Building on Henisz (2000), energy tax policies were identified in this thesis as having a direct impact on FINGI.

This thesis highlighted the relevance of energy policies, regulatory governance and judicial independence in attracting FINGI. Whereas in recent years much attention has been drawn upon regulatory governance there seems to be other factors with relevant capabilities determining investment flows in natural gas infrastructure. The second (Mexican case) and third (Sweden-Australia comparison) articles demonstrated that an independent judiciary is a relevant factor in attracting FINGI because it is within its functions to impede discretionary behaviour. Thus, judicial independence may be a more relevant factor than the creation of IRA's in determining FINGI flows. This discovery draws special attention to the need for a multidisciplinary approach when studying regulation and investment in utilities' infrastructure.

The interactive governance theory provided a methodology for the Mexican case study that has been tested in other areas and focused the research on the interactions surrounding governability of natural gas infrastructure. The qualities of governability were defined by the dynamics, scale, diversity and complexity of each of the systems analysed. The social sub-system of the system to be governed was composed by the users, stakeholders and investors in the natural gas infrastructure network whereas the governance system included independent regulators and operators, a security agency, a Secretariat of State and the Presidency of the Republic. In this article variables that proved relevant in previous studies of FINGI (Hernández Ibarzábal 2009, 2011, 2012, 2015) were analysed using a different methodology.

The findings of this thesis created knowledge about the explanandum and represent a solid contribution to the literature of investment in natural gas infrastructure, regulation of natural gas, governability of transmission pipelines and natural gas policy. These areas are attracting increasing scholarly attention.

This thesis highlighted that investment in natural gas infrastructure has specific explanatory variables and mechanisms, and that transmission pipelines are inherently difficult to govern. In the quest to finding these variables and mechanisms a model that could be generalized to other infrastructures and countries was created and tested. The analysis presented in this thesis, as mentioned in the third article (Hernández Ibarzábal 2015:11), contributed "to the transition of the empirical macro-political economy literature from

macro-macro (using existing political science measures to predict national variation in macroeconomic outcomes) to micro-micro" (Henisz 2000:20). The micro-micro approach was qualitative, case by case study or comparison of two cases. This approach allowed developing an integral study of FINGI and generating knowledge about this fast-changing and relevant explanandum.

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